

Advice to decision maker on coal mining project

IESC 2023-140: Moolarben Coal Complex OC3 Extension (EPBC 2022/9162 and SSD 33083358) – Expansion

Requesting agency	The Australian Government Department of Climate Change, Energy, the Environment and Water and the New South Wales Department of Planning and Environment
Date of request	14 December 2022
Date request accepted	21 December 2022
Advice stage	Assessment

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) provides independent, expert, scientific advice to the Australian and state government regulators on the potential impacts of coal seam gas and large coal mining proposals on water resources. The advice is designed to ensure that decisions by regulators on coal seam gas or large coal mining developments are informed by the best available science.

The IESC was requested by the Australian Government Department of Climate Change, Energy, the Environment and Water and the New South Wales Department of Planning and Environment to provide advice on the Moolarben Coal Operations' Moolarben Coal Complex OC3 Extension in New South Wales. This document provides the IESC's advice in response to the requesting agencies' questions. These questions are directed at matters specific to the project to be considered during the requesting agencies' assessment process. This advice draws upon the available assessment documentation, data and methodologies, together with the expert deliberations of the IESC, and is assessed against the IESC Information Guidelines (IESC, 2018).

Summary

Moolarben Coal Operations (the proponent) is seeking to expand the Moolarben Coal Complex, located approximately 40 km north of Mudgee, New South Wales. Moolarben Coal Complex OC3 Extension (the project) would extend the OC3 open-cut pit, with the development area occupying approximately 826 ha of the Moolarben Valley and partly surrounded by the Munghorn Gap Nature Reserve. Operations are expected to occur from 2025 until 2034.

The extension will comprise five open-cut pits to a maximum depth of 125 m, with an average depth of 34 m (MCO 2022, Figure 3-1, p. 3-3; AGE 2022, App. S, p. 5). All pits would be backfilled and rehabilitated

as mining progresses, and a 200-m buffer zone implemented along Moolarben and Murdering creeks (excluding surface infrastructure such as road crossings).

Groundwater-dependent vegetation along Moolarben Creek may include Central Hunter Valley eucalypt forest and woodland, a threatened ecological community (TEC) listed as critically endangered under the *Environmental Protection and Biodiversity Conservation Act (1999)* (EPBC Act). Groundwater-fed pools also occur along Moolarben Creek and may provide valuable aquatic habitat and connectivity.

Key potential impacts from this project are:

- predicted drawdown of up to 6 m in the Moolarben Creek alluvium (MCO 2022, p. 6-19), potentially leading to impacts on groundwater-dependent ecosystems (GDEs), and reduced surface water habitat and baseflow;
- up to 16% reduction in the size of the Moolarben Creek catchment (MCO 2022, p. 6-33), including the loss of at least 16 km of ephemeral drainage channels (Bio-Analysis 2022, Figure 4, p. 7), and associated infiltration pathways, and reductions to the extent, quality and availability of aquatic habitats; and
- construction of culverts and creek crossings (90-306 m wide) (Bio-Analysis 2022, p. 54), which are likely to disrupt aquatic and riparian habitat connectivity.

The IESC has identified key areas in which additional work is required to address the key potential impacts, as detailed in this advice. These are summarised below.

- Further conceptualisation of the alluvium along Moolarben Creek and assessment of how drawdown may propagate through the alluvium are required. This includes description of the extent, thickness and degree of saturation of the alluvium and its geometry in relation to the proposed mine extension.
- Given the limitations of the regional-scale groundwater model, an assessment of local-scale impacts on drawdown within the project area and any impact on baseflow.
- The extent and degree of groundwater use by potential terrestrial GDEs along Moolarben Creek should be assessed in the field and monitored in areas of predicted drawdown.
- Additional alluvial monitoring bores, surface water flow and water quality monitoring sites should be placed further upstream on Moolarben Creek, with baseline monitoring (including macroinvertebrate biomonitoring) data to be collected for at least two years before commencing mining operations.
- Surface water quality monitoring of metals and other parameters should be undertaken at least every six months throughout operations at monitoring locations along Moolarben Creek and the Goulburn River (including event-based sampling).
- Water quality monitoring of mine-water and sediment dams for additional relevant parameters (e.g., metals) is needed.
- Trigger action response plans (TARPs) for water-dependent assets associated with Moolarben and Murdering creeks are required.

Context

The Moolarben Coal Complex (MCC) is located approximately 40 km north of Mudgee, New South Wales. The current project comprises four approved open-cut mining areas (OC1 to OC4), three

approved underground mining areas (UG1, UG2 and UG4) and other mining-related infrastructure, including a water treatment plant and coal processing and transport facilities (MCO 2022, p. 1-1).

Moolarben Coal Operations proposes to extend their open-cut 3 (OC3) mining operations. The development area would cover approximately 826 ha in the Moolarben Valley (Niche 2022, p. i), leaving a 200-m buffer zone along major watercourses.

Associated infrastructure to be constructed as part of the project includes internal roads, waste rock emplacements, mine-affected water dams, sediment dams, clean water dams and diversions. The proponent also intends to construct three haul-road creek crossings (90 to 306-m wide). Up to 9 million tonnes (Mt) run-of-mine thermal coal would be extracted per year by the project, totalling approximately 40 Mt over the life of the project. Operations are expected to occur between approximately 2025 and 2034 (within the approved life of the MCC ending in 2038) (MCO 2022, p. 3-1).

The Ulan Coal Mine lies immediately north of the MCC and the Wilpinjong Coal Project is approximately 4 km to the northeast. Historical land use is mainly low-intensity agriculture (e.g., grazing). There are no private groundwater users in the project area. Moolarben Creek and associated riparian vegetation provide food trees for koala (*Phascolarctos cinereus*) (Niche 2022, pp. 96-97), habitat critical to the survival of regent honeyeater (*Anthochaera phrygia*) (Niche 2022, p. 171), and possible foraging habitat for large-eared pied bat (*Chalinolobus dwyeri*). The adjacent Munghorn Gap Nature Reserve provides contiguous woodland habitat connectivity with Goulburn River and Wollemi national parks.

Response to questions

The IESC's advice, in response to the requesting agencies' specific questions is provided below. Question 1: To what extent can decision makers have confidence in the predictions of potential impacts on surface water resources provided in the EIS, having regard to the proximity of the project to local creek lines and the Goulburn River.

- a) Have the appropriate models been selected and used by the Applicant? Are the assumptions used in the model reasonable?
- b) Has the model been calibrated with sufficient monitoring data to provide meaningful predictions, including worst-case impacts on surface water resources?
- c) Has an appropriate sensitivity and uncertainty analysis been undertaken, including consideration of the potential effects of climate change?

1. The surface water modelling is generally sufficient to provide some confidence in the proponent's predicted impacts on surface water resources; however, additional consideration is needed of how the available historic streamflow gauging data could improve confidence in the estimates of the potential impacts on surface water yields and floods (Paragraph 5). Improvements to the surface water impact methodology would increase confidence in model predictions; additionally, further discussion and justification of some results is required (see Paragraphs 3 and 4). The contribution of groundwater to surface water as base flow also requires further consideration (see Paragraph 9).
2. Modelling should ideally have included an ecohydrological conceptual model (ECM) to support identification of potential impact pathways from proposed activities to water-dependent assets. Two large-scale hydrogeological cross-sections have been supplied, but these do not adequately capture the complexity of ecohydrological relationships nor potential impacts to water-dependent biota, particularly those using surface water. An ECM should be developed and used to derive an appropriate geo-referenced impact pathway diagram that indicates the probable extent and magnitude of the project's impacts. The conceptual models should be sufficiently detailed to identify impacts to specific resources (e.g., individual groundwater-fed pools), and should be used to guide risk assessment and focus mitigation and monitoring strategies.

3. Loss of streamflow due to reduced catchment size (up to 16% of the Moolarben Creek catchment) was described by the proponent as indiscernible and likely to cause only negligible impacts to watercourses (WRM 2022, p. 97). Currently, insufficient data are presented to justify this conclusion, particularly as the spatial arrangement of the excised area may exacerbate impacts to run-off and infiltration. Excision of up to 16% of the catchment area, including the removal of at least 16 km of ephemeral drainage channels (Bio-Analysis 2022, Figure 4, p. 7) and associated infiltration patterns are likely to reduce the extent and quality of aquatic habitats over the life of the project. The IESC notes that Moolarben Creek is already moderately stressed but recommends that project-related impacts from altered flow regimes should be evaluated and include an assessment of the contribution to cumulative impacts from this project.
4. The proponent has predicted that there will be minimal impacts associated with overtopping of dams based on the outcomes of the water balance modelling (WRM 2022, p. 102). However, due to inadequacies in this model (see below), the IESC has concerns regarding this assessment.
 - a. The following are required to provide greater confidence in the water balance model.
 - i. The results of the water balance model are based on a statistical analysis of 121 unique climatic sequences used in simulations from monthly data spanning from 1889 to 2021. This analysis assumes that the past climate is representative of conditions over the next 20 years, which is not consistent with current understanding. An appropriately conservative emission scenario should be adopted (e.g., SSP8.5) by factoring or censoring the historic data used in the simulations, or by some other rainfall-based approach.
 - ii. It is not clear from the provided information that model validation results are within reasonable bounds. Further justification is required, with a numerical basis for this assertion. Consideration should be given to transposing information from the (now closed) gauging station for the Goulburn River at Ulan (station number 210046) to help inform the parameterisation of the Australian Water Balance Model.
 - iii. A sensitivity analysis is needed to provide greater confidence in model results.
 - b. The results of the revised water balance model must be considered to provide confidence that the following concerns have been addressed.
 - i. Design volumes for Dam 316, used for surge storage, have not been defined. As the inventory for the remainder of the water management system will be unable to hold the predicted excess (see WRM 2022, Figure 7.1, p. 75), more detailed information on Dam 316 and referencing the revised model is required.
 - ii. Limited freeboard is modelled to be available in wet conditions for in-pit water storages and mine-affected water dams (WRM 2022, Figures 7.2 and 7.6, pp. 75, 79). Further information is required on how contaminated water in dams within the 200-m buffer zone will be managed under extreme weather events.
 - iii. Overflow from sediment dams is expected to occur in conditions exceeding design specifications (WRM 2022, p. 102). The IESC suggests that water quality monitoring of sediment dams and mine-affected water dams be expanded to include additional parameters (e.g., metals) to ensure that potential impacts from overflows are fully understood.
5. The proponent has adopted a “rain-on-grid” methodology to estimating floods, a modelling approach that is not fully endorsed by the national flood guidelines (Ball et al., 2019, Book 5, Section 6.5.3). The comparisons undertaken with regional estimates provide some additional confidence, but use should be made of the flow data collected at the (now closed) gauging station located just downstream of the mining site (site number 210046). The uncertainties associated with accounting for

differences in upstream area when transposing the flow information to the mine site are probably less than those associated with the adopted approaches.

Question 2: To what extent can decision makers have confidence in the predictions of potential impacts on groundwater resources provided in the EIS, paying particular attention to key water features in the project's vicinity (ie 'the Drip' and other features within the Goulburn River National Park), groundwater dependent ecosystems and other water users.

a) Has an appropriate model been selected and used by the Applicant? Are the assumptions used in the model reasonable?

b) Has the model been calibrated with sufficient monitoring data to provide meaningful predictions, including worst-case impacts on groundwater resources?

c) Has an appropriate sensitivity and uncertainty analysis been undertaken, including consideration of the potential effects of climate change?

6. The IESC is satisfied that the Goulburn River National Park and The Drip are adequately considered by the groundwater assessment. The Drip is located 12 km north of the project site (Bio-Analysis 2022, p. 12) and is fed by a local shallow aquifer within the Triassic Sandstone on the far side of the Goulburn River (see recent work in ACARP 2022). Environmental tracers indicate The Drip seepage is distinctive from deeper aquifers, is a localised flow and is probably a perched aquifer.
7. The proponent has acknowledged that high-probability terrestrial GDEs occur along Moolarben Creek (MCO 2022, p. 19). Groundwater use by potential GDEs has not been proven or quantified. The proponent should quantify groundwater use in these potential GDEs using methods outlined in Doody et al. (2019).
8. The potential impacts to the groundwater resources occur at two scales: regional and local. The groundwater model selected is appropriate for understanding impacts at the regional scale, and cumulative impacts of multiple mine operations. At this scale, the assumptions adopted are reasonable and commensurate with the likely severity of potential impacts, and the model is capable of assessing the potential impact pathway of depressurisation through the coal seams.
9. The groundwater model is not sufficient to make predictions at the local scale due to inadequate hydrogeological characterisation and deficiencies in the regional groundwater model. Due in part to a lack of reporting on the modelling calibration within the project area, confidence is limited in the model's ability to make meaningful predictions, including worst-case impacts on groundwater resources along the alluvium beneath Moolarben Creek. The following paragraphs identify additional work that would increase confidence in these predictions.
 - a. The proponent states that interpretation of geophysical survey data indicates that the maximum thickness of the Tertiary palaeochannel sediments is approximately 30 metres (AGE 2022, p. 82); however, this is not clearly supported by the information provided. The proponent should clarify how the Tertiary palaeochannel sediments have been delineated as their representation in the groundwater model may affect predictions of drawdown in overlying unconsolidated sediments that could support GDEs. Similarly, the extent, thickness and degree of saturation of the alluvium present along Moolarben Creek and its geometry in relation to the proposed mine extension require clarification.
 - b. There is a discrepancy of three orders of magnitude between field-tested and modelled hydraulic conductivity of the alluvium. Tested hydraulic conductivities of the alluvium are quoted as being between 0.05 and 3 m/d with a median of 0.4 m/d, (AGE 2022, Table 5.4, p. 37 and Figure 5.2, p. 38), while the range in the calibrated model is from approximately 14 to 50 m/d, with 44.8 m/d highlighted (AGE 2022, Att. C, Figure C 5.20, p. 38 and Table C 5.1, p. 36). The reasons for, and

influence of, this discrepancy have not been explored. The alluvium within the model may be acting as a surrogate parameter, and appears to have been poorly constrained by the calibration process. The proponent presents summary results for two sets of hydraulic conductivity testing, but the location of these tests and their proximity to the mine extension area are not presented.

- c. Local-scale groundwater impacts need to be quantified, including drawdown in the alluvium and impacts on baseflow.
10. The proponent's approach to assess the sensitivity and uncertainty of the model is limited. As the model was calibrated using PEST (2021) and a detailed sensitivity matrix (Jacobian) has already been calculated, then a more detailed sensitivity analysis could easily have been undertaken. Regarding the uncertainty analysis, the IESC considers that additional scenarios are needed. For each quantity of interest, a combination of parameters should be selected within reasonable ranges that would maximise the potential impact. Riverbed conductance should also be included in the varied parameters. Climate-variability scenarios (e.g., extended high-rainfall periods and how that would change the mine dewatering requirements and groundwater level predictions) should be considered in future iterations of the model.
11. The recovery phase comprises 14 stress periods which represent 576 years (AGE 2022, Att. C, p. 11). The rationale behind this timeframe selection, which is an order of magnitude longer than the calibration period and likely to increase uncertainty, should be presented. Additionally, the proponent should provide model outcomes identifying when equilibrium has been reached (refer to AGE 2022, Figure 5.6, p. 99).
12. It is predicted that mounding would start approximately 30 years after operations have ceased and will stabilise around 470 m AHD somewhere in the middle of the predictive period (refer to AGE 2022, Figure 5.6, p. 99). The proponent should discuss potential adverse impacts (e.g., waterlogging) of the predicted mounding to the health and persistence of GDEs and riparian vegetation.
13. Based on the analysis of cation-anion ratios, the proponent assumes that water samples from springs are relatively recent (in terms of groundwater residence time), with no mixing with regional groundwaters (AGE 2022, p. 58). This conclusion should be further supported with additional data (e.g., residence times) to confirm that these GDEs are perched.
14. Potential impacts to stygofauna (including hyporheic invertebrates) due to drawdown in Moolarben Creek have not been adequately assessed. The proponent should conduct additional stygofauna surveys in saturated alluvial sediments where drawdown is predicted near Moolarben Creek, including the hyporheic zone. The proponent should continue macroinvertebrate and stygofauna biomonitoring throughout the operational period and use this information to infer and report on any alterations to ecosystem health.

Question 3: Does the EIS provide an adequate assessment of cumulative impacts to surface and groundwater resources during the mining operations and during the post-mining recovery phase, including baseflow losses to the Goulburn River, impacts on groundwater dependent ecosystems and the rate of recovery of groundwater levels. Do these assessments adequately differentiate impacts due to the Project, historical mining already undertaken and currently approved operations (ie mining yet to occur)?

15. The EIS provides minimal assessment of cumulative impacts to surface water resources. The proponent has stated that as potential impacts to surface water flow and quality are negligible, cumulative impacts would likewise be negligible. As discussed in Paragraph 3, impacts of an up to 16% reduction in catchment area for Moolarben Creek are unlikely to be negligible. The proponent should therefore reassess potential cumulative impacts with reference to the recommendations outlined in Paragraphs 3, 4 and 5.

16. Cumulative impacts to groundwater levels have been adequately assessed, assuming the local impacts are as predicted. The regional groundwater model captures impacts from the whole MCC and the surrounding Ulan Mine Complex and Wilpinjong Coal Mine.
17. The proponent should assess the potential cumulative impacts of impairment and loss of GDEs (some of which will be removed during open-cut mining whereas others will experience drawdown and potentially altered water quality) and aquatic habitats throughout the surrounding landscape. Moolarben Creek and its surrounding mosaic of GDEs and watercourses complement the contiguous woodland habitat provided by the Munghorn Gap Nature Reserve. Although historic land uses have degraded aquatic and riparian habitats in the area, some high-quality habitats remain (Bio-Analysis 2022, p. 27) and their persistence is important for maintaining landscape-scale ecosystem health and diversity.
18. The documentation provided does not differentiate impacts due to the project, historical mining and currently approved operations.

Question 4: Does the EIS provide reasonable strategies to effectively avoid, mitigate or minimise the likelihood, extent and significance of impacts, including cumulative impacts, to water-related resources?

19. The proposed mitigation strategies are largely focussed on maintaining the 200-m buffer for open-cut mining around creek lines and post-closure landscape rehabilitation, which are likely to be generally successful. However, few strategies to mitigate impacts that may occur during the operation period have been described in sufficient detail. The proponent should propose additional mitigation measures to ensure that ecosystem health and biodiversity associated with Moolarben Creek are likely to persist during operations or recover post-closure. This should include TARPs for water-dependent assets associated with Moolarben Creek within the project area, which should describe the remediation of riparian vegetation, potential groundwater-dependent vegetation and stream health.
20. The Surface Water Management Program (SWMP) and associated TARPs were not provided for assessment. The SWMP should be updated with TARPs to assist in adaptive management and to prevent repeated impacts. This is of particular importance as key mitigation strategies regarding impacts to surface water quality include appropriate monitoring strategies and water quality trigger values.
21. Trigger values for metals (e.g., ANZG 2018) should be applied to Moolarben Creek, in line with the suggested additional monitoring (Paragraph 4).

Question 5: Are there any additional mitigation, monitoring, management or offsetting measures that should be considered by decision makers to address the residual impacts of the Project on water resources?

22. The IESC notes that alluvial and streamflow monitoring on Moolarben Creek is extremely limited and provides little indication of flow regimes upstream of the present OC3 operations. Additional alluvial monitoring bores and flow monitoring sites should be placed upstream of the confluence with Lagoon Creek and within the project area downstream of the Murdering Creek confluence. Two years of continuous baseline monitoring data should be obtained to develop a comprehensive understanding of the alluvial system and flow patterns such that impacts to Moolarben Creek can be identified and assessed at the local scale, and suitable management plans developed to remediate impacts.
23. The existing water quality monitoring site SW09 will be relocated further upstream of Moolarben Creek as mining progresses (WRM 2022, p. 100). Relocating the monitoring site will prevent the proponent from assessing changes to water quality resulting from the project as there will likely be insufficient pre-impact baseline data available at the new location. To address this, additional water

quality monitoring sites should be established further upstream on Moolarben Creek instead of the proposed relocation.

24. Water quality monitoring frequency for dissolved metals and other parameters (dissolved organic carbon, total phosphorus, total nitrogen and total dissolved solids) has not been specified by the proponent. Results indicate that monitoring of various parameters has been inconsistent over time, ranging from 4 to 104 samples analysed between 2005 and 2021 (WRM 2022, Tables 3.7 – 3.9, pp. 38 – 39). Monitoring for these analytes should be completed at least six-monthly during operations (including event-based sampling).
25. The IESC recommends monitoring of sediment dams and mine-affected water dams should be expanded to include sampling metals and metalloids, dissolved organic carbon and nutrients.
26. During the backfilling and rehabilitation of final voids, annual rehabilitation monitoring does not appear to include environmental monitoring. Monitoring of surface water flows and water quality is integral for assessing the success of rehabilitation measures and should be incorporated into the rehabilitation monitoring strategy and associated TARPs.
27. The proponent intends to store waste brine in a mine-affected water dam for the first two stages of the project, then in the UG4 void (WRM 2022, p. 56). Further information and discussion are required concerning the design of brine storage facilities and long-term storage solutions, with particular consideration given to potential for leakage and seepage of contaminants into groundwater. The proponent should monitor groundwater quality in the vicinity of the proposed brine storages, to identify potential leaks and seepage.
28. The IESC previously recommended the development of a TARP by the operators of Moolarben, Ulan and Wilpinjong mines to provide an adaptive management approach to address water quality in the Goulburn River (IESC 2017). This included the installation of a flow and water quality monitoring point on the Goulburn River downstream of Wollar Creek to assess cumulative water quality impacts. This TARP was not provided nor discussed in the documentation but should be updated to accommodate the potential impacts associated with the project.

Date of advice	7 February 2023
Source documentation provided to the IESC for the formulation of this advice	Moolarben Coal Operations (MCO) 2022. <i>Moolarben Coal Complex OC3 Extension Project Environmental Impact Statement</i> . (Moolarben Coal Operations EIS).
References cited within the IESC's advice	ANZG 2018. <i>Australian and New Zealand guidelines for fresh and marine water quality</i>. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT. Available [online]: https://www.waterquality.gov.au/anz-guidelines. Australasian Groundwater & Environmental Consultants (AGE) 2022. <i>Moolarben Coal Complex OC3 Extension Project Groundwater Impact Assessment</i>. Prepared for Moolarben Coal Operations. (Appendix A of Moolarben Coal Operations EIS). Australian Coal Association Research Program (ACARP) 2022. <i>Water tracer tools for optimisation of water management for coal mines</i>. Final report for ACARP Project C28024. May 2022.

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