Appendix B

Groundwater responses

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24 February 2021

Our ref: 754-SYDGE206418-3-AS-Rev1

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Attention: Paul Freeman

Dear Paul

CGO Underground Development EIS - Addendum 2 of the hydrogeological assessment

1. Background

The NSW Department of Planning, Industry and Environment (DPIE) provided a review of the hydrogeological assessments prepared by Coffey Services Australia Pty Ltd (Coffey) for EMM Consulting Pty Ltd (EMM) for the Evolution Cowal Gold Operations (CGO) Underground Development Environmental Impact Statement (EIS).

The DPIE review (DPIE ref: OUT20/14674, dated: 22 January 2021) outlines a number of key items to be addressed prior to approval for the proposed CGO Underground Development, with reference to the hydrogeological aspects of the project set out in the following two reports:

- Cowal Underground Development EIS – Mine Site Hydrogeological Assessment (Coffey report ref: 754-SYDGE206418-3-AM, Final, dated 10 September 2020) (the mine site report).
- Cowal Gold Operations Underground EIS - Bland Creek Palaeochannel Borefield and Eastern Saline Borefield Groundwater Assessment (Coffey report ref: 754-SYDGE206418-3-AN-Rev1, dated 27 August 2020) (the BCPB report).

A separate independent peer review of the hydrogeological assessment was carried out by HydroGeoLogic Pty Ltd (HydroGeoLogic) (Cowal Gold Underground Development Groundwater Assessment Peer Review, HydroGeoLogic, dated: 10 December 2020 (initial review)) (the HydroGeoLogic review). Responses to the items in the HydroGeoLogic review are provided in the following report:

- CGO Underground Development EIS - Addendum 1 of the hydrogeological assessment (Coffey ref: 754-SYDGE206418-3-AP, dated: 17 February 2021)

Following discussions at a meeting on Tuesday 2 February with representatives from DPIE, HydroGeoLogic, Evolution, EMM and Coffey, this report addresses the key issues raised in the DPIE review.

2. Summary of key issues requiring clarification in the DPIE review

This report provides further details on the following key items raised in the DPIE / NRAR review:

- Field evidence showing poor connectivity between Lake Cowal and the groundwater system.
- A summary of existing field testing data.
- Solute migration predictions and the potential risk to Lake Cowal and groundwater users near the mine site.
- Groundwater take from the Upper Lachlan Alluvial groundwater source.
- Groundwater pressure decline at water supply works in the Lachlan Fold Belt Murray Darling Basin groundwater source due to mining.
- Groundwater inflow and drawdown due to the proposed CGO Underground Development only.
- Potential for increased fracturing above and around the stopes / tunnels.
- Numerical model details:
    - Steady state model.
    - Lateral boundaries.
    - TSF / IWL foundation parameters and boundary conditions.
    - Lake Cowal boundary conditions.
    - Effect of using confined conditions on model layer 6 to layer 20.
- Recommendations for future monitoring and model verification / updates.

3. Background

3.1. Previous hydrogeological studies

Coffey has been involved with the CGO site since 1994. Prior to the commencement of mining at the site, Coffey prepared hydrogeological assessments to investigate the potential for mine water supply, and provided initial pit dewatering assessments, and mine site water balance modelling. As mining commenced, Coffey developed the numerical groundwater models which were used in several hydrogeological assessments for major modifications to the mine.

3.1.1. Bland Creek Palaeochannel Borefield modelling

In 2006 Coffey developed a three-dimensional numerical groundwater flow model for assessing the impacts of pumping from the BCPB on the surrounding environment and other groundwater users. This was calibrated and used for predictive analysis.

In 2010, due to changes in the mine plan and the introduction of the Eastern Saline Borefield (ESB), the model was upgraded and used to assess the impacts from proposed future changes in pumping from the BCPB and ESB. The model was recalibrated at the time of the upgrade which included the addition of new pumping and monitoring records collected since 2006.

Predictive simulations were carried out in 2013, 2016 and 2018 as part of hydrogeological assessments for the Mod 11, Mod 13 and Mod 14 modifications to the mine, respectively. These assessments are available on the DPIE NSW Planning Portal (https://www.planningportal.nsw.gov.au/major-projects/project/12791).

The current assessment, as described in the BCPB report, builds upon the previous work which assessed the impacts of the mining operations in relation to changes to the CGO associated with the approved Mine Life Extension modification 14.

3.1.2. Mine site modelling

In 2011 Coffey developed a three-dimensional numerical groundwater flow model of the pit area and surrounds. This model was used to assess the potential for hydraulic connection between Lake Cowal and the mine site groundwater system, groundwater inflows to the open pit and the short and long-term effects of mine closure on groundwater conditions. The transient model was calibrated and used for predictive analysis.

Model re-calibrations and predictive simulations were carried out in 2013, 2016 and 2018 as part of hydrogeological assessments for the Mod 11, Mod 13 and Mod 14 modifications to the mine, respectively. These assessments are available on the DPIE NSW Planning Portal (https://www.planningportal.nsw.gov.au/major-projects/project/12791).

The current assessment, as described in the mine site report, builds on the previous work. The numerical groundwater model was expanded with a re-designed mesh to incorporate the proposed underground mine. The model was re-calibrated against monitoring data covering the period 2005 to 2020 using PEST calibration software, and an assessment of model parameter and observational uncertainty was carried out.

3.2. Model confidence class according to the Australian Groundwater Modelling Guidelines

An assessment of the model confidence level classification was carried out based on the Australian Groundwater Modelling Guidelines (Barnett et al., 2012). This indicates that the mine site and the BCPB groundwater models have attributes which fall into either Class 2 or Class 3. This confirms that the models are suitable for impact assessment scenario modelling purposes. Table 1 shows the assessment for the mine site model.

Table 1: Model confidence class attributes for the Mine site model (after Figure 5 of Middlemis and Peeters, 2018)

Class	Data	Calibration	Prediction	Quantitative indicators
1 (simple)	Not much / Sparse coverage	Not possible	Timeframe >> Calibration	Timeframe >10x
	No metered usage	Large error statistic	Long stress periods	Stresses >5x
	Low resolution topo. DEM	Inadequate data spread	Poor / no validation	Mass balance > 1% (or one-off 5%)
	Poor aquifer geometry	Targets incompatible with model purpose	Targets incompatible with model purpose	Properties <> field values
	Basic / Initial conceptualisation	Targets incompatible with model purpose	Targets incompatible with model purpose	No review by Hydro / Modeller
2 (impact assessment)	Some data / OK coverage	Weak seasonal match	Timeframe > Calibration	Timeframe = 3-10x
	Some usage data / low volumes	Some long term trends wrong	Long stress periods	Stresses = 2-5x
	Baseflow estimates. Some K & S measurements	Partial performance (eg some stats / part record / model-measure offsets)	OK validation	Mass balance < 1%
	Some high res. topo DEM and / or some aquifer geometry	Head & Flux targets used to constrain calibration	Calib & prediction consistent (transient or steady-state)	Some properties < > field values. Review by Hydrogeologist
	Sound conceptualisation, reviewed & stress-tested	Non-uniqueness and qualitative uncertainty partially addressed	Significant new stresses not in calibration	Some coarse discretisation in key areas of grid or at key times
3 (complex simulator)	Plenty data, good coverage	Good performance stats	Timeframe ~ Calibration	Timeframe < 3x
	Good metered usage info	Most long term trends matched	Similar stress periods	Stresses < 2x
	Local climate data	Most seasonal matches OK	Good validation	Mass balance < 0.5%
	Kh, Kv & Sy measurements from range of tests	Present day head / flux targets, with good model validation	Transient calibration and prediction	Properties ~ field measurements
	High res topo DEM all areas & good aquifer geometry	Non-uniqueness minimised, qualitative uncertainty justified	Similar stresses to those in calibration	No coarse discretisation in key areas (grid or time)
	Mature conceptualisation	Sensitivity and / or qualitative uncertainty	Quantitative uncertainty analysis	Review by experienced Modeller

Note: The colour 'green' signifies an attribute criteria of Class 2 or Class 3 met by the numerical model

4. Response to key items raised in the DPIE review

4.1. Field evidence of poor connectivity between Lake Cowal and the groundwater system

Historically, the ephemeral Lake Cowal floods approximately every five to ten years and can become completely dry in the intervening periods. Since 2005 there have been two significant flood events in Lake Cowal, one between October 2010 and November 2014 and the other between July 2016 and November 2017. The observed water level at Lake Cowal between 1998 and 2020 is shown in Figure 1.

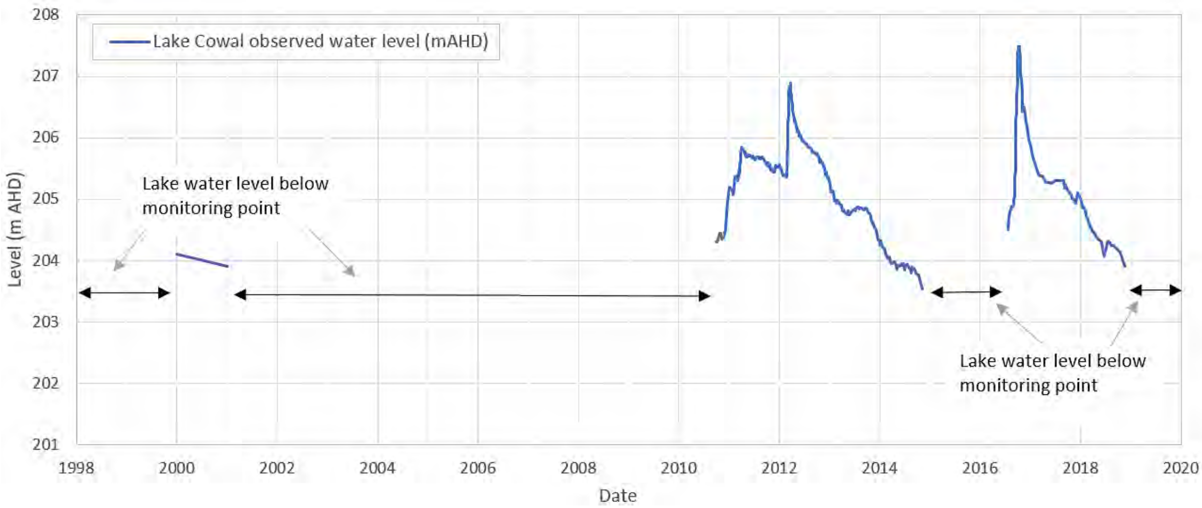

Figure 1: Observed water level at Lake Cowal between 1998 and 2020

4.1.1. CGO open pit dewatering records

The CGO open pit has been in operation since 2005 and is located in close proximity to Lake Cowal. A conceptual hydrogeological model through the CGO open pit and Lake Cowal is shown in Figure 2.

The CGO open pit is a significant groundwater sink. Groundwater is drawn toward the open pit, in particular from the fractured rock aquifer in which the majority of the open pit is excavated. Figure 3 shows modelled groundwater head contours around the open pit in 2019.

If there was a significant connection between Lake Cowal and the underlying fractured rock aquifer, it should be possible to observe an increase in groundwater inflow to the open pit during periods when Lake Cowal is in flood. The open pit is by far the dominant influence on groundwater around the western part of Lake Cowal. This can be seen from the groundwater flow directions shown in Figure 3.

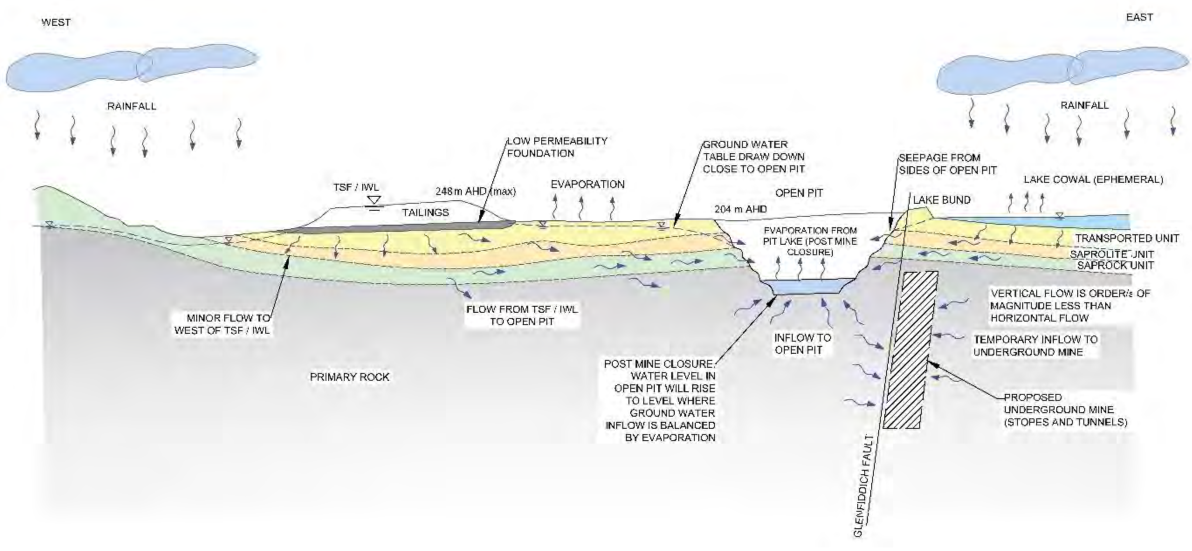

Figure 2: Conceptual hydrogeological model of the CGO site

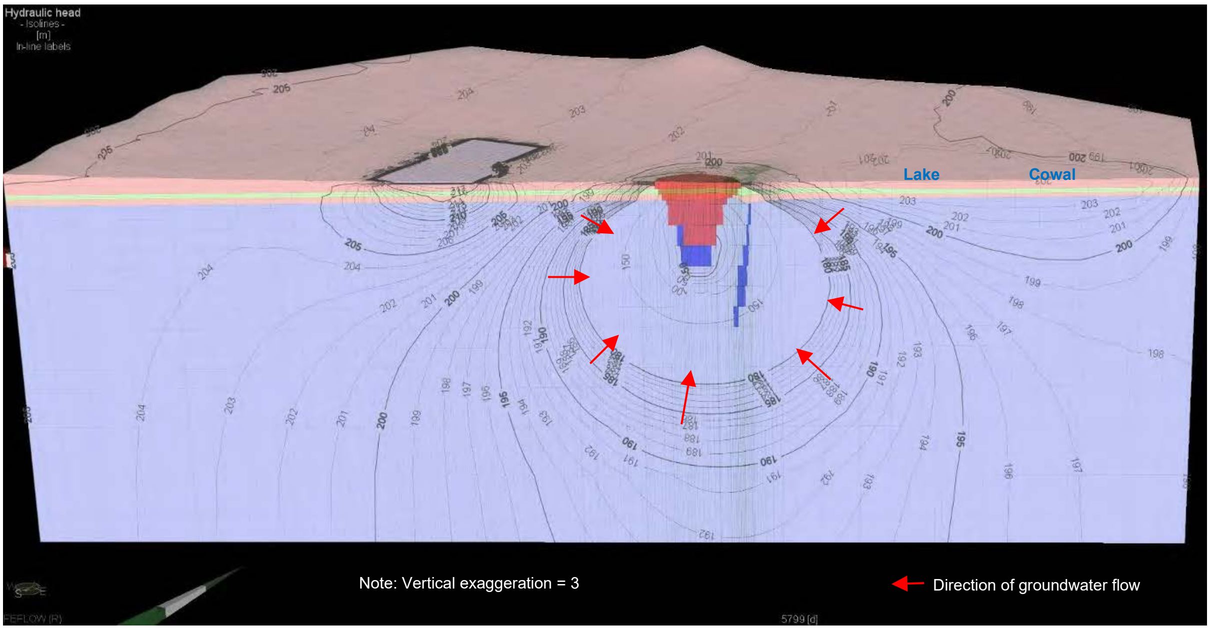

Figure 3: Modelled groundwater head contours for 2019 - west to east section looking north

Evolution has provided continuous daily pit dewatering records since 2005. These show the total daily volume dewatered from the open pit, which includes seepage from the pit walls, floor and dewatering bores, and surface water runoff that reaches the open pit. Due to the inclusion of surface water runoff in the records, the daily dewatering volume is quite variable and can reach high values after periods of rainfall. During long dry periods however, the proportion of surface water runoff is considered to be much lower, and the dewatering volume is considered more representative of groundwater inflow to the open pit.

Figure 4 shows open pit dewatering records along with the level of Lake Cowal between 2007 and 2020.

Periods when Lake Cowal is in flood and rainfall is low are circled in Figure 4. Pit dewatering rates during these periods can be seen to be approximately 1,000 m^3/day. This rate is consistent with pit dewatering rates during 2007 to 2010, 2015 and 2019 when Lake Cowal was dry. Of particular interest is the period from mid-2018 to mid-2019 during which Lake Cowal became dry and there was no observed decrease in pit dewatering rates.

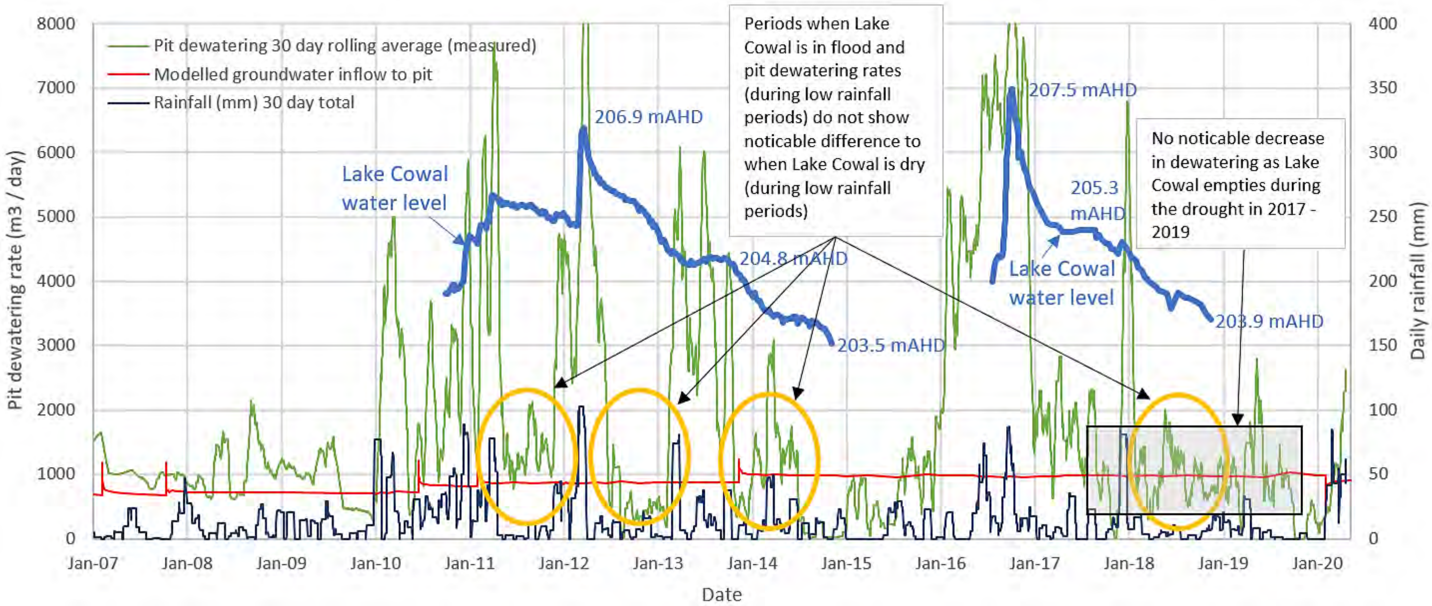

Figure 4: Pit dewatering and Lake Cowal levels

A consideration of these observations provides direct field evidence that Lake Cowal does not have a significant influence on groundwater inflow rates to the CGO open pit. The observations show that for periods of low rainfall (when pit dewatering can be considered representative of groundwater inflow), pit dewatering rates during periods when Lake Cowal is dry are approximately equal to pit dewatering rates when Lake Cowal contains water.

The CGO open pit is located adjacent to Lake Cowal and was over 200 m deep in June 2011 and over 300 m deep in January 2018. An excavation of this depth results in groundwater head gradients between Lake Cowal and the open pit attracting groundwater toward the open pit.

Open pit dewatering observations show that the rate of groundwater inflow to the open pit is independent of whether or not Lake Cowal is full. This represents significant field evidence of poor connectivity between Lake Cowal and the fractured rock groundwater system beneath Lake Cowal.

4.1.2. Evaporation from Lake Cowal

Lake Cowal is filled by runoff from the Bland Creek catchment to the south and flood breakout from the Lachlan River to the north east. The pit envelope impedes on the lake area, and a lake protection bund and dewatering programme form an integral part of the mine plan. At the overflow (full storage) level of about 205.7 m AHD the lake overflows into Nerang Cowal, another ephemeral lake to the north, and then into Bogandillon Swamp before returning to the Lachlan River.

Figure 5 shows available lake water level observations compared to flow at the gauge 412103 (Bland Creek at Morangarell, now disused). When the lake is draining, water levels show a quasi-logarithmic fall. Below the full storage level, the rate of water level fall is approximately linear with time. An analysis of eight recession events was undertaken. For each event, the time period was selected such that other data suggest negligible inflows to the lake from creeks and surface runoff were occurring. For each event, pan evaporation and direct rainfall to the lake water body were taken into account. The average fall in lake water level (accounting for rainfall) from the events was equal to 80% of pan evaporation. This is similar to recorded rates of water level fall for large shallow lakes that contain suspended and dissolved solids in a semi-arid climate. Results indicate that transfer of groundwater to or from Lake Cowal is low, with the precision of the results being less than that required to quantify the transfer.

This provides further field evidence of poor connectivity between Lake Cowal and the fractured rock groundwater system beneath Lake Cowal.

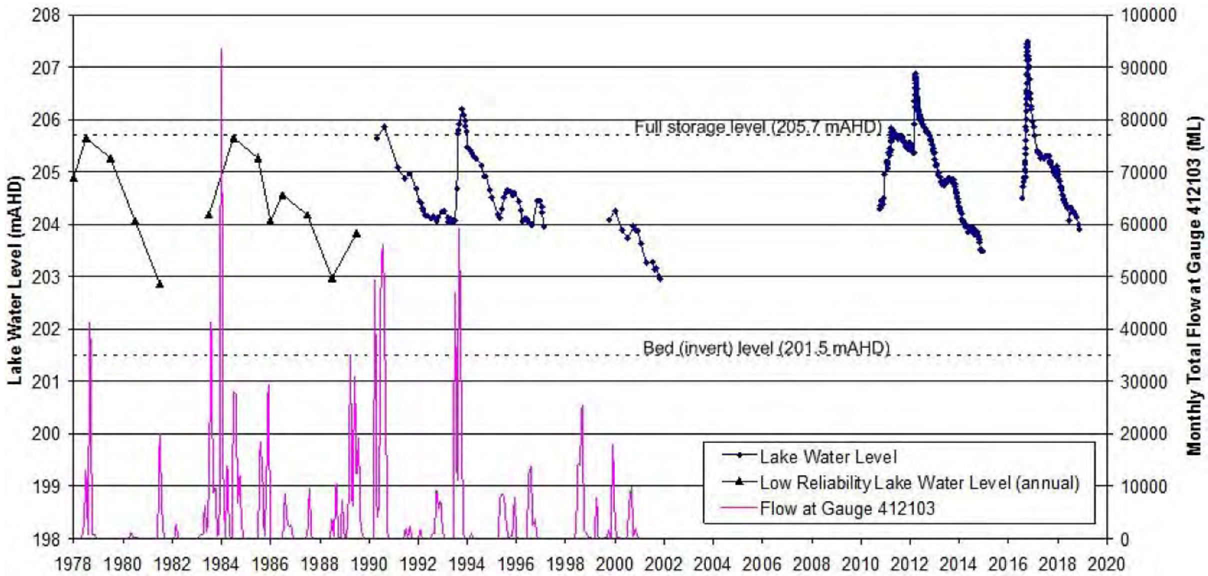

Figure 5: Observed water levels in Lake Cowal and flow at gauge 412103 (Bland Creek at Morangarell, now disused)

4.1.3. Seepage into the GRE46 exploration decline

The GRE46 exploration decline was constructed during 2019 and 2020 for the purposes of providing access for exploratory drilling into the area of the proposed CGO Underground Development. The decline has an approximately rectangular profile, 6 m wide and 6 m high, and in February 2020 extended for a 1,300 m length north westwards just to the west of the proposed stopes with two branches extending for approximately 300 m to the east into the area of the proposed stopes. The location of the GRE46 exploration decline is shown in Figure 6.

A Coffey field engineer conducted a site walkover and drive through the exploration decline on 27 February and 28 February 2020, mapping observed areas of seepage or dampness of the exposed tunnel face. Where possible, the rate of seepage was assessed by timing the rate of filling up of a bucket. The entire decline was observed except for a small area where drilling was in progress at the eastern end of the 985 arm. The floor of the decline was not observed as it was not practicable to obtain a clear view due to the presence of disturbed ground, mud or water. The observed seepage and estimated inflows are shown in Table 2. A map showing observed seepage is provided in Figure 7.

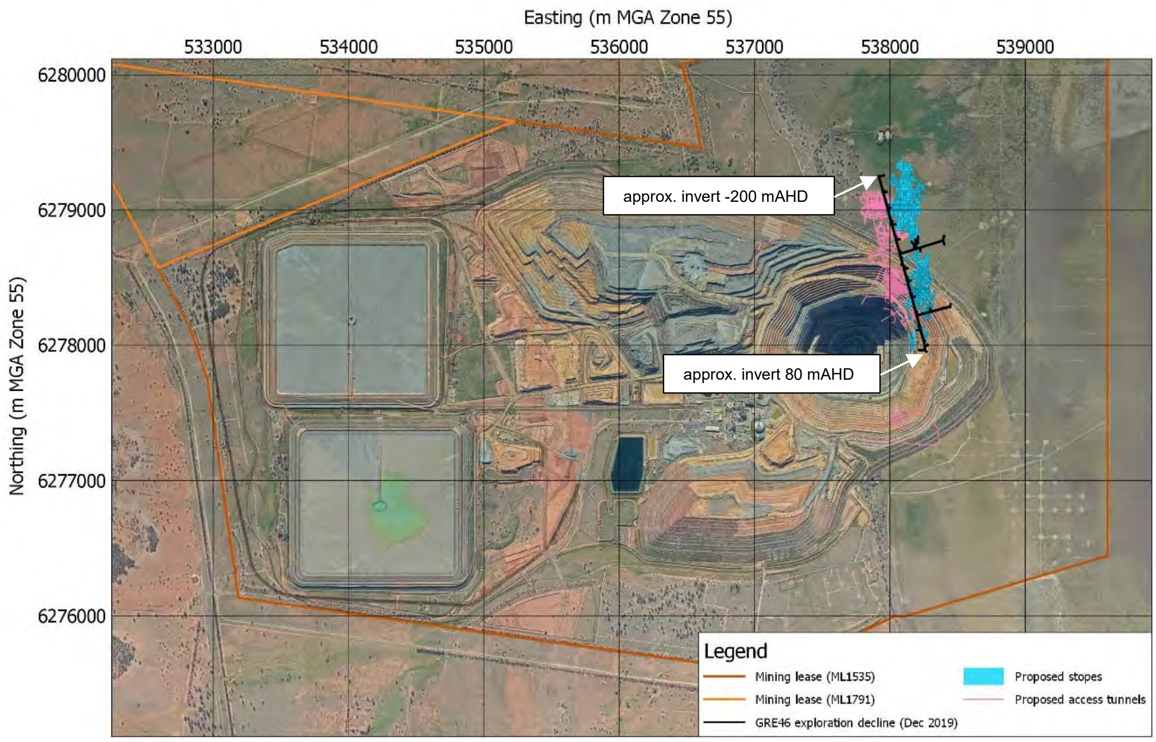

Figure 6: CGO mine site area showing GRE46 exploration decline with approximate invert levels

Table 2: Observed seepage in exploration decline (27 February 2020)

Category	Approximate flow rate (L/min)	Number observed	Total flow (L/min)	Total flow (L/s)
VVH	25	1	25.0	0.42
VH	7.5	3	22.5	0.38
H	3	6	18.0	0.30
L	1.5	7	10.5	0.18
M	0.2	47	9.4	0.16
TOTAL			85.4	1.42

The seepage inflow rate classifications listed in Table 2 were adopted to cover the range of inflows observed. Even the highest observed inflow rate is considered modest. The total aggregate observed flow into the decline is approximately 1.4 L/s. Doubling this value, to account for areas where seepage could not be observed due to mud and water and for approximations in assessing flow rates, results in an estimated groundwater inflow rate of 2.8 L/s into the whole exploration decline on 27 February 2020. It is noted that the floor of the tunnel could not be observed. This was approximately one third of the tunnel surface area. To reduce the risk of underestimating the inflows, the inflows were doubled to account for this rather than multiplying by 1.5.

An assessment of the hydraulic conductivity required to produce this flow rate was carried out. This was done by assuming an equivalent length tunnel in uniform rock with the same approximate groundwater heads and tunnel elevation profile. The assessed groundwater inflow was based on an analytic solution (Best and Parker, 2004) for steady state groundwater inflow to a tunnel:

$$q = \frac{2\pi kH}{\ln\left(\frac{4H}{D}\right)}$$

Where:

q = inflow per m run of tunnel (m^3/s)

k = hydraulic conductivity of an isotropic material (m/s)

H = groundwater pressure head at tunnel invert (m)

D = tunnel diameter (m)

The resulting hydraulic conductivity was found to be approximately 5.5 x 10^{-9} m/s, which is close to the following:

- The median hydraulic conductivity from seven packer tests in the Primary Rock was 3.5 x 10^{-9} m/s.
- The adopted horizontal hydraulic conductivity for the Primary Rock in the mine site model of 1 x 10^{-8} m/s.
- The adopted vertical hydraulic conductivity for the Primary Rock in the mine site model of 1x10^{-9} m/s.

Note that this method of assessing hydraulic conductivity is approximate, however groundwater inflow rates into the exploration decline serve as an excellent guide to expected groundwater into other excavations nearby such as the proposed stopes and access tunnels for the proposed CGO Underground Development.

Details of the hydraulic conductivity assessment are provided in the mine site report, Appendix E. It should be noted that the assessed hydraulic conductivity of the Primary Rock based on the seepage assessment is consistent with the parameters adopted in the mine site report.

4.1.4. Observed inflows from the Glenfiddich fault

Near its entrance from the open pit, the GRE46 exploration decline crosses the Glenfiddich fault. Exploration drill holes directed towards the east from the southern half of the exploration decline are interpreted to intersect the fault, which runs in an approximate NNW direction just east of the decline. The combined flows from the higher flowing drill holes in the southern half of the decline, as shown in Figure 7, which account for the majority of the observed seepage into the decline, was in the order of approximately 1 L/s. Note that in Figure 7 the terms describing observed seepage rate are comparative. The flows observed were all modest with the largest flow rates from individual features of the order of 20 L/min (0.3 L/s).

Considering the assessment described above in which the observed total rate of flow into the 1.3 km long decline was shown to be indicative of hydraulic conductivity values in the surrounding Primary Rock of 5.5 x 10^{-9} m/s, and considering the large number of exploration drill holes to the east of the decline which are interpreted to intersect the Glenfiddich fault, the Glenfiddich fault is not considered to significantly affect the overall groundwater flow regime in the area of the proposed CGO Underground Development.

The low rate of observed seepage into the GRE46 exploration decline in February 2020 ,which includes seepage from numerous exploration drill holes drilled to the east from the exploration decline inferred to intersect the Glenfiddich fault, provides evidence that the hydraulic conductivity of the Primary Rock in the area of the proposed CGO Underground Development indicates a very limited connectivity between Lake Cowal and the Primary rock at the elevation of the proposed stopes and access.

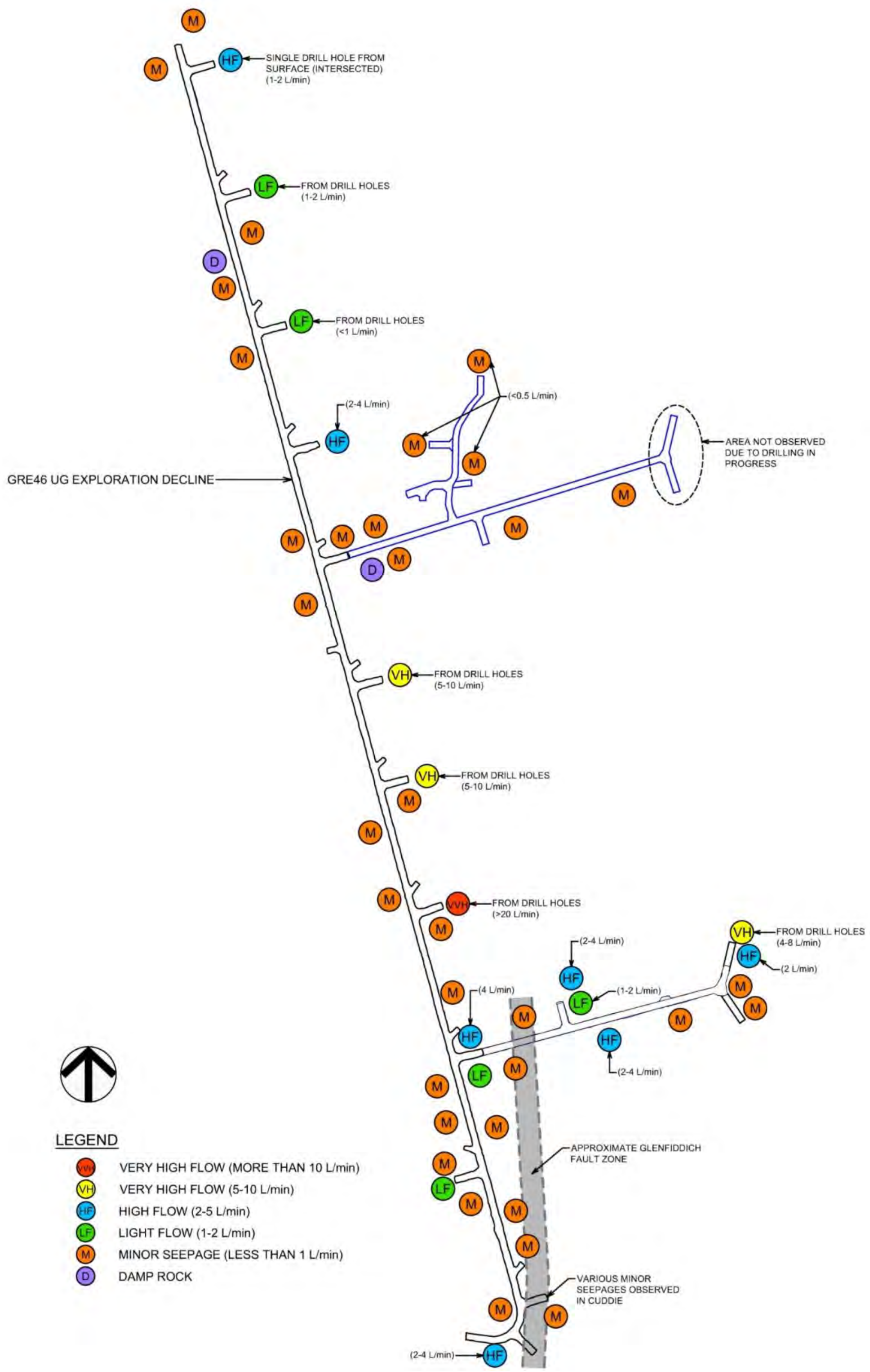

Figure 7: Mapped seepage into to GRE46 exploration decline (February 2020)

4.1.5. Pit monitoring piezometer responses

Existing pit area monitoring piezometer screen details are listed below:

- PDB1A - Saprock screen from 82 to 88 m below ground level.
- PDB3A - Saprock screen from 94.5 to 100.5 m below ground level.
- PDB5A - Saprock screen from 76.5 to 82.5 m below ground level.
- PDB1B - Transported screen from 14 to 20 m below ground level.
- PDB3B - Transported screen from 23.6 to 29.6 m below ground level.
- PDB5B - Saprolite screen from 23.8 to 29.8 m below ground level.

Groundwater levels observed at the pit area monitoring piezometers shown in Figure 8 illustrate the following features:

- Substantial fluctuations in groundwater level have been recorded in the Saprock as a result of changes in the rate of dewatering and changes associated with pit development. Fluctuations are dampened in the Transported unit.
- Groundwater levels show a response to rainfall (and possibly inundation of Lake Cowal) for shallow monitoring piezometers PDB1B, PDB3B and PDB5B screened in the Transported unit; with a limited response in deeper monitoring piezometers PDB1A and PDB5A screened in the Saprock unit.
- No response to rainfall is observed at Saprock piezometer PDB3A, which shows the greatest drawdown due to pit dewatering.

This provides further evidence of poor connectivity between Lake Cowal and the fractured rock groundwater system beneath Lake Cowal.

The location of the monitoring piezometers is shown in Figure.

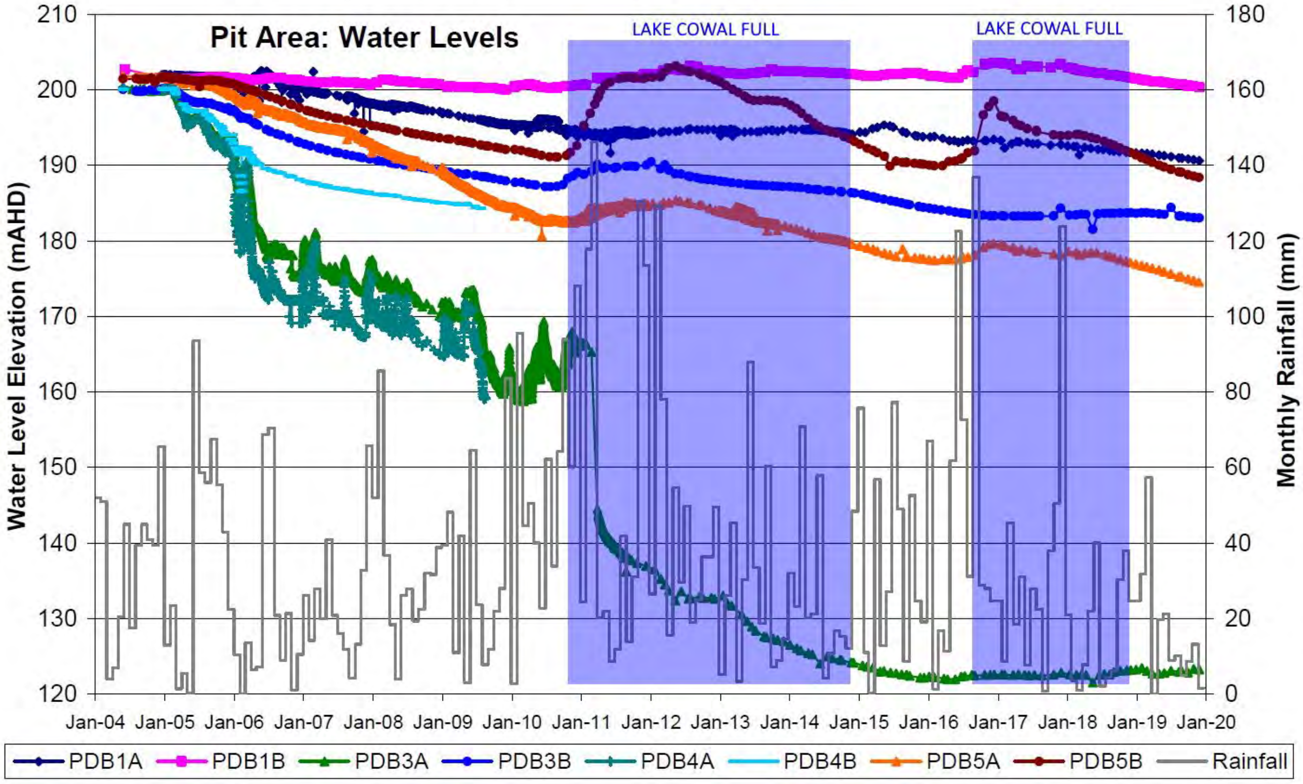

Figure 8: Groundwater levels at pit area monitoring piezometers between 2004 and 2020

4.2. Summary of existing field testing data

The mine site report Section 6.8 provides detailed discussion on historic in-situ hydraulic conductivity testing at the mine site and BCPB area (formerly known as the Jemalong Borefield Area). A large database has been compiled of hydraulic conductivity measurements from in-situ hydraulic testing. The database consists of the following:

- 26 single rate pump tests conducted at the CGO site.
- Three packer tests in volcanic rocks conducted at the CGO site.
- Two long-term single rate pump tests conducted at the two saline borefields (at other sites).
- Six long-term single rate tests conducted at the BCPB.
- 102 estimates of hydraulic conductivity from specific capacity data in government records for private water bores. 45 estimates are for the Lachlan Floodplain (north of the Corinella Constriction).

Figure 9 shows the hydraulic conductivity database developed from these measurements.

Hydraulic conductivity of the transported sediments at the CGO site has previously been assessed by field testing including nine large differential slug tests and one pit bore pumping analysis.

Further to the information shown in Figure 9, a field investigation program was carried out in early 2020 which included packer testing in the Primary Rock in the area of the proposed CGO Underground Development, and an assessment of seepage into the GRE43 exploration decline. The results of this investigation were consistent with parameters adopted based on calibration of the mine site numerical groundwater model to groundwater monitoring at 22 monitoring piezometers over the period 2005 to 2020.

The field investigation report is included as Appendix E of the mine site report.

Hydraulic conductivity distributions in the Department of Primary Industries Office of Water Upper Lachlan Groundwater Flow Model (Bilge 2012) showed a large range of calibrated values over the regional model domain. Upper and lower hydraulic conductivity bounds and initial estimates for the model were obtained from modelling presented by Coffey (2006) and Barnett and Muller (2008). The following range of values were adopted:

- Upper Cowra Formation: 0.1 to 30 m/day
- Lower Cowra Formation: 0.1 to 40 m/day
- Lachlan Formation: 1 to 100 m/day.

It is noted that these values are higher than the adopted values for the mine site model, however the regional scale modelling described by Bilge (2012) did not take account of the local conditions and mining operations at the CGO mine site, or the available groundwater monitoring data around the CGO open pit since 2005.

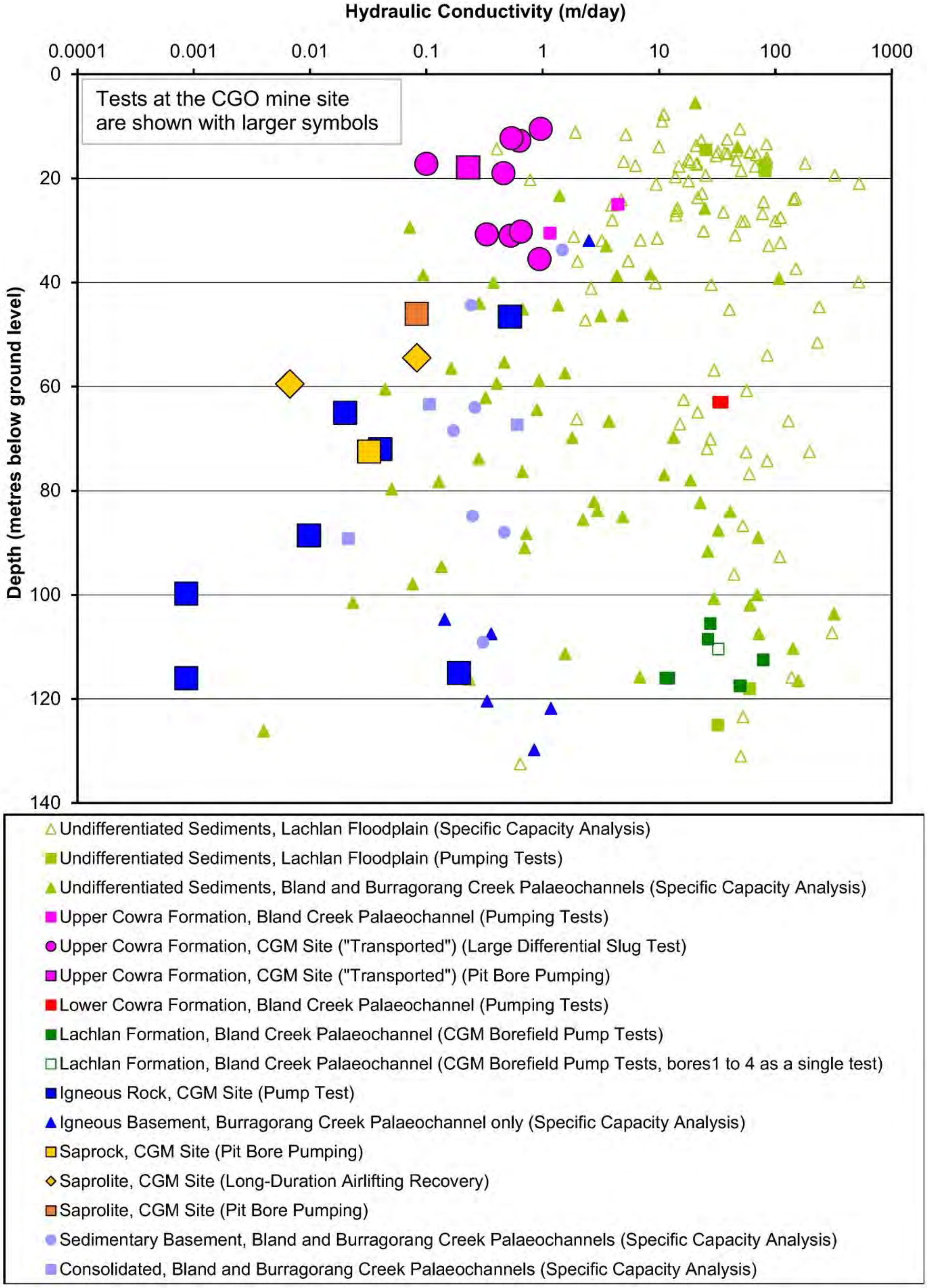

Figure 9: Hydraulic conductivity database for the CGO site and BCPB area

4.3. Groundwater monitoring around the CGO open pit

The CGO open pit has been in operation since 2005 and is currently approximately 400 m deep, influencing groundwater levels over a wide area around the mining lease. Groundwater levels have been continuously monitored since 2004, providing records of the influence of the open pit and adjacent tailings storage facilities on groundwater levels in each of the hydrogeological units on the mine site, in particular the Transported, Saprolite and Saprock units.

The mine site report describes the results of a transient calibration of a three-dimensional numerical model of the mining lease and surrounding area against 22 monitoring piezometers and pit dewatering records for the period 2004 to 2020 . The calibration was carried out using the automated software PEST, which resulted in a normalised root mean square error of 4.51%, indicating a good match of modelled results versus observations. The calibration provided an assessment of the vertical and hydraulic conductivities and specific storage for each of the hydrogeological units on the mine site.

It is considered that due to the wide area of influence, the operational time frame of over 15 years at the time of writing in February 2020, the incorporation of pit dewatering records, and the relevance to mining operations, the field data provided by the operation of the open pit and tailings storage facilities, provides a comprehensive and reliable set of field data for the mine site including the proposed CGO Underground Development which is to be located in close proximity to the north east of the open pit.

4.4. Solute migration predictions and potential risk to Lake Cowal and groundwater users near the mine site

A search of the Bureau of Meteorology Australian Groundwater Explorer public bore database (http://www.bom.gov.au/water/groundwater/explorer/map.shtml) was carried out on 9 February 2021. Bores labelled as being for the purposes of water supply, irrigation, stock and domestic and commercial and industrial within 30 km of the CGO mine site were identified and downloaded.

Figure 10 shows the predicted extent of solute transport from the TSF/IWL in 200 years following the end of mining. The figure also shows the existing registered groundwater users identified around the mining lease. Mine site groundwater bores are not shown in Figure 10. There is no evidence of any risk to existing registered groundwater users from the predicted solute transport in groundwater from the TSF/IWL in the 200 years post-mining.

The treatment of solute/contaminant transport in the mine site report adopted conservative retardation factors and chemical reactions, dispersion or diffusion were not included in the modelling. Field evidence that the solute transport predictions in the mine site model are conservative are provided by the lack of continuous detection of cyanide above detection limits in monitoring piezometers immediately adjacent to the TSFs during 15 years of operations, in particular at MON02A which is shown in Figure 38. Figure 11 shows that modelled solute particles starting out in 2007 from TSF south were predicted to be observed in MON02A long before January 2020. This has not occurred in reality.

We note that during 2019 total cyanide was detected on 15 October 2019 at two bores east of the northern TSF, TSFNB (0.252 mg/L) and TSFNC (0.027 mg/L). These bores were resampled on 25 October 2019 and results were below the laboratory detection limit. Evolution has confirmed via email communication through EMM to Coffey on 11 February 2021 that this detection was a false positive.

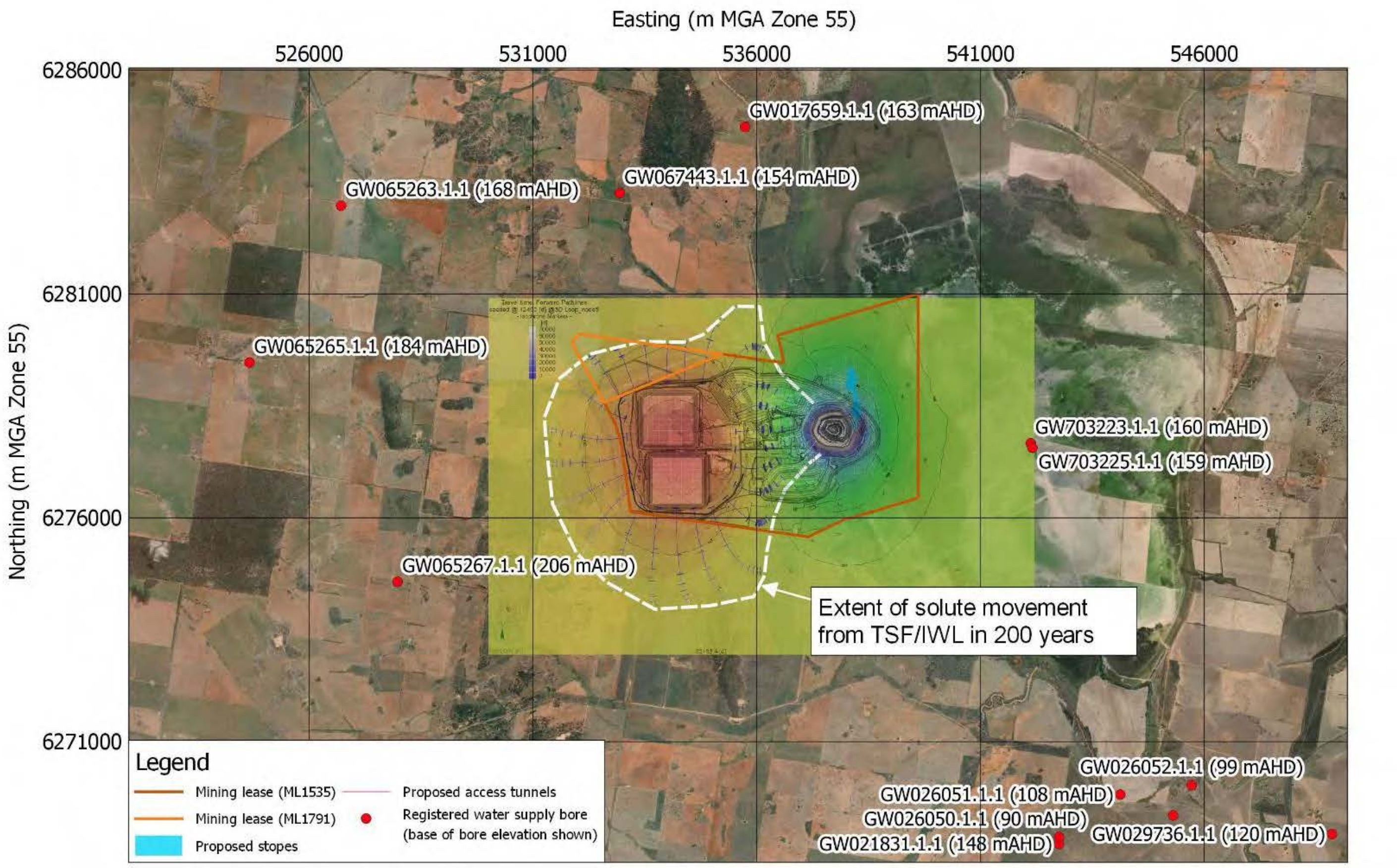

Figure 10: Predicted extent of solute movement in 200 years

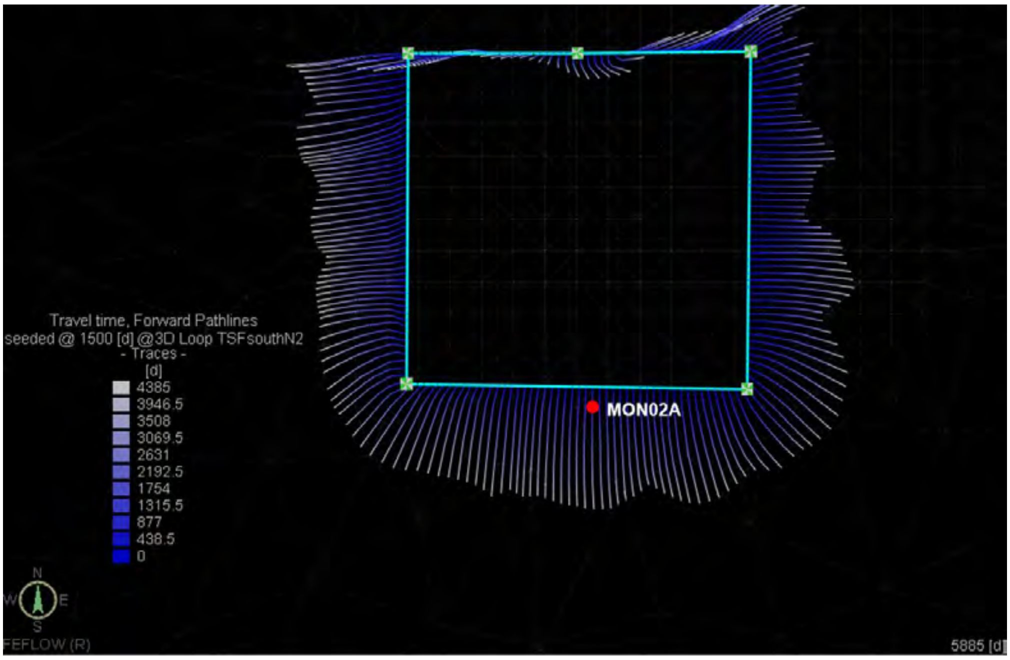

Figure 11: Predicted solute transport paths from 2007 to 2020 at TSF South showing the location of monitoring piezometer MON02A

The water in the completed mine workings beneath Lake Cowal will remain below 85 mAHD. Figure 9-2 of the mine site report shows the water level within the open pit void to be below 80 mAHD 200 years after the end of mining. This is well below the level of the bed of Lake Cowal (201.5 mAHD) and so there is no prospect of seepage from the mine entering Lake Cowal. The assessment of the post-mining open pit void water level is a result of a balance between evaporation, surface water and groundwater inflows to the open pit and is based on the combined hydrogeological and surface water assessments for the proposed CGO Underground Development. As existing groundwater levels are generally close to approximately 200 mAHD (as evidenced for example by groundwater monitoring observations around the mining lease in 2004), in the absence of other new deep groundwater works in the area, the open pit void will act as a groundwater sink which will draw groundwater towards itself from all directions, including from the western part of Lake Cowal.

Figure 12 and Figure 13 show the modelled groundwater streamlines starting from the TSF/IWL and from Lake Cowal based on modelled groundwater head conditions 200 years after the end of mining. It can be seen that the presence of the groundwater sink caused by the open pit void makes it physically impossible for water to seep from the TSF/IWL and emerge at the Lake Cowal area. Water from both the TSF/IWL and Lake Cowal east of the open pit are drawn to the area of lower groundwater head around the open pit void. Note that the streamlines shown in the figure do not provide particle travel times, they show path lines based on the modelled groundwater head conditions 200 years after the end of mining.

Note that while the streamlines shown in Figure 12 and Figure 13 show a connection between Lake Cowal and the mine, it should be noted that available field evidence indicates a poor or limited connection between Lake Cowal and the mine, as described in Section 4.1.

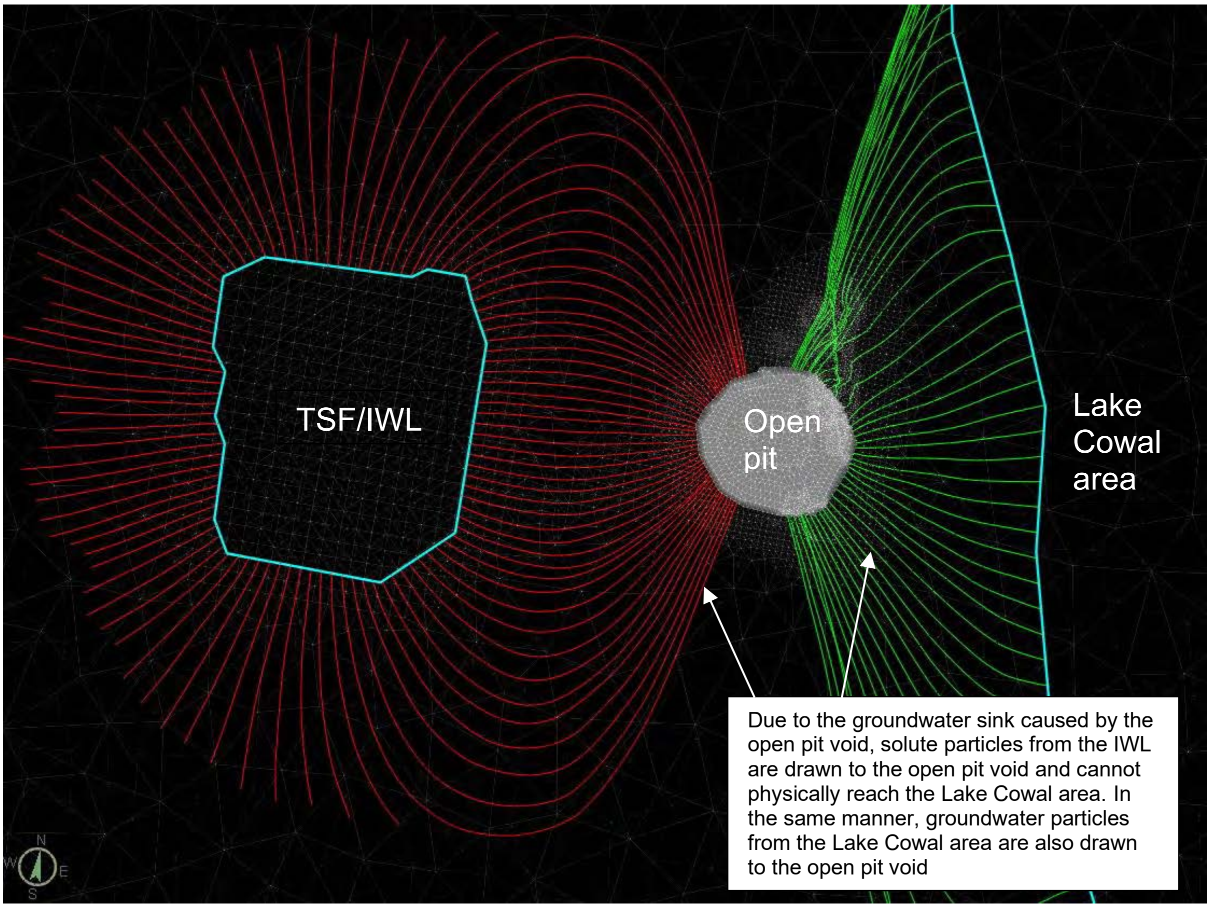

Figure 12: Groundwater streamlines from the IWL and Lake Cowal area based on modelled groundwater heads in 2238 – plan view

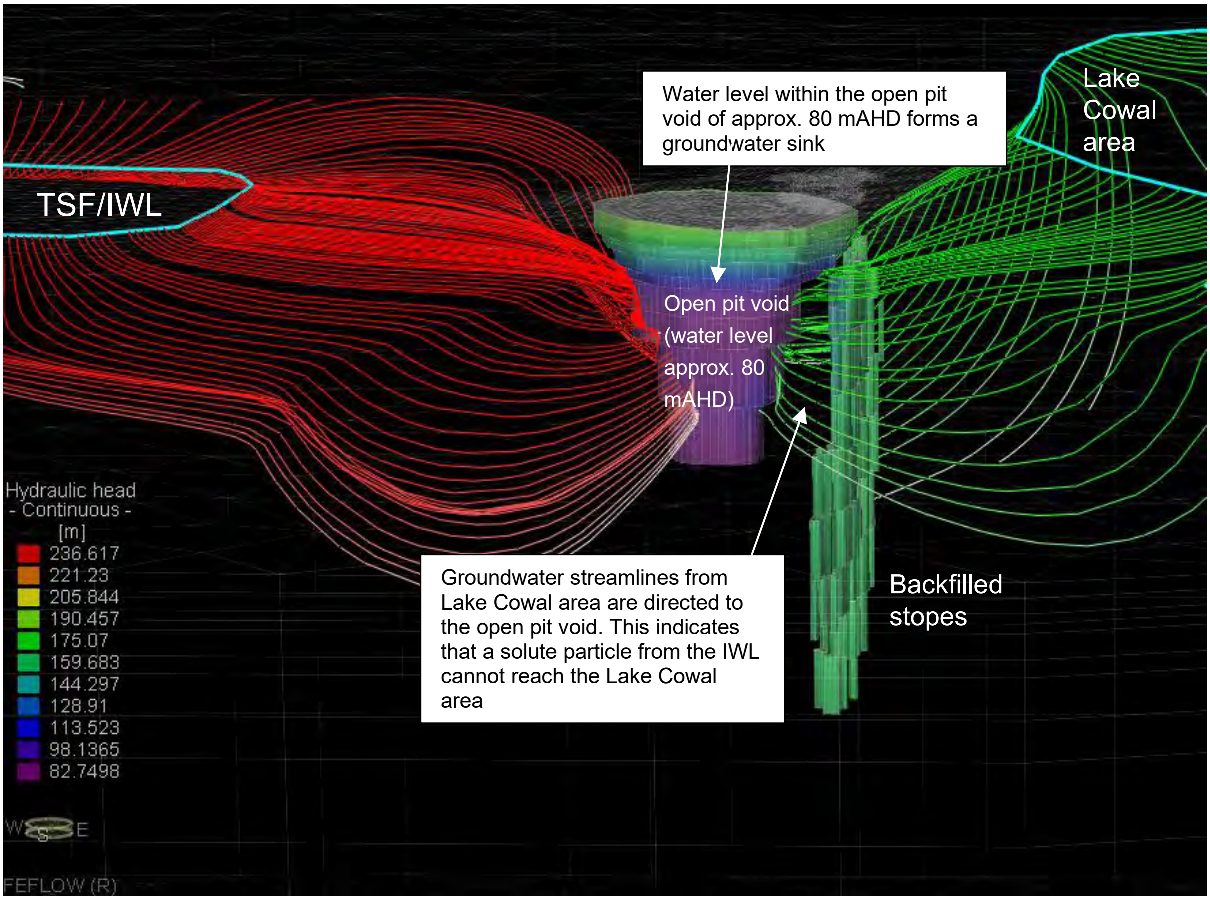

Figure 13: Groundwater streamlines from the IWL and Lake Cowal area based on modelled groundwater heads in 2238 – section view with 3x vertical exaggeration

4.5. Groundwater take from Upper Lachlan Alluvial groundwater source

CGO currently holds 3650 units (ML) / annum in the Upper Lachlan Alluvial Zone 7 Management Zone within the Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012.

Table 3 and Table 4 provide a breakdown of the components of seepage into the open pit and underground development at selected times for the model cases of a dry Lake Cowal and a full Lake Cowal respectively. These two cases were modelled by applying fixed head boundary conditions of 201.5 mAHD (dry lake case) or 206.5 mAHD (full lake case) to the surface of the model in the Lake Cowal area. The overall model water balances for the dry Lake Cowal case and the full Lake Cowal case in 2037 are shown in Table 5 and Table 6, respectively. Groundwater inflows during 2037 are representative of the period just prior to the end of underground mining when groundwater inflows are predicted to be at or close to their highest values.

Table 3 and Table 4 also show the predicted total groundwater inflow into the mine (open pit, stopes and access tunnels) originating from the Upper Lachlan Alluvium. This includes all groundwater originating from the Transported unit over an area encompassing the open pit and underground development and extending east to beyond the Lake Protection Bund and west to an area just outside the open pit. The predicted total groundwater inflow into the mine originating from the Upper Lachlan Alluvium is approximately 10% of the total inflow into the mine, reducing slightly towards the end of mining when substantially more inflow to the mine originates from the Primary Rock at elevations below -700 m AHD. The balance of the inflow to the mine comes from the fractured rock of the Lachlan Fold Belt Murray Darlin Basin (MDB) groundwater source.

Table 3: Components of groundwater seepage (m^3/day) at selected times for the dry Lake Cowal case (a negative number indicates seepage into the model)

Seepage component	Date			
	17-11-19	06-11-22	18-11-26	05-10-37
Pit walls	584	624	407	300
Pit floor	262	197	215	141
Dewatering bores	124	0	0	0
Access tunnels	0	115	512	722
Stopes	0	16	476	1555
TSF / IWL foundation	-447	-545	-602	-849
Western model boundary	-9	-10	-13	-100
Eastern model boundary	190	128	96	-198
Lake Cowal	1243	280	53	-104
Storage	-370	793	463	159
Rainfall infiltration	-1577	-1577	-1577	-1577
Total inflow to mine	970	952	1610	2718
Total inflow to mine from Upper Lachlan Alluvium groundwater source	107	101	102	78
Total inflow to mine from Lachlan Fold Belt MDB groundwater source	863	851	1508	2640
Percentage of total inflow to mine from Upper Lachlan Alluvium	11%	11%	6%	3%

Table 4: Components of groundwater seepage (m^3/day) at selected times for the full Lake Cowal case (a negative number indicates seepage into the model)

Seepage component	Date			
	17-11-19	09-09-22	18-11-26	03-12-37
Pit walls	584	625	409	287
Pit floor	262	198	215	141
Dewatering bores	124	0	0	0
Access tunnels	0	115	512	717
Stopes	0	16	476	1556
TSF / IWL foundation	-447	-548	-603	-854
Western model boundary	-9	-10	-13	-100
Eastern model boundary	190	222	219	-73
Lake Cowal	1244	-1482	-284	-408
Storage	-371	2406	686	321
Rainfall infiltration	-1577	-1577	-1577	-1577
Total inflow to mine	970	954	1612	2701
Total inflow to mine from Upper Lachlan Alluvium groundwater source	107	101	102	78
Total inflow to mine from Lachlan Fold Belt MDB groundwater source	863	853	1510	2623
Percentage of total inflow to mine from Upper Lachlan Alluvium	11%	11%	6%	3%

Table 5: Model mass balance, 5 October 2037 – dry Lake Cowal case

Component	Out (m^3/day)	In (m^3/day)
Fixed head and seepage face boundary conditions	2904.4	5401.4
Rainfall recharge	0	1577.4
Storage	5422.9	1290.5
Total	8327.3	8269.3
Absolute error	58.1	
Percentage error	0.70%	

Table 6: Model mass balance, 3 December 2037 – full Lake Cowal case

Component	Out (m^3/day)	In (m^3/day)
Fixed head and seepage face boundary conditions	2992.6	5719.1
Rainfall recharge	0	1577.4
Storage	5542.2	1207.9
Total	8534.8	8504.4
Absolute error	30.4	
Percentage error	0.36%	

4.6. Groundwater pressure decline at water supply works in the Lachlan Fold Belt Murray Darling Basin groundwater source due to mining.

A search of the Bureau of Meteorology Australian Groundwater Explorer public bore database (http://www.bom.gov.au/water/groundwater/explorer/map.shtml) was carried out on 9 February 2021. Bores labelled as being for the purposes of water supply, irrigation, stock and domestic and commercial and industrial within 30 km of the CGO mine site were identified and downloaded. The available records provided bore coordinates and bore depths. An approximate surface elevation at each bore was found using a publicly available, 1 second digital elevation model provided by ELVIS (Geoscience Australia). Using the surface elevation, the approximate elevation of the base of the bores was found.

Modelled groundwater head drawdown around the mine site due to the open pit and underground development increases with depth below ground. Figure 14 shows modelled groundwater head drawdown contours at 150 mAHD in January 2038. This date is representative of the period immediately before the end of underground mining. The drawdown shown is the difference in groundwater head since 2004 as a result of the combined effects of the approved Mod14 development along with the proposed CGO Underground Development. Figure 14 also shows the public bores identified around the mine site, along with the assessed elevation of the base of each of the bores. These bores are identified as being for the purposes of water supply, irrigation, stock and domestic and commercial and industrial.

Figure 14 illustrates that, for bores with base elevations above 150 mAHD, the combined groundwater head drawdown from the approved Mod14 development along with the proposed CGO Underground Development is less than 2 m.

Figure 15 shows the combined Mod14 and CGO Underground Development modelled groundwater head drawdown contours at 100 mAHD in January 2038, along with bores assessed to have base elevations below 150 m. The mine site model does not extend to cover the cluster of bores located approximately 10 km to 15 km south east of the open pit. It can be seen from the modelled drawdown contours that the 2 m drawdown contour does not appear to be approaching any of these bores. The closest bore to the 2 m contour is GW026054.1.1, which has a base of bore elevation of 138 mAHD. As the base elevation of this bore is closer to 150 mAHD, the drawdown contours at 150 mAHD shown in Figure 14 are likely to better represent the drawdown at the base of GW026054.1.1 than those shown in Figure 15. As such, it is considered that combined drawdown from the approved Mod14 and the proposed CGO Underground Development is less than 2 m at bores shown in Figure 15.

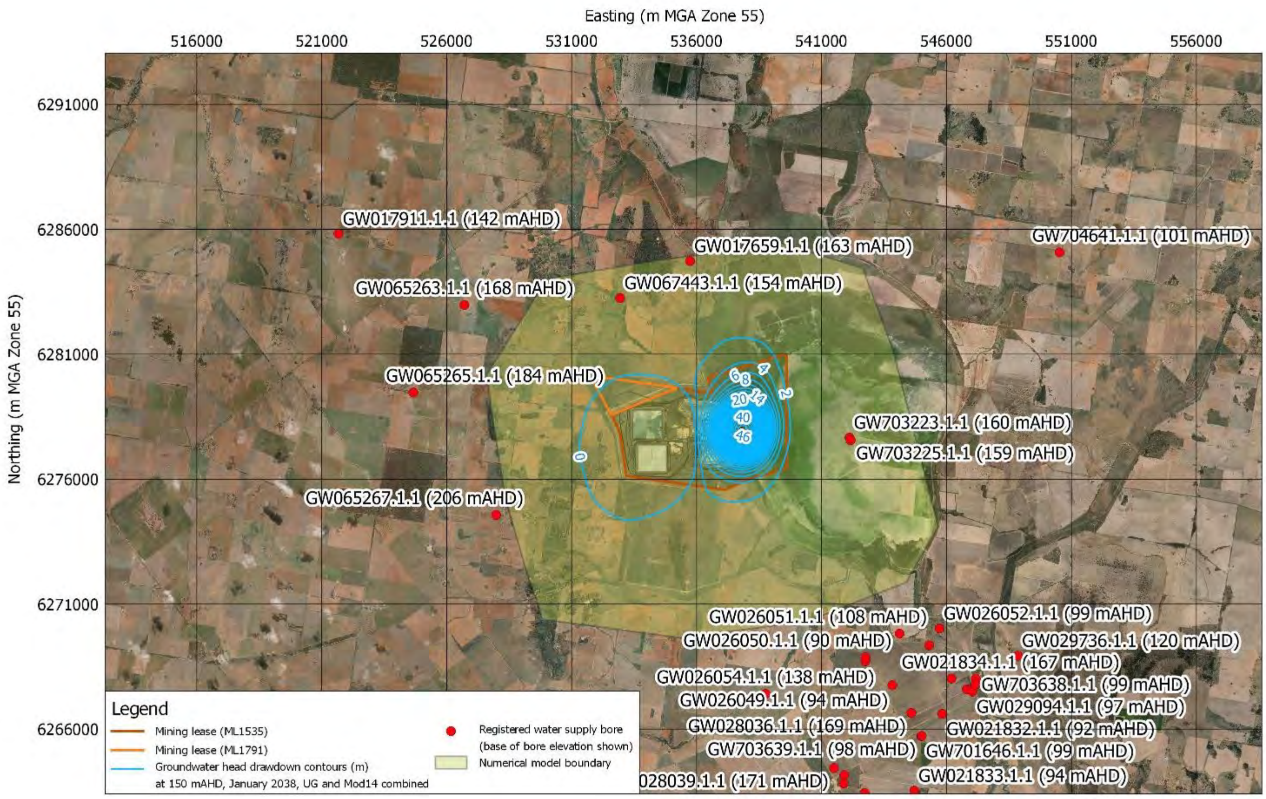

Figure 14: Combined (Mod14 and UG) drawdown at 150 mAHD, January 2038

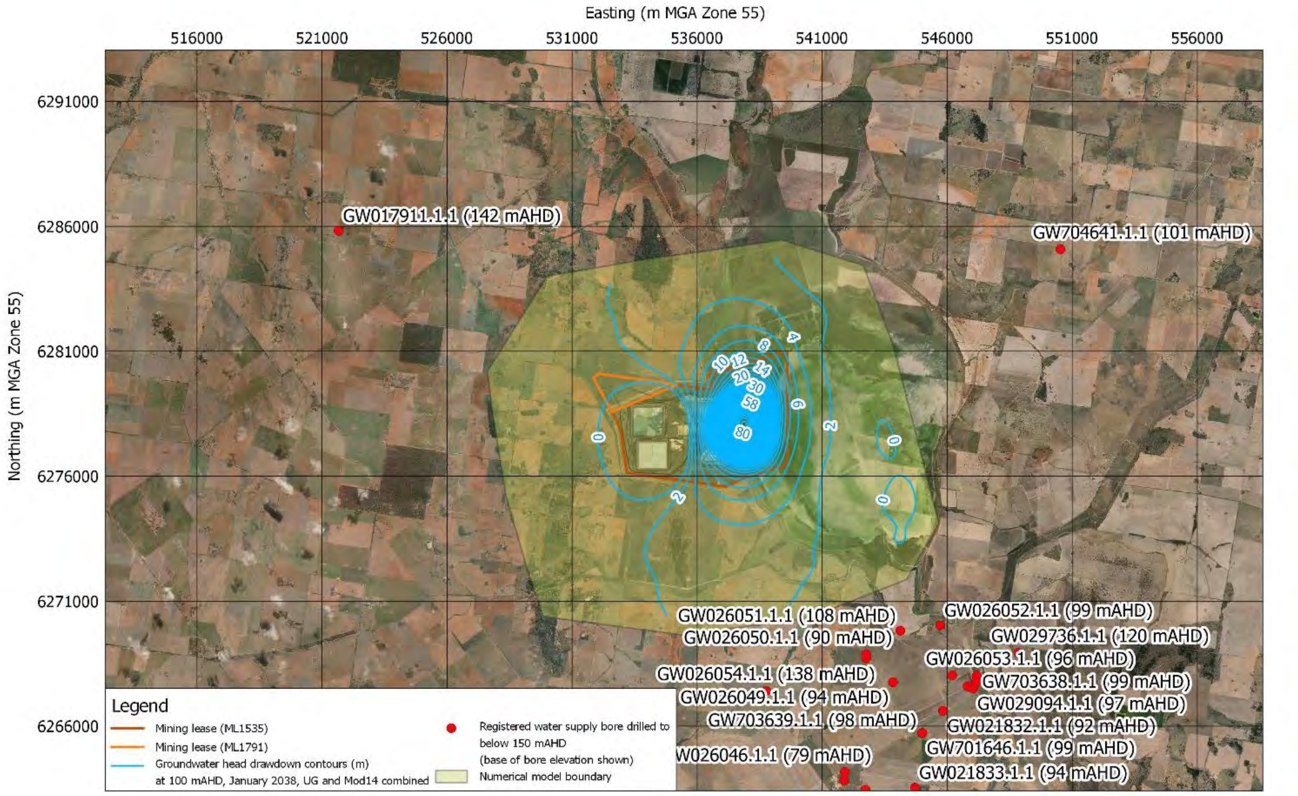

Figure 15: Combined (Mod14 and UG) drawdown at 100 mAHD, January 2038

4.7. Groundwater inflow and drawdown due to the proposed CGO Underground Development only

Figure 16 shows modelled groundwater inflows to the open pit, stopes and tunnels compared to the approved open pit development (Mod 14) only.

Groundwater inflow due to the underground development only is predicted to increase from zero at the commencement of the underground development in 2022 to a peak of approximately 1,800 m^3/day in 2031, and then continue at approximately this rate until the end of mining in mid-2039. Between mid-2039 and approximately 2066, groundwater infiltration to the paste backfilled stopes and access tunnel voids occurs. After this time, there is no additional groundwater inflow from the underground development compared to the approved Mod 14 open pit development.

It can be seen from the Figure 16 that, if the approved Mod 14 effects are excluded, the underground development is predicted to result in groundwater extraction from aquifers surrounding the mine site only between the years 2022 and approximately 2066.

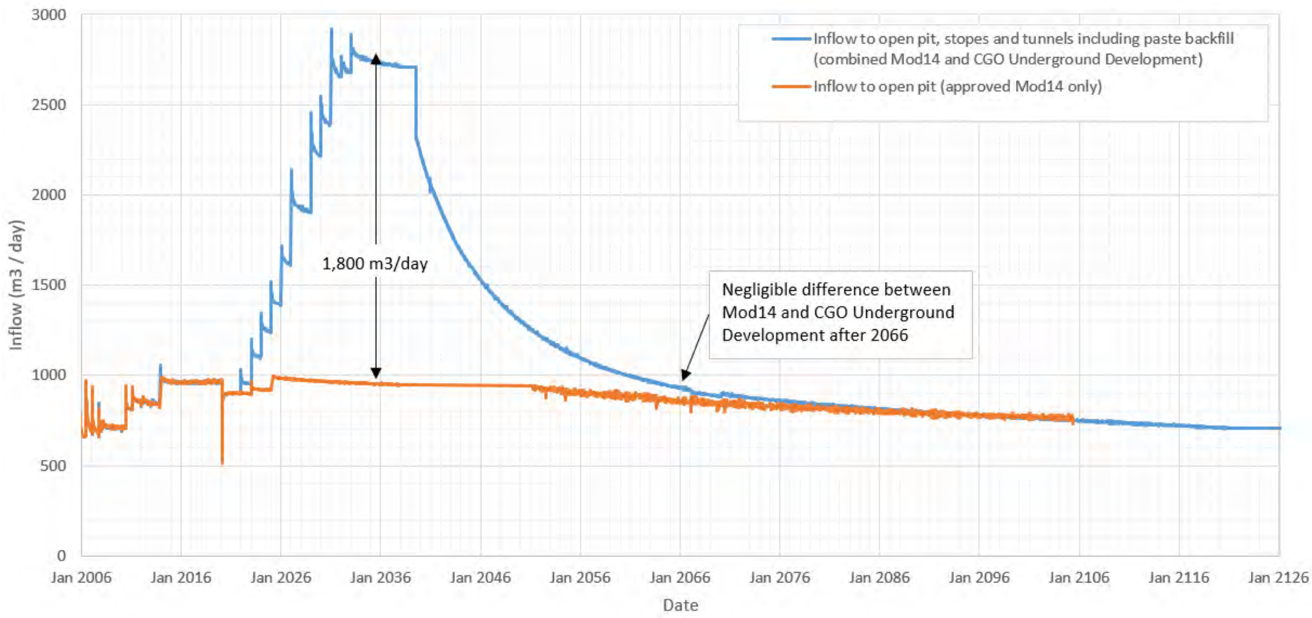

Figure 16: Inflow to the proposed CGO Underground Development and the approved Mod14

Figures 17 to 19 show modelled drawdown around the mine site for the groundwater table and groundwater heads at January 2038 due to the proposed CGO Underground Development only. January 2038 is representative of the period immediately before the end of underground mining. Minor changes to groundwater mounding around the tailings storage facilities as a result of the underground development only are not shown.

Figure 17 shows that the 2 m groundwater table drawdown contour resulting from the underground development only is contained within the mining lease in January 2038.

Figure 18 and Figure 19 shown that groundwater head drawdown in January 2038 in the Transported, Saprolite and Saprock units resulting from the underground development only is contained within or close to the mining lease.

Figure 19 shows that drawdown is noticeably more in the Primary Rock compared to the shallower units above. This is a result of stope mining as part of the proposed underground development, which is to be carried out in the Primary Rock at elevations below approximately 80 mAHD.

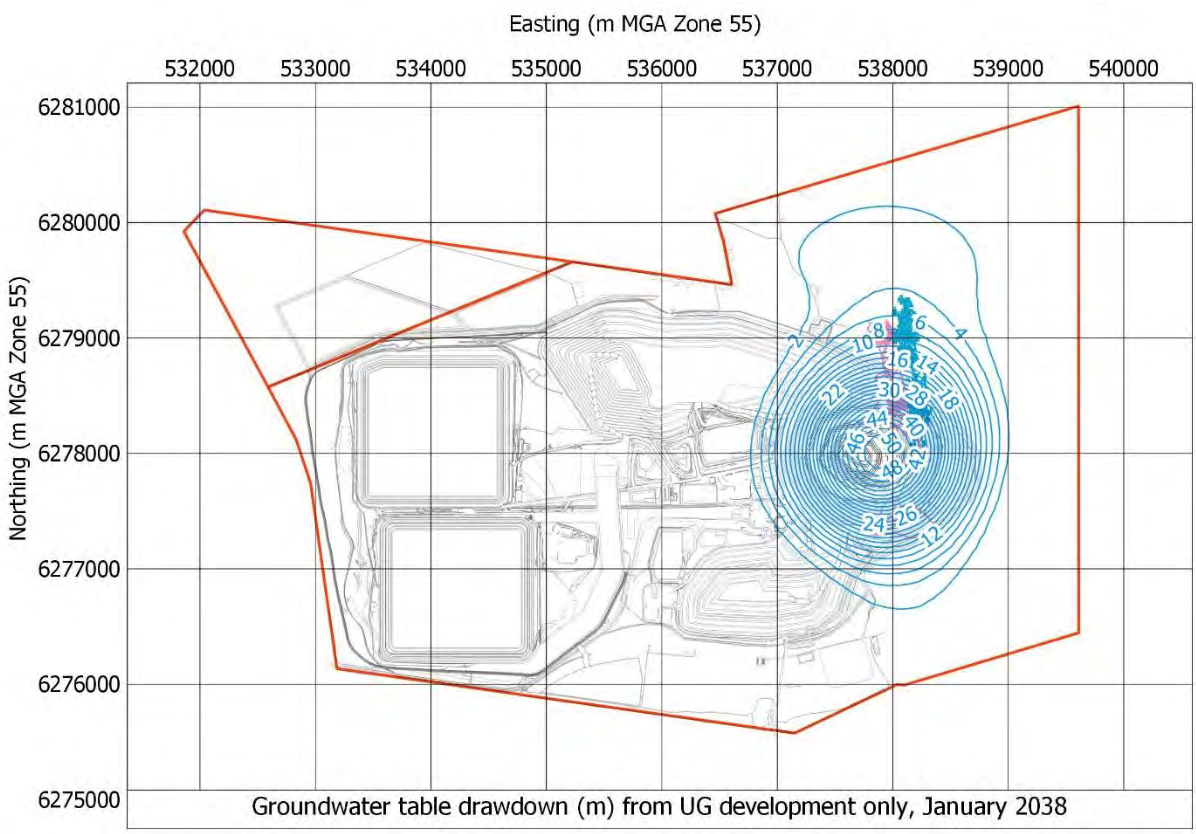

Figure 17: Groundwater table drawdown from underground development only, January 2038

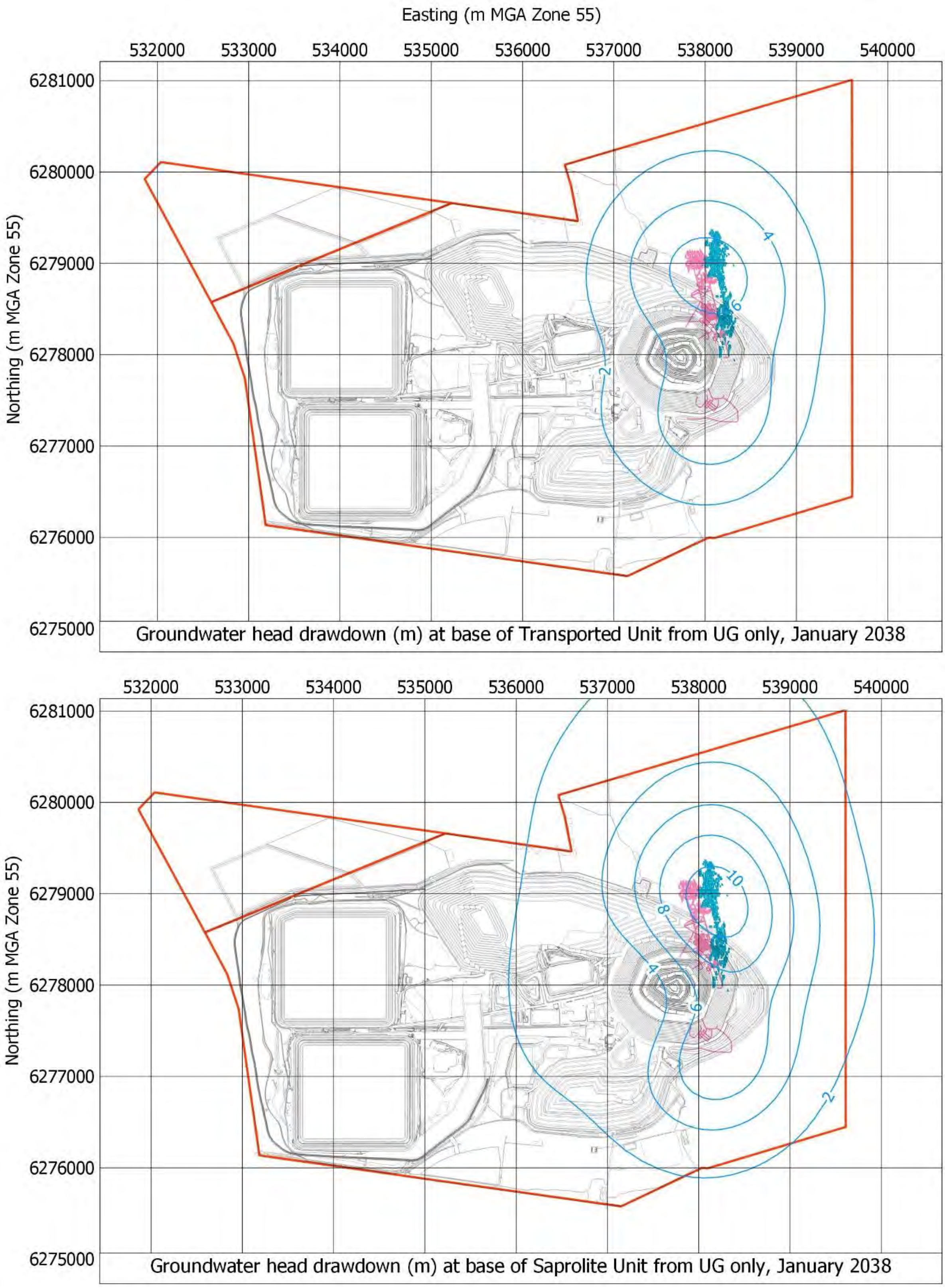

Figure 18: Groundwater head drawdown from underground development only at base of Transported and base of Saprolite, January 2038

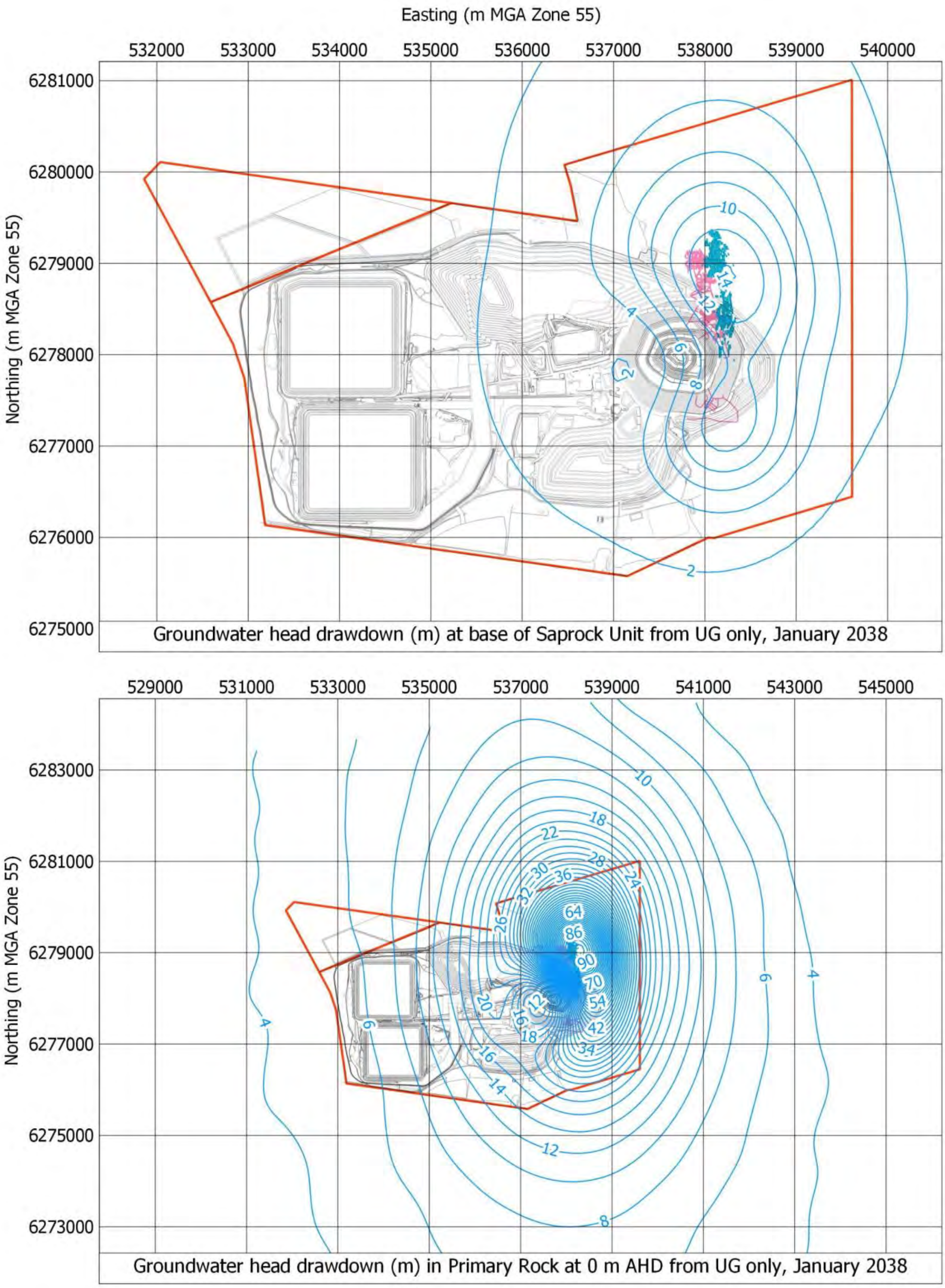

Figure 19: Groundwater head drawdown from underground development only at base of Saprock and at 0 mAHD in Primary Rock, January 2038

4.8. Potential for increased fracturing above and around stopes / tunnels

An assessment of predicted surface subsidence due to the proposed CGO Underground Development is provided in the subsidence report (Beck Engineering, 2020).

The subsidence report states that based on current geological understanding:

- Vertical displacement forecasts on the surface above the proposed underground mine are generally less than 15mm and considered negligible.
- The model does not forecast significant rockmass damage or major instability above the upper stopes. However, local geological conditions encountered may be different from the current understanding.

Several figures are presented in the subsidence report which show predicted rockmass damage around the underground development. Predicted rockmass damage in the horizontal direction is limited to a zone within 10 to 20 m from the stopes, as shown in Figure 20. In the vertical direction, negligible rockmass damage is predicted to occur in the Primary Rock above the upper stopes, although a zone of rockmass damage is predicted in the Saprolite and Transported units immediately adjacent to the open pit, as shown in Figure 21. Note there is negligible predicted rockmass damage adjacent to the top of the stopes in this area.

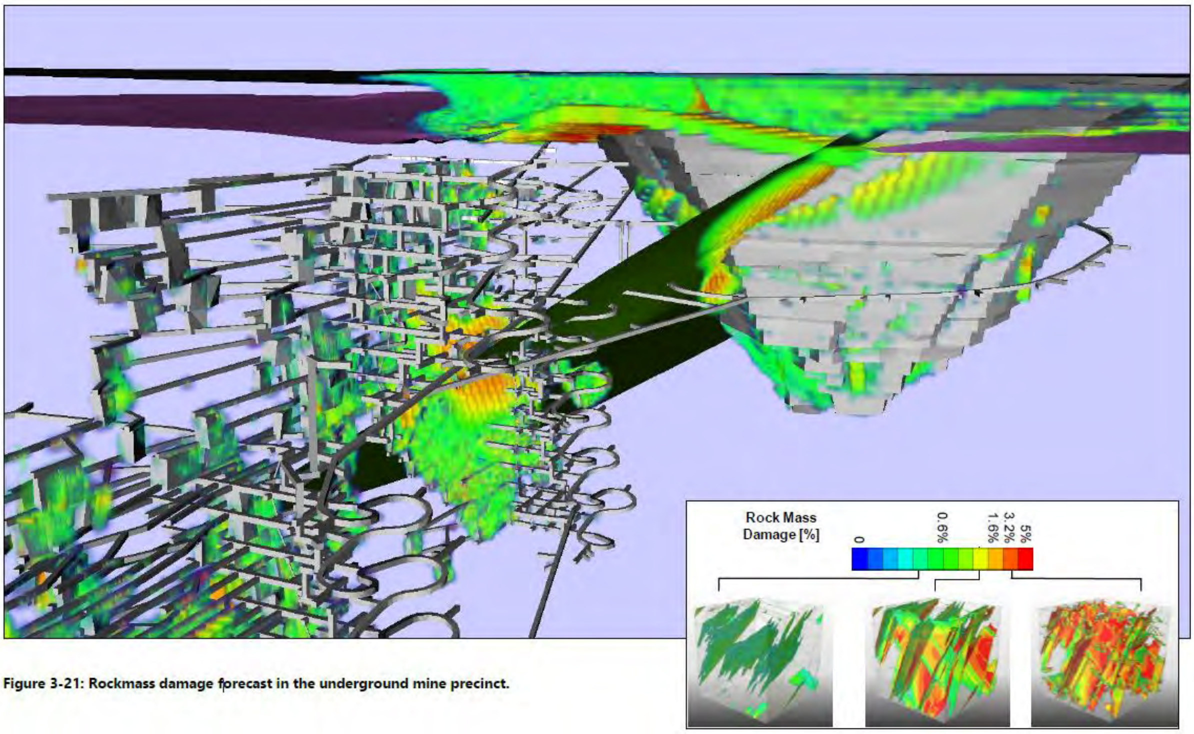

Figure 3-21: Rockmass damage forecast in the underground mine precinct.

Figure 20: Predicted rockmass damage around the proposed CGO Underground Development (after Beck Engineering, 2020)

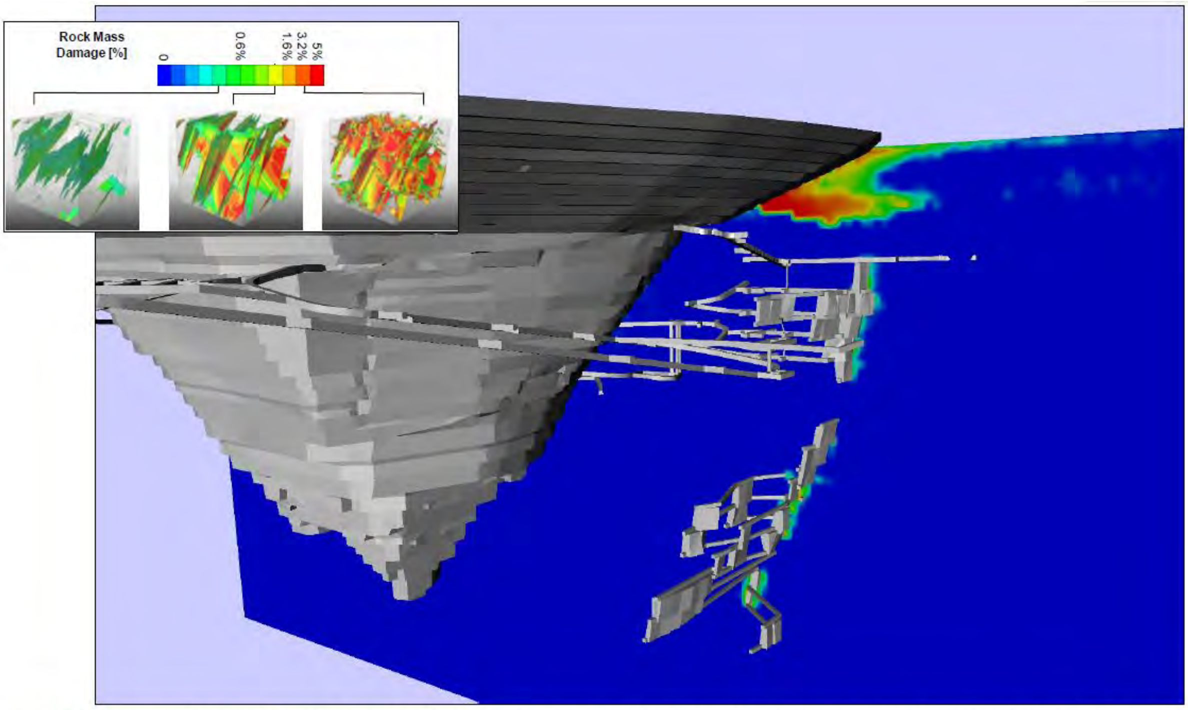

Figure 3-20: Cross section of rockmass damage forecast in the underground mine precinct. Note the most significant damage is in the transported and soft oxide layers in proximity to the open pit

Figure 21: Predicted rockmass damage in the soft oxide (Saprolite) and Transported units near the open pit (after Beck, 2020)

To assess the impacts on predicted groundwater inflows to the underground development as a result of the potential for increased fracturing above the stopes, two sensitivity cases were assessed.

In the first case, the model was run with the horizontal and vertical hydraulic conductivity of the Primary Rock in the area of the stopes, from the level of the base of highest level of stoping up to the interface with the Saprock unit, increased by a factor of 10. The maximum predicted increase in inflow during the period 2020 to 2056 was less than 2%. This can be understood by considering the low vertical hydraulic conductivities in the Transported, Saprolite and Saprock units overlying the stopes. These units have a combined thickness of between 50 m and 100 m in the area above the stopes. Additionally, as the stoping progresses to depths reaching up to 900 m below the ground surface (see Figure 7-6 of the mine site report), a large proportion of the total inflow is predicted to be from flows into the deepest stopes from the nearby rock, rather than from sources close to the ground surface.

In the second case, an assessment of the effects on inflows resulting from a higher hydraulic conductivity in the Transported Unit was carried out by factoring the horizontal and vertical hydraulic conductivity of the Transported Unit up by a factor of 10. The predicted increase in inflow to the stopes and tunnels during the period 2020 to 2056 was less than 2%. This can be understood by considering that between the base of the Transported Unit and the top of the highest stopes at approximately 80 mAHD, there is an approximate combined thickness of 60 m to 100 m of Saprolite, Saprock and Primary Rock. The vertical hydraulic conductivities of these units is low based on the calibration of the numerical model to observed groundwater levels and open pit inflows between 2005 and 2020.

For this report, a third sensitivity case was carried out with the horizontal and vertical hydraulic conductivity of the Primary Rock, Saprock, Saprolite and Transported units in the area of the stopes, from the level of the base of highest level of stoping up to the interface with the Saprock unit, increased by a factor of 10. The results show a difference in predicted inflows of less than approximately 100 m^3/day throughout the life of the underground development, as shown in Figure 22. This difference is less than 5% of the predicted maximum inflow to the open pit, stopes and access tunnels and is considered negligible.

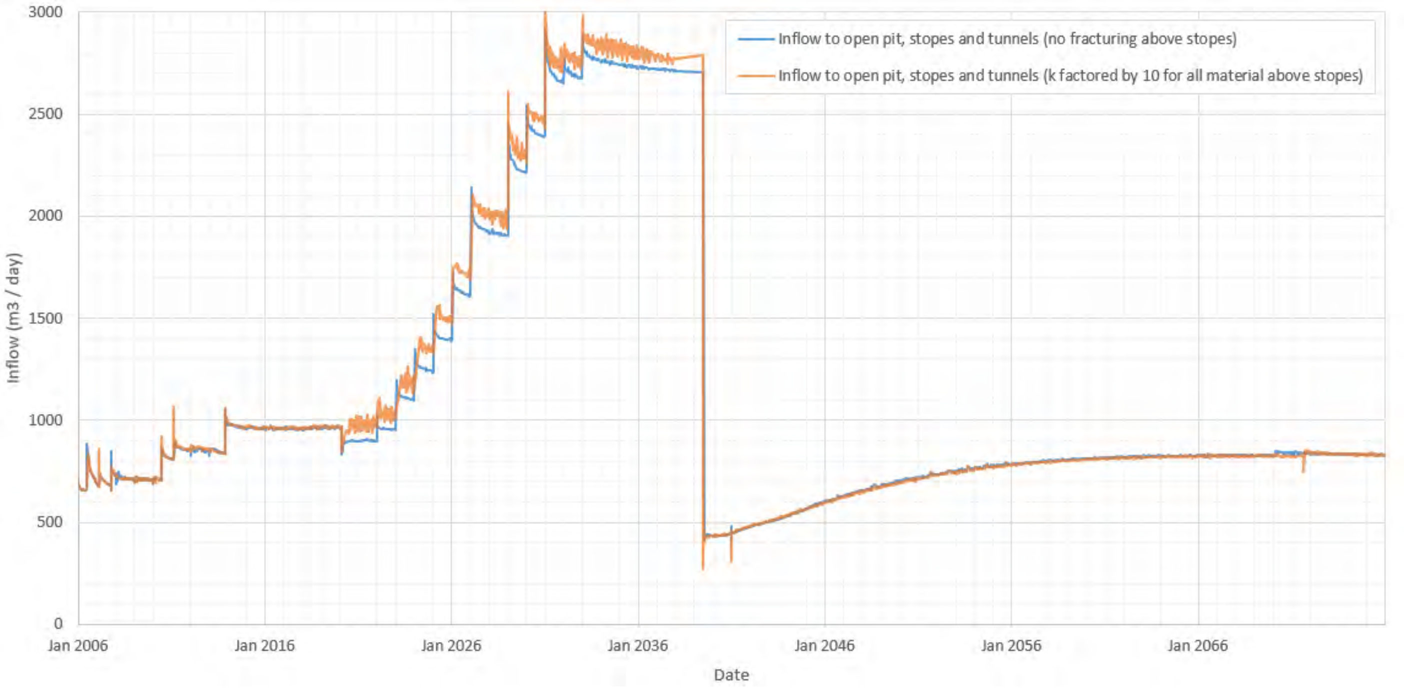

Figure 22: Impact on predicted inflows of increased hydraulic conductivity in all units above the stopes

The subsidence report forecasts that the Glenfiddich fault may become slightly mobilised due to nearby underground mining. This may lead to increased hydraulic conductivity in a small area adjacent to the fault. Mapping of groundwater seepage into the GRE46 exploration decline carried out by a Coffey field engineer in February 2020 indicates that in its current condition the Glenfiddich fault, which was intersected by a number of exploration drill holes drilled from the decline to the east, did not result in groundwater inflow rates into the decline above what was expected based on the calibrated hydraulic conductivity parameters for the Primary Rock adopted for the mine site model.

In the event that increased flows associated with the Glenfiddich fault occur during the construction of the CGO Underground Development, these are likely to occur over a relatively small zone of rock around the fault. Various engineering controls will be evaluated if the inflow rates are problematic to continued mining.

4.9. Numerical model details

4.9.1. Steady state model

The mine site report presents results from a transient numerical model calibrated to a total of 22 piezometers with monitoring data for the period 1 January 2004 to 1 January 2020. A steady state model was developed for the purpose of providing starting groundwater heads for 1 January 2004 for the transient model.

A total of 16 piezometers around the mine site provided groundwater level observations in 2004. These were used as a basis for calibrating the steady state model for the purpose of providing starting groundwater heads for 1 January 2004 for the transient model. Details of the 16 piezometers are provided in Table 7. Their locations are shown in Figure 23.

Excluding the results at the TSFN and P412A piezometers, which may have been influenced by activities on the mining lease, the observations indicate the existence of local groundwater gradient of approximately 1 m per km to the east over the mining lease in 2004, with minimal evidence of flows in the north-south direction. This, along with topographic considerations, provided justification for adopting no flow boundaries on the northern and southern boundaries of the transient model. Fixed head boundaries were applied to the western and eastern boundaries of the model to drive a small west to east gradient in groundwater levels in the steady state model. It can be seen in Figure 24 that west of the mining lease, the land rises gently, gaining approximately 60 m in elevation over 5 km, to where a small north south ridge line exists. This topography is consistent with the local groundwater gradient to the east.

Fixed head values for the western and eastern boundary were manually adjusted until a reasonable match between modelled and observed groundwater levels was obtained. This resulted in a value of 205 mAHD for the western boundary and 198 mAHD for the eastern boundary. These lateral boundary conditions were adopted for the transient model. The effect of these boundary conditions on the results of the transient model is discussed further in Section 4.9.2.

It was not considered necessary to incorporate rainfall recharge into the steady state model as the calibration of model parameters, including hydraulic conductivity, specific storage and rainfall recharge, were carried out in the transient model. As stated earlier, the purpose of the steady state model was only to provide starting heads for the transient model.

Table 7: Groundwater level observations used to obtain starting heads for transient model

Name	Easting (m MGA94 Zone55)	Northing (m MGA94 Zone55)	Elevation (mAHD)	Date	Observed groundwater level (mAHD)	Modelled groundwater level (mAHD)
PDB3A	538502.1	6277855	107.3	2004-08-03	200.0	200.8
PDB3B	538507.2	6277855	178.2	2004-05-26	200.0	200.8
P412A	535170.8	6277495	192.2	2004-02-25	201.5	202.4
PDB5B	537774.8	6276932	182	2004-05-26	201.5	201.3
PDB1B	537283.3	6279031	191.2	2004-12-14	201.6	201.2
TSFNA	535438	6278074	120.3	2004-05-25	201.6	202.3
TSFNB	535442.6	6278073	188.1	2004-05-25	201.6	202.3
TSFNC	535447.5	6278072	200.3	2004-05-25	201.6	202.3
PDB5A	537769.9	6276933	129.6	2004-05-26	201.8	201.3
PDB1A	537281.2	6279033	123.3	2004-12-14	202.0	201.2
P414B	535360.3	6276680	204.1	2004-02-25	202.8	202.4
P414A	535363.8	6276681	189	2004-02-25	202.9	202.4
P418A	534862.4	6279181	188.2	2004-04-06	202.9	202.4
P418B	534859.6	6279182	201.2	2004-04-06	202.9	202.4
P417B	535888.9	6276333	205.5	2004-02-25	203.2	202.2
P417A	535889.3	6276338	186.5	2004-02-25	203.3	202.2

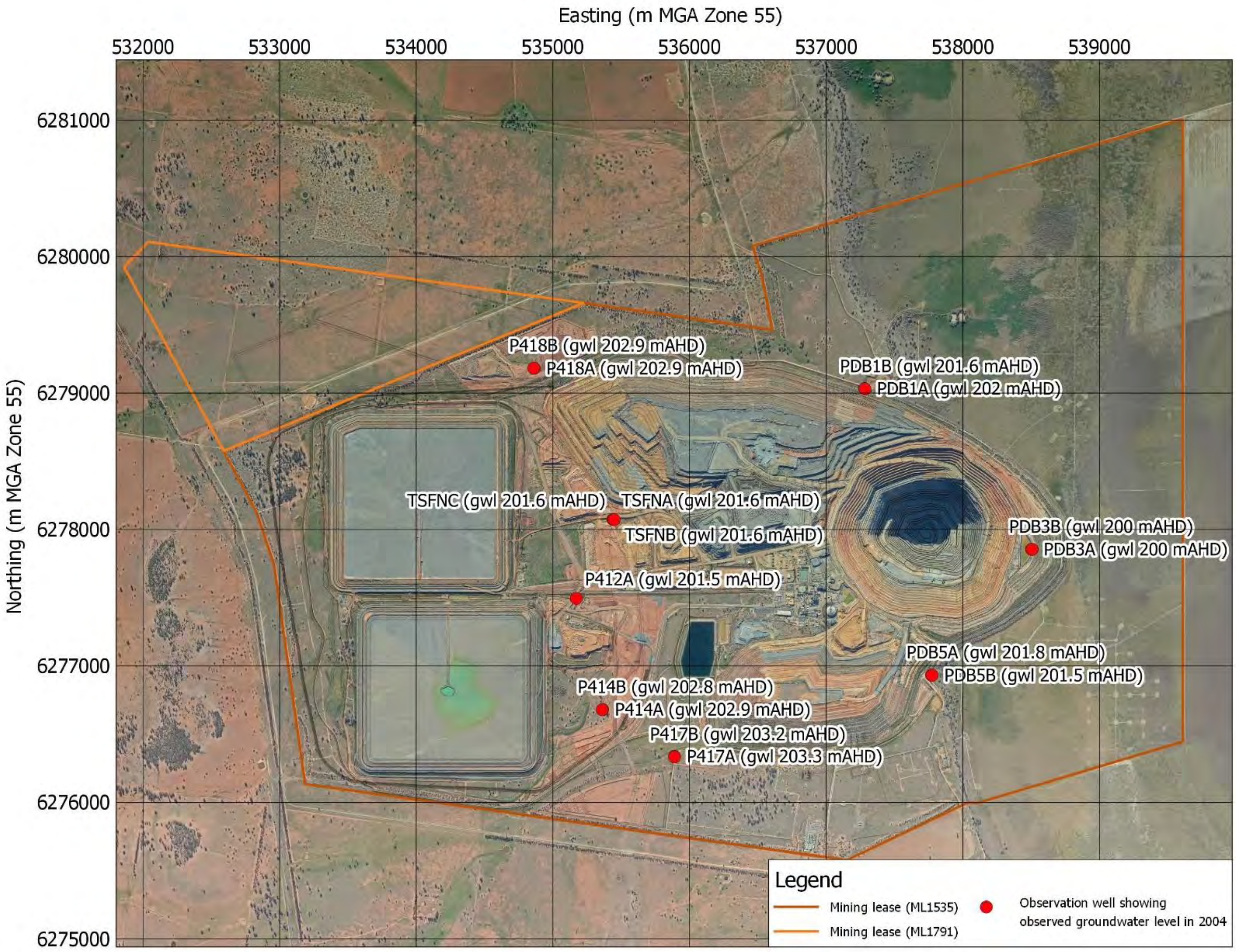

Figure 23: Location of observation piezometers used to obtain starting heads for the transient model

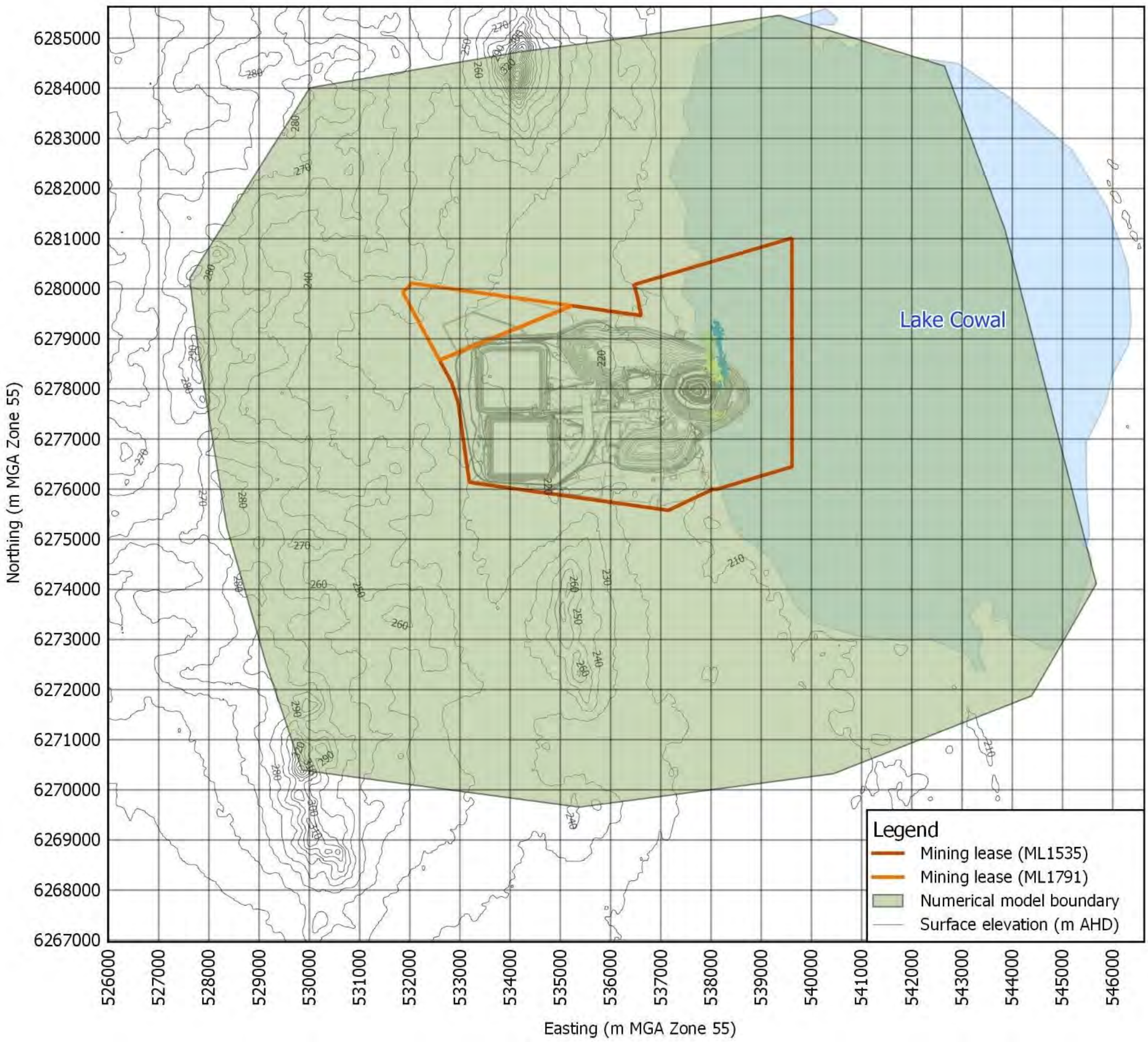

Figure 24: Surface elevation around the mining lease (elevation data: ELVIS, Geoscience Australia)

Figure 25 presents a chart showing observed versus modelled heads for the steady state model. The Root Mean Square Error (RMSE) of the data is 0.68 m and the Normalised RMSE (NRMSE) is 20.7%. Given the relatively small range in observed groundwater levels, these results are considered reasonable for use as starting heads for the transient model.

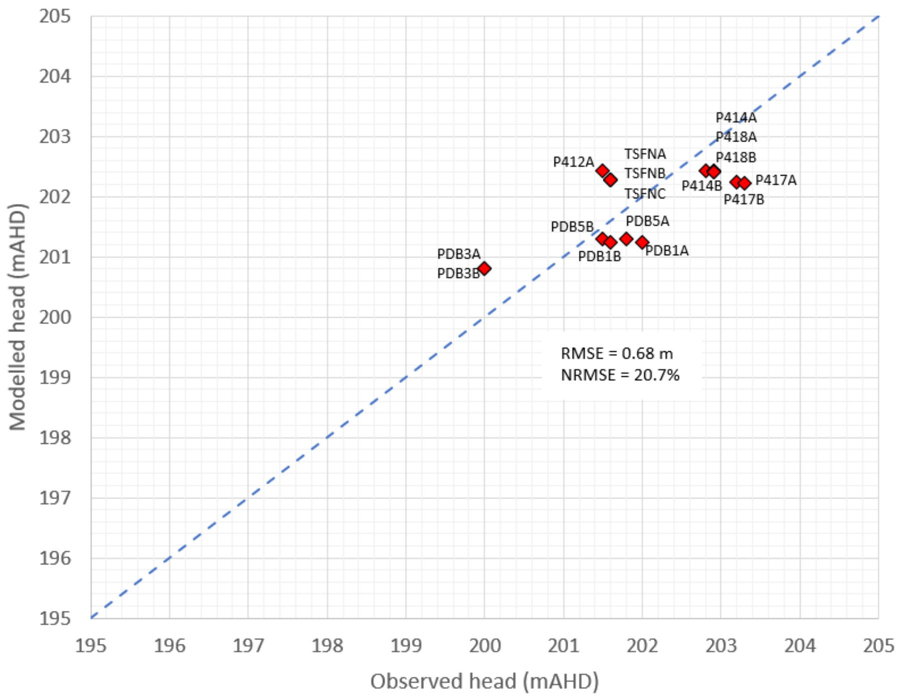

Figure 25: Comparison of observed versus modelled starting heads for the transient model

The model mass balance error for the steady state model is shown in Table 8. It is noted that this is a property of the modelling software (Feflow Version 7.2) and unlike the transient model, not dependent on time step size criteria specified by the user.

Table 8: Steady state model mass balance error (m^3/day)

Component	Out	In
Fixed head and seepage face boundary conditions	46.2	46.2
Total	46.2	46.2
Absolute error	0	0.0000055
Percentage error	0.000012%	

In terms of the impact of the selection of starting heads on the transient model, the calibration charts shown in Figure 26, which are typical of the results at the 22 piezometers used in the transient calibration, do not show any evidence of strange behaviour in model results at early times. This would be the case if the model starting heads were significantly out of alignment with the rest of the transient head observations to which the model was calibrated to. For this reason, the adopted starting heads for the transient model are considered appropriate, and the steady state model served its purpose of providing starting heads for 1 January 2004 for the transient model.

It is noted that the results from the steady state model are not intended to represent long term steady state conditions in and around the mining lease, only that they provide a reasonable representation of conditions in 2004 based on available observation data, as shown in Table 7 and Figure 23 .

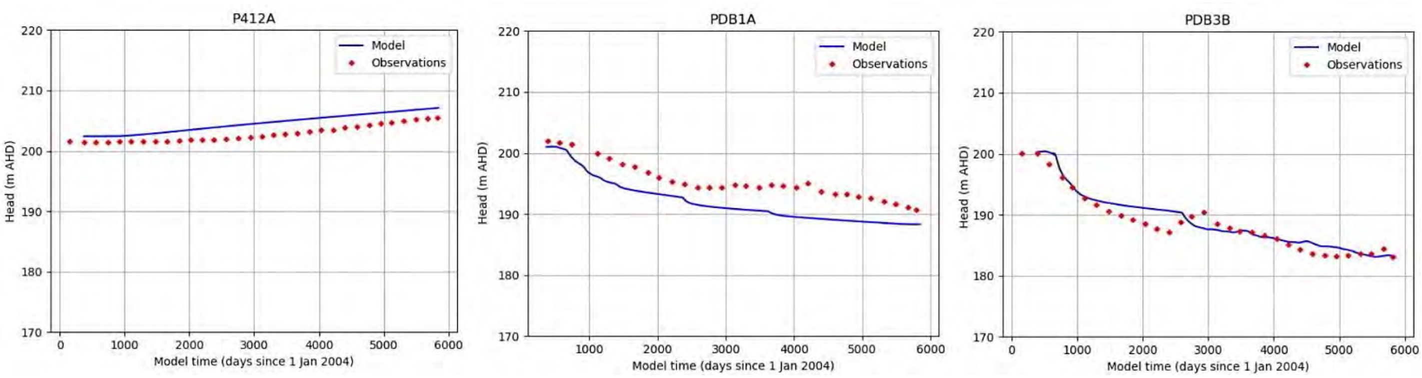

Figure 26: Transient calibration charts for P412A, PDB1A and PDB3B

4.9.2. Lateral boundaries

As discussed in Section 4.9.1, an assessment of groundwater level observations taken in 2004 around the mining lease indicated the existence of a local groundwater gradient of approximately 1 m per km to the east around the mining lease in 2004 prior to mining operations, with minimal evidence of flows in the north-south direction. Based on these observations, the western and eastern boundaries of the model were assigned fixed head boundary conditions. The fixed head values for the western and eastern boundary were manually adjusted until a reasonable match between modelled and observed groundwater levels was obtained under a steady state simulation. This resulted in a value of 205 mAHD for the western boundary and 198 mAHD for the eastern boundary. No flow boundary conditions were applied to the northern and southern model based on the observation data from 2004 indicating negligible north south groundwater flow around the mining lease prior to mining operations.

The numerical groundwater model for the CGO Underground Development EIS was designed for the purpose of providing a regional scale assessment of impacts to groundwater levels and flow regimes around the mine site. The impacts relate to the predicted groundwater table drawdown, impacts to existing groundwater users and the predicted groundwater take from the alluvial and fractured rock aquifers around the mine site.

The mine site model boundaries are similar to previous mine site assessments including Mod 14. Figure 27 shows the mine site model boundary with respect to the BCPB model hydrogeological units. The approximate western extent of the Lachlan Formation is the geological boundary adopted for the mine site model eastern boundary. A small portion of the Lachlan formation has not been included within the mine site model boundary as it is not considered to influence impacts from the mine.

It should be noted that there are no steady groundwater level observations available in the Primary Rock east of Lake Cowal, as publicly available bores are screened mainly in the Lachlan formation and significant groundwater level fluctuations occur due to pumping from the Lachlan formation. Observed drawdowns in the Saprock / Saprolite units on the mining lease after 15 years of mining can be seen to extend approximately 2 km west of the open pit, as illustrated in Figure 28. Drawdown is influenced by rising groundwater levels around the TSF.

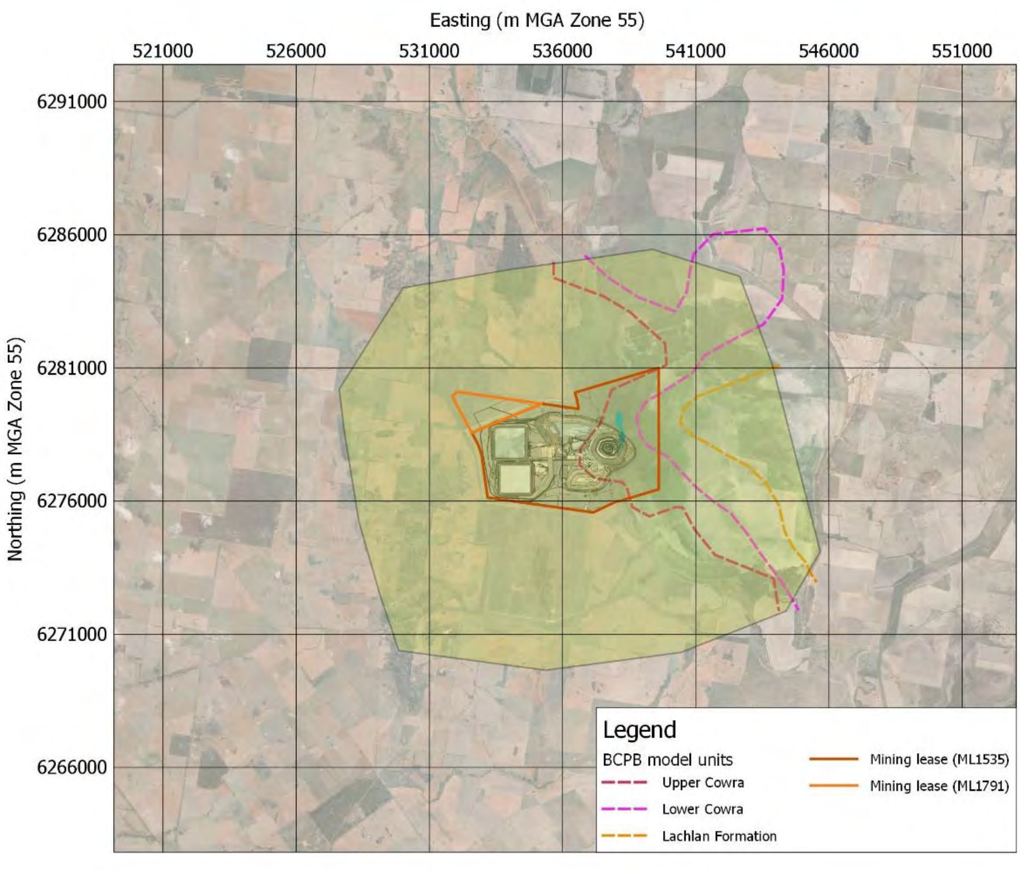

Figure 27: Model boundaries in relation to BCPB model hydrogeological units

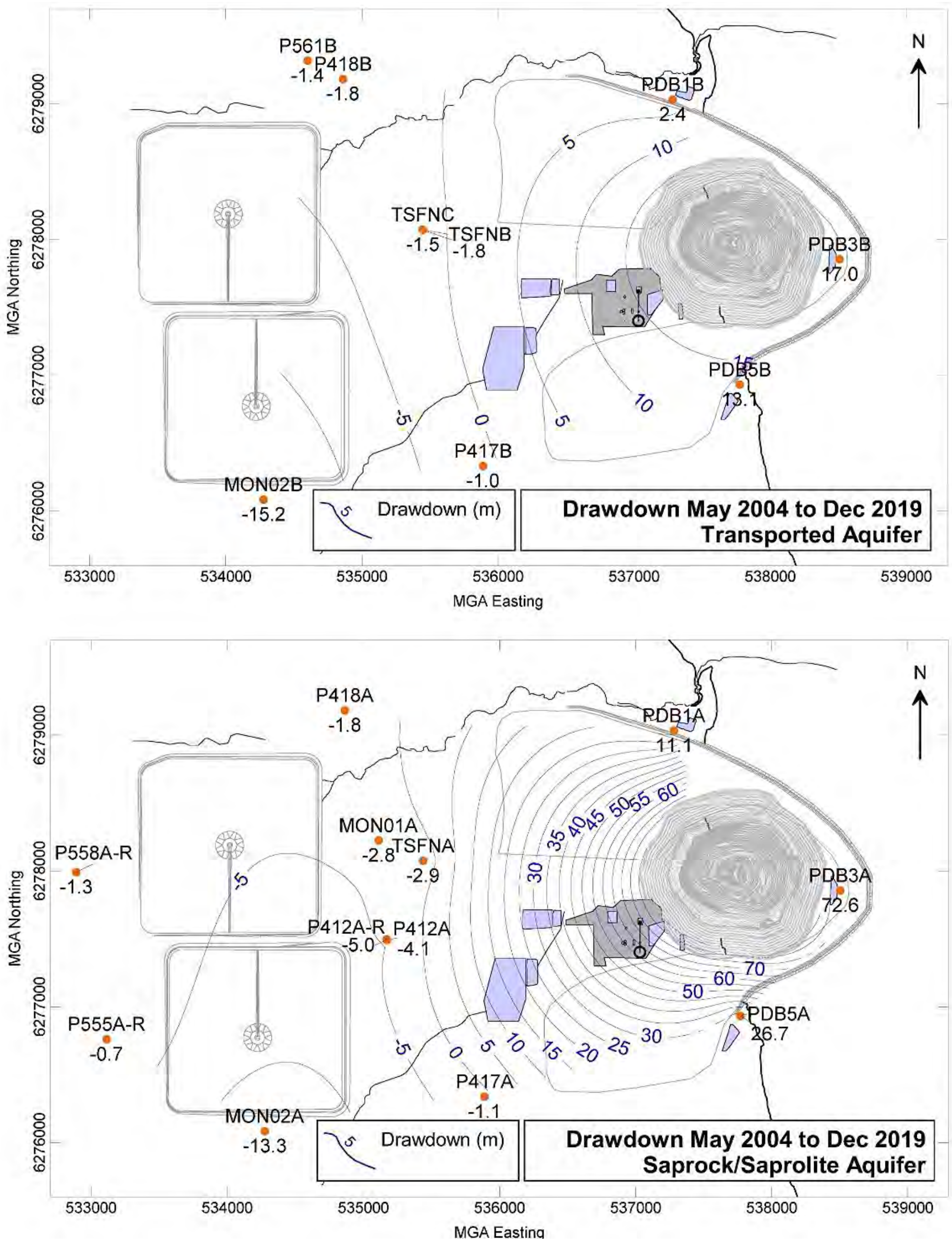

Figure 28: Observed groundwater drawdown between May 2004 and December 2019 around the open pit (after Coffey, 2020)

Effect on predicted inflows to the mine

To assess the effect of the model lateral boundary fixed head conditions on the predicted groundwater inflow to the mine, Figure 29 and Figure 30 present flows into and out of the numerical model from the model fixed head western and eastern boundaries and the Lake Cowal time varying fixed head nodes for the Lake Cowal dry and flood cases respectively. The results divide the eastern boundary into an upper and lower level. This was done to separate localised outflow at the top of the eastern model boundary which occurs due to the interaction of the Lake Cowal fixed head nodes and the eastern boundary fixed head nodes. This flow to the east from the eastern part of Lake Cowal has a negligible impact on inflows to the mine site. Figure 31 which shows the typical groundwater head contours along a west to east section is intended to show this more clearly.

Note that Figure 29 shows a large outflow from the Lake Cowal nodes in 2023. This is a result of the surface-groundwater interchange associated with the filling and emptying events within Lake Cowal which is independent of mine related seepage. This is discussed further in Section 4.9.6.

The results, excluding the Lake Cowal and upper eastern boundary nodes, are similar for the Lake Cowal dry and flood cases. The combined inflow to the model from the western and the lower eastern boundaries is less than 3% of the inflow to the mine during the calibration period up to 2020. This shows that the eastern and western boundaries have a negligible influence on model calibration results. After 2020, the combined inflow from the western and the lower eastern boundaries rises to a peak of 18% of the total mine inflow just after end of underground mining in 2041.

The northern and southern no flow boundaries lead, in a similar way, to a slight under-estimation of flows. These boundaries are located similar distances from the underground development to the western and eastern boundaries, and their effect will tend to be to reduce the over-estimation due to the western and eastern boundaries. The combined effect on the predicted inflow to the underground mine from all of the model lateral boundaries is assessed to be insignificant.

To further quantify the effects of the lateral boundary conditions on modelled inflow to the mine, two sensitivity cases were run. One case with the model lower eastern boundary (node layers 12-20) set as a no flow boundary instead of a 198 mAHD fixed head and a second case with the model northern and southern boundaries set as having a 200 mAHD fixed head instead of a no flow condition.

The variability in modelled inflow to the open pit, stopes and access tunnels at the end of mining for the original model and the two sensitivity cases was less than 2% of the original modelled inflow. This provides evidence of the negligible effects of the model lateral boundary conditions on modelled inflow to the mine.

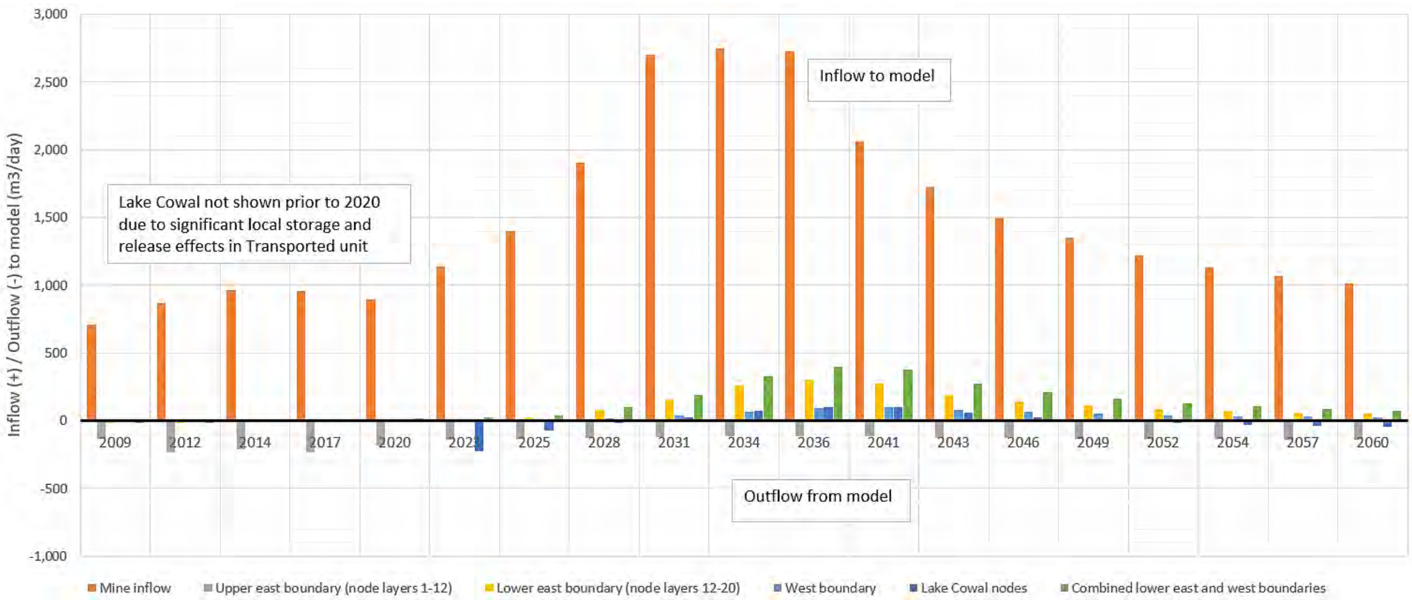

Figure 29: Inflow / outflow at model boundaries and Lake Cowal nodes for the Lake Cowal dry case

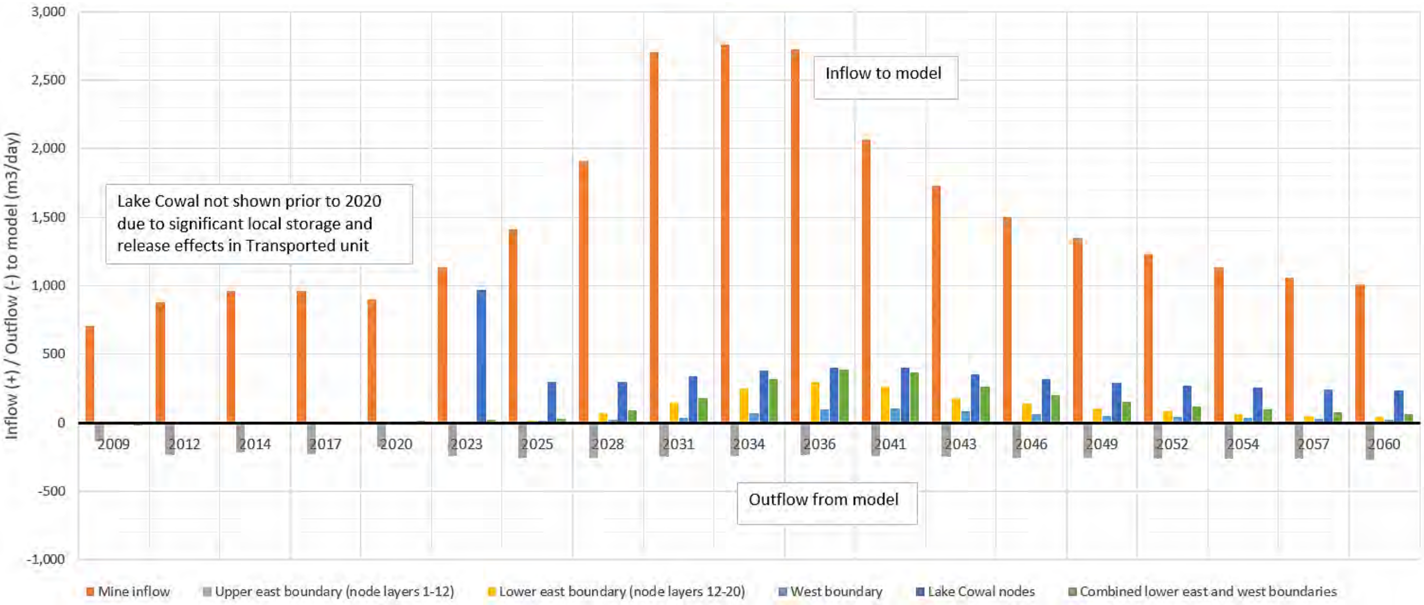

Figure 30: Inflow / outflow at model boundaries and Lake Cowal nodes for the Lake Cowal full case

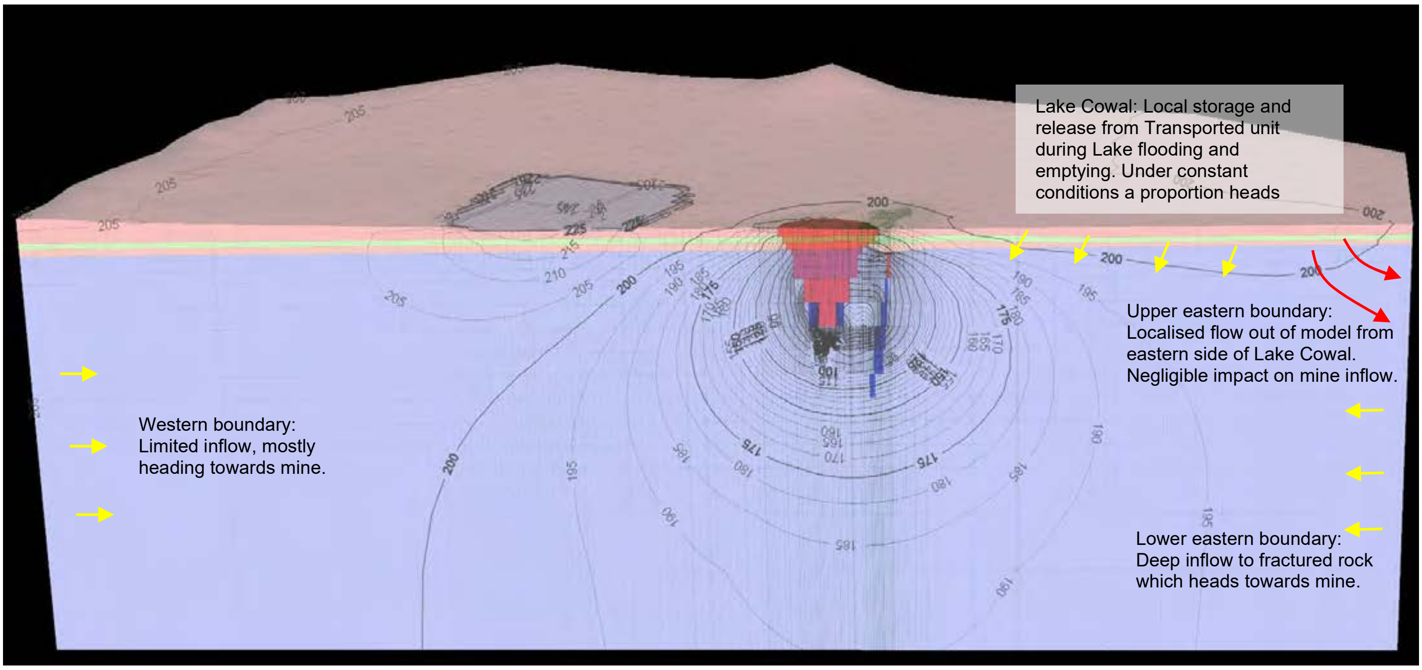

Figure 31: West to east section showing 5 m head contours, July 2024

Effect on assessed impacts to existing groundwater users

Figure 32 which is repeated from Section 4.6, shows bores labelled as being for the purposes of water supply, irrigation, stock and domestic and commercial and industrial around the mining lease. These were obtained from a search of the Bureau of Meteorology Australian Groundwater Explorer public bore database (http://www.bom.gov.au/water/groundwater/explorer/map.shtml) carried out on 9 February 2021.

Figure 32 also shows drawdown contours at 150 mAHD from the approved Mod-14 open pit development and the proposed CGO Underground Development in January 2038, immediately prior to the end of underground mining. At elevations above 150 mAHD, the 2 m drawdown contour is located closer to the open pit mine than that shown in Figure 32. This can be understood from the section illustrated in Figure 33 which show groundwater head contours at the end of mining decreasing with depth around the open pit and underground development.

The groundwater drawdown contours for the period just prior to the end of mining can be seen from Figure 31 to be concentrated around the eastern part of the mining lease, with the 2 m drawdown contour at least 3 km from model boundaries, and there is no evidence from the figure that the 2 m drawdown contour is influenced by the model boundaries. As the identified groundwater users around the mining lease have bores drilled to elevations above 150 mAHD, the effect of the model lateral boundaries on existing groundwater users is considered negligible.

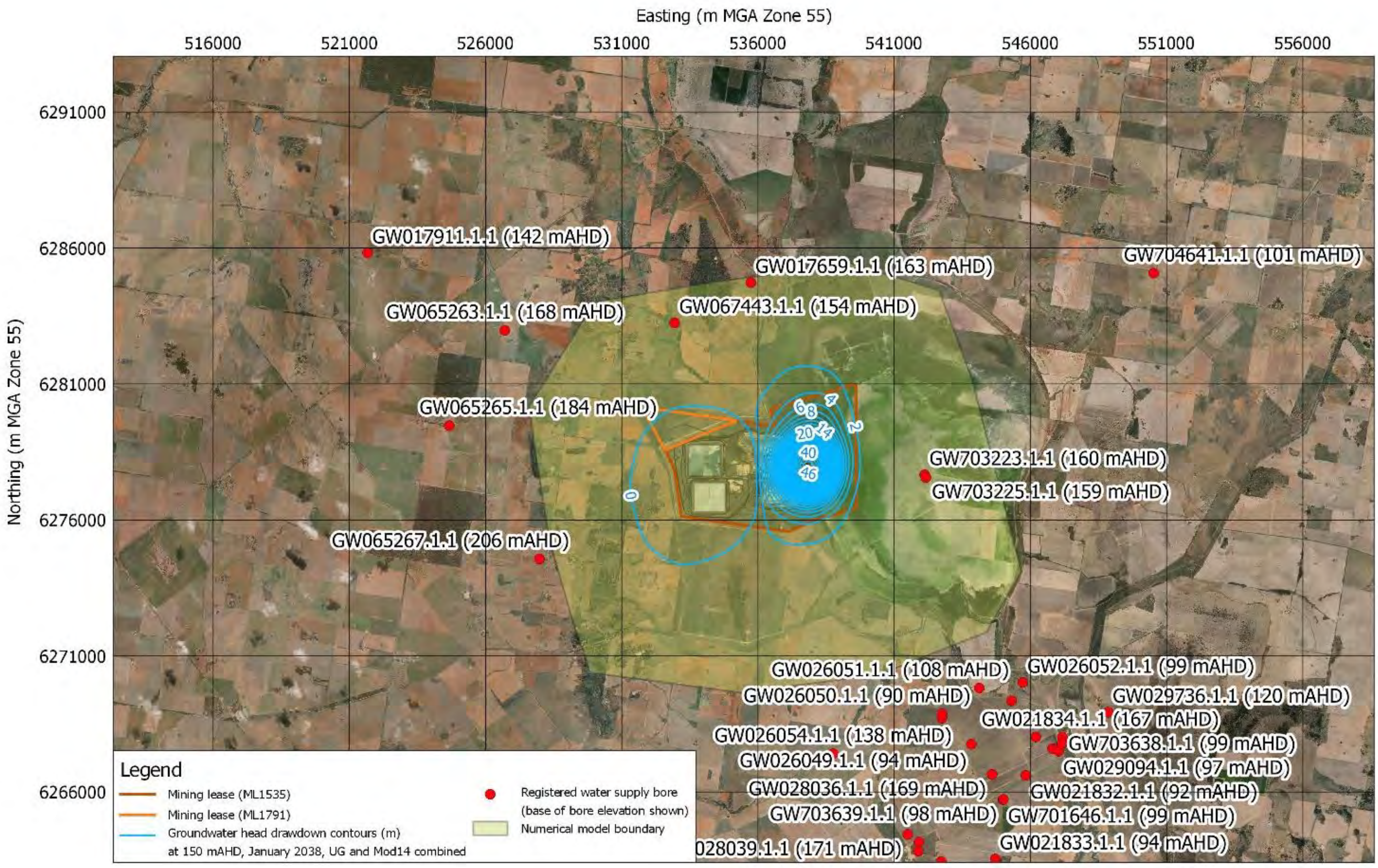

Figure 32: Combined (Mod14 and UG) drawdown at 150 mAHD, January 2038

Figure 33 shows a west to east section through the model at the end of underground mining. This figure indicates that the eastern fixed head boundary of 198 mAHD does not affect modelled drawdown in the shallow units, however it does affect modelled drawdown in the deeper units close to the eastern boundary. As there are no registered groundwater users in this area, this does not affect the assessment of impacts to existing groundwater users for the CGO Underground Development EIS.

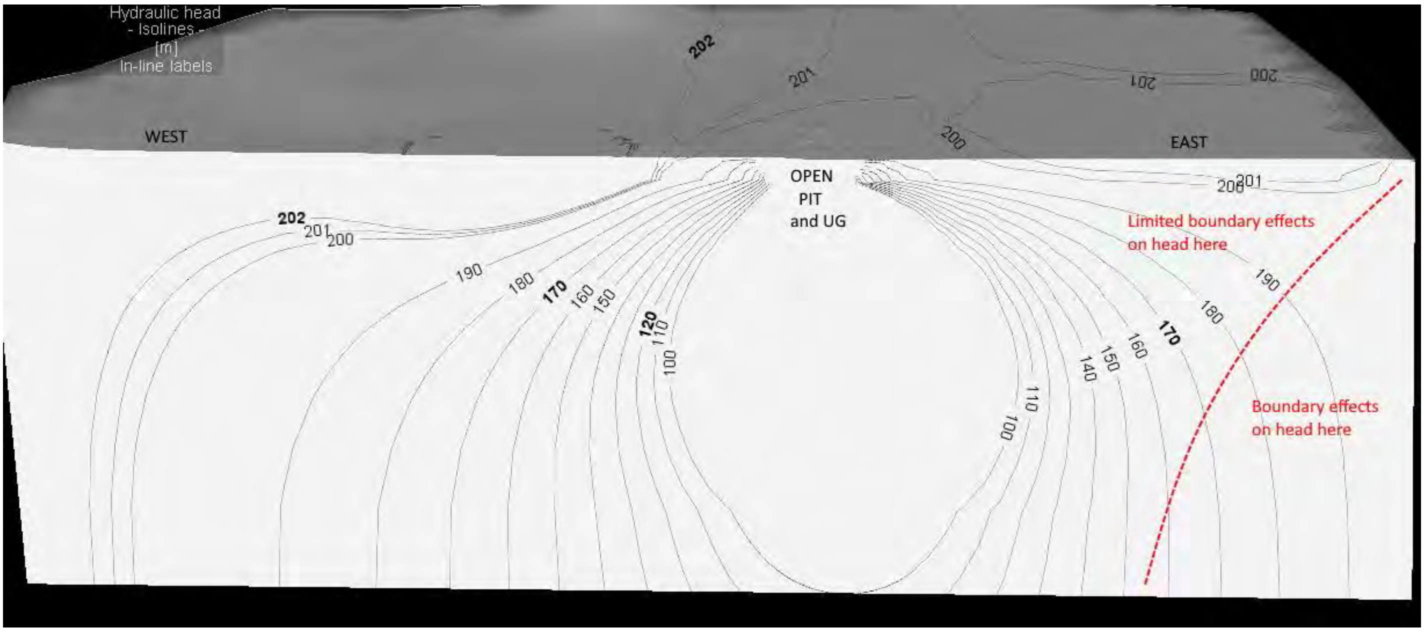

Figure 33: West to east section showing groundwater head contours, January 2038 (note the decrease in head with depth around the mine)

The influence of the model boundaries on groundwater head in the Primary Rock at 0 mAHD is illustrated in Figure 34. The influence of model boundaries is considered to be negligible except in the area as shown around the border of the model. For elevations above 0 mAHD, the influence of the model boundaries is less than that shown in Figure 34

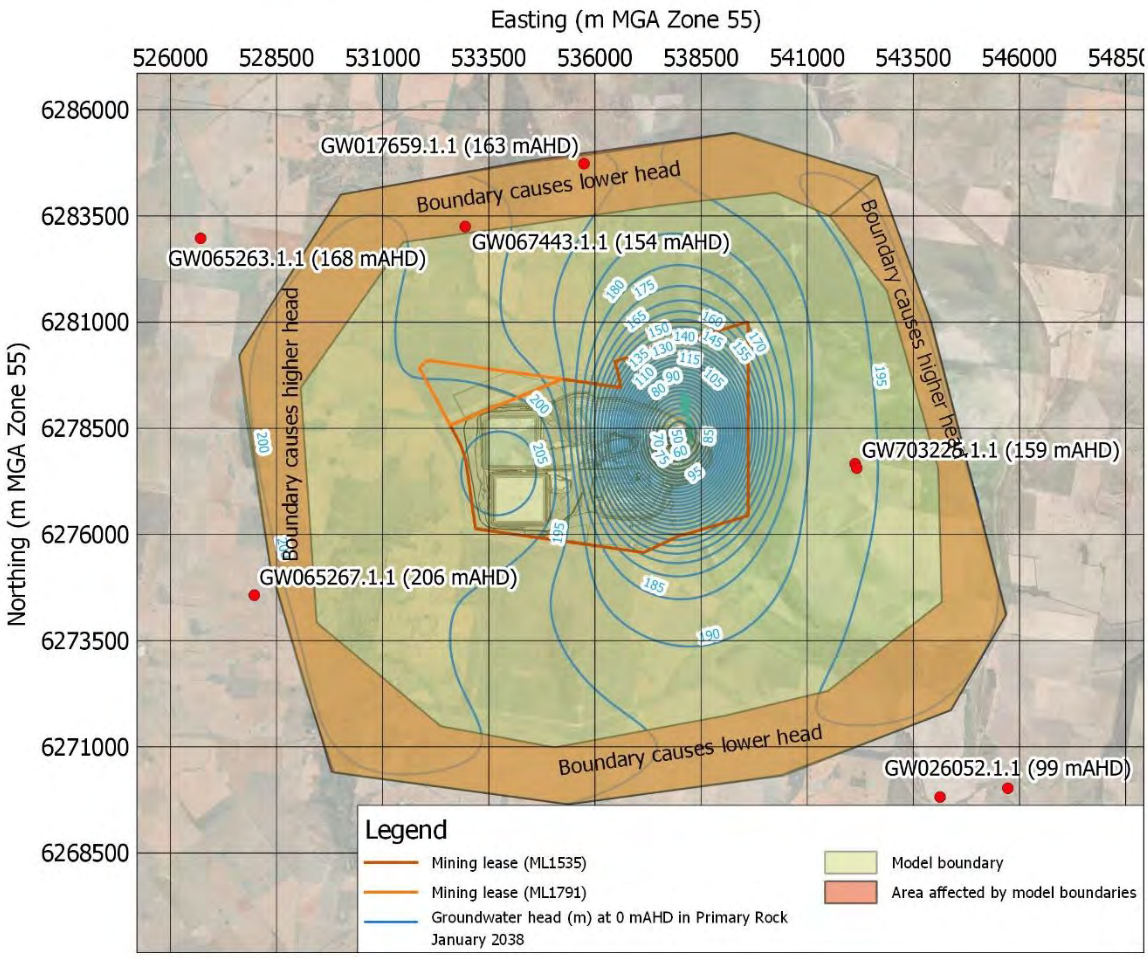

Figure 34: Zone of influence of model boundaries on groundwater levels at 0 mAHD in the Primary Rock

4.9.3. TSF / IWL foundation parameters and boundary conditions

The proposed CGO Underground Development results in a 1 m increase in the final height of the IWL and no changes to the final heights of TSF north and TSF south compared to the approved Mod 14 development. The TSF/IWL will be in operation until the end of mining in mid-2039, which is an increase of seven years compared to the approved Mod 14 development.

The hydrogeological assessment for the approved Mod 14 development, which is available on the DPIE NSW Planning Portal (https://www.planningportal.nsw.gov.au/major-projects/project/12791), provides a detailed discussion on the assessment of foundation parameters for the TSF/IWL foundations. Given the relatively small changes to the TSF/IWL, it is considered that the assessment of the TSF/IWL foundation parameters carried out for the approved Mod 14 development is applicable to the CGO Underground Development. The TSF/IWL foundation parameters adopted for the CGO Underground Development project are consistent with those adopted for the approved Mod 14 development.

The results presented in the mine site report indicate a good match of modelled versus observed groundwater levels around the TSF/IWL during the calibration period between 2004 and 2020. In particular, the groundwater model captures the notable increases in groundwater levels observed at MON02A and MON02B, the more gradual increases observed at P412 and P414 and the negligible increases observed elsewhere. This can be seen from Figure 35, which presents calibration results at piezometers MON02A, P412A-R and P417A. The location of these observation piezometers are shown in Figure 38.

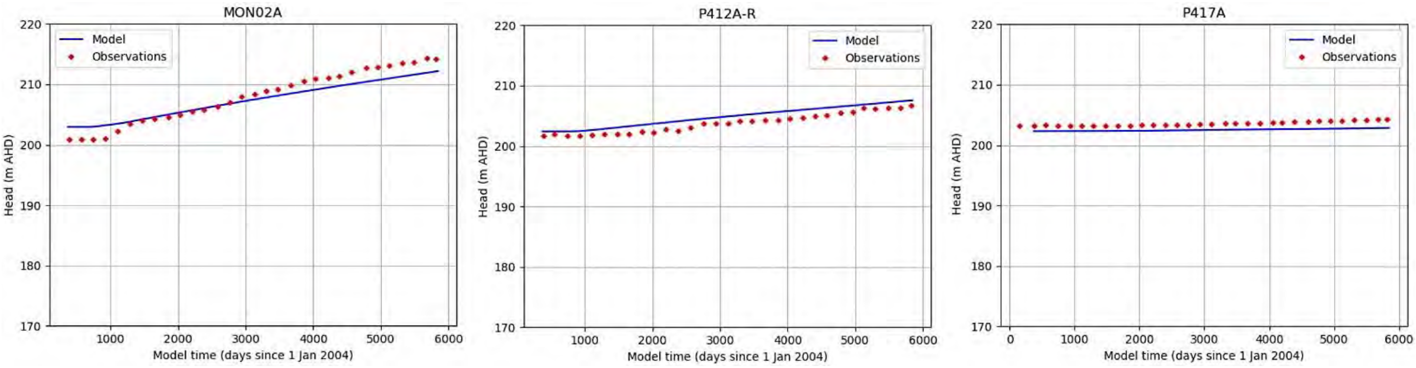

Figure 35: Calibration charts for monitoring piezometers MON02A, P412A-R and P417A located near the TSF/IWL

During operation, the TSF/IWL were modelled by the use of time varying fixed head boundary conditions, with heads equal to the provided low points for each of the TSFs and the IWL. As the fixed head value moves above the elevation of the top of the model, the software (Feflow Version 7.2) automatically extends storage to the water table above ground. This allows for a convenient and realistic representation of the TSF/IWL without the need to continuously alter the top of model elevation as the TSF/IWL levels rise.

At the end of mining, the fixed head conditions are deactivated for the TSF/IWL and the model slowly releases stored groundwater through the TSF/IWL foundation under the driving force of the head difference at the top and bottom of the foundation. The groundwater head at the top of the TSF/IWL foundation is reduced by the model according to the volume of groundwater released through the foundation. This is considered an adequate representation of the conditions at the TSF/IWL for the period following the end of mining, particularly for the purposes of solute transport modelling and impact assessment for the CGO Underground Development EIS.

4.9.4. Lake Cowal boundary conditions

The mathematical modelling of groundwater flow provides for the use of three types of boundary conditions:

- Fixed head boundary condition: The specification of a groundwater head value at a boundary
- Fluid flux boundary condition: The specification of a flow rate at a boundary
- Fluid transfer boundary condition: The specification of a reference groundwater head and transfer rate parameter for a transfer layer at a boundary

An additional boundary condition, called a seepage face, is a fixed head boundary condition with an additional constraint that the boundary condition is only active if there is no flow into the model as a result of the boundary condition being active. Seepage faces are important boundary conditions to model the edges of an excavation such as the CGO open pit.

In terms of modelling Lake Cowal, the fluid flux boundary condition is not applicable as there is no available data on the rate of flow into the groundwater system from the bed of Lake Cowal. It may be considered feasible to use fluid transfer boundary conditions at Lake Cowal, however this would require the specification of a transfer rate parameter for the bed of Lake Cowal. This is similar to adopting a fixed head boundary condition only, with the top layer of the model serving the same purpose as the transfer layer in the fluid transfer boundary condition.

Based on the availability of historic water levels for Lake Cowal, the use of time varying fixed head boundary conditions was considered the most appropriate method to model Lake Cowal.

4.9.5. Predictive modelling of dry lake and full lake conditions

It is not possible to accurately predict future levels at Lake Cowal. The effects of the water level at Lake Cowal on predicted inflows to the combined open pit and CGO Underground Development were assessed by modelling two alternative future scenarios, one with the groundwater level at Lake Cowal fixed at 201.5 mAHD and another with the groundwater level at Lake Cowal fixed at 206.5 mAHD. These represent dry lake and full lake conditions, respectively. The results of the modelling showed the difference between the two scenarios was negligible in terms of predicted inflows to the mine.

4.9.6. Local groundwater flow regime at Lake Cowal

During periods of alternate flooding and drying of Lake Cowal, the groundwater model indicates that a localised regime of storage and release of groundwater in the sediments and weathered rock beneath Lake Cowal occurs. Figure 36presents modelled inflow to the Lake Cowal nodes (including rainfall recharge which is indicated by the horizontal black dashed line) and resulting net inflow to the model accounting for storage in layers 2 to 5, representing the Transported and Saprolite units, beneath Lake Cowal. Storage in the Lake Cowal nodes themselves is omitted from the calculations.

Whilst it is not the purpose of the hydrogeological assessment to provide a detailed discussion on the dynamic local effects related to Lake Cowal drying and flooding, the results are included here to provide an illustration of the surface-groundwater interchange associated with the filling and emptying events within Lake Cowal which is independent of mine related seepage.

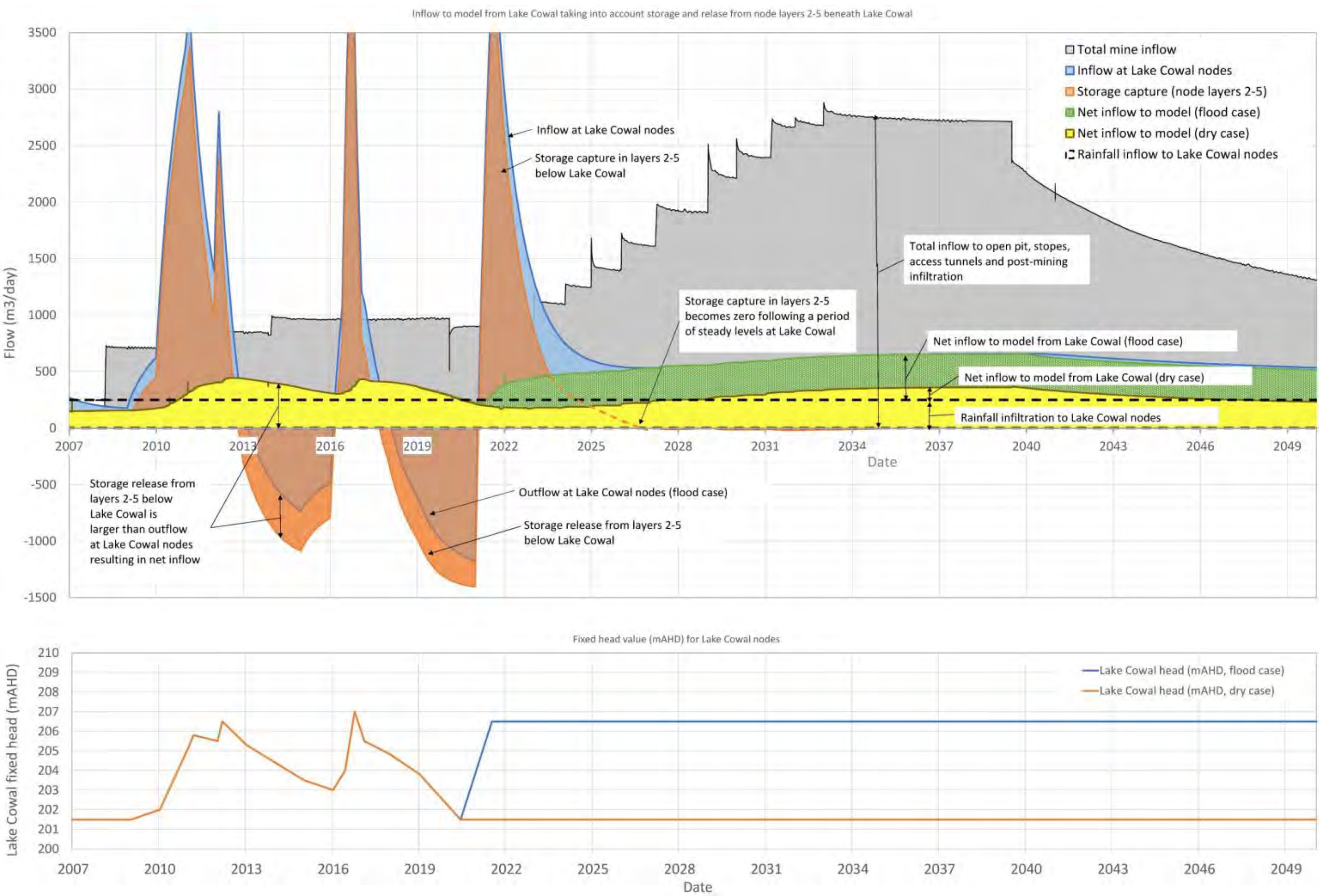

Figure 36: Inflow to the model from Lake Cowal accounting for storage capture and release from model layers 2-5 (Transported and Saprolite units) beneath Lake Cowal

4.9.7. Effect of confined conditions for the Primary Rock (model layers 6 to 20)

Based on observations of seepage around the CGO open pit in 2020, seepage into the open pit is occurring from elevations above the top of the Primary Rock. This indicates that confined, or fully saturated conditions, exist in the Primary Rock around the open pit in 2020.

The modelled groundwater table drawdown in 2038, as shown in Figure 37, is generally less than about 60 m at the edges of the open pit, which is above the level of the top of the Primary Rock. Groundwater table drawdown decreases rapidly away from the open pit. In the area where the southern end of stopes and access tunnels pass close to the open pit, the Primary Rock may become unsaturated. The effect of adopting fully saturated conditions for the Primary Rock in the model results in a higher hydraulic conductivity for the Primary Rock in this area compared to unsaturated conditions. This means the model may slightly over-estimate flows in that area. Considering the much larger groundwater head gradients at the lower compared to the upper elevations of the stopes, and associated larger inflows, the effects of adopting fully saturated conditions for the Primary Rock are considered to be negligible with respect to predicted inflows to the mine.

As there are no existing groundwater users in the area near the open pit where there is a slight potential for unsaturated conditions in the Primary Rock, the effects of adopting fully saturated conditions for the Primary Rock are considered to be negligible with respect to the assessment of impacts to existing groundwater users.

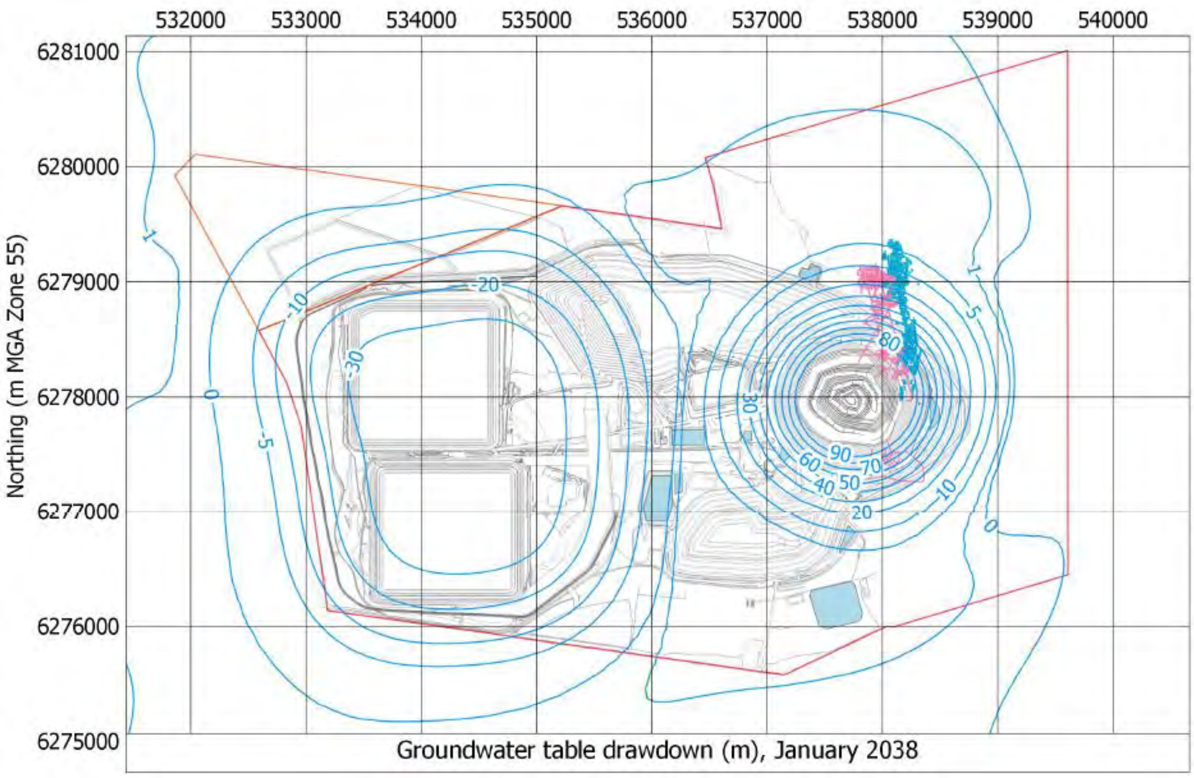

Figure 37: Modelled groundwater table drawdown, January 2038

4.10. Recommendations for future monitoring and model verification / updates

Groundwater monitoring recommendations:

Coffey recommends that the CGO annual groundwater monitoring review be expanded to include groundwater level monitoring at fully grouted piezometers UG-BH-01, UG-BH-02, UG-BH-03, UG-BH04, PZ13 and PZ17. The details of these piezometers are shown in Table 9. Note that sensor elevations for fully grouted piezometer PZ17 are not available at this time. Groundwater level monitoring is to continue at the existing monitoring piezometers around the CGO site (refer to Figure 38) and the BCPB area. If existing monitoring wells are impacted by the IWL construction, replacement monitoring wells will require installation. The monitoring piezometers and fully grouted piezometers around the CGO site are shown in Figure 38.

The CGO annual groundwater monitoring review should report groundwater inflow volumes into the underground development according to each underground area of the stopes and access tunnels, in a similar way that open pit dewatering volumes are currently reported. A groundwater model can benefit greatly from segregation of flow rates from each component of pumping as it allows a calibration dataset. This data should be collected during mining operations and provided to Coffey.

We note that monitoring of the water level in Lake Cowal has been carried out by Evolution in the past. Ongoing monitoring of Lake water levels is required.

Table 9: Proposed additional groundwater level monitoring to be included in CGO annual groundwater monitoring review

Fully grouted piezometer name	Screened unit	Easting (m MGA Zone 55)	Northing (m MGA Zone 55)	Sensor elevation (m AHD)	Monitoring frequency
UG-BH-01 (SG1)	Transported	537751.6	6278843.8	189.1	6 hourly via data logger
UG-BH-01 (SG2)	Transported	537751.6	6278843.8	174.1	6 hourly via data logger
UG-BH-01 (SG3)	Saprock	537751.6	6278843.8	134.1	6 hourly via data logger
UG-BH-02 (SG1)	Transported	538180.0	6279593.8	190.8	6 hourly via data logger
UG-BH-02 (SG2)	Saprolite	538180.0	6279593.8	160.8	6 hourly via data logger
UG-BH-02 (SG3)	Primary Rock	538180.0	6279593.8	103.8	6 hourly via data logger
UG-BH-03 (SG1)	Transported	538019.1	6278883.0	188.9	6 hourly via data logger
UG-BH-03 (SG2)	Saprolite	538019.1	6278883.0	173.9	6 hourly via data logger
UG-BH-03 (SG3)	Primary Rock	538019.1	6278883.0	133.9	6 hourly via data logger
UG-BH-04 (SG1)	Transported	538169.0	6278916.0	188.8	6 hourly via data logger
UG-BH-04 (SG2)	Saprock	538169.0	6278916.0	158.8	6 hourly via data logger
UG-BH-04 (SG3)	Primary Rock	538169.0	6278916.0	102.3	6 hourly via data logger
PZ13VWP1	Primary Rock	538342.3	6278585.0	83.8	6 hourly via data logger
PZ13VWP2	Saprock	538342.3	6278585.0	128.8	6 hourly via data logger
PZ13VWP3	Saprock	538342.3	6278585.0	143.8	6 hourly via data logger
PZ13VWP4	Saprolite	538342.3	6278585.0	171.8	6 hourly via data logger
PZ17	Nested piezometers in multiple units similar to PZ13	538516.9	6277389.3	T.B.A.	6 hourly via data logger

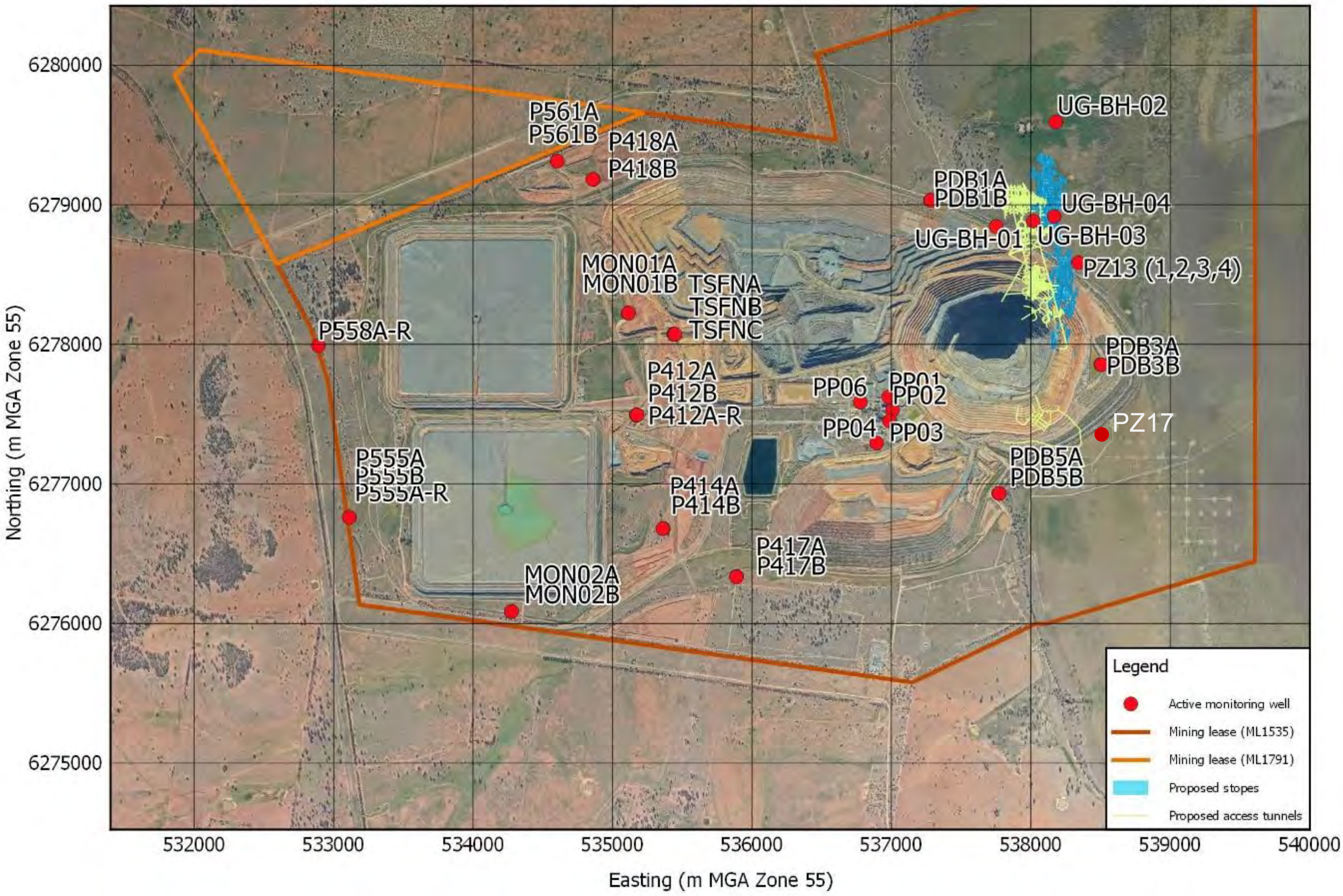

Figure 38: Location of groundwater monitoring piezometers including fully grouted piezometers near the proposed underground development

Model verification and updating:

Following commencement of underground mining, when continuous inflow and groundwater level observation records are available for a period of at least one year, the following should be carried out by a hydrogeologist:

- Comparison of observed inflows to the open pit, stopes and access tunnels against predicted values (as shown in mine site report Figure 10-6).
- Comparison of groundwater level observations above the stopes and access tunnels against predicted values using the numerical model.
- Assessment and reporting on the significance of differences between modelled and observed values.

If observed inflows are outside the range shown in mine site report Figure 10-6, or if groundwater levels are showing trends away from predicted values, the numerical model for the mine site is to be revised. This will include updating the model according to the final underground mine design, model re-calibration and preparation of revised inflow and groundwater level predictions.

We assume that as-built data for the underground development, open pit and TSF/IWL will be made available as required for model verification and updating.

5. References

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Coffey Services Australia Pty Ltd (2020). Groundwater Monitoring Review 2019, Cowal Gold Operation, Report No. 754-SYDGE270760-AA, dated 30 April 2020.

Middlemis, H. and Peeters L.J.M. (2018), Uncertainty analysis—Guidance for groundwater modelling within a risk management framework. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2018.

6. Closure

Please do not hesitate to contact the undersigned if you have any questions or comments in relation to this report.

For and on behalf of Coffey,

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Senior Groundwater Engineer

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19 February 2021

Our ref: 754-SYDGE206418-3-AQ-Rev1

EMM Consulting Pty Ltd

Level 10, Suite 01
87 Wickham Terrace
Spring Hill QLD 4000

Attention: Paul Freeman

Dear Paul,

Response to community submission from Peta Emes regarding objection to the Cowal Gold Operations Modification 16 - surface changes to support the Underground Development (SSD 10367)

1. Introduction

This letter presents a response to the community submission from Peta Emes regarding objection to the Cowal Gold Operations (CGO) Modification 16.

CGO is operated by Evolution Mining (Cowal) Pty Limited (Evolution). Coffey Services Australia Pty Ltd (Coffey) was commissioned by EMM Consulting Pty Ltd (EMM) for the hydrogeological assessments conducted as part of the CGO Underground Development Environmental Impact Statement (EIS).

The submission outlines concerns to be addressed as part of the approval process for the proposed Modification 16 with reference to the groundwater aspects of the project set out in the following two reports:

- Cowal Underground Development EIS – Mine Site Hydrogeological Assessment (Coffey 2020a) (the mine site report).
- Cowal Gold Operations Underground EIS - Bland Creek Palaeochannel Borefield and Eastern Saline Borefield Groundwater Assessment (Coffey 2020b) (the BCPB report).

Groundwater supply for the CGO is sourced from the Bland Creek Palaeochannel Borefield (BCPB) and Eastern Saline Borefield (ESB).

This letter outlines the groundwater aspects of the response to the submission.

2. Summary of key issues requiring clarification in the submission

This letter provides further details on the following groundwater items raised in the submission:

- Water use;
- Groundwater level recovery;
- Groundwater users; and
- Regulatory considerations.

3. Responses

3.1. Water use

Comment

"This Application includes an increase in the actual water used per annum.

At this time it is not possible to predict the state of Ground Water for extraction by the ten bores and the state of Irrigation Water from the Jemalong Irrigation Channel nor the state of water in the Lachlan Valley as a whole for the time periods requested.

The water in the Lachlan Valley is considerably over allocated. The Wyangala Dam has not been able to carry the valley through this three year drought, due to the pressure on it to keep the river flowing. The dam depleted more quickly than in previous longer droughts. There were reduced inflows to the river from groundwater along its length.

There is currently an Inquiry into water in the Lachlan Valley, the Lachlan Regional Water Strategy, being done by the NSW Government, as a part of the review of the Murray Darling Basin for the Australian Government.

I suggest that Approval of this Application by Evolution Mining be postponed until after the Lachlan Strategy is completed and appropriate decisions made regarding it.

I suggest that Evolution Mining be asked to restructure their plans so that there is no increase in water taken from bores and the Irrigation Channel, and preferably so that less is taken. This could be done by postponing the commencement of the extraction of ore from the underground mine.

Evolution say that they have a higher approved rate of water use but this does not take into account the needs of other water users in the valley. If everyone used their full allocation it would be an even greater disaster than this drought has been. The Consultant Coffey in the Application only considers the needs of 2 near farming neighbours. If the ground water is not extracted it will flow down to the Lachlan, having some of the salinity filtered along the way.

This is at a time when the Lachlan Valley is experiencing drought years with future uncertainty, and when the MDBA has placed a cap on water use in the MDB which includes the Lachlan River.

The historical meteorological records and the paleo geological records show that there have been much longer droughts in the past and that they are likely to occur again now and in the future. The conditions prevailing from 2032 to 2040 cannot yet be predicted.

Current water use by CGO is stated as approximately 7,430 ML of process water, plus more water for dust settling, laboratory work and human activities. It is projected to also use water in the production of reinforcing paste for the underground mine, and in rehabilitation works.

The water comes from on site seepage, bores, rainwater and from the Jemalong Irrigation Channel. They state that they recycle approximately 50%."

Coffey response

The regional groundwater modelling work conducted by Coffey for the Underground Development resulted in a decrease in the maximum daily groundwater extraction rate for the CGO BCPB to 4.0 ML/day (Coffey 2020b) from 4.4 ML/day in the Modification 14 model (Coffey 2018). The decrease in groundwater extraction was required to maintain groundwater levels above the government trigger level (discussed further below) for an eight year extension in mine pumping from 2032 to 2040. Groundwater extraction from the CGO ESB remains at 1.5 ML/day for the Underground Development.

Table 11.2 of the main report EIS (EMM 2020) details site water demand, shown below. Water use of 7,340 ML/year (20.1 ML/day) is listed for the median rainfall case.

The main consumers of water at CGO are the process plant, construction and haul road dust suppression. Since 2007, the CGO ore processing rate (total) has averaged 7.4 Mtpa and the water demand (total) has averaged 17 ML/day, of which up to approximately 7.6 ML/day (around 45%) on average was supplied by on-site recycled and incident rainfall water. Monitoring records show that water consumption for haul road dust suppression averages 0.62 ML/day.

For the Underground Development the paste fill plant will require water usage in the order of 1.2 ML/day which will be sourced from internal sources. Water will also be required for dust suppression and ventilation requirements, in the order of approximately 2.5 ML/day, also from internal sources.

As discussed above, the long-term average daily groundwater extraction rate for the CGO BCPB for the Underground Development cannot exceed 4.0 ML/day and continued monitoring of groundwater levels will remain part of the groundwater management strategy for the mine.

Table 11.2 Site water demand

Inflows (ML/year)	10th percentile Rainfall Sequence (Dry)	Median Rainfall Sequence	90th percentile Rainfall Sequence (Wet)
Catchment runoff	1,114	1,380	1,443
Tailings bleed	2,579	2,579	2,579
Open-cut pit and Project groundwater	685	685	685
Saline groundwater supply bores (within ML 1535)	52	43	49
Bland Creek Palaeochannel bores	1,777	1,628	1,597
Eastern saline bores	438	430	421
Lachlan River licensed extraction*	754	686	676
Total Inflow	7,399	7,430	7,449
Outflows (ML/year)			
Evaporation	960	1,011	1,037
Haul road dust suppression	223	222	221
Construction water	93	93	93
Process plant supply	5,880	5,880	5,880
Overflow	0	0	0
Underground mine vent loss	134	134	134
Total outflow	7,290	7,340	7,364

ML/year = megalitres per year
*Modelled volume of water actually reaching CGO – excludes irrigation channel losses

The BCPB report (Coffey 2020b) includes more than two private bore irrigators. The report focuses on the Billabong and Maslin farming operations due to the large groundwater extraction rates at these locations as discussed below. Groundwater extraction in the area covered by the model domain occurs from Evolution and private bores. Appendix E of the BCPB report lists the 18 active pumping bores in the model, and contains a map showing their locations (refer to Figure 1 below). The list excludes basic rights bores (registered for stock and domestic use) which have no associated entitlement. Basic rights bores are not active in the model.

Large groundwater extraction rates are concentrated in three main areas and are the focus of the BCPB report. One of the areas encompasses the CGO, BCPB and ESB. The other two areas encompass private bores. These areas are identified on the map in Appendix E (refer to Figure 1 below). Each area also has a monitoring piezometer used by the NSW government to monitor groundwater levels in the Lachlan Formation (at the request of the Bland Palaeochannel Groundwater Users Group) for groundwater management purposes. These piezometers have associated triggers defined by bore water levels where, should the bore water level fall to the trigger, various management actions are initiated.

If the investigation trigger level is breached, the effects on nearby users will be investigated and measures to mitigate impacts on water supply for existing stock and domestic use will be put in place for affected bores. If the mitigation trigger level is breached one or both of the following measures would be put in place in consultation with the NSW Department of Planning, Industry and Environment (DPIE):

- Alter the pumping regime to maintain the water level in the impacted stock and domestic bores;
- Maintain a water supply to the owner/s of impacted stock and domestic bores.

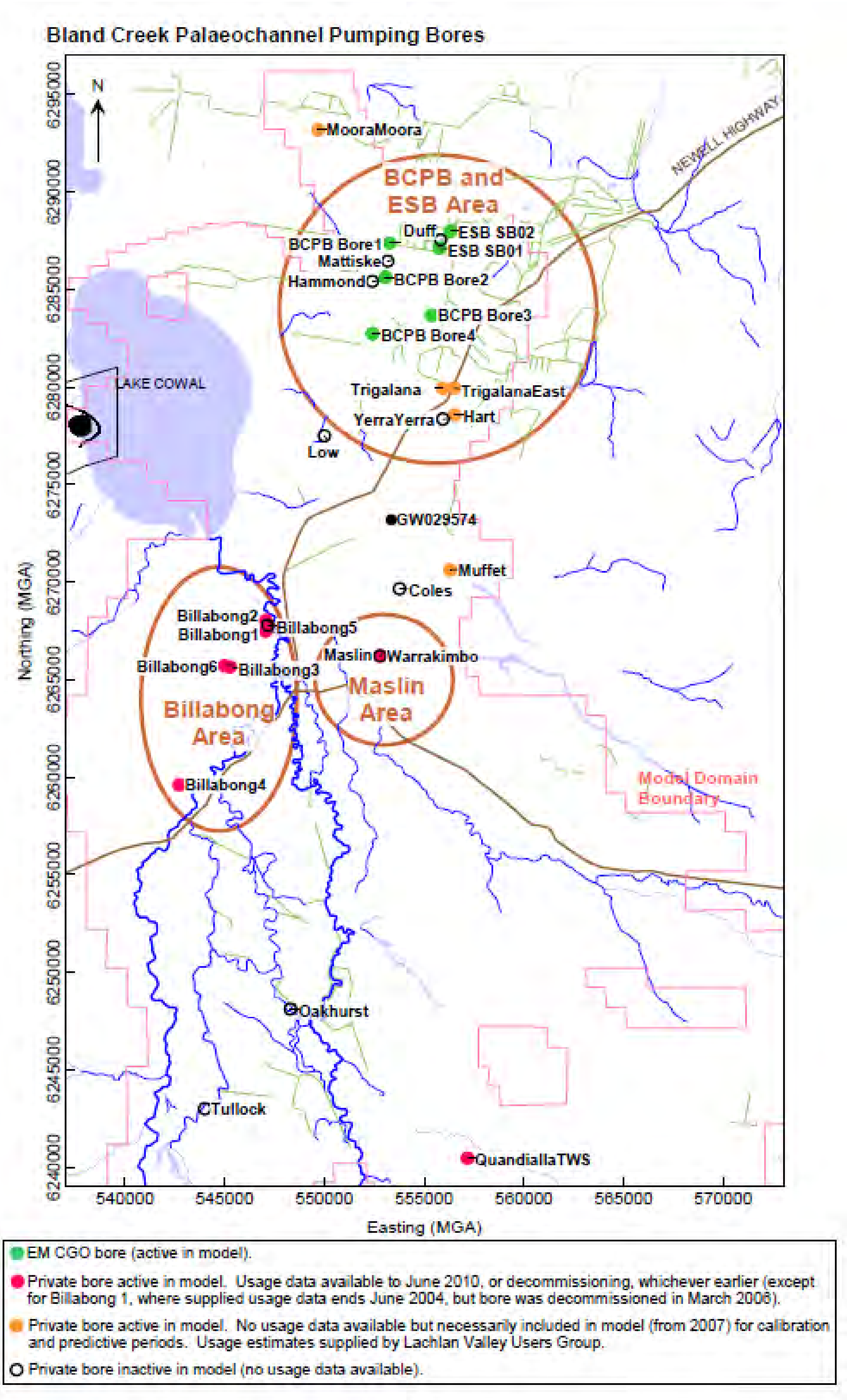

Figure 1. Bland Creek Palaeochannel model pumping bores

Table 1 lists the main pumping areas and associated pumping bores (see BCPB report Appendix E for bore details) and trigger piezometers. The pumping bores listed in Table 1 account for about 96% of the known groundwater extraction from the Lachlan and Cowra Formations in the model area. All bores in Table 1 pump from the Lachlan Formation except the ESB which pumps from the Cowra Formation.

The operation of the BCPB and ESB is managed through the monitoring of water levels at piezometer GW036553. Predicted groundwater levels at monitoring piezometer GW036553 due to the BCPB and ESB pumping for the Underground Development is illustrated in Figure 2. The long-term average daily groundwater extraction rate for the CGO BCPB for the Underground Development cannot exceed 4.0 ML/day and continued monitoring of groundwater levels will remain an integral part of the groundwater management strategy for the mine.

Water levels at piezometers GW036597 and GW036611 do not govern the operation of the BCPB and ESB.

Trigger piezometer locations are illustrated in Figure 3.

Table 1. High-extraction pumping areas in the regional area

Area	Pumping Bores	DPIE Trigger Piezometer	
		Registration No.	Trigger Level (m AHD)*
BCPB and ESB	BCPB: Evolution Bores 1 to 4. ESB: Evolution bores SB01 and SB02*	GW036553	137.5 (Investigation) 134.0 (Mitigation)
Billabong	Billabong 4 and Billabong 6	GW036597	143.7
Maslin	Maslin Bore	GW036611	145.8

* ESB pumping bores SB03 to SB05 (see Appendix E) are currently not used for pumping.

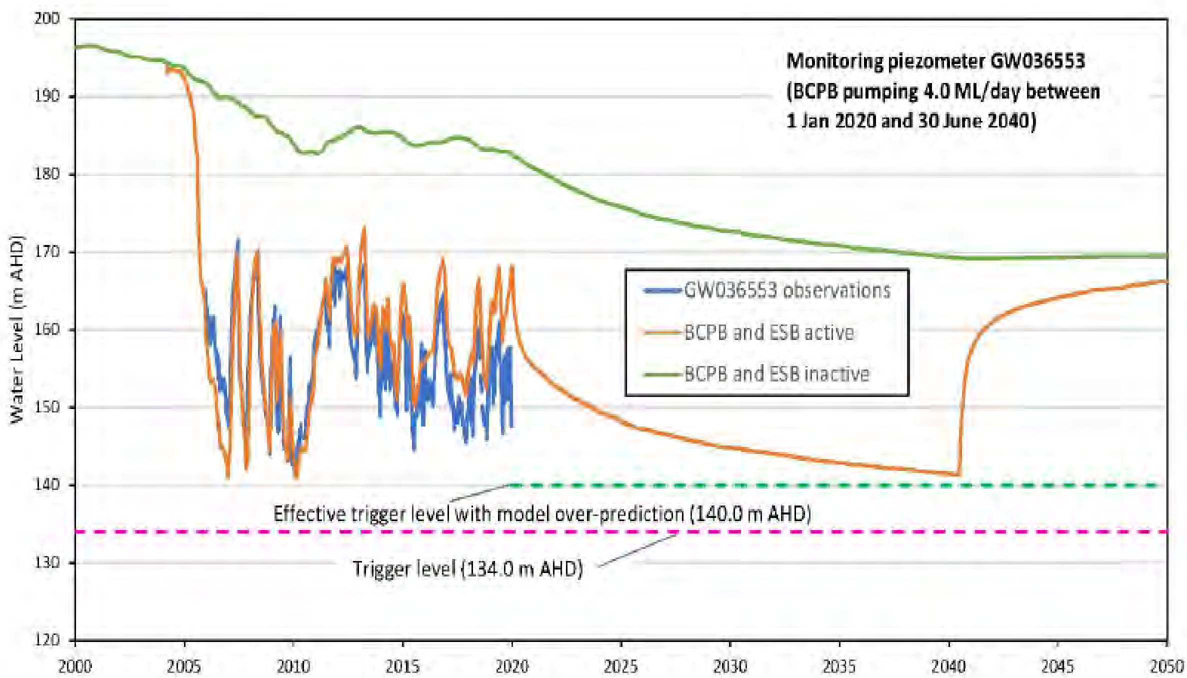

Figure 2. Predicted groundwater levels at trigger piezometer GW036553

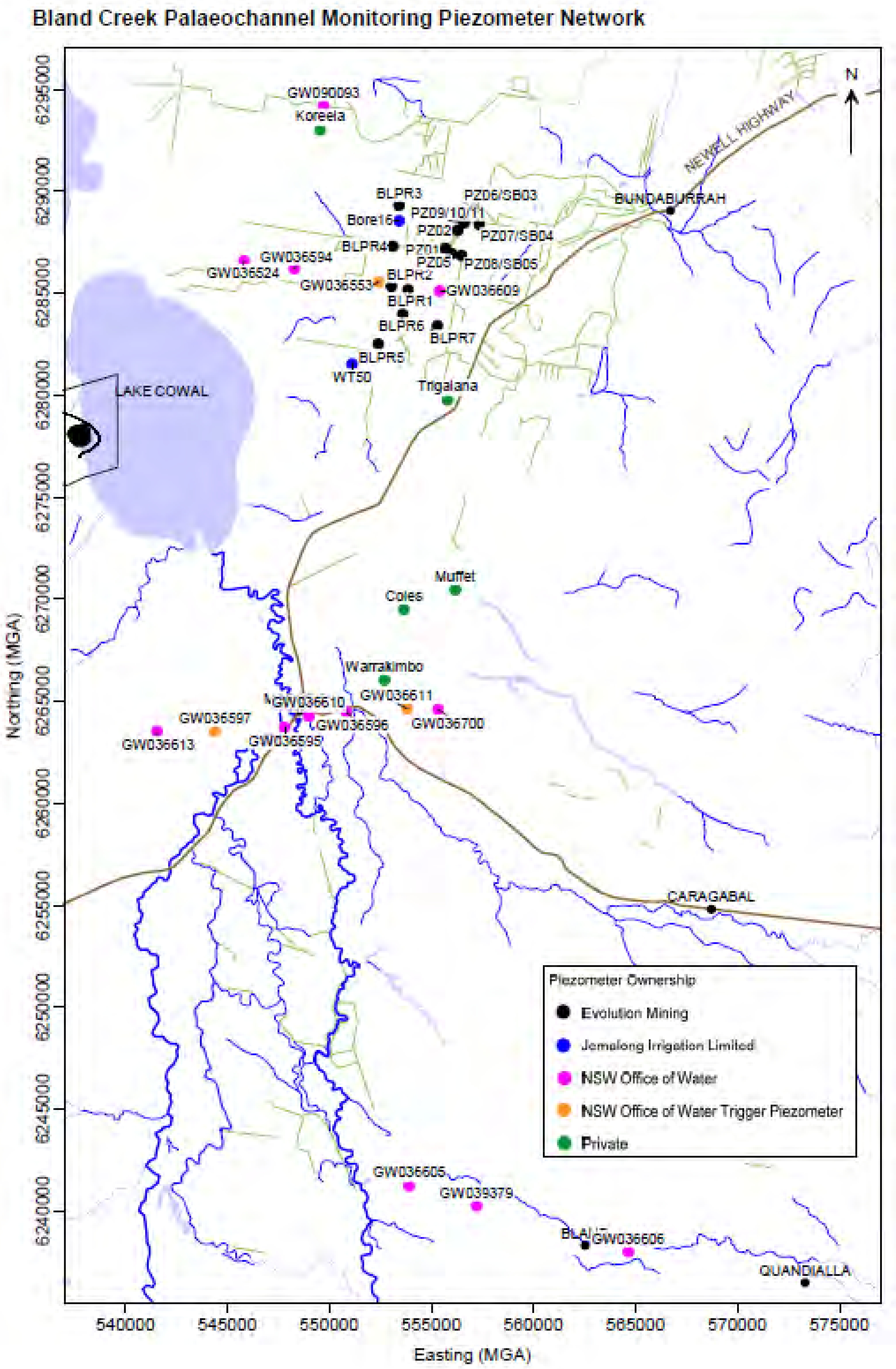

Figure 3. Bland Creek Palaeochannel monitoring piezometer network

3.2. Groundwater level recovery

<u>Comment</u>

“The Application states on pages 105 and 108, 6.5.3 & 6.5.5

‘Recovery of the ESB and BCPB “(6 bores)” is predicted at around 166 m AHD “(Australian Height Datum)“ in ten years (about 30 m below 1998 water levels), and will continue to gradually recover over time subject to the amount of ongoing abstraction from private bores after CGO closes and the prevailing climate. It is possible that it will take significant periods of time for water levels to recover to levels seen in the late 1990s (prior to the drought and onset of extensive pumping) due to the low rate of recharge and continuing pumping for irrigation.’

It is quite usual for the smaller gold mines in this section of the Lachlan Valley to be reopened and the tailings and waste rock reprocessed to extract copper lead silver and the rare elements such as lithium. If manganese is being found in quantity that may be targeted also.

As Evolution Mining is measuring and monitoring the concentrations of these, and processing some for sale according to market demands, it looks as if they are also readying the mine for resale to a new miner who specialises in mining these elements.

So it cannot be assumed that the water table will return to normal some time after 2050.

To approve this Application would be condemning the farmers, people, towns and environment of the Lower Lachlan to extreme droughts with reduced access to groundwater and creek and river water until well past 2050.”

<u>Coffey response</u>

Coffey agrees that the groundwater table is unlikely to return to levels recorded in the late 1990s assuming that extensive pumping for mining, agriculture and other water supplies continues in this area following CGO mine closure.

Groundwater level recovery following CGO mine closure is dependent on the volume historically pumped, private bore usage following mine closure, and climatic conditions.

Management of groundwater extraction in this area needs to consider water use for all groundwater users including both mining and agriculture, as discussed further below.

3.3. Groundwater users and regulatory considerations

<u>Comment</u>

“Coffey does not give sufficient attention to the differing contexts of the neighbouring farms and the mine’s way of using water. The farms use water only in particular seasons and years, and the mine uses water 24/7/360. The total ML per annum for each would be more useful for comparisons.

Coffey does not at all consider the effects of the CGO’s use of groundwater, from inflows (seepage) and from bores, on the region and on the creeks and the Lachlan River, and on the other users of the Jemalong Irrigation Channel.

All Lachlan users from Jemalong downriver, particularly the Lower Lachlan users, will lose some water to CGO, and to the major mines upriver. The environment also loses.

There is no consideration of the downriver effects on Lachlan River flow levels. The groundwater from CGO borefields flows to the Lachlan unless extracted. Likewise the inflows to the mine.

Particularly during droughts, the water supply to the Lower Lachlan users will be decreased by an increased groundwater extraction rate by CGO.

There are several major mines drawing groundwater in the Lachlan Valley, both by inflows and bores, and their effects on the water table and the Lachlan River are cumulative. Obviously the groundwater flows to the Lachlan River at a lower height AHD as the Lachlan Valley does not have an Artesian Basin.

Coffey does not give regional relative usage rates per annum and volumes available, to allow the magnitude of CGO's effect on other users to be seen, and for the other major miners' cumulative effect to be seen.

Also there is absolutely no respect for and no mention of the MDBA cap on water use, with both the MDBA and the NSW government saying there should be no increases in water use in the MDB.

During this three year drought farmers have been trucking hay from Victoria and South Australia with great expenses. In previous years it could be grown in the Lachlan Valley on the irrigated farms during droughts.

It is the usual habit of farmers to cut and store hay and silage in normal years and then in dry years particularly to irrigate to provide hay, silage and pastures to carry on.

In this three year drought without the stored Wyangala Dam water to carry them through the farmers have suffered much hardship and there have been great costs to them and to the NSW Government and the Australian Government. There has been a great loss of breeding stock which will reduce their ability to operate for years to come, and loss of their innovations inbreeding.

The large scale mining is already at a level which has harmed other users.

Increases in water use by miners and the works which require the increase should not be approved.

The towns are suffering with the lack of river water, and with water restrictions and the loss of gardens and garden festivals. Gardens are a long term local cultural activity.

The CGO Application to increase it's production and significantly increase actual water use is a totally arrogant disregard for other water users outside their immediate area and should not be approved."

<u>Coffey response</u>

Coffey agrees that drought conditions exacerbate conflicting demands for water, particularly between large groundwater users such as mining and large-scale irrigation operations.

Over the period 1 July 2004 to 31 December 2019, the average total pumping rates at the largest groundwater extraction bores were as follows:

- 4.1 ML/day (1496.5 ML/year) at the BCPB supplying CGO;
- 5.5 ML/day (2007.5 ML/year) at the two largest farming operations (2.8 ML/day at the Billabong bores, and 2.7 ML/day at the Maslin bore).

This pumping resulted in groundwater levels above the trigger levels at each of the NSW government monitoring piezometers. The lowest observed groundwater levels over the period 1 July 2004 to 31 December 2019 were as follows:

- BCPB Area - GW036553: 7.5 m above trigger (141.5 m AHD on 15 January 2010).
- Billabong Area - GW036597: 1.5 m above trigger (145.2 m AHD on 21-23 November 2019).
- Maslin Area - GW036611: 1.6 m above trigger (147.4 m AHD on 16 December 2019).

It is noted that pumping rates for the Billabong and Maslin bores, as used in model verification analysis, involve significant assumptions.

Nine private bores are active during the predictive model simulations, as listed in Table 2. These bores all pump from the Lachlan Formation. Actual past usage is available for four of the bores up to June 2010. Usage is also available for the Billabong bores between 2014 and 2017.

For the purpose of verification of the hydrograph for GW036597, usage for the two Billabong bores was estimated from 2010 to 2013 and 2017 to 2019 using a pump capacity of 5 ML/day, and on/off times interpreted from the GW036597 hydrograph. To match the observed GW036597 hydrograph troughs in March and November 2019, both Billabong bores were estimated to be pumping at 5 ML/day, a total rate of 10 ML/day. Previous modelling assumed a pump capacity of 4 ML/day.

For the purpose of verification of the hydrograph for GW036611, usage for Maslin was estimated using a pump capacity of 12 ML/day, and on/off times interpreted from the GW036611 hydrograph. To match the observed GW036611 hydrograph troughs in November and December 2019, the Maslin bore was estimated to be pumping at 12 ML/day. Previous modelling assumed a pump capacity of 7 ML/day.

No usage information has ever been received for five of the bores. In 2007 the Lachlan Valley Water Group (LVWG) supplied future usage estimates for all nine bores, listed in Table 2, for use in predictive simulations.

The combined LVWG estimate for the Billabong bores is 4.62 ML/day, which compares with an estimated average actual pumping (from significant assumptions) of 2.8 ML/day used in the verification modelling. The LVWG estimate for the Maslin bore is 4.52 ML/day, which compares with an estimated average actual pumping (from significant assumptions) of 2.7 ML/day used in the verification modelling. The LVWG estimates were used in the current Underground Development modelling for predictive simulations (applied from 1 January 2020).

Table 2. Private bore future average annual pumping rates for modelling

Bore	Estimated future average annual usage as at 2007 (Lachlan Valley Water Group)^ (ML/day)
Billabong 3/6*	2.22
Billabong 4	2.40
Maslin	4.52
Quandialla TWS	0.10
Hart	0.02
Moora Moora	0.13
Muffet	0.02
Trigalana	0.08
Trigalana East	0.13
Total:	9.62

* Billabong 3 was replaced by Billabong 6 in 2008 (see BCPB report Appendix E).
^ Used for predictive simulations (applied from 1 January 2020).

Modelling of the responses in this area is hampered by the lack of data available regarding historic and planned irrigator pumping. Coffey has recommended that irrigator pumping rates are provided for model verification and that the future usage provided in 2007 be reassessed and updated accordingly in future revisions of the groundwater model.

Regulatory and licensing considerations

The Murray-Darling Basin Authority (MDBA) is the principal government agency in charge of managing the Murray-Darling basin in an integrated and sustainable manner. The cap on water use has been incorporated in both the regional BCPB model report and the mine site report by reporting of the groundwater take and consideration of licensed shares, as described below.

Lachlan unregulated plan

The *Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012* (the Lachlan Unregulated Plan) covers 22 unregulated surface water sources that are grouped into one extraction management unit (EMU) and two alluvial groundwater sources.

A summary of the Lachlan Unregulated Plan is provided below:

- The CGO Project is located within the Upper Lachlan Alluvial Zone 7 Management Zone;
- The Upper Lachlan Alluvial groundwater source has a total of 177,277 entitlements (shares) made up of 5,595 licences;
- Trade is prohibited between the eight groundwater management zones because the sustainable level of extraction for each zone is unknown;
- The Long Term Average Annual Extraction Limit (LTAAEL) for the whole Upper Lachlan Alluvial groundwater source is 94,196 ML/year and has been based on previous average usage;
- Entitlements are higher than the LTAAEL. Therefore the "growth-in-use" response could be triggered. Available Water Determination (AWD) is measured in ML/unit share, which can decrease to less than 1 ML/unit share if the growth-in-use response is triggered; and
- Licence holders can carry over up to 20% of their entitlement from one year to the next.

CGO currently holds 3650 shares (ML) / annum in the Upper Lachlan Alluvial Zone 7 Management Zone within the Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012. Evolution would continue to extract groundwater from the Upper Lachlan Alluvial Water Source in accordance with existing licence entitlements, and in accordance with the contingency strategy as described in Section 9.2.3 of the BCPB report.

The contingency strategy is to ensure groundwater levels at the BCPB remain above the government piezometer trigger level. A maximum long-term average groundwater extraction rate of 4.0 ML/day at the BCPB and 1.5 ML/day at the ESB has been adopted for the Underground Development (Coffey 2020b), which is an annual groundwater take from the Upper Lachlan Alluvium of 2007.5 ML/year.

Table 3 and Table 4 provide a breakdown of the components of seepage into the open pit and underground development at selected times for the model cases of a dry Lake Cowal and a full Lake Cowal, respectively. These two cases were modelled by applying fixed head boundary conditions of 201.5 mAHD (dry lake case) or 206.5 mAHD (full lake case) to the surface of the mine site model in the Lake Cowal area. Groundwater inflows during 2037 are representative of the period just prior to the end of underground mining, when groundwater inflows are predicted to be at or close to their highest values.

Table 3 and Table 4 also show the predicted total groundwater inflow into the mine (open pit, stopes and access tunnels) originating from the Upper Lachlan Alluvium. This includes all groundwater originating from the Transported unit over an area encompassing the open pit and underground development and extending east to beyond the Lake Protection Bund and west to an area just outside the open pit. The predicted total groundwater inflow into the mine originating from the Upper Lachlan Alluvium is approximately 10% of the total inflow into the mine, reducing towards the end of mining when substantially more inflow to the mine originates from the Primary Rock unit at elevations below -700 m AHD.

The BCPB regional model does not extend to the Lachlan River. The northern boundary of the model is the Corinella Constriction, therefore flow budgets with respect to Lachlan River are not reported in the BCPB report (Coffey 2020b). The northern boundary of the model was chosen at a point where narrowing of the Bland Creek Palaeochannel is interpreted to occur in the Lachlan Formation. Assuming the full volume extracted at the CGO borefields (BCPB and ESB) and seepage to the open pit and underground from the Upper Lachlan Alluvium would otherwise flow north through the Corinella Constriction and not flow south towards drawdown induced by other large groundwater users, the decrease in groundwater discharging to the Lachlan River would be up to around 2050 ML/year, within the licence limit of 3650 ML/year.

MDB fractured rock plan

Groundwater seepage to the open pit and underground results primarily in extraction of groundwater from the Lachlan Fold Belt Murray Darling Basin (MDB) groundwater source.

The background document for the *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2012* indicates that the LTAAEL for the Lachlan Fold Belt MDB groundwater source is 875,652 ML/year.

In the study area only the Lachlan Fold Belt MDB groundwater source within the WSP for the NSW Murray Darling Basin Fractured Rock Groundwater Sources had unassigned water available as part of the controlled allocation process. The controlled allocation order for 2020 indicated 3,618 shares were available for purchase.

The numerical modelling predicts dewatering rates due to inflow to the open pit, stopes and tunnels, as described in detail in the mine site report (Coffey 2020a). The equivalent average annual groundwater take modelled from 2020 to the end of mine life is approximately 796 ML/year.

Peak predicted flow from 2031 to 2039 is 1,022 ML/year.

The groundwater is predominantly sourced from the rock hydrogeological units. It is assessed that 90% of groundwater inflow originates from the fractured rock aquifer with the remaining 10% from the overlying sediments.

Existing mine groundwater inflows are assessed as 365 ML/year (1 ML/day).

A letter from DPI Water to Barrick (then the owners of CGO) titled “Cowal Gold Mine – Request for reallocation of water access licence under the Water Management Act 2000” dated 7 January 2014, states that the CGO holds licences to access 366 unit share components in the Lachlan Unregulated and Alluvial water sources (Upper Lachlan Alluvial Zone 7 Management Zone) and another 3,294 unit share components in the NSW Murray-Darling Basin Fractured Rock Groundwater Sources.

These include allowance for pumping of 256 ML/year from the saline borefield (Upper Lachlan Alluvial Zone 7) and allowing 10% (37 ML/year) of the pit groundwater inflow rate from the Upper Lachlan Alluvial Zone 7 sediments with the remaining 90% (329 ML/year) from the fractured rock aquifer.

Peak predicted inflow from the fractured rock aquifer for the Underground Development including the open pit is less than the 3,294 unit share components in the Lachlan Fold Belt MDB groundwater source.

Table 3. Components of modelled groundwater seepage (m3 / day) at selected times - dry Lake Cowal case (a negative number indicates seepage into the model)

Seepage component	Date			
	2019-11-17	2022-11-06	2026-11-18	2037-10-05
Pit walls	584	624	407	300
Pit floor	262	197	215	141
Dewatering bores	124	0	0	0
Total pit	970	821	622	441
Access tunnels	0	115	512	722
Stopes	0	16	476	1555
TSF / IWL foundation	-447	-545	-602	-849
Western model boundary	-9	-10	-13	-100
Eastern model boundary	190	128	96	-198
Lake Cowal	1243	280	53	-104
Total inflow to mine	970	952	1609	2718
Total inflow to mine from Upper Lachlan Alluvial groundwater source	107	101	102	78
Total inflow to mine from Lachlan Fold Belt Murray Darlin Basin groundwater source	863	851	1507	2640
Percentage of total inflow to mine from Upper Lachlan Alluvium	11%	11%	6%	3%

Table 4. Components of groundwater seepage (m3 / day) at selected times - full Lake Cowal case (a negative number indicates seepage into the model)

Seepage component	Date			
	2019-11-17	2022-11-06	2026-11-18	2037-10-05
Pit walls	584	624	407	300
Pit floor	262	197	215	141
Dewatering bores	124	0	0	0
Total pit	970	821	622	441
Access tunnels	0	115	512	722
Stopes	0	16	476	1555
TSF / IWL foundation	-447	-545	-602	-849
Western model boundary	-9	-10	-13	-100
Eastern model boundary	190	128	96	-198
Lake Cowal	1243	280	53	-104
Total inflow to mine	970	952	1609	2718
Total inflow to mine from Upper Lachlan Alluvial groundwater source	107	101	102	78
Total inflow to mine from Lachlan Fold Belt Murray Darlin Basin groundwater source	863	851	1507	2640
Percentage of total inflow to mine from Upper Lachlan Alluvium	11%	11%	6%	3%

4. References

Coffey Services Australia Pty Ltd. 2018. Cowal Gold Operations Processing Rate Modification (MOD 14) Bland Creek Palaeochannel Borefield and Eastern Saline Borefield Groundwater Assessment. Report reference 754-SYDGE206418-BCPB, dated 14 March 2018.

Coffey Services Australia Pty Ltd. 2020a. Cowal Underground Development EIS – Mine Site Hydrogeological Assessment. Report reference 754-SYDGE206418-3-AM, dated 10 September 2020.

Coffey Services Australia Pty Ltd. 2020b. Cowal Gold Operations Underground EIS Bland Creek Palaeochannel Borefield and Eastern Saline Borefield Groundwater Assessment. Report reference 754-SYDGE206418-3-AN-Rev1, dated 27 August 2020.

EMM Consulting Pty Ltd. 2020. Cowal Gold Operations Underground Development Environmental Impact Statement, October.

5. Closing

Coffey has read the submission and responded as requested by Evolution.

Please do not hesitate to contact the undersigned if you have any questions or comments in relation to this letter.

For and on behalf of Coffey

C. DeCastro

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