

Advice to decision maker on coal mining project

IESC 2014-045: New Acland Coal Mine Stage 3 (EPBC 2007/3423) – Expansion

Requesting agency	The Australian Government Department of the Environment and the Queensland Office of the Coordinator-General
Date of request	25 February 2014
Date request accepted	5 March 2014
Advice stage	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 New Acland Coal Mine Stage 3 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 to expand and extend by up to 12 years, the New Acland Coal Mine, located approximately 35 km northwest of Toowoomba in the Lagoon Creek Catchment in the Clarence-Moreton Basin of Queensland. The proposed project involves creation of three open cut pits to increase production of coal from the Walloon Coal Measures from 4.8 Mtpa to 7.5 Mtpa of thermal product coal. Ancillary infrastructure developments would include upgrading the existing coal handling and preparation plant (CHPP) and associated stockpile areas as well as construction of an 8 km rail spur and balloon loop, and a train load-out facility.

The proposed project is located in the Lagoon Creek catchment. Lagoon Creek is an ephemeral creek flowing only after periods of significant rainfall. Lagoon Creek flows into Oakey Creek, which is part of the larger Condamine River Catchment of the Murray Darling Basin. Vegetation within the proposed project's development area provides habitat for *Pteropus poliocephalus* (Grey-headed Flying-fox) and *Phascolarctos cinereus* (Koala), which are listed as 'vulnerable' under the *Environment Protection and Biodiversity Conservation Act 1999*. Three 'endangered' and five 'of concern' regional ecosystems listed under the Queensland *Vegetation Management Act 1999* are also located within the proposed project's development area.

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

The following data and information are needed for potential impacts arising from proposed project to be fully assessed:

- A comparison between observed and modelled potentiometric heads, presented in a series of maps, to enable better assessment of the reliability of the groundwater flow model;
- Measured flow data to improve confidence in the characterisation of Lagoon Creek's flow regime;
- Additional monitoring data, across a greater spatial and temporal extent, to more robustly characterise existing surface water quality in Lagoon Creek;
- Use of consistent salinity thresholds for discharges of mine-affected water to Lagoon Creek and inclusion of other key water quality indicators in the site water management system's release rules;
- Assessment of ecosystems associated with Oakey Creek and Myall Creek; and
- Identification and assessment of terrestrial groundwater dependent ecosystems within the predicted cone of depression.

Application of appropriate methodologies: key conclusions

Confidence in the predictive capacity of the numerical groundwater model is low due to the adopted boundary conditions, anisotropic hydraulic conductivity and recharge values, and the lack of sensitivity testing of the model to these parameters. The exclusion of other groundwater users within the model domain further limits confidence in the model's predictions. A revised groundwater study is needed to improve confidence in the conclusions of the assessment documentation and enable development of appropriate measures to monitor and manage uncertainties and risks to water-related assets.

Reasonable values and parameters in calculation: key conclusions

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

- Numerical groundwater model boundary conditions;
- The substantial differences between vertical and horizontal permeability values used in the numerical groundwater model;
- The application of a uniform percentage for recharge from rainfall for each time step in the numerical groundwater model; and
- Uncertainties in the mine water balance resulting from:
 - The thresholds used for discharges of mine-affected water, which do not adequately consider ambient water quality or flow; and
 - The assumed flow regime in Lagoon Creek, which is likely to over-estimate opportunities for discharges of mine-affected water.

The IESC recommends that the proponent develop any further project assessment documentation in line with its Information Guidelines¹.

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? What does the Committee consider are the features of a monitoring and management framework that would address these uncertainties and risks? In responding to this question, please consider the matters raised by the State and Commonwealth (Attachments B and C) as well as additional information contained in the RFA.

1. There are uncertainties and risks in the hydrogeological conceptualisation and numerical groundwater model relating to design and implementation, which impact on the reliability of model predictions. An updated hydrogeological study that considers the following matters would enable risks to water resources to be more accurately evaluated. Suggested enhancements to the proponent's Groundwater Monitoring and Impact Management Plan (GMIMP) are provided in the response to Question 3. However, until the IESC's concerns about the groundwater model are addressed it is difficult to determine the appropriateness of the management and mitigation measures.

Conceptualisation

- a. The absence of confining units of low hydraulic conductivity (with the exception of the Evergreen Formation) in the conceptual and numerical models will result in an unrealistic parameterisation of the hydrogeological regime. In particular, the low vertical hydraulic conductivities assigned to aquifers within the model will result in the underestimation of vertical drawdown propagation.

Model Documentation

- b. Several predicted drawdown maps are provided; however, the pre-development head patterns have not been presented. A qualitative comparison between observed and modelled potentiometric heads, in a series of maps, would enable better assessment of model reliability. Modelled heads in each layer need to be presented, across the entire model domain, and at intervals representing pre-mining, the proposed project's operational phase, immediately post-mining, and longer term, in order to evaluate the modelled spatial and temporal pattern of groundwater flow.
- c. Extension of the water balance to include predicted post-mining groundwater levels data would enable evaluation of long term risks. An indication of fluxes by aquifer is also needed.

Boundaries

- d. Constant head cells have been assigned along the northern, western, southern and part of the eastern margins of the model domain, which may result in unrealistic water budgets and laterally constrained drawdown within the model. Small variations in flow through these constant head boundaries may introduce large uncertainties in groundwater impact predictions.
- e. The setting of boundary conditions has relied on one potentiometric head map for the Walloon Coal Measures that is restricted to the vicinity of the proposed project. Confidence in the adopted boundary conditions could be improved by incorporating potentiometric head maps from other hydrostratigraphic units as this would help to identify groundwater flow features and provide justification for the selected model boundaries. The use of the Queensland Government's Office of Groundwater Impact Assessment (OGIA)² groundwater flow model would assist in determining the wider groundwater flow conditions.

- f. Confidence in the groundwater model's predictive capability would be improved by providing and justifying the numerical values assigned to the constant head cells along the northern, western, southern and eastern boundaries. These values, in particular the relationship between the constant head values adopted at the same location but for different layers, may have a strong influence on the flow fields and heads, and hence the model's performance, including its predictive capability.
- g. Choices for groundwater model boundaries should be described with respect to the spatial distribution of water entitlements and developments. The model excludes wells associated with other developments within the model domain; for example, the 9,000 ML/year groundwater entitlements that exist within 8 km of the proposed project. These developments are likely to invalidate the assumed boundary conditions, resulting in model constraints that produce inaccurate water budgets and model predictions.
- h. Modelling of recharge as a fixed percentage of rainfall is considered simplistic in a climate where evaporation exceeds rainfall for most of the year. As recharge is the largest inflow to the model, even small variations in recharge introduce large uncertainties in groundwater impact predictions. It is recommended that the magnitude of recharge be estimated using methods other than model calibration (refer to Scanlon et al., 2002) and that a sensitivity analysis be undertaken to explore the robustness of the model predictions to variations in recharge rates.
- i. The evaporation rate and extinction depth adopted in the model are not described. Evaporation appears to be the second most important contributor to flows leaving the model domain and small variations in evaporation may introduce large uncertainties in groundwater impact prediction.
- j. Walls or flow barriers have been used to simulate faults in the model. While some faults may form barriers to flow, others may provide conduits for groundwater flow. Therefore, a justification for the use of flow barriers in the groundwater model is warranted.
- k. Myall Creek is included in the groundwater model as a drain boundary condition despite evidence that groundwater elevations lay significantly below stream bed elevations. While it is noted that Myall Creek is situated to the north of the proposed project, justification is needed for the assumed boundary condition as it does not allow for seasonal flows to recharge groundwater.

Model Layers

- l. An understanding of the conceptual hydrology across the entire model domain would improve understanding of lateral drawdown propagation from the Walloon Coal Measures to the Quaternary Alluvium. This may be achieved by inclusion of north-east to south-west cross-sections across the entire model domain and identification of the extent of each hydrogeological unit.
- m. Information in relation to the geometry of the hydrostratigraphic units across the model, including the top, base and thickness of model layers, would aid understanding of how the numerical model parameterisation relates to the conceptual model. Individual model layers may include more than one unit which can result in an oversimplification of the hydrostratigraphy; in particular, inaccurate representation of hydraulic conductivity values. A description of how the south-west dipping conceptual hydrogeology was incorporated in the groundwater model is also needed.
- n. The Lower Walloon Coal Measures are conceptualised as separated from the Walloon Coal Measures by clays with low primary porosity, rather than low vertical hydraulic conductivity.

Evidence, in the form of a potentiometric head map for the Lower Walloon Coal Measures, a comparison between heads from adjacent bores, or a head to elevation analysis within the Walloon Coal measures is needed to support this conceptualisation.

Model parameterisation and calibration

- o. Calibrated model parameters indicate substantially higher horizontal and vertical hydraulic conductivity ratios than generally expected for alluvium, sandstone, and shale. Further, specific yield values are substantially lower than generally applied in groundwater models (for example, in Freeze and Cherry (1979)), which may underestimate unconfined aquifer storage. The rationale for the adopted values should be explained.
- p. The information provided in the assessment documentation does not appear to support a scaled Root Mean Square (RMS) value of 8 per cent. Further explanation of the scaled RMS errors, including an analysis of those across the entire model domain, at appropriate time intervals and for each model layer, would improve confidence in model calibration.

Model predictions

- q. Given the uncertainties in determining recharge and the limited documentation of the constant head boundaries across which flow occurs, there is the potential for large variations in the predicted drawdown and pit inflows, and an uncertainty/sensitivity analysis should be undertaken.
- r. Predicted drawdown in 2030 indicates a steep cone of depression in the Walloon Coal Measures and basalts. Given the comparatively high hydraulic conductivity assigned to the adjoining Oakey Alluvium at this location, and the potential presence of groundwater dependent ecosystems in the Oakey Creek catchment, the cause of the restricted lateral drawdown in all hydrostratigraphic units should be clarified.
- s. The presentation of drawdown contours for the Marburg Sandstone indicates that drawdown in this aquifer in the vicinity of the proposed project is greater than drawdown in the coal measures and basalts. This presentation is inconsistent with assessment documentation conclusions, which state that drawdown in the Marburg Sandstone is less than in the coal measures and basalts. This discrepancy should be reconciled.
- t. The presentation of drawdown maps should be reviewed and amended to ensure that groundwater drawdown predictions in the alluvium are accurate. The assessment documentation lacks clarity around why contour lines cross the Lagoon Creek Alluvium but do not cross the alluvium associated with Oakey Creek.
- u. The model predictions in terms of drawdown or stream depletion are shown in a deterministic manner; however, the model has considerable uncertainties in the calculation of the much larger components of recharge, flow across constant head boundary cells, and evapotranspiration. Inclusion of stochastic results or error/confidence intervals would better reflect the model uncertainties in the presentation of drawdown and stream depletions.
- v. Use of pan evaporation to assess the final void water balance may lead to overestimation of evaporation rates as void walls can protect water in the void from wind and sunlight. It is suggested that this effect is explored in the revised hydrogeological study and alternate evaporation rate factors are adopted if applicable; for example, Castendyk and Eary (2009) use a factor of 0.7 to account for the reduced evaporation from pit lakes. If the rate of evaporation is reduced in the model, the predicted post-mining drawdown will be smaller and the predictions for the post mining water levels in the Manning Vale West, Willeroo and Manning Vale East voids would need to be revised. Inclusion of either stochastic results or

error/confidence intervals would better reflect the model uncertainties in the presentation of post-mining drawdown and groundwater levels in the final voids.

- w. The proponent states that the final voids will act as groundwater sinks and therefore will not permit pooled water to flow outwards into the regional groundwater system. This concept may apply to times when evaporation is larger than rainfall. If, however, episodic large rainfall events bring the pool level above that of the surrounding groundwater, there may be flow to the groundwater system; the probability of which would increase with a decreased model evaporation rate factor. Evaluation of the potential for groundwater recharge from the final voids would enable assessment of the proposed project's long term risks to groundwater quality.
 - x. A sensitivity and uncertainty analysis of the major components of the proponent's groundwater balance would enable evaluation of confidence limits for model outputs.
2. Additional characterisation of surface water resources associated with Lagoon and Oakey Creeks, as described below, would enable potential impacts on water quality and aquatic ecosystems to be more robustly evaluated.

Existing Conditions

- a. Spatial and temporal limitations of the baseline monitoring program are not acknowledged in the assessment documentation. For example, characterisation of existing metals concentrations is based on one sampling event; however, the uncertainty associated with this limitation is not discussed. Consequently, existing conditions are difficult to ascertain and describe, which leads to reduced confidence levels when determining current state and condition; and attributing future impacts associated with the proposed works/activities. The following additional information would enable a more confident characterisation of the existing condition:
 - i. existing and background water resource conditions, including explicit identification of processes such as different flow, mixing, chemical and redox regimes;
 - ii. key water quality indicators and the appropriate sensitivity of measurement;
 - iii. temporal and spatial sampling frequency; and
 - iv. appropriate sample collection, sampling preservation and analytical methods.
- b. Methods used to characterise macroinvertebrate diversity in Lagoon Creek are not appropriate for dams or dry season pools. It is suggested that future sampling rounds are undertaken in accordance with the Queensland Monitoring and Sampling Manual 2009 (DEHP, 2013)³.
- c. Groundwater dependent ecosystems, particularly those dependent on the alluvium and tertiary basalt aquifer, are not clearly identified in the assessment documentation. A map identifying seasonal groundwater depths and the vegetation present within the predicted area of groundwater drawdown would aid understanding of the extent and type of groundwater dependent ecosystems across the proposed project's area of influence. The identification of groundwater dependent ecosystems should be undertaken with reference to the Queensland Government's groundwater dependent ecosystem mapping in WetlandInfo.⁴ Quantification of groundwater dependent ecosystem water requirements as well as the reliance of terrestrial ecosystems on shallow groundwater systems would inform the evaluation of the risks to these ecosystems posed by proposed project development.

- d. Assessment of the dependency of threatened species, such as *Pteropus poliocephalus* (Grey-headed Flying-fox) and *Phascolarctos cinereus* (Koala) on groundwater dependent vegetation would provide a more comprehensive understanding of the significance of groundwater dependent ecosystems in the proposed project's development area.
- e. The assessment documentation would benefit from a review of published literature in relation to existing aquatic and terrestrial ecosystems in the region; for example, see Cosser, P. (1988)⁵.

Water Quality Objectives

- a. The proponent identifies three possible descriptors of aquatic ecosystem environmental values for Lagoon Creek; however, the 'slightly to moderately disturbed' value has been adopted without explanation. Further justification for adoption of this environmental value, with due consideration of the spatial distribution of the environmental values along potentially affected watercourses, would ensure that this watercourse has been appropriately classified.
- b. Explanation of the rationale for using water quality objectives developed for south-eastern Australia and the Fitzroy Basin would enable evaluation of their applicability to the Lagoon Creek and Oakey Creek catchments.
- c. Evidence is needed to support the proponent's adoption of a water quality objective for electrical conductivity which is double the typical measured values in the upper reaches of Lagoon Creek. This should be informed by continuous, flow weighted electrical conductivity measurements.

Integrity and Limitations of the Data

- d. Limitations of the monitoring data should be described in the assessment documentation; particularly in relation to: the ability of the existing data to describe the water resources both spatially and temporally; data quality; discussion on the analytes collected (for example, the suitability of some analytes as indicators or surrogates for other analytes).
3. Aquatic and terrestrial ecosystem assessments are limited to Lagoon Creek and do not acknowledge the potential for the following groundwater drawdown-induced impacts.
 - a. The groundwater model predicts a reduction in baseflow for Oakey Creek and Myall Creek, indicating that there is a connection between the proposed project's operations and baseflow discharges to these watercourses. Characterisation of the existing aquatic and terrestrial ecosystems associated with Oakey Creek and Myall Creek is needed, clearly integrating the hydrological and water quality characterisations with the hydrogeological and ecological characteristics of the catchment.
 - b. The assessment of potential groundwater drawdown impacts on terrestrial vegetation is based on the depth to groundwater in the Walloon Coal Measures. It is suggested that consideration of groundwater drawdown in the alluvium and tertiary basalt aquifers would more appropriately inform risks to groundwater dependent ecosystems.
 - c. If the studies suggested in Paragraphs 2(c), 3(a) and 3(b) above indicate that groundwater dependent ecosystems are present and would be affected by groundwater drawdown, the consequential impacts on threatened species should be evaluated.
 4. The proposed project's site water balance and proposed discharge scenarios are likely to underestimate potential impacts on water resources. The site water balance should be updated to address the following matters:

- a. The simulated daily flow regime in Lagoon Creek is a poor fit in comparison to the calibration data set. The flow duration curve for Lagoon Creek is not consistent with measured data at the Oakey Creek stream gauge, which indicates that the proponent has assumed higher and more frequent flows in Lagoon Creek than are likely to be the case. This creates uncertainty with respect to the modelled mine water balance and a mine water management system that relies on releases to Lagoon Creek. Real time flow and water quality measurements on Lagoon Creek would more effectively direct the release of water from environmental dams to Lagoon Creek and inform the significance of any potential impacts;
 - b. Salinity trigger values for discharge water quality exceed the measured salinity within Lagoon Creek and may be expected to result in water quality exceeding the water quality objectives. This assessment is supported by model predictions which indicate that water quality downstream of the mixing zone in Lagoon Creek will exceed the 500 $\mu\text{S}/\text{cm}$ water quality salinity objective proposed by the proponent. Adoption of release rules that enable water quality objectives to be achieved would minimise risks to water quality and water-related assets;
 - c. Inclusion in the water release rules of additional water quality indicators which can be measured reliably in the field, such as dissolved oxygen, turbidity, temperature and pH, would reduce the risk of adverse impacts to water quality and aquatic ecosystems. In addition, routine sampling of a more detailed list of analytes (e.g. metals) should be implemented to verify the effectiveness of mitigation and management measures;
 - d. Release rules that are specified in terms that relate to the measured ambient water quality in Lagoon Creek, in addition to flow rates during a release, could provide a more appropriate approach to avoiding environmental impacts, including changes to the flow regime; and
 - e. The provision of verified, measured electrical conductivity values for treated wastewater proposed to be imported for operational use by the proposed project would justify the proponent's adopted value of 250 $\mu\text{S}/\text{cm}$. This water will be managed as part of the mine water management system and potentially released to Lagoon Creek. Therefore, it is important that water quality parameters are accurately reflected within the site water balance.
5. An investigation of the cause of the elevated copper concentration in Lagoon Creek is needed to understand whether these concentrations result from natural processes. The analysis of measured data from the mine water management system would inform this assessment. If a link with existing mining operations is suspected and expected to be continued under the proposed project, water quality management and monitoring strategies would be needed to minimise water quality risks.
 6. An evaluation of the potential impacts of mine-affected water discharges on surface water users downstream of the proposed project would provide a more comprehensive analysis of risks to water-related assets.

Question 2: Have cumulative impacts with other developments in the region that may impact water resources been sufficiently addressed?

7. The proponent has qualitatively considered cumulative groundwater impacts, which the IESC considers reasonably deals with 4 surrounding mines but not coal seam gas (CSG) activities, or entitlements. Confidence in the proponent's assessment of potential cumulative impacts on water resources and water-related assets would be improved by:
 - a. Describing the choice for groundwater model boundaries used in this model with respect to OGIA's groundwater flow model. In particular, CSG activities may affect the heads in the

proponent's groundwater model, in particular along boundaries, which could render the proponent's boundary assumptions invalid; and

- b. Incorporating entitlements from other groundwater users in the model domain into an updated groundwater model. These entitlements represent over 9,000 ML/year of groundwater abstraction, which is large compared to modelled pit inflows. Therefore, their exclusion may result in inaccurate model predictions.

Question 3: Are additional measures and commitments required to mitigate and manage impacts to water resources and water-related assets?

8. A number of additional measures and commitments are suggested to mitigate and manage impacts:
 - a. Following revision of the numerical groundwater model, it is suggested that the proponent's GMIMP consider and incorporate:
 - i. Selection of key groundwater monitoring bores on the basis of criteria such as target aquifers, and potentially affected groundwater users and groundwater dependent ecosystems;
 - ii. Selection of key groundwater monitoring bores and commencement of monitoring within a timeframe that enables seasonal and inter-annual measurement of groundwater flux;
 - iii. Identification of modelled drawdowns and triggers based on the updated hydrogeological study suggested in this advice;
 - iv. Groundwater data from the existing New Acland Mine's monitoring program and/or other regional monitoring programs;
 - v. A bore at coordinates 370000:6976000 to monitor the predicted 20m drawdown in the Walloon Coal Measures between monitoring bores 114P and the unnamed monitoring bore to the west near Lagoon Creek; and
 - vi. An additional monitoring bore in the Marburg Sandstone (near bores 5a and 5b), given the uncertainties in relation to predicted drawdown within this aquifer described in Paragraph 1(s);
 - c. Real time flow and water quality monitoring stations on Lagoon Creek would enhance management of controlled releases from the proposed project's environmental dams. It is suggested that measured water quality parameters include turbidity, dissolved oxygen, pH and electrical conductivity, and that these are measured in the environmental dams, as well as near the release point and at the junction with Oakey Creek;
 - d. Risks to water quality would be minimised by updating the water balance to incorporate a more robustly calibrated representation of the flow and quality regime within Lagoon Creek. Based on the results of the updated study, the size of the environment dams and frequency and duration of releases may need to be reassessed;
 - e. Regular monitoring of wastewater treatment plant effluent quality would enable early detection of any changes to effluent quality over time;
 - f. Incorporation of suitable strategies to manage leachate from waste rock with elevated manganese concentrations into the proponent's environmental management plan would minimise risks to water quality;

- g. Independent certification of infrastructure design by a practising erosion control or waterway specialist would provide a greater level of confidence that works within the floodplain would create minimal long term impacts;
 - h. Implementation of an environmental inspection program to identify emerging erosion and sediment mobilisation issues would enable early detection and management of potential impacts; and
 - i. Commitments for surface and groundwater monitoring should be presented as part of a water monitoring plan and should be consistent with the National Water Quality Management Strategy.
9. The Northland Inland Catchment has been identified as a Bioregional Assessment priority region. Data and relevant information from the proposed project should be made accessible for this Bioregional Assessment to assist the knowledge base for regional scale assessments.

Date of advice	10 April 2014
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Source documentation available to the Committee in the formulation of this advice	New Hope Group (2014) Environmental Impact Statement for the New Acland Coal Mine Stage 3 Project
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References cited within the Committee's advice	<p>¹ Information Guidelines for Proposed projects Relating to the Development of Coal Seam Gas and Large Coal Mines where there is a Significant Impact on Water Resources available at: http://iesc.environment.gov.au/pubs/iesc-information-guidelines.pdf</p> <p>² Queensland Water Commission (QWC), 2012. <i>Underground Water Impact Report for the Surat Cumulative Management Report</i></p> <p>³ Department of Environment and Heritage Protection (2013) <i>Monitoring and Sampling Manual 2009</i>, State of Queensland, Brisbane</p> <p>⁴ Queensland Government (2014) Wetland Info. URL: http://wetlandinfo.ehp.qld.gov.au/</p> <p>⁵ Cosser, P. R. (1988) Macroinvertebrate Community Structure and Chemistry of an Organically Polluted Creek in South-east Queensland, <i>Australian Journal of Marine and Freshwater Research</i>, 39, 671-83</p>
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