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16 June 2022

Tomingley Gold Operations Pty Ltd
c/o RW Corkey and Co Pty Ltd
Attention: Mitchell Bland
62 Hill Street
ORANGE NSW 2800
Via email: mitchell@rwcorkery.com

Groundwater Model Peer Review – Tomingley Gold Extension Project

Introduction

JBS&G Australia Pty Ltd (JBS&G) is currently engaged to RW Corkery and Co Pty Ltd (Corkerys) to prepare a peer review of the groundwater model used in support of the current Environmental Impact Statement (EIS) for the Tomingley Gold Extension Project:

- *Groundwater Assessment: Tomingley Gold Extension Project* (Jacobs, 2021)

This letter presents JBS&G's review and was prepared in accordance with our proposal (JBS&G-145335, dated 13 May 2022).

Approach to Review

Prior to undertaking its review, JBS&G has read relevant correspondence, including the Gateway Assessment and Report.

JBS&G have undertaken its review using the Australian Groundwater Modelling Guidelines Checklist (SKM, 2013) of the Australian Groundwater Modelling Guidelines (Barnett et. al., 2012). The completed checklist is presented as **Attachment A**.

A face-to-face meeting (virtual) was held between JBS&G and Jacobs Group (Australia) Pty Ltd (Jacobs) during preparation of this review.

In addition, further correspondence between JBS&G and Jacobs has occurred and is summarised in:

- *Response to draft groundwater model peer review comments and RFIs* (Jacobs, 2022)

General Comments

The Tomingley Gold Extension Project is an extension of an existing mine operation in a region where similar, and extensive, mine activity has been undertaken since 2014.

JBS&G concurs with Jacobs's assessment that the extension project can be considered to be low risk to groundwater environment.

The Residue Storage Facilities (RSF) comprise RSF1 and RSF2. As JBS&G understands it, RSF1 (Stages 1 to 9) and RSF2 (Stages 1 and 2) are already approved. RSF2 (Stages 3 to 9) is part of the Tomingley Gold Extension Project, however, there is no increase in footprint of RSF2. The RSFs are not included in the groundwater model. This is appropriate and reasonable because the RSFs have been installed with a clay liner to NSW EPA specifications, namely a vertical hydraulic conductivity of $<1\times10^{-9}$m/s over a distance of 1m.

Review of the compilation of water strike in exploration holes, supplemented by existing, site-only, monitoring piezometers and water supply wells, reinforce the conceptualisation presented in Jacobs (2021).

The rate of applied recharge to the model, as a percentage of rainfall, is very low; however, in the context that this recharge is 'recharge to the regional groundwater system' and not the near-surface aquifers, in effect being leakage through the shallow aquifer, which is typically unsaturated or only partially saturated in localised areas, into the deep system, JBS&G can accept the justification presented in Jacobs (2021).

As JBS&G understands it the installation of additional groundwater monitoring to the north and south of the mine site to provide additional confirmation of the conceptualisation has been commissioned. A request for additional monitoring, in particular off-site, was noted in 'water management related' regulator and agency comments.

The value of Specific Storage, Ss, in the groundwater model is very low. Whilst the value of Ss is expected to be low, it is recommended that this value is revised in the next version of the groundwater model, in the context of the lower physical limit of the compressibility of water is close to the value adopted. As presented in Jacobs (2021), however, a 10x higher value of Ss has been assessed in the model uncertainty analysis. That increase led to an increase in predicted dewatering rate of 14%. Accordingly, this issue can be addressed in the next version of the groundwater model and does not need to be addressed at this moment.

Jacobs (2021) has provided justification as to why the cumulative impact of historical and existing adjacent projects were not required to be represented in the model.

Model outcomes implies drawdown in the vicinity of 'BP TruckStop' monitoring piezometers. Presuming these piezometers were installed for the purpose of monitoring potential leakage from Underground Storage Tanks at that location, clarification was requested as to the potential for migration of hydrocarbon contaminated groundwater into existing mine workings. As presented in Jacobs (2022), there is drawdown in the spatial vicinity of those monitoring piezometers; however, vertically, they are installed in the shallow groundwater system. As has been established there is a hydraulic disconnection between the shallow groundwater system and the deep groundwater system (which will be impacted by mining). Accordingly, as stated in Jacobs (2022), there is no potential for migration of contaminated groundwater into the mine workings.

It is understood the final void equilibrium water levels were calculated via an external water balance (Jacobs, 2021) and then applied as a target Drain (DRN) stage in the groundwater model (Jacobs, 2022). As JBS&G understands it, the equilibrium modelled levels are substantially below the regional water table thereby confirming that the pit lakes will act as groundwater sinks.

Review Findings

JBS&G consider that the numerical groundwater model of the Tomingley Gold Extension Project, as presented in Jacobs (2021) and inclusive of recommendations for additional monitoring locations presented in Jacobs (2021), is "*fit-for-purpose*" in accordance with the requirements of the NSW Aquifer Interference Policy (DPE Water, 2012).

Requirements for Current Revision of Groundwater Model (Pre-Approval)

Following clarification of some matters by Jacobs (2022), there are no matters that require addressing at this Response to Submissions stage.

Recommendations for Next Revision of Groundwater Model (Post-Approval)

The following recommendations are provided for the next revision of the groundwater model, when undertaken:

- A 1:10 vertical to horizontal anisotropy is not consistent with a fractured rock setting and is more typical of a sedimentary, porous rock setting. It is recommended that this 'base case' assumption be revised in the next update of the groundwater model
- Consider improving model calibration (to groundwater elevation) through use of automated techniques such as PEST or PESTPP-iES
  - Separation of head and "change in head" targets may be of assistance in that regard
  - JBS&G's experience is that when using a 'piece-wise constant' approach to model calibration, PEST can struggle with sufficient degrees of freedom.
- Incorporate mapped geological lineaments into the model domain and assess the implication to model prediction (extent of modelled drawdown)
- Consider introducing 'deep leakage' at the base of the groundwater model
  - This will also assist in providing a small, vertically downward, head gradient.
- Revise model geometry from a constant elevation approach, outside of mine area, to a 'depth below ground' approach
  - This should assist in resolving the current sharp change in horizontal hydraulic gradient and assist in model convergence.
- Whilst the selection of the approach to predictive uncertainty analysis is consistent with IESC (2018), in the context of being a low-risk project, a more sophisticated approach to predictive uncertainty analysis is encouraged.

References

Barnett B., Townley L.R., Post V., Evans R.E., Hunt R.J., Peeters L., Richardson S., Werner A.D., Knapton A. and A. Boronkay, 2012. *Australian Groundwater Modelling Guidelines - Waterlines Report Series No. 82*. Prepared by Sinclair Knight Merz Pty Ltd and National Centre for Groundwater Training and Research on behalf of the National Water Commission. Reference No. ISBN 978-1-921853-91-3, dated June 2012.

DPE Water, 2012. *NSW Aquifer Interference Policy – NSW Government policy for the licensing and assessment of aquifer interference activities*. Policy prepared by the NSW Department of Planning and Environment: Division of Water (formerly NSW Department of Primary Industries – Office of Water). Reference No. ISBN 978-1-74256-338-1, dated September 2012.

IESC, 2018. *Uncertainty Analysis – Guidance for groundwater modelling within a risk management framework*. A report prepared by Middlemis, H. and L.J.M. Peeters for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of Environment and Energy, Commonwealth of Australia. Reference No. n/a, dated December 2018.

Jacobs, 2021. *Groundwater Assessment – Tomingley Gold Extension Project*. Consultant report prepared by Jacobs Group (Australia) Pty Ltd for Tomingley Gold Operations Pty Ltd. Reference No. IA257200-A.CS.EV.PT3 GW-NW-RPT-001, dated 23 December 2021.

Jacobs, 2022. *Response to draft groundwater model peer review comments and RFIs*. Consultant memorandum prepared by Jacobs Group (Australia) Pty Ltd to Tomingley Gold Operations Pty Ltd c/o RW Corkery and Co. Pty Ltd. Reference No. IA257200-A.CS.EV.PR-NW-MEM-001, dated 8 June 2022.

SKM, 2013. *Australian Groundwater Modelling Guidelines: Companion to the Guidelines*. Prepared by Sinclair Knight Merz Pty Ltd on behalf of the National Water Commission. Reference No. ISBN 978-1-922136-23-7, dated July 2013.

Closing

Should you require clarification, please contact the undersigned on 02 8245 0313 or by email jbell@jbsg.com.au.

Yours sincerely:

Dr Justin Bell
Principal Environmental Engineer
JBS&G Australia Pty Ltd

Attachments:
A) Australian Groundwater Modelling Guidelines Checklist

Attachment A – Australian Groundwater Modelling Guideline Checklist

Model Review Checklist (after SKM, 2013)

Review Questions	Yes/No	Comment
1. Planning		
1.1 Are the project objectives stated?	Yes	Chapter 1
1.2 Are the model objectives stated?	Yes	Section 6.1
1.3 Is it clear how the model will contribute to meeting the project objectives?	Yes	Model targeted on deep groundwater system to predict mine inflows and extent of drawdown. This report presents additional work since time of Gateway Assessment.
1.4 Is a groundwater model the best option to address the project and model objectives?	Yes	Model supplemented by hydraulic testing, plus is an extension of an existing mine operation.
1.5 Is the target model confidence level classification stated and justified?	Yes	Whilst a relatively simple model geometry, extensive on-site hydraulic testing has been used to validate the approach. Transient calibration undertaken. Fit can be improved with increased degrees of freedom, plus refinement of constant elevation geometry in a future revision.
1.6 Are the planned limitations and exclusions of the model stated?	Yes	Section 6.3 presents the model assumptions and limitations.
2. Conceptualisation		
2.1 Has a literature review been completed including examination of prior investigations?	Yes	The area has been subject to regional studies by DPE Water as well as being an established mining area, with on-ground experience elsewhere in the region.
2.2 Is the aquifer system adequately described?		
2.2.1 Hydrostratigraphy including aquifer type (porous, fractured rock ...)	Yes	The region is reasonably well understood and is an existing mining operation. Confirmation of consistency of expected hydrostratigraphy is provided by the extensive exploration drilling program undertaken, as well as the geotechnical investigation of the extension area.
2.2.2 Lateral extent, boundaries and significant internal features such as faults and regional folds	Yes	Regional geology, including faults is presented Figure 3.2, after the Parkes Special 1:100,000 Geology Sheet. That detail is part of the geologic circumstance for the resource. The fault is not directly included in the model, however, and is a recommendation for the future.
2.2.3 Aquifer geometry including layer elevations and thicknesses	N/A	A constant elevation approach to the groundwater model was adopted, in order to host the different mine elevations. It is recommended in a future revision, away from the mine, that a 'depth below ground' approach is adopted, to improve model performance.
2.2.4 Confined or unconfined flow and the variation of these conditions in space and time	Variable	Perched and shallow groundwater system are unconfined but are not included in the numerical model. The regional groundwater system is variably confined/unconfined, with only the bottom most layer set to confined (for model stability).
2.3 Have data on groundwater stresses been collected and analysed?		
2.3.1 Recharge from rainfall, irrigation, floods, lakes	Yes	Watercourses in the region are ephemeral and are regularly 'dry creek beds'. Conceptually, there is very little recharge to the deep groundwater system. SILO climate datasets for rainfall were used in the study.

Review Questions	Yes/No	Comment
2.3.2 River or lake stage heights	N/A	There are no perennial rivers or lakes in the region.
2.3.3 Groundwater usage (pumping, returns, etc.)	N/A	Except for mine operations, which is an industrial use, there is negligible use of groundwater for agricultural purposes in the region. This is due to the saline quality of groundwater in the regional groundwater system.
2.3.4 Evapotranspiration	Yes	SILO climate datasets for evapotranspiration were used in the study.
2.3.5 Other	N/A	
2.4 Have groundwater level observations been collected and analysed?		
2.4.1 Selection of representative bore hydrographs	Yes	Chapter 4 presents the groundwater monitoring network, and relevant hydrographs.
2.4.2 Comparison of hydrographs	Yes	Multiple hydrographs presented on the same chart in Chapter 4, so as to allow comparison.
2.4.3 Effect of stresses on hydrographs	Yes	Cumulative Departure from Mean Rainfall (CRD) curve presented alongside hydrographs. There is no irrigation-related pumping in the region. Anecdotal experience and the site water balance prepared for the operation indicates that
2.4.4 Water table maps / piezometric surfaces	Yes	Composite of all units presented in a water table map (Figure 3.13), with detail presented in Figure 4.7 and 4.8. It is recommended that the dataset for Figure 3.13 be segregated into interpreted units, so as to avoid confusion.
2.4.5 If relevant, are density and barometric effects taken into account in the interpretation of groundwater head and flow data?	N/A	Whilst regional groundwater is saline, this is not of importance to the interpretation.
2.5 Have flow observations been collected and analysed?		
2.5.1 Baseflow in rivers	N/A	Watercourses in the vicinity are ephemeral, and frequently are dry creek beds.
2.5.2 Discharge in springs	No	There is no statement in Jacobs (2021) as to location of springs. It is recommended that this aspect be covered off in the next update to the groundwater model report.
2.5.3 Location of diffuse discharge areas	No	Whilst flow monitoring of watercourses has not been undertaken, nor is considered warranted, Jacobs (2021) has identified desktop mapping (BOM) groundwater dependent ecosystems. To the far northwest of the site, the 'depth to water' figure (Figure 3.13) is consistent with 'swamp areas' marked on the topographic map.
2.6 Is the measurement error or data uncertainty reported?		
2.6.1 Measurement error for directly measured quantities (e.g. piezometric level, concentration, flows)	Yes	An interpretation of groundwater level hydrographs, omitting erroneous values is presented in Section 4.2.
2.6.2 Spatial variability / heterogeneity of parameters	Yes	Spatial and depth interpretation of hydraulic testing presented in Section 4.4.
2.6.3 Interpolation algorithm(s) and uncertainty of gridded data	Yes/No	Hydrographs are interpreted, by default, from the model grid output by the Graphical User Interface. Justification provided in Jacobs (2021) as to 'piece-wise constant' values of hydraulic properties.
2.7 Have consistent data units and geometric datum been used?	Yes	Metres for length, Australian Height Datum (AHD) for elevation, Megalitres per day (ML/d) for flow.
2.8 Is there a clear description of the conceptual model?		

Review Questions	Yes/No	Comment
2.8.1 Is there a graphical representation of the conceptual model?	Yes	Chapter 5 presents a plan and cross-sections.
2.8.2 Is the conceptual model based on all available, relevant data?	Yes	The conceptual model benefits from the extensive on-site exploration drilling program, where 'water strike' has been used to supplement the current groundwater monitoring network.
2.9 Is the conceptual model consistent with the model objectives and target model confidence level classification?		
2.9.1 Are the relevant processes identified?	Yes	Limited 'deep recharge' due to the presence of the shallow aquifer, which is typically unsaturated or only partially saturated in localised areas, above the fractured rock, and hence hydraulically disconnected, was thoroughly explored.
2.9.2 Is justification provided for omission or simplification of processes?	Yes	A detailed justification of why the regional groundwater system only is considered in the groundwater model is presented. This was necessary because a variably saturated approach to groundwater modelling, rather than a saturated flow only approach, whether otherwise be required.
2.10 Have alternative conceptual models been investigated?	N/A	Not relevant. The area has been subject to regional studies by DPE Water in the past and the conceptualisation presented by Jacobs (2021), whilst based on their own investigations, is consistent with that of DPE Water.
3 Design and construction		
3.1 Is the design consistent with the conceptual model?	Yes	The regional groundwater system is modelled only. Near-surface perched and shallow aquifers are not considered, because they are hydraulically isolated, due to the shallow aquifer being typically unsaturated or only partially saturated in localised areas, from the fractured aquifer in which mining will occur.
3.2 Is the choice of numerical method and software appropriate?		
3.2.1 Are the numerical and discretisation methods appropriate?	Yes	15.625 to 500m variable sized grid (quadtree refinement). Model domain is 37m wide (oriented west-east, north-south) and 27km tall (north-south). Temporal discretisation was one moth for calibration and prediction simulations. The recovery simulation used a 200 year stress period duration. Separated steady-state, calibration (transient) and prediction simulations.
3.2.2 Is the software reputable?	Yes	MODFLOW-USG in saturated flow mode. Graphical User Interface is Groundwater Vistas, V7.15.8.
3.2.3 Is the software included in the archive or are references to the software provided?	Yes	MODFLOW is a public-domain groundwater flow model code. Groundwater Vistas is a commercially available Graphical User Interface.
3.3 Are the spatial domain and discretisation appropriate?		
3.3.1 1D / 2D / 3D	3D	No comment required.
3.3.2 Lateral extent	Yes	As 3.2.1. Domain sufficient to encompass regional hydrogeologic divides and assumed down-gradient regional groundwater flux to the northwest.
3.3.3 Layer geometry	Yes	6 layers, constant elevation. Constant elevation used to provide platform for representation of mining. It is recommended that

Review Questions	Yes/No	Comment
		'depth below ground' is considered away from the mine, in a future update to the model, so as to improve model performance under Harveys Range.
3.3.4 Is the horizontal discretisation appropriate for the objectives, problem setting, conceptual model and target confidence level classification?	Yes	As 3.2.1. The model was zonated, based on the geological model, before being simplified.
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	6 layers used, which with the same hydraulic properties. Analysis by Jacobs (2021) suggests no differentiation in hydraulic properties of the regional groundwater system with depth below ground surface. That analysis was based on an extensive program of packer testing.
3.4 Are the temporal domain and discretisation appropriate?		
3.4.1 Steady state or transient	Both	As 3.2.1.
3.4.2 Stress periods	Yes	As 3.2.1.
3.4.3 Time steps	Yes	Four time steps per period for all Stress Periods.
3.5 Are the boundary conditions plausible and sufficiently unrestrictive?		
3.5.1 Is the implementation of boundary conditions consistent with the conceptual model?	Yes	No flow boundaries aligned with hydrogeologic divides. A general head boundary to the northwest to represent regional groundwater flow direction.
3.5.2 Are the boundary conditions chosen to have a minimal impact on key model outcomes? How is this ascertained?	Yes	Prediction drawdown contours well within the model extent.
3.5.3 Is the calculation of diffuse recharge consistent with model objectives and confidence level?	Yes	'Deep recharge' is limited to the regional groundwater system. A variety of zonation schemes were attempted, before being simplified.
3.5.4 Are lateral boundaries time-invariant?	Yes	General head boundary is at a fixed elevation
3.6 Are the initial conditions appropriate?		
3.6.1 Are the initial heads based on interpolation or on groundwater modelling?	Model	Model comprises a steady-state, calibration (transient), prediction (transient) and recovery (transient, single stress period). Due to use of steady-state, the initial condition, aside from numerical convergence, is not relevant. Due to a sequential approach to groundwater modelling, the initial condition of the calibration (transient) is the converged solution of the steady-state simulation etc.
3.6.2 Is the effect of initial conditions on key model outcomes assessed?	N/A	No comment required.
3.6.3 How is the initial concentration of solutes obtained (when relevant)?	N/A	No comment required.
3.7 Is the numerical solution of the model adequate?		
3.7.1 Solution method / solver	Yes	SMS (as per Jacobs (2022))
3.7.2 Convergence criteria	Yes	HCLOSE is 0.01m (as per Jacobs (2022))
3.7.3 Numerical precision	Yes	Table 6.5 and Table 6.8 present the mass balance error for the steady-state and calibration (transient). Both of which are 0.02.
4 Calibration and sensitivity		
4.1 Are all available types of observations used for calibration?		
4.1.1 Groundwater head data	Yes	All available data was utilised.
4.1.2 Flux observations	Yes	The site water balance and, anecdotal evidence from existing operations, implies that essentially all

Review Questions	Yes/No	Comment
		groundwater inflow to the existing open cut is lost to evaporation. Jacobs (2021) have used the site water balance, noting the potential for recirculation, as a guide to the calibration of mine inflows.
4.1.3 Other: environmental tracers, gradients, age, temperature, concentrations, etc.	N/A	Not considered required by the reviewer. Conceptually, environmental receptors are not hydraulically connected to the existing or proposed mine operation.
4.2 Does the calibration methodology conform to best practice?		
4.2.1 Parameterisation	No	Whilst the approach to calibration is not consistent with best practice, use of a 'trial-and-error' method is commensurate with 'low risk' of the project to regional groundwater. Consideration of use of PEST or PESTPP-iES in the update to the groundwater model is recommended.
4.2.2 Objective function	N/A	An objective function was not constructed, as calibration was undertaken manually.
4.2.3 Identifiability of parameters	N/A	The parameter identifiability techniques of PEST were not considered because PEST was not used.
4.2.4 Which methodology is used for model calibration?	Trial and Error	No comment required.
4.3 Is a sensitivity of key model outcomes assessed against:		
4.3.1 Parameters	Yes	Summarised in Section 6.8.3, with detail presented in Appendix D. Each parameter assessed separately. Comparison to sum of squared residuals (Table D.2), which is heads, rather than a combined objective function, which would include mine inflows. Outcome is that horizontal hydraulic conductivity and recharge, which are proportional to each other with respect to the groundwater flow equation, are the most sensitive.
4.3.2 Boundary conditions	Yes	Conductance of General Head and Drain (Mine) boundaries considered and found to be insensitive.
4.3.3 Initial conditions	N/A	No comment required.
4.3.4 Stresses		
4.4 Have the calibration results been adequately reported?		
4.4.1 Are there graphs showing modelled and observed hydrographs at an appropriate scale?	Yes	Section 6.8.1.5 presents steady-state calibration results. Section 6.8.2.4 presents transient calibration results.
4.4.2 Is it clear whether observed or assumed vertical head gradients have been replicated by the model?	No	As stated in Jacobs (2022), there are no nested piezometers installed within the regional groundwater system. There is a vertical head gradient demonstrated between the shallow groundwater system and the deep groundwater system; however, the numerical model only considers the deep groundwater system. In the next version of the groundwater model, it is recommended that consideration be given to introducing 'deep leakage' at the base of the model

Review Questions	Yes/No	Comment
		to provide separation of modelled groundwater elevation within the main body of the model.
4.4.3 Are calibration statistics reported and illustrated in a reasonable manner?	Yes	Scaled RMS values, as well as RMS error is provided for steady-state and transient calibration.
4.5 Are multiple methods of plotting calibration results used to highlight goodness of fit robustly? Is the model sufficiently calibrated?		
4.5.1 Spatially	Yes	Provided in Jacobs (2022). Results are reasonable.
4.5.2 Temporally	Yes	As 4.4.1.
4.6 Are the calibrated parameters plausible?	Yes	It is highlighted that a vertical to horizontal anisotropy of 1:10 is probably not consistent with the hydrogeological setting, as those values are more typical of sedimentary (porous) rock. It is recommended that the 'base case' is updated in the next revision of the groundwater model.
4.7 Are the water volumes and fluxes in the water balance realistic?	Yes	The influence of the open cut mine is represented by Drain (DRN) boundary conditions, hence the Evapotranspiration (EVT) outflow does not change significantly between the transient calibration and the steady state water balances.
4.8 has the model been verified?	Yes	The project is an extension of existing operations. A site water balance was available to consider modelled inflows against measured and anecdotal evidence. Given the environmental setting, it is expected that mine inflows will be lost as evapotranspiration.
5 Prediction		
5.1 Are the model predictions designed in a manner that meets the model objectives?	Yes	Assessment of the extent of drawdown of regional groundwater elevation surrounding the extension area. Assessment of potential mine inflows for the purpose of operational management as well as groundwater licensing.
5.2 Is predictive uncertainty acknowledged and addressed?	Yes	A 'Method 1' approach (IESC, 2018), which is subjective change to model parameterisation, is presented in Appendix D of Jacobs (2021).
5.3 Are the assumed climatic stresses appropriate?	Yes	Section 6.9.3 states that the factors applied to rainfall in the Recharge (RCH) package were maintained but applied to long-term average monthly rainfall. This is appropriate. It is noted that Climate Change was not assessed. The reviewer, however, does not consider that this is required, however, Jacobs is requested to provide justification for this decision in the next version of the Groundwater Assessment.
5.4 Is a null scenario defined?	Yes	A null case was simulated to allow calculation of drawdown and change to mine inflows due to the project.
5.5 Are the scenarios defined in accordance with the model objectives and confidence level classification?		
5.5.1 Are the pumping stresses similar in magnitude to those of the calibrated model? If not is there reference made to the associated reduction in model confidence?	Yes	There are no irrigation works in the vicinity of the Extension Project, due to the low (saline) quality of groundwater. Existing mine operations, however, have led to significant drawdown in the area and therefore the impact of the Extension Project is similar in magnitude to that existing change.
5.5.2 Are well losses accounted for when estimating maximum pumping rates per well?	N/A	No comment required.

Review Questions	Yes/No	Comment
5.5.3 Is the temporal scale of the predictions commensurate with the calibrated model? If not is there reference made to the associated reduction in model confidence?	Yes	Monthly stress periods (4 time steps per period) were used for the transient prediction simulation from May 2021 through to February 2031. The transient calibration period was March 2007 through to April 2021.
5.5.4 Are the assumed stresses and time scale appropriate for the stated objectives?	Yes	Transient prediction through to February 2031 encompasses the mining period. This is followed by a 200 year recovery period (single stress period, with four time steps).
5.6 Do the prediction results meet the stated objectives?	Yes	Predicted drawdown due to the Extension Project and mine inflows for the purpose of groundwater licensing were obtained.
5.7 Are the components of the predicted mass balance realistic?		
5.7.1 Are the pumping rates assigned in the input files equal to the modelled pumping rates?	Yes	Whilst there are no irrigation works, the conductance of Drain (DRN) cells representing mine activity was set very high, so as to ensure that groundwater drawdown met the assigned, temporally changing, mine elevation.
5.7.2 Does predicted seepage to or from a river exceed measured or expected river flow?	N/A	Ephemeral watercourses are not represented in this model.
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	Provided in Jacobs (2022).
5.7.4 Is diffuse recharge from rainfall smaller than rainfall?	Yes	Jacobs (2022) has clarified that a factor of 0.036% (Zone 1) and 0.177% (Zone 2) is applied to observed monthly rainfall or to observed annual rainfall, as relevant.
5.7.5 Are model storage changes dominated by anomalous head increases in isolated cells that receive recharge?	No	Drawdown plots do not indicate anomalous changes in groundwater elevation.
5.8 Has particle tracking been considered as an alternative to solute transport modelling?	No	JBS&G understands that the modelled equilibrium water levels (calculated externally, with a Drain (DRN) applied in the groundwater model during recovery) are substantially below the proximal regional water table; hence particle tracking to confirm the final voids are acting as groundwater sinks should not be required.
6 Uncertainty		
6.1 Is some qualitative or quantitative measure of uncertainty associated with the prediction reported together with the prediction?	Yes	'Method 1' (IESC, 2018) uncertainty analysis has been undertaken, and is appropriate for this 'low risk' project. Appendix D presents a comparison of the extent of drawdown considering the outcome of uncertainty analysis.
6.2 Is the model with minimum prediction error variance chosen for each prediction?	No	PEST or PESTPP-iES has not been used. Instead, subjective change to value of hydraulic properties have been used instead.
6.3 Are the sources of uncertainty discussed?		
6.3.1 Measurement of uncertainty of observations and parameters	Yes	A discussion of the range of results from hydraulic testing informed the approach to model structure. Analysis indicated there did not appear to be a depth-dependence to the values of hydraulic conductivity. Accordingly, Jacobs (2021) have assumed consistent values of hydraulic properties with depth.
6.3.2 Structural or model uncertainty	Yes	Exclusion of identified faults/geological lineaments is noted, and justified, as a limitation to the groundwater model.

Review Questions	Yes/No	Comment
		The role of these features is recommended to be included in the next version of the groundwater model.
6.4 Is the approach to estimation of uncertainty described and appropriate?	Yes	'Method 1' of IESC(2018), whilst simple, and subjective, is reasonable in the context of this being a 'low risk' extension to an existing mine, in a region where mining has been on-going for a considerable period.
6.5 Are there useful depictions of uncertainty?	Yes	Contours of outcome of different prediction uncertainty simulations with respect to drawdown are presented in Appendix D.
7 Solute Transport	N/A	No comment required.
8 Surface water – groundwater interaction		
8.1 Is the conceptualisation of surface water–groundwater interaction in accordance with the model objectives?	Yes	The approach adopted by Jacobs was to consider the regional groundwater system only. As such, there is no expected surface water/groundwater interaction due to the Extension Project.
8.2 Is the implementation of surface water–groundwater interaction appropriate?	N/A	No comment required.
8.3 Is the groundwater model coupled with a surface water model?		
8.3.1 Is the adopted approach appropriate?	N/A	No comment required.
8.3.2 Have appropriate time steps and stress periods been adopted?	N/A	No comment required.
8.3.3 Are the interface fluxes consistent between the groundwater and surface water models?	N/A	No comment required.