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Memo

To	Emma McGivern	Company	Rio Tinto Copper
From	Jon Hall and Kathryn Rozlapa	Job No.	238D
Date	23rd April 2025	Doc No.	014b
Subject	Winu H3 Peer Review		

1. EXECUTIVE SUMMARY

AQ2 reviewed the Winu H3 Hydrogeological Investigation report prepared by Worley (Rev 1: REP-HG-032). The report documents the hydrogeological investigations and associated groundwater modelling to support the dewatering assessment for the Winu Open Pit. The assessment also included the simulation of additional water supply pumping from bores located to the north and south of the proposed pit.

The work completed to date (including exploratory drilling, test pumping and groundwater modelling) has supported the assessment of dewatering requirements for the Winu Open Pit over a range of aquifer parameters using an automated modelling approach. The parameter ranges adopted for the modelling are supported by the additional hydraulic testing completed, however we note that there is still some uncertainty in the adopted unconfined aquifer storage (specific yield) values adopted in the modelling. The approach taken and work completed to date has also demonstrated that there will likely be minimal regional drawdown impacts in response to proposed pumping.

The work completed to date is suitable to support the Department of Water and Environmental Regulation H3 level of assessment.

2. INTRODUCTION

The Winu project is wholly owned by Rio Tinto and is located approximately 320 km east of Port Hedland in the Pilbara region of Western Australia. The project will develop a copper-gold mine and associated infrastructure. The Winu Open Pit will require dewatering and over the life of the mine an additional water supply of up to 2.8GL/a may be required to support the project in some years. The development (and licensing) of the Rimfire Borefield to meet this potential additional demand is the subject of a separate stand-alone report.

The dewatering assessment for Winu has been the subject of ongoing hydrogeological, drilling and testing programmes since 2018. The current Winu Department of Water and Environment (DWER) H3 level hydrogeological assessment summarises the outcomes of all studies to date to support:

- The hydrogeological conceptualisation of the Winu mine area.
- The life of mine dewatering requirements for the Winu Open Pit and associated water supply requirements and a life of mine water balance.

- The impacts of dewatering and water supply pumping.

3. CURRENT SCOPE OF WORK

AQ2 were engaged by Rio Tinto to provide ongoing review during the assessment and modelling phases of the project. This report presents a documented Peer Review of the work completed to support the DWER H3 assessment. The review includes:

- The current (updated) hydrogeological conceptualisation.
- The representation of the current hydrogeological conceptualisation in the groundwater model.
- Groundwater model updates, calibration performance, predictions and treatment of uncertainty.

The Winu H3 Hydrogeological Assessment (Document no. Rev 1: REP-HG-032) was used to complete the review (Worley, 2025). Groundwater model input and output files were not reviewed. No further analyses of data or model runs were completed.

4. REVIEW

4.1 Background

The Winu H3 report prepared for the project provides detail on the previous hydrogeological studies completed by Golder and the most recent hydrogeological studies completed by Worley in 2023/2024. The studies completed by Worley included:

- Pumping tests at four bores (WINU0910, WINU0913, WINU0942 and WINU0944) in 2023.
- Pumping tests at four bores (WINU0076, WINU0917, WINU0925 and WINU1305) in 2023 /2024.
- Inclusion of the analyses of pumping tests in the hydrogeological conceptual model.
- Inclusion of additional geological information in the hydrogeological conceptual model including:
    - Consideration of the impact of the Thorny Devil Fault and the pre-mineralisation mafic sill as it impacts hydraulic connection to regional aquifers to the west and east of the Winu open pit.
    - The extent of the granite at Winu South consistent with drilling results and geophysical data.
- Updates to the Winu regional numerical including:
    - Updates to the Winu area hydrogeological conceptualisation.
    - Calibration of the model (to pumping tests) using automated techniques (pilot points) and aquifer parameter ranges constrained by aquifer testing to date.
    - Re-prediction of dewatering and water supply requirements and impacts using the updated groundwater model.

The outcomes of the current study are generally reported by comparison to the outcomes of previous studies for the Winu Open pit.

4.2 Review

Our review of the H3 report is below:

- The results of additional hydraulic testing are consistent with the existing hydrogeological conceptualisation for the Winu area.
- The model updates are consistent with the updates to the hydrogeological conceptualisation. The model calibration approach is reasonable given the amount of available data and uses the test pumping data collected across the Winu site for model calibration. The calibration approach uses an automated approach (pilot points) to produce a number of possible model calibrations based on constrained aquifer parameters ranges. The aquifer parameter ranges and weightings used to

complete the calibration are consistent with the available data. The model set up and calibration performance is also consistent with the amount of available data and the hydrogeological complexity observed at Winu.

- Values of specific yield (unconfined storage) have been varied as part of the automated model calibration process, however during model calibration all aquifers remained confined (due to limited drawdown). As a result there is still some uncertainty in the assigned values of aquifer specific yield rather than any certainty derived from model calibration.
- Some details of the model set up are not clearly presented including:
  - Conductance values assigned to the general head boundaries (model inflow and outflow boundaries).
  - The pumping constraints (minimum water levels) assigned to dewatering and water supply bores.
- Model predictions are completed for two cases of hydrogeological uncertainty to assess the impact of horizontal flow barriers on dewatering requirements (i.e. the impact on dewatering of reduced flow through the Thorny Devil Fault and the pre-mineralisation mafic sill).
- Model predictions have been completed to include dewatering from in-pit and ex-pit bores. Model predictions also included a water supply strategy to provide water supply for the early stages of mine development. The water supply aspects of the predictions were not optimised but were used to provide an indication of the likely water supply capacity of the near mine area (in addition to targeted dewatering).
- Combined dewatering and water supply was simulated over the life of mine (2027 to 2069). Model predictions of dewatering and water supply were completed for the updated mine plan and the two structural permeability scenarios.

  For the case that included no impediment to flow, predicted dewatering and water supply rates were predicted to be:
  - 150 to 250L/s from Yr 1 to Yr 13;
  - 125 to 150L/s from Yr 15 to Yr 29;
  - Less than 125L/s after Yr 19.

  For the partial flow barrier case, dewatering and water supply rates were predicted to be:
  - Between 150 and 250L/s up to Yr 15;
  - Between 125 and 175L/s from Yr15 to Yr 23;
  - Less than 125L/s from Yr 23.
- Model uncertainty analysis has been completed using an automated approach based on 150 model realisations (or equally plausible calibrations). These explored ranges in:
  - Horizontal and vertical hydraulic conductivity.
  - Confined and unconfined storage coefficient.

  This approach to addressing uncertainty is consistent with the guidelines developed by Peeters and Middlemis (2023).
- Combined dewatering and water supply predictions are presented as a range around the P50 realisation. Maximum and minimum (P5 and P95) dewatering predictions from this approach are predicted to deviate from the P50 realisation by up to 40%. Impacts from this approach suggest that predicted drawdown over the life of mine is unlikely to extend beyond 15 km from the open pit and to sensitive receptors in the region (groundwater soaks). This drawdown prediction is based on the extent of predicted drawdown of 2 m. While these minimum and maximum predictions are described as very unlikely the possibility of these outcomes cannot be discounted at this stage of the study.
- It is not clearly stated in the report what specific parameter values drive the variation in predicted dewatering (and water supply) requirements. While the uncertainty analysis has been reported, it is

not clear if the assigned storage or hydraulic conductivity values result in the variations in predicted outcomes.

- The comparatively short length of time of the available groundwater monitoring data, the spatial distribution of water levels included in the model calibration data set and the magnitude of the aquifer stresses in relation to the length of time and stresses included in model predictions means that there is still uncertainty associated with long term model predictions (i.e. over the life of the mine). However, this is no different to any pre-mining dewatering prediction.
- The model is classified as Class 2 under the best practice guidelines (Barnett et all, 2012) although some areas of the model remain within the Class 1 (lowest) classification. The modelling review checklist of the Australian Groundwater modelling guidelines (Barnett et al, 2012) is provided in Appendix A.
- Detailed water balance assessment results are presented for the P50 or likely outcome only. However, it is stated that water balance results for the unlikely and very unlikely uncertainty outcomes indicate that make up water demand might be as high as 2GL/a in some years. This make up water demand can be met by pumping from the Rimfire Borefield.

5. SUMMARY

The additional analysis and hydrogeological conceptualisation completed for the Winu mine area to support the current H3 report appears to be reasonable based on the available data.

The overall model development and calibration appears reasonable and is consistent with the amount of data available at this stage of the project. However, the length of time of the monitoring and the spatial distribution of water levels included in the model calibration data set and the magnitude of the aquifer stresses compared to the length of time and stresses included in model predictions means that there remains some uncertainty associated with long term model predictions (i.e. over the life of the mine and once mining is complete). Again, this is consistent with any pre-mining dewatering assessment and (as with any other mining project) it will not be possible to significantly reduce the residual uncertainty until such time as operational dewatering monitoring data are available to validate and recalibrate (if necessary) the groundwater model.

Model uncertainty has been addressed by using an automated uncertainty analysis approach, consistent with the guidelines developed by Peeters and Middlemis (2023). These predictions show a range of combined dewatering and water supply predictions and drawdown impacts. The model is not calibrated to aquifer specific yield and the extreme values of dewatering (high and low or P5 and P95) cannot be discounted at this stage of the assessment.

More certainty in model predictions will only be achieved via operation of the dewatering and water supply schemes and the incorporation of operational data into the hydrogeological conceptualisation and groundwater model (via model set up and re-calibration if required).

6. REFERENCES

Worley, 2025. Winu H3 Hydrogeological Assessment. Prepared for Rio Tinto Copper. March 2025. Document No Rev 1: REP-HG-032

Barnett et al, 2012. *Australian groundwater modelling guidelines*, Waterlines report, National Water Commission, Canberra.

Peeters LJM and Middlemis H 2023. Information Guidelines Explanatory Note: Uncertainty analysis for groundwater modelling, A report prepared for the Independent Expert Scientific Committee on Coal Sean.

Gas and Large Coal Mining Development through the Department of Climate Change, energy the Environment and Water, Commonwealth of Australia, 2023.

Regards,

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Attached: Appendix A

APPENDIX A

Appendix A

Winu Groundwater Model

Table A1: Review checklist (after Table 9-2 of Australian Groundwater Modelling Guidelines)

Review Questions	***Yes/No/NA[1]/U[2]/C[3]***	***Comment***
1. Planning		
1.1 Are the project objectives stated?	Yes	
1.2 Are the model objectives stated?	Yes	
1.3 Is it clear how the model will contribute to meeting the project objectives?	Yes	
1.4 Is a groundwater model the best option to address the project and model objectives?	Yes	
1.5 Is the target model confidence-level classification stated and justified?	Yes	.
1.6 Are the planned limitations and exclusions of the model stated?	Yes	
2. Conceptualisation		
2.1 Has a literature review been completed, including examination of prior investigations?	Yes	
2.2 Is the aquifer system adequately described?	Yes	
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	
2.2.3 Aquifer geometry including layer elevations and thicknesses	Yes	
2.2.4 Confined or unconfined flow and the variation of these conditions in space and time?	Yes	
2.3 Have data on groundwater stresses been collected and analysed?		
2.3.1 Recharge from rainfall, irrigation, floods, lakes	Yes	
2.3.2 River or lake stage heights	NA	
2.3.3 Groundwater usage (pumping, returns etc)	Yes	Pumping tests.
2.3.4 Evapotranspiration	Yes	
2.3.5 Other?	NA	
2.4 Have groundwater level observations been collected and analysed?		
2.4.1 Selection of representative bore hydrographs	Yes	Pumping test only
2.4.2 Comparison of hydrographs	Yes	

[1]Not applicable
[2] Unknown
[3] Comment

Review Questions	*Yes/No/NA[1]/U[2]/C[3]*	*Comment*
2.4.3 Effect of stresses on hydrographs	Yes	
2.4.4 Watertable maps/piezometric surfaces?	Yes	
2.4.5 If relevant, are density and barometric effects taken into account in the interpretation of groundwater head and flow data?	NA	
2.5 Have flow observations been collected and analysed?		
2.5.1 Baseflow in rivers	NA	
2.5.2 Discharge in springs	NA	
2.5.3 Location of diffuse discharge areas?	NA	
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)	NA	
2.6.2 Spatial variability/heterogeneity of parameters	Yes	
2.6.3 Interpolation algorithm(s) and uncertainty of gridded data?	Yes	
2.7 Have consistent data units and geometric datum been used?	Yes	
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	
2.8.2 Is the conceptual model based on all available, relevant data?	Yes	
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	
2.9.2 Is justification provided for omission or simplification of processes?	Yes	
2.10 Have alternative conceptual models been investigated?	Yes	
3. Design and construction		
3.1 Is the design consistent with the conceptual model?	Yes	
3.2 Is the choice of numerical method and software appropriate (Table 4-2)?	Yes	
3.2.1 Are the numerical and discretisation methods appropriate?	Yes	
3.2.2 Is the software reputable?	Yes	
3.2.3 Is the software included in the archive or are references to the software provided?	No	
3.3 Are the spatial domain and discretisation appropriate?		
3.3.1 1D/2D/3D	Yes	
3.3.2 lateral extent	Yes	

Review Questions	*Yes/No/NA[1]/U[2]/C[3]*	*Comment*
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	
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	
3.4 Are the temporal domain and discretisation appropriate?		
3.4.1 Steady state or transient	Yes	
3.4.2 Stress periods	Yes	
3.4.3 Time steps?	U	Detail on time stepping not provided.
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	
3.5.2 Are the boundary conditions chosen to have a minimal impact on key model outcomes? How is this ascertained?	Yes	
3.5.3 Is the calculation of diffuse recharge consistent with model objectives and confidence level?	NA	Not included
3.5.4 Are boundaries time-invariant?	Yes	
3.6 Are the initial conditions appropriate?		
3.6.1 Are the initial heads based on interpolation or on groundwater modelling?	Yes	Based on a steady state calibration.
3.6.2 Is the effect of initial conditions on key model outcomes assessed?	NA	
3.6.3 How is the initial concentration of solutes obtained (when relevant)?	NA	
3.7 Is the numerical solution of the model adequate?		
3.7.1 Solution method/solver	Not provided	
3.7.2 Convergence criteria	NA	
3.7.3 Numerical precision	Yes	
4. Calibration and sensitivity		
4.1 Are all available types of observations used for calibration?	Yes	
4.1.1 Groundwater head data	Yes	
4.1.2 Flux observations	NA	
4.1.3 Other: environmental tracers, gradients, age, temperature, concentrations etc.	NA	
4.2 Does the calibration methodology conform to best practice?		
4.2.1 Parameterisation	Yes	
4.2.2 Objective function	Yes	

Review Questions	*Yes/No/NA[1]/U[2]/C[3]*	*Comment*
4.2.3 Identifiability of parameters	Yes	
4.2.4 Which methodology is used for model calibration?	Automated	PEST suite. Pilot points
4.3 Is a sensitivity of key model outcomes assessed against?		
4.3.1 Parameters	Yes	
4.3.2 Boundary conditions	No	
4.3.3 Initial conditions	No	
4.3.4 Stresses	No	
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	
4.4.2 Is it clear whether observed or assumed vertical head gradients have been replicated by the model?	Yes	Not simulated
4.4.3 Are calibration statistics reported and illustrated in a reasonable manner?	Yes	
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	
4.5.2 Temporally	Yes	
4.6 Are the calibrated parameters plausible?	Yes	
4.7 Are the water volumes and fluxes in the water balance realistic?	Yes	
4.8 Has the model been verified?	No	Not enough data available for this
5. Prediction		
5.1 Are the model predictions designed in a manner that meets the model objectives?	Yes	
5.2 Is predictive uncertainty acknowledged and addressed?	Yes	
5.3 Are the assumed climatic stresses appropriate?	Yes	
5.4 Is a null scenario defined?	No	Not required.
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?	No	Pumping stresses and durations are much larger than those included in model calibration.
5.5.2 Are well losses accounted for when estimating maximum pumping rates per well?	No	
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?	No	Uncertainty is acknowledged

Review Questions	*Yes/No/NA[1]/U[2]/C[3]*	*Comment*
5.5.4 Are the assumed stresses and timescale appropriate for the stated objectives?	Yes	
5.6 Do the prediction results meet the stated objectives?	Yes	
5.7 Are the components of the predicted mass balance realistic?	Yes	
5.7.1 Are the pumping rates assigned in the input files equal to the modelled pumping rates?	NA	
5.7.2 Does predicted seepage to or from a river exceed measured or expected river flow?	NA	
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)?	NA	
5.7.4 Is diffuse recharge from rainfall smaller than rainfall?	NA	
5.7.5 Are model storage changes dominated by anomalous head increases in isolated cells that receive recharge?	No	
5.8 Has particle tracking been considered as an alternative to solute transport modelling?	NA	Not required.
6. Uncertainty		
6.1 Is some qualitative or quantitative measure of uncertainty associated with the prediction reported together with the prediction?	Yes	
6.2 Is the model with minimum prediction-error variance chosen for each prediction?	Yes	
6.3 Are the sources of uncertainty discussed?	Yes	
6.3.1 Measurement of uncertainty of observations and parameters	No	
6.3.2 Structural or model uncertainty	Yes	Parameter & hydrogeological uncertainty
6.4 Is the approach to estimation of uncertainty described and appropriate?	Yes	
6.5 Are there useful depictions of uncertainty?	Yes	
7. Solute transport		
7.1 Has all available data on the solute distributions, sources and transport processes been collected and analysed?	NA	
7.2 Has the appropriate extent of the model domain been delineated and are the adopted solute concentration boundaries defensible?	NA	
7.3 Is the choice of numerical method and software appropriate?	NA	
7.4 Is the grid design and resolution adequate, and has the effect of the discretisation on the model outcomes been systematically evaluated?	NA	
7.5 Is there sufficient basis for the description and parameterisation of the solute transport processes?	NA	
7.6 Are the solver and its parameters appropriate for the problem under consideration?	NA	
7.7 Has the relative importance of advection, dispersion and diffusion been assessed?	NA	

Review Questions	*Yes/No/NA[1]/U[2]/C[3]*	*Comment*
7.8 Has an assessment been made of the need to consider variable density conditions?	NA	
7.9 Is the initial solute concentration distribution sufficiently well-known for transient problems and consistent with the initial conditions for head/pressure?	NA	
7.10 Is the initial solute concentration distribution stable and in equilibrium with the solute boundary conditions and stresses?	NA	
7.11 Is the calibration based on meaningful metrics?	NA	
7.12 Has the effect of spatial and temporal discretisation and solution method taken into account in the sensitivity analysis?	NA	
7.13 Has the effect of flow parameters on solute concentration predictions been evaluated, or have solute concentrations been used to constrain flow parameters?	NA	
7.14 Does the uncertainty analysis consider the effect of solute transport parameter uncertainty, grid design and solver selection/settings?	NA	
7.15 Does the report address the role of geologic heterogeneity on solute concentration distributions?	NA	
8. Surface water–groundwater interaction		
8.1 Is the conceptualisation of surface water–groundwater interaction in accordance with the model objectives?	NA	
8.2 Is the implementation of surface water–groundwater interaction appropriate?	NA	
8.3 Is the groundwater model coupled with a surface water model?	NA	
8.3.1 Is the adopted approach appropriate?	NA	
8.3.2 Have appropriate time steps and stress periods been adopted?	NA	
8.3.3 Are the interface fluxes consistent between the groundwater and surface water models?	NA	