NSW GOVERNMENT | Department of Industry

OUT19/4515

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Dear Mr Armstrong

Independent Expert Panel for Mining in the Catchment –
DoI Water Submission

Thank you for the opportunity to provide a submission to the Independent Expert Panel for Mining in the Catchment (IEPMC). We look forward to further involvement in the sustainable oversight of coal mining projects within the Sydney Drinking Water Catchment.

We provide a brief overview of the legislative and policy framework for water and mining and our agency's role, and make comments and recommendations in relation to the Terms of Reference 1 and 2 and the IEPMC's '*Initial report on specific mining activities at the Metropolitan and Dendrobium coal mines'* (initial report).

Water regulation in relation to mining activities is done under a complex legal framework involving the *Environmental Planning and Assessment Act 1979* (EP&A Act), *Water Management Act 2000* (WM Act), *Water Act 1912* (Water Act), and supporting regulations and policies.

The NSW Department of Industry – Water (DoI Water) plays a crucial role in the assessment, management and review of major coal mining projects in NSW. Under the provisions of the EP&A Act, DoI Water provides advice to the NSW Department of Planning and Environment (DPE) and major project proponents to ensure that developments are sustainable and consistent with the broader management principles of the state's water resources and their dependent ecosystems for the benefit of both present and future generations.

In reviewing and preparing comment on mining development proposals, DoI Water takes into account the requirements of the WM Act, Water Act and related regulations and instruments, including water sharing plans. The NSW Aquifer interference Policy (2012) is the key policy that sets out the licensing and assessment requirements for aquifer interference activities including mining.

In forming its advice, DoI Water also considers guidelines such as *Groundwater Monitoring and Modelling Plans - Information for prospective mining and petroleum exploration activities* (2014), the *Australian Groundwater Modelling Guidelines* (2012) and the *NSW Guidelines for controlled activities on waterfront land* (2012).

As requested by IEPMC, we have reviewed Terms of Reference 1 and 2 and our recommendations are given in Attachment A. These have been divided into three key areas:

- Water Monitoring
- Water Modelling
- Regional Water Balance

Comments to support these recommendations are provided in Attachment B.

Our advice confirms the complex nature of this region and the importance of improved datasets, monitoring and modelling to better inform decision making about coal mining in the Greater Sydney Water Catchment Special Areas.

We are keen to work with you as well as relevant agencies, industry and the community to identify the most appropriate strategy and funding model to address gaps in critical data and understanding.

Please send any further requests for this matter to landuse.enquiries@dpi.nsw.gov.au.

Yours sincerely

Mitchell Isaacs
Director Strategic Relations
Department of Industry - Water
24 April 2019

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ATTACHMENT A

Summary of Recommendations

Water Monitoring

1. DoI Water supports the recommendation by the IEPMC for mines to develop a standard process for (a) managing water monitoring data and reporting and (b) facilitating information sharing through a common platform.

2. DoI Water recommends that mining companies use a broader geographic and stratigraphic spread of monitoring with respect to groundwater systems.

Water Modelling

3. DoI Water recommends that some aspects of modelling be standardised, such as:
    a. Clear reporting and justification of modelling parameters.
    b. Development of applicable and comparable surface flow modelling tools

4. DoI Water supports WaterNSW's recommendations in its May 2018 submission for the implementation of improved modelling methods, specifically:
    a. Improved geotechnical and geomechanical modelling should be undertaken.
    b. Identifying surface water modelling requirements and data gaps and opportunities to improve surface flow limits.
    c. Giving further consideration to incorporating sub-catchment scale water quality loading analyses and modelling to be introduced throughout the Special Areas.
    d. Comprehensive characterisation of significant structural features to provide knowledge and understanding of focussed mining impacts.

Regional Water Balance

5. DoI Water recommends increasing the understanding relating to the risks of absolute and proportional losses to catchment yield and stream flow caused by mining subsidence noting the rivers in this area are prioritised for conservation, through:
    a. identifying limitations to existing modelling frameworks;
    b. developing short term (6 month) reviews of catchment yield against historic trend analysis;
    c. devising water accounting procedures to ensure all water take is licensed and accounted to the appropriate water sources in accordance with water sharing plan rules; and
    d. improving the reporting and auditing of water sharing plan targets and performance.

6. DoI Water recommends that further discussion is required about the value and use of a state-owned regional water balance model (that could integrate information from the existing groundwater and geotechnical models).

END ATTACHMENT A

ATTACHMENT B

Details of Recommendations

Water Monitoring

Recommendation 1: DoI Water supports the recommendation by the IEPMC for mines to develop a standard process for managing and reporting water monitoring data and to facilitate information sharing through a common platform.

DoI Water acknowledges the difficulties associated with the spectrum of scales ranging from local to regional for the activities, impacts and consequences related to coal mining. In particular, monitoring of water resources over regional scales can be complicated by local variations and, conversely localised measurements may not be representative of the larger systems. It is therefore understood that the monitoring and modelling of coal mining activities will not be perfect and that uncertainty will persist.

However that does not mean that the data collected should not be as accurate as possible. In support of the IEPMC recommendation for standardised data collection, reporting and distribution, DoI Water considers that the key aspects are as follows:

- Monitoring points should be appropriately located to address a water-related risk.
- They should be constructed or established so as to provide meaningful data.
- Sensible triggers for the activation of response mechanisms should be applied.

Those response measures should be reasonable in terms of quantifiable improvement or successful amelioration.

The IEPMC's initial report notes that there are disparities between different mining domains (e.g. hydraulic parameters of geological formations at page 87, extent of swamp monitoring at page 114), therefore there is an apparent benefit for a more regionally consistent approach to monitoring, modelling and reporting. DoI Water supports this as it could be addressed in part by the expansion of the existing network with purpose-built monitoring bores that have been fully cored and tested as described below.

As part of the NSW Government Water Monitoring Framework, DoI Water commenced a 'data ingestion project' for the purposes of facilitating the uploading of water monitoring data from mining companies to a web-based repository. That project was progressed to an early stage, however the ongoing development has been constrained by a number of issues. The recommencement of that project should be in alignment with the recommendation made in the IEPMC 's initial report, that is "*mines operating in the Catchment Special Areas need to develop, in consultation and with the agreement of regulators and key stakeholders, a standard for field investigations, data collection, analysis and reporting that provides for and integrates the interests of all stakeholders and facilitates the sharing of the information by being presented on a common platform*" (pages 90 and 128).

As per the recent release of the Integrated Mining Policy by the Department of Planning & Environment (DPE), the standardisation, collection and reporting of water-related monitoring data is a joint DPE, DoI Water and WaterNSW matter that will require close cooperation for it to succeed. However, DoI Water has already invested in this approach (in response to previous recommendations of the Chief Scientist & Engineer) and considers the development of a common database beneficial for the future sustainable management of water resources.

To help facilitate this standardisation, formal reporting mechanisms should be established. This will identify agency and mine operation responsibilities for data collection, reporting and auditing of the effectiveness of arrangements to quantify and address the impacts of mining-induced subsidence on the range of flows in rivers in the drinking water catchment Special Areas.

This should extend from the two individual mining operations identified in the initial review (Dendrobium and Metropolitan mines), throughout previously mined, current mining zones and into potential future resource development areas in the Special Areas.

Additionally, the identification of commitments from stakeholder agencies would assist in this developing this standardisation. This would include the commitments to implement data collation, modelling, interpretation and formation of water management rules around surface flow loss and/or contamination of surface flows.

Availability of Information

In reviewing applications for coal mining projects, it is imperative to develop a geological visualisation of the proposed area of impact to inform the understanding of potential hydrological and hydrogeological impacts. This would commonly involve the review of geological long-sections and cross-sections (i.e. fence diagrams) developed from intrusive investigation results—in this case the bore logs from resource exploration drilling across the mining domain.

However, in many cases, these basic tools are either not constructed or not provided, and often there are commercial-in-confidence concerns about releasing certain data. This withheld information creates a major obstruction to a robust technical assessment and results in additional delays, costs and confusion about specific recommendations in many cases. It should be noted that this is an issue not limited to coal mining activities, but is a larger concern that relates to many industries and projects.

Greater availability of information is required to allow for the proper understanding of existing impacts and for improved assessment of future applications.

Groundwater Monitoring Reliability

DoI Water has ongoing concerns over the adequacy of groundwater monitoring for the purpose of identifying and addressing the impacts of underground mining.

The use of vibrating wire piezometers is widely adopted by mining companies to monitor pore pressures at substantial depths across mining domains and to provide data suitable for input into numerical groundwater models. However it is becoming increasingly clear to DoI Water that these devices are not performing to the standard required for ongoing monitoring, with data loss, flatlining and unnatural step changes often being observed. Of itself, that would not necessarily be a problem, as it would be expected that replacement of the faulty or any failed instruments would occur and monitoring could recommence. However, as identified on page 60 of the IEPMC's initial report, such replacement is rarely possible.

DoI Water is also aware that the instruments provide groundwater level estimates that are only reliable to within a ten metre (or more) range. This is despite discussions with technical specialists that indicate the properly calibrated and installed instruments can achieve substantially greater accuracy in many situations. Where the estimated groundwater levels are inaccurate, the ability for numerical groundwater models using these data as inputs to perform adequately in matching observed measurements and predicting future outcomes is significantly constrained, at best (particularly where claimed impacts are at the sub-metre

scale). It would appear that many of the shortcomings of some current predictive models are due to the poor monitoring results that are being obtained.

DoI Water is not aware of any reported technical studies directly comparing the performance of those installations with conventional purpose-built cased and screened monitoring bores. DoI Water considers that such studies should be carried out across a range of environments and depths to confirm the suitability of vibrating wire piezometers and identify approaches to their calibration and installation that can be used to improve their functionality, accuracy and performance. In the absence of such seminal work, DoI Water recommends that caution should be applied in the use of vibrating wire piezometers for monitoring.

Given technological advancements over time, it may be possible to source different instrumentation types and applications. Such periodic reviews of technical advancements are known from long-term contaminated site rehabilitation projects and a similar approach could apply in these cases. Mining companies could be required to investigate and report on advancements in deep groundwater monitoring technologies on a three-yearly basis to identify whether more robust and accurate instrumentation has become available either domestically or internationally.

Recommendation 2: DoI Water recommends that mining companies have a broader geographical and stratigraphical spread of monitoring with respect to groundwater systems.

In addition to the IEPMC's initial report recommendations regarding monitoring and performance measures (pages 128 and 129), there is benefit in mining companies having a broader geographical and stratigraphical spread of monitoring with respect to groundwater systems (please note standardisation of monitoring has also been discussed in Recommendation 1). The adequacy of the monitoring network coverage over large areas within individual mine domains is unclear and the reliance on the use of vibrating wire piezometers for the bulk of monitoring data is a risk, as detailed above. DoI Water makes the following recommendations:

- Additional monitoring installations should be established to address some of the shortcomings identified by DoI Water and the IEPMC. In particular, there should be a focus on the Hawkesbury Sandstone, as the most significant aquifer across the Greater Sydney region, as well as the other major geological formations beneath.
- Shallow groundwater monitoring within Hawkesbury Sandstone (in association with surface water monitoring), comprising a large number of purpose-built cased and screened monitoring bores to moderate depth should be installed at selected locations alongside the rivers and streams most likely to be impacted. These are intended to monitor the shallow groundwater regime of the upland valleys and the data could be analysed to identify the gaining or losing conditions of specific reaches.
- Deep groundwater monitoring should also take place at a smaller number of sites within each mining domain with each location incorporating four individual bores intersecting the deeper Hawkesbury Sandstone, the upper and lower Bulgo Sandstone and the Scarborough Sandstone. These should all be in isolation, using purpose-built cased and screened monitoring bores. These deeper monitoring bores should be fully cored and comprehensively packer tested throughout to provide interval-specific data for the consistent development of numerical groundwater modelling parameters. Once constructed, each of the bores should be pump-tested to derive bulk aquifer transmissivity values and storativity estimates (where possible).

They should also be used for characterisation of groundwater quality from within each formation. This data would then be used to inform the project-specific databases as recommended by the IEPMC's initial report (pages 90 and 129), as well as the use of isotopic signatures in assessing connectivity (pages 91 and 129).

- Additionally, groundwater level monitoring should be implemented as soon as possible using water level loggers recording at a minimum daily frequency and continuing for period after the cessation of mining.

Water Modelling

Recommendation 3: DoI Water recommends that some aspects of modelling be standardised, such as:

a) Clear reporting and justification of modelling parameters.

In addition to the accuracy of monitoring data being used for numerical modelling inputs, another concern to DoI Water is the lack of detail regarding modelling parameters. Some aquifer parameters are not readily measured during routine investigations, and therefore there is benefit in them being grouped together in order for the modelling to be undertaken. Whilst it is acknowledged that such an approach is generally accepted, there is a lack of clarity in modelling reports about how this has been undertaken and the uncertainty implications arising from doing this. DoI Water is of the opinion that the details of the model parameters lumped for each layer, and the specific justification for doing so, should be clearly documented in every modelling report prepared.

b) Development of applicable and comparable surface flow modelling tools.

Surface hydrological modelling is fundamental to obtaining a comprehensive framework to equitable sharing of water between human water use and environmental water requirements. Currently, packages such as Australian Water Balance Model are used for specific applications, but appear incapable of analysing alterations to low flow metrics and longitudinal connectivity. Development of applicable and comparable surface flow modelling tools should be undertaken after collation of catchment flow audits and analysis of groundwater trends. This should aim to identify possible and likely changes in surface to ground water levels, connectivity and regime under non-subsided, fringing (extended non-systematic) and systematic subsidence regions.

Recommendation 4: DoI Water supports WaterNSW's recommendations for the implementation of improved modelling methods, specifically:

a) Improved geotechnical and geomechanical modelling should be undertaken.

Improved geotechnical and geomechanical modelling should be undertaken, using a combination of models, as has occurred for Wallarah No. 2 and Hume Coal. The Mine Subsidence Technology Society (Engineers Australia) should be consulted as to appropriate geotechnical modelling approaches to encompass the greater extent of subsidence-related surface deformation and strain distributions than previously understood, and incorporating the range and severity of surface and sub-surface fracturing zones. This should be undertaken under review by the IEPMC or nominated funded agency and results used to formulate the extent and priority areas for assessing surface water interception and flow losses in the Special Areas and adjacent rivers, such as the Upper Georges River.

b) *Identify surface water modelling requirements and identifying data gaps and opportunities to improve surface flow limits.*

Identify surface water modelling requirements and identifying data gaps and opportunities to improve surface flow limits under natural and subsidence-impacted states. Relevant surface water modelling packages should be reviewed for best fit to the particular geological and geomorphologic constraints for rivers in the Special Areas, and, if possible, a range of modelling applications used to identify limitations and likely erroneous factors in existing surface water modelling packages.

c) *Give further consideration to incorporating sub-catchment scale water quality loading analyses and modelling to be introduced throughout the Special Areas.*

Water quality alteration due to subsidence-related redirection of surface flows into sub-surface fracture networks is a significant impact to water sustainability within the drinking water catchment. WaterNSW has identified water quality trends for Cataract and Cordeaux catchments and recommends a combination of water balance analysis and lumped rainfall-runoff models.

d) *Comprehensive characterisation of significant structural features to provide knowledge and understanding of focussed mining impacts.*

In sedimentary basins the geological layering and structure should be clearly defined in models and reports, particularly where these have a substantial influence on the movement of groundwater regionally and in the vicinity of mining operations. Research of structural features across the Southern Coalfield is identifying that there is substantial influence on groundwater flow from faults and joint sets, both before and after mining. It is necessary to fully understand the characteristics of faults within the mining domains as they can represent, either as barriers to flow, or conduits for water to access mined voids. Information from the underground coal mine at Tahmoor indicates that the Nepean Fault is a source of groundwater that contributes a substantial inflow to the current mine workings.

Where faults have been identified across a mining domain, their extent and characteristics should be fully investigated, to scope their impact on the mine operation and to identify the quantity of groundwater that will be taken (in accordance with the NSW Aquifer Interference Policy). The characterisation work should include sufficient geological and hydrogeological detail to inform a numerical groundwater model. The strike and dips of faults should be identified and pump testing undertaken around high permeability structures such as faults or dykes to quantify potential groundwater inflows.

Furthermore, existing mine dewatering volumes should be measured at various locations (such that volumes can at least be partitioned across defined parts of the mining operation) in order to better understand the ongoing take and improve numerical modelling outcomes. Information should be provided about sites where mining and faults intersect and make water, as well as locations where faults are shown to be relatively dry. Mapping such faults from depth to the surface is important in providing knowledge and understanding of the mining impacts and providing valuable information that could be used to inform future mining development in the area.

Recommendation 5: DoI – Water recommends increasing the understanding relating to the risks of absolute and proportional losses to catchment yield and stream flow caused by mining subsidence, noting the rivers in this area are prioritised for conservation.

DoI Water agrees with WaterNSW that increasing understanding relating to the risks of absolute and proportional losses caused by mining subsidence to catchment yield and stream flow assists the approval and regulatory regime.

The rivers within the Sydney Drinking Water Catchment Special Areas provide dual purposes; drinking water supply and ecosystem function. These functions are recognised within the *Water Sharing Plan for the Greater Metropolitan Unregulated River Water Sources 2011*. It is important that the outcomes from the IEPMC review support the protection of these inter-linked purposes.

Rivers in the Special Areas are generally gaining systems as river flows persist and extend due to contributions from the surrounding groundwater regime. Persistence in pool depth and storage capacity is a function of base integrity and longitudinal connection over rock bars and through boulder fields between pools.

Rivers formed in Hawkesbury Sandstone and similar lithologies of the Narrabeen Group have moderate frangibility. They are characteristically confined by rigid strata, which form elevated rock bars and lateral gorge barriers. These rivers erode the softer inter-strata to form overhangs, waterfalls and chutes and boulder fields. Strata deformation not only increases tensile strains within the more rigid strata, but enhances scour potential in underlying softer strata, concentrating strains within rock bars and other rigid features.

Block failure and bar fracture and collapse occur naturally in rivers and gorges developed in the Hawkesbury Sandstone and similar lithologies of the Narrabeen Group. However, this is enhanced by mining-induced subsidence. This increases the rate of rock bar fracture, bar failure and subsurface drainage by many orders of magnitude compared to naturally occurring rates.

Subsurface capture of flows and reduced pool depth and extent, and increased zero flow periods are an inevitable result of enhanced bar fracture. Historic mining-induced subsidence has impacted river flows significantly in watercourses such as Lizard Creek, which experiences extended zero flow periods more than 30 years after mining subsidence occurred. The duration of flow loss varies from river to river, but has occurred in all streams that have been undermined and subsided by mining activity to some degree.

a) identify limitations to existing modelling frameworks;

By identifying the limitations to existing modelling frameworks (used to estimate catchment yields and water quality trends) we can extend them from a specific river reach scale to regional scale. This could include identifying data holders, stakeholders and regulators responsible to collate, analyse and interpret sub-catchment scale surface water budget changes and alterations to low flow characteristics and pool depth and capacities within zones of surface/ground water interception and drawdown.

b) develop short term (6 month) reviews of catchment yield against historic trend analysis;

Developing short term (6 month) reviews of catchment yield against historic trend analysis would help identify anomalies and report on likely decline in low flows and flow trends across the Special Areas. Improving the reporting and auditing of water sharing plan targets and performance, could be related to catchment-scale water balance and water quality loading and trend analyses.

c) devising water accounting procedures to ensure all water take is licensed and accounted to the appropriate water sources in accordance with water sharing plan rules;

Water accounting from multiple ground water sources requires accurate metering and piezometric monitoring in order for accounts to be drawn up for each water source from which take occurs. In sites where risks of surface water take may be combined with groundwater extraction, multiple monitoring methods must be used to ensure measured, rather than inferred, dewatering or depressurisation forms the basis of accounting.

Accounting for take from linked surface and ground water sources should incorporate improved monitoring program design and reporting to DoI Water. This is essential if the actual volume of water taken from each water source is quantified and formed into an accounting and reporting mechanism. The licence holder should then be required to provide an account of total water take from each water source against the access shares it holds and the total long term average annual extraction limit (LTAAEL) and any daily access limits applicable to the water source(s).

d) improving the reporting and auditing of water sharing targets and performance.

Current reporting of water sharing plan targets is conducted via General Purpose Water Accounting Reports. These are currently reported to only inland regulated rivers. Improving confidence in accounting and reporting against targets in water sharing plans - such as protecting groundwater dependent ecosystems - requires greater transparency and reporting to ensure total water source yields remain below long-term average annual extraction limits within water sharing plan areas.

Recommendation 6: DoI Water recommends that further discussion is required about the value and use of a state-owned regional water balance model (that could integrate information from the existing groundwater and geotechnical models).

The IEPMC's initial report recognises the "potential value in having a state-owned regional water balance model that could integrate information from the existing groundwater and geotechnical models" (page125). DoI Water has reservations about this objective, as the development of a water balance model would necessarily be dependent on the standardisation of monitoring data collection, reporting and distribution. Furthermore, the development of a broad scale water balance model would be subject to the scaling issues outlined above, as well as the inclusion of areas within the respective mining domains having little or no data for calibration purposes. A further difficulty would be the limited baseline data that is available, and for the water balance model to be successfully implemented the commencement of baseline monitoring in proposed future mining locations should occur immediately.

DoI Water supports further work on cumulative impacts and a better understanding of the elements of a water balance model. However, there are significant questions and considerations that should be investigated prior to potentially developing such a tool, such as:

- Is there enough data?
- What is it going to be used for?
- Cumulative impacts should be quantified and qualified to validate the use of the model; and
- Who will maintain and use the model?

END ATTACHMENT B