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Project No. 42907707

Resource Development Iron Ore, Rio Tinto
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Attention: Dr Shawan Dogramaci
Specialist Hydrogeologist

Dear Shawan

Subject: Yandicoogina Model Review

1. Background

The Yandicoogina Model was developed by Rio Tinto Resource Development, Iron Ore. This regional scale groundwater model was developed for the Yandicoogina Mine, located approximately 85 km northwest of Newman and 145 km east of Tom Price in the Pilbara Region of Western Australia.

The expected applications of the Yandicoogina Model included:

- To incorporate the new conceptual understanding of the local hydrogeology at Yandicoogina into a regional-scale, numerical groundwater model;
- To calibrate this model to accurately reflect regional trends in the groundwater domain;
- To keep the model as simple as possible, while honouring the conceptualisation and therefore the previous objectives; and
- To use the calibrated model to run predictive dewatering scenarios for future mine plans.

2. Review Result

The model peer review was carried out in accordance with the Murray Darling Basin Commission Groundwater Flow Modelling Guideline (MDBC, 2001). The review covered nine categories of the modelling work with the findings in each category are summarised below.

1. Model Report

Three reports have been produced, including

- Yandicoogina 2010 Regional Groundwater Modelling Report (Inverarity, February, 2011). This provides the technical details about the model development and calibration results. It also provides the result of dewatering simulations for the proposed mining operation.

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- Yandicoogina Water Balance; Pre and Post Mining Hydraulics and Hydrochemistry (Kirkpatrick and Dogramaci, April 2010). This report provides a review of groundwater quantity and quality data for the period 1974 and 2009. The report emphases hydrographic and hydrochemical responses to recharge and discharge (natural and man-made), groundwater flow and evaporation process. It also provides analysis of stream flow hydrograph in responding to groundwater and mining discharge interactions.

- Yandicoogina Hydrogeological Assessment of the CID and Adjacent Floodplain (Kirkpatrick and Dogramaci, August 2010). This report provides hydrogeological assessment and catchment water balance and hydrological interpretation. It provides detailed hydrogeological cross sections and hydrochemical analyses.

2. Data analysis

The data analysis includes rainfall and recharge analyses in terms of quantity and quality, hydrographs and hydrochemical analysis, aquifer property interpretation, and surface water quantity and quality sampling and analysis.

3. Hydrogeological Conceptualisation

There is detailed analysis of the geological and hydrogeological setting and parameterisation, characterisation of groundwater flow and hydrochemical processes, groundwater recharge using both water quantity and quality data, and interpretation of surface and groundwater interaction.

4. Model Design

The model covers an area of 600 km^2 (30 km by 20 km) and includes the majority of RTIO's Yandicoogina Deposits. The grid size is 100 m by 100m. The model has three layers to represent the alluvium, CID and fractured rock aquifer, and Weeli Wolli / Brockman Formation. Boundary conditions include recharge, drains, wells, evaporation, constant head boundary and streamflow-routing package.

The modelling platform includes Visual Modflow and Modflow Surfact.

5. Calibration

Steady-state and transient calibrations have been performed. Four calibration measures and criteria have been assessed and reported, including:

- Water Balance error;
- Iteration residual error;
- Qualitative measures; and
- Quantitative measures.

The scaled Root Mean Square (RMS) is 8.59%.

6. Verification

The model calibration period is between January 1991 and December 2007, and the verification is a continuation of the calibration, from 2007 to December 2009. Seventeen monitoring sites were used for the model verification.

7. Model Prediction

The calibrated model has been used for a series of predictive dewatering simulations based on the mine plans.

8. Sensitivity Analysis

Sensitivity analyses were carried out through model calibration and post calibration. It was indicated that Type IV sensitivity exists in the model. It was considered unnecessary to perform detailed sensitivity analysis, for the purpose of this modelling excise.

9. Uncertainty Analysis

A quantitative analysis of model uncertainty is considered not within in the scope of the current modelling work. Uncertainty was discussed, however, in the context of calibration.

3 Conclusion

The review finds that the Yandicoogina Model has been developed satisfactorily with respect to the stated objectives. The model conceptualisation is supported by significant improvement in the conceptual hydrogeological model, and is reported and illustrated in detail. This conceptual hydrogeological model and Yandicoogina Model were complimented by detailed hydrochemical interpretations and mass balance calculations. The model design and reporting are adequate with respect to the modelling objectives.

The model was assessed in accordance with the MDBC Groundwater Modelling Guidelines. It was concluded that the model construction and calibration meet the MDBC Groundwater Modelling Guidelines, and the model was suitable for the intended applications.

Yours sincerely

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