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Independent peer review of the Clarence Colliery 918 Panel Numerical Groundwater Model

Dear Peter

Introduction

This letter presents an independent peer review of the numerical groundwater model developed by JBS&G to support extraction of the 918 Panel at Clarence Colliery. Clarence Colliery Pty Ltd commissioned GHD Pty Ltd (GHD) to complete the model review.

Clarence Colliery is located in the Western Coalfields of NSW, approximately 100 km northwest of Sydney. Clarence Colliery is an underground mine that has operated since 1979. Mining targets the Katoomba Seam within the Illawarra Coal Measures, with extraction methods adopted to minimise surface subsidence. Extraction of the 918 Panel represents an expansion of the approved mining activities.

The lithology of the region is characterised by sequences of Triassic and Permian-age sandstone, siltstone, claystone, shales and coal. The Mt York Claystone is conceptualised as a regionally significant aquitard that hydraulic isolates the shallow groundwater system from the underlying coal seams, however mining activities that result in goafing can establish vertical connectivity.

Identified receptors comprising Temperate Highland Peat Swamps on Sandstone (THPSS) and hanging swamps overly the coal seams, and the assessment of impacts on these receptors was a key focus area of the model.

Limitations

This review has been prepared by GHD for Clarence Colliery Pty Ltd and may only be used and relied on by Clarence Colliery Pty Ltd for the purpose agreed between GHD and Clarence Colliery Pty Ltd.

GHD otherwise disclaims responsibility to any person other than Clarence Colliery Pty Ltd arising in connection with this review. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The opinions, conclusions and any recommendations in this review are based on the information reviewed at the date of preparation of the review. GHD disclaims liability arising from any of the material supplied to support the review being incorrect.

Documentation

The groundwater model review was based on the following documents:

- Extraction Plan for 918 Panel: Groundwater Assessment – Clarence Colliery Pty Ltd – Rev A (document number 68229 | 171726), JBS&G, 12 November 2025.
- Extraction Plan for 918 Panel: Groundwater Assessment – Clarence Colliery Pty Ltd – Rev B (document number 68229 | 171726), JBS&G, 30 January 2026.
- Extraction Plan for 918 Panel: Groundwater Assessment – Clarence Colliery Pty Ltd – Rev 0 (document number 68229 | 171726), JBS&G, 13 February 2026.

GHD was supplied updated reports throughout the review process. Reviewed sections of the report were not re-reviewed upon receipt of updated revisions, however where aspects of the report were noted to be updated, that was considered in the review process.

Several meetings were held between GHD and JBS&G as part of the review process. These meetings were used as a platform for JBS&G to explain the model setup and approach to GHD:

- 20 March 2025
- 7 October 2025
- 16 October 2025
- 21 October 2025
- 6 February 2026

Review methodology

The model review was undertaken in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al, 2012). The review also drew upon the following guidance to support the review process:

- Information guidelines for proponents preparing coal seam gas and large coal mining development proposals (IESC 2024, Commonwealth of Australia).
- Information Guidelines Explanatory Note: Uncertainty analysis for groundwater modelling (Peeters LJM and Middlemis H (2023)).

The model review was completed with combination of professional experience and judgement, together with the model appraisal checklist provided in the Australian Groundwater Modelling guidelines.

The model review was based upon supplied documentation and meetings between GHD and JBS&G. The model files were not reviewed, and data was not independently verified as part of this process.

The model review was completed by James Dowdeswell (Technical Director – Hydrogeology) and Alyssa Baron (Technical Director – Hydrogeology).

Model review

The Clarence Colliery is located on the Newnes Plateau, a topographically elevated sandstone feature with an elevation of approximately 1200 mAHD. Topographically steep valleys incise the plateau, which, combined with contrasting transmissivity of the sedimentary Triassic lithology, result in perched water tables above the regional water table.

To account for the hydrogeological complexity, a 30-layer numerical model has been developed. The model utilises the MODFLOW USG-Transport platform with variably saturated flows. Layer pinch outs are utilised, and the model has a total of 427,833 active nodes.

Geological lineaments are represented in the model in a manner that supports lateral and vertical connectivity along the fault plane. The model also represents fault 'reactivation' associated with mining, to facilitate enhanced inflow to the underground workings directly following disturbance.

The model represents historical mining extending from the late 1800's to present day from multiple underground mines. Detailed representations have been incorporated into the model to simulate the enhancement of vertical connectivity associated with underground mining. The approach is based on the empirical relationship developed by Tammetta (2013) and augmented with additional parameters guided by the historical impacts of mining on the groundwater system within the model domain.

The model utilises a complex parameterisation strategy, with 11,354 parameters. Parameterisation is implemented through a variety of mechanisms including pilot points, cosimulation, warping fields and ramp functions. Calibration was completed to optimise parameter values.

Model predictions are based on comparing currently approved mining activities at Clarence Colliery and surrounding mines with the proposed scenario. Section 4.15.3 of the report defines the proposed scenario as: *Mining at Clarence Colliery will continue as currently approved as well as the development and extraction of 918 Panel.*

Model prediction is largely completed utilising stochastic methods to incorporate predictive uncertainty. A null-space Monte Carlo approach was utilised for this purpose.

The model is complex and has been developed and refined over multiple iterations and years. The JBS&G modelling team bring detailed experience to the modelling approach based on historical assessment at Clarence Colliery and the adjacent mines.

Overall, the model is considered 'fit for purpose' with regard to supporting the assessment of impacts associated with the development of the 918 Panel at Clarence Colliery.

Review comments are summarised in Table 1 and Table 2 which have been reproduced from the Australian Groundwater Modelling Guidelines (Barnett et al, 2012).

Table 1 Compliance checklist

No.	Question	Yes/No	Comment
1	Are the model objectives and model confidence level classification clearly stated?	Yes	Section 4.2.1 of the JBS&G modelling report lists the model objectives. The objectives include the quantification of groundwater impacts associated with the development of the 918 Panel at the Clarence Colliery. The model is classified as a class 2 model with data provided to support this assignment.
2	Are the objectives satisfied?	Yes	The report documents the modelling process in detail, including achievement of the model objectives.
3	Is the conceptual model consistent with objectives and confidence level classification?	Yes	The conceptual model supports the numerical model and is developed at a level consistent with the model confidence level.
4	Is the conceptual model based on all available data, presented clearly and reviewed by an appropriate reviewer?	Yes	The conceptual model has been developed based upon relevant data and presented with supporting graphics to aid interpretation.
5	Does the model design conform to best practice?	Yes	The model is developed based on the conceptual model incorporating 30 layers to represent lithology at a suitable resolution. The model utilises MODFLOW USG-Transport as the numerical platform, with variably saturated flow options used to represent perched groundwater systems.
6	Is the model calibration satisfactory?	Yes	The model has been calibrated to an acceptable standard, particularly considering the geological complexity and extensive historical and ongoing mining in the region.
7	Are the calibrated parameter values and estimated fluxes plausible?	Yes	Calibrated parameters are consistent with literature values. Estimated fluxes are consistent with historically observed fluxes and appear reasonable.
8	Do the model predictions conform to best practice?	Yes	Detailed model predictions are presented, however it is noted that the report does not provide a breakdown of component flows. The addition of this information would be beneficial. Further details are provided in the recommendations.

No.	Question	Yes/No	Comment
9	Is the uncertainty associated with the predictions reported?	Yes	A detailed uncertainty analysis has been completed utilising the null-space Monte Carlo approach. Most model predictions are presented in stochastic format to characterise the associated uncertainty.
10	Is the model fit for purpose?	Yes	The modelling study represents a detailed assessment of the groundwater impacts associated with the proposed mining of 918 Panel at the Clarence Colliery.

Table 2 Review Checklist

No.	Review Questions	Yes/No	Comment
1	**Planning**		
1.1	Are the project objectives stated?	Yes	The Project objective was to complete a groundwater assessment associated with proposed extraction from the 918 Panel at Clarence Colliery.
1.2	Are the model objectives stated?	Yes	The model objectives are stated and include update of the existing Clarence Colliery groundwater model to support the assessment of groundwater impacts associated with extraction of the 918 Panel.
1.3	Is it clear how the model will contribute to meeting the project objectives?	Yes	The model has been developed to simulate historical and proposed mining activities at Clarence Colliery as well as regional mining activities.
1.4	Is a groundwater model the best option to address the project and model objectives?	Yes	The groundwater system is complex at Clarence Colliery, with steep incised topography and contrasting hydraulic parameters. A numerical groundwater model is required to adequately predict impacts.
1.5	Is the target model confidence-level classification stated and justified?	Yes	The model has been designated a Class 2 model. Data and discussion are presented to support this conclusion.
1.6	Are the planned limitations and exclusions of the model stated?	Yes	The limitations of the model are discussed in the report.
2	Conceptualisation		
2.1	Has a literature review been completed, including examination of prior investigations?	Yes	The model builds upon previous studies and model revisions. Detailed knowledge of the groundwater system is presented in the report and was communicated during meetings between GHD and JBS&G.
2.2	Is the aquifer system adequately described?	Yes	The aquifer system is described in detail, comprising of a perched system, a shallow system and a deep system. Variably saturated flow is present in the upper groundwater systems due to contrasting hydraulic conductivity of the lithology combined with the steep, incised topographical setting.
2.2.1	hydrostratigraphy including aquifer type (porous, fractured rock ...)	Yes	
2.2.2	lateral extent, boundaries and significant internal features such as faults and regional folds	Yes	The extent of modelled hydrostratigraphic units is presented. Faults / lineaments are discussed in detail along with supporting conceptual understanding of impacts on the groundwater system, both in the undisturbed state and due to mining induced disturbance.
2.2.3	aquifer geometry including layer elevations and thicknesses	Yes	Figures and cross sections are used to present aquifer geometry and elevation.
2.2.4	confined or unconfined flow and the variation of these conditions in space and time?	Yes	Discussion of the aquifer type is provided, including desaturation effects due to mining operations.

No.	Review Questions	Yes/No	Comment
2.3	Have data on groundwater stresses been collected and analysed?	Yes	Information is presented on groundwater stresses, including hydrographs comparing climate trends to groundwater levels.
2.3.1	recharge from rainfall, irrigation, floods, lakes	Yes	Historical rainfall is sourced from SILO gridded data. New South Wales and Australian Capital Territory Regional Climate Modelling Project (NARCliM) was used for the predictive scenarios, with climate data scaled to provide consistency with calibration phase data.
2.3.2	river or lake stage heights	Yes	Rivers and surface water bodies are represented in the model, however they are considered to be distant from mining related impacts.
2.3.3	groundwater usage (pumping, returns etc)	Yes	Groundwater usage is reviewed in the report – limited abstraction occurs outside of mining.
2.3.4	evapotranspiration	Yes	Historical evapotranspiration is sourced from SILO gridded data. New South Wales and Australian Capital Territory Regional Climate Modelling Project (NARCliM) was used for the predictive scenarios, with climate data scaled to provide consistency with calibration phase data.
2.3.5	other?	Yes	Influence of historical mining activities has been included in the conceptual understanding of the regional groundwater system.
2.4	Have groundwater level observations been collected and analysed?	Yes	Groundwater level data is presented in the report.
2.4.1	selection of representative bore hydrographs	Yes/No	While groundwater level hydrographs are presented in the report, discussion in relation to the effects of stresses on groundwater levels is generally restricted to the deeper system and the effects of mining. Topography is mentioned as playing a significant role in the control of groundwater levels. The Rev A version of the report omitted a figure displaying surface topography. The Rev B and Rev 0 versions included a figure, however the elevation coverage did not cover the full model domain, was partially obscured by other map features and lacks a reference scale.
2.4.2	comparison of hydrographs		
2.4.3	effect of stresses on hydrographs		
2.4.4	watertable maps/piezometric surfaces?	No	Figures displaying piezometric surfaces and the water table are not presented based on observational data. It is understood that data density and challenges in resolving the upper water table are likely to limit development of a contour map for the water table based on observational data.
2.4.5	If relevant, are density and barometric effects taken into account in the interpretation of groundwater head and flow data?	N/A	
2.5	Have flow observations been collected and analysed?	Yes	Groundwater inflows have been recorded and used to constrain calibration for Clarence Colliery, and at Springvale Mine and Angus Place Colliery.
2.5.1	baseflow in rivers	Yes	The report states: "Seepage faces, where groundwater is discharged to atmosphere at outcrop of hydrogeological units, are an important contribution to surface water flow"
2.5.2	discharge in springs		

No.	Review Questions	Yes/No	Comment
2.5.3	location of diffuse discharge areas?		Groundwater contribution to baseflow is reported to be small within the location of the 918 Panel. Discussions with the modelling team and Centennial personnel indicate that limited baseflow measurements are collected due to the low flow volumes and the disturbance required to install flow measuring stations. Perennial watercourses are represented in the model with surface water / groundwater interaction simulated. Perennial watercourses are located distant from the 918 Panel location.
2.6	Is the measurement error or data uncertainty reported?	Yes	Measurement error is discussed within the report
2.6.1	measurement error for directly measured quantities (e.g. piezometric level, concentration, flows)	Yes	Measurement error is discussed with assumed error values adopted.
2.6.2	spatial variability/heterogeneity of parameters	Yes	Heterogeneity of parameters is addressed, including hydraulic properties and recharge.
2.6.3	interpolation algorithm(s) and uncertainty of gridded data?	No	Discussion not provided
2.7	Have consistent data units and geometric datum been used?	Yes	Consistent metric units adopted and suitable spatial datum utilised.
2.8	Is there a clear description of the conceptual model?	Yes	
2.8.1	Is there a graphical representation of the conceptual model?	Yes	Several graphical cross-section conceptual models presented.
2.8.2	Is the conceptual model based on all available, relevant data?	Yes	Conceptual model incorporates lithological data, water level data, receptors, key flow processes and mining induced impacts
2.9	Is the conceptual model consistent with the model objectives and target model confidence level classification?	Yes	
2.9.1	Are the relevant processes identified?	Yes	The conceptual model identified key inflows, outflows, the significance of topography, lithology and impacts that mining has on the groundwater flow process.
2.9.2	Is justification provided for omission or simplification of processes?	Yes	While data is discussed to support the conceptual model, the conceptual model would benefit from: - additional assessment of hydraulic stresses supported by hydrographs at an appropriate scale - review of potential recharge rates against literature values and using site-based data.
2.10	Have alternative conceptual models been investigated?	No	
3	**Design and construction**		
3.1	Is the design consistent with the conceptual model?	Yes	

No.	Review Questions	Yes/No	Comment
3.2	Is the choice of numerical method and software appropriate (Table 4-2)?	Yes	MODFLOW USG-Transport with variably saturated flow
3.2.1	Are the numerical and discretisation methods appropriate?	Yes	Quadtree refinement with layer pinch outs utilised
3.2.2	Is the software reputable?	Yes	Widely adopted software code.
3.2.3	Is the software included in the archive or are references to the software provided?	Yes	Software referenced: MODFLOW USG-Transport, Version 2.5.0.
3.3	Are the spatial domain and discretisation appropriate?	Yes	Model strives to balance the trade-off of between model extent and refinement against numerical complexity, stability and runtime. The model is a 3D model that extends 34.4km west-east and 29.2km south-north and utilises 30 layers, with a regional cell size of 400m refined to 200m around water courses and 100m within the active areas of mining. The model has a total active cell count of 427,833 cells.
3.3.1	1D/2D/3D	Yes	
3.3.2	lateral extent	Yes	
3.3.3	layer geometry?	Yes	
3.3.4	Is the horizontal discretisation appropriate for the objectives, problem setting, conceptual model and target confidence level classification?	Yes	100m cell sizing within the mining area. This is on the larger size of what is typically adopted, however the vertical discretisation with 30 layers is considered a more important consideration with respect to model design. The approach to the assignment of mining induced stress and the parametrisation of fault zones accounts for the differences between cell size and represented conditions. The model resolution is considered appropriate based on these factors.
3.3.5	Is the vertical discretisation appropriate? Are aquitards divided in multiple layers to model time lags of propagation of responses in the vertical direction?	Yes	30 layers adopted. While aquitards are represented as single layers, the vertical discretisation is sufficient to represent the groundwater processes faithfully.
3.4	Are the temporal domain and discretisation appropriate?	Yes	
3.4.1	steady state or transient	Yes	Transient simulation, with the calibration model adopting 144 stress periods and the predictive model using 241 stress periods. The nature of variable saturated flow simulation results in the predictive simulation re-running the calibration phase model as initial conditions are unable to be exported and saved. The model simulates the period from 1867 to 2049. Stress period length varies from 5 to 11 years until 1993, with quarterly stress periods adopted thereafter.
3.4.2	stress periods		
3.4.3	time steps?		
3.5	Are the boundary conditions plausible and sufficiently unrestrictive?	Yes	Boundary conditions are well considered and discussed in detail in the report.
3.5.1	Is the implementation of boundary conditions consistent with the conceptual model?	Yes	Adopted boundary conditions: • Recharge was simulated using the recharge (RCH) package. Recharge is applied using pilot points • Perennial watercourses were simulated using the river (RIV) package.

No.	Review Questions	Yes/No	Comment
			• Evapotranspiration was simulated utilising the evapotranspiration (EVT) package. Pilot points were used to parameterise the EVT package. • Ephemeral watercourses and swamps were simulated using the drain (DRN) package, supported by the conceptual understanding that all watercourses in the Newnes Plateau and in the Wolgan Valley are considered to be gaining watercourses. • Seepage faces were assigned where model layers pinch out using the DRN package • Surface overland flow was simulated using the DRN package. Surface overland flow was conceptualised as narrow, shallow tribulets that are below the scale of hydrologic mapping and were applied to the upper model nodes were water courses and seepage faces were not represented. • Mine dewatering was simulated utilising the DRN package. Stacked drains were used to simulate the initial progression of mining with the DRN package applied to the mined seam and overlying strata. Ongoing dewatering utilised the DRN package applied to the mined seam. • Connection with the regional groundwater system in the northeastern and eastern model domain boundaries was represented utilising the general head boundary (GHB) package. • Underground water storage in the State Mine Complex was simulated using the GHB package. • Leakage through the base of the groundwater model was represented using the well (WEL) package.
3.5.2	Are the boundary conditions chosen to have a minimal impact on key model outcomes? How is this ascertained?	Unknown	Discussion is not presented in the report. Drawdown figures do not extend to the model boundary so it is unclear if boundary conditions impact model predictions.
3.5.3	Is the calculation of diffuse recharge consistent with model objectives and confidence level?	Yes	Spatially variable recharge is implemented based on scaled SILO rainfall via pilot points.
3.5.4	Are lateral boundaries time-invariant?	Yes	External GHBs are time invariant.
3.6	Are the initial conditions appropriate?	Yes	The initial conditions are not specified in the report however a steady state simulation was completed initially which overrode initial conditions. The calibration phase ran over a period of 128 years. Initial conditions for the predictive phase model were developed via model simulation through the calibration phase. The adopted approach is considered appropriate.
3.6.1	Are the initial heads based on interpolation or on groundwater modelling?		
3.6.2	Is the effect of initial conditions on key model outcomes assessed?		
3.6.3	How is the initial concentration of solutes obtained (when relevant)?	N/A	

No.	Review Questions	Yes/No	Comment
3.7	Is the numerical solution of the model adequate?	Yes	The cumulative model mass balance error is less than 0.1% which is below the target guideline criteria of 1% indicating an adequate numerical solution.
3.7.1	Solution method/solver		Sparse Matrix Solver (SMS)
3.7.2	Convergence criteria	Yes	HCLOSE was set at 0.05m and HICLOSE was set at 0.001m.
3.7.3	Numerical precision	Yes	Single precision output, in accordance with MODFLOW USG-Transport protocols.
4	**Calibration and sensitivity**		
4.1	Are all available types of observations used for calibration?	Yes	Calibration utilises head, head change, hydraulic conductivity and mine inflow targets.
4.1.1	Groundwater head data	Yes	Calibration dataset includes standpipe piezometers and vibrating wire piezometers. Targets assigned to head values and head difference values.
4.1.2	Flux observations	Yes	Inflows to Springvale Mine, Angus Place Colliery and Clarence Colliery are used for calibration.
4.1.3	Other: environmental tracers, gradients, age, temperature, concentrations etc.	No	Not used, however this omission is considered justified in light of the project context.
4.2	Does the calibration methodology conform to best practice?	Yes	The calibration process is well documented.
4.2.1	Parameterisation	Yes	The model is heavily parameterised with 11,354 parameters. Parameterisation strategy included horizontal and vertical hydraulic conductivity, storage parameters, recharge, evapotranspiration parameters, conductance of conductance terms for riverbed, general head and drain boundaries, as well as parameters associated with the change in hydraulic parameters associated with subsidence effects due to mining. Pilot points were used to parameterise spatial arrays.
4.2.2	Objective function	Yes	The objective function and evolution of the objective function is discussed in the report.
4.2.3	Identifiability of parameters	Yes	Parameter uncertainty variance reduction assessment was completed. This identified that approximately half the parameters are constrained to some extent through the calibration process.
4.2.4	Which methodology is used for model calibration?	Yes	PEST_HP was used for calibration utilising singular value decomposition and Tikhonov regularisation.
4.3	Is a sensitivity of key model outcomes assessed against?	Yes	
4.3.1	parameters	Yes	Parameter uncertainty variance reduction assessment was completed. This identified that approximately half the parameters are constrained to some extent through the calibration process.

No.	Review Questions	Yes/No	Comment
4.3.2	boundary conditions	Yes	Boundary conditions are included in the model parameterisation and incorporated in the sensitivity analysis.
4.3.3	initial conditions	No	Assessment against initial conditions is not required as a steady state simulation overwrites initial conditions.
4.3.4	stresses	No	Discussion of model sensitivity to stresses is not presented.
4.4	Have the calibration results been adequately reported?	Yes/No	The calibration results have been reported in detail, however some aspects hinder interpretation, including: The scale of the hydrographs precludes detailed interpretation in some cases; calibration scatter plots are hard to read; a suitable water balance is not provided – the reported water balance for example only provides output for 'drains' without breaking the drain flow down into the multiple components that they represent in the model (seepage faces, mine inflow, discharge to ephemeral streams etc).
4.4.1	Are there graphs showing modelled and observed hydrographs at an appropriate scale?	Yes/No	Some hydrographs are presented at a scale that is challenging to interpret. This is partially due to the manner in which hydrographs are presented, which in contrast, is effective. Hydrographs are presented on maps, allowing placement of the results. Vertical gradients are shown. Overall, the presentation of hydrographs is effective, however the scale becomes an issue with the shallow bores where the water level is at or near the ground surface.
4.4.2	Is it clear whether observed or assumed vertical head gradients have been replicated by the model?	Yes	Hydrographs are presented to show vertical gradients effectively.
4.4.3	Are calibration statistics reported and illustrated in a reasonable manner?	Yes	Calibration statistics are presented reasonably well, however Figures 4.25 and 4.26 would benefit from the addition of transparency as Group 3 obscures the data from Group 1 and 2.
4.5	Are multiple methods of plotting calibration results used to highlight goodness of fit robustly? Is the model sufficiently calibrated?	Yes	The model is well calibrated considering the complexity of the lithology and the multiple historic and ongoing mining operations. Multiple methods are utilised to demonstrate calibration output both temporally and spatially, including hydrographs, and an array of figures.
4.5.1	spatially		
4.5.2	temporally		
4.6	Are the calibrated parameters plausible?	Yes	Calibrated values are consistent with expected ranges supported by literature.
4.7	Are the water volumes and fluxes in the water balance realistic?	No	An appropriate water balance is not provided. The reported water balance is a direct extract from the model output without supporting analysis and breakdown. As mentioned in no. 4.4, it would be beneficial for flow components to be broken down into 'real world' terms. The 'drain' term for example represents multiple aspects of the regional water balance, such as seepage faces, discharge to ephemeral streams, inflow into mine workings etc. Recharge is not summarised in a manner that supports comparison with other studies (i.e. equivalent recharge in mm/y of percentage of annual rainfall is not

No.	Review Questions	Yes/No	Comment
			presented). The conceptual model does not present referential water balance terms, and no discussion of the representativeness of the water balance is presented aside from comparison against recorded mine inflows at selected mines.
4.8	has the model been verified?	No	Dataset was not retained for verification. It is the opinion of this reviewer that data is better used for calibration purposes than verification purposes. The reviewer agrees with the adopted approach.
5	**Prediction**		
5.1	Are the model predictions designed in a manner that meets the model objectives?	Yes	Model predictions are presented in a variety of ways to support assessment of impacts from mining activities. The approach is particularly effective at presenting the propagation of depressurisation vertically.
5.2	Is predictive uncertainty acknowledged and addressed?	Yes	A null-space Monte Carlo approach has been adopted to quantify uncertainty.
5.3	Are the assumed climatic stresses appropriate?	Yes	The projected climate was adopted from New South Wales and Australian Capital Territory Regional Climate Modelling Project (NARCliM) (NSW DCCEEW, 2025) using ‘Average’ climate conditions by the ECHAM5_R3 model.
5.4	Is a null scenario defined?	Yes	The null model adopted for the assessment is termed the ‘approved’ model and includes historical and approved mining activity. No baseline model has been developed where no mining is represented.
5.5	Are the scenarios defined in accordance with the model objectives and confidence level classification?	Yes	
5.5.1	Are the pumping stresses similar in magnitude to those of the calibrated model? If not, is there reference to the associated reduction in model confidence?	Yes	Historical groundwater abstraction from mining is represented. The assessment includes a detailed approach to assessing impacts from varying mining methods based on the extraction amount and the potential for goafing. The adopted approach is informed by history matching to simulate existing and historical mining operations.
5.5.2	Are well losses accounted for when estimating maximum pumping rates per well?	N/A	
5.5.3	Is the temporal scale of the predictions commensurate with the calibrated model? If not, is there reference to the associated reduction in model confidence?	Yes	Historical mining is simulated from the late 1800’s.
5.5.4	Are the assumed stresses and timescale appropriate for the stated objectives?	Yes	Mining stresses are applied to the model in considerable detail, accounting for multiple factors affecting the propagation of mine induced drawdown. The approach clearly draws upon an extensive body of knowledge possessed by the modelling team and is supported by a detailed history matching process.
5.6	Do the prediction results meet the stated objectives?	Yes	The reported outputs have been developed to detail the vertical and lateral propagation of depressurisation from mining. Multiple cross sections with model generated head,

No.	Review Questions	Yes/No	Comment
			pressure and water table location are presented along with predictive hydrographs, piezometric surfaces and drawdown plots.
5.7	Are the components of the predicted mass balance realistic?	Yes	Plausible inflows into the Springvale Mine, Angus Place Colliery and Clarence Colliery are presented. Changes to groundwater discharge to surface water is also assessed in the vicinity of the 918 Panel.
5.7.1	Are the pumping rates assigned in the input files equal to the modelled pumping rates?	N/A	
5.7.2	Does predicted seepage to or from a river exceed measured or expected river flow?	No	Not addressed in the report.
5.7.3	Are there any anomalous boundary fluxes due to superposition of head dependent sinks (e.g. evapotranspiration) on head-dependent boundary cells (Type 1 or 3 boundary conditions)?	No	Modelling approach discusses how boundary conditions are assigned to prevent this occurrence.
5.7.4	Is diffuse recharge from rainfall smaller than rainfall?	Yes	Recharge is assigned as a factor (less than unity) of rainfall.
5.7.5	Are model storage changes dominated by anomalous head increases in isolated cells that receive recharge?	No	Modelled head distribution, both in cross section and plan, looks physically plausible.
5.8	Has particle tracking been considered as an alternative to solute transport modelling?	N/A	No transport simulations or particle tracking was completed, consistent with the model objectives.
6	**Uncertainty**		
6.1	Is some qualitative or quantitative measure of uncertainty associated with the prediction reported together with the prediction?	Yes	A detailed assessment of uncertainty has been completed utilising a null-space Monte Carlo approach. Predictions are generally presented in stochastic form rather than deterministic form.
6.2	Is the model with minimum prediction-error variance chosen for each prediction?	Yes	A parameter ensemble was generated using parameter sensitivities developed from and centred on the calibrated model.
6.3	Are the sources of uncertainty discussed?	Yes	
6.3.1	measurement of uncertainty of observations and parameters	Yes	Measurement uncertainty is addressed through assignment of observations to measurement error grouping categories based upon a qualitative assessment of typical error.
6.3.2	structural or model uncertainty	No	Structural uncertainty is not addressed.
6.4	Is the approach to estimation of uncertainty described and appropriate?	Yes	The report explains the approach to the estimation of uncertainty in detail.
6.5	Are there useful depictions of uncertainty?	Yes	The report presents outputs in a variety of ways. The approach is well considered.

No.	Review Questions	Yes/No	Comment
7	**Solute transport**		
7.1	Has all available data on the solute distributions, sources and transport processes been collected and analysed?	N/A	
7.2	Has the appropriate extent of the model domain been delineated and are the adopted solute concentration boundaries defensible?	N/A	
7.3	Is the choice of numerical method and software appropriate?	N/A	
7.4	Is the grid design and resolution adequate, and has the effect of the discretisation on the model outcomes been systematically evaluated?	N/A	
7.5	Is there sufficient basis for the description and parameterisation of the solute transport processes?	N/A	
7.6	Are the solver and its parameters appropriate for the problem under consideration?	N/A	
7.7	Has the relative importance of advection, dispersion and diffusion been assessed?	N/A	
7.8	Has an assessment been made of the need to consider variable density conditions?	N/A	
7.9	Is the initial solute concentration distribution sufficiently well-known for transient problems and consistent with the initial conditions for head/pressure?	N/A	
7.10	Is the initial solute concentration distribution stable and in equilibrium with the solute boundary conditions and stresses?	N/A	
7.11	Is the calibration based on meaningful metrics?	N/A	
7.12	Has the effect of spatial and temporal discretisation and solution method taken into account in the sensitivity analysis?	N/A	
7.13	Has the effect of flow parameters on solute concentration predictions been evaluated, or have solute concentrations been used to constrain flow parameters?	N/A	

No.	Review Questions	Yes/No	Comment
7.14	Does the uncertainty analysis consider the effect of solute transport parameter uncertainty, grid design and solver selection/settings?	N/A	
7.15	Does the report address the role of geologic heterogeneity on solute concentration distributions?	N/A	
8	**Surface water–groundwater interaction**		
8.1	Is the conceptualisation of surface water–groundwater interaction in accordance with the model objectives?	Yes	The model considers surface water – groundwater interaction in detail. The approach is appropriate. It is noted that hydrographs for some bores in the swamp areas display consistent groundwater levels equal to ground level with limited temporal variability in water level. The model simulates groundwater levels that are time variant and slightly below the model top (ground level). This indicates that there are other components to the water balance, likely due to surface water inflow from upstream. The adopted assessment is however considered conservative as it is expected to overpredict impacts without the potentially mitigating effects of surface water flows.
8.2	Is the implementation of surface water–groundwater interaction appropriate?		
8.3	Is the groundwater model coupled with a surface water model?	No	
8.3.1	Is the adopted approach appropriate?	N/A	
8.3.2	Have appropriate time steps and stress periods been adopted?	N/A	
8.3.3	Are the interface fluxes consistent between the groundwater and surface water models?	N/A	

Recommendations

While the assessment is considered ‘fit for purpose’ there are aspects of the assessment and reporting that could be improved. Commentary is provided below. It is recommended that these considerations are adopted in future revisions if they are undertaken.

- The report is complex and difficult to read with some sections reading like a modelling log. Much of the report would benefit from being distilled down to address key features in a concise and accessible format.
- The report would benefit from additional information to support the conceptual understanding of the groundwater system. For example, hydraulic stresses are only discussed briefly. Additional discussion, supported by hydrographs at an appropriate scale, to characterise hydraulic stresses would aid the conceptual interpretation.
- Scale should be considered when presenting conceptualisations and results. For example, key receptors (THPSS) are surficial, yet a conceptual representation of key water balance components as they relate to the THPSS is not presented at a suitable scale. Basement to surface representations restrict the review of water balance components at a scale relevant to the receptor.
- The model generated water balance is not broken down into flow terms that align with the conceptual model. For example, drains are used to represent multiple flow components within the model, however the water balance is only represented for the aggregate drain outflow. A breakdown of contributing flow terms, such as mine inflow, discharge to ephemeral streams, discharge to seepage faces etc. would benefit the interpretation of the model output. Furthermore, it would be beneficial if the magnitude of these flows are considered based on a referential water balance. Similar comments apply to recharge: discussion of net recharge in mm/y and percentage of rainfall, aided by comparison to literature, comparative studies and project data (such as water table fluctuation and chloride mass balance) would be beneficial.

Regards

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References

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