INDEPENDENT EXPERT ADVISORY PANEL FOR MINING

ADVICE RE:

DENDROBIUM COAL MINE

LONGWALLS 24 to 29

SUBSIDENCE MANAGEMENT PLAN

24 April 2026

Report No: IEAPM 202604-01

EXECUTIVE SUMMARY

On 16 March 2026, the NSW Department of Planning, Housing and Infrastructure (DPHI – "the Department") requested the Independent Expert Advisory Panel for Mining (IEAPM – "the Panel") to provide advice in relation to the adequacy of the groundwater model used as the basis for the proposed Subsidence Management Plan (SMP) for secondary coal extraction from Longwalls 24 to 29 (LWs 24-29) in Area 3C at the Dendrobium Coal Mine.

The scope of the request sought advice from the Panel on the following matters:

"*whether the updated groundwater model and assessment:*

- *address previous Panel recommendations on groundwater modelling made in the Panel advice on LW 21A dated 2 July 2024; and*
- *are adequate to sufficiently inform water[1] related impacts and hydrogeological processes relevant to the proposed extraction of LWs 24-29 and water access licence (WAL) requirements for the mine*".

The Panel notes that GM[3] ("the proponent") has recently submitted a Cumulative Impact Assessment (CIA) as directed by the Department, which considers cumulative subsidence-related impacts of mining in Areas 3A, 3B and 3C up to and including Longwall 21 (LW 21).

A copy of this request for advice is provided in Appendix A.

The Panel's advice is in three parts:

1. Alignment with the Panel's LW 21A Groundwater Modelling Advice
2. Groundwater Model Updates, Modifications and Predictions
3. Additional Comments on the CIA (Appendix F – Groundwater and Surface Water)

KEY FINDINGS

The numerical groundwater model is an effective tool to predict impacts to both surface water and groundwater, in particular groundwater drawdown and depressurisation impacts, and estimates of mine water inflows and surface water seepage losses.

The updated modelling is sufficient to progress an approval for the SMP, however further model improvements are required to more accurately predict the full extent of groundwater drawdowns, and to quantify surface water seepage losses. Predictive results presented in the next model upgrade schedules for 2027/28 will inform the timing for subsequent LWs.

Based on the material presented to the Panel, the Panel has made the following key findings in alignment with the Panel's advice in three parts:

<u>Part 1 - Alignment with the Panel's LW 21A Groundwater Modelling Advice</u>

1. The model improvements in Watershed HydroGeo 2025 satisfy some but not all of the previous Panel recommendations on groundwater modelling improvements stated in the Panel advice on

[1] The Panel understands that dot point 2 relates to both groundwater and surface water.

LW 21A dated 2 July 2024. The updated modelling is much improved however there are two remaining technical issues that should be addressed in the next model update:

- It is uncertain to what extent permeability data from local barrier zone and fault investigations in Area 3C adjacent to Cordeaux Reservoir, recent monitoring, and appropriate lakebed conductance values have been used in the updated modelling, and
- The inclusion of time variable off-goaf (valley closure) effects is required for those areas adjacent to the proposed longwalls to better predict surface water and groundwater impacts.

Part 2 - Groundwater Model Updates, Modifications and Predictions

1. The improvements that have been made to the groundwater modelling approach have enabled assessment of the sensitivity of model predictions to key parameters.
2. The predictive modelling and monitoring of mine water volumes within the mine is adequate to sufficiently inform the groundwater take and align with the groundwater WAL allocation held for the mine.
3. The current predictive modelling is useful in being able to predict surface water take however losses from reservoirs cannot be validated because there is no means of practically measuring or reliably estimating losses from field data.
4. There are no aggregated surface water take estimates presented in the updated predictive modelling for each of the water years during the extraction of LWs 24-29 (i.e. 2027/28 to 2032/33). Volumes need to be quantified to provide a useful basis for determining the annual surface water take requirements for the mine's surface water WAL. There is a low degree of confidence in the recent year estimates due to the removal of time variable off-goaf (valley closure) effects and the possibility of enhanced permeability of the geological strata in the barrier zone adjacent to Cordeaux Reservoir and Wongawilli River.

Part 3 - Additional Comments on the CIA (Appendix F – Groundwater and Surface Water)

1. The cumulative impacts described in this report include groundwater depressurisation, reductions in surface water flow and impacts on swamps.
2. These cumulative impacts are also included in the current modelling predictions for LWs 24-29.

SUMMARY RECOMMENDATIONS

In regard to the updated regional groundwater model used for model predictions and the use of a local model to optimise aquifer parameters, the Panel recommends that next numerical model update should occur before the completion of LW23 (expected in September 2027), prior to the commencement of LWs 24-29. The Panel recommendations the following specific matters be addressed in the next model update:

1. Site specific data from the extraction of LWs 21, 21A, 22 and potentially LW 23 be used to revise and then recalibrate any local model/regional model (whichever model the proponent adopts for the next model update).
2. Aquifer parameter and monitoring data from the 2024 investigations in the barrier zone between the Area 3C longwalls and Cordeaux Dam be used in the next regional model update.

3. Improvements to recharge parametrisation. Forecasting models should account for a range of rainfall scenarios, in line with predicted climate conditions for the region of interest.
4. Model revisions that address time variable off-goaf effects be reinstated in the next regional model update to better estimate:
    - the quantum of streamflow and reservoir seepage losses, and
    - the lateral extent of drawdown in all aquifers and the quantum of mine water inflows
5. The revised model architecture and predictions be peer reviewed prior to the commencement of LW 25.
6. The observed cumulative impact of mining activities undertaken at Dendrobium Mine be incorporated into updates of the numerical groundwater flow models.

Sections 4.1.1, 4.2.6 and 4.3.1 provide recommendations specific to each part of the Panel's advice.

1.0 INTRODUCTION

The Dendrobium Coal Mine is an operating underground coal mine located approximately 8 kilometres (kms) west of Wollongong. The Dendrobium Coal Mine was determined pursuant to development consent DA60-03-2001 ("the consolidated consent") and has been subsequently modified several times.

The proponent is seeking approval for a Subsidence Management Plan (SMP) for secondary coal extraction in the Wongawilli Seam from LWs 24-29 in Area 3C at the Dendrobium Coal Mine (refer to Figure 1).

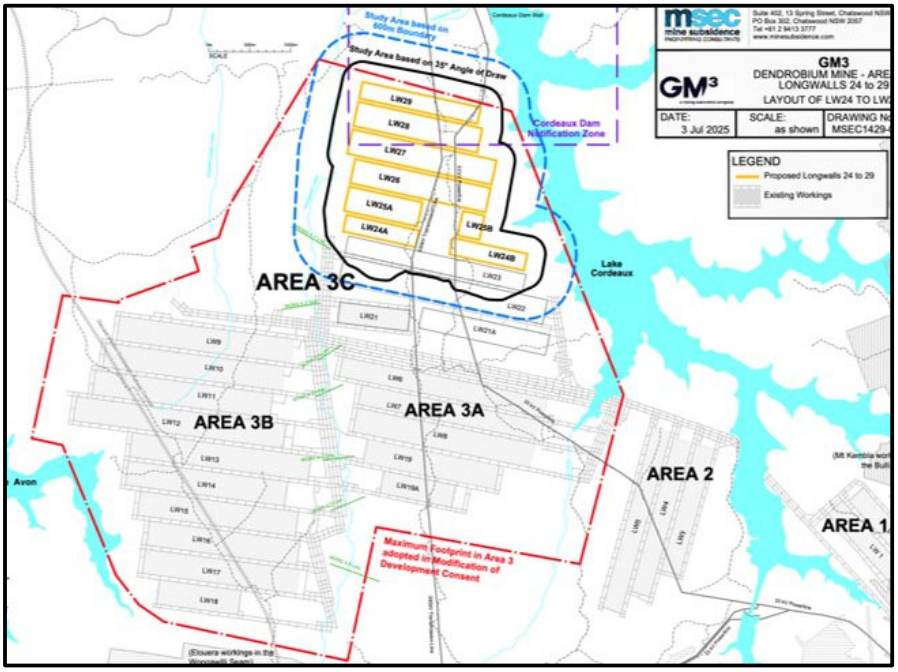

Figure 1: LWs 24-29 in Area 3C

Proposed key design parameters are:

Longwall panels:

- oriented west-northwest between Wongawilli Creek and Lake Cordeaux
- void widths between 210-305 m
- extraction height of 3.9 m
- depth of cover range of 300-400 m.

Layout is optimised to minimise/avoid subsidence impacts, including:

- setback at least 300 m from full supply level of Cordeaux Reservoir
- setback at least 205 m from Wongawilli Creek
- retention of solid coal barrier between LWs 24 and 25 to provide setback from a rock platform containing Aboriginal sites.

Within the Study Area based on 600 m boundary are several sub-catchments of Lake Cordeaux, Wongawilli Creek and Cordeaux River. Cordeaux Dam is a heritage-listed arch dam wall located to the north at the mouth of Cordeaux River. The Study Area is within the Cordeaux Dam Notification Zone. The Cordeaux Reservoir has an operating capacity of 93,640 ML and a full supply level (FSL) of

303.9 mAHD[2]. Several upland swamps, rivers, creeks and tributaries are also within the Study Area based on a 600 m boundary as shown in Figure 2.

Figure 2: Swamps, rivers, creeks and tributaries above LWs 24-29

Regulations and operating conditions require that a 3D numerical groundwater model be developed for large-scale mining operations and projects in NSW. Such a groundwater model ("the model") has been used at Dendrobium Mine for over a decade and updated several times during that period. The consolidated consent and SMP approvals require periodic updates to the model.

Water Access Licences (WAL) for groundwater 'take' were issued in 2016. A Water Access Licence (WAL) for incidental surface water 'take' by Dendrobium was first sought in 2016 and was granted 03/05/2024. The conditions of this surface water WAL, as set by NSW Department of Climate Change, Energy, Environment and Water (DCCEEW), require an update to the model.

The most recent update of the model was undertaken by Watershed HydroGeo in 2025.

[2] Watershed HydroGeo 2025 Table 2.3 Page 27

2.0 SCOPE OF WORKS

On 16 March 2026, the NSW Department of Planning, Housing and Infrastructure (DPHI – "the Department") requested the Independent Expert Advisory Panel for Mining (IEAPM – "the Panel") to provide advice in relation to the adequacy of the groundwater model used as the basis for the proposed Subsidence Management Plan (SMP) for secondary coal extraction from Longwalls 24 to 29 (LWs 24-29) in Area 3C at the Dendrobium Coal Mine.

The Department considered "*the key technical issue associated with the SMP application is the adequacy of the updates and modifications to the groundwater model, which have included:*

- *incorporating the findings of the over-goaf and Avon shoreline investigative drilling program;*
- *developing a "local-scale" sub-model focusing on Areas 2, 3A and 3B;*
- *incorporating improved methods for simulating surface water and groundwater interactions, including the inclusion of recharge, hydraulic conductivity in all units; surface and sub-surface fracturing and geological structure fields and parameters in the modelling; and*
- *improved model sensitivity analysis and parameter estimation, uncertainty analysis and automated calibration between local and regional models to inform predictive simulations*".

The scope of the Advice sought from the Panel on the following matters:

"*whether the updated groundwater model and assessment:*

- *address previous Panel recommendations on groundwater modelling made in the Panel advice on LW 21A dated 2 July 2024; and*
- *are adequate to sufficiently inform water related impacts and hydrogeological processes relevant to the proposed extraction of LWs 24-29 and water access licence (WAL) requirements for the mine*".

A copy of this request for advice is provided in Appendix A.

The Acting Chair of the Panel (Mr Neil Alston) nominated the following members of the IEAPM to prepare the advice. Mr Neil Alston convened this individual Panel and coordinated the advice report:

- Mr Neil Alston – Subsidence and Mining
- Mr John Ross – Groundwater
- Prof Lucy Reading – Groundwater

More background on the Panel can be viewed at Appendix B.

3.0 METHOD OF OPERATION

3.1. ACTIVITIES AND TIMELINE

The Panel convened by videoconference during the preparation of its advice and was administratively supported by the Panel Secretariat staff provided by DPHI – Major Projects Advisory.

The timeline relating to the IEAPM's assessment of the Dendrobium Longwalls 24 to 29 SMP is summarised in Table 1.

Table 1: Timeline relating to IEAPM's assessment of Dendrobium LW24-29 SMP

Date	Milestone
16/3/2026	DPHI request for advice from IEAPM
17/3/2026	IEAPM Panel convened and supply of initial documentation from the proponent and the agencies
19/3/2026	Briefing from DPHI staff. Panel discuss issues and report structure
24/3/2026	Supply of additional information by the proponent – post submission consultation
26/3/2026	Panel teleconference (groundwater Panel members) to discuss report content and structure
2/4/2026	Panel teleconference to discuss draft report and to resolve any advice queries
7/4/2026	Draft final report circulated to Panel for review
9/4/2026	Draft final report provided to the secretariat
13/4/2026	Panel teleconference to discuss final report

Due to the limited scope of the request for advice related to groundwater model and assessment only, there was:

- no site visit conducted by the Panel,
- no presentation given by the proponent, and
- no request for information process conducted by the Panel.

3.2. REFERENCE DOCUMENTATION

Numerous key documents were provided through DPHI to support the Panel in preparing this Advice. These documents are listed in Table 2. A range of documents that the Panel has had in regard to in compiling this advice are also recorded under References.

Table 2: Reference documentation

Stage	Document Reference	Document Name
Initial Documentation	Provided by DPHI	**SMP Documentation** **LW24-29 SMP Rev2 that included:** • Appendix 1 – Graphical Plans • Appendix 2 – WIMMMCP Rev K1 • Appendix 3 – SIMMCP Rev J1 • Appendix 4 – Landscape TARP • Appendix 5 – Agency Consultation • Attachment A – Aquatic Flora and Fauna Assessment by Stantec • Attachment B – Groundwater Assessment by Watershed HydroGeo • Attachment C – Subsidence Assessment by MSEC • Attachment D – Risk Assessment by Axys • Attachment E – Surface Water Assessment by HGEO • Attachment F – Terrestrial Ecology Assessment by Niche • Attachment G – Geology by GM[3] • Attachment H – Aboriginal Cultural Heritage Assessment by Niche • Attachment I – Aboriginal Cultural Heritage Management Plan by Niche **Pre Lodgement Agency Advice:** • Water NSW • Conservation Programs, Heritage and Regulation Group (CPHR) of the NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW) – Water Group and Heritage NSW • Environment Protection Authority • NSW Resources (Resources Regulator) • Dam Safety NSW **Cumulative Impact Assessment:** • Cumulative Impact Assessment by EMM V3 January 2026 which considers the cumulative impacts of mining within Area 3 in Longwalls 6, 7, 8, 19 and 19A in Area 3A, Longwalls 9 to 18 in Area 3B, and Longwall 21 in Area 3C **Relevant Previous Panel Advice:** • The Panel's advice for LW 21A (IEAPM 202407-1)
Supplementary Information	Provided by DPHI	**Post Lodgement Proponent Responses:** • Request for information by Department of Planning, Housing and Infrastructure related to improvements to the cumulative impact assessment Version 3 dated January 2026 • Clarification of surface water losses • A revised cumulative impact assessment Version 4 dated March 2026 – Appendix F Groundwater and Surface Water by HGEO NB: No other content of this ~1000 pages document was considered.

4.0 PANEL ASSESSMENT AND REVIEW

The Panel has completed a detailed assessment and review of the reference documentation in Section 3.2 and provides advice in three parts:

1. Alignment with the Panel's LW 21A Groundwater Modelling Advice – Section 4.1
2. Groundwater Model Updates, Modifications and Predictions – Section 4.2
3. Additional Comments on the CIA (Appendix F – Groundwater and Surface Water) – Section 4.3

4.1. PART 1 - ALIGNMENT WITH THE PANEL'S LW 21A GROUNDWATER MODELLING ADVICE

The Panel's recommendations on groundwater modelling from the Panel's LW 21A (Executive Summary) Advice (IEAPM 2024) were (the relevant paragraphs are highlighted bold):

2. Adoption of the recommendations contained in Section 4 of the Seepage Validation Report of HGEO (2024) being:

   • *Groundwater levels and strata movements within and around dyke DD9 should be monitored as mining progresses in Area 3C. Observations and trends should be documented at each end of panel review and recommendations made with respect to adaptive management and further investigations if required.*

   • ***Numerical and seepage models should be updated regularly to incorporate new observations from the barrier zone investigations. Seepage estimates should be reviewed after each longwall is extracted. Model re-calibration should be carried out if groundwater level observations fall outside expected ranges.***

   • ***The mine water balance for Area 3C should be reviewed regularly and trends compared with those expected from numerical modelling.*** *Mine water chemistry, including tritium and carbon-14 can provide an early indication of surface water inflows. Review of the water balance and water chemistry for Area 3C should form part of regular reporting.*

   3. Updated numerical groundwater modelling at the completion of the barrier investigation studies and nearby dyke investigations, including more extensive uncertainty analyses, to improve

      3.1. predictions of baseflow reductions to and seepage losses from Lake Cordeaux and baseflow reductions in Wongawilli Creek, and

      3.2. predictions of drawdown in the shallow and deep aquifers.

The numerical groundwater model (the "regional model") has been modified from previous assessments by including results from Illawarra Coal Holding's (ICH) over-goaf and Avon shoreline drilling programs and the site-specific model of subsidence fracturing, as well as improved methods for simulating surface water and groundwater-surface water interaction (Watershed HydroGeo, 2025).

A coupled "local-scale" and "regional-scale" modelling approach was also developed to more accurately predict mine water inflow, groundwater level and drawdown, and surface water flow reduction estimates across the whole Dendrobium mine site and adjacent areas. The "local-scale" model

focused on calibrating key parameters within a model area that included Dendrobium Areas 2, 3A, 3B and part of 3C. The calibration was carried out using PEST for a relatively small ensemble of realisations (60). There are substantial data sets for Areas 2, 3A and 3B, however the recent barrier zone investigations in the southern Area 3C area, adjacent to Cordeaux Reservoir are not mentioned or referenced in Section 3.2.2 (Investigations adjacent to storage reservoirs) of Watershed HydroGeo, 2025. It is not known whether this site-specific information was used in the revised (local-scale) conceptualisation and updated modelling. Improved parameterisation from the local-scale model was then included in the regional-scale model for use in the predictive scenarios (Watershed HydroGeo, 2025). It is noted that new LWs 24-29 are adjacent to but are not included in the current local-scale model area.

The Panel supports this approach of better defining model parameters and processes on a local scale (where there is sufficient geological and hydrogeological data) to better inform the regional model. For future regional modelling, the Panel also supports the recommendation (provided run times are manageable) that:

> *A model mesh be developed that is smaller than the current 'regional' model, and with coarser cells away from Dendrobium, and potentially removing or reducing the areas of 'square' mesh around Dendrobium which recent experience suggests results in unnecessary additional model cells.*

This approach would remove the need for the paired local-regional model approach and the necessity to expand the local-scale model, by allowing calibration and prediction with a single (more robust) groundwater model. Watershed HydroGeo, 2025 recommends that the regional model be reviewed and verified again in 2028 (if it has not occurred before), after more groundwater data has been gathered in Area 3C. The Panel recommends that the next regional model update occur before the completion of LW 23 which is expected to finish in September 2027 (i.e. before the commencement of LWs 24-29).

The lateral extent of the two groundwater models and important geological features are shown in Figure 3.

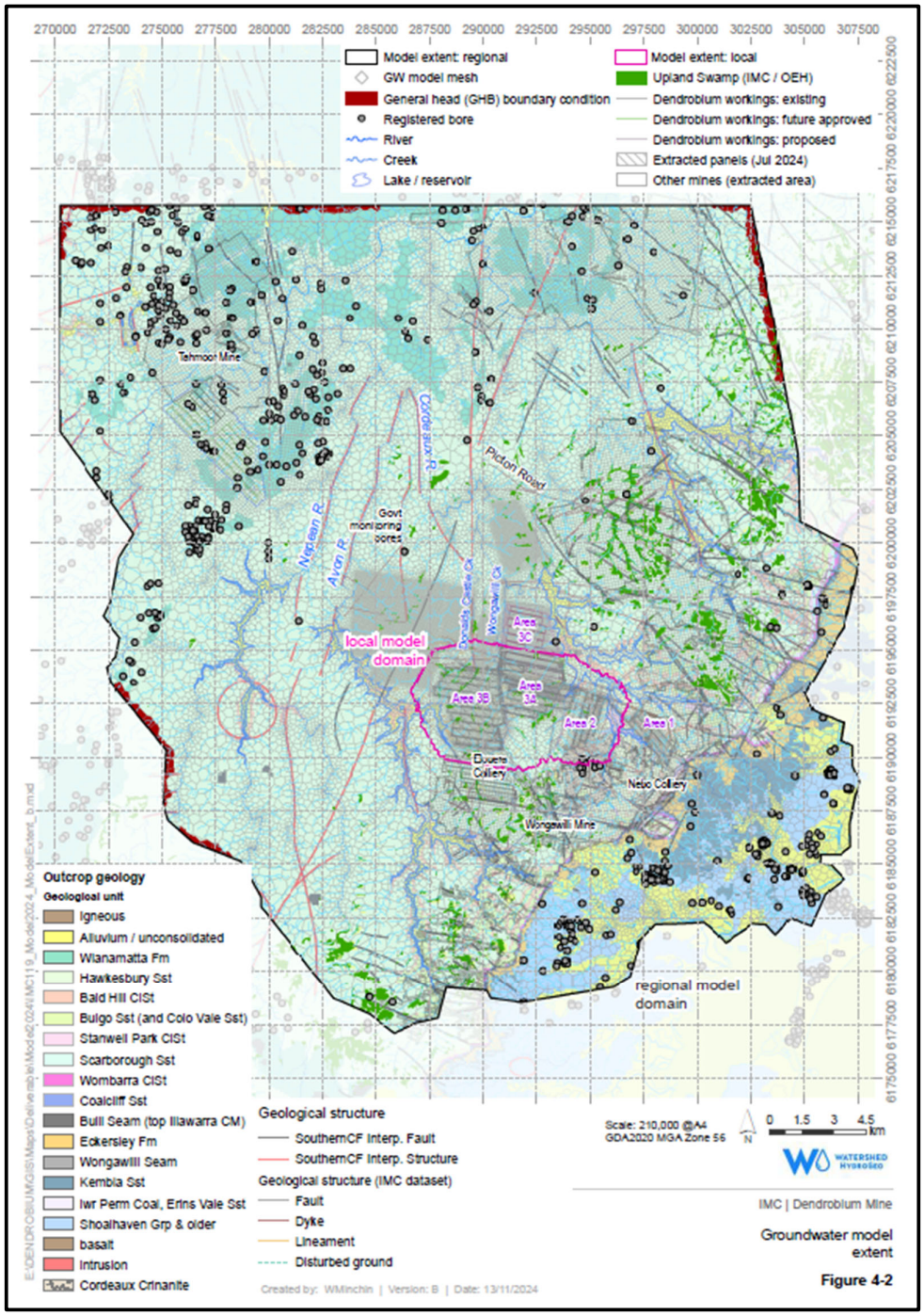

Figure 3: Groundwater model extents (Figure 4.2 from Watershed HydroGeo 2025)

There is only brief mention of updated seepage modelling or verification data following the completion of barrier zone investigations in the vicinity of LWs 21-23 in Area 3C in 2024/25. The previous Seepage Validation Report (HGEO, 2024) was reviewed by the Panel in its LW 21A Advice (IEAPM, 2024). There are revised model predictions of small seepage losses (up to a maximum 0.12 ML/d) from Cordeaux Reservoir (Section 6.5.1 of Watershed HydroGeo, 2025) due to the extraction of LWs 24-26 and then LWs 27-29, however it is uncertain whether local aquifer/layer parameterisation and lakebed

conductance values are used as the report states that there is *"potential for PEST to have adopted lower lakebed hydraulic conductivity parameters"* and "*potential for the reservoir losses to be slightly higher than reported here*". Gradient based calculations that assume strata permeability values that are greater than the values adopted in the regional model suggest slightly higher seepage estimates of 0.22 to 0.82 ML/d for Area 3C (Section 4.5.3 of HGEO, 2025a).

These seepage losses may be underestimated if fracturing extends towards Cordeaux Reservoir in the barrier zone and beneath Wongawilli Creek to the west in the lower Hawkesbury Sandstone / Bulgo Sandstone (model layers 4, 6 and 7), and enhanced aquifer permeabilities are greater than predicted.

The Panel still concludes that "*seepage losses greater than 1 ML/day from Lake Cordeaux (i.e. leakage plus loss of baseflow inflow) are possible*" (IEAPM, 2024) for longwall panel extractions in Area 3C.

More detailed technical comments from the Panel on both the regional and local-scale model updates, modifications and predictions are provided in Section 4.2 of this Advice.

4.1.1. Conclusions

The Panel concludes that the model improvements in Watershed HydroGeo 2025 satisfy some but not all of the previous Panel recommendations on groundwater modelling improvements stated in the Panel advice on LW 21A dated 2 July 2024 (IEAPM, 2024). The exceptions are:

- It is uncertain to what extent permeability data from local barrier zone and fault investigations adjacent to Cordeaux Reservoir, recent monitoring and appropriate lakebed conductance values have been used in the updated modelling to predict groundwater drawdown and surface water seepage losses in the vicinity of the reservoir.
- The removal of time variable off-goaf (valley closure) effects from the current model simulations with an increased focus on calibrating over-goaf effects means impacts are likely to be underestimated, and in particular:
    - there is increased uncertainty regarding the quantum of streamflow and reservoir seepage losses, and
    - the lateral extent of drawdown in all aquifers and the quantum of mine water inflows is likely to be greater than predicted.

The report does however acknowledge that:

> *This feature has been removed for now, but this advanced feature will be included again in future once other aspects are incorporated in the modelling workflow.*

The Panel believes this is critical to properly assess, quantify and verify the seepage losses from both permanent streams and Cordeaux Reservoir, and the extent of groundwater impacts.

4.2. PART 2 - GROUNDWATER MODEL UPDATES, MODIFICATIONS AND PREDICTIONS

The following improvements have been made to the regional model in Area 3C:

- Recharge is now set as an adjustable parameter.
- Hydraulic conductivity of all units, including aquitards, is now set as adjustable parameters.
- Selected dykes and faults are now included in the model.

4.2.1. Recharge Parameterisation (Section 4.4.4 of Watershed HydroGeo, 2025)

Rainfall recharge input to the groundwater model is based on "various estimates from analysis of field data and literature" but these are not presented in the Watershed HydroGeo, 2025 report. The derived estimates are stated to compare favourably with long term estimates of recharge from BoM's AWRA-L (a landscape scale water balance model). The regional groundwater model now uses variable recharge rates for water table accessions in the Hawkesbury Sandstone that correlate with periods of low and high rainfall. For example, the extended period of low rainfall from mid-2017 through 2019 used rainfall recharge rates of less than 1% to the regional water table in the Hawkesbury Sandstone, while the wet conditions through much of 2020-22 used recharge rates of between 3 and 12%. The Panel strongly supports the use of transient recharge rates for model calibration.

For the forecasting period, recharge is simulated using historical averages for the months simulated by each stress period plus extreme wet years (representing 2022) for 2029 and 2033. No below average rainfall periods are simulated in the forecasting period which could lead to an overestimation of recharge during the forecasting period.

4.2.2. Hydraulic Conductivity Parameterisation (Sections 4.5 and 4.6 of Watershed HydroGeo, 2025)

Pilot points have been used to assign hydraulic parameters across the whole of the regional model domain. Five different sets of pilot points were used to apply parameters to the model; four of which are used to apply "background" hydraulic conductivity (K), and confined and unconfined storage (Ss and Sy respectively) to each stratigraphic unit/model layer, and a fifth set to apply hydraulic conductivity to selected geological structures.

There is no independent focus on the hydraulic conductivity of the strata in the barrier zone between the longwall panels in Area 3C and Cordeaux Reservoir.

Strata deformation in the numerical model is simulated above the mined areas in the goaf and connected fracture network which extends up into model layers 4 to 6: i.e. Lower Hawkesbury Sandstone to upper Bulgo Sandstone (Figure D2 in Appendix D of Watershed HydroGeo, 2025). A TVM (Time-varying properties) approach is applied whereby K and Sy increase in specified layers and zones after longwall extraction.

In areas beyond each longwall panel footprint and the goaf areas (i.e. the off-goaf areas), the TVM approach that previously applied increases in Kh have been removed in the current modelling simulations. The Panel believes this omission may underestimate actual stream losses and seepage losses from Cordeaux Reservoir, and the extent of groundwater drawdown and mine water inflow predictions in the areas adjacent to LWs 24-29 (see Section 4.2.4 below).

The Panel strongly supports the time varying approach to K and Sy but is concerned that strata deformation located beyond the immediate longwall extraction footprint is not factored into aquifer drawdown predictions and surface water losses. The adopted initial minimum, maximum and median values appear reasonable for these parameters.

4.2.3. Selected Dykes and Faults Conceptualisation and Parameterisation (Sections 4.5 and 4.6 of Watershed HydroGeo, 2025)

Seven (linear) geological features have been included in the numerical modelling in Area 2 (one feature), Area 3A (two features), Area 3B (two features) and Area 3C (three features). Pilot points are assigned to each end of these geological features with appropriate aquifer parameters. Hydraulic conductivity (K) values for these features are slightly higher than the adjacent strata.

The Panel supports these geological features being included in the modelling and the adopted approach.

The fact that the local-scale groundwater model does not include LWs 24-29 means that the calibrated parameters that are being applied to the regional scale model may not be appropriate to capture the local features within the LWs 24-29 area. This includes the features likely to impact hydraulic properties, particularly faults. In cases where a mining-induced fracture zone intersects with a fault, failure to account for these local complexities could lead to an underestimate of mining impacts.

4.2.4. Predicted Drawdown and Depressurisation in Areas Adjacent to LWs 24-29

The maximum predicted drawdown (50^{th} percentile estimate) in the lower Hawkesbury Sandstone (model layer 4) is reproduced in Figure 4.

All these plots predict significant drawdown and effective desaturation of the lower Hawkesbury Sandstone above all longwalls with the cone of depression extending east (to the reservoir) and west (to and just beyond Wongawilli Creek), although predicted drawdowns are typically less that one metre in the area beyond the footprint of each longwall.

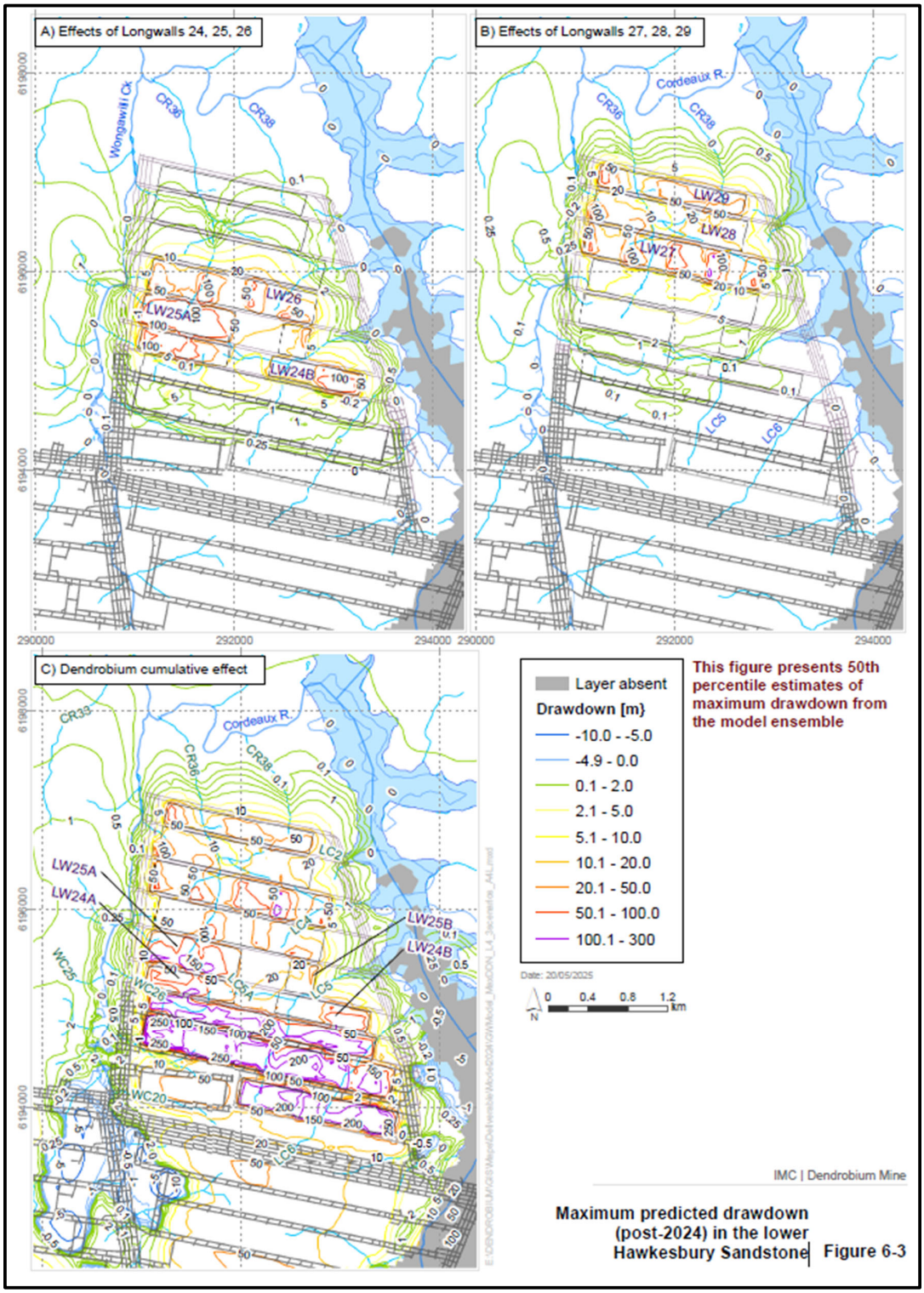

Figure 4: Maximum predicted drawdown in the Lower Hawkesbury Sandstone (Figure 6.3 from Watershed HydroGeo 2025)

Similarly for the underlying Bulgo Sandstone (model layers 6 and 7) which is the predominant geological unit in contact with the stored water in Cordeaux Reservoir, the drawdowns are extensive. The comparison of the maximum predicted drawdowns (50th percentile estimate) in the lower Bulgo Sandstone (model layer 6 - left), lower Hawkesbury Sandstone (model layer 4 - centre), and the upper Hawkesbury Sandstone (water table - right) is reproduced in Figure 5.

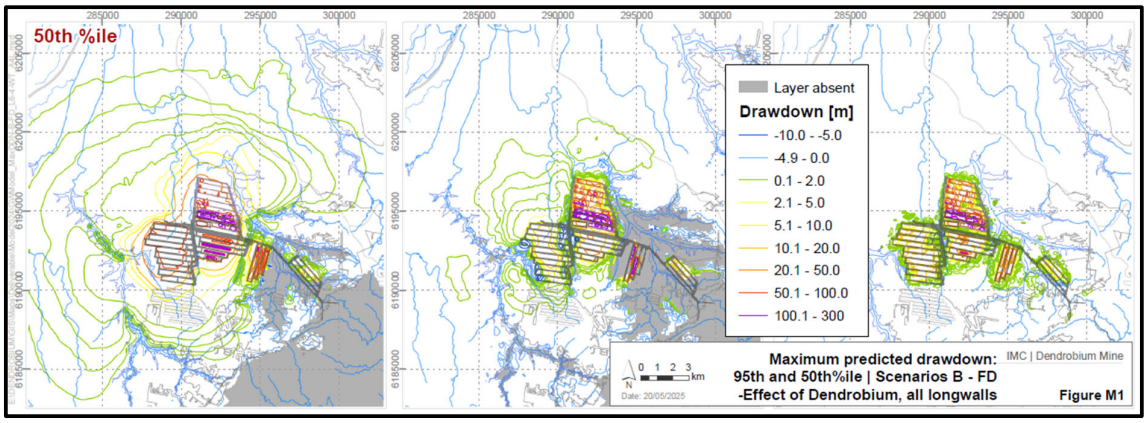

Figure 5: Maximum predicted drawdown in various model layers (part of Figure M1 from Appendix L of Watershed HydroGeo 2025)

Drawdowns of between 10 and 50 m are predicted in the lower Bulgo Sandstone in the immediate eastern, northern and western areas adjacent to LWs 24-29.

The Panel concludes that the updated modelling is sufficient to progress an approval for the SMP, however further model improvements are required to more accurately predict the full extent of groundwater drawdowns, and to quantify surface water seepage losses. The Panel is concerned that the TVM approach that previously applied increases in Kh in the off-goaf area surrounding each longwall has been removed in the current modelling simulations and both surface water and groundwater impacts may be underestimated.

Predictive results presented in the next model upgrade schedules for 2027/28 will inform the timing for subsequent LWs.

4.2.5. Water Access Licence (WAL) Predictions (Sections 6.3 to 6.5 of Watershed HydroGeo, 2025)

4.2.5.1. Groundwater Take

The method for monitoring groundwater take is the mine water balance, which is a model of the inputs and outputs measured by flow meters around the underground mine, that is then used to estimate groundwater inflow to each mine domain, as well as the total mine water inflows.

Based on the current modelling, annualised total mine water inflow is forecast to reach almost 3,000 ML/yr (median estimate) (with approximately 4,000 ML/yr being the high range estimate) between 2029 and 2032 (Table 6.2 in Watershed HydroGeo, 2025). The Panel believes that these volumes may be slightly underestimated given that time variable off-goaf effects are not included in the

current model simulations, and it is uncertain whether intercepted discharges from the regional water table that would have discharged from the regional water table in the Hawkesbury Sandstone as baseflow to permanent streams have been accounted for.

Groundwater take estimates remain well below the current annual groundwater entitlements held for Dendrobium Mine (total of 9,455 shares where currently one share equals 1 ML/yr). The ICH water access licences (WALs) comprise:

- 9,455 shares for Sydney Basin Nepean Sandstone Management Zone 2:
  - WAL 37465 = 3,962 shares
  - WAL 42386 = 3,653 shares; and
  - WAL 42385 = 1,840 shares.
- 75 shares for Sydney Basin South Groundwater Source (WAL 36473)

The Panel concludes that the modelling, even allowing for an underestimation of inflows from off-goaf areas, provides sufficient confidence that total groundwater take will be within the authorised volumes of the WALs that ICH hold for Dendrobium.

4.2.5.2. Surface Water (Seepage) Take

Surface water losses at Dendrobium are 'incidental', that is water is not deliberately taken from watercourses or reservoirs. These losses occur due to a combination of subsidence-induced fracturing, and groundwater depressurisation and drawdown.

The predicted surface water takes for 2024-25 and 2025-26 for the whole Dendrobium Mine (permanent streams, and Avon and Cordeaux reservoirs) are provided in Tables 6.7 and 6.8 in Watershed HydroGeo, 2025. Predicted median losses from the Upper Nepean Rivers water source were 1573 ML/yr and 2017 ML/yr respectively for these two water years. No aggregated 'whole of mine' surface water seepage predictions are presented in the report for the extraction of LWs 24-29, however some visual representations of losses are presented in Figures 6.7 to 6.9 for the proposed longwalls. The Panel believes that when all the proposed Area 3C longwalls are included, the total aggregated losses will be greater that the current water year predictions. These losses should be quantified more precisely when the model is next updated and reviewed, and after time variable off-goaf effects are included in the model.

In May 2024, Dendrobium Mine secured a water access licence (WAL 45165) to account for surface water take from the Upper Nepean Rivers Water Source as a result of dewatering and subsidence effects at the mine. This zero share WAL requires water allocations to be procured annually in advance of expected surface water seepage losses for that year. Condition DS8777-00001 of the WAL states that:

> *By 30 June each year, beginning in 2025, the licence holder must hold a water allocation, in its water allocation account for this licence, of a volume equal to or exceeding the average water take, determined by the model, from the water source for that water year, as stated in the annual water take report required for that water year. If that report includes a range of predicted volumes, the average predicted volume is to be used for this purpose.*

The Panel concludes that the current modelling and seepage assessments are likely to underestimate the surface water losses from permanent streams and reservoirs. Also, it is apparent that the proponent will

require substantially more allocation than it held for the 2025/26 water year (850 ML as stated in Section 1.6 of Watershed HydroGeo, 2025) in future water years.

4.2.6. Conclusions

The Panel concludes that:

- The improvements that have been made to the groundwater modelling approach have enabled assessment of the sensitivity of model predictions to key parameters. At a regional scale, the drawdowns are generally well represented according to the calibration statistics with a scaled root-mean-squared error of 8.9% (page 149 of Watershed HydroGeo, 2025). However, the improvements in modelling have focused on Areas 2, 3A, 3B and part of 3C. Therefore, the simulated impacts for LWs 24-29 may be underpredicted. Further monitoring and local-scale modelling (or improved regional modelling) for LWs 24-29 would be required to assess this.
- The predictive modelling and monitoring of mine water volumes within the mine is adequate to sufficiently inform the groundwater take and align with the groundwater WAL allocation held for the mine.
- The current predictive modelling is useful in being able to predict surface water take however losses from reservoirs cannot be validated because there is no means of practically measuring or reliably estimating losses from field data.
- There are no aggregated surface water take estimates presented in the updated predictive modelling for each of the water years during the extraction of LWs 24-29 (i.e. 2027/28 to 2032/33). Volumes need to be quantified to provide a useful basis for determining the annual surface water take requirements for the mines surface water WAL. There is a low degree of confidence in the recent year estimates due to the removal of time variable off-goaf (valley closure) effects and the possibility of enhanced permeability of the geological strata in the barrier zone adjacent to Cordeaux Reservoir and Wongawilli River.

4.3. Part 3 - Additional Comments on the CIA (Appendix F – Groundwater and Surface Water)

In July 2024, DPHI requested the completion of a comprehensive assessment of the cumulative impact of mining activities undertaken at Dendrobium Mine. No revised modelling is presented in the Cumulative Impact Assessment (CIA) (EMM Consulting, 2026a and b) although a useful history of groundwater modelling that describes the key features of model updates from 2007 to 2025 is presented in Appendix A of Appendix F (HGEO, 2025b) of the CIA.

The relevant impacts that were identified in Appendix F – Groundwater and Surface Water include:

- Depressurisation of groundwater within some of the stratigraphic units is being observed, including drawdown from the Wongawilli Seam up to and including the Bulgo Sandstone. These drawdown impacts are identifiable up to 1.5 km from the longwall panels in Areas 3A.
- The end of panel reports have shown that drawdown has occurred in both the Hawkesbury Sandstone and the Bulgo Sandstone.
- Reductions in surface water flow are occurring as a result of mining (TARP levels 1-3

- Improvements in information about swamp characteristics and hydrology has led to the current understanding that there is a "*high likelihood for impacts to swamps that overlap or extend within 120 m of the proposed longwall footprint*"

It is important that these observed impacts are incorporated into updates of the numerical groundwater flow models and there is evidence in the groundwater modelling report (Watershed HydroGeo, 2025) that this is occurring. For example, a very large dataset derived from approximately 1,200 bore and piezometer locations is being used through a quality assessment process to develop a set of "drawdown" targets for model calibration and the model is also calibrated against both mine inflow and surface water flow losses. The predicted impacts from the modelling are generally consistent with the conceptual model which was developed based on mining in previous areas, especially Areas 3A and 3B. Regular updating of the groundwater model as new monitoring data is collected is expected to further improve the accuracy of the model predictions.

4.3.1. Conclusions

The Panel concludes that:

- The cumulative impacts identified in the CIA have also been included in the current modelling predictions for LWs 24-29.
- The observed cumulative impact of mining activities undertaken at Dendrobium Mine should also be incorporated into any future updates of the numerical groundwater flow models.

Yours sincerely,

Neil Alston
Panel Convenor

REFERENCES

DCCEEW (2025) Submission labelled *Dendrobium Mine (DA60-03-2001) Longwall 24-29 Subsidence Management Plan Consultation.* Reference OUT 25/12172 dated 17 November 2025.

EMM Consulting (2026a), *Cumulative Impact Assessment.* Final version E250289 RP#1 dated 30 January 2026.

EMM Consulting (2026b), *Cumulative Impact Assessment.* Updated Final version E250289 RP#1 with tracked changes dated 17 March 2026.

HGEO (2024). *Dendrobium Mine Area 3C seepage validation report (No. D24242)*, Report for Illawarra Metallurgical Coal dated 24 April 2024.

HGEO (2025a), *Dendrobium Area 3C Longwalls 24 to 29: Assessment of surface water flow and water quality effects.* Report D24269 Revision 3 dated 28 July 2025.

HGEO (2025b), *Cumulative Impact Assessment: groundwater and surface water.* Report D24262 Revision C dated 5 December 2025. Note that this report is Appendix F in EMM Consulting 2026a and b.

IEAPM (2024), *Advice Re: Dendrobium Coal Mine Longwall 21A Subsidence Management Plan.* IEAPM Report 202407-1 dated 2 July 2024.

Watershed HydroGeo (2025), *Groundwater Model Update / A3C Longwall 24-29.* Report R062f Revision F dated 13 July 2025.

APPENDIX A – DPHI REQUEST FOR ADVICE

Department of Planning, Housing and Infrastructure

Our ref: DA60-03-2001-PA405

Neil Alston
Acting Chair – Independent Expert Advisory Panel for Mining

By email: neil.alston68@gmail.com

16 March 2026

Subject: Request for Advice –Dendrobium Mine – Longwalls 24 -29 Subsidence Management Plan

Dear Mr Alston,

I am writing to you to request advice from the *Independent Expert Advisory Panel for Mining* (the Panel) in relation to the Dendrobium Underground Coal Mine (DA60-03-2001).

GM[3] is seeking approval for a Subsidence Management Plan (SMP) for secondary coal extraction from Longwalls (LWs) 24 to 29 in Area 3C at the Dendrobium Coal Mine. A copy of the SMP application is provided as **Attachment 1**.

GM[3] has consulted with a number of agencies in preparation of this SMP. Copies of agency advice and GM[3]'s response to this advice is attached for your consideration (**Attachments 2** and **3**). Company response on advice received from NSW Heritage will be provided to the Panel when received.

The Department considers the key technical issue associated with the SMP application is the adequacy of the updates and modifications to the groundwater model, which have included:

- incorporating the findings of the over-goaf and Avon shoreline investigative drilling program;
- developing a "local-scale" sub-model focusing on Areas 2, 3A and 3B;
- incorporating improved methods for simulating surface water and groundwater interactions, including the inclusion of recharge, hydraulic conductivity in all units, surface and sub-surface fracturing and geological structure fields and parameters in the modelling; and
- improving model sensitivity analysis and parameter estimation, uncertainty analysis and automated calibration between local and regional models to inform predictive simulations.

As such, the Department is seeking advice from the Panel on whether the updated groundwater model and assessment:

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www.dphi.nsw.gov.au

- address previous Panel recommendations on groundwater modelling made in the Panel advice on LW 21A dated 2 July 2024; and
- are adequate to sufficiently inform water related impacts and hydrological processes relevant to the proposed extraction of LWs 24-29 and water access licence (WAL) requirements for the mine.

I note that GM³ has recently submitted a Cumulative Impact Assessment (CIA) as directed by the Department, which considers cumulative subsidence-related impacts of mining in Areas 3A, 3B and 3C (up to and including LW 21) (**Attachment 4**).

It would be appreciated if the Panel can provide advice on the SMP by 13 April 2026. Please contact me on (02) 8274 1274 or jessie.evans@dpie.nsw.gov.au if you have any questions or require additional information for your review.

Yours sincerely,

Jessie Evans
Director, Energy and Resource Assessments

Attachments:

1. LWs 24-29 SMP application
2. Agency advice on the SMP (WaterNSW, NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) Conservation Planning and Heritage Regulation (CPHR), DCCEEW Water Group, NSW Dams Safety, NSW Resources and Heritage NSW)
3. GM³ response to agency advice
4. Dendrobium Mine Cumulative Impact Assessment (EMM, January 2026)

APPENDIX B – PANEL BIOGRAPHY

Mr Neil Alston

Neil is a mining engineer with over 30 years' of experience, including in senior operational, technical and statutory positions. He has been a mine manager across a broad range and scale of underground bord-and-pillar and longwall coal mines. Neil has expertise in mine management, mine design and planning, due diligence, research and development, strata control and subsidence for projects across Australia. He also has expertise in gas management and greenhouse gas emissions mitigation, particularly ventilation air methane abatement for underground coal mines.

Mr John Ross

John is a Senior Principal Hydrogeologist with over 50 years' experience specialising in water resource, site contamination, infrastructure, mining and natural resource impact assessment and management. His specialty is sedimentary basin hydrogeology, particularly the Great Artesian Basin, Sydney-Gunnedah and Gloucester basins here in NSW. John has held specialist management roles in public and private corporations and environmental consultancies. He has a Bachelor of Science (Geology) and a Certificate in Engineering Hydrology and Groundwater Hydrology.

John provides technical hydrogeological expertise and advice across the spectrum of water resource development, environmental/water planning, assessment and management projects, including environmental impact assessments, environmental audits and technical peer reviews, monitoring programs, remedial action plans, modelling and groundwater licensing matters. John also has extensive experience in community and regulatory consultation across the eastern seaboard.

Associate Professor Lucy Reading

Lucy is an Associate Professor of Hydrogeology at the Queensland University of Technology (QUT). She has completed a Bachelor of Applied Science (Honours) at QUT and a Doctor of Philosophy in Environmental Engineering at the University of Queensland. Dr Reading now specialises in setting up groundwater monitoring networks with communities, assessing groundwater and surface water resources (quantity and quality) and assessing impacts of mining activities on groundwater. Lucy has over 20 years of experience in groundwater investigations, including roles with the University of Queensland and the Queensland Government.