7 NUMERICAL GROUNDWATER MODELLING OVERVIEW

7.1 Model Development

A 3D numerical groundwater flow model was developed using MODFLOW-USG software to represent the conceptual hydrogeological model described in Section 6. A detailed description of the modelling methodology is provided in Appendix I. KCB has modified the existing groundwater model that KCB has developed for the Dawson Central and North PRC plan and the associated data and assessment that has been completed to date on that project.

The model represents the key hydrostratigraphic units using multiple layers and the full model extent is ~7,110 km^2 (Figure 7.1). The model extent is as follows:

- North – a distance far enough away from the Project such that the model boundary does not influence the model results in the vicinity of the Project area.
- East – aligned with the surface water catchment.
- South – Surat Basin extent and surface water catchment.
- West – Dawson Range.

A total of five layers were used in the model to represent the Baralaba Coal Measures. Additional interburden layering was used to assist with the representation of the A, B, C, D and E coal seams. Model layers are presented in Table 7.1.

Table 7.1 Layers applied to the model domain

<table>
<tr><th></th><th>Model Layer</th><th>Hydrostratigraphic Unit</th><th>Geological Age</th></tr>
<tr><td rowspan="3">Shallow aquifers</td><td>1</td><td>N/A - boundary layer to set up boundaries for spoils and inpit tailings (for extended Central/North Area)</td><td>N/A</td></tr>
<tr><td>2</td><td>Alluvium, tailings, rehabilitation and backfill material</td><td>Quaternary</td></tr>
<tr><td>3</td><td>Tertiary sediments/Duaringa formation</td><td>Tertiary</td></tr>
<tr><td rowspan="8">Deeper units</td><td>4</td><td>Rewan Group - Upper</td><td rowspan="2">Triassic</td></tr>
<tr><td>5</td><td>Rewan Group - Lower</td></tr>
<tr><td>6</td><td>Baralaba Coal Measures - A seam</td><td rowspan="5">Permian</td></tr>
<tr><td>7</td><td>Baralaba Coal Measures - B seam</td></tr>
<tr><td>8</td><td>Baralaba Coal Measures - C seam</td></tr>
<tr><td>9</td><td>Baralaba Coal Measures - D seam</td></tr>
<tr><td>10</td><td>Baralaba Coal Measures - E seam</td></tr>
<tr><td>11</td><td>Undivided Basement unit</td><td>Permian and older units</td></tr>
</table>

This model uses the calibrated model developed by KCB (2023) to support the Dawson Central and North PRCP as a starting point. Additional data provided by Anglo from ongoing monitoring and activities in the Dawson South area were included to amend the existing model. This model was refined to include details of current and historical mining and the Proposed expansion of Dawson South.

The regional groundwater model previously developed by KCB for the Westside Coal Seam Gas (CSG) fields was also used as reference (where needed) to amend the existing model built to support the Dawson North and Central PRCP (KCB 2023). This report details the design basis for the groundwater modelling, including the purpose of the model, assumptions, and limitations.

The Australian Groundwater Modelling Guidelines (Barnett et al. 2012) were used to frame the calibration process. A detailed description of the calibration method is provided in Appendix I. The groundwater model was initially calibrated using groundwater levels form 95 monitoring bores screened across a variety of aquifers and aquitards, which included the monitoring of groundwater levels between October 1990 and March 2023.

The calibration process included steady-state and transient calibration. The results of the steady-state calibration were used to define starting conditions for the transient calibration. The transient (time variant) calibration which considered the change in groundwater levels as a result of mining activities and/or residual landforms. The transient calibration achieved a 6.97% scaled RMS error which is an acceptable calibration metric as recommended by the Australian Groundwater Modelling Guidelines (Barnett et al. 2012). Furthermore, the calibrated groundwater levels, vertical gradients and flow patterns replicate measured data and groundwater trends.

The model calibration is therefore considered robust. The calibrated groundwater model was used to predict groundwater inflows, changes in groundwater levels and the associated groundwater level drawdown extent in response to the Proposed mine closure design.

7.2 Model Predictions

The calibrated groundwater model was used to predict groundwater inflows, changes in groundwater levels and the associated groundwater level drawdown extent in response to the Project development, including the simulation of the open pits in accordance with the proposed and existing Dawson South mine closure plan. Both sensitivity analyses and an alternate more conservative closure scenario for the Proposed Project was simulated (for the conservative case a lower post-closure void water level elevation was maintained; see associated model report for further details).

8 POTENTIAL CUMULATIVE IMPACTS

This section describes the operational and post-closure impact of the Project on:

- Groundwater resources;
- Groundwater users; and
- Surface water features.

The predicted impacts are related to the cumulative groundwater drawdown resulting from proposed mining activity. The drawdown has been calculated as the difference in the groundwater level between the calibrated pre-mining levels (nominally 1963) and the results for each mining time period. These results indicated that during 2052 (end of operational period) the largest associated groundwater drawdown may be expected.

At five years post mine closure the drawdown in the southern area of the mine lease is between 150 m and 170 m. There is little difference between the modelled groundwater drawdown between the existing and the Proposed mine closure landforms.

At 50 years post mine closure, existing mine plan groundwater drawdown in the northern area of the study is 80 m and 140 m in the southern area. 50 Years post mine closure for the Proposed Project, the groundwater drawdown in the northern area of the study is 85 m and 135 m in the southern area.

The associated Project related cumulative groundwater drawdown in the southern area decreases from 170 m, 5 years post-mining to 135 m after 50 years post-mining.

8.1.1 Potential Impacts on Groundwater Resources

The impacts on the groundwater system are presented in the Dawson South Model Report in Appendix I. Groundwater resources within the study area and its surrounds are located within the Fitzroy Basin. The project area is outside of any Groundwater management areas in the Water Plan (Fitzroy Basin) 2011. The Project site is located adjacent to, however does not lie within the Dawson Valley Water Management Area (Dawson H), under Schedule 3B of the Water Plan (Fitzroy Basin) 2011 area.

The highest impact on potential groundwater resources occurs at the end of mining. This is indicated by the comparison of the predicted heads for end of existing mine plan mining, 1,000 years after closure, with the representative head from the same period of the proposed Project (Figure 8.1, Figure 8.2 and Figure 8.3 respectively). The maximum cumulative Project impacts (i.e. the incremental change between the current and proposed landform) manifests at closure. A comparative figure shows the difference between the cases and indicates the end of mining as the period of greatest influence on water levels, as well as the comparative difference between the Existing mine plan and the Proposed Project plan at 1, 000 years (Figure 8.4).

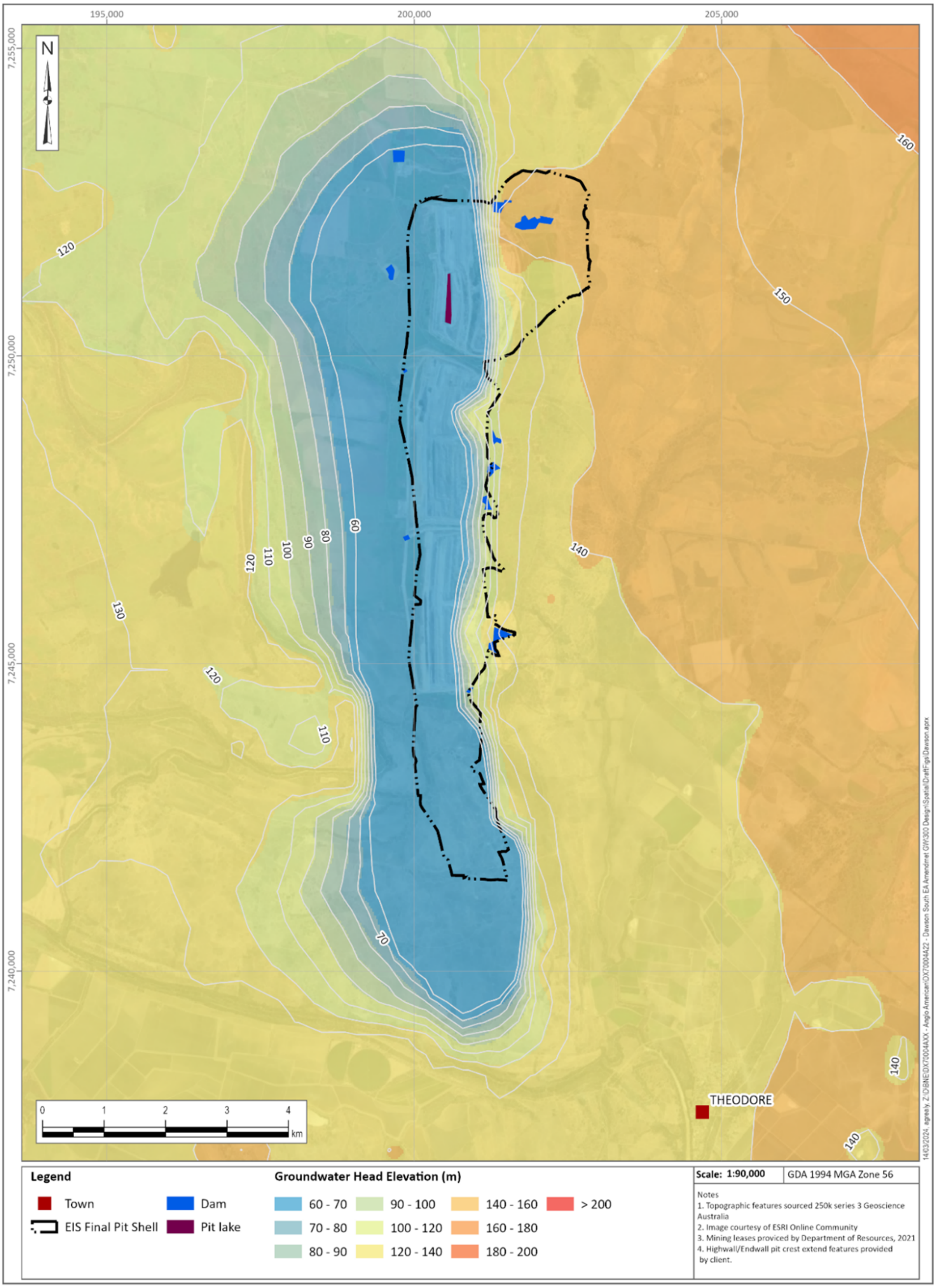

Figure 8.1 Predicted heads in the shallowest hydrostratigraphic unit at end of mining (2052)

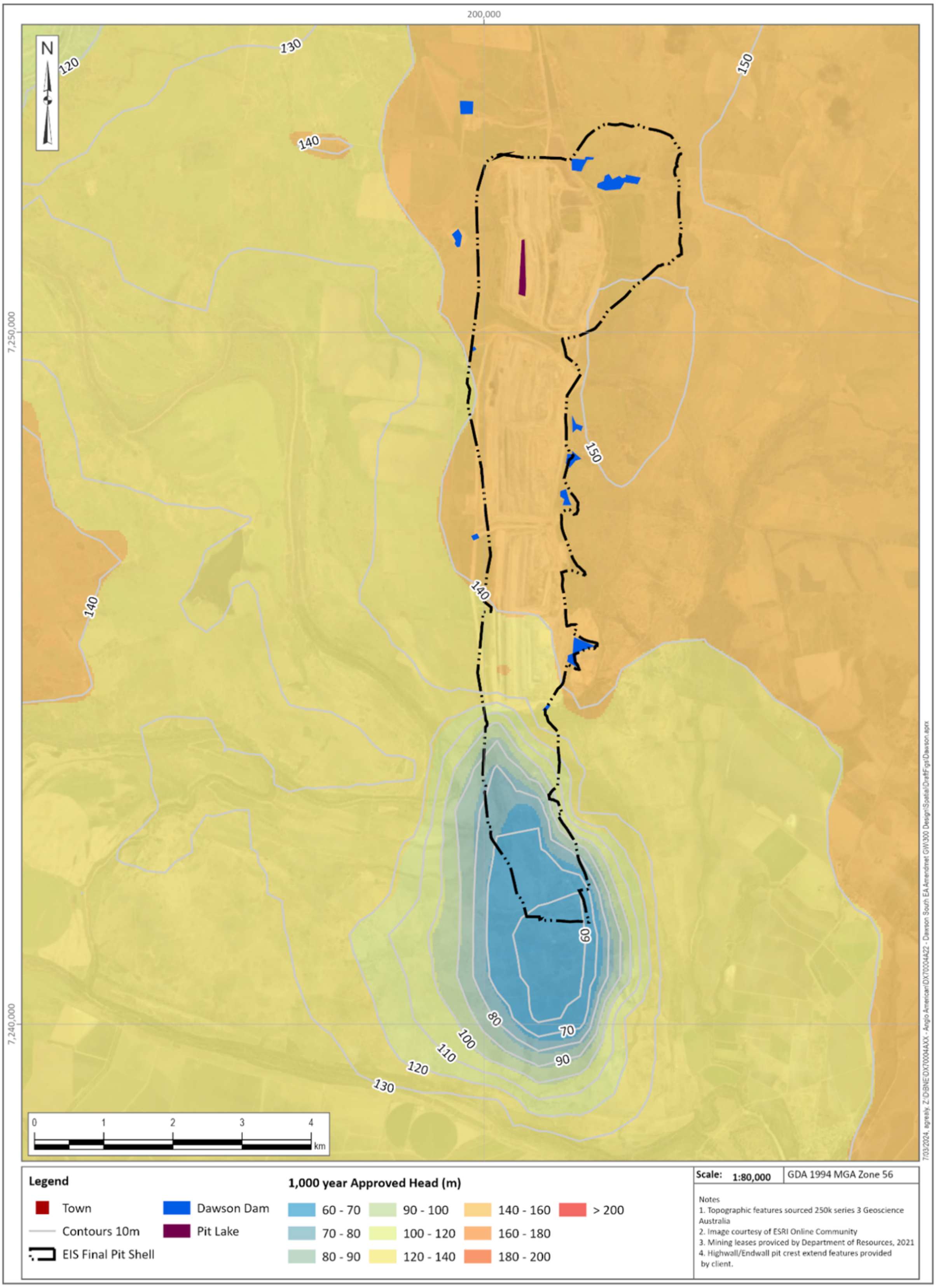

Figure 8.2 Predicted heads in the shallowest hydrostratigraphic unit – 1,000 years post-closure (existing mine plan)

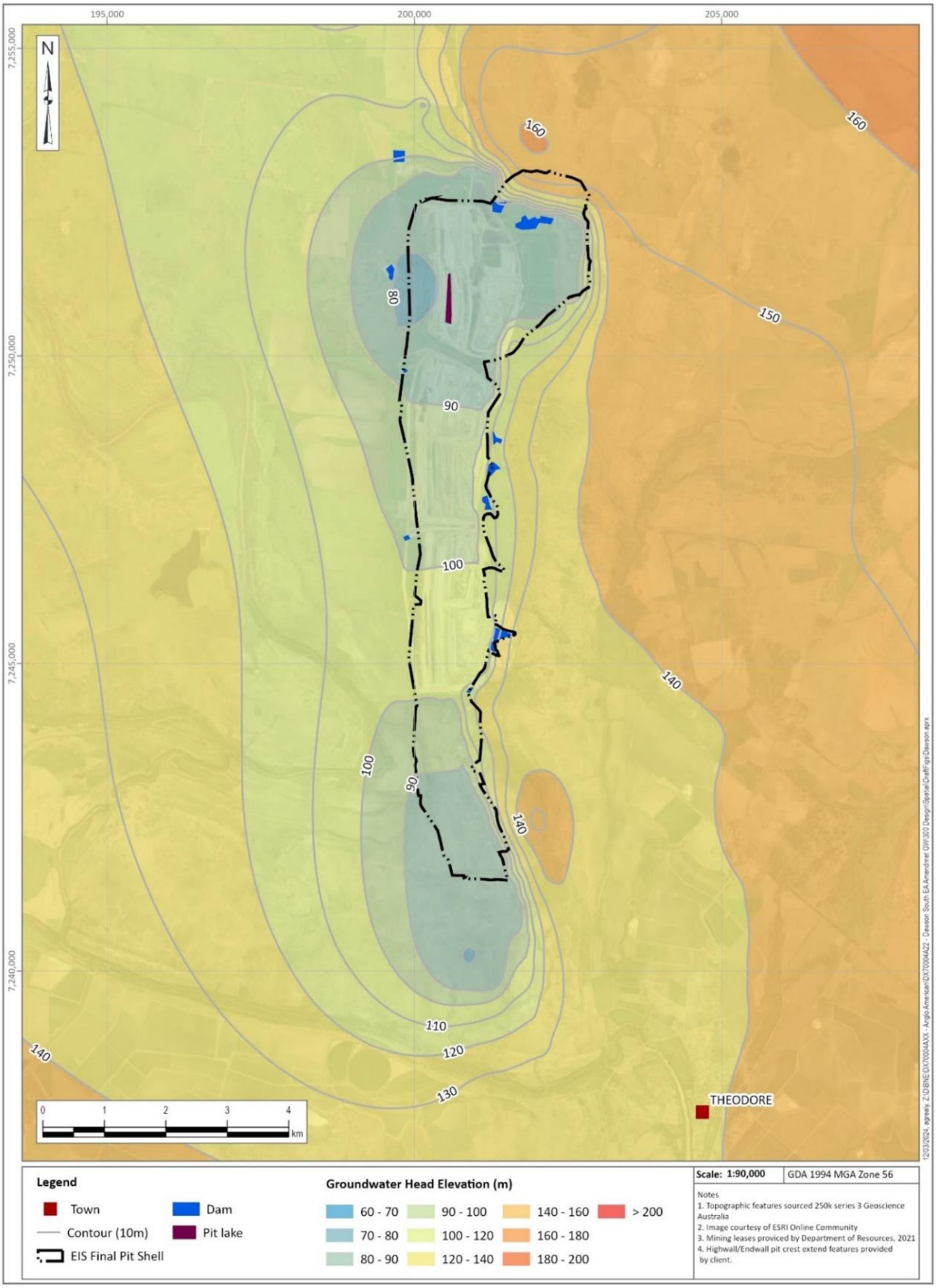

Figure 8.3 Predicted heads in the shallowest hydrostratigraphic unit – 1,000 years post-closure (proposed Project)

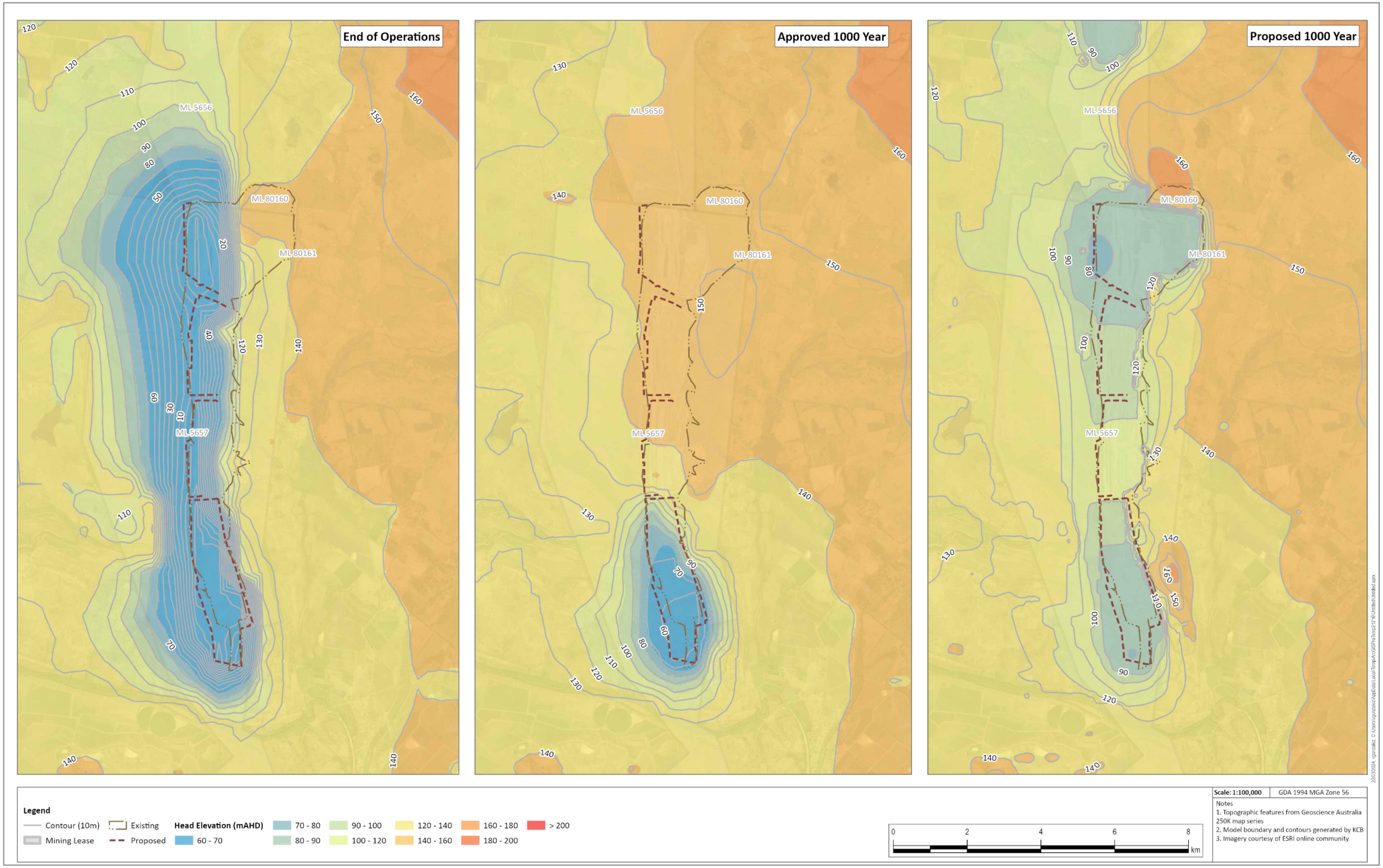

Figure 8.4 Predicted heads in the shallowest hydrostratigraphic unit at end of mining and at 1,000 years post-closure (Existing and proposed project outlines shown)

8.1.2 Potential Impacts to Third-Party Groundwater Users

A desktop assessment was used to identify water supply bores surrounding the project site that could potentially be impacted by the Project. The bore census drew upon information gathered from a search of the DNRME groundwater database. The bore census was targeted towards bores and properties that could potentially be impacted by the project due to their proximity to proposed mining activities. It included a conservative search radius of 5 km beyond the boundary of the project site. The bore census found that groundwater use is typically groundwater monitoring and water supply for agricultural purposes.

The groundwater drawdown at the end of operations and the mine closure were assessed against the location of the water supply bores. The 5 m groundwater drawdown for the existing mine plan Pit 28 landform is identical to the proposed landform. Therefore, no impacts to third-party groundwater users are predicted due to the Project.

8.1.3 Impacts on Surface Drainage

The Project site is located adjacent to Dawson River. The Dawson River and its tributary drainage lines and ephemeral and are characterised by short duration, surface water flows that are typically restricted to periods after rainfall events.

Two groundwater monitoring bores (DSMB05 and DSMB13) are located adjacent to the Dawson River, which monitor the groundwater elevations in the alluvial aquifer. The groundwater elevation in the alluvium did not show any significant response to rainfall recharge (Figure 8.5). This suggests that there is no direct interconnection between runoff and the alluvial aquifer.

Groundwater monitoring bore DSBM05 is located adjacent to Pit 27 and monitors the groundwater level in the alluvium. There is no response (drawdown) to the groundwater level in the alluvium at this location from the current mining of the Permian coal seams in Pit 27. This suggests that the groundwater aquifer in the alluvium is not well connected to the Permian Coal Seam aquifer. These observations suggests that the Project will unlikely have any cumulative impact on the surface water environment.

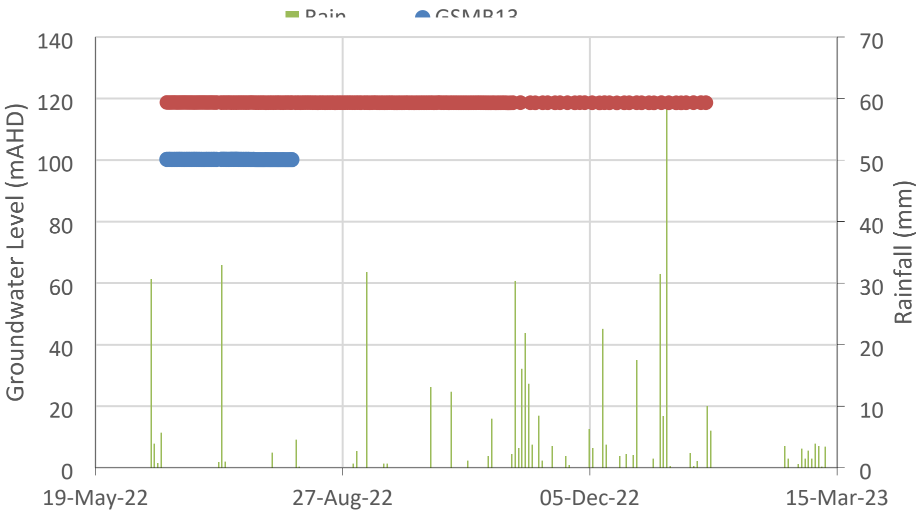

Figure 8.5 Current groundwater elevations in bores screened in the Alluvium

During operations, the existing mine plan and proposed scenarios have very similar impacts on groundwater and consequently there is a negligible difference in river interaction with the aquifers. For the 1,000-year post-closure scenario (i.e. the greatest incremental impact), the River Boundary water balance across the entire extent of the Dawson South was extracted as comparison (Table 8.1).

The results indicate that for all layers (i.e. considering all the fluxes that may occur from the River Boundary condition), that an additional ~ 46 m^3/day (~0.5 L/s) may be taken from the Dawson River as result of the proposed Project. Overall, the total river boundary outflows (loss to groundwater) are 11.9% and 11.5% respectively for the existing mine plan and proposed scenarios.

Table 8.1 Comparison of the River Boundary condition flux across the Dawson South Mine Lease (1,000-year post closure)

		Influx (m^3/d)	Outflux (m^3/d)
Existing mine plan	River	1416.7	-700.8
Proposed	River	1403.8	-678.5
Proposed (Conservative)	River	1470.0	-654.6

8.1.4 Impacts on Groundwater Quality

During operations, no additional impacts to water quality are anticipated. The mining process will result in drawdown effects toward the voids for both the existing mine plan landform and the proposed landform, which should limit migration of salinity away from the mining area (remaining mine voids will act as groundwater sinks).

Groundwater levels will slowly recover after each pit is completed and the spoils are progressively rehabilitated, and Pit 26 and Pit 27 are fully back filled. With Pit 25 and Pit 28 being maintained as final voids, the proposed landform will maintain lower water elevations (i.e. encourage flows toward the final voids), with the result, that provided the final void elevations remain below the regional water table (which is expected based on the negative climatic water balance), risks to regional groundwater qualities are reduced for the proposed landform compared to the existing mine plan landform.

The impacts on the water quality for Pit 28 were addressed in the Dawson South Groundwater EIS update investigation for Pit 28 (KCB 2023). This assessment reviewed the water quality of the void water and the spoil water and its potential impact on the groundwater. The water quality data was sourced from the void salinity modelling (WRM 2019), the spoils water quality results and site-specific groundwater monitoring data. These water quality inputs were used in the KCB 2023 groundwater model for the existing mine plan mine closure design.

The water quality assessment data was included in the 2023 and indicate that although the water quality in the void would progressively deteriorate due to the effects of evapo-concentration (more evaporation than freshwater dilution), the water quality risks to surrounding water resources remain low.

Using the Office of the Queensland Mine Rehabilitation Commissioner's leading practice guidance it is considered:

- Very unlikely that the voids would discharge to surface water or shallow aquifers;
- Likely that the salinity in the void would exceed relevant water quality thresholds in the very long-term; and
- Very unlikely that the voids will represent a source to the surrounding groundwater environment.

Details are contained in the Pit 28 Final Void and groundwater assessment report (KCB 2023).

In terms of post-closure risks, consideration of the particle tracking assessment confirms that that Pit 25 and Pit 28 will remain as long-term sinks. The forward projections (i.e. indications of flow paths from the final voids) for both North/Central and Dawson South are shown to assess the potential cumulative impact of the post-mining recovery. The results show that some inter-void flow will occur as the voids fill but that the successive voids act to limit flow away from the mining complex and that the void complex remain a sink after closure (Figure 8.6).

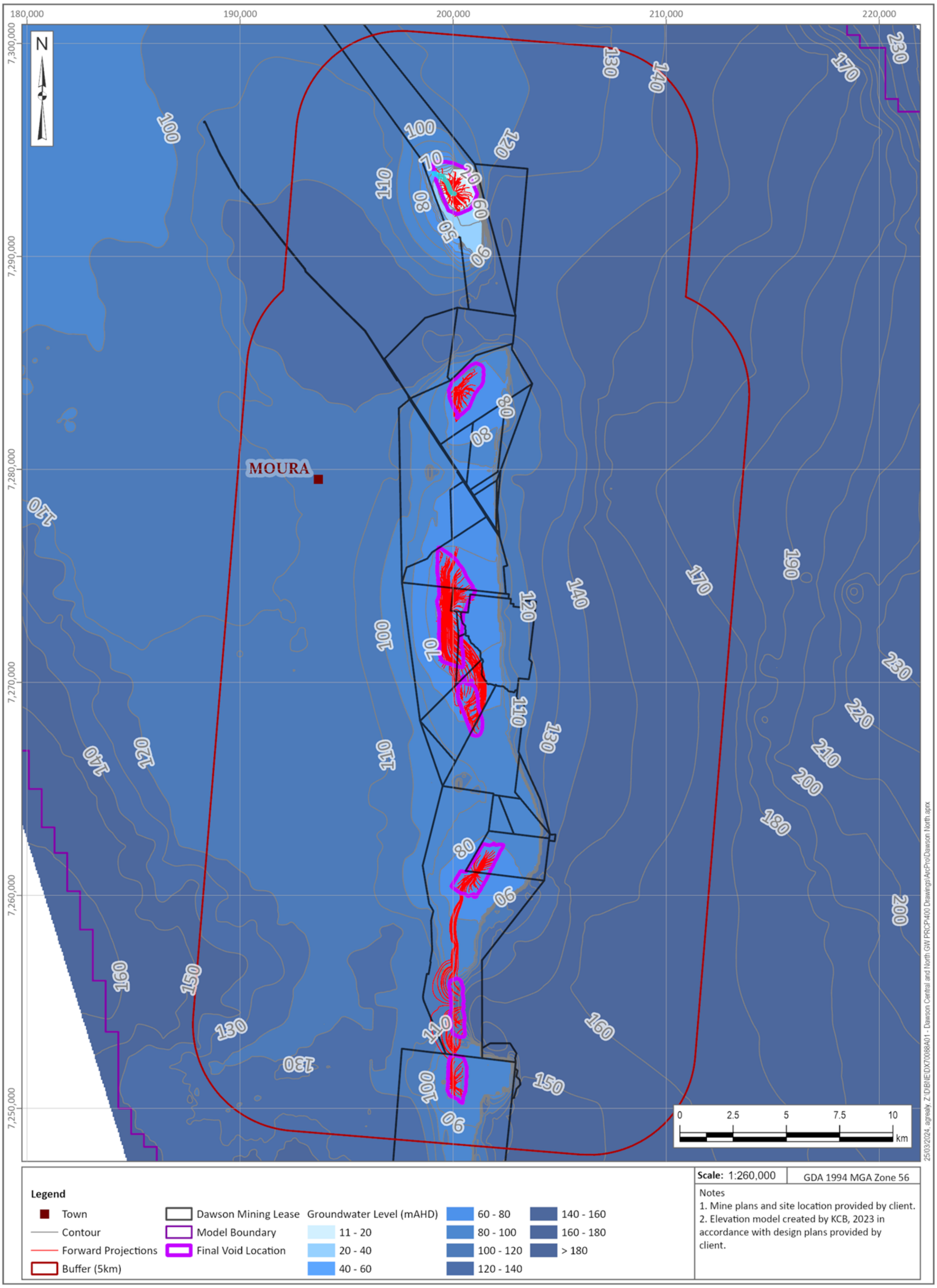

Figure 8.6 Particle tracking assessment from final voids (forward projections)

8.1.5 Potential Impacts to Spring Complexes

Section 6.6 has identified that there are no springs or wetlands within a 5 km buffer of the Project area. Therefore, there will be no impacts to springs or wetlands as a result of the proposed Project development.

8.1.6 Potential Impacts to Groundwater Dependant Ecosystems

Low potential terrestrial GDEs (identified from GDE mapping datasets) are located along the Dawson River and Lonesome Creek and vegetation managed wetland located near the town of Theodore which are within 5 km of the Project.

The low potential terrestrial GDEs located adjacent to Dawson River, to the west of the Project area are within the predicted 0.2 m drawdown extent at the end of operations. The low potential terrestrial GDEs (i.e. an area where the likelihood of groundwater supporting the ecosystem is regarded as low) adjacent to Lonesome Creek to the east of the project site are within >0.2 m drawdown extent at the end of operations.

The maximum groundwater drawdown at 1,000 years post-mine closure with the existing mine plan landform design is 40 m at the Dawson River. This drawdown extends to the Dawson River directly west of Pit 25 where the mapped low potential terrestrial GDEs are present. The maximum drawdown at 1,000 years post-mine closure for the proposed landform design is 30 m at the Dawson River. Therefore the proposed landform design will not have as a significant impact to the potential terrestrial GDE's than the existing mine plan landform design.

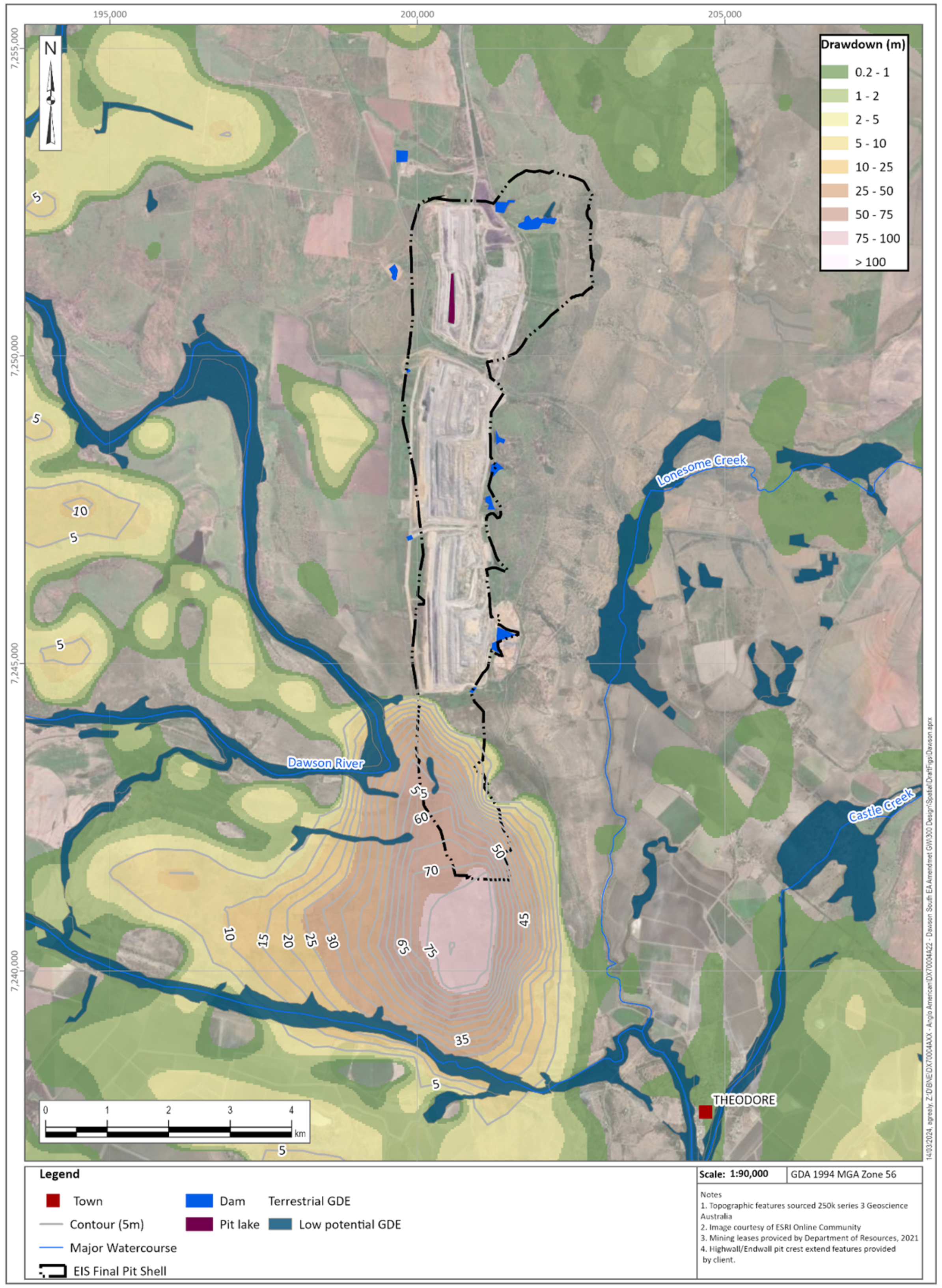

Figure 8.7 **Mapped Potential GDE's Mapped Potential Terrestrial GDEs and Predicted Drawdown – Existing mine plan mine design (1,000 years after operations)**

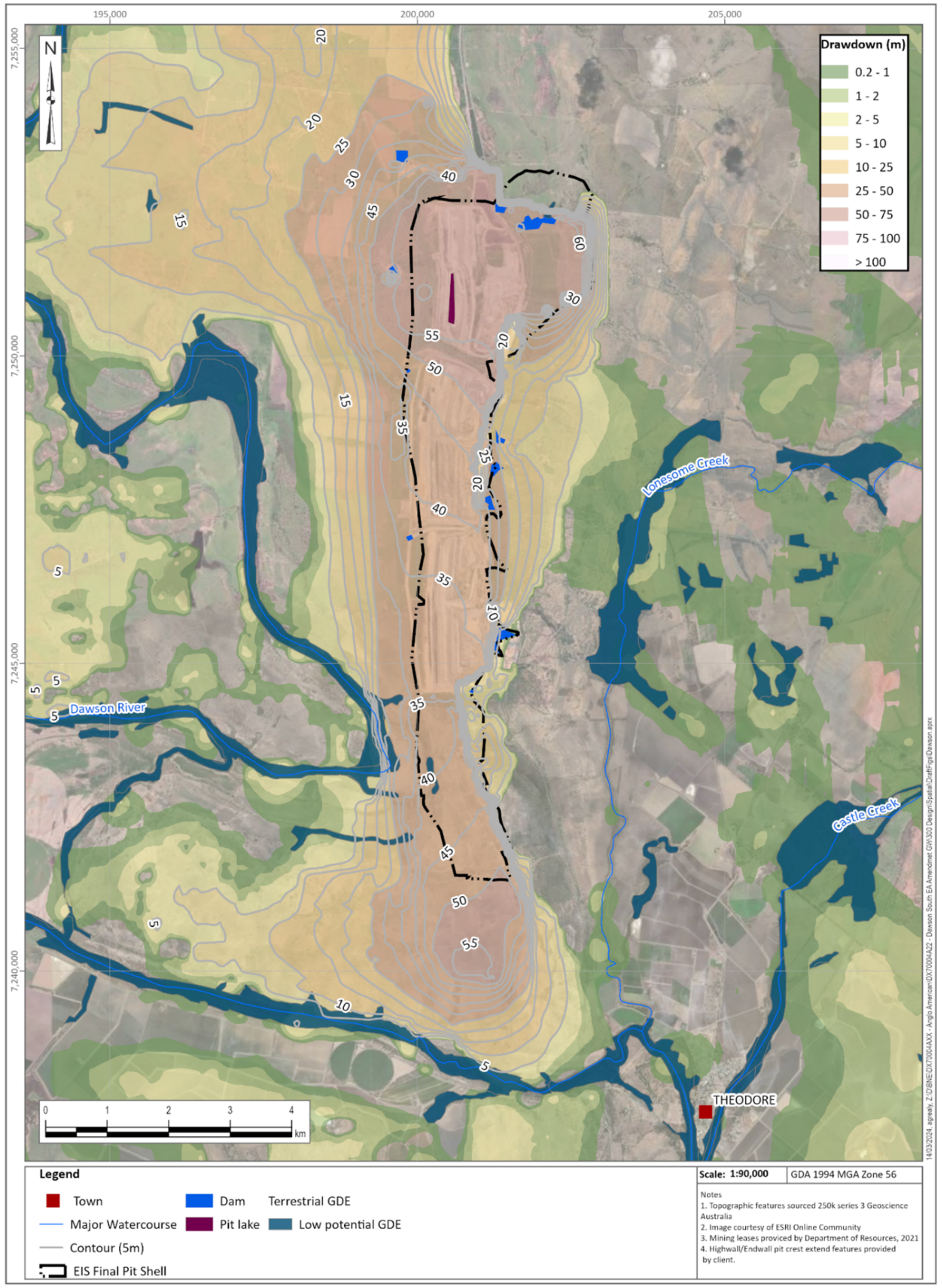

Figure 8.8 **Mapped Potential GDE's Mapped Potential Terrestrial GDEs and Predicted Drawdown Area -Proposed mine design (1,000 years after operations)**

9 CONCLUSIONS

An assessment has been completed to compare the existing mine plan final landform design at Dawson South against the proposed final landform design (extension of Pit 28 and maintaining Pit 25 as a final void).

The assessment updated an existing numerical groundwater model that included both Dawson Central and North as well as Dawson South and refined this model to account for the potential predicted cumulative changes associated with the proposed Project.

From the observations, the following aspects are worth highlighting:

- The updated groundwater model was able to achieve a good calibration between the measured/observed water levels and the model-predicted water levels for the transient calibration period. The model calibration metrics are acceptable and within the requirements of the Australian Groundwater Modelling Guidelines. The transient hydrograph comparisons between simulated and measured water levels show that the model is able to match the general trends and responses observed in the data record, including the shallower hydrostratigraphic units which may potentially be impacted by mining activities.
- Modelling results show that the greatest dewatering occurs at the end of mining operations. This period is when the actively mined coal seams would have resulted in the lowest groundwater elevations in the final active pit and coincide with the period when the cumulative dewatering impact from the interaction between the pits is at its highest. Since the groundwater system is very slowly recovering outside of the active mining, the end of mining period shows the greatest overall groundwater drawdown at Dawson South.
- The modelling results indicate that during operations there is negligible change between the existing mine plan final landform and proposed final landform, because of the overall drawdown that would have resulted from the related mining activity and the slow recovery in the system. For Pit 25, a conservative end of mining scenario was assumed where the pit void was allowed to fill naturally rather than storing additional water which would result in a higher void water level, than the modelled value. Should additional mine water be stored in this void, this will reduce the drawdown extent (i.e. a decreased overall impact on the groundwater system can be expected, than has been modelled – representing a worst-case scenario).
- Due to the proposed scenario maintaining a final void in Pit 25 and the larger pit void in Pit 28, the difference between water in the existing mine plan and the proposed landform scenarios becomes progressively more pronounced after closure. Under both conditions, the groundwater slowly recovers, however, due to excess evaporation (compared to inflows) in the final voids, water levels recover more slowly in the proposed scenario, until the system has stabilised (i.e. the final voids reach their equilibrated elevations). The largest difference between the existing mine plan scenario and the proposed Project in terms of groundwater conditions occurs at this point.
- Although the equilibrated pit lake water levels for Pit 25 lie at a lower elevation than in the existing mine plan scenario, the overall zone of influence is smaller at the end of

operations (confirming that end of operations represents the period of greatest impact to groundwater irrespective of the proposed change in landform).

- For the proposed Project, the equilibrated water level elevation in Pit 28 is higher than in the existing mine plan landform. As a result, the proposed impact from Pit 28 is reduced compared to the existing mine plan landform in the southern part of Dawson South.
- The maximum difference in terms of the impact on surface water resources will occur once the pit voids have reached equilibrium (a steady state). The results indicate that under the conservative scenario modelled, the surface water (creeks and Dawson River) will likely provide additional flows to the groundwater system (lose water), but for the Project final landform, the recovery of the water levels in Pit 25 above 75 mRL and in Pit 28 just below 80 mRL, there is negligible difference in surface water impacts estimated in the south. The exchange between surface water and the alluvial aquifer may be marginally reduced for the proposed Project landform.
- The results suggest that there is no cumulative change to impacted water uses and that no additional registered groundwater users are likely to be impacted by the proposed Project.
- Post-closure voids water levels reduce the risk associated with impact to groundwater quality on the surrounding environment. Pit void water elevations will likely remain lower than the local groundwater elevation, meaning the pit voids will permanently act as a 'groundwater sink' and reduce the potential migration of saline water from these final voids.

10 CLOSING

We thank you for the opportunity to work on this assignment. Should you have any queries please do not hesitate to contact the undersigned.

KCB AUSTRALIA PTY LTD.

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