OUT20/14674

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Dear Mr Nevill

Cowal Gold Operations Underground Development (SSD 10367) & Cowal Gold Mine (DA 14/98) Modification 16
EIS & Modification Report

I refer to your email of 21 October 2020 to the Department of Planning, Industry and Environment (DPIE) Water and the Natural Resources Access Regulator (NRAR) about the above matter.

DPIE Water and NRAR have the following key concerns that should be addressed prior to approval:

- **Groundwater model** - The model in its current form is based on limited field data and requires improvement. There are several conceptual and numerical issues that require clarification and/or resolution prior to determination. Given the scale of the project, presence of sensitive receptors nearby, lack of independent peer review and issues raised in this review, this model is not considered to be fit for purpose in its current form to support a robust understanding of the likely impacts of the project and requires significant improvement.
- **Groundwater impacts** - Several points of clarification are required on key potential groundwater/surface water impacts of the project. The improvements to the groundwater numerical model are likely to change the model results. Therefore, the proponent will need to re-assess the groundwater impacts (including the minimal impact considerations) using the revised numerical model.
- **Surface water** – The proponent should re-assess surface water impacts (including minimal impact considerations) following the revision of the numerical model.

Detailed explanation and requirements of the above can be found in **Attachment A**. Specific issues with the groundwater numerical model can be found in **Attachment B** which we will discuss with DPIE Planning & Assessment officers and the proponent in early February.

Any further referrals to DPIE Water & NRAR can be sent by email to: landuse.enquiries@dpi.nsw.gov.au.

Yours sincerely

Mitchell Isaacs
Chief Knowledge Officer
Water – Knowledge
22 January 2021

ATTACHMENT A

Detailed advice to DPIE - Planning & Assessment regarding the Cowal Gold Operations Underground Development (SSD 10367) & Cowal Gold Mine (DA 14/98) Modification 16 EIS & Modification Report

1. Groundwater

1.1 Explanation

Groundwater Model

The groundwater numerical model presented in the EIS represents a commendable effort to help understand the potential consequences of the Project. However, the model in its current form is based on limited field data and there are several conceptual and numerical issues that require clarification and/or resolution prior to determination. Briefly these are:

- Limited field data with respect to hydraulic connectivity between the fractured rock systems and the lake-bed sediments
- It is unclear if information for the 3D geological model has been used in conceptualisation
- Model domain does not include entire extent of Lake Cowal. This may cause bias in model calibration and scenario runs
- Independent peer review of model not undertaken
- Water balance and calibration statistics for the steady state model are not provided
- Rainfall recharge and flood events not incorporated in the steady state model which may introduce additional uncertainty
- No geotechnical modelling to estimate post-mining enhancement of hydraulic conductivity in the stratigraphic sequence above the proposed stopes, including the lakebed sediments
- No field data to substantiate the assumptions of horizontal hydraulic conductivity and the sensitivity of the model to horizontal anisotropy in Saprolite, Saprock and Primary Rock units
- Tailings Storage Facility (TSF) foundation hydraulic properties were not optimised through the model calibration process and the model sensitivity
- No evidence to substantiate the assumption that 90% of the groundwater inflow to open pit, stopes and tunnels originates from the fractured rock aquifer with the remaining 10% from the overlying sediments (transported unit)
- Comparison made between model predictions in water table for four ‘parameter sets’ shows little variation between the four ‘parameter sets’ particularly adjacent to the Integrated Waste Landform (IWL) which suggests that results are strongly controlled by boundary conditions rather than hydraulic parameters

Given the scale of the project, presence of sensitive receptors nearby, lack of independent peer review and issues raised in this review, this model is not considered to be fit for purpose in its current form and requires significant improvement.

Groundwater Impacts

The improvements to the groundwater numerical model are likely to change the model results. Therefore, it will be necessary for the proponent to re-assess the groundwater impacts (including the minimal impact considerations) using the revised numerical model.

The proponent has endeavoured to address the key potential groundwater/surface water impacts of the project, constructed a water balance and proposed monitoring and mitigation measures. However, several points of clarification are required due to the issues listed below.

Impacts on Water Users

- It is unclear if cumulative groundwater drawdowns as a result of the Project (and existing open pit) will result in declines exceeding the Aquifer Interference Policy (AIP) level 1 impacts particularly in the Murray-Darling Basin (MDB) Groundwater Source (Groundwater Impact Assessment (GIA) Appendix C)
- The GIA demonstrates through particle tracking that contaminants could travel up to 2.3 km in a radius from the IWL perimeter (200 years post mine closure). It is unclear if these impacts will reach adjacent or future (third party properties) water supply works thereby breaching AIP requirements

Water Balance

The water balance provided shows:

- 90th percentile rainfall sequence (Dry) annual demand from the Bland Creek Paleochannel Bores to be approximately 3,700 ML/year (in year 2022). The proponent currently holds a licence with an entitlement of 3,650 ML/year
- A difference (shortfall) of 109 ML/year between inflow and outflow for the dry rainfall sequence (90th percentile) shown in EIS Appendix G is without any explanation.
- Section 10.4 provides total take from the open pit without separating it by groundwater source (Upper Lachlan Alluvial or Lachlan Fold Belt MDB groundwater source).
- Does not include incidental take from overlying Upper Lachlan alluvium

Groundwater Monitoring

- A lack of monitoring is evident to the north and east of the Project particularly in the Transported Unit beneath Lake Cowal, a high potential aquatic Groundwater Dependent Ecosystem (GIA Section 11.2.1). In order to ensure protection of Lake Cowal, additional monitoring is also required to ensure that contaminant particles from IWL do not reach ground surface at any location outside confinement of IWL.
- Groundwater monitoring in vicinity of the project (particularly to the north east and south) should be improved by installation of nested monitoring bores in the transported, saprock and primary rock units. This additional monitoring would facilitate further refinement in the groundwater model and further reduce risk of unforeseen impacts.
- Cyanide was detected in monitoring bore TSFNB at a concentration exceeding its previous maximum (0.252 mg/L) on October 15, 2019. This monitoring bore is situated between the current TSF's (future IWL) and the open pit.

The recommended improvements to the groundwater numerical model are likely to result in additional monitoring. Therefore, it will be necessary for the proponent to re-assess the groundwater monitoring requirements for the Project following the revision of the numerical model.

1.2 Recommendations

Prior to approval

- DPIE Water has identified several issues with the numerical model used in the EIS for the impact assessment. A meeting has been arranged between DPIE Water and the Proponent to discuss the suggested revisions to the groundwater numerical model. A list of issues regarding the numerical model that needs to be resolved is included in **Attachment B**.

- Given the scale of the project and the presence of sensitive receptors nearby, an independent assessment advising if the groundwater model platform is fit for purpose is warranted in accordance with the AIP and developed consistent with the Australian Groundwater Modelling Guidelines.
- The Proponent undertakes investigation and provides data to substantiate the assumptions of horizontal hydraulic conductivity and the sensitivity of the model to horizontal anisotropy in Saprolite, Saprock and Primary Rock units.
- Using the revised model the proponent provide evidence to support the assumption that 90% of the groundwater inflow to open pit, stopes and tunnels originates from the Fractured Rock aquifer with the remaining 10% from the overlying sediments (transported unit).
- Account for take from Upper Lachlan Alluvial and underlying Lachlan Fold Belt MDB groundwater sources for the open pit. It should include any incidental take as a result of the project from overlying Upper Lachlan Alluvial Groundwater Source.
- The groundwater impact assessments and predictions be revised following the review of groundwater model. Note, this includes groundwater re-assessment of quantity and quality impacts including minimal impact considerations.
- The Proponent specifically demonstrate that cumulative groundwater pressure decline does not exceed 2 m at any water supply work installed within Lachlan Fold Belt Water Source. This was not addressed in the GIA.
- Provide explanation for the negative difference (shortfall) of 109 ML/year between inflow and outflow for the dry rainfall sequence (90th percentile) shown in EIS Appendix G Table 17.
- Use the dry rainfall sequence (90th percentile) instead of median sequence for prediction of the project water requirements throughout the EIS Report and appendices where water requirements are mentioned.
- Provide an explanation for the single relatively high detection (Cyanide - 0.252 mg/L) at monitoring bore TSFNB during sampling on October 15, 2019.
- Updated documents should show the location of monitoring bore CB01. For example it would be beneficial if this was presented in GIA Figure 6-8 and EIS Report Figure 10.1.
- Clarify (in GIA) that the extent of the predicted contaminant plume (particle tracking analysis) does not extend to any adjacent surface or groundwater users.

2. Surface Water

2.1 Explanation

Surface Water

- There is no measured hydrogeological data immediately above the underground mine within the transported unit (Cowra Formation) (hydraulic laboratory analysis and packer or pumping tests) to confirm the Proponent's assumption that Lake Cowal is disconnected from the underlying groundwater system.
- The current model indicates that some particles reach ground surface within 1 km particularly to the north from ML 1535. This predicted interception of contaminant particles with ground surface presents a risk that these particles could then migrate along surface water pathways to adjacent Lake Cowal.

2.2 Recommendations

<u>Prior to approval</u>

- It will be necessary for the proponent to re-assess surface water impacts adjacent Lake Cowal (including minimal impact considerations) following the revision of the numerical model.

- The Proponent provides hydrogeological data (hydraulic laboratory analysis and packer or pumping tests) to substantiate the assumption that Lake Cowal is disconnected from the underlying groundwater system.

3. Water Take

3.1 Explanation

Insufficient entitlement is held by the proponent in the surface water source to account for the proposed extraction from the Lachlan Regulated River. This is to be addressed by temporary trading which represents a commercial risk to the proponent due to the potential for insufficient water to be available in a small proportion of years. As mentioned in the water balance issues of the groundwater impacts section above, the 90th percentile rainfall sequence (Dry) annual demand from the Bland Creek Paleochannel Bores will be approximately 3,700 ML/year (in year 2022). The proponent currently holds a licence with an entitlement of 3,650 ML/year. Therefore the proponent has a shortfall of 50 ML/year water entitlement.

The project is going to result in an increase in groundwater take at the mine site from 1ML/d to a maximum of 2.8ML/d due to inflows to the underground workings. Water demands in addition to the current project include supplying the paste fill plant at 1.2ML/d and 2.5ML/d for underground operations. The maximum approved processing rate is not to be exceeded with the proposed project, however the water demand is to increase from the current processing demand of 22ML/d up to a maximum of 25ML/d.

The water demands for the overall project including both open cut and underground operations are proposed to be met by the existing internal and external water sources. Internal sources are modelled to supply 63% (4686ML) of the demands for a median rainfall sequence and external sources 37% (2744ML). It is noted that the external water demands for this project are less than what was proposed for Modification 14 which is understood to be due to reduced processing water requirements for the targeted ore.

The external water sources are mainly supplied by the Bland Creek Paleochannel Bores and extraction from the Lachlan Regulated River. Due to existing trigger levels in the aquifer which can restrict pumping from the bores there is the potential for reduced water availability in drier times and or periods of increased irrigation activity. If this occurs it is proposed to increase the reliance on water from the Lachlan River to a maximum of 3160ML/yr. Based on trading statistics, volumes in excess of 3160ML have been traded in 14 of the last 16 years, with 9 years in excess of 50,000ML. There is therefore evidence of the ability to access sufficient water from the Lachlan River in most years, however there is the likelihood in drought times that this will not be available. Prioritisation of water resources and storing adequate supplies on site will be critical to minimise this risk, however the proponent will need to be aware of the potential of inadequate water being available and the need to reduce operations accordingly.

The final rehabilitated landform proposes surface runoff from the rehabilitated area to drain into the final void. As identified on review of Modification 14 for this project the capture of clean surface runoff will need to be considered for licensing requirements. This may result in the need to redesign the final landform and it is recommended this be addressed in a management plan update.

A comprehensive water balance for the underground operations will be required to validate groundwater take predictions and to inform model updates and licence requirements. This will need to include accurate metering of water pumped into and out of the mine combined with modelled inputs and outputs. The groundwater level monitoring program will assist in verifying groundwater level changes associated with inflows to the mine and flagging any changes inconsistent with predictions.

3.2 Recommendations

Prior to approval

- Include a strategy for acquiring entitlement shortfall since current demand (90th percentile) from Bland Ck Paleochannel Bores (3,700 ML/year) exceeds current entitlement held (3,650 ML/year).

Post approval

- The Water Management Plan be updated to reflect additional monitoring, metering and management measures to report on groundwater inflows and potential impacts to water sources due to the underground development.
- The Water Management Plan be updated to reflect changes to and additional surface infrastructure and any resulting changes to surface water management within the Internal Catchment Diversion System.
- The ability to accurately meter and monitor water take from surface and groundwater sources will need to be developed with ongoing review of actual versus modelled predictions. This will be a key component to confirm impact predictions, the adequacy of mitigating measures and compliance for water take.
- The proponent must report on water take at the site each year (direct and indirect) in the Annual Review. This is to include water take where a water licence is required and where an exemption applies. Where a water licence is required the water take needs to be reviewed against existing water licences.
- The proponent must ensure sufficient water entitlement is held in a water access licence/s to account for the maximum predicted take for each water source prior to take occurring.
- The proponent must ensure that relevant nomination of work dealing applications for Water Access Licences proposed to account for water take by the project have been completed prior to the water take occurring.
- The proponent must comply with the rules of the relevant water sharing plans.
- The proponent should review the final rehabilitated landform based on the surface water licensing requirements under the *Water Management At 2000* and to maximise the return of water to the downstream environment.

END ATTACHMENT A

ATTACHMENT B Specific numerical model issues for discussion

(A) The following information is required:

1. Clear analysis of the groundwater flow directions using field measurements. The report must make recommendations on additional monitoring to enhance the conceptual and numerical groundwater models for the Project.
2. Description of the steady-state model, including sensitivity and uncertainty analyses, calibration method, targets, parameters, metrics, plots, and the water balance.
3. Water budgets for selected years or periods from the transient model, accounting for uncertainty. In addition to the overall water balance, water budgets must be presented for significant features like the open pit, the proposed underground works and Lake Cowal.
4. Sources and values of the initial conditions and parameters adopted for the steady-state and transient models.
5. Clear description of the TSF–IWL transition.

(B) The following clarifications are required:

1. Clarify the extent of the 3D geological model.
2. Explain the reason for discarding the 3D geological model in the groundwater model development as implied in Section 8.1.1.2.
3. Explain the basis for the delineation of the model peripheral boundaries.
4. Confirm if the steady-state model domain is larger than the transient model domain. If not, then using the steady-state model to determine the extent (peripheral boundaries) of the transient model is prejudiced and, therefore, inappropriate.
5. Confirm all the model layers continuous throughout the model domain or do some pinch out. Presenting cross-sections in various directions across the model would assist understanding the Project’s hydrostratigraphy.
6. Explain why rainfall recharge was not represented in the steady-state model.
7. Explain the reason for the apparent discrepancy in evapotranspiration (ET) estimates between Section 6.7.2 and Section 9.1.1 in the GIA. The model must be adjusted if needed.
8. Verify how much direct ET from the water table accounts for in the groundwater budget. Estimates are required for the overall system as well as significant features like the open pit, the proposed underground works, Lake Cowal and the TSF/IWL. Where temporal changes are anticipated, this information must be provided for key times/periods.
9. Explain the reason for not representing direct ET from the water table in the surficial aquifer and the TSF/IWL in the groundwater model. If necessary, the revised model must account for ET from the water table in natural and built environments.
10. Verify the stress periods and time steps used in the transient model.
11. Verify the boundary conditions assumed at the IWL post 2040.
12. Provide the hydraulic properties used to represent the horizontal drains in the groundwater model.
13. Verify if the area under Lake Cowal always remained saturated during various model runs. In other words, is there evidence on the lake being perched above the water table? If the lake was perched, how was unsaturated flow (seepage from the lake) represented?

14. Explain why vertical bores were represented using seepage face and fixed head rather than wells. The explanation must clarify the possible implications of alternative representation methods.
15. Indicate what the Project modellers recommended in terms of model verification and updating through the Project life.

(C) Additional information/analysis:

1. Use higher resolution topographic data (e.g. LiDAR) in the groundwater model and geotechnical analysis. This is deemed important given the relative flatness of the Lake Cowal area.
2. Discuss the effects of the fixation of confinement conditions for various layers throughout the modelled periods on the model simulation and predictions considering that these aquifer conditions could change due to the proposed underground mining. If required, appropriate changes must be made to the model.
3. Undertake composite parametric sensitivity analysis (parameter identifiability assessment) and uncertainty analysis on the steady-state model.
4. Undertake additional sensitivity and uncertainty analyses on the transient model as implied to be necessary in this review.
5. Consider the need to incorporate flood events recharge in the Project's groundwater simulations and predictions.
6. Compare and comment on the differences in rainfall recharge between the GIA and DPI (2012) models.
7. Analyse vertical groundwater flows in the Project area and, if necessary, recommend additional monitoring to enable undertaking this assessment.
8. Prepare a plan for further field testing for aquifer parameters (e.g. hydraulic conductivity, porosity, and storage properties) and the hydraulic properties of the bed of Lake Cowal to compensate for the remarkable shortage in field data for the Project's model. There is very limited field testing (e.g. apparently only seven packer tests according to Figure 8 and Appendix C in the Companion Report). This plan must be agreed by DPIE Water and all the field data must be incorporated in the required groundwater model and assessment updates.
9. Assess the hydraulic connection between Lake Cowal and groundwater, including undertaking special field testing, monitoring, and modelling if found necessary.
10. Comment on the viability of the representation of the lake using time varying fixed heads rather than other possible methods, including how this may affect predictions of the lake water level and losses to groundwater, the existing open pit, and the proposed underground works.
11. List and consider the use of alternative methods to model Lake Cowal using various finite element modelling options.
12. Undertake appropriate geotechnical assessment and/or modelling for the likely enhancement of the hydraulic properties in the bed of Lake Cowal and the geological sequence above the proposed underground works. The results of this modelling must be used to inform the calibrated and predictive models.
13. Assess the potential groundwater level drawdown effects in different hydrostratigraphic units and the bed of Lake Cowal considering the potential enhancement in hydraulic properties in the lakebed and the strata above the proposed underground works concurrently due to fracturing and ground settlement. The assessment should consider enhancement in storage parameters in addition to hydraulic conductivity. The possibility of developing open conduits between Lake Cowal and the proposed underground works

must be discussed. The assessment must consider conceptual and parametric uncertainty and is required to be based on geotechnical evidence.

14. Provide a plausible justification supported by field testing data for the similarity of results of the dry and the flooded lake modelling scenarios. If found necessary, appropriate modifications must be made to the model.
15. Compare the influence of the peripheral boundaries against the influence of the hydraulic parameters on the model historical simulation and future predictions. If required, the alignment, type and characteristics of the model's peripheral boundaries must be adjusted.
16. Include the mine borefield in the model, the general water budgets and, if needed, special water budgets.
17. Provide field evidence on horizontal anisotropy or assume horizontal isotropy in the groundwater model.
18. Use Budget Analysis or a similar method to predict effects of different mining activities on various environmental and mine elements.
19. Undertake uncertainty analysis with regards to the potential for the Glenfiddich Fault to act as a significant preferential conduit for groundwater flow.
20. Include storage parameters (specific yield and specific storage) in the transient model calibration and the uncertainty analysis.
21. Include the hydraulic properties of the backfill paste in the sensitivity and uncertainty analysis.
22. Discuss the implications of the increasing model mass balance error with time on the model predictions.
23. Incorporate TSF foundation hydraulic properties in the model calibration and sensitivity and uncertainty analyses.
24. Present and discuss the conceptual and parametric uncertainty relating to the observed and predicted groundwater mounding associated with the TSF/IWL.
25. Represent the noticed groundwater mounding due to TSF/IWL in the calibrated model and uncertainty and predictive runs.
26. Assess the effects of the proposed underground mining by running and comparing two scenarios: (a) continuation of mining without the proposed underground works, and (b) addition of the proposed underground works to the open pit mining. Results are required to be presented and discussed for all hydrostratigraphic units, especially the Transported unit and Lake Cowal. The uncertainty in the estimates must be assessed.
27. Clarify the influence of surface runoff on the water balance and level in the open pit.
28. Present yearly groundwater inflow data and estimates separately for the open pit and the proposed underground development at various conceptual and parametric scenarios in table format and graphically if deemed useful. The scenarios must include potential enhancement of fractures in both the lakebed and strata above the proposed underground development.
29. Represent the linear projection of water level in the piezometers located to the south of the southern TSF that predicts that groundwater levels reach the ground surface by the end of 2026 (as presented in GIA Section 12) in the model and uncertainty runs.
30. Undertake field and/or laboratory assessment of total and effective porosity in support to particle tracking modelling.
31. Analyse the conceptual and parametric uncertainty in the contaminant transport predictions.
32. Analyse the proposed mitigation measures using the groundwater model and/or other appropriate methods.

33. Revise the assessment of the Project's aquifer interference effects considering the groundwater model conceptual and parametric uncertainties. Assessment is particularly required for:
    a) Groundwater take from each water source expressed in Megalitres/year.
    b) Surface water take from Lake Cowal expressed in Megalitres/year.
    c) Impacts on the water table at all adjacent water supply works.
    d) Impacts on groundwater pressures at all adjacent water supply works.
    e) Potential effects on Lake Cowal and associated ecosystems.

34. Provide an improved assessment of the potential effects of the proposed underground development on Lake Cowal based on groundwater modelling and other acceptable hydrogeological evidence. It must account for conceptual and parametric uncertainties, including defendable peripheral model boundaries and the possibility of enhanced hydraulic conductivity above the proposed underground works. It must clearly describe the cause-effect relationships (e.g. certain amount of drop in the lake water level due to the underground works alone).

35. Provide a groundwater modelling and assessment updating plan to DPIE Water for approval. The plan must include clear uncertainty analysis and predictive scenarios. The model updating plan must incorporate the use of 3D laser scanning of each void during the production phase and prior to backfilling.

(D) Preferred modelling report presentation

1. A standalone numerical groundwater model report is required. If not feasible, it could be included in a standalone Groundwater Impact Assessment (GIA) report. The modelling report/GIA should make minimal referencing to external documents. Relevant data from other documents can be summarised (e.g. in table format) and, if necessary, relevant parts of other documents (e.g. maps and figures) could be included in the report or appendices.
2. Include additional header levels in the table of contents (currently three) to enable easier understanding of the document structure and cross-referencing as may be necessary.
3. Check for inaccurate cross-references as part of the document proofreading.
4. Include table of abbreviations and acronyms.
5. Include appropriate captions for figures and tables, including cross-referencing as may be needed (e.g. cross-section lines are shown on Figure X-Y).
6. Use A3 page size for figures (including maps) and tables if required.
7. Consider merging some tables to make them more useful (e.g. Tables 6-7 and 6-8).
8. Maps must be drawn to the same extent and scale as much as practicable, with appropriate legends and scale information. This would facilitate cross-interpolation of data.
9. Include figures with appropriate axis scales to clearly show the data.
10. Consider showing additional data on figures without cluttering them, e.g. add over and under estimation lines to the observed versus modelled groundwater head plot (Figure 8-15).
11. Present comparison plots for modelled and observed groundwater levels for all bores including those bores not used in the final model calibration like UG-BH-03, UG-BH-04 and PZ13.
12. Include point values where appropriate in contoured or colour shaded maps and cross-sections (e.g. Figure 6-5 in GIA and Figure 4-10 in the Eastern Saline Borefield

Groundwater Assessment) to enable comparison between measurements and geospatial interpolation results.

13. Include updated conclusions and recommendations based on the revised model and considering conceptual and parametric uncertainties.

End Attachment B