BHP Mitsubishi Alliance

Appendix G

Third Party Groundwater Peer Review

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From: **Dr Noel Merrick**

Re: **Grevillea Pit EPBC Approval – Groundwater Peer Review**

Introduction

This report provides a third party review of the groundwater modelling and impact assessment for the Grevillea Pit within the Saraji Mine (SRM) for the client BM Alliance Coal Operations Pty Ltd (BMA). The groundwater modelling has been done by SLR Consulting Australia (SLR) as a prelude to an impact assessment (by SLR) that focuses on federal requirements under the EPBC Act.

The Grevillea Pit lies between the Ebony and Hakea pits within the SRM open cut coal mine at a distance of 13 km due north of Dysart (Qld) in the Bowen Basin. It is flanked by Spring Creek to the north and Phillips Creek to the south. Continuation of the pit eastwards towards the Lake Vermont Mine is planned with a production life of about 30 years.

The scope of work is limited to a peer review of final groundwater modelling as articulated in the draft final groundwater impact assessment report by SLR. The focus of the review is on gaps or deficiencies pertinent to federal government approval.

The review has been conducted solely by Dr Noel Merrick of HydroAlgorithmics Pty Ltd. He has considerable familiarity with the hydrogeology of the coal mines in the Bowen Basin, having recently completed reviews of the groundwater components of the Saraji East Mining Lease Project and the Saraji South Mine PRC Plan.

He is a long-term member of the Queensland Office of Groundwater Impact Assessment (OGIA) Technical Advisory Panel for the Surat Cumulative Management Area, which includes the southern Bowen Basin. He was Technical Director for the Olive Downs South (ODS) groundwater impact assessment[1], and was engaged by Pembroke to act as an expert witness in a court case on that project. He has conducted many peer reviews of models in the Bowen Basin, including Caval Ridge, Horse Pit Extension, South Walker, Winchester South, Blackwater, and Lake Vermont Meadowbrook.

[1] HydroSimulations, 2018. Olive Downs Coking Coal Project Groundwater Assessment. Report HS2018/26 for Pembroke Olive Downs Pty Ltd. July 2018.

Documentation

This review is based on the following report:

1. SLR, 2024. Saraji Mine Grevillea Pit Continuation Project Groundwater Impact Assessment. Prepared for Engeny on behalf of BM Alliance Coal Operations Pty Ltd. Project 620.040484.00001. Revision 04, 13 September 2024. 138p + 1 Appendix.

The Appendix documents the groundwater modelling for the Project:

2. SLR, 2024. Saraji Mine Grevillea Pit Continuation Project Groundwater Modelling Technical Report. Prepared for Engeny on behalf of BM Alliance Coal Operations Pty Ltd. 620.040484.00000. Revision 3.0, 12 September 2024. 98p + 5 Appendices.

Document #1 has the following major sections:

1. Introduction
2. Legislative Requirements and Guidelines
3. Existing Environment
4. Groundwater Model
5. Impact Assessment
6. Management Measures
7. References

Document #2 has the following major sections:

1. Introduction
2. Model Construction and Development
3. Predictive Modelling
4. Sensitivity Analysis
5. Uncertainty Analysis
6. Model Confidence Level Classification
7. Groundwater Model and Data Limitation
8. Conclusions
9. References

The Appendices are:

A. Calibration Residuals
B. Calibration Hydrographs
C. Hydraulic Parameters and Recharge Zone Distribution
D. Stress Periods and Simulated Active Mine Timings
E. Uncertainty Analysis Parameter Distributions

Groundwater Model Status

The groundwater model has developed from the well-received groundwater model for the approved ODS Coking Coal Project to the east of the Project (HydroSimulations, 2018). This foundational model has undergone a number of updates for more precise geometry and optimised parameterisation at other individual coal mines. For this Project, the model has retained the same extent and parameterisation as for a recent investigation for the Saraji East underground project without including the longwall panels in that project.

The model extent is necessarily large, being about 60 km in an east-west direction and about 95 km in a north-south direction. Given the large area and 19 layers, a minimum

cell dimension of 50 m, and incorporation of many neighbouring open cut and underground mines, a total cell count of 1.36 million remains efficient but is close to the limit of a manageable model size. Separate layers are designated for four coal seams (Q, P, H, D) in the Moranbah Coal Measures.

Key features of the modelling approach are:

- MODFLOW-USG plus AlgoMesh software platform for better mass balance and better spatial resolution;
- conventional PEST calibration for steady-state and transient conditions;
- application of an identifiability procedure during the calibration process to replace sensitivity analysis by perturbation, in which many more model properties can be included, and relative sensitivities are produced as a matter of course;
- assessment of the sensitivity of the magnitude of key model predicted outputs by a Type I to IV identifiability analysis; the considered outputs (Quantities of Interest) are pit inflow and maximum cumulative drawdowns; and
- an IESC-compliant *monte carlo* style rigorous procedure for uncertainty analysis.

The reviewer concurs with the applied modelling methodology and recognises it as "state-of-art".

Calibration performance statistics of 5.9% SRMS and 8.9 mRMS for the entire model are acceptable. Table 2-7 in Document #2 unpacks the performance at individual mines in terms of the average residual statistic. This shows a tendency to overestimation of groundwater levels at most mines, contrary to net underestimation at the Saraji mine (including Grevillea Pit). The scatter plot in Figure 2-7 reinforces this bias toward underestimation for the basecase model. A high-level consequence might be an underestimation of pit inflows, but that deduction is offset through investigating the separate outputs of a multitude of similarly calibrated models in the subsequent uncertainty analysis.

While Appendix A presents all simulated hydrographs in comparison to measurements over the full model extent, those closest to Grevillea Pit are:

- MB36 to the south-east in Fort Cooper Coal Measures; here, the simulated level is low by about 5 m.
- MB39 and MB40 in regolith and Tertiary sediments beneath Phillips Creek downsteam; they show simulated levels about 10 m lower than those measured.
- PZ06A, PZ06B and PZ06C to the south in P, H and D seams; respectively, they are about 8 m low, 5 m low and 4 m high.

Bore MB32 in upstream Phillips Creek alluvium shows good correlation with rainfall trends in Figure 21 of Document #1, but no simulated hydrograph for this bore is shown in Document #2.

Groundwater Assessment

The groundwater modelling objectives are stated in Document #2 at the outset (Section 1.2) in the form of three dot points:

- *Assess the groundwater inflow to the Project mine workings as a function of mine position and timing.*
- *Simulate and predict the extent of groundwater level drawdown due to the Project.*
- *Identify areas of potential environmental risk, where groundwater impact management measures may be necessary.*

The model has been constructed and applied to address these objectives satisfactorily.

The broader groundwater assessment objective is to meet the requirements of the EPBC Act Significant Impact Guidelines and the IESC Information Guidelines, as outlined in Sections 2.2 and 2.3 of Document #1, respectively. Based on outputs from the modelling, the potential for significant impacts is discussed in Section 5.5 of Document #1.

My opinions on the key features of the groundwater assessment are summarised in the following sections.

Overviews

Adequate coverage is provided for:

- The sensitivity, quality and value of the groundwater resource.
- Regulations and guidelines.
- Project purpose, scale and duration.
- Geology and hydrogeology.
- Data collation and hydrogeological conceptualisation.
- Modelling methodology.

Quantities of Interest (QoIs)

The relevant Quantities of Interests (QoIs) are defined in Section 7.0 of Document #2 as “the groundwater inflows and drawdowns to assess licensing, site water management and drawdown impacts”.

Cumulative Impact

The Grevillea groundwater model assesses the cumulative impact of all coal mines in the model area by running scenarios with and without Grevillea Pit. A null scenario (with no mining) allows determination of drawdowns by differencing simulated groundwater levels.

The effects of the Bowen Gas Project (BGP) are not simulated. The BGP is a coal seam gas (CSG) development by Arrow Energy Pty Ltd, targeting gas within coal seams of the Rangal Coal Measures and Moranbah Coal Measures. The modelling report by Ausenco Norwest[2] (2012) suggests planned activity close to the Grevillea Pit

[2] Ausenco Norwest Corporation, 2012. Groundwater Model, Northern Bowen Basin Regional Model Impact Predictions Queensland, Australia. Report for Arrow Energy Pty Ltd, 10 October 2012.

footprint, and indicates significant drawdowns only in Permian sediments close to Grevillea Pit.

Inclusion of large-scale CSG activity in a groundwater model would be a major undertaking. It was modelled in the ODS study (HydroSimulations, 2018) but to the best of my knowledge has not been specifically simulated since then for coal mine developments in the Bowen Basin. In my opinion, reference to the results of Ausenco Norwest (2012) and HydroSimulations (2018) would be sufficient by invoking the Principle of Superposition.

Project Impact

The Project's impact intensity, duration, magnitude and extent of QoIs are addressed fully by displays of:

- Pit inflow variability with time (2026-2054) for all SRM pits with and without Grevillea Pit [Figure 35 in Document #1; Figure 3-22 in Document #2].
- Maximum spatial drawdown in model layers 1, 2, 12, 14, 16 and 18 [Figures 36-41 of Document #1].

Predicted "hot spots" are indicated by the centres of closed maximum drawdown contours. "Hot moments" are evident by the years when inflow spikes are predicted to occur, with a periodicity of about five years. They are not explored, however, for the drawdown QoI - in other words, only the maximum drawdown magnitude is shown, not the year(s) in which drawdown peaks.

Interactions with Phillips Creek and Isaac River are examined and the effects on them by Grevillea Pit mining are predicted to be negligible.

Uncertainty

Uncertainty is explored by both identifiability analysis and a full *monte carlo* uncertainty analysis. In both cases, the considered parameters are horizontal hydraulic conductivity, hydraulic conductivity anisotropy, specific storage, specific yield and diffuse recharge.

The results of the identifiability analysis are:

- the highest identifiabilities during calibration were found for horizontal hydraulic conductivity and recharge;
- for predicted pit inflows, four layer anisotropies and one specific yield are significant as having the potential to cause large changes in predictions for small changes in their adopted values; and
- for predicted maximum drawdown, two anisotropies, two specific yields and two specific storages are found to present risk.

The uncertainty analysis is performed by using an ensemble of 71 calibrated model realisations to infer the probabilities of occurrence of the QoIs in IESC-compliant language. The tests for convergence of each QoI (not often done) indicate that stable estimates are not quite converged as a slight downwards trend is evident. This suggests that the reported predictions of both inflow and maximum drawdown will be conservative in the sense of being overestimations of likely effects.

Faulting

There are no structural faults mapped across the Grevillea Pit footprint, but there is a regional fault clipping the western corner of the pit. Across the broader model area, many structural faults are included as zones of finer discretisation (100 m) with properties separate from the host materials.

Comparison of Tables 2-10 and 2-11 (Document #2) for the best calibrated model suggests similar horizontal permeability in the Moranbah Coal Measures and the faults, but generally higher permeability in the faults than in younger formations overlying the Moranbah Coal Measures. However, Section 4.1 (Document #2) notes that "*The horizontal hydraulic conductivity of most of the faults generally has not been able to be constrained well during calibration, relative to their surrounding unit*".

The average horizontal hydraulic conductivity ranges from 0.0019 m/day in Layer 19 to 0.0098 m/day in Layer 3, with assumed log-linear decay through intervening layers. During calibration-constrained uncertainty analysis, no conceptual constraint was placed on faults as to whether they might be barriers or conduits.

Section 3.5.3.2 (Document #1) provides evidence and conceptual reasoning for probable cementation and "healing" of the partings generated when fault displacements occurred, indicating that faults are unlikely to act as hydraulic conduits.

Risk Assessment

Section 5.4 (Document #1) presents a qualitative risk assessment in terms of ranked assessment of consequence and likelihood for six identified risks.

Monitoring

As reported in Table 8 (Document #1) for the current SRM groundwater monitoring network, data on water levels are available since 2014 and water quality data are available from 2009.

The existing 2023 version of the SRM Groundwater Monitoring and Management Plan will require updating to include the proposed Grevillea Pit activities.

Conclusion

Section 7.0 of Document #2 provides a qualitative assessment of four sources of scientific uncertainty, and discusses *fitness for purpose* in terms of model usability, reliability and feasibility, as recommended by the latest IESC Explanatory Note for Uncertainty Analysis[3].

The reviewer agrees that the key conclusions listed in Section 5.5 (Document #1) and in Section 8.0 (Document #2) provide a true and fair account of the results produced by groundwater modelling of the likely effects of Grevillea Pit mining.

The stated regulatory and technical objectives have been addressed adequately.

[3] 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 Seam Gas and Large Coal Mining Development through the Department of Climate Change, Energy, the Environment and Water, Commonwealth of Australia, July 2023.