Appendix C

Groundwater Technical Modelling Details – Central Mining Area

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C-1 Introduction

This Appendix outlines the groundwater modelling undertaken for the Golden Point / Frasers Area for the Macraes Phase 4 Fast Track Approvals project. An overview of the site location and project description is provided in Sections 1 and 2, respectively, of the “Macraes Phase 4 FTA – Surface and Groundwater Assessment” report, of which this Appendix forms Appendix B. The limitations and assumptions set out in Section 1 of the “Surface and Groundwater Assessment” also apply to this Appendix.

C-2 Conceptual Site Model

The conceptual understanding of the groundwater system in the vicinity of the Macraes central area is as follows:

- Recharge of the groundwater system via rainfall infiltration through fractures within the bedrock.
- Groundwater flow is generally topographically driven, with discharge via seeps and/or springs in topographic lows (streams and depressions).
- Hydraulic conductivity of the schist is primarily influenced by the degree of weathering in the schist bedrock, with variability (anisotropy) in horizonal hydraulic conductivity due to rock mass fracturing by structural features such as foliation-parallel fractures, faults and shear zones.

Based on the current hydrogeological understanding of the project area the conceptual groundwater flow model for the Central area of the mine (including Frasers Pit, Innes Mills Pit and Golden Point Pit) area is presented in Figure C-2.1.

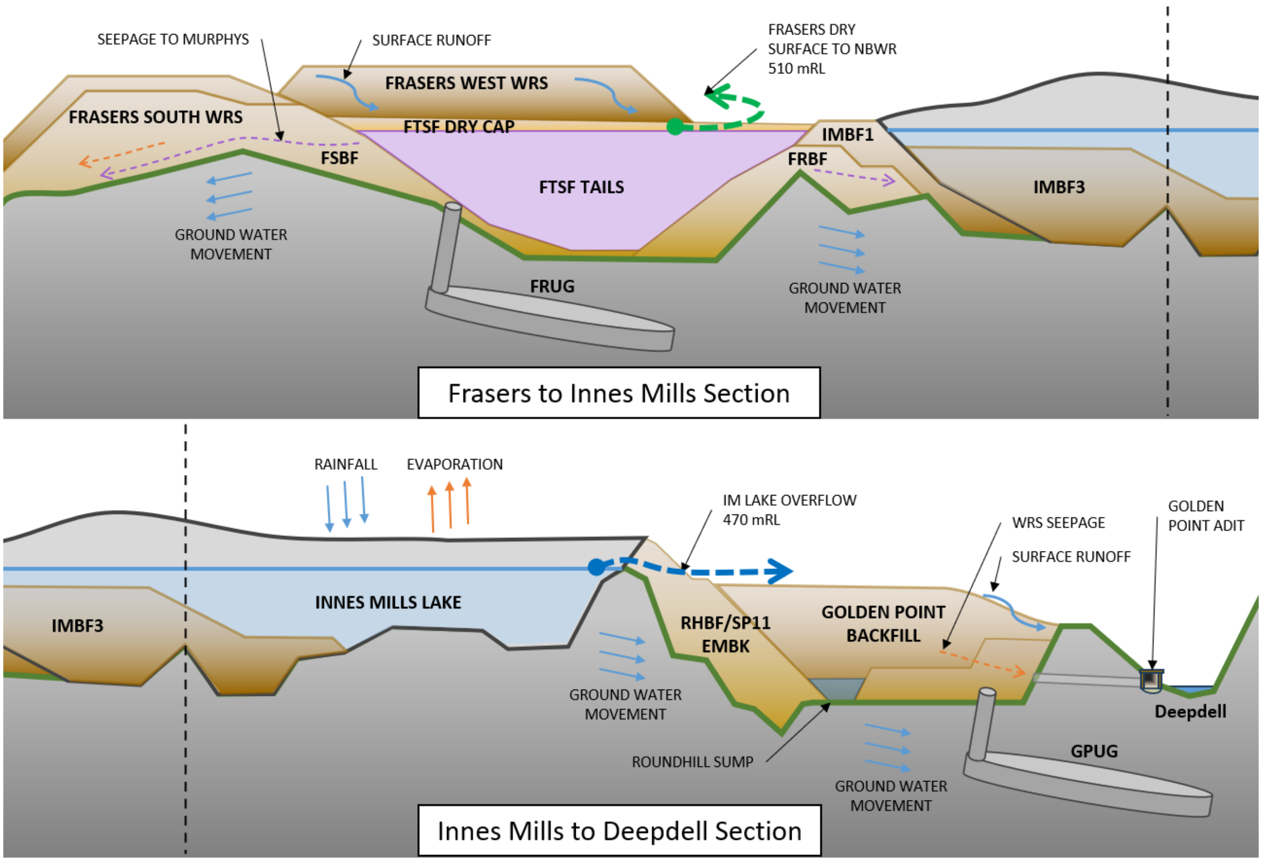

Figure C-2.1 Central mine site conceptual site model

C-3 Groundwater Model Set up

C-3.1 Previous modelling

Kingett Mitchell (2002, 2005a, 2005b), Golder Associates (2011a), CDM Smith (2016), GHD (2021), and GHD (2024) have all used 3D groundwater models for previous Macraes hydrogeological assessments. CDM Smith reviewed the Kingett Mitchell and Golder Associates models as part of their data review (CDM Smith, 2016, p. 3-21). In 2021 GHD updated the CDM Smith Model (2016), as part of the proposed mining expansion of the existing Golden Point and Round Hill Open Pits (RHOP project). The model utilised in this assessment is largely based on the GHD (2021) model, with updated modelling code, mine plan, and Frasers Pit co-disposal options.

Both GHD (2021) and CDM Smith (2016) models were developed using MIKE-DHI - FEFLOW finite element modelling software. However, due to software limitations with grid refinement and updates, the GHD (2024) model changed to MODFLOW-USG. This modelling code (MODFLOW-USG) has been developed and maintained by the United States Geology Survey (USGS) and is widely used in the groundwater modelling industry. For the current modelling Groundwater Vistas has been used as a graphical user interface to MODFLOW-USG to pre-and-post process of the modelling data.

C-3.2 Current model details

A 3D numerical groundwater flow model of the Macraes central area has been set up using Groundwater Vistas and Leapfrog software, using MODFLOW-USG (numerical modelling code) developed by the USGS.

The model domain comprises an area of 203 km^2. It has been aligned with Macraes Grid North Projection (MGPG) which follows the orientation of the Hyde Macraes Shear Zone (HMSZ). The current model has 12 layers. The model layers were derived from topographic surfaces obtained at the end of November 2025, while 3D shapes within the original model were used to assign material properties to specific entities (i.e. TSF, WRS).

Grid dimensions for the MODDFLOW-USG model has been refined to approximately 25 m spacing near the proposed mining, tailings, waste rock and along the Deepdell Creek and Tipperary Creek, and approximately 100 m spacing outside. Grid design is presented in Figure C-3.1. This grid design resulted in a total of 871,704 model cells for the 12 layers (or 72,642 model cells per layer).

The boundaries have been set far enough away from the MGP area to minimise boundary-induced effects on groundwater flow predictions. The boundaries were originally defined by topographic ridges and major catchment divides which act as natural groundwater flow divisions/boundaries:

– The northern boundary and northern part of eastern boundary follow a topographic ridge.
– The remaining eastern boundary follows the Shag River.
– The southern boundary follows McCormicks Creek and additional drainage pathways.
– The western boundary generally follows the Waikouaiti River North Branch.

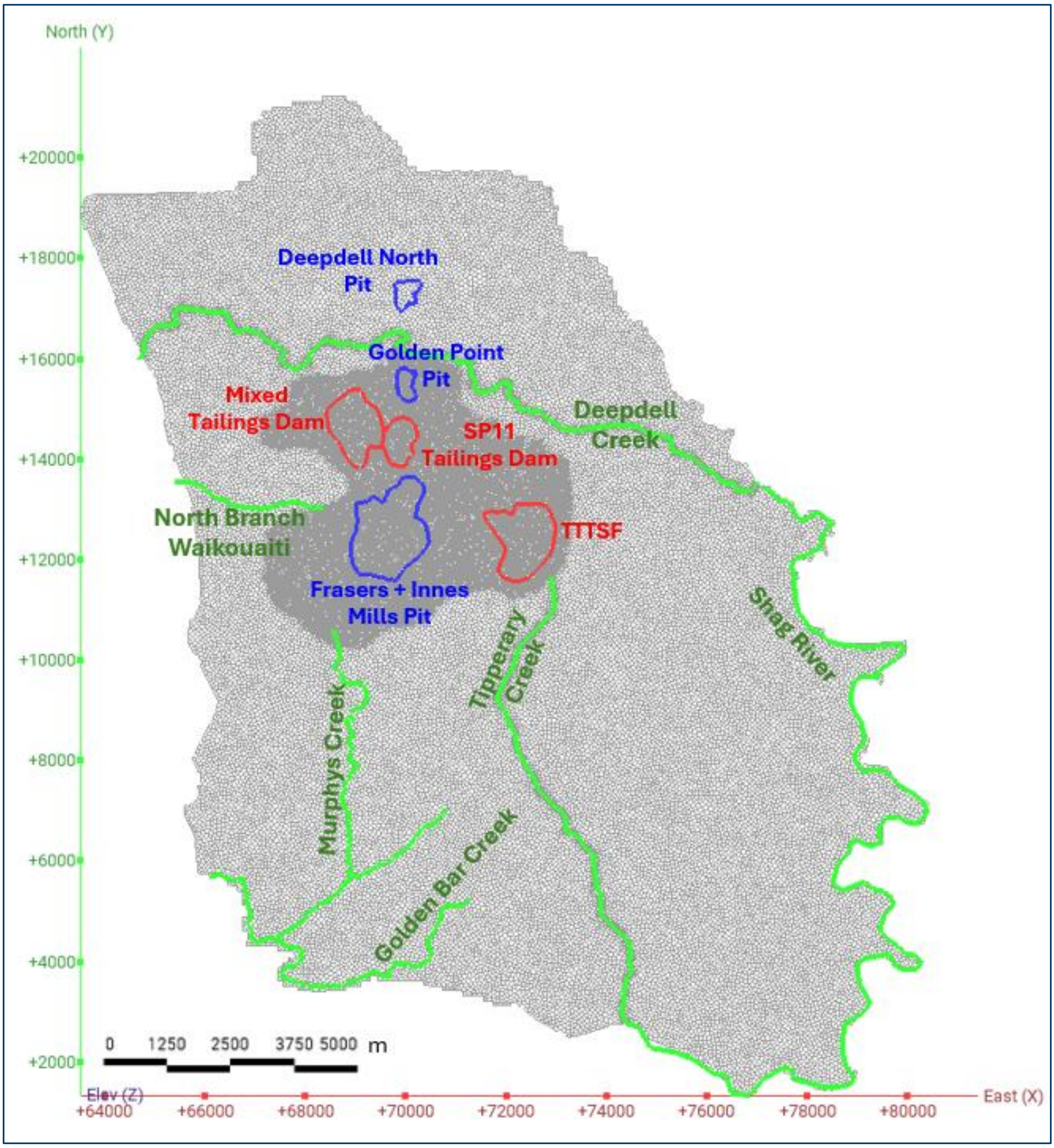

Figure C-3.1 Grid design of the entire model domain and some key mining pits and TSFs

C-3.3 Boundary conditions

The boundary conditions applied are driven by the catchments and surface water bodies within the model domain. Figure C-3.2, Figure C-3.3 and Figure C-3.4 show the boundary conditions assigned for the existing conditions, dewatering and recovery models, respectively. Further details of the modelling approach are provided in Sections C-4 and C-5. The following boundaries have been applied:

– **River Boundary:** The Deepdell Creek, Tipperary Creek, Waikouaiti River North Branch, Murphys Creek, Clydesdale Creek, Golden Bar Creek, McCormicks Creek and Shag River have been modelled using the MODFLOW River (RIV) package (Figure C-3.2, Figure C-3.3 and Figure C-3.4). River stage was set at ground surface level and river bottom was set at 1 m below the surface, riverbed conductance was assigned to 5 m^2/d/m for all river boundaries.

– **Drain Boundaries (Pits and Underground Dewatering):** The MODFLOW drain (DRN) package (Figure C-3.2, Figure C-3.3 and Figure C-3.4) has been used to simulate:

- Dewatering of the Frasers Pit, Innes Mills Pit, Golden Point Pit, Deepdell North Pit, have been modelled with drain bottom elevation set at the low point of proposed excavation.
- Dewatering of Frasers Underground (FRUG) and Golden Point Underground (GPUG) have been modelled with drain bottom elevation (from model layer 2 to layer 10) corresponding to the low point of the model cells assigned to represent the underground mining. Figure C-4.7 shows how the FRUG and GPUG works were assigned to the MODFLOW model cells.
- Small creeks and tributary boundaries have also been modelled as drain boundary conditions with drain bottom elevation set at topographic level.
- Seepage capture drains are applied in the recovery model as a drain boundary at several locations across the model domain, with the most significant structures planned around the Frasers West and East WRSs. The drain bottom elevation was set at 1.2m below the topographic (schist) level. The location of the capture drains is shown in Figure C-3.4 and Figure C-5.11 with details presented in GHD 2026a and Appendix F of this report.
- Drain boundary has also been applied in the recovery model to represent the seepage capture bores in the Golden Point backfill. Their location is shown in Figure C-3.4.

– **General Head Boundaries (GHB)**: The MODFLOW General Head Boundary (GHB) package was used to represent head-dependent flux boundaries within the model. These boundaries were implemented in both the dewatering model to simulate filling of FTSF and Deepdell North Pit (Figure C-3.3) and the water level recovery model to simulate post-mining conditions in the Innes Mills, Frasers, and Deepdell North pit lakes (Figure C-3.4). Boundary head values were derived from surface water model outputs, specifically the pit lake filling curves, and are presented in Figure C-3.5. Details on the Innes Mills pit filling curve are discussed in detail in Appendix G.

– **Constant Head Boundaries (CHD):** For the existing conditions and dewatering models, CHDs were applied on the existing TSF's where ponding is occurring and over small areas of the model to simulate surface water pooling (i.e. silt ponds). Location and assigned head values are displayed in Figure C-3.2 and Figure C-3.3.

– **Well boundary:** The MODFLOW Well (WEL) package was used to represent the proposed long-term injection of concentrated brine generated from the reverse osmosis water treatment process into the FRUG workings. The well was represented as a specified inflow at the proposed injection location near the deepest part of FRUG, at approximately -260 m RL. The adopted injection rate was 3.45 L/s.

– **Recharge boundary:** Several reports (Kingett Mitchell, 2005a, Golder, 2011a, CDM Smith, 2016) have stated that the accepted recharge rate of the area is 32 mm/yr (equating to 5.3% of annual rainfall of 607 mm). In this assessment, the recharge rates applied to the mining features for the existing conditions and dewatering models are based on site-specific measurements (as detailed in Appendix E). These are summarised in Table C-3.1, with relevant mine features depicted in Figure C-3.2. A 32 mm/year was applied across the remainder of the model domain, consistent with previous studies and to the proposed rehabilitated waste rock stacks for the recovery model runs, in line with OceanaGold's proposed WRS rehabilitation efforts (Table C-3.1).

Table C-3.1 Recharge values adopted in the models.

Mine Feature*	Recharge value - Existing conditions and dewatering models (mm/year)	Recharge value– Recovery model rehabilitated WRSs (mm/year)
Northern Gully WRS	42	32
Small WRS areas contributing to Battery Creek and Māori Tommy silt ponds	38	32
Golden Point and Roundhill Backfill	128	32
Frasers East WRS	39	32
Frasers West WRS	73	32
Frasers Pit and Innes Mills Backfill and embankment	128	32
TTTSF embankment	38	32
SP11 embankment	38	32
MTI embankment	38	32
Deepdell North WRS	38	32
Deepdell East WRS	38	32
Everywhere else	32	32
Rechange values applied to WRSs and TSFs to both existing conditions, dewatering and recovery scenarios.		

Climate change has not been explicitly included in the groundwater recovery simulations, and the groundwater predictions should be regarded as baseline-condition estimates subject to climate-related uncertainty. The projected shift toward wetter winters, drier summers and more episodic heavy-rainfall events may alter the temporal distribution of recharge. This implies that groundwater recharge may become more seasonally concentrated and episodic, rather than changing uniformly through time (WDC, 2023). Applying eastern Otago climatic drivers using the national methodology of Mourot *et al.* (2022) indicates that the mean rainfall-recharge response for Otago is relatively small; however, the direction and magnitude of change are uncertain, with projected changes spanning approximately ±0.4 mm/day. Therefore, although there may be some potential implications for seasonal groundwater levels and groundwater contributions to streams these effects are expected to be most relevant to the timing and variability of groundwater discharge, rather than to the overall direction of groundwater flow or the broad spatial extent of modelled plumes. Considering the low-permeability nature of the Macraes schist groundwater system and the relatively small but uncertain mean recharge response indicated by regional climate-recharge assessments, the groundwater-related results remain suitable for assessing long-term groundwater recovery and plume behaviour, provided they are interpreted with recognition that future recharge may become more episodic and seasonally variable than represented in the model.

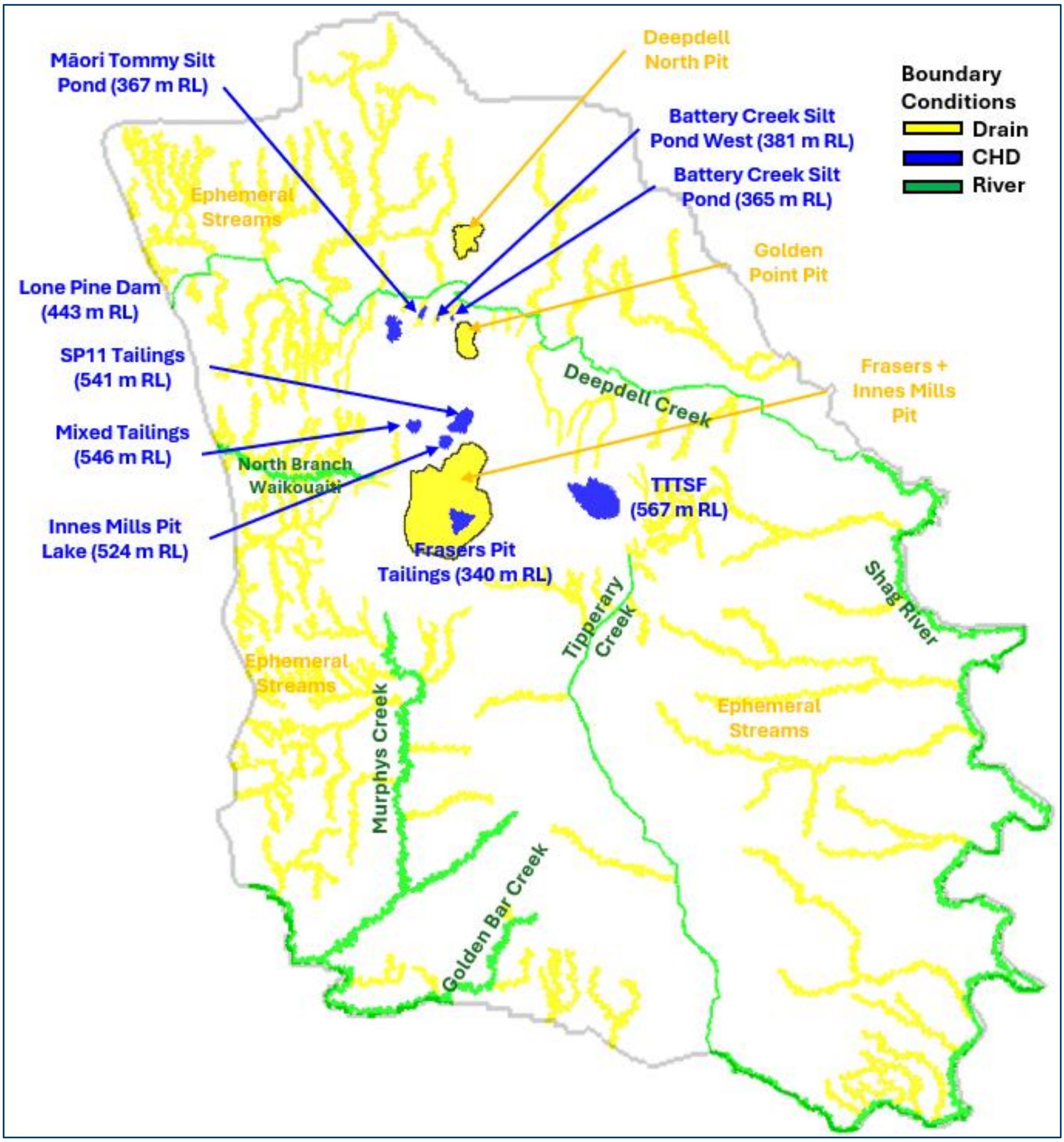

Figure C-3.2 Boundary conditions assigned in layer 1 of the existing conditions steady state model

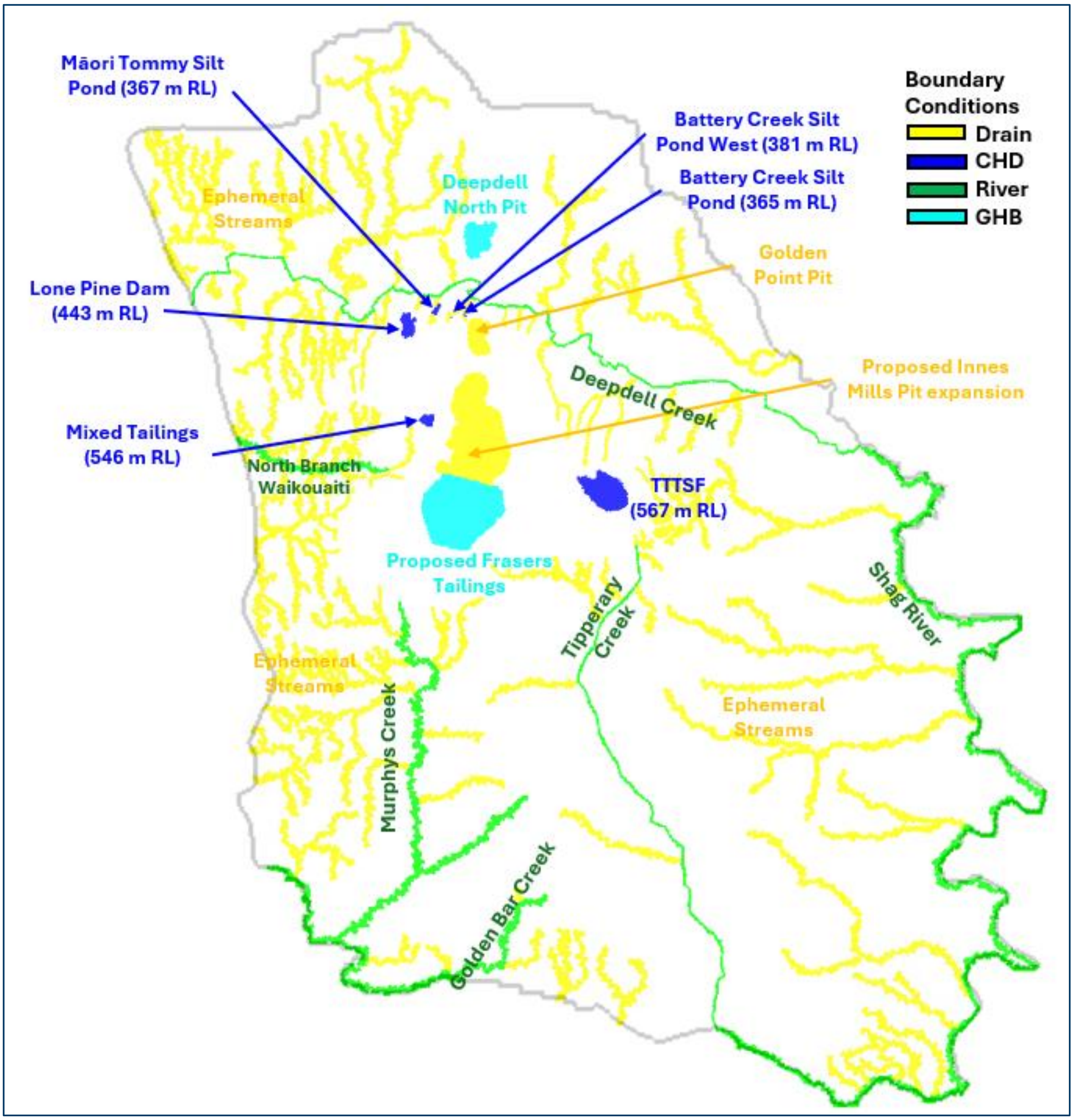

Figure C-3.3 Boundary conditions assigned in layer 1 of the dewatering transient model

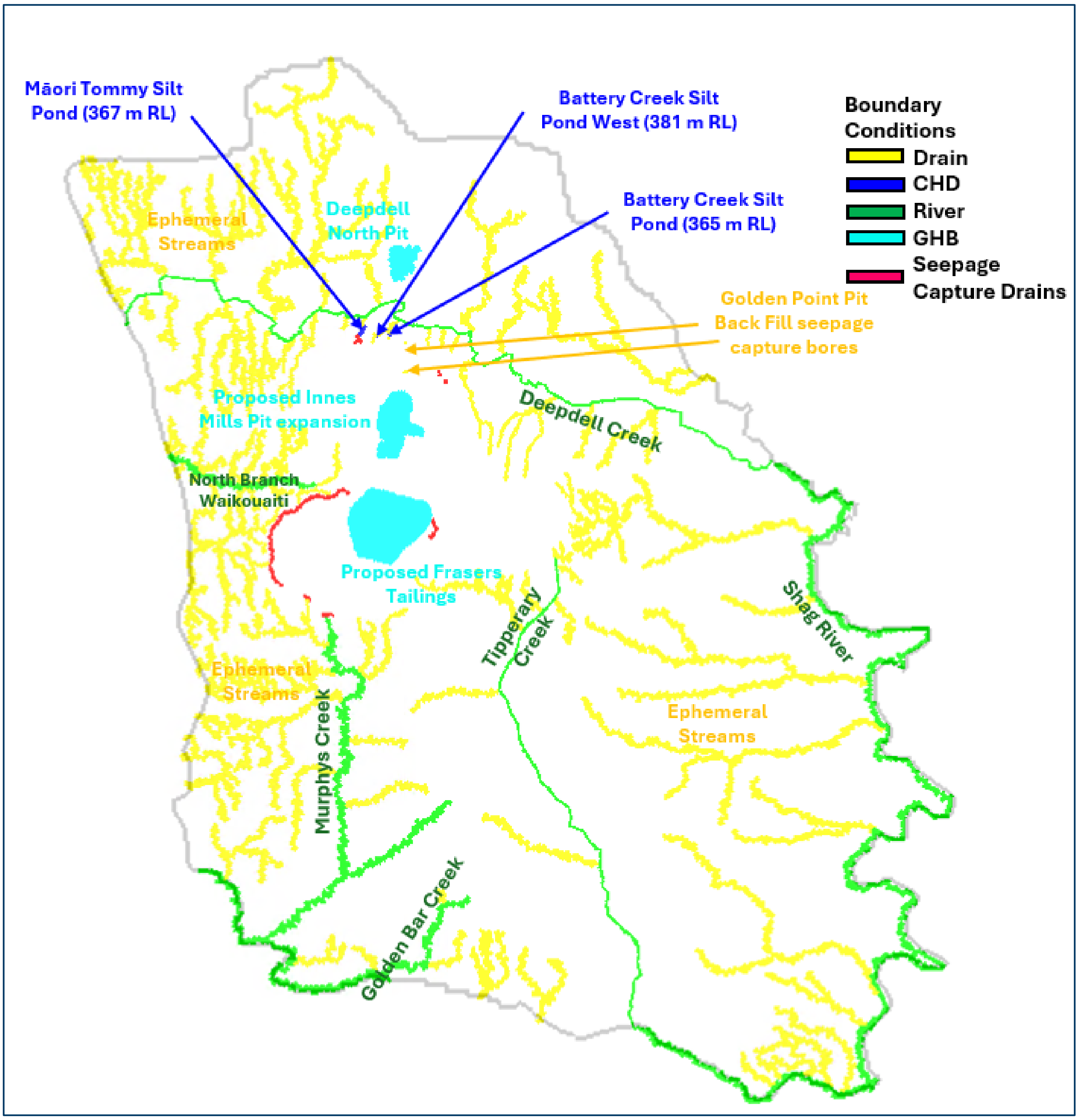

Figure C-3.4 Boundary conditions assigned in Layer 1 of the groundwater recovery transient model

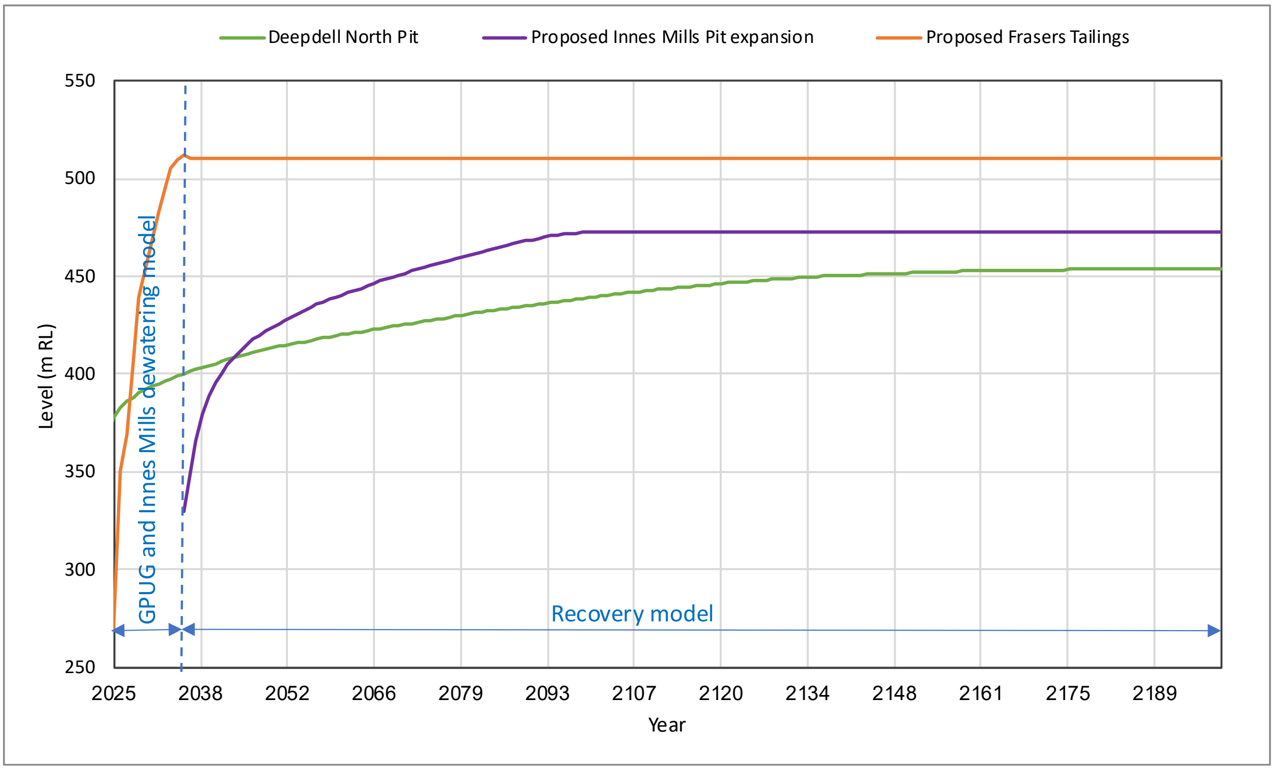

***Figure C-3.5** General Head Boundary filling curves for the Deepdell North Pit, proposed Innes Mills Pit expansion, and proposed Frasers Tailings Storage Facility used in the GPUG and Innes Mills Dewatering model and Recovery model.*

C-4 Steady-state model calibration

For the model calibration initial model parameters used were based on previous studies (Golder Associates, 2011a, Golder Associates, 2016, GHD, 2021, WSP, 2023b, and GHD, 2024) and values were adjusted during the calibration process. The model developed for this assessment was calibrated and compared against existing conditions at the Site (i.e. water levels measured in bores across the site and recent available dewatering rates in GPUG). The location of and groundwater level data used as calibration targets are presented in Figure C-4.1 and the final hydraulic parameters from the model calibration are presented in Table C-4.1. An enlarged version of the location plan and the groundwater levels used as calibration targets are presented in Attachment 1 of this Appendix.

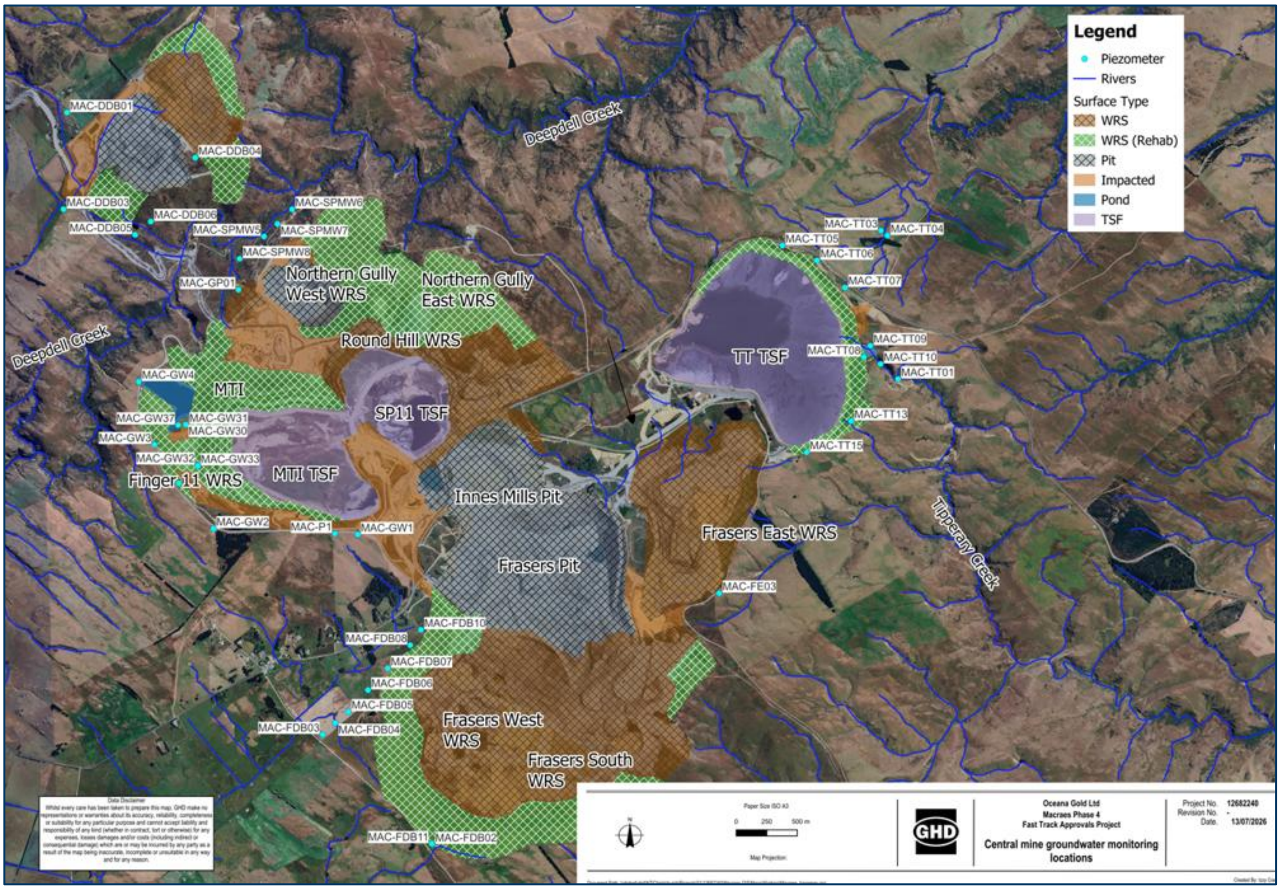

Figure C-4.1 Mine features and location of boreholes used in model calibration check.

The performance of model calibration is commonly associated with the difference between measured and modelled water levels. This measure is quantified through the scaled root mean square (SRMS) error. The SRMS is expressed as a percentage and is a more representative measure of the fit than the standard root mean square (RMS), as it accounts for the scale of the potential range of data values. Therefore, if the ratio of the RMS error to the total head change is small, the error is only a small part of the overall model response. The steady-state calibration for the Site Wide model resulted in SRMS of 6.2% and is considered acceptable as per Australian Groundwater Modelling Guidelines (Barnett et al, 2012).

Table C-4.1 Model input parameters

Unit Name	Model Layer (Thickness of layer)	Kx m/s (m/d)	Kz m/s (m/d)	Ky m/s (m/d)	Specific Yield *	Specific Storage 1/m*
Tailings	1 (Various thickness)	2.0×10^{-7} (0.017)	2.0×10^{-7} (0.017)	2.0×10^{-7} (0.017)	0.35	1.0×10^{-5}
Waste Rock	1 (Various thickness)	1.0×10^{-6} (0.086)	1.0×10^{-6} (0.086)	1.0×10^{-6} (0.086)	0.18	1.0×10^{-5}
Moderately Weathered Schist	1 to 2 (L1 various thickness and L2 30m thick)	8.7×10^{-8} (0.0075)	5.2×10^{-8} (0.0045)	2.2×10^{-7} (0.0188)	0.02	1.0×10^{-5}
Slightly Weathered shist	3 (50 m thick)	2.9×10^{-8} (0.0025)	2.9×10^{-9} (0.00025)	2.9×10^{-8} (0.0025)	0.01	1.0×10^{-5}
Slightly weathered / Unweathered Schist Bedrock	4 to 6 (50 m thick)	1.2×10^{-8} (0.001)	1.2×10^{-9} (0.0001)	1.2×10^{-8} (0.001)	0.005	1.0×10^{-5}
Unweathered Schist	7 to 12 (L7 to L9 50 m thick, L10 to L12 various thickness)	1×10^{-8} (0.0009)	1×10^{-9} (0.00009)	1×10^{-8} (0.0009)	0.005	1.0×10^{-5}
Notes:	Kx-denotes horizontal hydraulic conductivity in x direction Ky-denotes horizontal hydraulic conductivity in y direction Kz-denotes vertical hydraulic conductivity Vertical anisotropy represents ratio of hydraulic conductivity in horizontal x (Kx) to z (Kz) directions (Kx/Kz) *Parameter used in transient model only.					

The modelled (computed) vs observed (measured) head plot from the steady-state model calibration is plotted in Figure C-4.2 and tabulated in Attachment 1 of this Appendix.

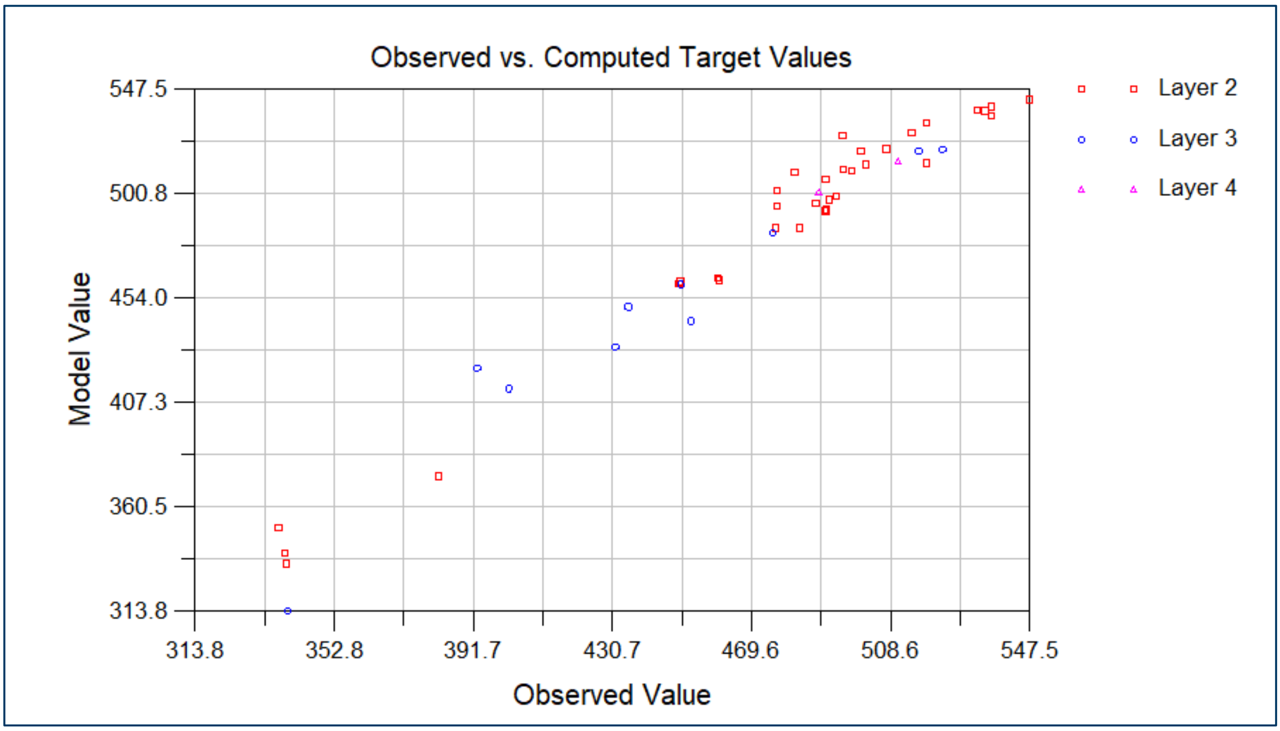

Figure C-4.2 Steady state scatter plot (model computed vs observed head)

The overall mass balance error (outflows - inflows) for the steady state model (Figure C-4.3) is <0.01%, suggesting that the model is numerically stable.

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 VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP       1 IN STRESS PERIOD       1
 ---------------------------------------------------------------------------------------

    CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
    ------------------                 ------------------------

          IN:                                      IN:
          ---                                      ---
            STORAGE =           0.0000               STORAGE =           0.0000
      CONSTANT HEAD =      637551.2687         CONSTANT HEAD =        1746.7158
             DRAINS =           0.0000                DRAINS =           0.0000
      RIVER LEAKAGE =      213079.3765         RIVER LEAKAGE =         583.7791
           RECHARGE =     6929750.2734              RECHARGE =       18985.6172

           TOTAL IN =     7780380.9186              TOTAL IN =       21316.1121

         OUT:                                     OUT:
         ----                                     ----
            STORAGE =           0.0000               STORAGE =           0.0000
      CONSTANT HEAD =       63571.2749         CONSTANT HEAD =         174.1679
             DRAINS =     5411867.1137                DRAINS =       14827.0332
      RIVER LEAKAGE =     2304942.5635         RIVER LEAKAGE =        6314.9111
           RECHARGE =           0.0000              RECHARGE =           0.0000

          TOTAL OUT =     7780380.9521             TOTAL OUT =       21316.1122

           IN - OUT =      -3.3478E-02              IN - OUT =      -9.1720E-05

PERCENT DISCREPANCY =            -0.00     PERCENT DISCREPANCY =           -0.00
```

Figure C-4.3 Steady state model water balance (units – m^3 for volumes and m^3/day for rates)

Steady-state modelled head contours using the parameters presented in Table C-4.1 are plotted in Figure C-4.4 with an enlarged view in Figure C-4.5. Groundwater flow generally follows topography and is diverted towards the dewatered pits.

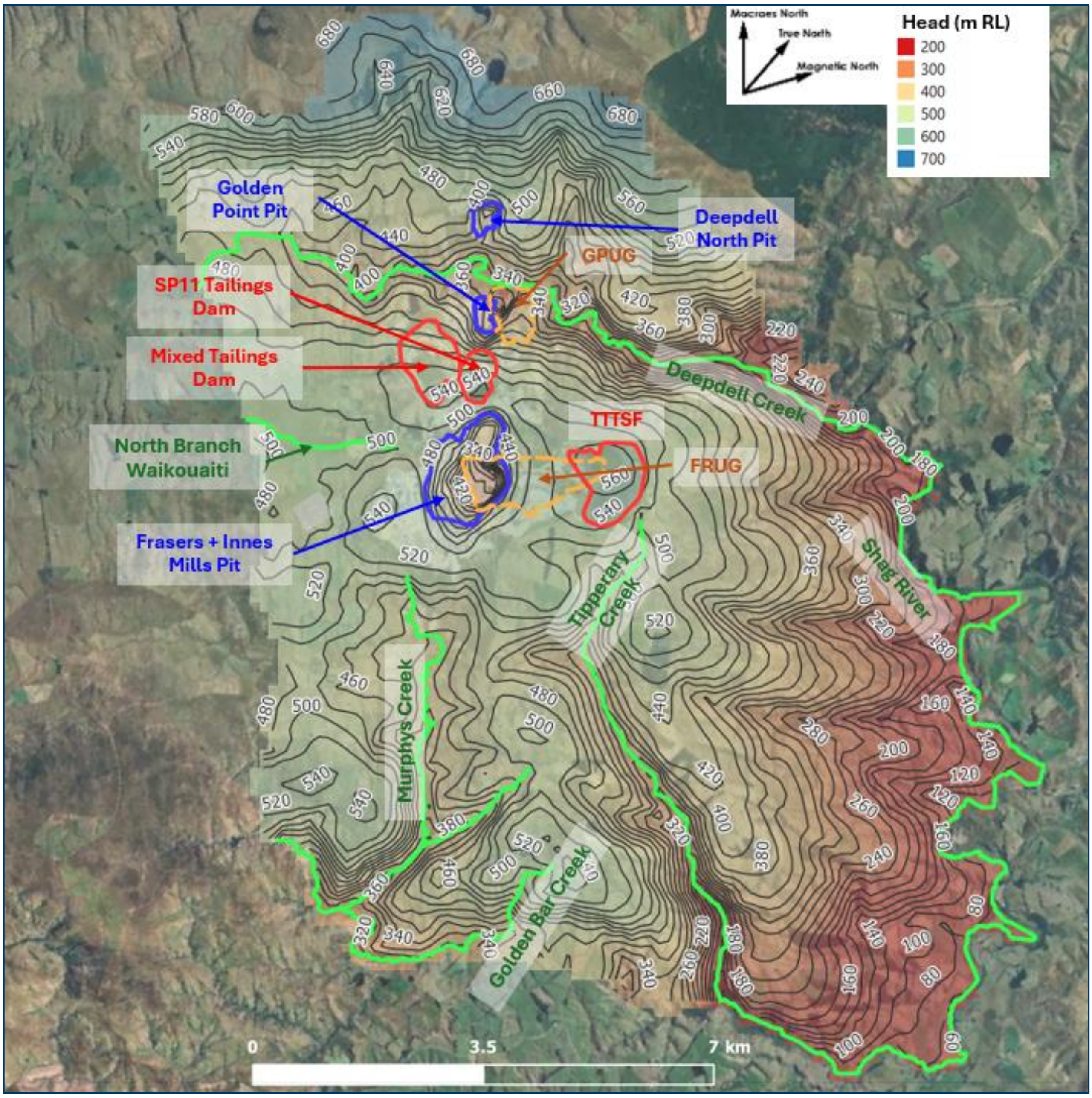


Figure C-4.4 Steady state water table (existing conditions model).

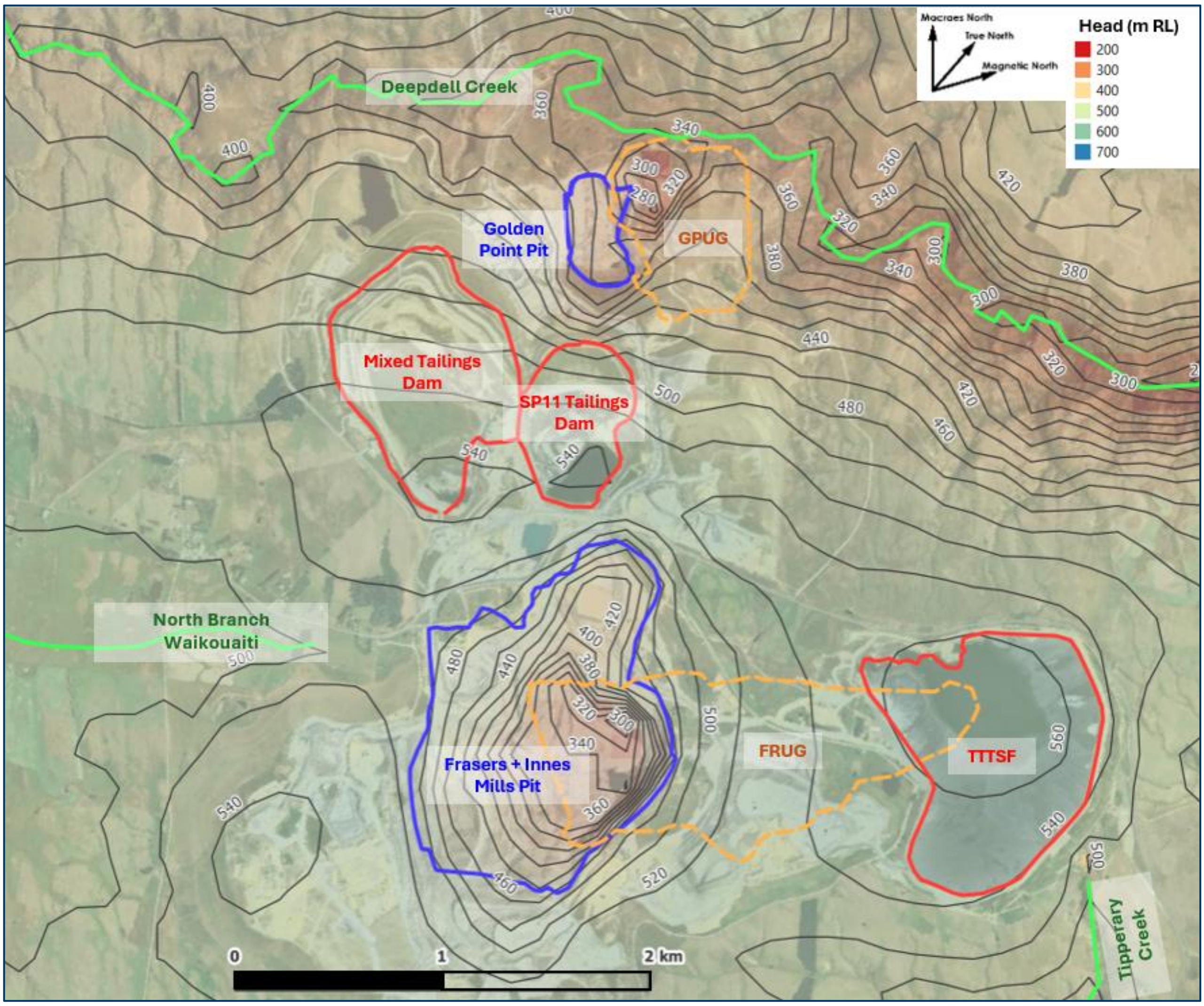
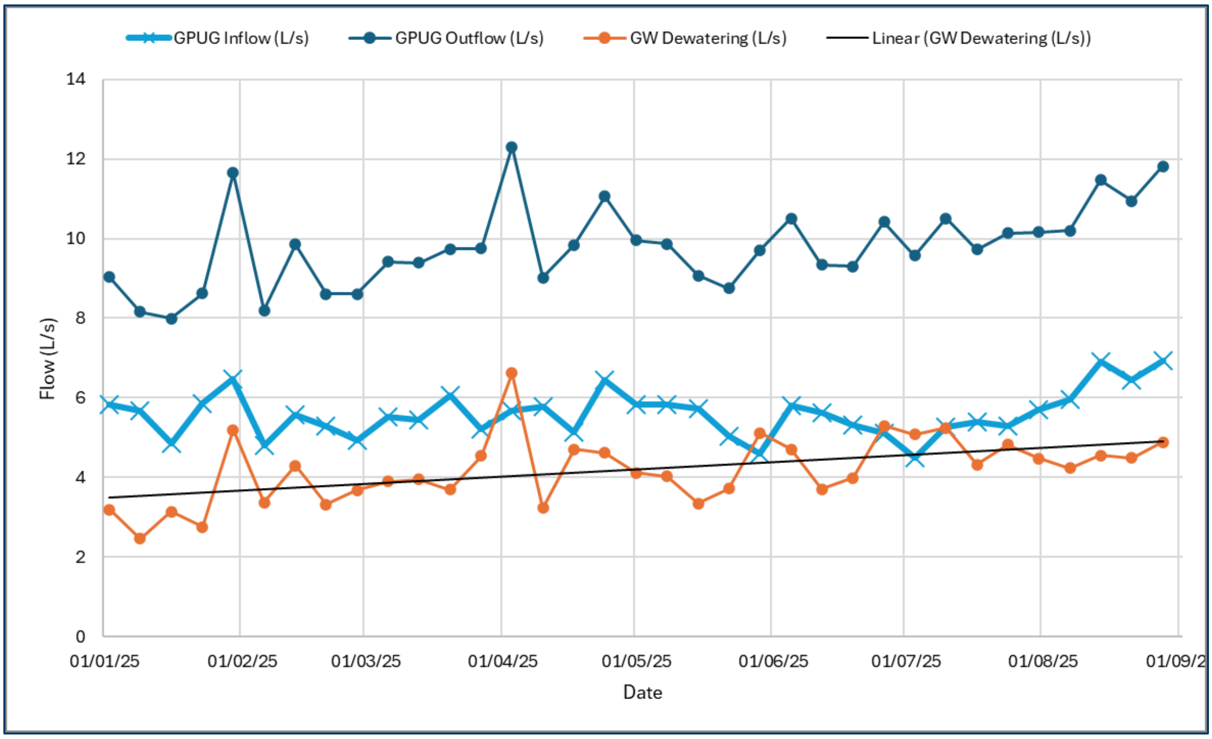


Figure C-4.5 Enlarged view of water table contours near main mine features.

C-4.1 Steady state existing conditions model recorded discharge check

GPUG mining started in 2020, with first ore production in October 2021. Recent recorded pumped data are presented in Figure C-4.6 (OGNZL, 2026).



*GPUG Inflow = Water pumped underground for operational use during mining; GPUG Outflow = Measured abstracted underground water; GW Dewatering = GPUG Outflow – GPUG Inflow

Figure C-4.6 GPUG Recorded flows (OGNZL, 2026)

The FRUG has been operational since 2008, and ceased to operate in 2025. Recorded mine water discharge from FRUG were typically between 1,000 to 2,000 m3/d (12-24 L/s) with peaks of around 5,000 m^3/d (58 L/s) (WGA, 2020).

Drain boundary conditions were applied in model layers 2 to 10 for the FRUG and layers 2 to 9 for the GPUG to represent continuous groundwater pumping for the management of the respective underground voids. These boundaries were assigned by importing the provided DXF design files of the FRUG and GPUG geometries into Leapfrog, converting them into coarser solids, and subsequently assigning the resulting geometries to the appropriate MODFLOW model grid cells. This process is illustrated in Figure C-4.7. The FRUG drain boundary conditions were removed during the prediction modelling runs (drawdown and recovery) while the GPUG drain boundaries were extended for the dewatering run and removed during the recovery runs to represent progressive recovery in the groundwater levels in the underground workings through these periods.

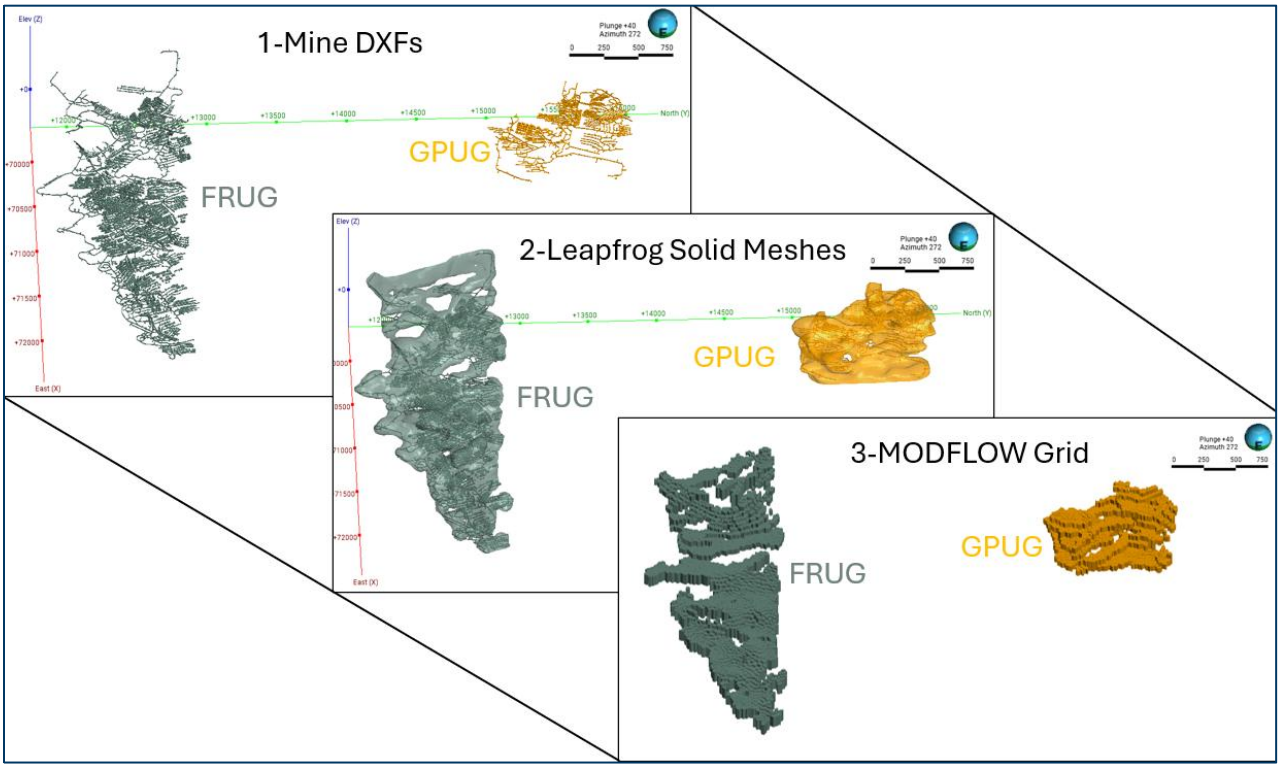


Figure C-4.7 Assigning the FRUG and GPUG to the MODFLOW model cells (hydraulic parameters and drain boundary conditions).

Since the GPUG and FRUG mining areas comprise of various underground workings, tunnels, overall permeability of the rock mass in the underground mining areas mining area is considered significantly higher than that of the host rock, hence the following hydraulic properties were assigned for the underground workings areas (Table C-4.2). A conductance of 10 m/d/m length was assumed for the drain boundary, such that it does not restrict inflow to the drain boundary.

Table C-4.2 Hydraulic parameters for GPUG and FRUG.

Unit Name	Kx m/s (m/d)	Kz m/s (m/d)	Ky m/s (m/d)	Specific Yield	Specific Storage 1/m
GPUG & FRUG	1.0×10^{-6} (0.086)	1.0×10^{-6} (0.086)	1.0×10^{-6} (0.086)	0.18	1.0×10^{-5}

The steady state modelled inflow rates to GPUG is 6.0 L/s (520 m^3/day) which is in relative agreement to the recorded pumping data (Figure C-4.6). The modelled inflow results for FRUG is 33.8 L/s (2924 m^3/day), which is also in general agreement to the reported recorded rates (WGA, 2020). The model is therefore surmised to adequately reflect groundwater flow rates into the underground workings.

C-5 Predictive Analysis

C-5.1 Innes Mills open pit and GPUG extension dewatering

Pit dewatering was simulated using drain boundary conditions applied throughout the operational periods of the Innes Mills Pit and GPUG, including during their proposed expansions for descriptions of the expansions, refer to the main report). Continuous dewatering of the Golden Point Pit was also simulated using drain boundary (refer to section 3.3 of this Appendix), as this pit must remain dry to ensure access to the GPUG during the mining phase. Relative to the steady-state existing conditions model, several additional changes were incorporated in this model run, including: a general head boundary was assigned to the Deepdell North Pit to represent the recovery of the pit lake; and a general head boundary was introduced within the proposed Frasers Tailings storage (to be placed within the Frasers Pit) to simulate the deposition of saturated material in that area concurrent with the expansion of the Innes Mills Pit (refer to section 3.3 of this Appendix).

General head boundary values were derived from surface water modelling results (WBM detailed in Appendix E). The dewatering simulation spans 11 years, consistent with the indicative Macraes mining schedule (OGL, 2026) at the time of completing this report. For the dewatering simulation the greater and deeper extent of the proposed design for both the Innes Mills pit and GPUG extension were assumed throughout the dewatering period. This represents a conservative approach, as it maximises the duration and extent of dewatering effects and is therefore considered appropriate for assessment purposes.

Modelled head contours at the end of IM pit and GPUG dewatering (11 years) are plotted in

Figure C-5.2 and the water balance from the end of proposed dewatering of all pits and underground workings is presented in Figure C-5.3. A south to north cross section through selected site features, showing the predicted water table in Layer 1 for the existing conditions, at the end of dewatering period (11 years of dewatering), and at the end of the recovery model (400 years), is provided in Attachment 4 of this Appendix. Furthermore, in Section 5.2 of this Appendix Figure C-5.15, Figure C-5.16 and Figure C-5.17 show the pressure head (existing conditions, at the end of 11 years dewatering and 30 years into the recovery run) in layer 10 that represent the model layer containing the base of the FRUG and GPUG workings as represented in the groundwater model.

Modelling results indicate that dewatering of GPUG is lowering the pressure heads in the deeper layers of the model. This is in agreement with measurement in vibrating wire piezometers (VWPs) installed in 2022 near Deepdell Creek (OGNZL, 2025). The location of the VWPs and measurements are shown in Figure C-5.1 and Attachment 5. Monitoring data show in the deep VWPs in all four drillholes (i.e. 170 m bgl to 266 m bgl) groundwater drawdown is approximately 95 m to 150 m.

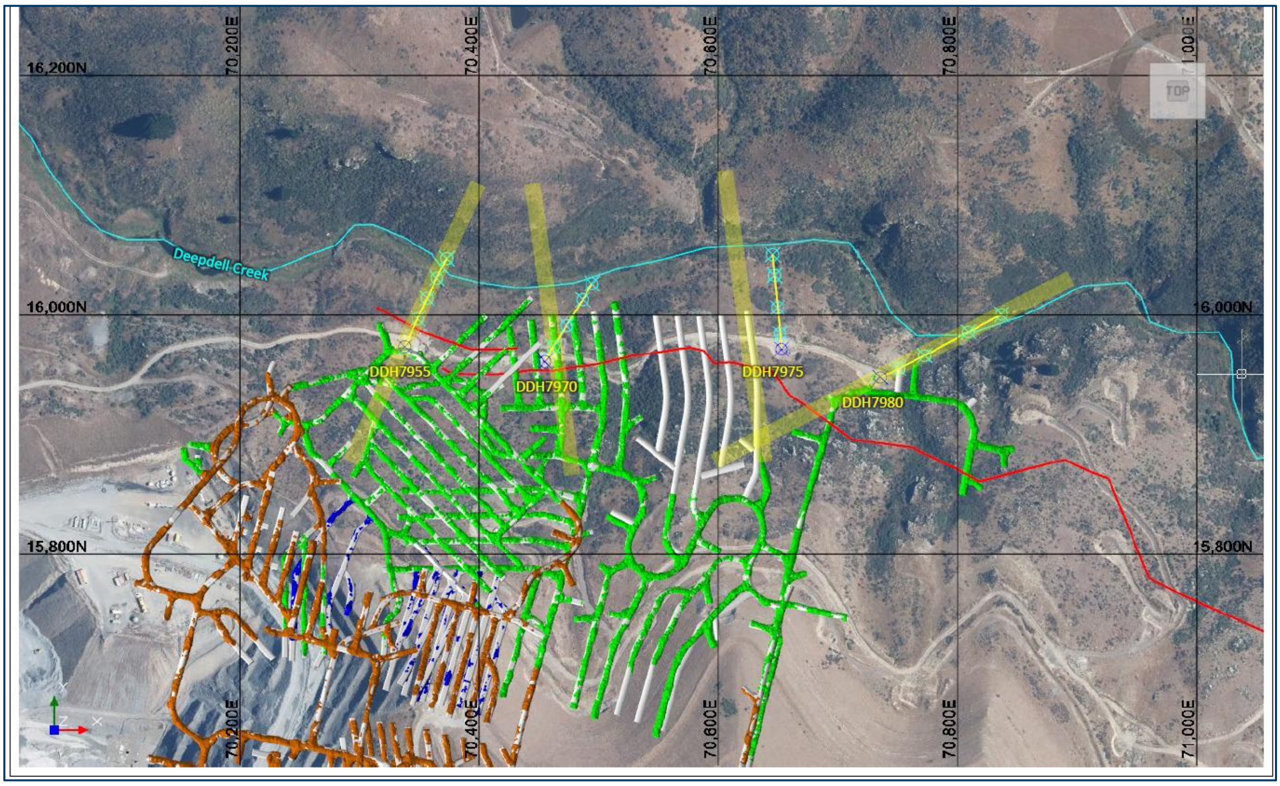


Figure C-5.1 GPUG – Deepdell Creek VWPs – 4 drillholes with 4 VWPs extending beneath the creek (OGNZL, 2025)

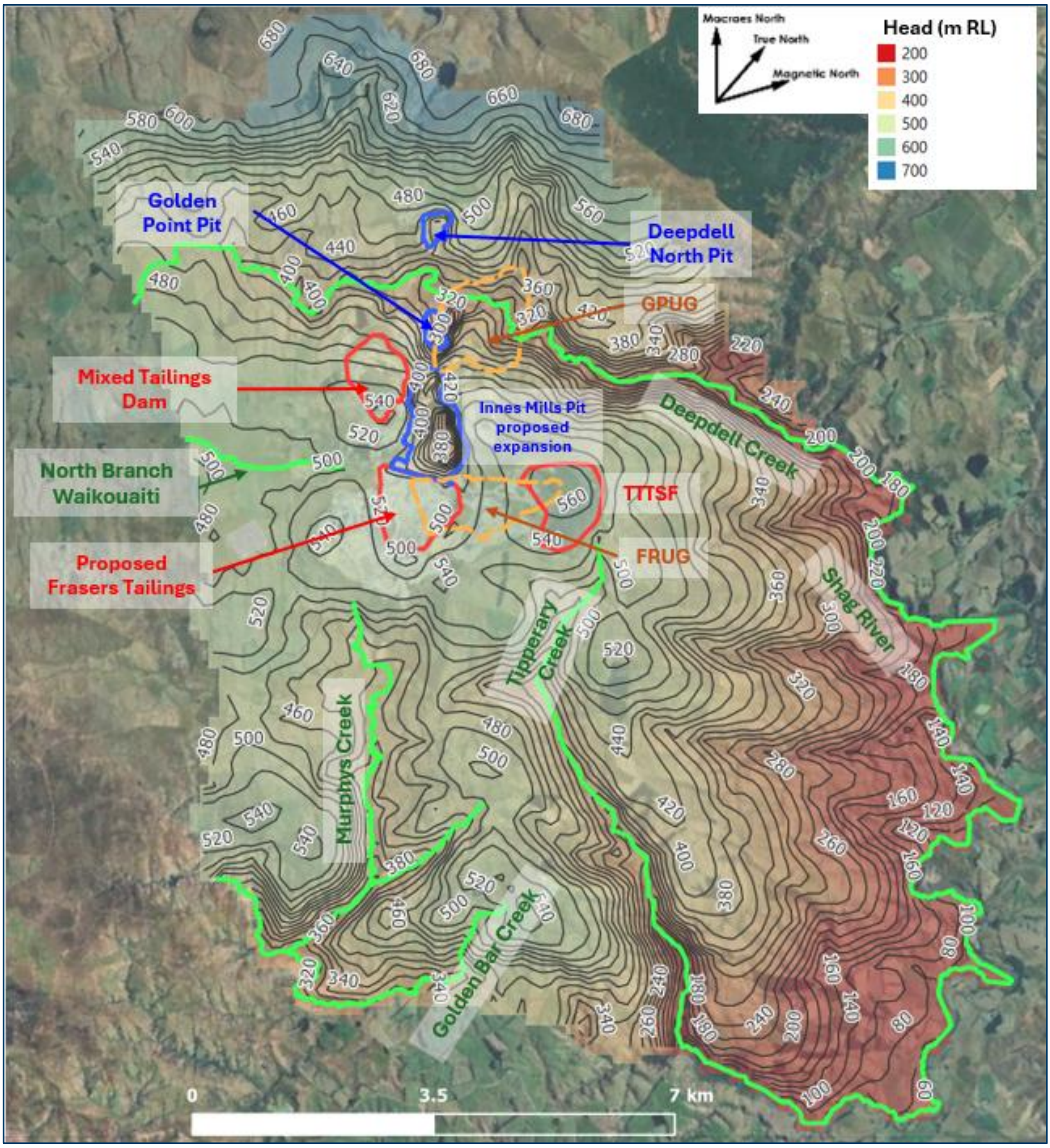


Figure C-5.2 *Modelled phreatic groundwater table (layer1) at the end of dewatering model run.*

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  VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP      12 IN STRESS PERIOD      11
  ---------------------------------------------------------------------------------------

     CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
     ------------------                 ------------------------

           IN:                                      IN:
           ---                                      ---
             STORAGE =    18597128.4492             STORAGE =        1115.6796
       CONSTANT HEAD =      688206.3610       CONSTANT HEAD =         172.5949
               WELLS =           0.0000               WELLS =           0.0000
              DRAINS =           0.0000              DRAINS =           0.0000
       RIVER LEAKAGE =     2065680.7369       RIVER LEAKAGE =         518.7704
     HEAD DEP BOUNDS =    57645159.5889     HEAD DEP BOUNDS =        1670.1310
            RECHARGE =    75872184.2871            RECHARGE =       18897.1816

            TOTAL IN =   154868359.4232            TOTAL IN =       22374.3575

          OUT:                                     OUT:
          ----                                     ----
             STORAGE =    66111081.4379             STORAGE =        2406.4754
       CONSTANT HEAD =      299357.0304       CONSTANT HEAD =          75.2295
               WELLS =           0.0000               WELLS =           0.0000
              DRAINS =    61337924.7201              DRAINS =       13328.5683
       RIVER LEAKAGE =    24868309.9986       RIVER LEAKAGE =        6184.7935
     HEAD DEP BOUNDS =     2272548.9281     HEAD DEP BOUNDS =         379.4214
            RECHARGE =           0.0000            RECHARGE =           0.0000

           TOTAL OUT =   154889222.1151           TOTAL OUT =       22374.4881

            IN - OUT =      -20862.6914            IN - OUT =          -0.1306

 PERCENT DISCREPANCY =           -0.01     PERCENT DISCREPANCY =          -0.00
```

Figure C-5.3 Water balance at the end of IM and GPUG dewatering (units – m^3 for volumes and m^3/day for rates)

Estimated dewatering rates (groundwater inflow) for the proposed GPUG extension including groundwater flows into the existing GPUG workings is presented in Figure C-5.4. As presented in this figure, the predicted groundwater inflows for the GPUG extension appearing instantaneous decrease from approximately 196 L/s at the start of dewatering to approximately 22 L/s towards the end of the 11-year dewatering period. The initial high inflow is interpreted to reflect the model setup, in which the full GPUG extension is represented from the start of the predictive simulation rather than sequentially developed through time. This approach assumes rapid dewatering of the excavated and surrounding rock mass. In practice, the mine develops from near the highpoint, progressively extending down with time therefore, the inflow rates predicted towards the end of the modelled sequence are considered more representative of expected operational conditions. Dewatering rates from the current development of the GPUG mine support this interpretation (See Section 4.1).

Estimated dewatering rates (groundwater inflow) for the proposed expansion of the Innes Mills pit are presented in Figure C-5.5. The modelled pit inflows decline from approximately 12 L/s to a minimum of around 2.6 L/s at year 6, then rise to approximately 14.6 L/s by year 11. The initial decline reflects the depletion of groundwater storage around the pit and the reduction of the hydraulic gradient toward the pit. The subsequent increase is driven by the recovery of the groundwater level in the adjacent Frasers Tailings facility. As the tailings phreatic surface increases, the hydraulic gradient toward the pit increases, producing growing lateral seepage.

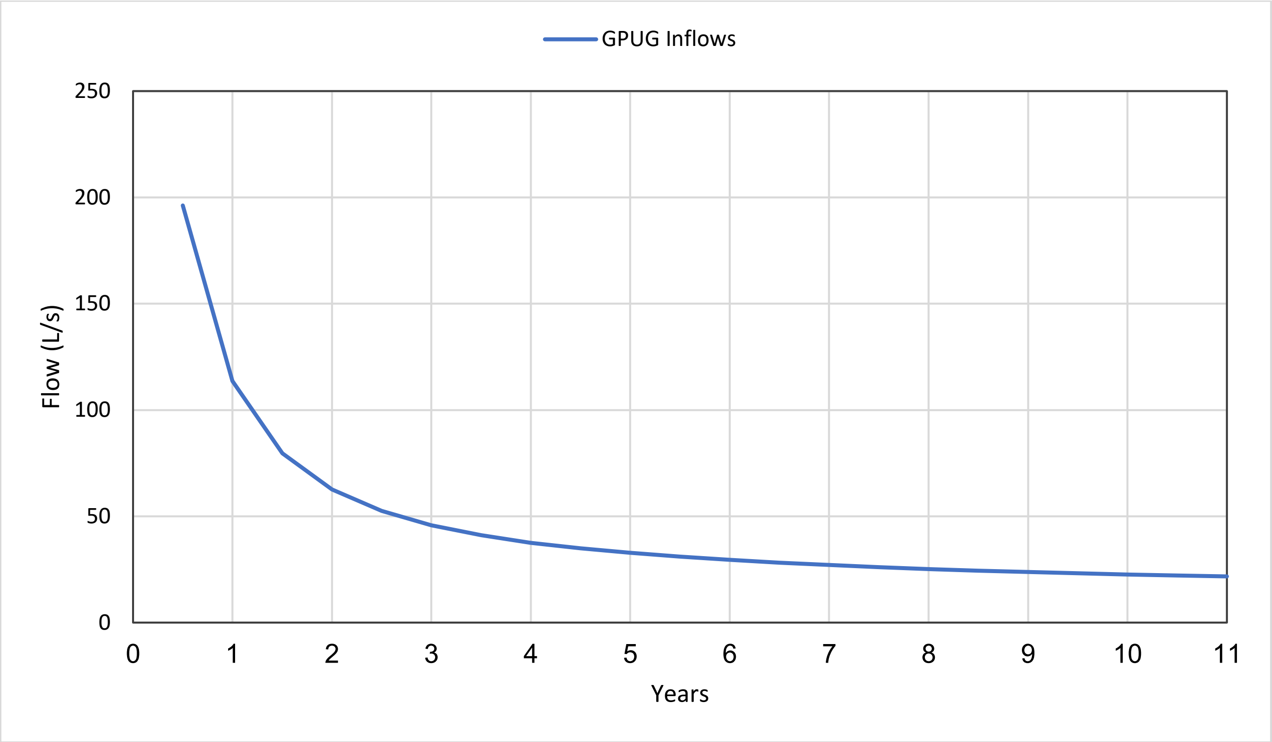


Figure C-5.4 ***Modelled dewatering rates for the proposed GPUG extension***

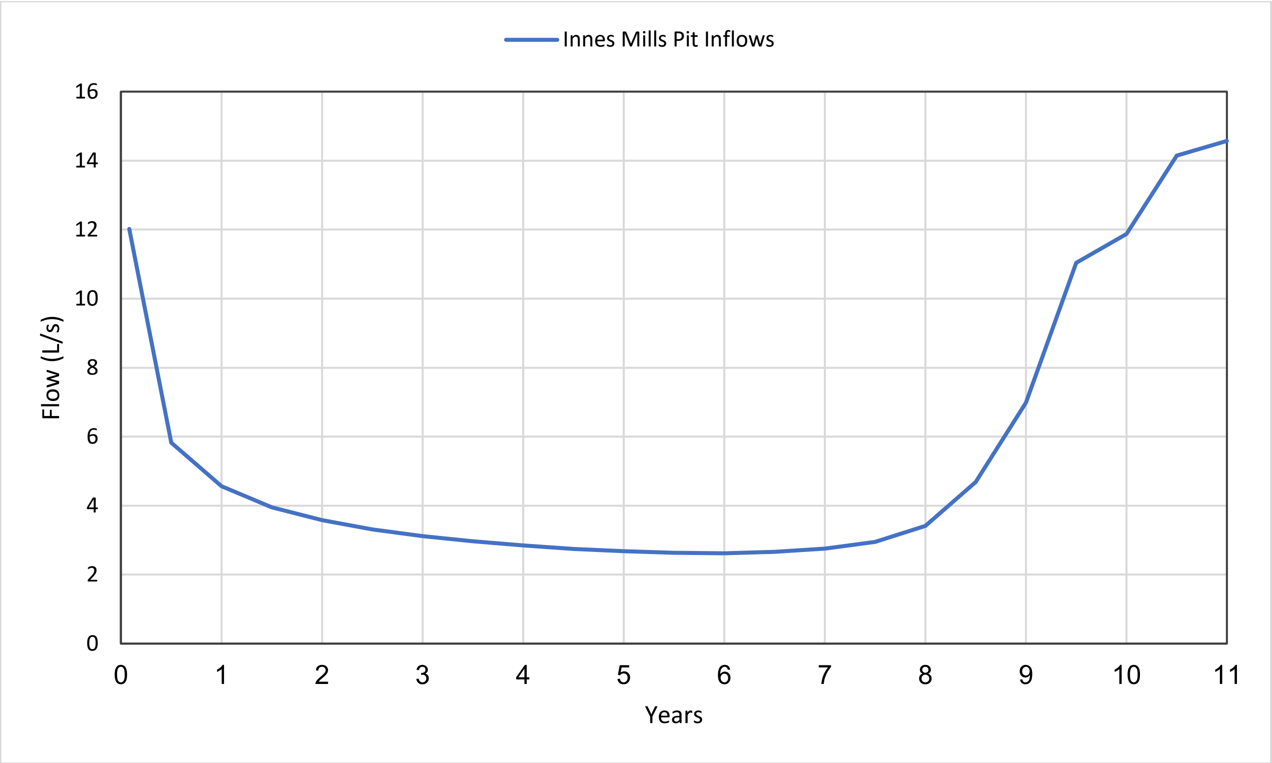


Figure C-5.5 ***Modelled dewatering rates for the proposed Innes Mills pit expansion***

C-5.1.1 Drawdown effects to surrounding creeks/streams

Modelling results indicate that drawdown greater than 1 m is predicted to extend approximately 3,900 m to the northeast of the proposed Innes Mills Pit area (Figure C-5.6).

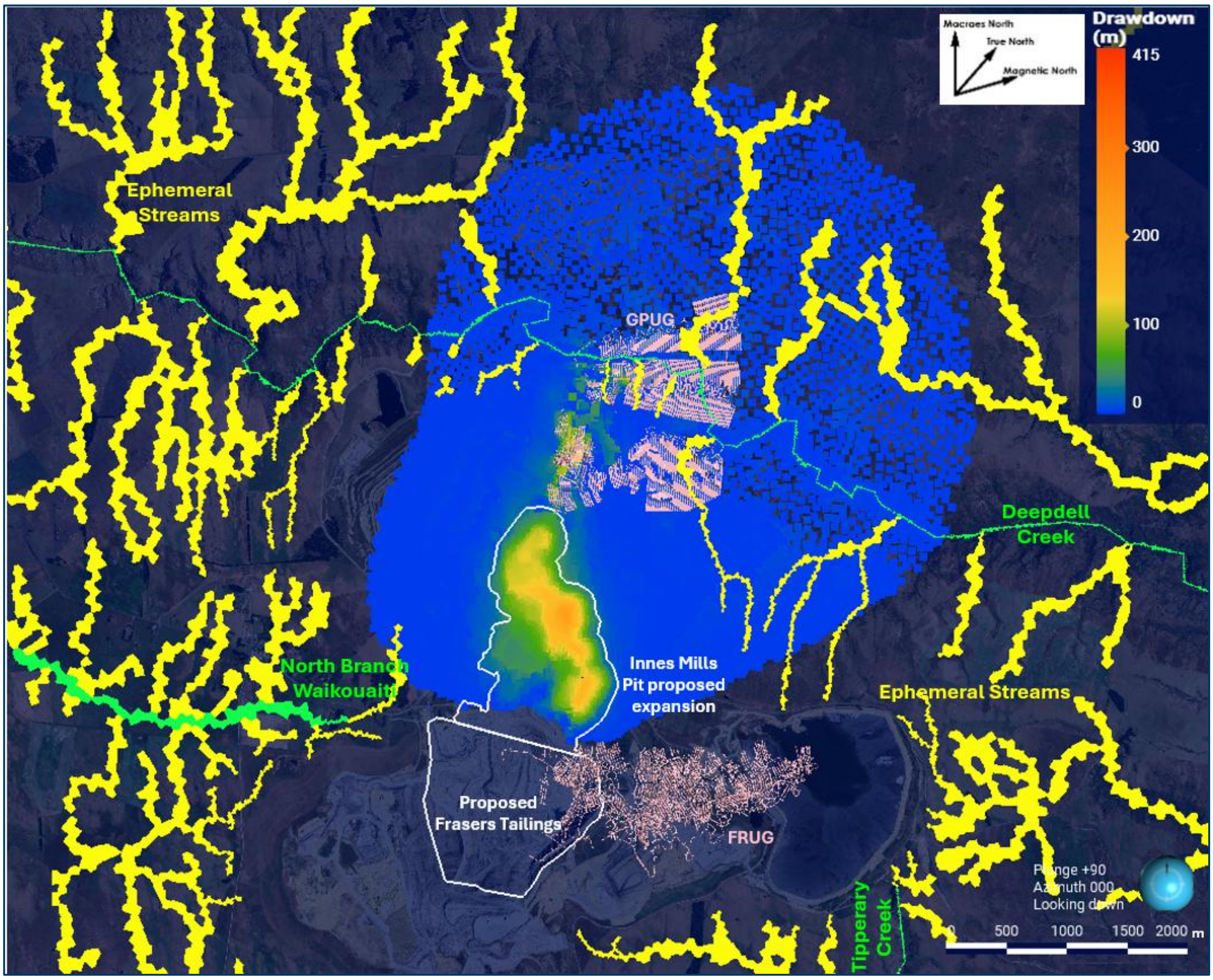


Figure C-5.6 Modelled extent of drawdown greater than 1 m after 11 years of dewatering of the proposed Innes Mills pit and GPUG extension

The creeks in the Macraes site are perennial watercourses running dry for short periods in late summer (measured flow data are shown in Appendix E). Deepdell Creek is interpreted to be a gaining stream, receiving groundwater discharge and associated baseflow contributions along much of its length. Consistent with this interpretation, Deepdell Creek has been characterised as having relatively low baseflows while exhibiting rapid and pronounced runoff responses to storm events, resulting in short-duration peak flows following rainfall (Golder, 2011). WSP Golder (2023) estimated the average groundwater-derived baseflow contribution to Deepdell Creek over the period from 1 January 1991 to 31 December 2015 to be approximately 38.2 L/s, equivalent to a specific discharge of 0.92 L/s/km² representing 32% of total creek flow.

WSP Golder (2023) assessed the dewatering effects associated with the Golden Point Underground (GPUG) mine workings in isolation from other existing and proposed mining-related dewatering activities. Their model predicted total groundwater inflows to the GPUG workings to be expected rates ranging between approximately 2.5 and 3 L/s, only a small proportion of which was attributable to the modelled GPUG extension (Figure C-5.7). The WSP Golder (2023) modelling therefore focused solely on the GPUG mining extent and its associated groundwater drawdown effects. Under this scenario, their model predicted a reduction in groundwater-derived baseflow to Deepdell Creek of 0.24 to 0.54 L/s.

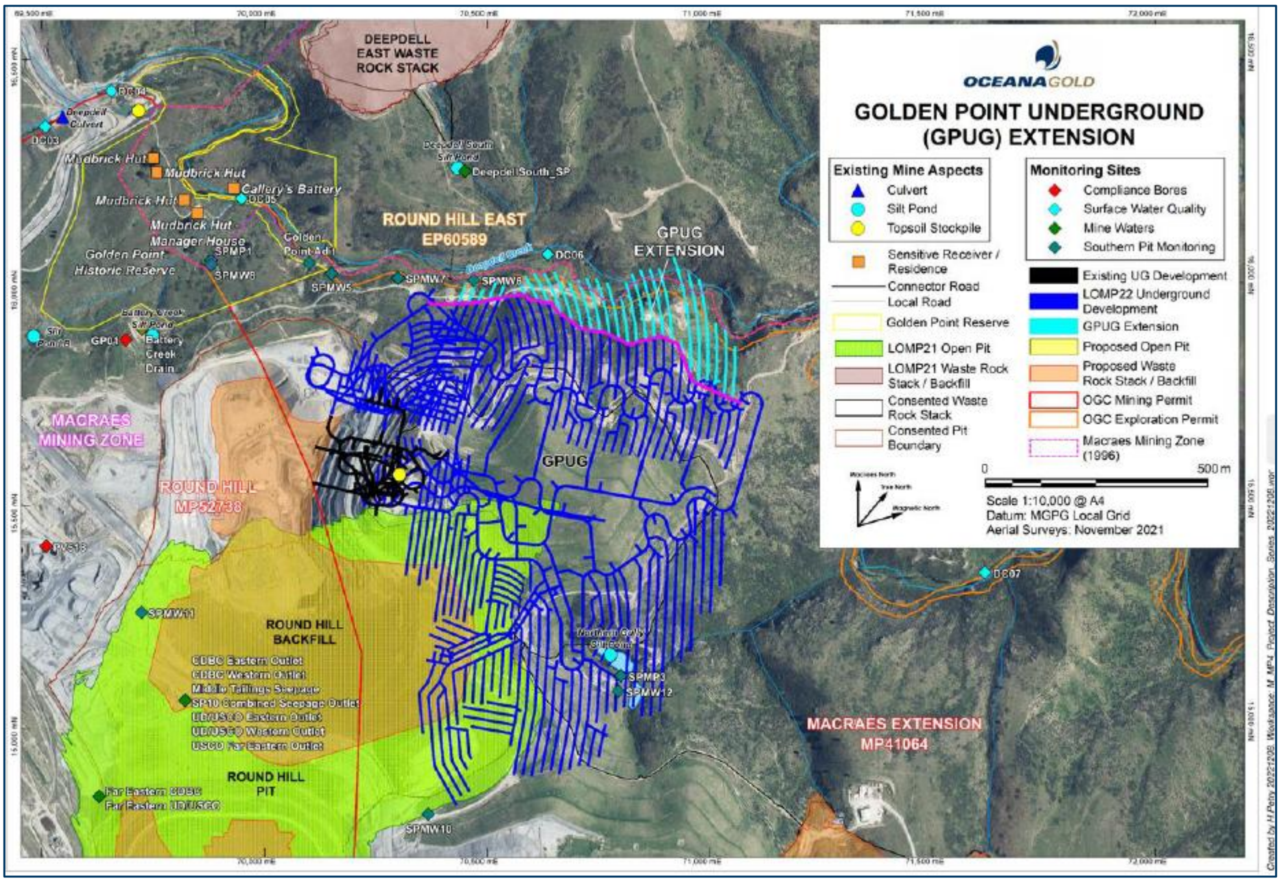


Figure C-5.7 GPUG extension (OGL, 2022 2020a) – Figure 1 in WSP Golder, 2023 report

To assess the potential effects of dewatering, modelled groundwater outflows to surface water under existing conditions were compared with those predicted by the dewatering model. The model domain was divided into catchments for this purpose, as shown in Figure C-5.8. The catchments were delineated to correspond with key compliance points, surface water monitoring nodes and surface water monitoring programs (Figure C-5.8). The catchments include the major creeks, represented in the groundwater model using river boundaries, and ephemeral streams, represented using drain boundaries. The modelled changes of groundwater contribution to the creeks due to dewatering of the pits and GPUG are presented in Table C-5.1.

Modelling results indicate that pit dewatering is expected to have a negligible effect on groundwater contributions to the majority of creeks and their tributary ephemeral streams. The predicted reduction in groundwater discharge to the NBWR, Murphy's and Golden Bar Creek, Tipperary Creek and the Shag River is estimated to be less than 0.1 L/s (<0.5%) within the study area (Table C-5.1). However, for Deepdell Creek to DC08 and tributary ephemeral streams, the predicted reduction in groundwater discharge is calculated to be 1.5 L/s (3.4% of 42.3L/s modelled for the existing conditions model) due to dewatering when compared to the existing conditions groundwater contributions (Table C-5.1).

These results represent changes to the groundwater component of flow only, rather than total streamflow, which will also be influenced by rainfall runoff, catchment storage, seasonal variability and other surface water processes.

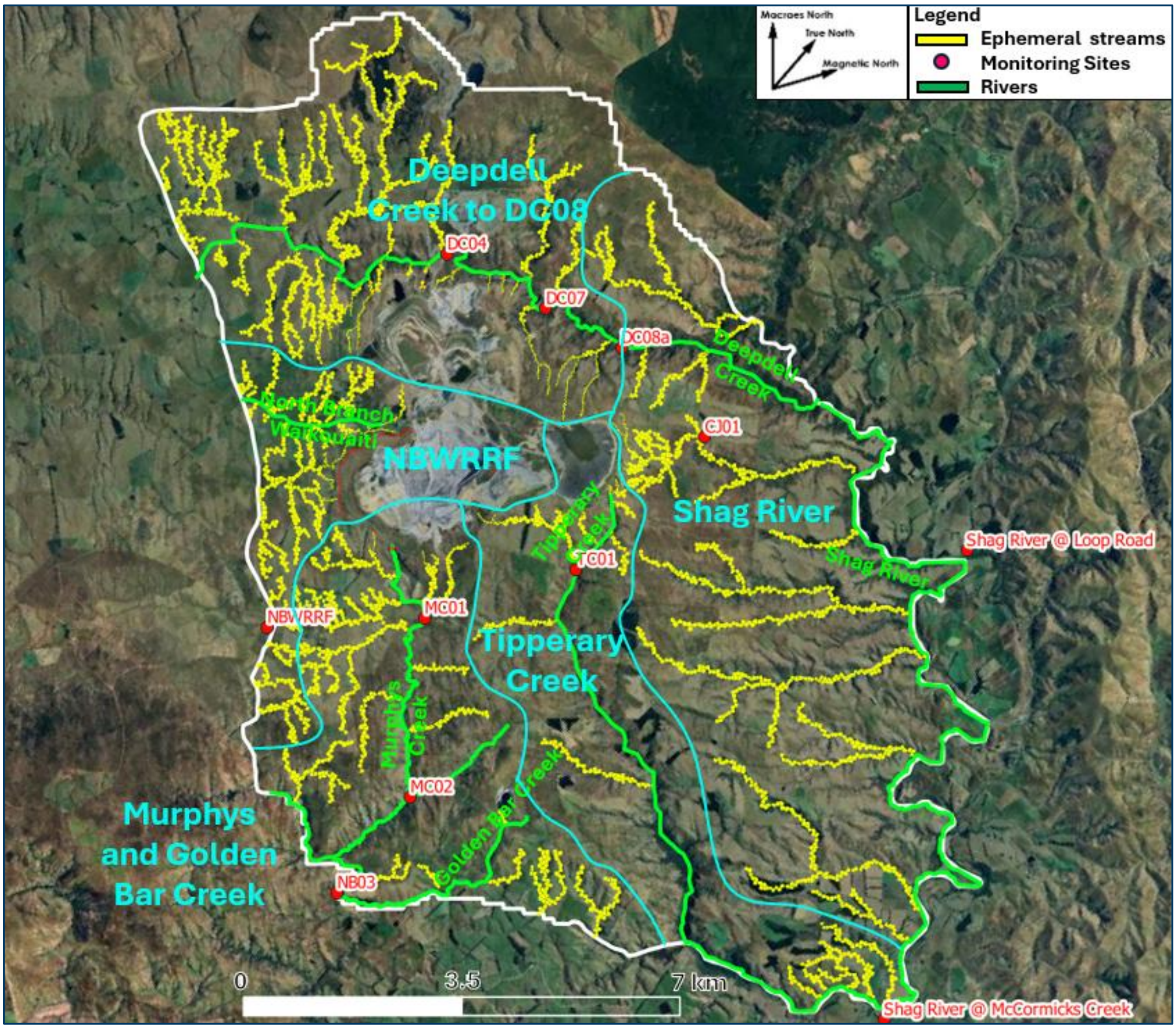


Figure C-5.8 Catchments defined in the groundwater model and surface water compliance monitoring site locations.

Table C-5.1 Change in groundwater contribution to creeks and tributary streams during dewatering

Catchment	Modelled groundwater flow to creeks and tributary streams - Existing Conditions model (L/s)	Modelled groundwater flow to creeks and tributary streams - Dewatering model (L/s)	Modelled change of groundwater contribution due to dewatering (L/s)	% of change in groundwater contribution
Deepdell Creek to DC08	42.3	40.8	1.5	3.4% decrease
NBWRRF (Waikouaiti River North Branch - Ross Road Ford)	10.3	10.2	0.1	<0.5% decrease
Murphys and Golden Bar Creek	37.6	37.8	0.2	0.6% increase*
Tipperary Creek	65.2	65.1	0.1	<0.5% decrease
Shag River	29.2	29.1	0.1	<0.5% decrease
Notes	*Associated with the water level increase in FRUG and in the proposed Frasers Tailings structure			

C-5.1.2 Drawdown effects on existing groundwater users

The location of the existing and proposed groundwater bores[1] as well as consented groundwater takes[1] are shown in Figure C-5.9 and Figure C-5.10. Groundwater modelling results indicate that groundwater drawdown associated with current and proposed mining activities (Figure C-5.6) is predicted to remain largely confined to areas close to the existing and proposed pit extensions and underground workings (Figure C-5.9 and Figure C-5.10). On this basis, adverse effects on groundwater levels in non-OGL groundwater bores are considered unlikely.

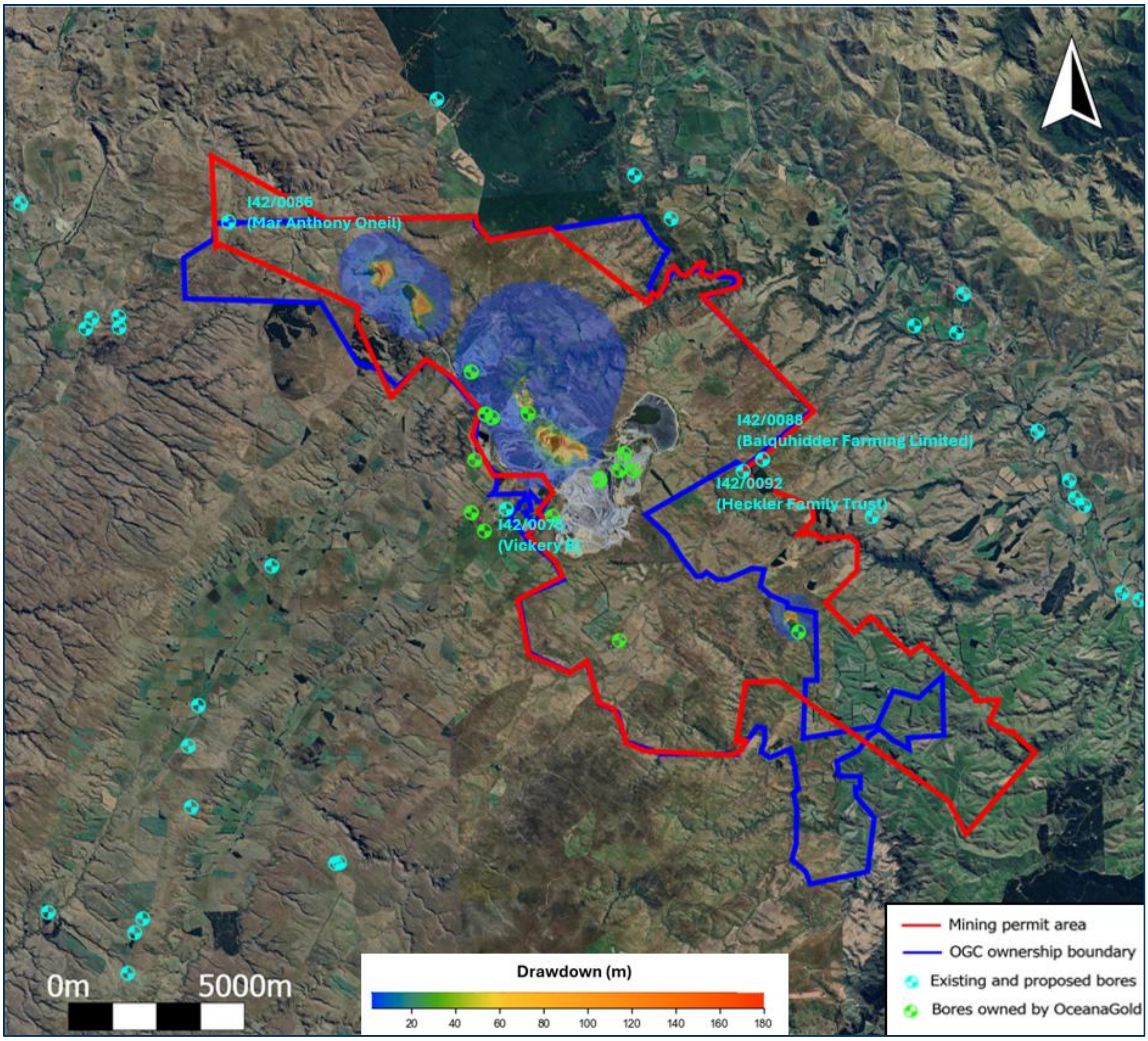


Figure C-5.9 Existing and proposed bore locations (ORC, 2027) and extent of modelled drawdown greater than 1 m at the end of dewatering for all three mining areas

[1] **https://maps.orc.govt.nz/OtagoMaps/** accessed July 2027

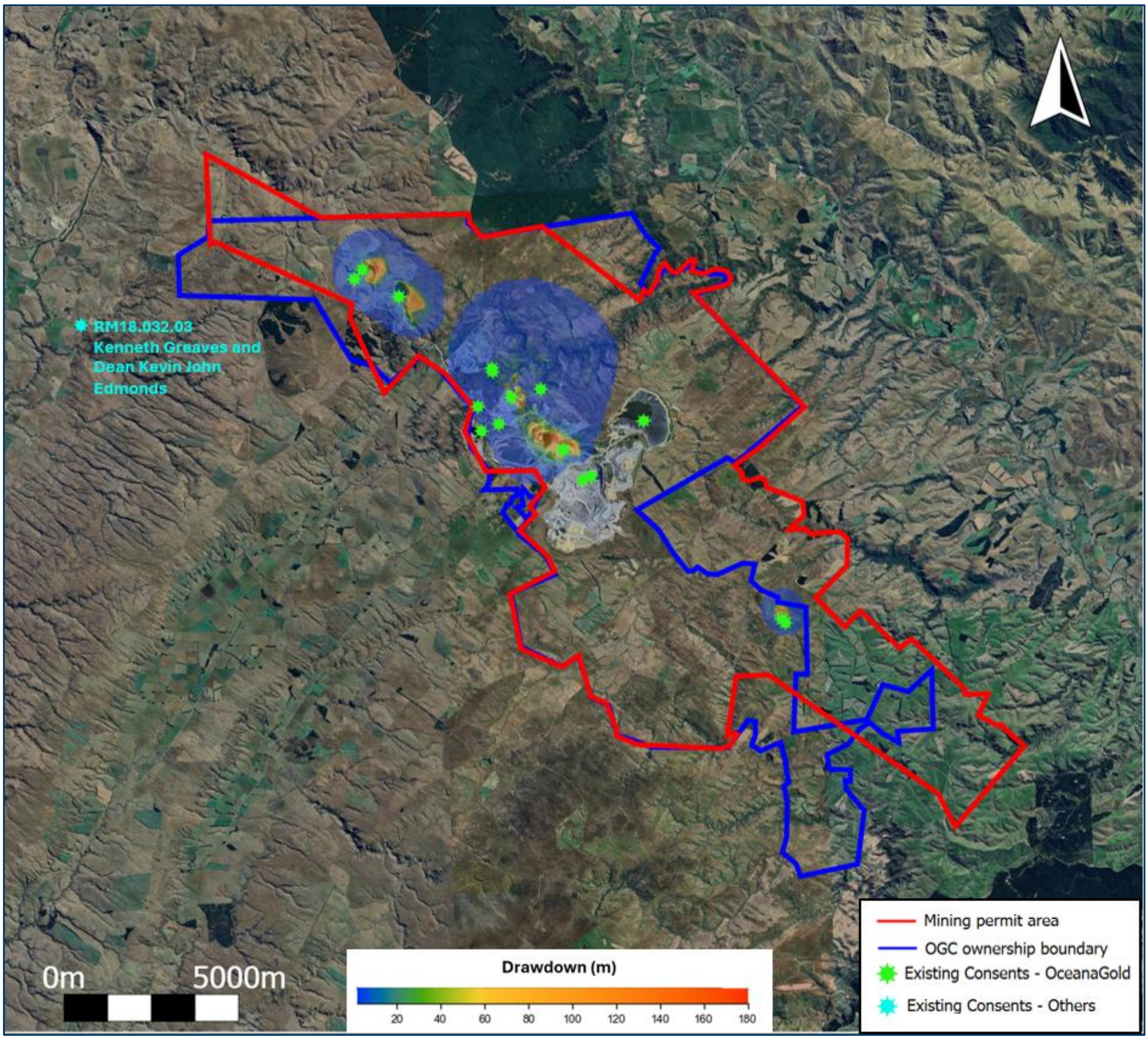


Figure C-5.10 Current groundwater take consents (ORC 2027), and extent of modelled drawdown greater than 1 at the end of dewatering for all three mining areas

C-5.2 Groundwater recovery

Groundwater recovery was simulated over a 400-year period, with the proposed Innes Mills Pit lake represented as a general head boundary (GHB) condition, alongside the continuation of recovery in the Deepdell North Pit and the proposed Frasers TSF, both also simulated as GHB conditions. The head values assigned to these boundary conditions were derived from the water balance model (WBM) used to estimate pit lake filling rates and long-term equilibrium water levels (refer Appendix G). This model also included the proposed WRS backfill within the Golden Point Pit, incorporating seepage capture bores within the WRS as shown in Figure C-3.4 of Section C-3.3. It also included the proposed WRS backfill south of the proposed Innes Mills Pit expansion, which was applied following completion of dewatering operations for that pit.

Seepage capture drains are proposed at several locations across the area, with the most significant structures planned around the Frasers West and East WRSs (refer Figure C-5.11 and Figure C-5.12). The seepage capture drains will comprise a series of trenches connecting to collection sumps, intercepting WRS seepage before it enters surface water. Collected seepage will be pumped from the sumps to a water treatment facility or for use onsite within the mine water management system. The concept design for the seepage capture drains is included in “Macraes Phase 4 FTA Project. Engineered Seepage Capture Drain – Concept Design Report, GHD (2026a)”, with an exert of a typical cross section shown in Figure C-5.12. The seepage capture drains have been modelled as drain boundaries at their proposed locations, consistent with the mine design intended to intercept and manage potentially contaminated seepage originating from the waste rock stack.

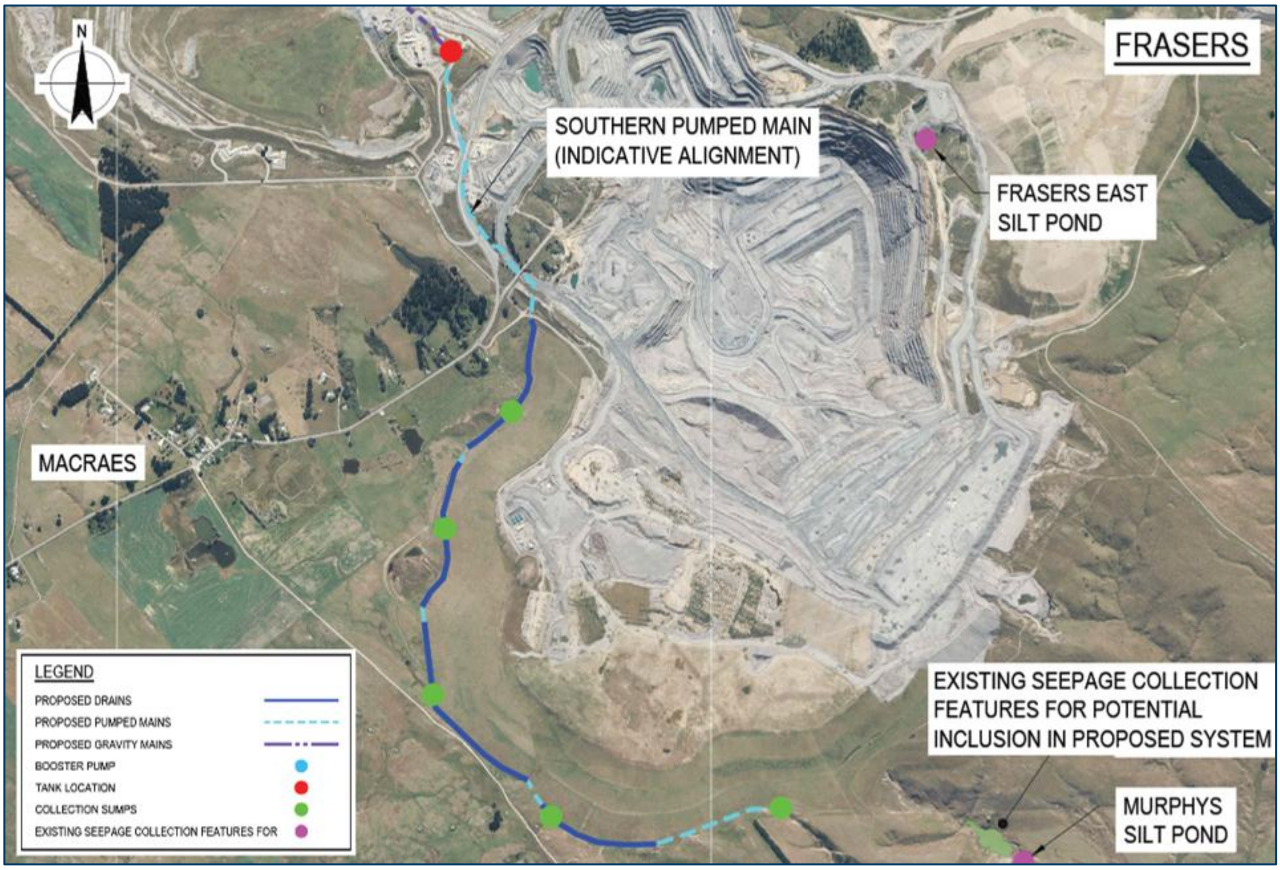


Figure C-5.11 Seepage capture drains around the Frasers West and East WRSs (not to scale)

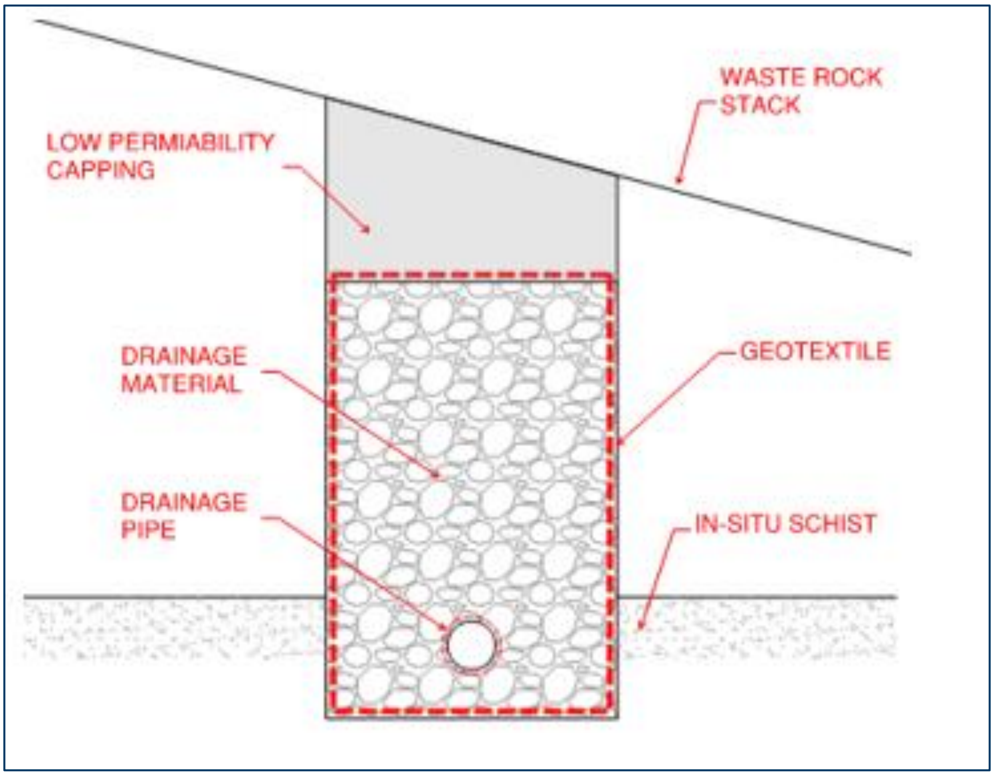


Figure C-5.12 Typical cross section of engineered seepage drain trench.

The water balance summary, as well as modelled pressure head contours at the end of the recovery run are presented in Figure C-5.13 and in Figure C-5.14 respectively.

```
  VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP     60 IN STRESS PERIOD     74
  ------------------------------------------------------------------------------------

     CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
     ------------------                 ------------------------

           IN:                                      IN:
           ---                                      ---
             STORAGE =    15590149.7321             STORAGE =          0.0000
       CONSTANT HEAD =        7445.3890       CONSTANT HEAD =      5.0661E-02
               WELLS =           0.0000               WELLS =          0.0000
              DRAINS =           0.0000              DRAINS =          0.0000
       RIVER LEAKAGE =    75246183.2332       RIVER LEAKAGE =        512.2753
     HEAD DEP BOUNDS =    42943559.4873     HEAD DEP BOUNDS =        202.1124
            RECHARGE =  2603597468.7500            RECHARGE =      17832.8594

            TOTAL IN =  2737384806.5915            TOTAL IN =      18547.2978

          OUT:                                     OUT:
          ----                                     ----
             STORAGE =    75354527.7308             STORAGE =         29.6572
       CONSTANT HEAD =     3471216.5194       CONSTANT HEAD =         23.9368
               WELLS =           0.0000               WELLS =          0.0000
              DRAINS =  1661241592.1016              DRAINS =      11563.8194
       RIVER LEAKAGE =   903656806.3770       RIVER LEAKAGE =       6236.8604
     HEAD DEP BOUNDS =    93661960.2779     HEAD DEP BOUNDS =        693.0235
            RECHARGE =           0.0000            RECHARGE =          0.0000

           TOTAL OUT =  2737386103.0065           TOTAL OUT =      18547.2971

            IN - OUT =      -1296.4150            IN - OUT =      6.3361E-04

 PERCENT DISCREPANCY =           -0.00    PERCENT DISCREPANCY =          0.00
```

Figure C-5.13 Water balance at the end of recovery run after 400 years (units – m^3 for volumes and m^3/day for rates)

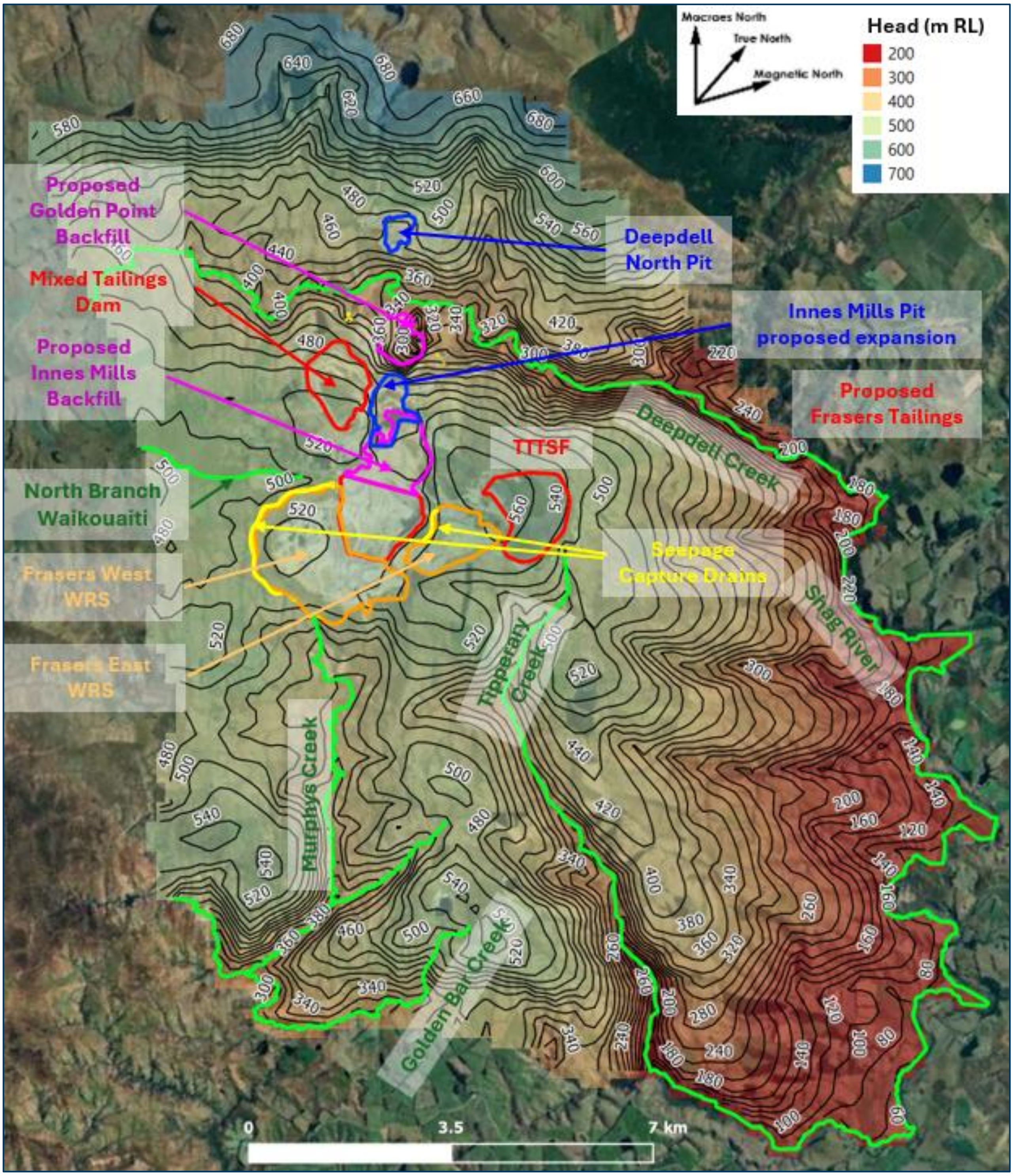


Figure C-5.14 Water table at the end of the recovery run after 400 years.

A south to north cross section through selected site features, showing the predicted water table in Layer 1 for the existing conditions, at the end of dewatering period (11 years of dewatering), and at the end of the recovery model (400 years), is provided in Attachment 4 of this Appendix.

Figure C-5.15 to Figure C-5.17 present cross sections of the modelled pressure head in Layer 10 along the FRUG and GPUG alignments existing conditions, at the end of 11 years dewatering (GPUG) and 30 years into the recovery model simulation. Layer 10 corresponds to the model layer containing the base of the FRUG and GPUG workings as represented in the groundwater model.

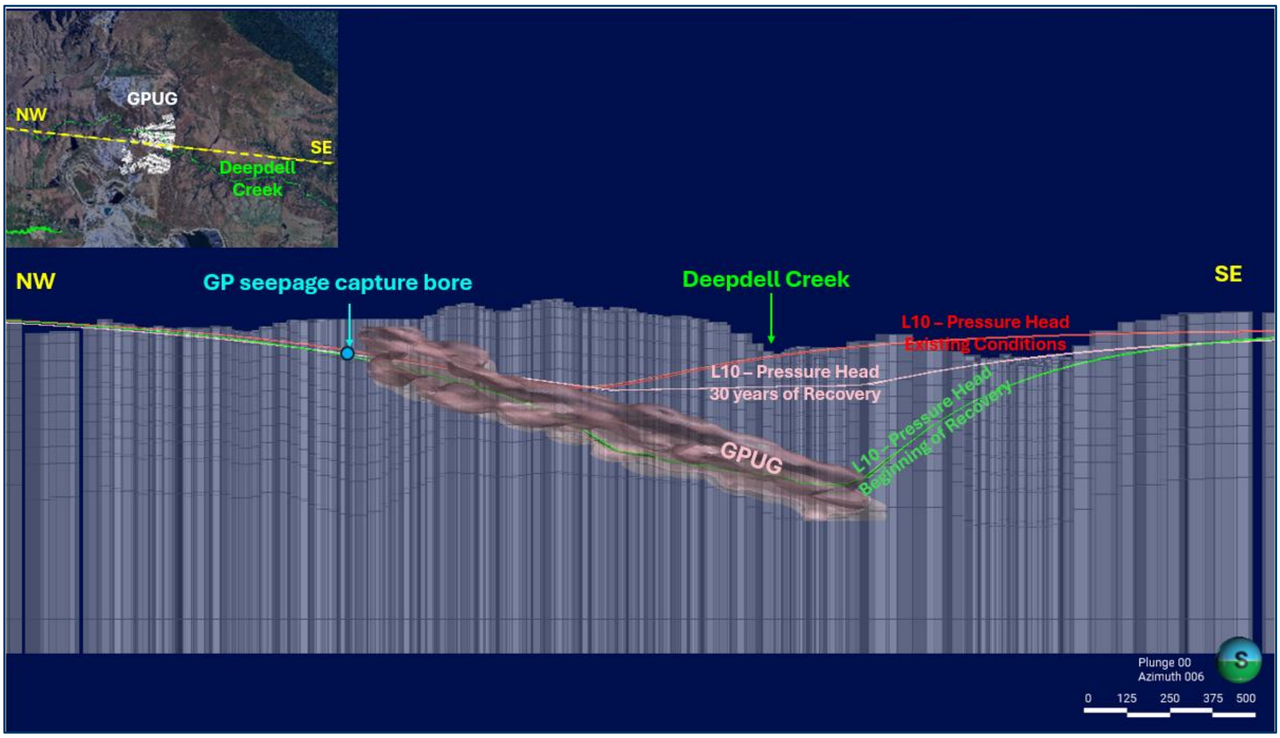


Figure C-5.15 Northwest-Southeast cross section through GPUG, showing pressure heads in layer 10 - existing conditions, at the end of 11 years dewatering and 30 years into the recovery run.

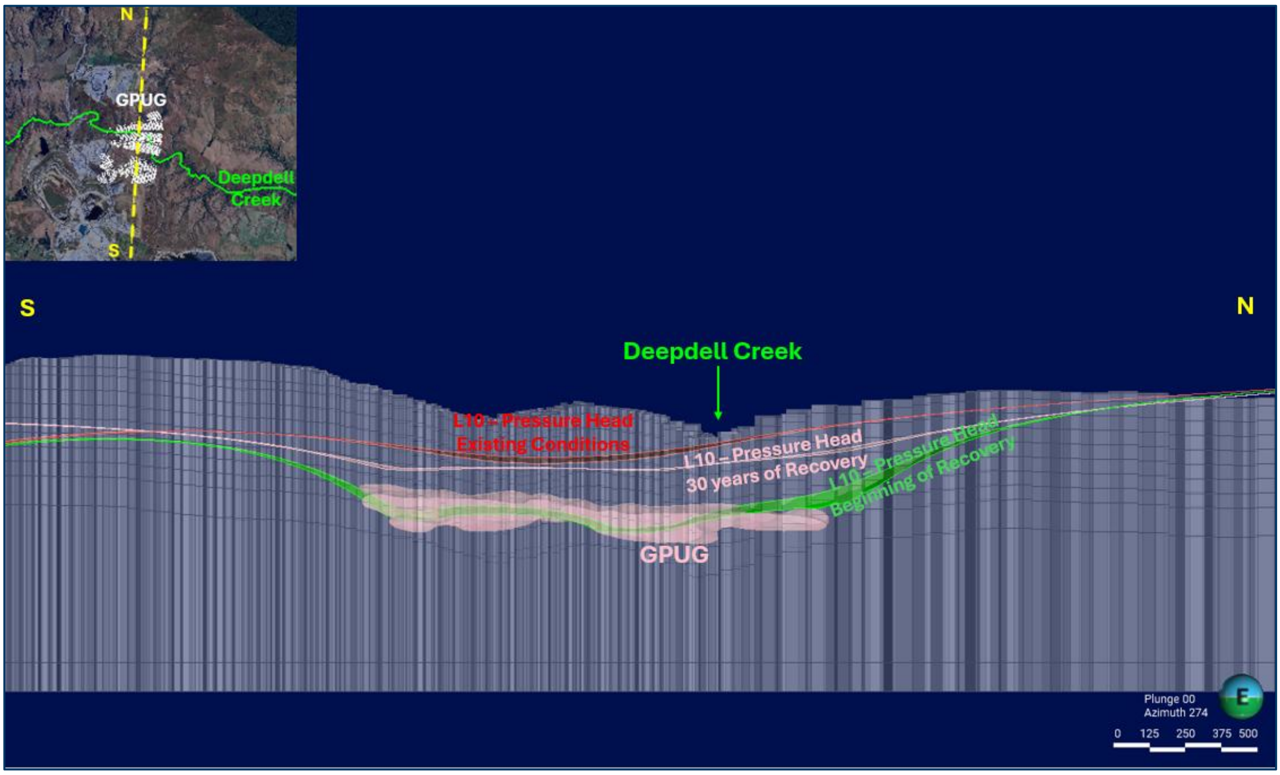


Figure C-5.16 South-North cross section through GPUG, showing pressure heads in layer 10 - existing conditions, at the end of 11 years dewatering and 30 years into the recovery run.

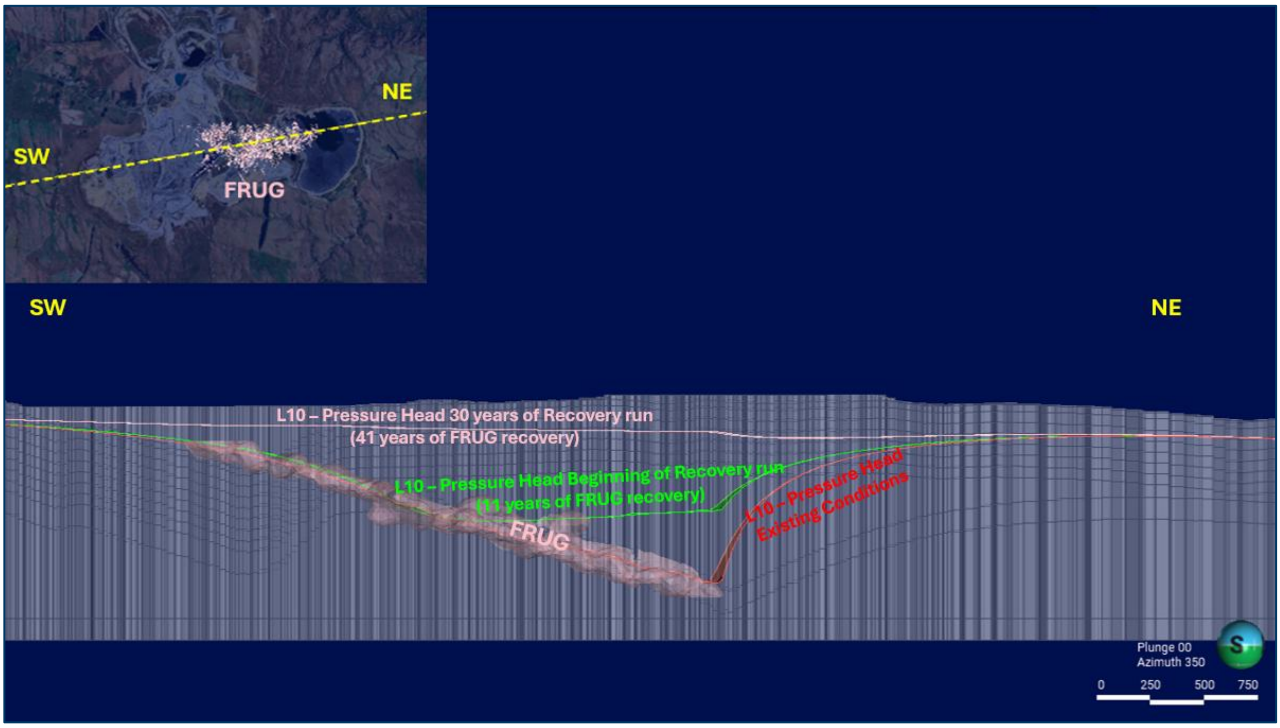


Figure C-5.17 Southwest-Northeast cross section through FRUG, pressure heads in layer 10, existing conditions, at the end of 11 years dewatering and 30 years into the recovery run.

In Figure C-5.15 to Figure C-5.17 the pressure head lines for intermediate stage recovery periods show flat gradients above sections of the underground workings. These flat gradients reflect the modelled water pressures within partially flooded underground workings where groundwater recovery is still progressing.

C-5.3 Contaminant Transport

Sulphate contaminant transport modelling was undertaken using the solute transport modelling code (MODFLOW USG-TRANSPORT) in the Existing Conditions, Dewatering and Recovery models. Sulphate has been modelled due to its expected elevated concentration (relative to other key contaminants), its existing elevated nature in some receiving surface water bodies around the MGP site as a result of mining activity, and its limited ability to attenuate within the groundwater system. It is therefore considered a conservative element with which to assess contaminant mobilisation and transport from the backfilled waste, WRSs and subsequent pit lakes to receiving surface water bodies via the groundwater system.

The following inputs were used in the contaminant transport models:

- Effective porosity values equal to specific yield values (Table C-4.1).
- Longitudinal dispersivity value = 20 m (assumed 10% of plume length based on initial test run where plume was expected to migrate approximately 200 m)
- Transverse dispersivity value = 2 m (10% of the longitudinal)
- The adopted sulphate concentrations are presented in Figure C-5.18 and Figure C-5.19 were derived from MWM (2026b) as outlined in Appendix E. These concentrations were implemented in the groundwater contaminant transport model as time-varying Constant Concentration Boundary conditions, with concentration values updated at each stress period. Annual stress periods were used during the existing conditions, dewatering, and early recovery phases to represent the relatively rapid changes in sulphate concentrations. During the later stages of the recovery phase, when concentration changes were less pronounced, the stress period duration was increased to 10 years.

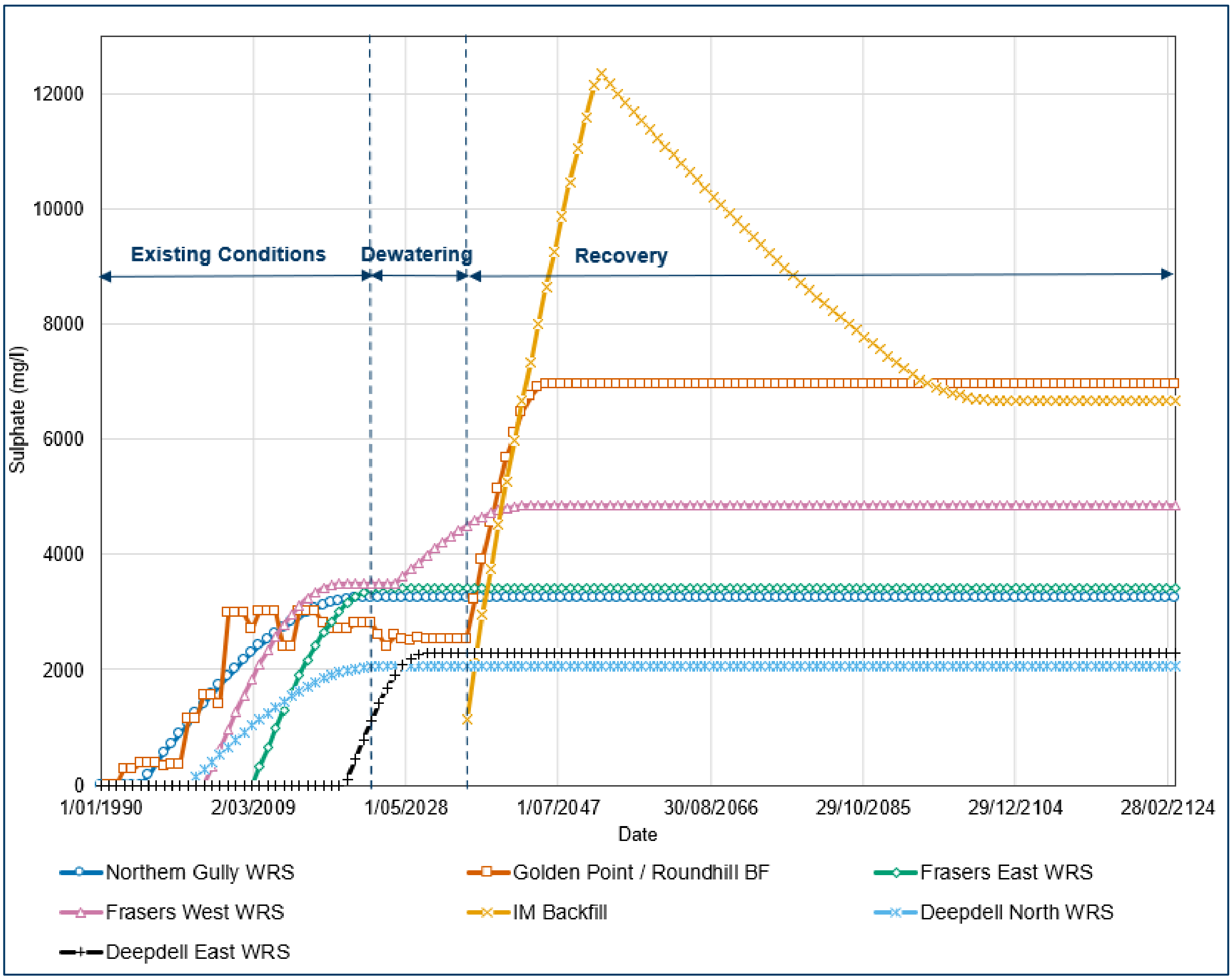


Figure C-5.18 Sulphate concentrations used as inputs for groundwater contaminant transport modelling in the WRSs and backfills.

Water balance error and solute transport mass balance error for all contaminant transport runs (existing conditions, dewatering and recovery models) were <0.01%, indicating all model runs completed were numerically stable (Figure C-5.20 to Figure C-5.22). In these figures Cumulative mass units are kg/m^3 x m^3 = kg and mass flux units are kg/m^3 x m^3/day= kg/day.

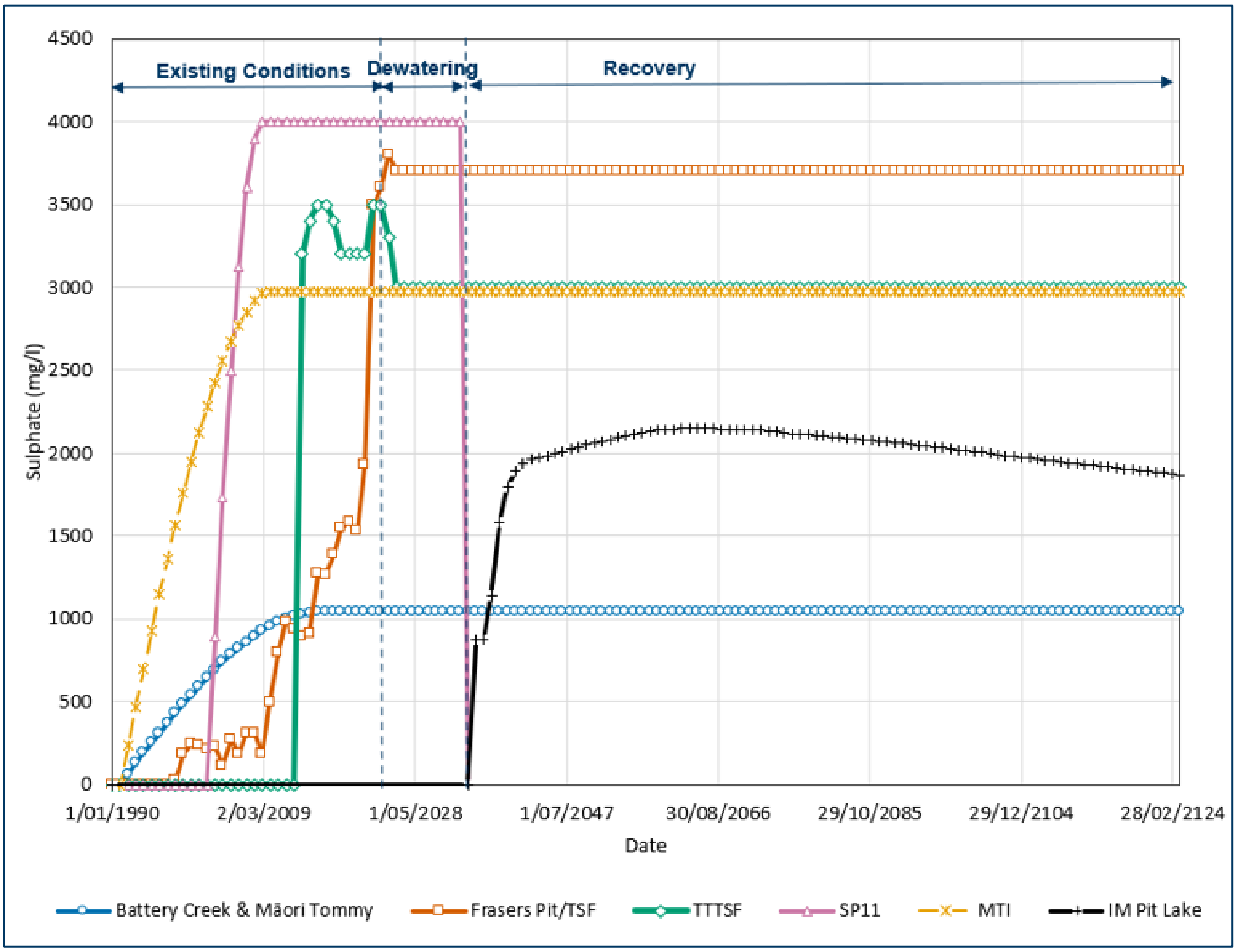


Figure C-5.19 Sulphate concentrations used as inputs for groundwater contaminant transport modelling in the pit lakes, silt ponds and tailings.

```
MASS BUDGET FOR ENTIRE MODEL AT END OF TIME STEP      12 IN STRESS PERIOD      35
 ------------------------------------------------------------------------------------

   CUMULATIVE MASS         M/L^3 * L^3       RATES FOR THIS TIME STEP      M/L^3 * L^3/T
   ------------------                 ------------------------

         IN:                                       IN:
         ---                                       ---
      MASS STORAGE =     6843794.4876           MASS STORAGE =       1.9833E-04
     ADSORBED MASS =           0.0000          ADSORBED MASS =           0.0000
  PRESCRIBED CONCS =   212244973.8642       PRESCRIBED CONCS =       12078.8564
  CNST H MASS FLUX =           0.0000       CNST H MASS FLUX =           0.0000
     DRN MASS FLUX =       1.7665E-11          DRN MASS FLUX =           0.0000
     RIV MASS FLUX =       8.2279E-07          RIV MASS FLUX =           0.0000
     RCH MASS FLUX =           0.0000          RCH MASS FLUX =           0.0000

          TOTAL IN =   219088768.3519              TOTAL IN =       12078.8566

        OUT:                                      OUT:
        ----                                      ----
      MASS STORAGE =   191435029.9163           MASS STORAGE =        5567.7310
     ADSORBED MASS =           0.0000          ADSORBED MASS =           0.0000
  PRESCRIBED CONCS =     7987614.2134       PRESCRIBED CONCS =         207.4709
  CNST H MASS FLUX =       1.6352E-15       CNST H MASS FLUX =           0.0000
     DRN MASS FLUX =    18400639.1953          DRN MASS FLUX =        6015.9668
     RIV MASS FLUX =     1265485.0240          RIV MASS FLUX =         287.6876
     RCH MASS FLUX =           0.0000          RCH MASS FLUX =           0.0000

         TOTAL OUT =   219088768.3491             TOTAL OUT =       12078.8562

          IN - OUT =       2.7563E-03              IN - OUT =       3.9670E-04

PERCENT DISCREPANCY =           0.00    PERCENT DISCREPANCY =          0.00
```

Figure C-5.20 Existing conditions model mass balance summary

```
MASS BUDGET FOR ENTIRE MODEL AT END OF TIME STEP      12 IN STRESS PERIOD      11
 ------------------------------------------------------------------------------------

   CUMULATIVE MASS         M/L^3 * L^3       RATES FOR THIS TIME STEP      M/L^3 * L^3/T
   ------------------                 ------------------------

         IN:                                       IN:
         ---                                       ---
      MASS STORAGE =    15973479.8443           MASS STORAGE =         512.3615
     ADSORBED MASS =           0.0000          ADSORBED MASS =           0.0000
  PRESCRIBED CONCS =   294118098.9442       PRESCRIBED CONCS =       15733.4766
  CNST H MASS FLUX =           0.0000       CNST H MASS FLUX =           0.0000
    WELL MASS FLUX =           0.0000         WELL MASS FLUX =           0.0000
     GHB MASS FLUX =           0.0000          GHB MASS FLUX =           0.0000
     DRN MASS FLUX =      2.1388-145           DRN MASS FLUX =           0.0000
     RIV MASS FLUX =      8.1705-100           RIV MASS FLUX =           0.0000
     RCH MASS FLUX =           0.0000          RCH MASS FLUX =           0.0000

          TOTAL IN =   310091578.7885              TOTAL IN =       16245.8380

        OUT:                                      OUT:
        ----                                      ----
      MASS STORAGE =   278790289.2252           MASS STORAGE =        9333.7734
     ADSORBED MASS =           0.0000          ADSORBED MASS =           0.0000
  PRESCRIBED CONCS =    18670627.0059       PRESCRIBED CONCS =        1407.6014
  CNST H MASS FLUX =           0.0000       CNST H MASS FLUX =           0.0000
    WELL MASS FLUX =           0.0000         WELL MASS FLUX =           0.0000
     GHB MASS FLUX =           0.0000          GHB MASS FLUX =           0.0000
     DRN MASS FLUX =    10916524.7798          DRN MASS FLUX =        5011.6836
     RIV MASS FLUX =     1714137.7778          RIV MASS FLUX =         492.7794
     RCH MASS FLUX =           0.0000          RCH MASS FLUX =           0.0000

         TOTAL OUT =   310091578.7887             TOTAL OUT =       16245.8378

          IN - OUT =      -1.8275E-04              IN - OUT =       1.8311E-04

PERCENT DISCREPANCY =          -0.00    PERCENT DISCREPANCY =          0.00
```

Figure C-5.21 Dewatering model mass balance summary

```
MASS BUDGET FOR ENTIRE MODEL AT END OF TIME STEP      60 IN STRESS PERIOD      74
-------------------------------------------------------------------------------------

   CUMULATIVE MASS         M/L^3 * L^3       RATES FOR THIS TIME STEP      M/L^3 * L^3/T
   ------------------                  ------------------------

         IN:                                       IN:
         ---                                       ---
      MASS STORAGE =   124638565.4250          MASS STORAGE =          26.2752
     ADSORBED MASS =           0.0000         ADSORBED MASS =           0.0000
  PRESCRIBED CONCS =  1373092761.5881      PRESCRIBED CONCS =        8340.9844
  CNST H MASS FLUX =           0.0000      CNST H MASS FLUX =           0.0000
    WELL MASS FLUX =           0.0000        WELL MASS FLUX =           0.0000
     GHB MASS FLUX =           0.0000         GHB MASS FLUX =           0.0000
     DRN MASS FLUX =       3.7094-130         DRN MASS FLUX =           0.0000
     RIV MASS FLUX =       4.6744E-72         RIV MASS FLUX =           0.0000
     RCH MASS FLUX =           0.0000         RCH MASS FLUX =           0.0000

          TOTAL IN =  1497731327.0131              TOTAL IN =        8367.2596

        OUT:                                      OUT:
        ----                                      ----
      MASS STORAGE =   403628617.6490          MASS STORAGE =         479.6740
     ADSORBED MASS =           0.0000         ADSORBED MASS =           0.0000
  PRESCRIBED CONCS =   529373530.3301      PRESCRIBED CONCS =        3341.8474
  CNST H MASS FLUX =           0.0000      CNST H MASS FLUX =           0.0000
    WELL MASS FLUX =           0.0000        WELL MASS FLUX =           0.0000
     GHB MASS FLUX =           0.0000         GHB MASS FLUX =           0.0000
     DRN MASS FLUX =   502489165.6841         DRN MASS FLUX =        4037.9822
     RIV MASS FLUX =    62240013.2500         RIV MASS FLUX =         507.7560
     RCH MASS FLUX =           0.0000         RCH MASS FLUX =           0.0000

         TOTAL OUT =  1497731326.9132             TOTAL OUT =        8367.2596

          IN - OUT =       9.9892E-02              IN - OUT =      -1.9073E-05

PERCENT DISCREPANCY =            0.00    PERCENT DISCREPANCY =          -0.00
```

Figure C-5.22 Recovery model mass balance

The predicted sulphate plume extent in model layer 1 for existing conditions is shown in Figure C-5.23. The existing conditions modelled sulphate results were compared with recently measured sulphate concentrations in existing groundwater monitoring wells within the Macraes site (Appendix J). The comparison shows that modelled sulphate concentrations for the existing-conditions model (with very few exceptions as shown in the scatter plot shown in Figure C-5.24) are higher than measured concentrations, providing a relatively conservative basis for the initial sulphate concentrations adopted in the dewatering and groundwater recovery model runs. The location of the monitoring wells used and the difference between modelled versus measured sulphate concentrations for each well is shown in Figure C-5.25.

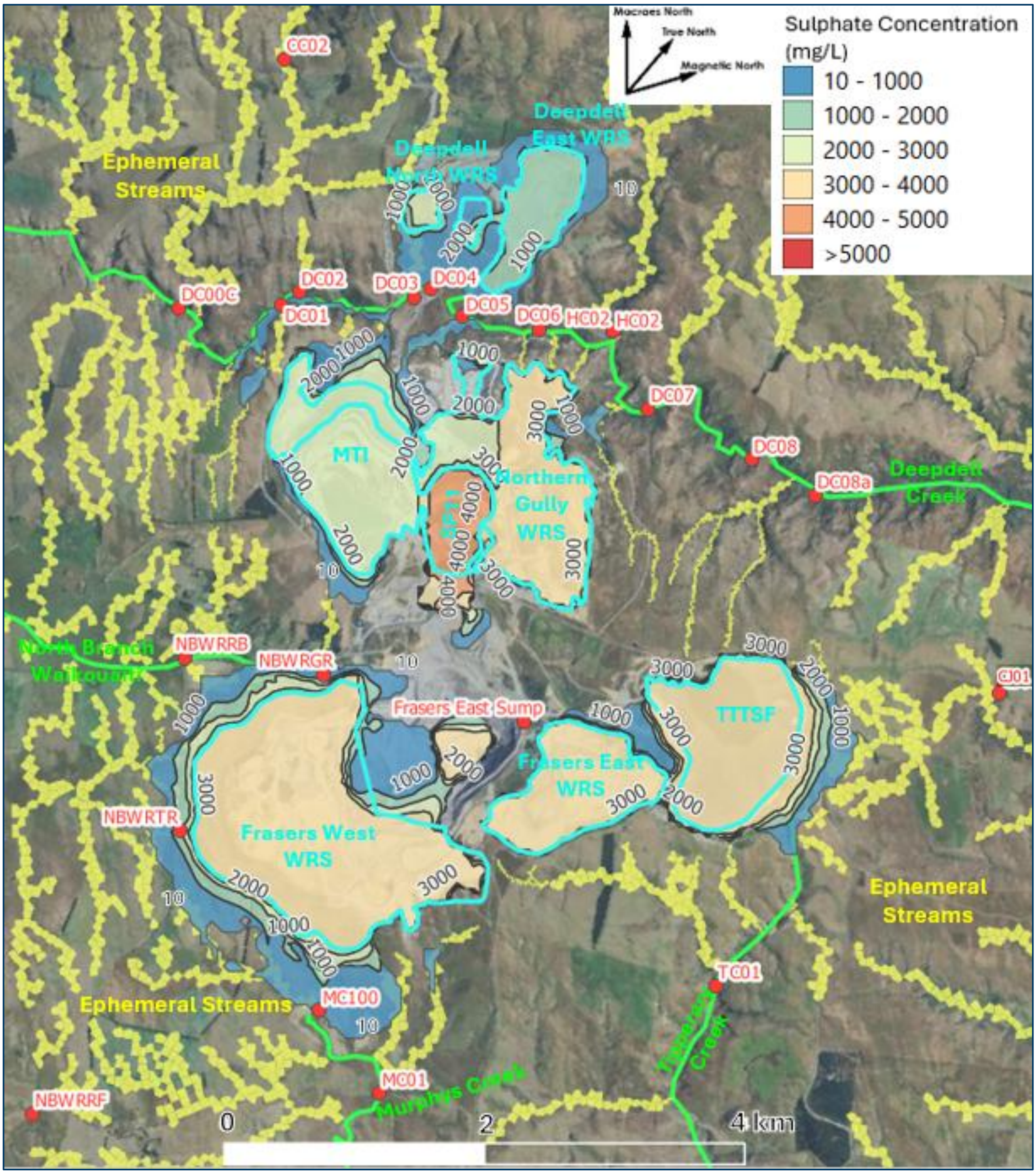


Figure C-5.23 Modelled sulphate plume extent in Model Layer 1 for the existing conditions model.

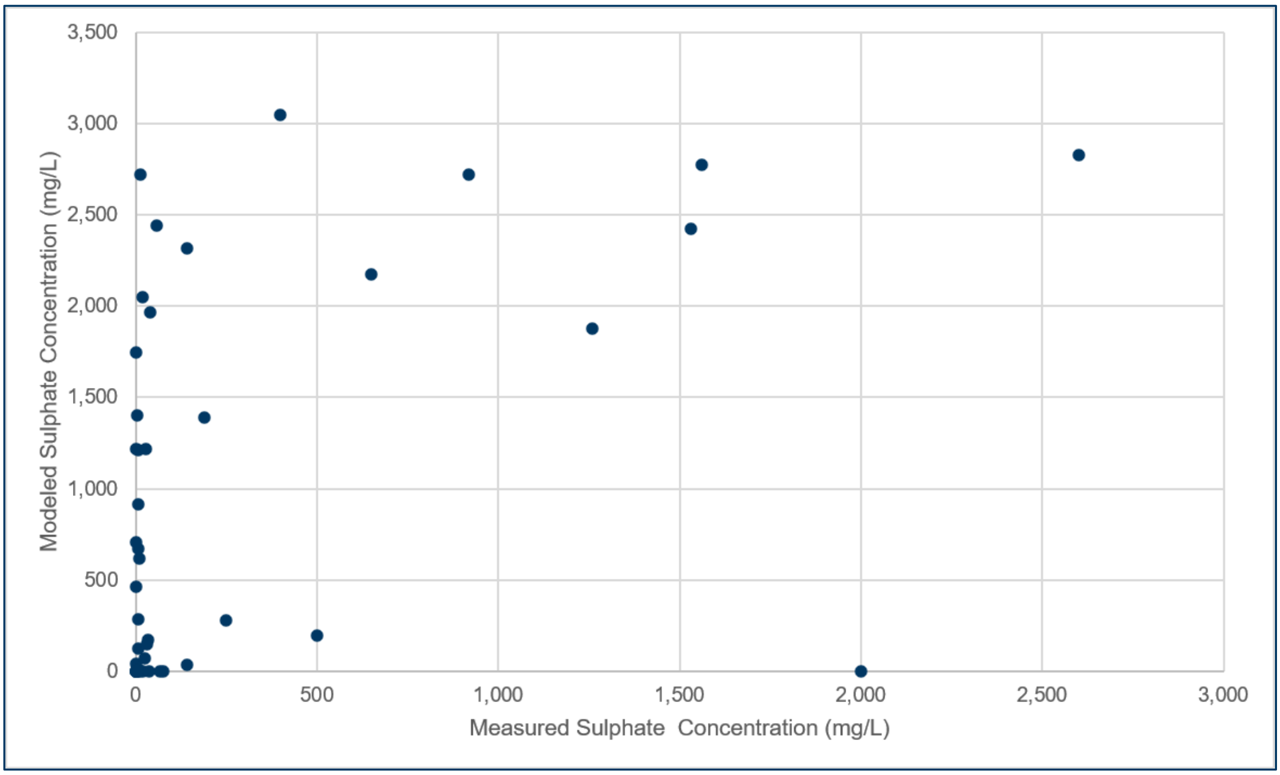


Figure C-5.24 Scatter plot modelled versus measured sulphate concentration

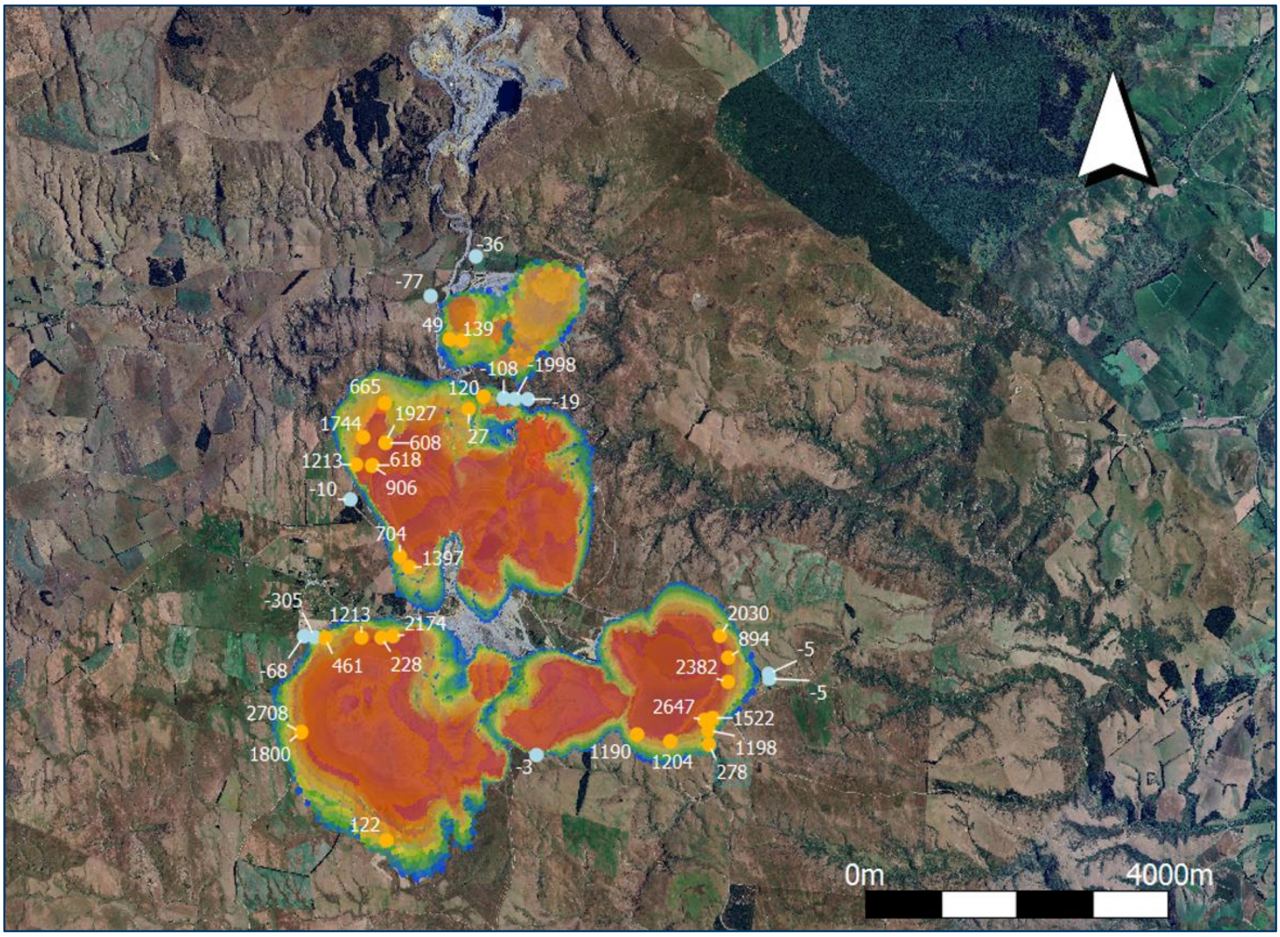


Figure C-5.25 Location of monitoring wells sampled and difference between modelled and measured sulphate concentration - positive number (mg/L) indicates that the modelled value is larger than the measured value.

The predicted plume extents for the dewatering and recovery models, are presented in Figure C-5.26 and Figure C-5.27, respectively. Enlarged views and the predicted plume extent in deeper model layers are provided in Attachment 3 of this Appendix.

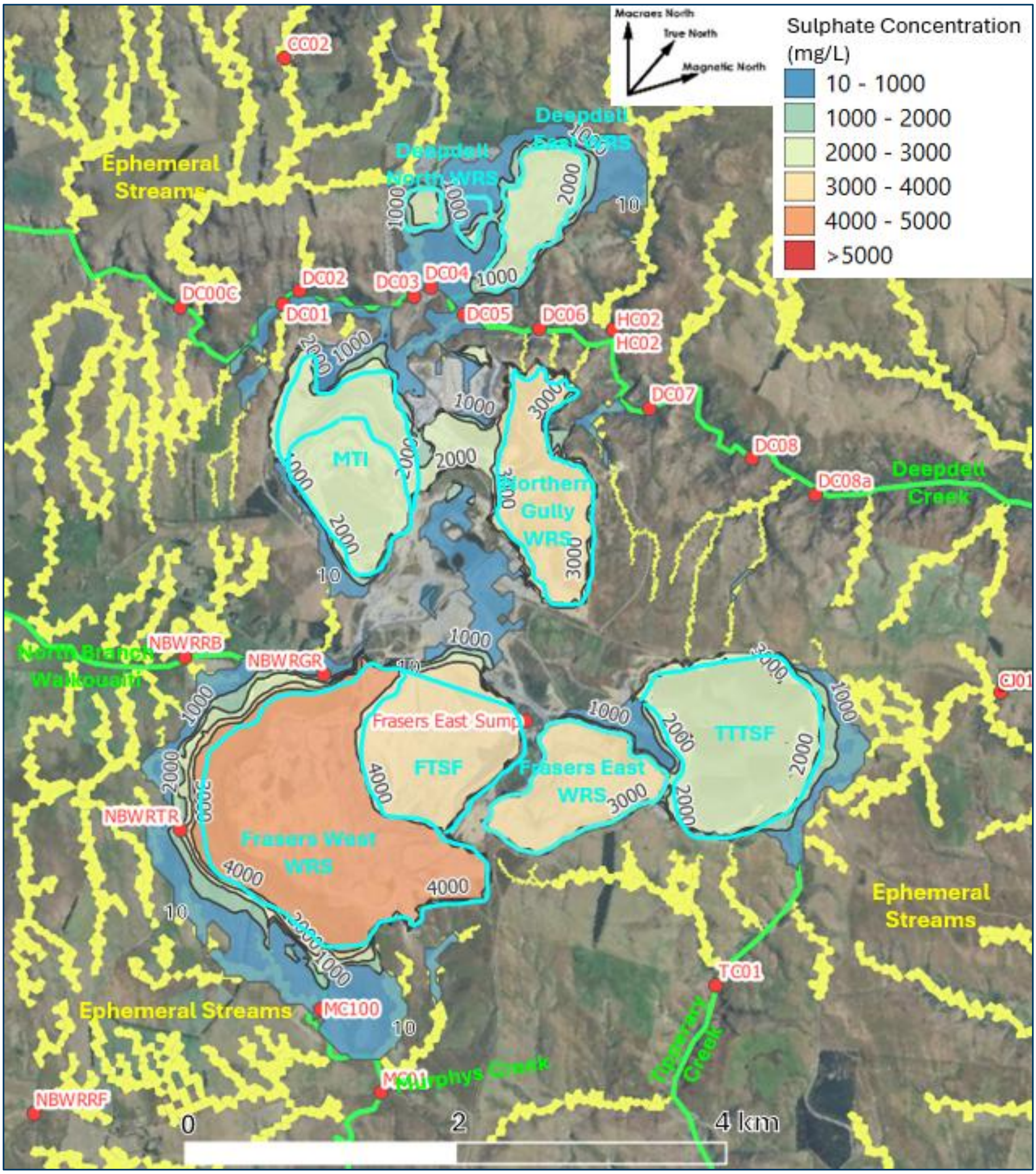


Figure C-5.26 Modelled sulphate plume extent in Model Layer 1 at the end of Innes Mills Pit and GPUG dewatering.

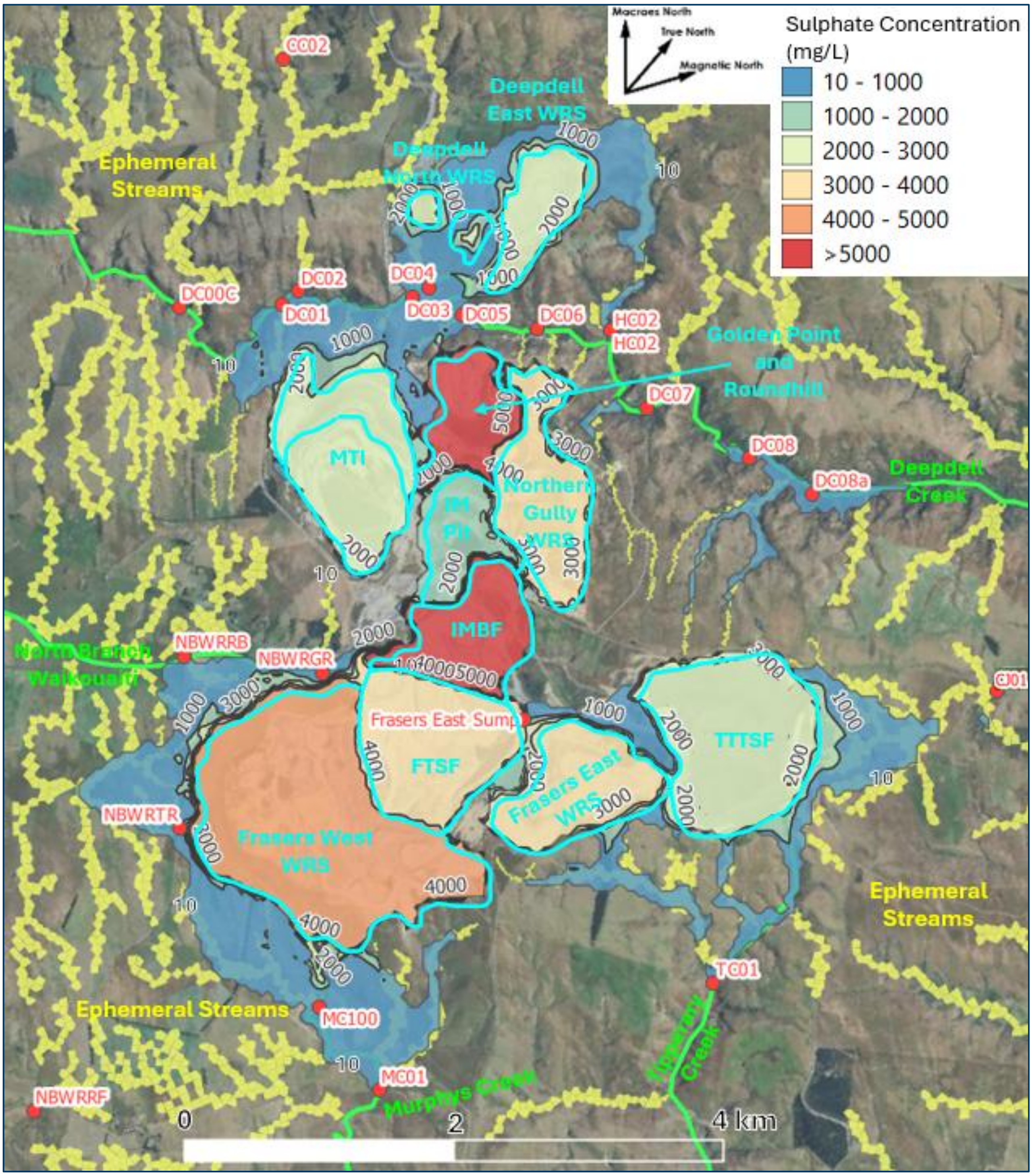


Figure C-5.27 Contour plot showing sulphate plume extent at the end of the recovery model (400 years of recovery) in model layer 1.

Comparison of the existing conditions, dewatering and recovery results, shows that sulphate plume distribution is as expected primarily controlled by mine-related source areas and local groundwater flow pathways. Dewatering causes localised modifications to plume geometry near the pits and underground workings, while the recovery simulations indicate gradual long-term plume migration under recovering groundwater conditions.

Figure C-5.28, Figure C-5.29 and Figure C-5.30 present cross sections showing the modelled sulphate plume extent along the FRUG and GPUG alignments at the end of the 400-year recovery simulation. Furthermore, a south–north cross section through selected main key site features, showing the modelled sulphate plume, is provided in Attachment 4 of this Appendix.

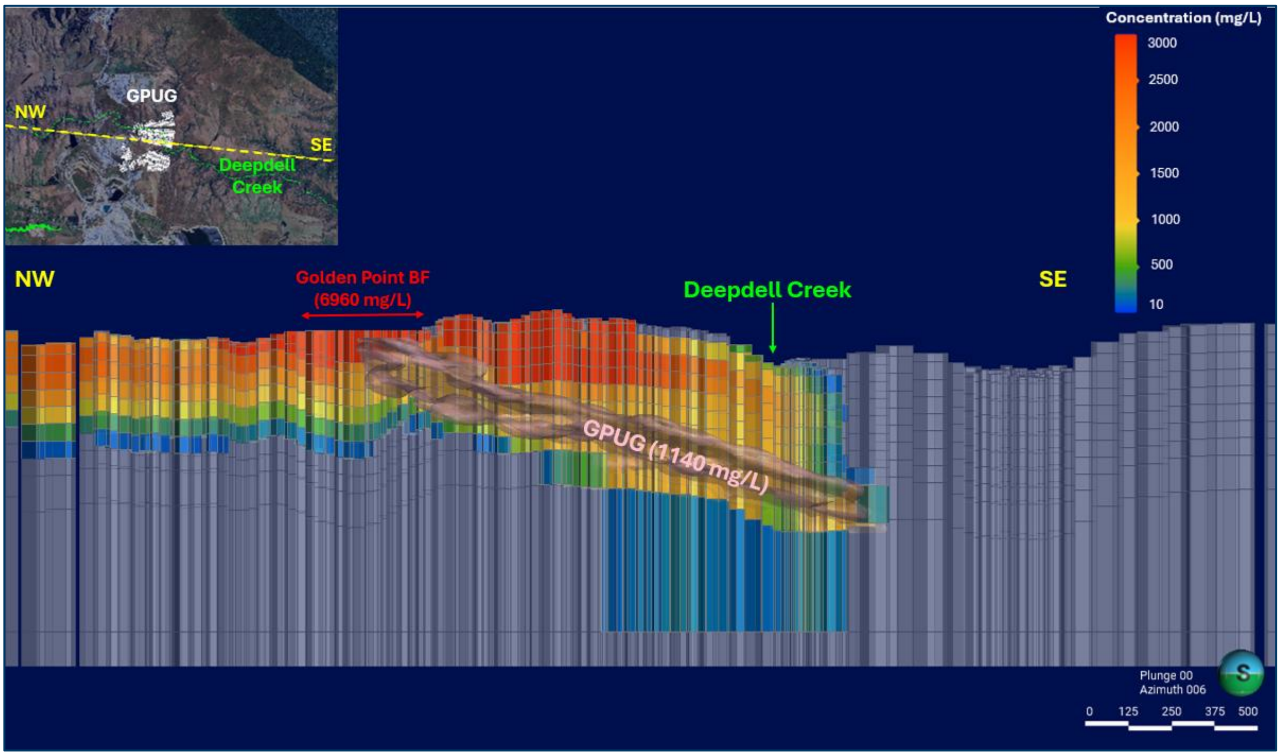


Figure C-5.28 Northwest-Southeast cross section through GPUG, showing the extent of the sulphate plume at the recovery run after 400 years.

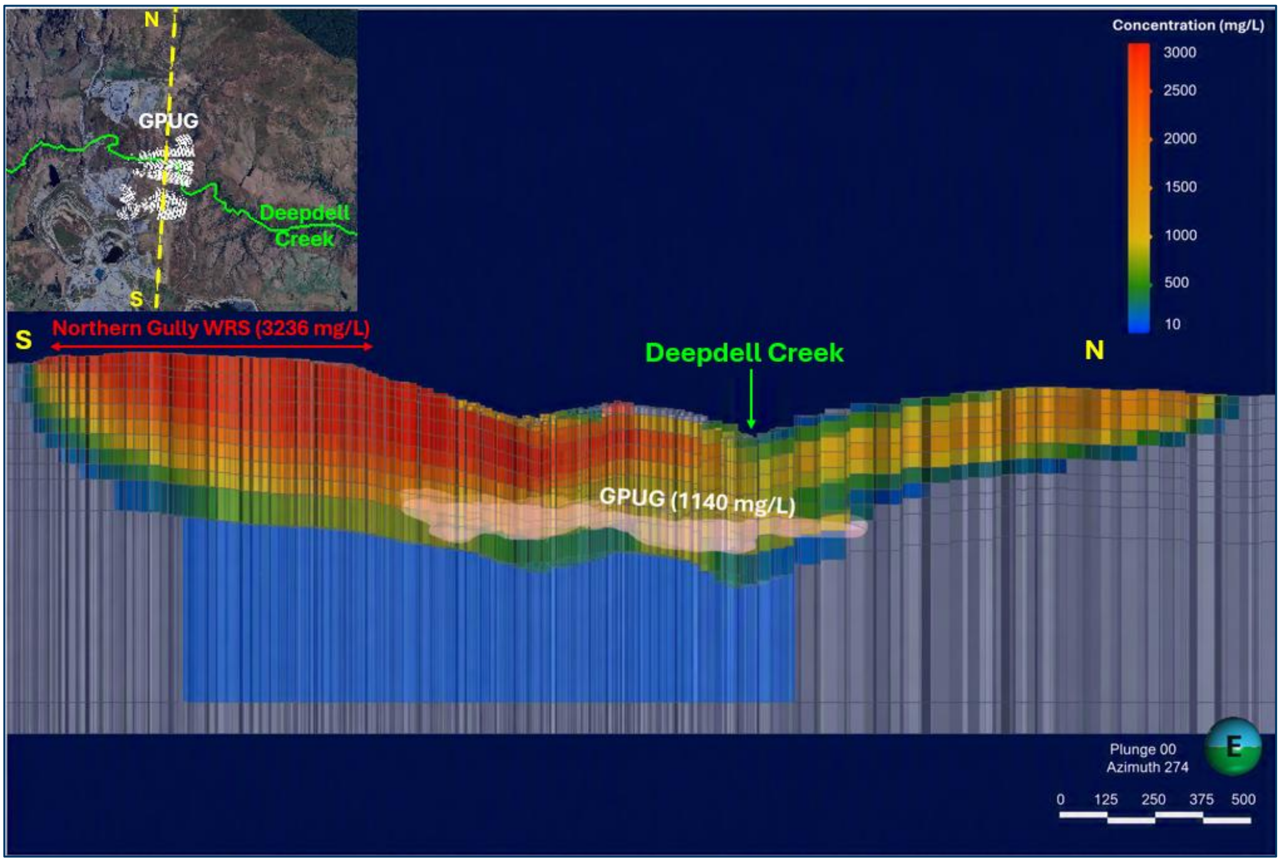


Figure C-5.29 South-North cross section through GPUG, showing the extent of the sulphate plume at the recovery run after 400 years.

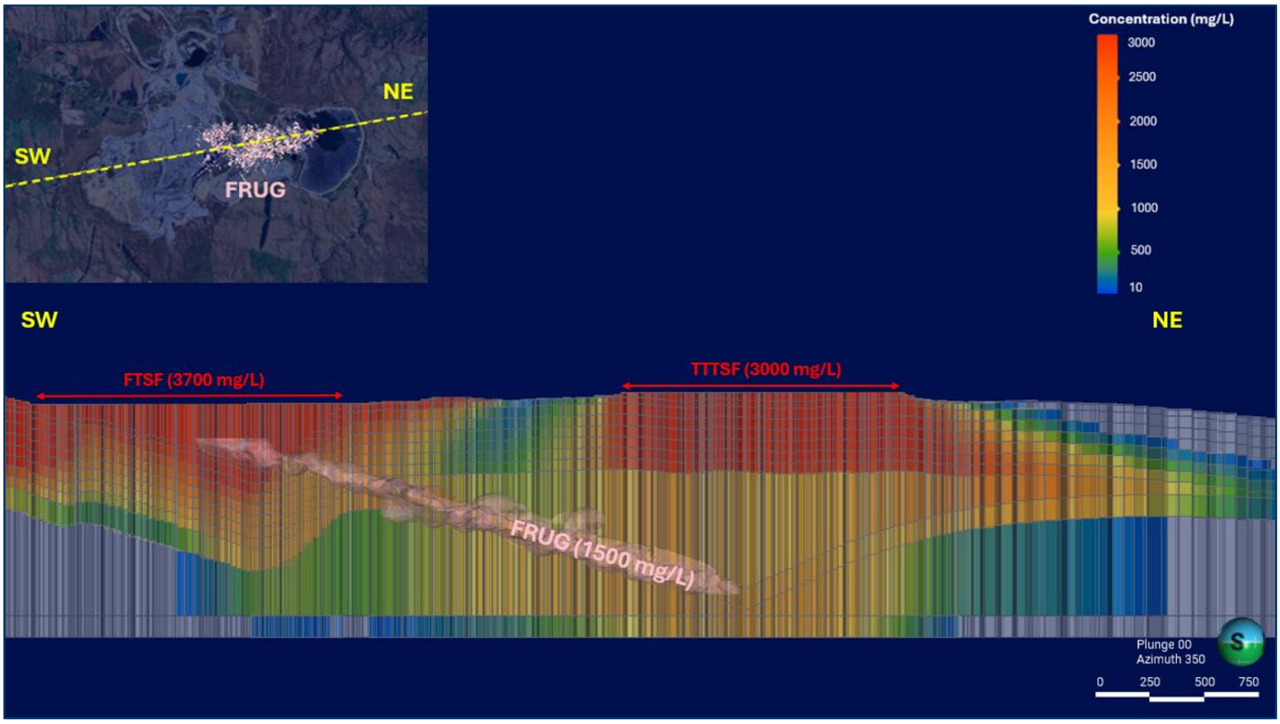


Figure C-5.30 Southwest-Northeast cross section through FRUG, showing the extent of the sulphate plume at the recovery run after 400 years.

The total modelled sulphate mass discharged to the catchments was estimated by combining contaminant transport model results with simulated flows across surface-water boundaries, including river boundaries representing the creeks and drain boundaries representing the ephemeral streams and seepage capture drains. The catchments were delineated to correspond with key compliance points, surface water monitoring nodes and surface water monitoring programs (Figure C-5.31). Predicted results for the 400-year post-closure period are summarised in Table C-5.2.

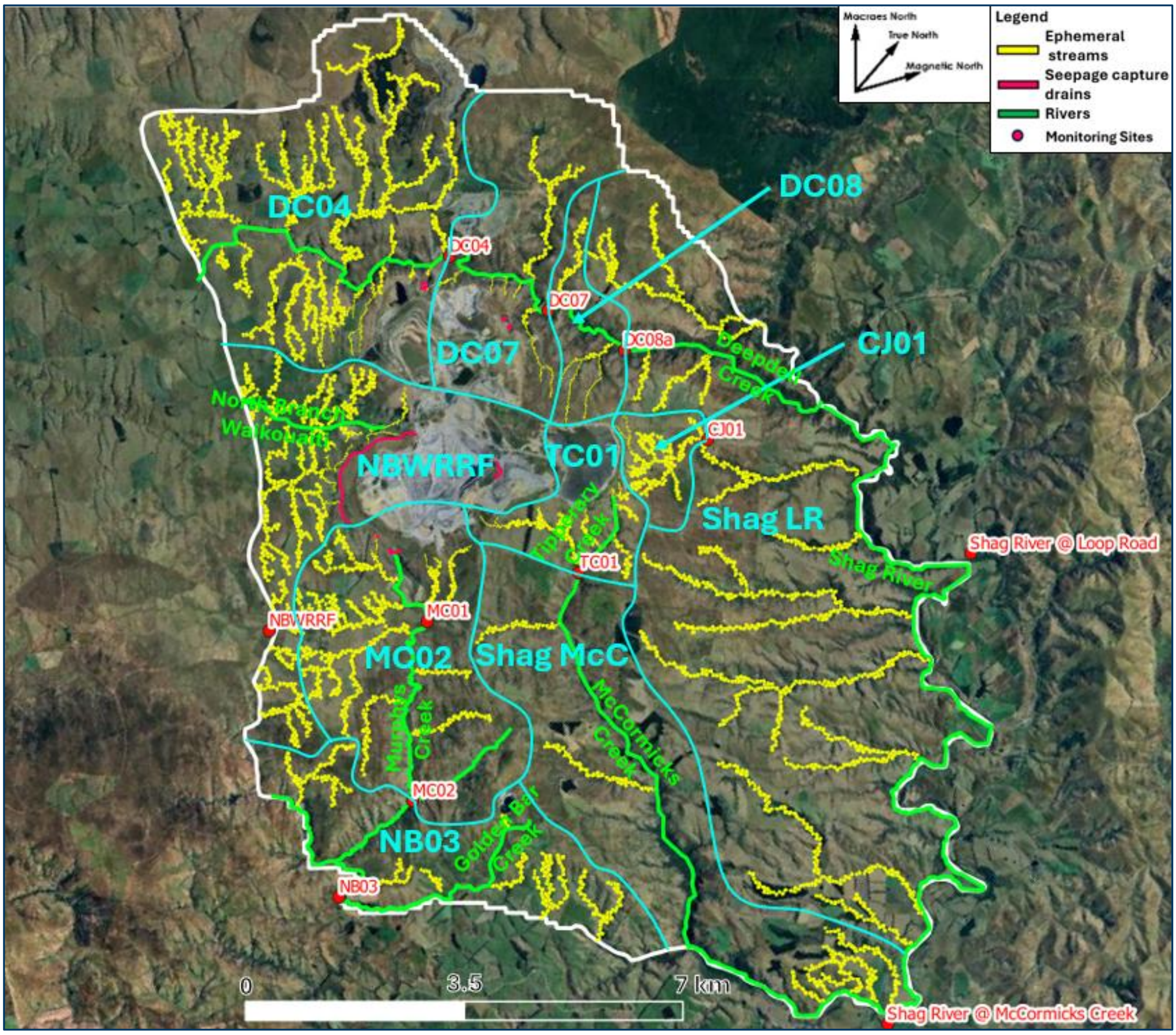


Figure C-5.31 Catchments with respect to surface water compliance monitoring points analysed for the contaminant transport model results

Table C-5.2 Estimated groundwater sulphate flux at surface water compliance monitoring points - 400 years post-closure

Catchment	Sulphate flux (kg/day)
Deepdell Creek- DC04	125.6
Deepdell Creek - DC07	131
Deepdell Creek - DC08	34
North Branch Waikouaiti River Ross Road Ford (NBWRRF)	109
North Branch Waikouaiti River - NB03	<1
Murphys Creek - MC02	309
Tipperary Creek - TC01	220
Cranky Jims Creek - CJ01	85
Shag River at Loop Road	<1
Shag River at McCormicks	8
Seepage capture drains	868

Existing consented groundwater takes[2], existing bores and proposed bores[2] were reviewed against the maximum predicted extent of the modelled sulphate plume as shown in Figure C-5.32 and Figure C-5.33 respectively. This review indicates that these groundwater receptors are not expected to be intersected by the predicted plume extent, and adverse effects on groundwater users are therefore considered unlikely.

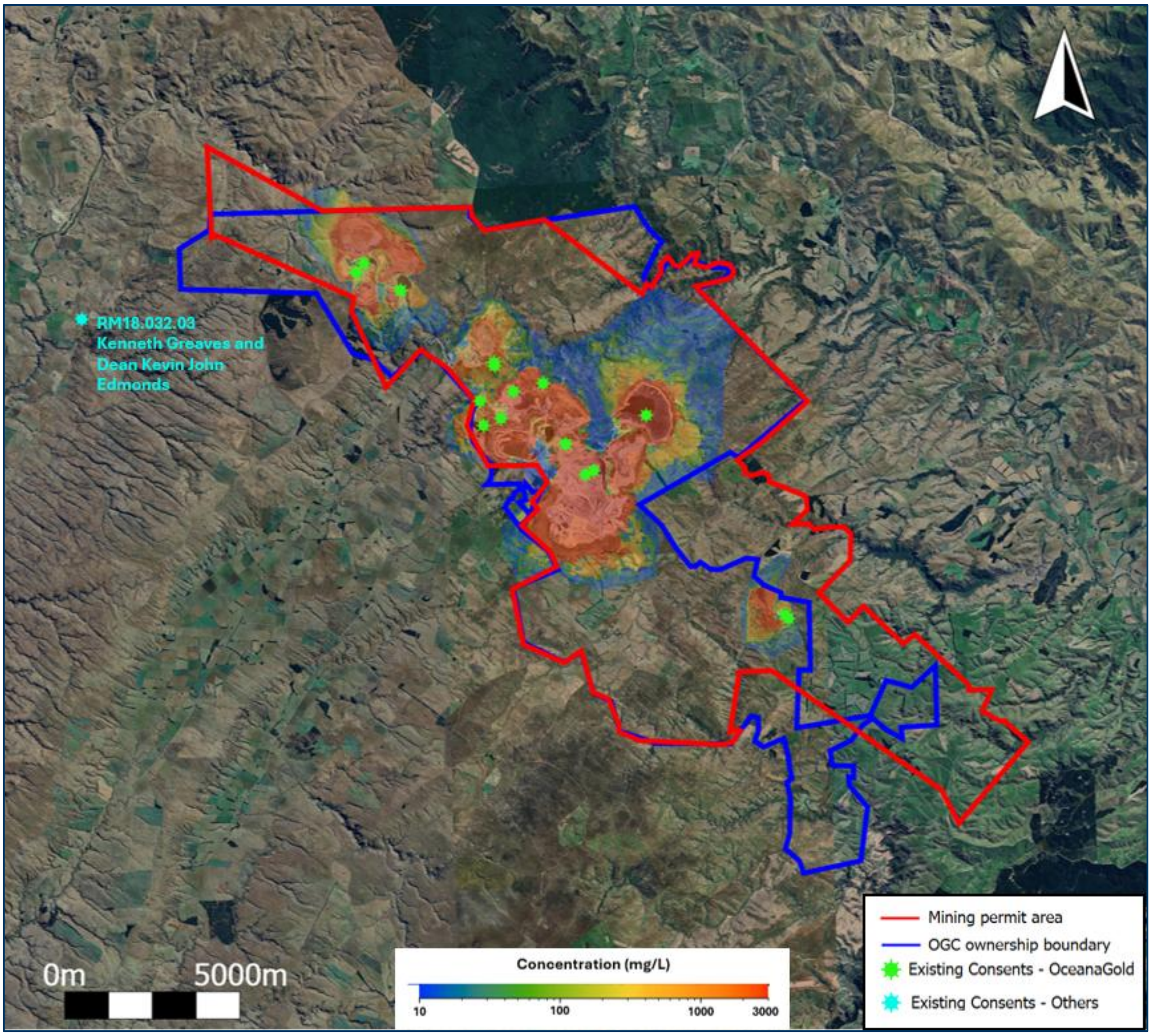


Figure C-5.32 Existing groundwater consented takes and sulphate plume extent at the end of the recovery model (400 years of recovery)

[2] **https://maps.orc.govt.nz/OtagoMaps/** accessed July 2027

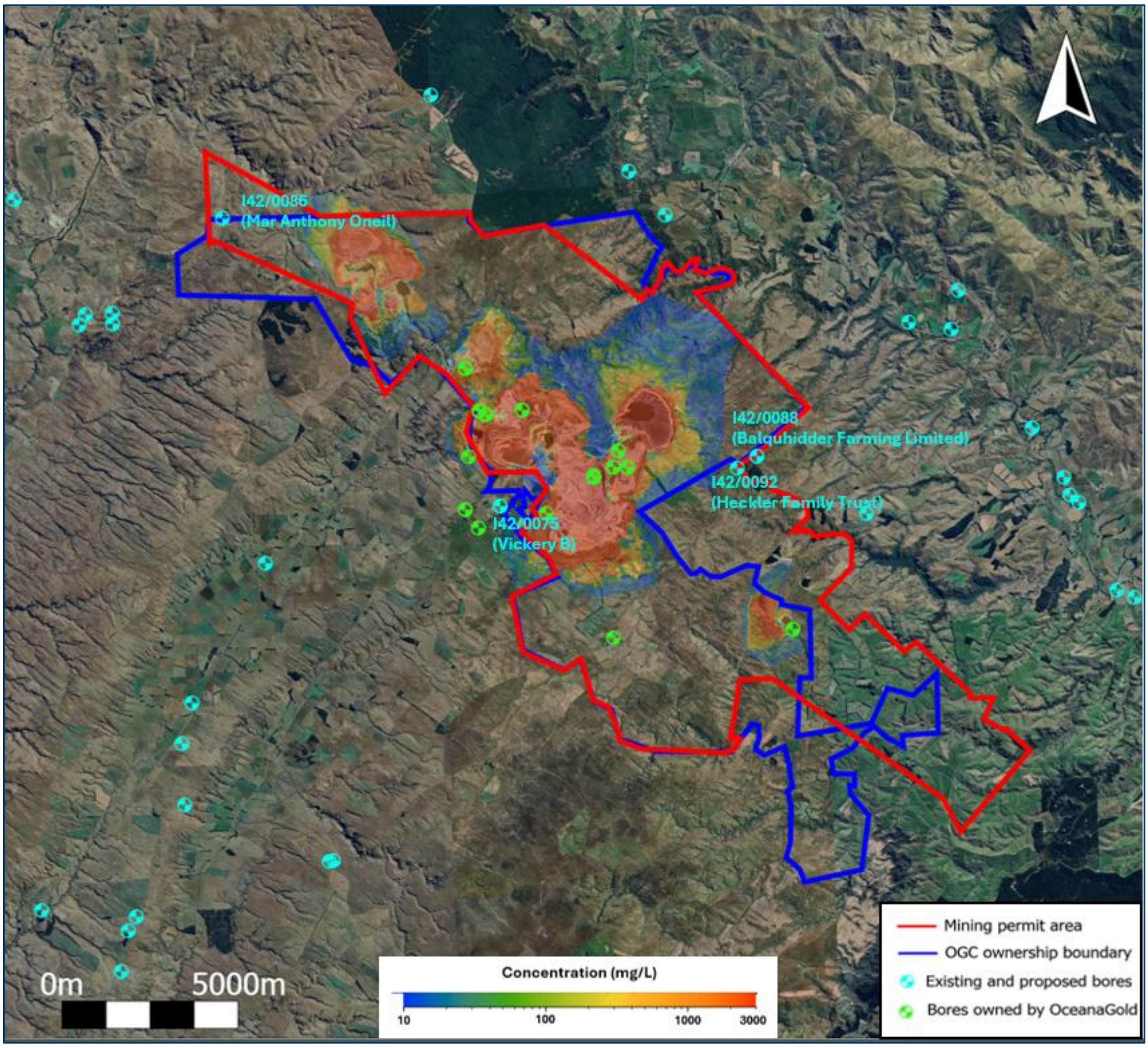


Figure C-5.33 Existing and proposed groundwater bores and sulphate plume extent at the end of the recovery model (400 years of recovery)

C-5.4 Brine Disposal Option – FRUG

C-5.4.1 Modelling approach

As discussed in Appendix F of this report, water treatment considered for the site includes an active water treatment plant (WTP) operating through the mining period and into the future to treat water prior to discharge to the environment, reducing contaminant mass load discharges from the site. A two-stage water treatment process including pre-treatment through lime dosing and settling, followed by a reverse osmosis (RO) treatment process is proposed and detailed in Process Flow (2026a). A concentrated brine is generated as a by-product of the RO process that requires long term management. To assess a potential disposal option, density-dependent groundwater modelling was undertaken to evaluate the behaviour of brine injected into the FRUG workings.

The recovery model discussed above was adapted using the density-dependent transport modelling code MODFLOW USG-TRANSPORT to simulate the injection of a brine solution in the FRUG workings. The simulation represented brine injection through a well screened at approximately -260 m RL, near the deepest point of the FRUG workings. The density-dependent formulation was used to account for the higher density of the injected brine relative to the surrounding groundwater and to evaluate its long-term migration under post-closure groundwater recovery conditions.

Additional parameters and assumptions used for this modelling are:

- Long term brine injection rate: 3.45 l/s
- Density of brine: 1.032 t/m^3 (for reference, freshwater typically has a density of approximately 1,000 kg/m^3, while seawater has an average density of around 1,025 kg/m^3).
- Injection point: near the deepest part of FRUG (approximately -260 mRL)
- Modelled constituent: Brine only for this model simulation. The injected fluid was assigned a relative concentration of 1, representing 100% brine and 0% freshwater or other mine water.
- Simulation period: 400 years.
- Plume extent criterion: 1% brine concentration (equivalent to 99% freshwater or other mine water)

Water balance error and transport mass balance error were <0.01%, indicating the model run completed was numerically stable (Figure C-5.34).

```
 MASS BUDGET FOR ENTIRE MODEL AT END OF TIME STEP      60 IN STRESS PERIOD      74
 -------------------------------------------------------------------------------------

    CUMULATIVE MASS         M/L^3 * L^3       RATES FOR THIS TIME STEP      M/L^3 * L^3/T
    -----------------                 -----------------------

          IN:                                       IN:
          ---                                       ---
       MASS STORAGE =          16.7134          MASS STORAGE =       1.2278E-06
   CNST H MASS FLUX =           0.0000      CNST H MASS FLUX =           0.0000
     WELL MASS FLUX =   43519678.0396         WELL MASS FLUX =         298.0800
      GHB MASS FLUX =       9.3326E-05         GHB MASS FLUX =       4.5866E-09
      DRN MASS FLUX =       2.3620E-10         DRN MASS FLUX =       3.1089E-14
      RIV MASS FLUX =       7.8561E-11         RIV MASS FLUX =       1.1468E-20
      RCH MASS FLUX =           0.0000         RCH MASS FLUX =           0.0000

           TOTAL IN =   43519694.7531              TOTAL IN =         298.0800

         OUT:                                      OUT:
         ----                                      ----
       MASS STORAGE =   43120126.4240          MASS STORAGE =         287.2561
   CNST H MASS FLUX =           0.0000      CNST H MASS FLUX =           0.0000
     WELL MASS FLUX =           0.0000        WELL MASS FLUX =           0.0000
      GHB MASS FLUX =     396027.6829          GHB MASS FLUX =          10.5609
      DRN MASS FLUX =       1110.5833          DRN MASS FLUX =       6.7408E-02
      RIV MASS FLUX =       2430.0585          RIV MASS FLUX =           0.1955
      RCH MASS FLUX =           0.0000         RCH MASS FLUX =           0.0000

          TOTAL OUT =   43519694.7486             TOTAL OUT =         298.0800

           IN - OUT =       4.4559E-03             IN - OUT =       4.4263E-07

PERCENT DISCREPANCY =            0.00    PERCENT DISCREPANCY =            0.00
```

Figure C-5.34 Brine Disposal Option model mass balance summary

Figure C-5.35 to Figure C-5.38 show the predicted extent of the brine plume after 400 years. For the purposes of this assessment, the plume was defined as the area containing relative brine concentrations between 1% (equivalent to 99% freshwater) and 100% (pure brine).

The model results indicate that the predicted plume extends approximately 5,000 m from southwest to northeast and approximately 4,700 m from north to south. Model results also indicate that the plume is not predicted to daylight at any major creeks and/or any tributary of these creeks. Instead, it is expected to remain at depth, approximately 65 m below the bed of Deepdell Creek and more than 260 m below the streambed of Tipperary Creek.

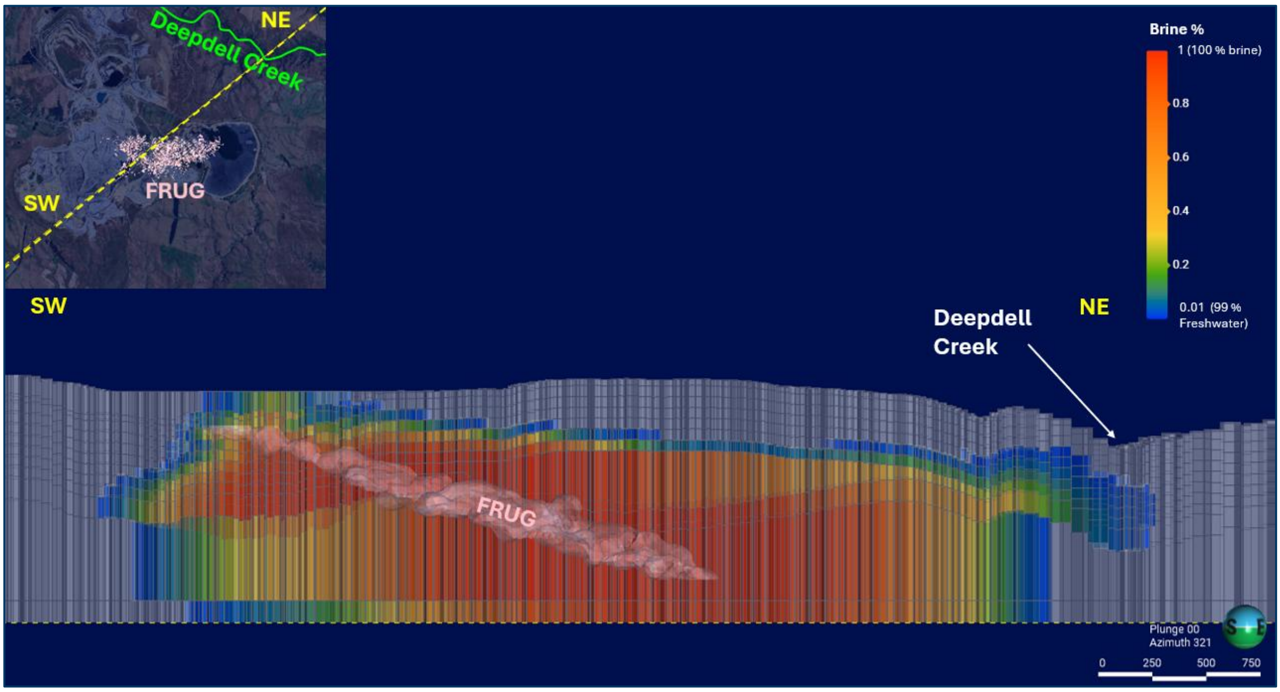


Figure C-5.35 Section view showing the predicted brine plume extent between FRUG and Deepdell Creek.

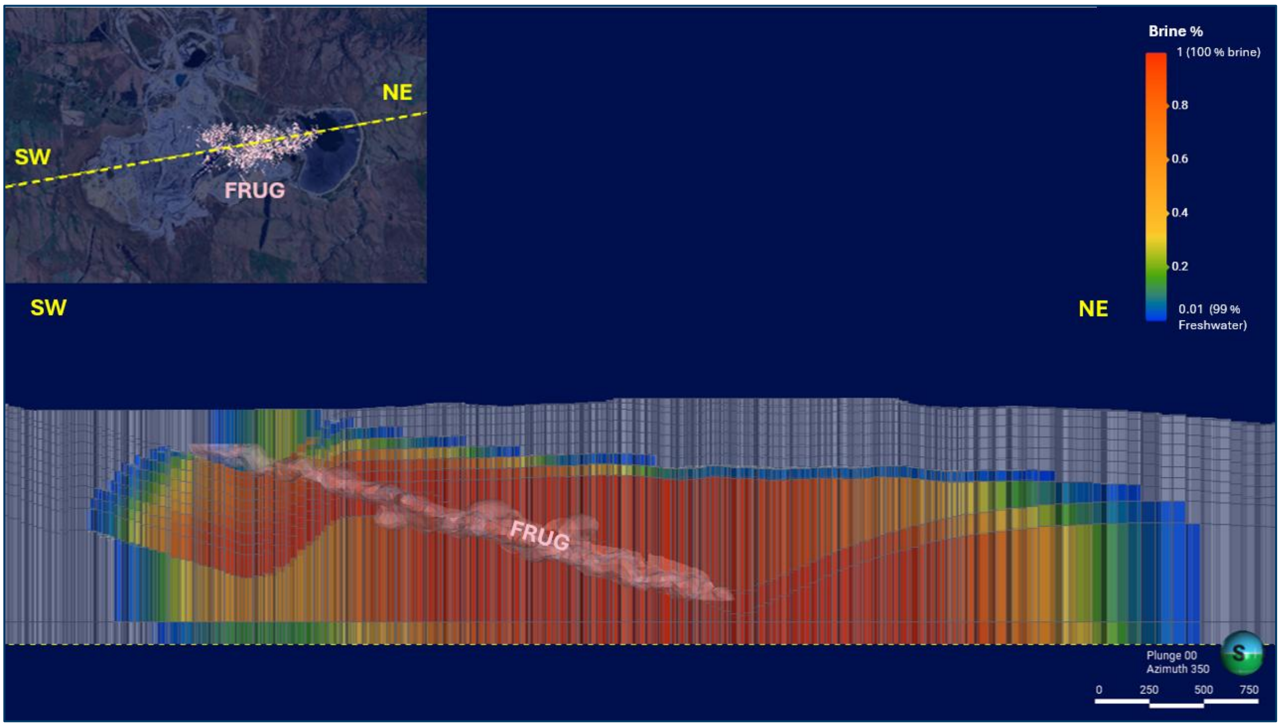


Figure C-5.36 Longitudinal section view showing the predicted brine plume extent along FRUG.

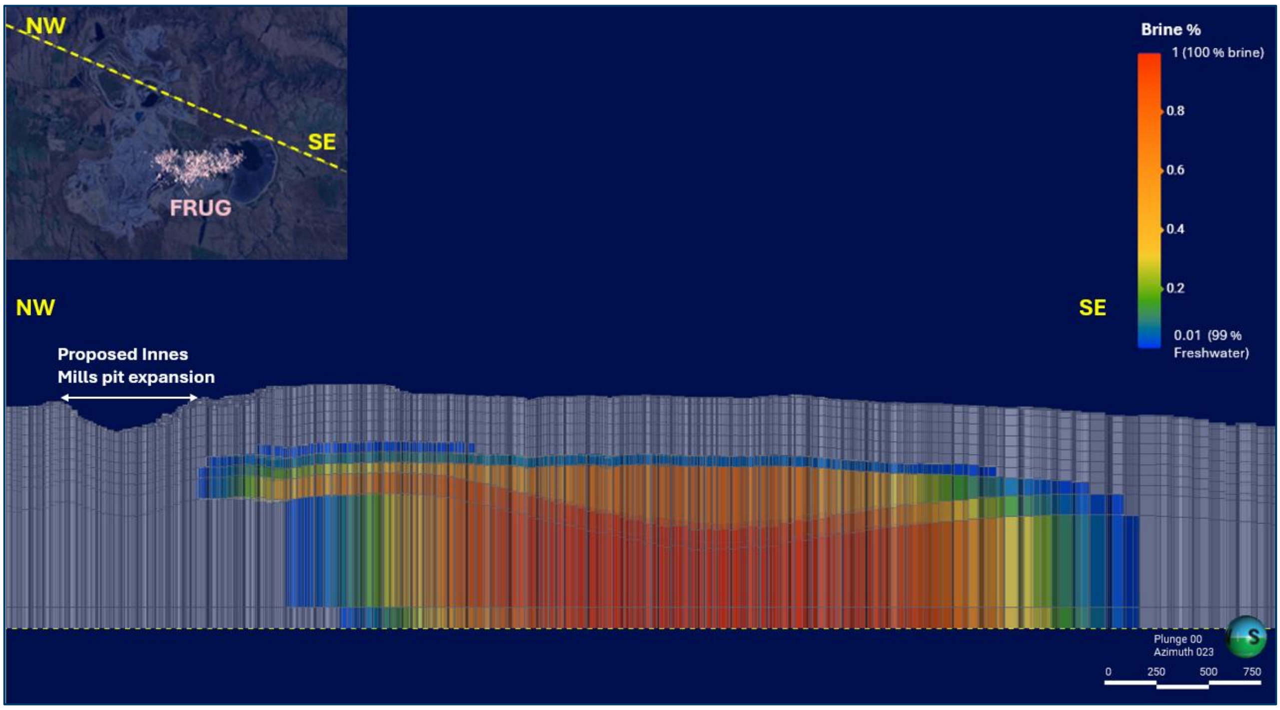


Figure C-5.37 Section view showing the predicted brine plume extent near the proposed Innes Mills Pit expansion.

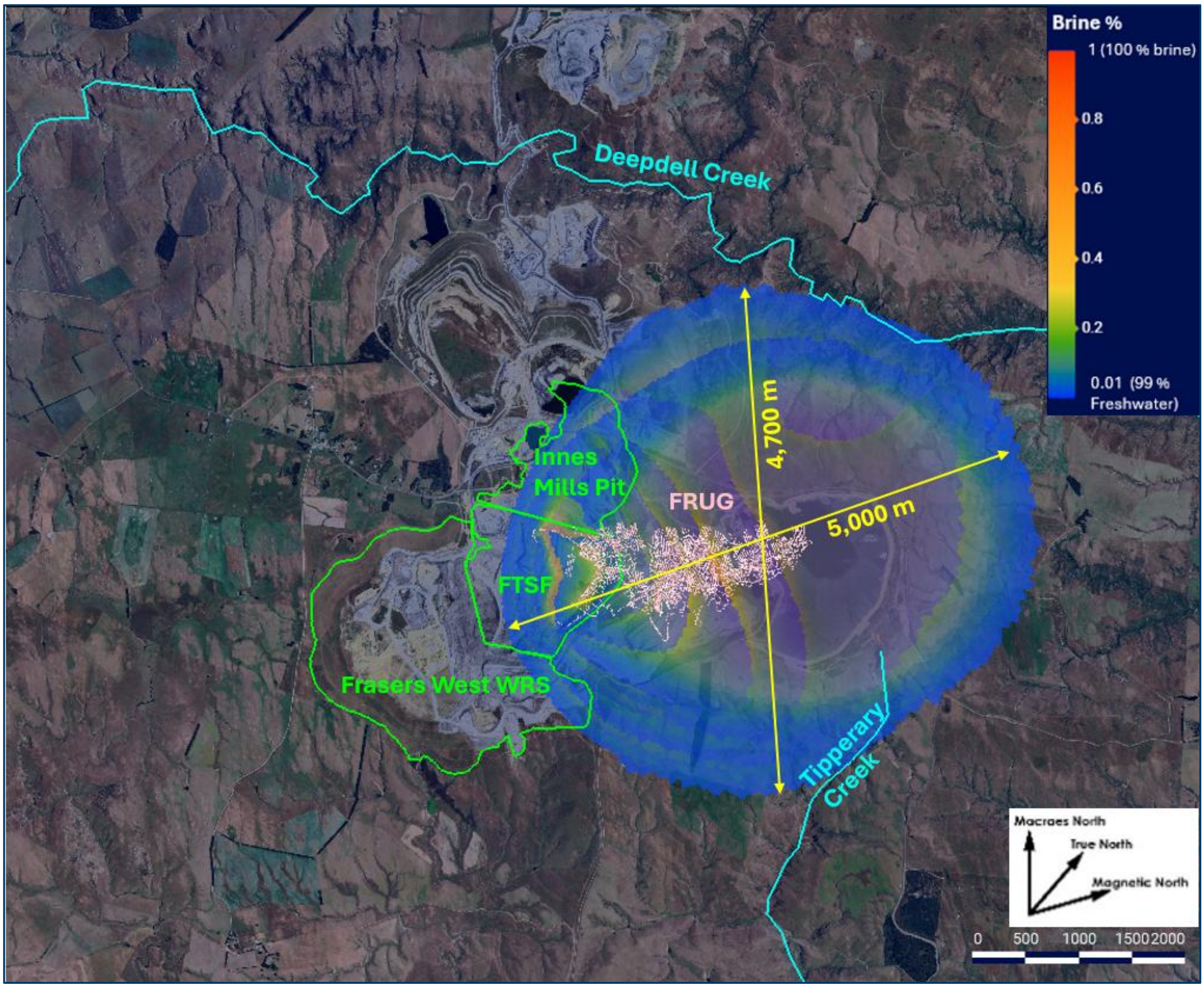


Figure C-5.38 Plan view showing the predicted brine plume extent.

C-6 Groundwater Assessment Summary

A three-dimensional numerical groundwater flow and solute transport model has been developed for the central mining area of the Macraes Phase 4 Fast Track Approvals project using MODFLOW-USG and MODFLOW-USG-TRANSPORT. The model was developed to represent the current conceptual understanding of the groundwater system across the central Macraes mine area and to assess the potential groundwater effects associated with proposed mining, dewatering, tailings, waste rock stack and post-mining recovery activities. The assessment considered existing groundwater conditions and potential effects of dewatering on groundwater discharge to nearby streams during the proposed dewatering period. Groundwater recovery following mine closure was assessed over a 400-year period. Sulphate transport from mine-related source areas, including pit backfills, waste rock stacks and tailings facilities was undertaken. In addition, a density-dependent transport assessment was undertaken to evaluate the long-term behaviour of a potential brine disposal plume within the FRUG under post-closure conditions.

Groundwater modelling results indicate that the extent of groundwater effects from dewatering of the proposed pits and underground working extensions is generally localised around the mining areas. Modelled groundwater inflows and drawdown extent around the proposed mining areas are summarised below in Table C-6.1.

Table C-6.1 Summary of modelled dewatering rates and groundwater level drawdown

Mining feature extensions - Dewatering	Groundwater Inflows	Extent of modelled drawdown (<1m) from the extension of pit
Innes Mills Pit	12 L/s to a minimum of around 2.6 L/s at year 6, then rise to approximately 14.6 L/s by year 11.	3,900 m to the northeast 1,500 m to the west 2,500 m to the east
GPUG	196 L/s at the start of dewatering to approximately 22 L/s towards the end of the 11-year dewatering period	

Modelling results indicate that dewatering for the proposed pit and underground workings extensions will reduce groundwater discharge to some local streams and creeks; however, these reductions are expected to represent a relatively small proportion of the total groundwater contribution to stream flows for the majority of the creeks. However, for Deepdell Creek (to DC08) and its tributary ephemeral streams, the predicted reduction in groundwater discharge is calculated to be 1.5 L/s (a 3.4% decrease compared to the existing conditions modelled groundwater discharges). A summary of the results representing changes to the groundwater component of flow only is presented in Table C-6.2.

Table C-6.2 Summary of groundwater discharge rate changes to surface water for Main Site

Dewatering	Deepdell Creek (DC08)	NBWRRF (Waikouaiti River North Branch - Ross Road Ford)	Murphys and Golden Bar Creek	Tipperary Creek	Shag River
Innes Mills Pit and GPUG extensions	1.5 L/s 3.4% decrease	0.1 L/s <0.5% decrease	0.2 L/s 0.6% increase*	0.1 L/s <0.5% decrease	0.1 L/s <0.5% decrease
Notes	*Associated with the water level increase in FRUG and in the proposed Frasers Tailings structure				

Groundwater modelling results indicate that groundwater drawdown associated with current and proposed mining activities is predicted to remain largely confined to areas close to the existing and proposed pit extensions and underground workings. The modelling does not indicate appreciable drawdown propagation over the wider groundwater system as a result of the proposed mining activities. On this basis, adverse effects on groundwater levels in non-OGL groundwater bores are considered unlikely.

Following completion of mining, groundwater recovery was simulated for a period of 400 years using pit lake levels derived from the surface water balance modelling. The modelling predicts that groundwater levels will progressively recover after cessation of dewatering and pit lake formation, although local groundwater flow patterns will continue to be influenced by the presence of pit lakes, backfilled voids and WRSs.

Contaminant transport modelling was undertaken using sulphate as the primary contaminant indicator because it is expected to occur at elevated concentrations, is already present in some receiving waters due to historic mining activities, and has limited attenuation potential within the groundwater system. The contaminant transport modelling forms part of an integrated groundwater–surface water assessment, where groundwater-derived contaminant fluxes are used as inputs to the receiving water quality models.

Modelling results indicate that sulphate plumes are generally constrained by the relatively low-permeability schist groundwater system and tend to migrate through the weathered and fractured schist and near-surface groundwater pathways toward local receiving environments, mine water management infrastructure, seepage capture systems, silt ponds and pit lakes. During dewatering, plume migration is influenced by local drawdown around the active pits and underground workings, with drawdown and associated transport effects generally limited to areas relatively close to the proposed mining extensions.

Predicted results for the 400-year post-closure period are summarised in Table C-6.3. Modelled sulphate fluxes from the groundwater transport models were compared to the values used as inputs to the surface water quality model.

Table C-6.3 Estimated sulphate flux at surface water compliance monitoring points - 400 years post-closure

Catchment	Sulphate flux (kg/day)
Deepdell Creek- DC04	125.6
Deepdell Creek - DC07	131
Deepdell Creek - DC08	34
North Branch Waikouaiti River Ross Road Ford (NBWRRF)	109
North Branch Waikouaiti River - NB03	<1
Murphys Creek - MC02	309
Tipperary Creek - TC01	220
Cranky Jims Creek - CJ01	85
Shag River at Loop Road	<1
Shag River at McCormicks	8
Seepage capture drains	868

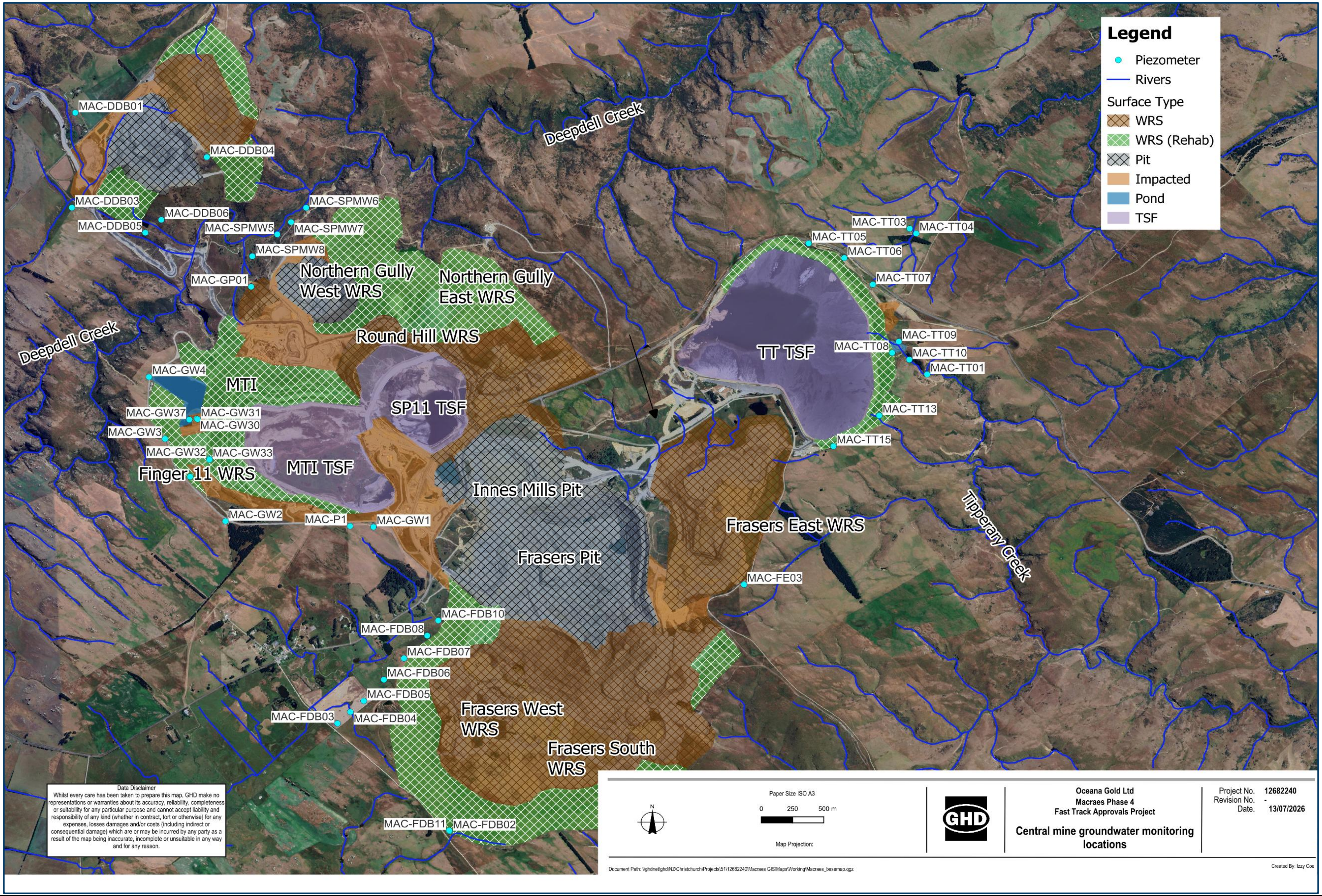
Existing consented groundwater takes, existing bores and proposed bores were reviewed against the maximum predicted extent of the modelled sulphate plume. This review indicates that these groundwater receptors are not expected to be intersected by the predicted plume extent, and adverse effects on groundwater users are therefore considered unlikely. Overall, the contaminant transport results provide a relatively conservative basis for assessing long-term groundwater-to-surface-water contaminant contributions and for informing mitigation, monitoring and adaptive management requirements.

A density-dependent brine transport assessment was undertaken to simulate the injection of a brine solution near the base of the FRUG within the groundwater recovery modelling framework. Modelling results indicate that the predicted plume remains at depth and is not expected to daylight at any major river and/or any tributary of these rivers. The predicted brine plume extends approximately 5,000 m from southwest to northeast and approximately 4,700 m from north to south, remaining approximately 65 m below the bed of Deepdell Creek and more than 260 m below the bed of Tipperary Creek. These results indicate that the injected brine is expected to remain within deeper groundwater pathways and is unlikely to directly intersect major surface-water receptors.

The proposed Camp Creek augmentation dam has not been explicitly represented in the dewatering or groundwater recovery model runs. The dam is intended to provide augmentation flows to Deepdell Creek, during low-flow periods, when receiving-water dilution capacity is reduced and the potential influence of uncaptured seepage on water quality compliance is greatest. Its proposed operation is described in Appendix F. The principal effect of the dams is represented within the receiving water quality assessment, through increased dilution and improved compliance resilience during critical low-flow conditions.

Attachment 1

Groundwater bore location plan and groundwater levels


Legend
Piezometer
Rivers
Surface Type
WRS
WRS (Rehab)
Pit
Impacted
Pond
TSF
Deepdell Creek
Deepdell Creek
Tipperary Creek
MAC-DDB01
MAC-DDB04
MAC-DDB03
MAC-DDB06
MAC-DDB05
MAC-SPMW6
MAC-SPMW5
MAC-SPMW7
MAC-SPMW8
MAC-GP01
Northern Gully West WRS
Northern Gully East WRS
Round Hill WRS
MAC-GW4
MTI
SP11 TSF
MAC-GW37
MAC-GW31
MAC-GW30
MAC-GW3
MAC-GW32
MAC-GW33
Finger 11 WRS
MTI TSF
Innes Mills Pit
MAC-GW2
MAC-P1
MAC-GW1
Frasers Pit
MAC-TT03
MAC-TT04
MAC-TT05
MAC-TT06
MAC-TT07
TT TSF
MAC-TT09
MAC-TT08
MAC-TT10
MAC-TT01
MAC-TT13
MAC-TT15
Frasers East WRS
MAC-FE03
MAC-FDB10
MAC-FDB08
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MAC-FDB03
MAC-FDB04
Frasers West WRS
Frasers South WRS
MAC-FDB11
MAC-FDB02
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GHD
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Macraes Phase 4
Fast Track Approvals Project
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Revision No. -
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Created By: Izzy Coe

Table 1.1 Measured and modelled groundwater level data measured in 2025, representing existing conditions

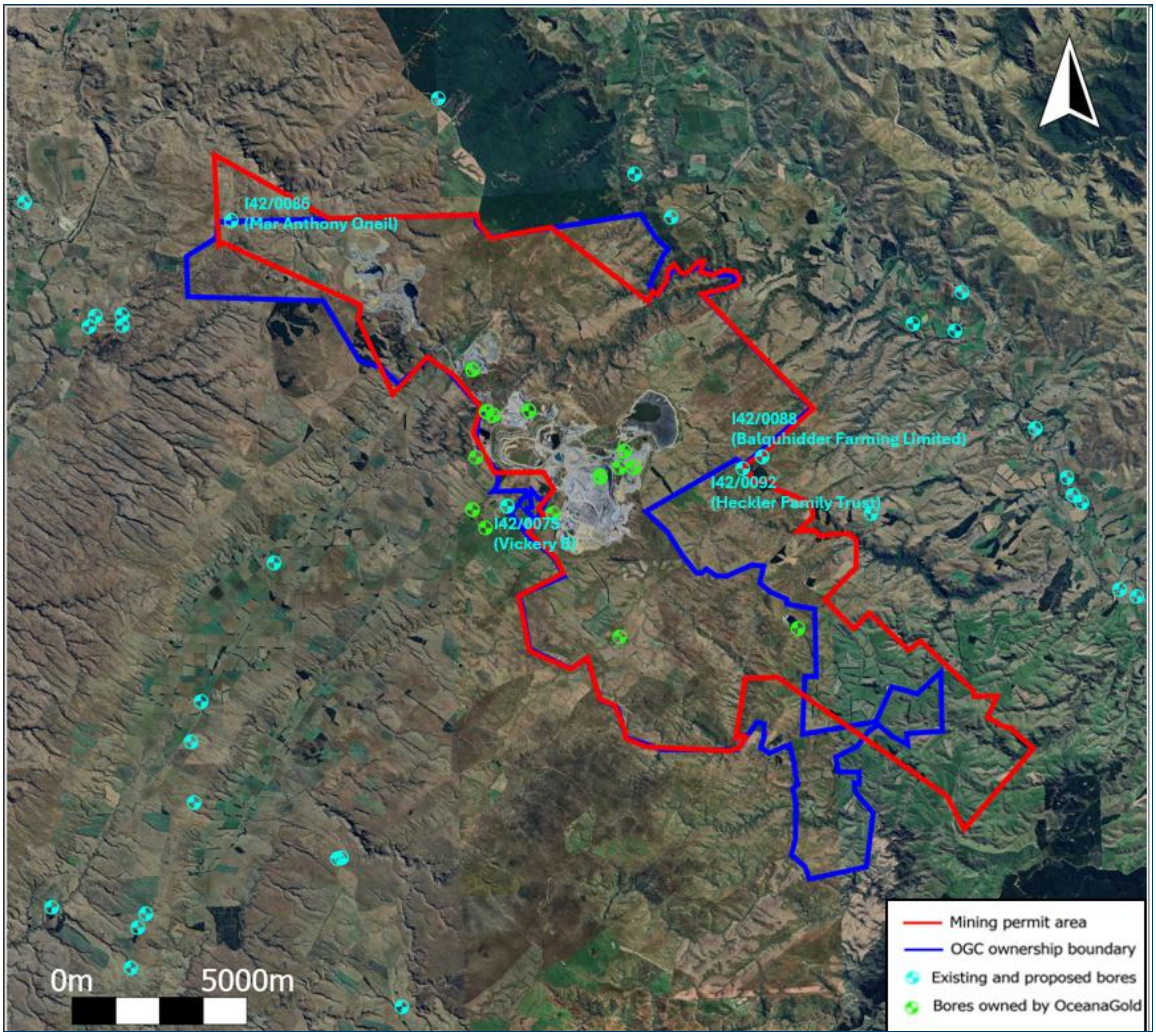
Hole ID	Easting (MGPG)	Northing (MGPG)	Elevation (m RL)	Measured Groundwater level (m RL)	Modelled groundwater level (m RL)	Residual (m) (weightings of 1)
MAC-DDB01	69780.77	17891.56	471	487.70	496.37	-8.67
MAC-DDB03	69185.31	17368.29	444	460.26	462.96	-2.70
MAC-DDB04	70233.36	16872.55	447	452.75	443.73	9.02
MAC-DDB05	69436.2	16797.44	379	392.78	422.71	-29.93
MAC-DDB06	69602.36	16778.37	383	401.67	413.51	-11.84
MAC-FDB02	67470	11600	497	500.34	519.84	-19.49
MAC-FDB03	67510	12869.99	481	476.67	495.24	-18.57
MAC-FDB04	67650	12860.01	486	490.45	493.08	-2.63
MAC-FDB05	67790.01	12845	487	491.32	498.20	-6.88
MAC-FDB06	68030	12850	489	493.32	499.52	-6.21
MAC-FDB07	68270	12855	489	497.62	510.90	-13.28
MAC-FDB08	68535	12850	491	495.35	511.51	-16.16
MAC-FDB10	68687.44	12872.6	485	501.74	513.95	-12.21
MAC-FDB11	67473.07	11606.41	489	507.36	520.92	-13.57
MAC-FDB13	68598.85	10171.7	415	435.14	450.08	-14.93
MAC-FE03	70582.36	11299.6	481	488.42	501.39	-12.97
MAC-GP01	69688.61	15872.04	367	382.00	374.08	7.92
MAC-GW1	68900.32	13785.15	515	532.86	538.32	-5.46
MAC-GW2	68123.83	14678.91	501	518.71	514.56	4.15
MAC-GW3	68292.67	15502.09	439	460.51	462.01	-1.50
MAC-GW30	68588.44	15432.78	432	449.38	460.40	-11.02
MAC-GW31	68590	15425	418	450.00	460.02	-10.02
MAC-GW32	68414.57	15130.28	462	476.38	485.51	-9.13
MAC-GW33	68409.69	15124.61	446	475.50	483.36	-7.87
MAC-GW37	68542.69	15471.29	427	449.76	461.53	-11.77
MAC-GW38	68200	15140	473	483.18	485.37	-2.19
MAC-GW4	68580	15949.99	415	431.49	432.04	-0.55
MAC-P1	68777	13926	523	534.94	537.79	-2.86
MAC-RCH2585	71000.23	5399.655	504	523.11	520.57	2.54
MAC-RCH2613	70698.72	5898.765	472	516.44	519.88	-3.43
MAC-RCH2775	71098.7	5749.145	486	510.75	515.47	-4.72
MAC-SPMW5	70150	16020	320	338.81	339.86	-1.05
MAC-SPMW6	70470	16005	320	339.29	335.15	4.14
MAC-SPMW7	70299.99	16010	320	339.67	313.80	25.87

Hole ID	Easting (MGPG)	Northing (MGPG)	Elevation (m RL)	Measured Groundwater level (m RL)	Modelled groundwater level (m RL)	Residual (m) (weightings of 1)
MAC-SPMW8	69880	16040	322	337.20	351.28	-14.08
MAC-TT01	72864.35	11437.81	465	476.77	502.13	-25.37
MAC-TT03	73653.06	12374.25	466	490.16	493.35	-3.20
MAC-TT04	73659.52	12308.56	474	490.48	493.58	-3.10
MAC-TT05	73009.32	12877.84	516	536.70	539.64	-2.94
MAC-TT06	73116.62	12587.59	498	518.61	532.37	-13.76
MAC-TT07	73112.17	12268.61	496	514.49	527.94	-13.45
MAC-TT08	72802.64	11765.21	484	495.21	526.88	-31.66
MAC-TT09	72907.63	11790.3	475	490.38	507.40	-17.02
MAC-TT10	72856.05	11626.63	468	481.64	510.51	-28.87
MAC-TT13	72350.87	11481.15	515	536.79	535.82	0.97
MAC-TT15	71913.05	11571.37	536	547.51	542.92	4.60

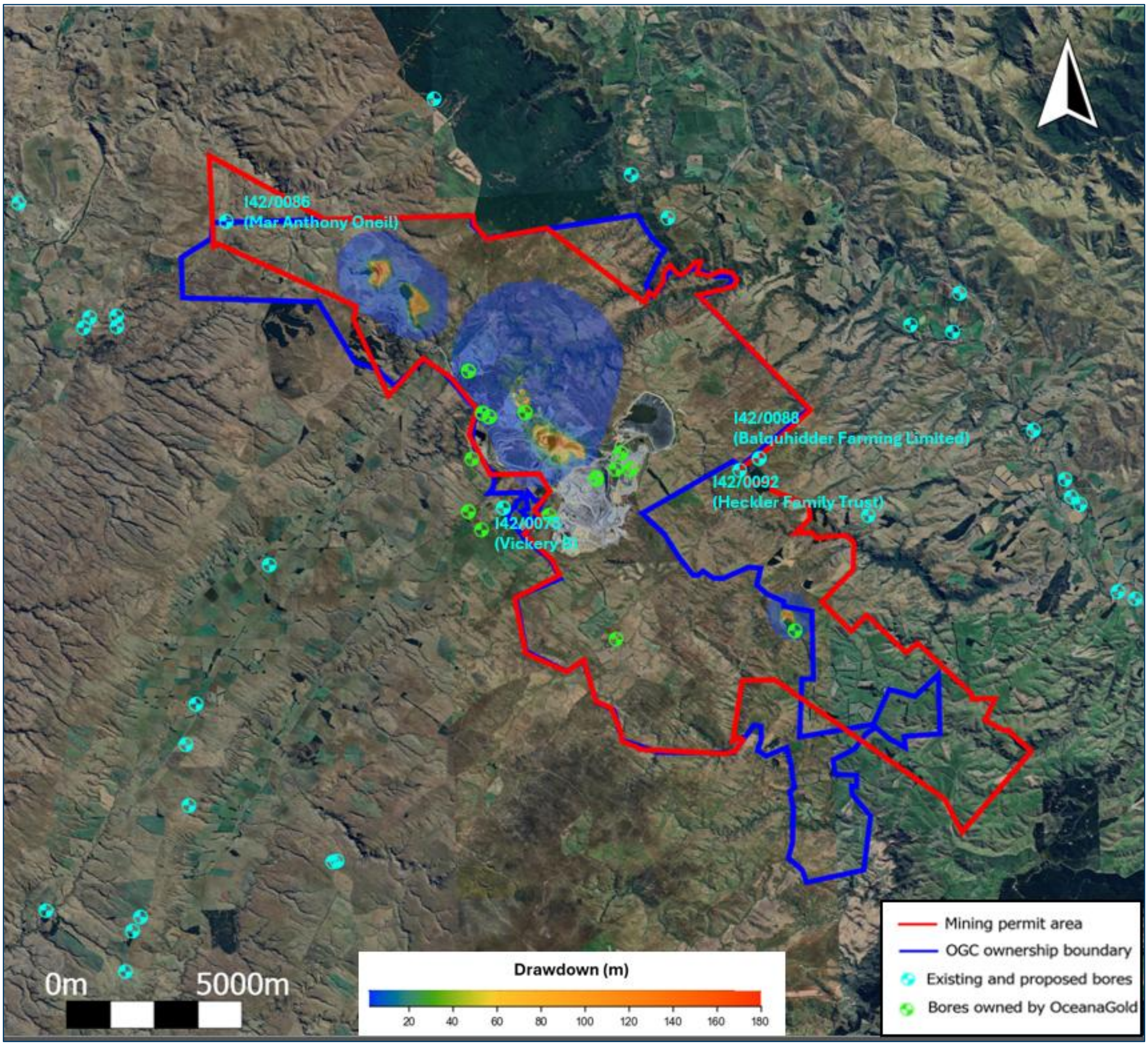
Attachment 2

Existing and proposed groundwater bores and consented groundwater takes location plans

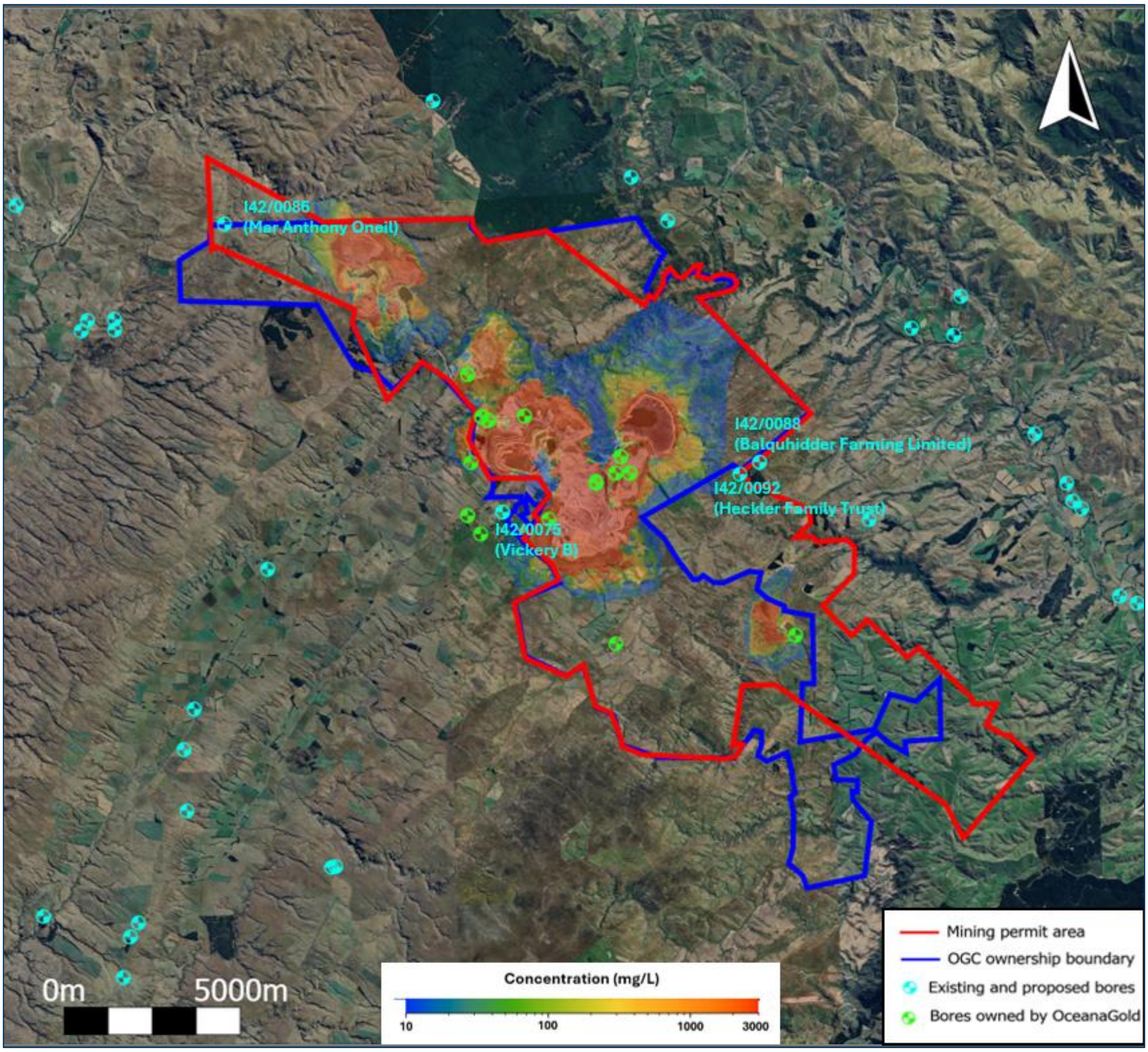
Existing and proposed bore location plan (ORC, 2027)



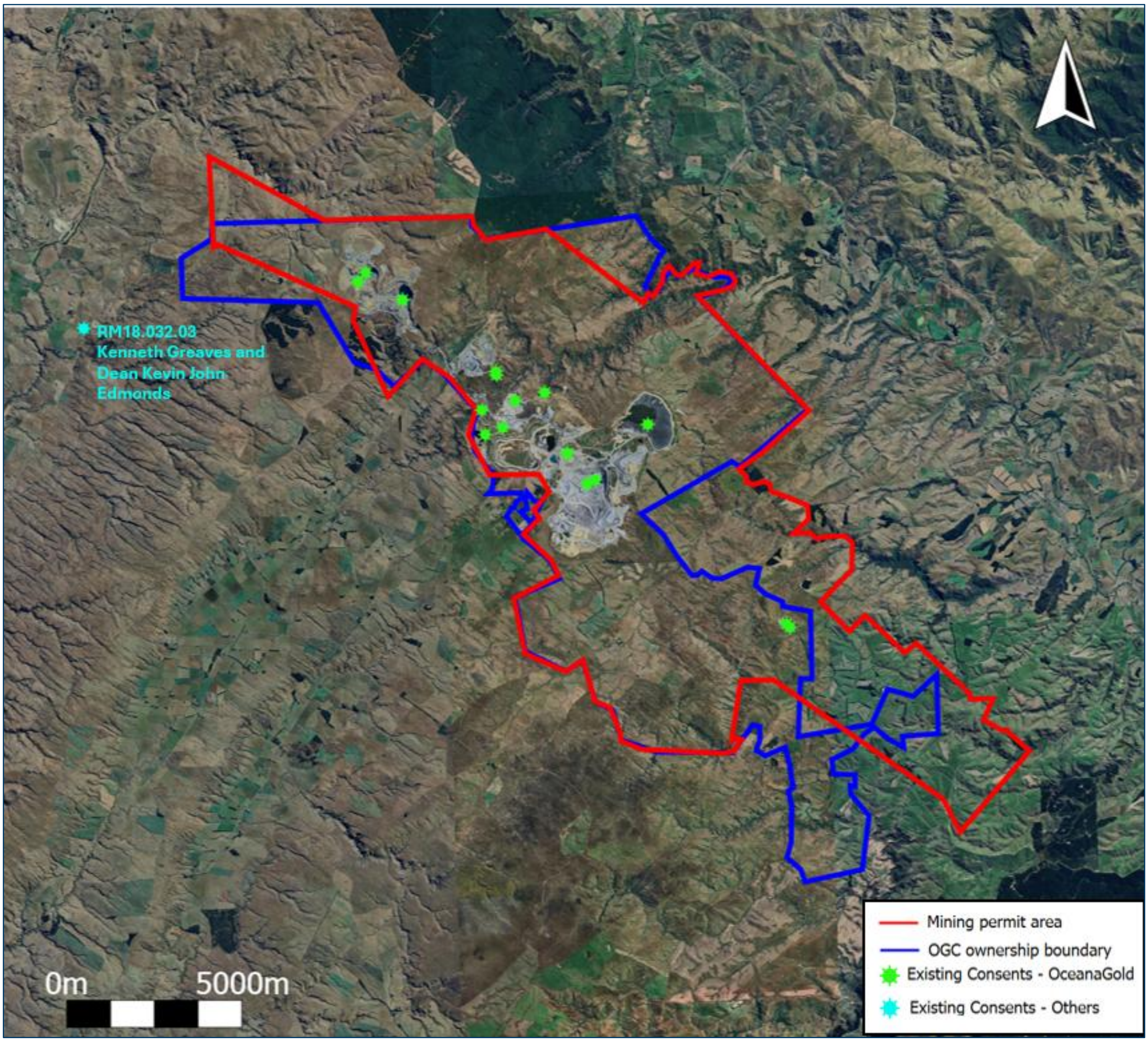
Existing and proposed bore locations (ORC, 2027) and extent of modelled drawdown greater than 1 at the end of dewatering for all three mining areas



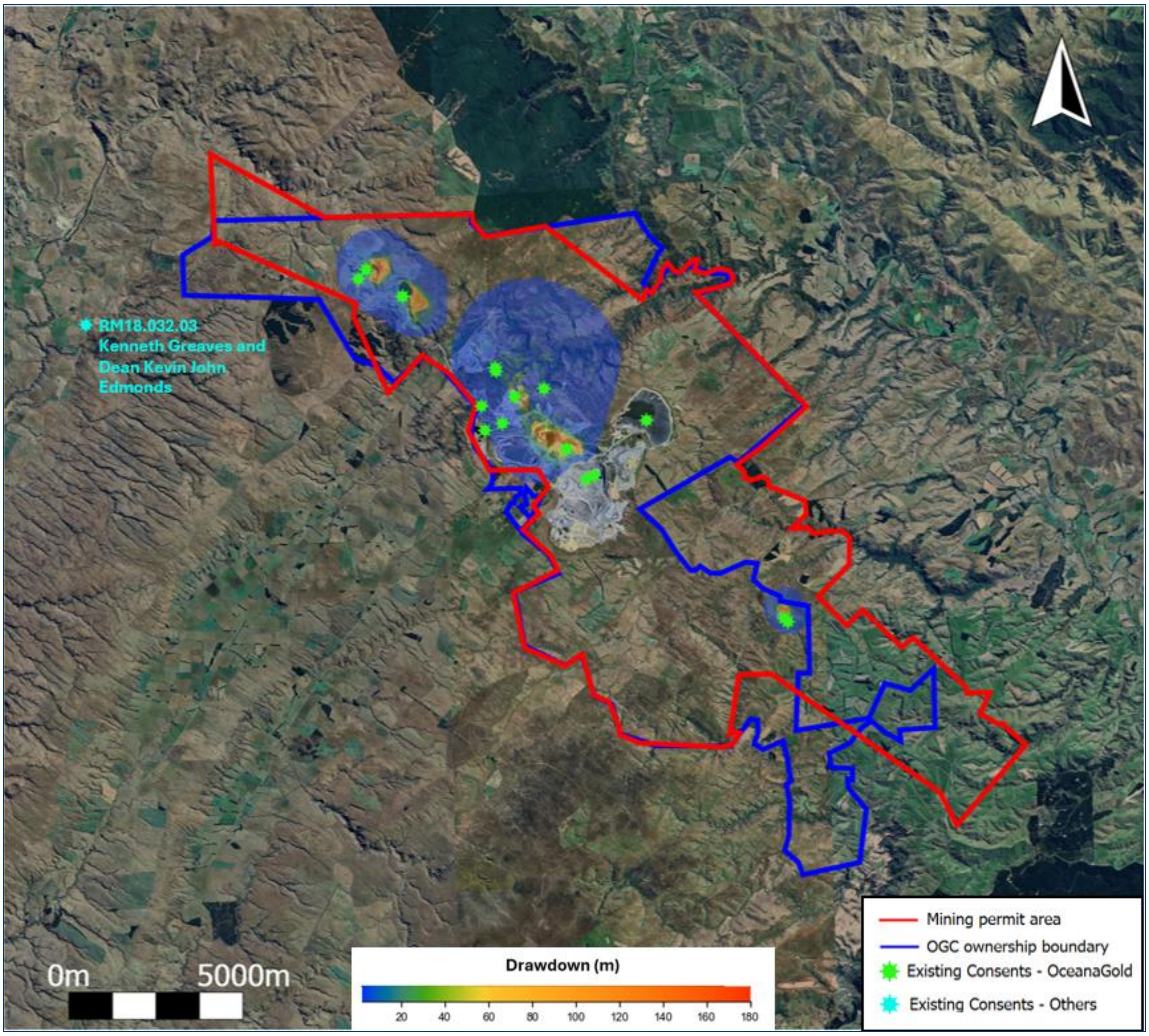
Existing and proposed bore locations (ORC, 2027) and sulphate plume extent at the end of the recovery model (400 years of recovery) for all three mining areas



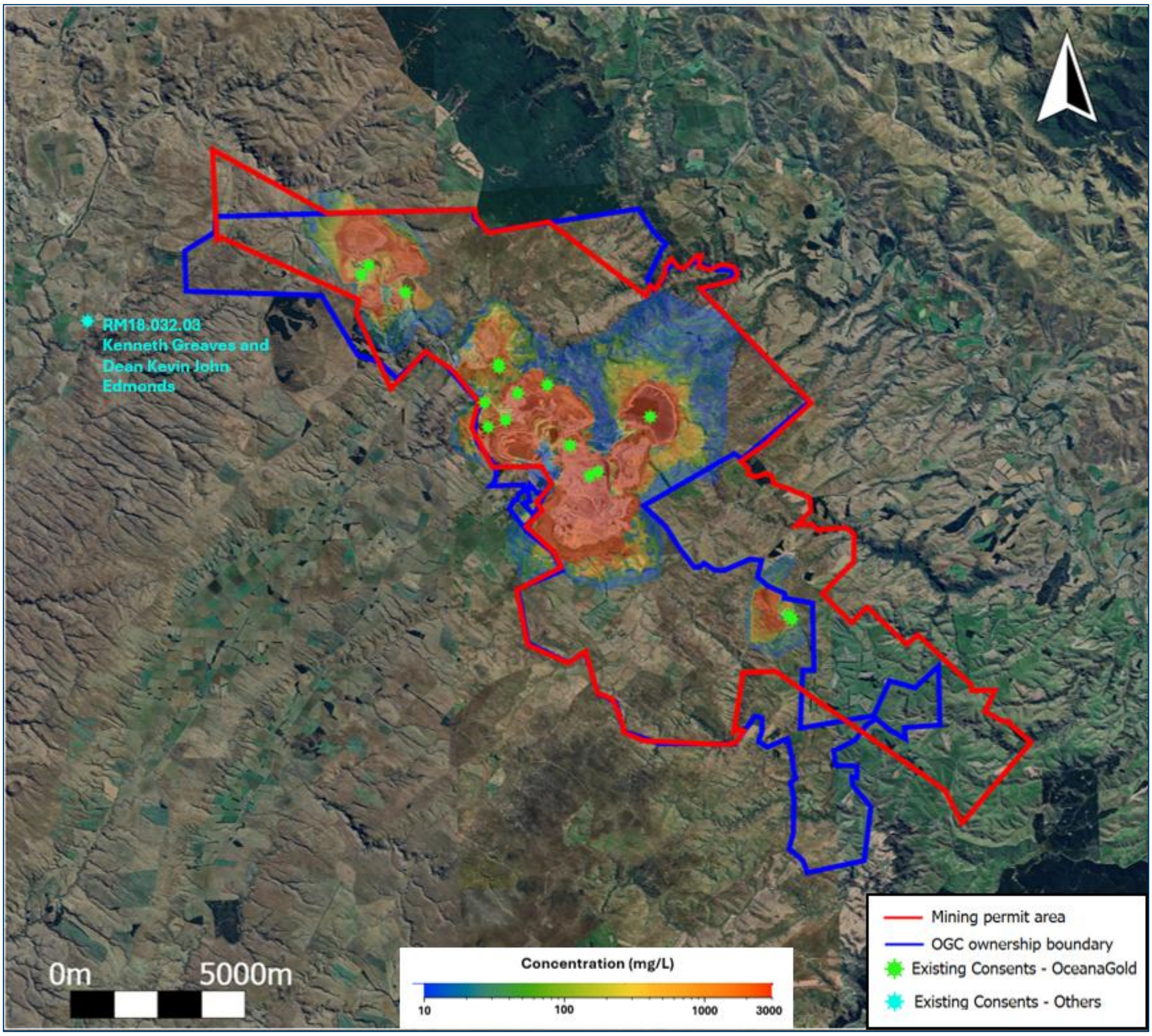
Current groundwater take consents (ORC 2027) location plan



Current groundwater take consents (ORC 2027), and extent of modelled drawdown greater than 1 at the end of dewatering for all three mining areas



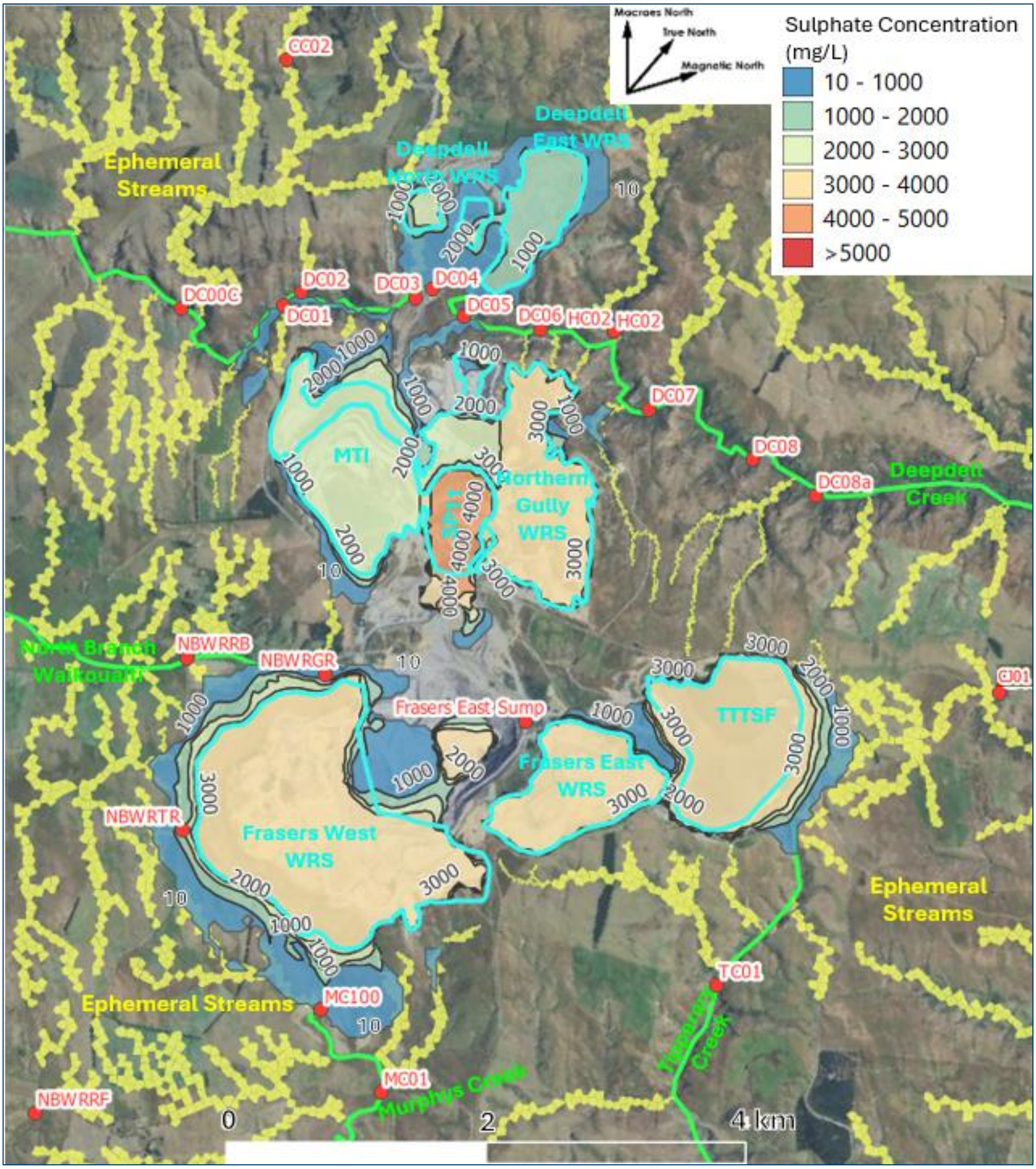
Current groundwater take consents (ORC 2027), and sulphate plume extent at the end of the recovery model (400 years of recovery) for all three mining areas



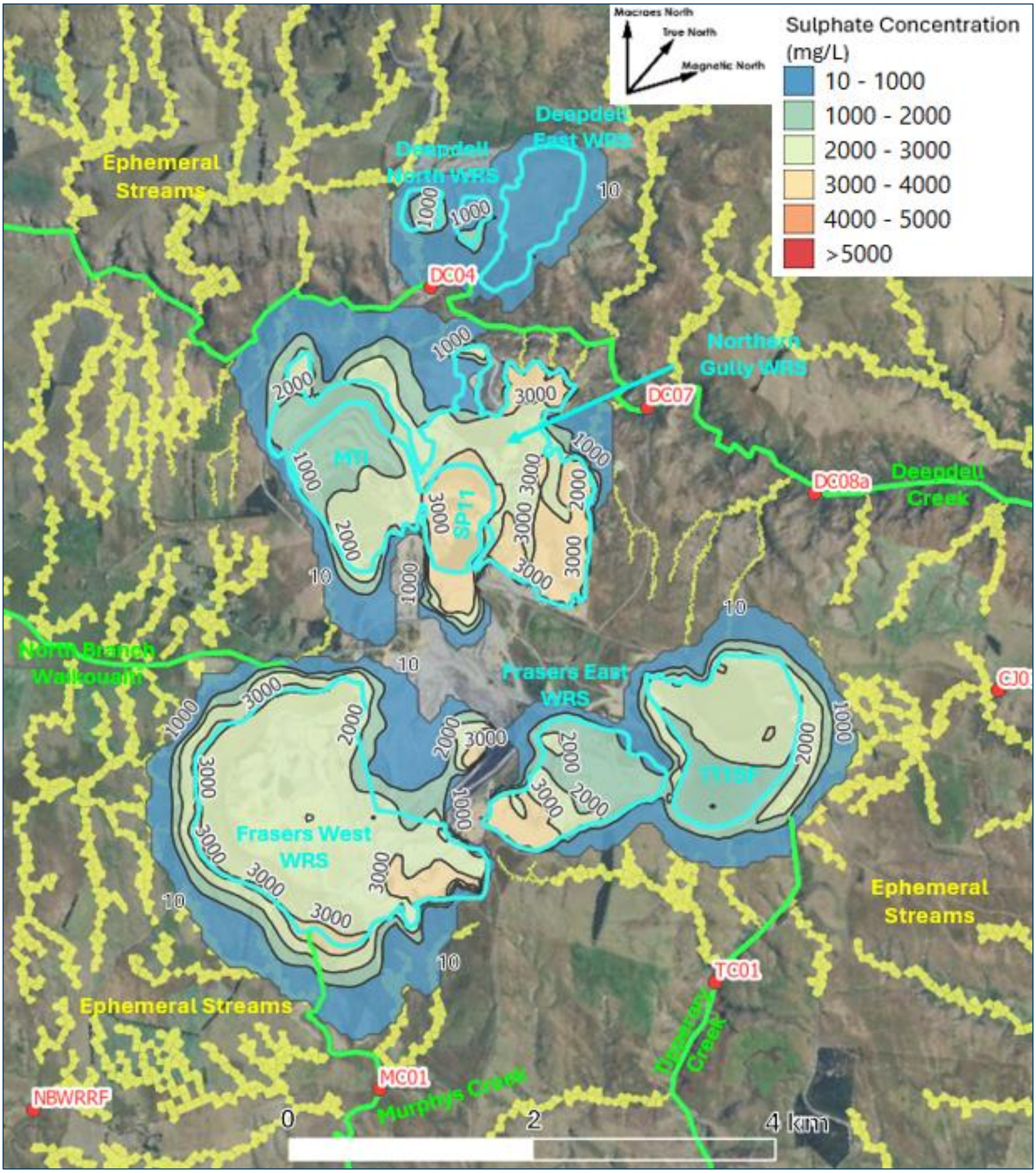
Attachment 3

Sulphate Plume Contours

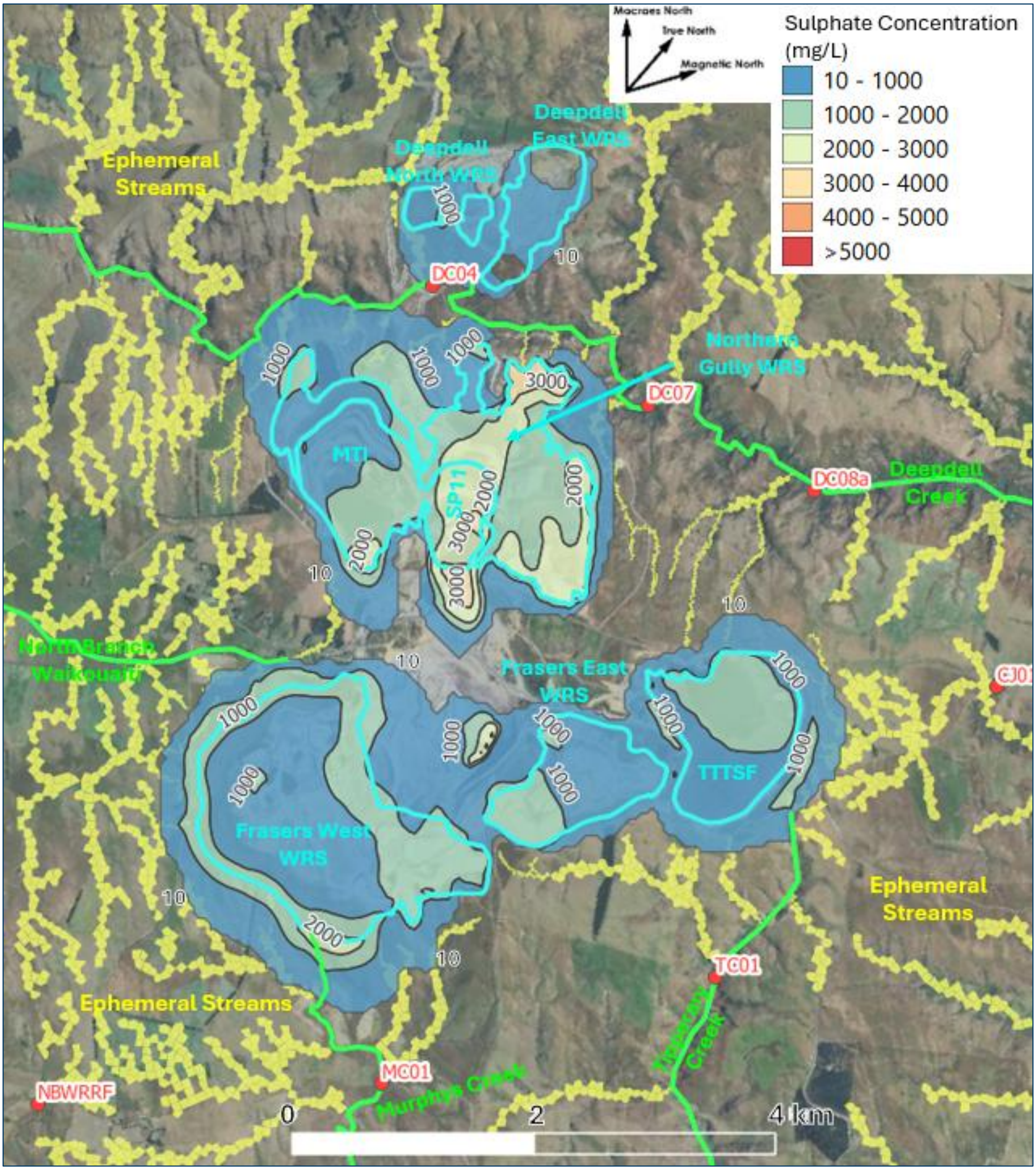
Contour plot showing sulphate plume extent at the end of the existing conditions model in model layer 1.



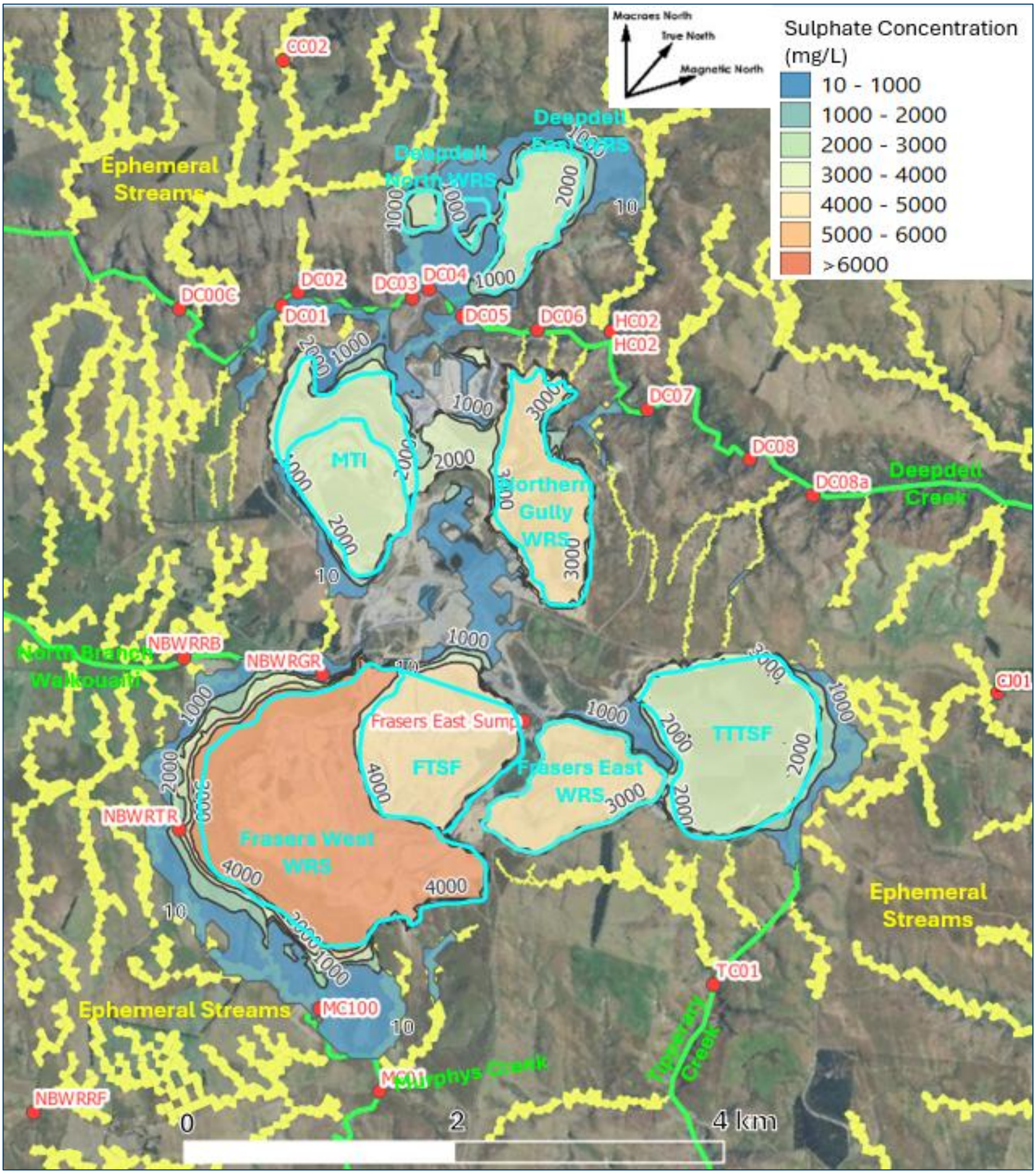
Contour plot showing sulphate plume extent at the end of the existing conditions model in model layer 2.



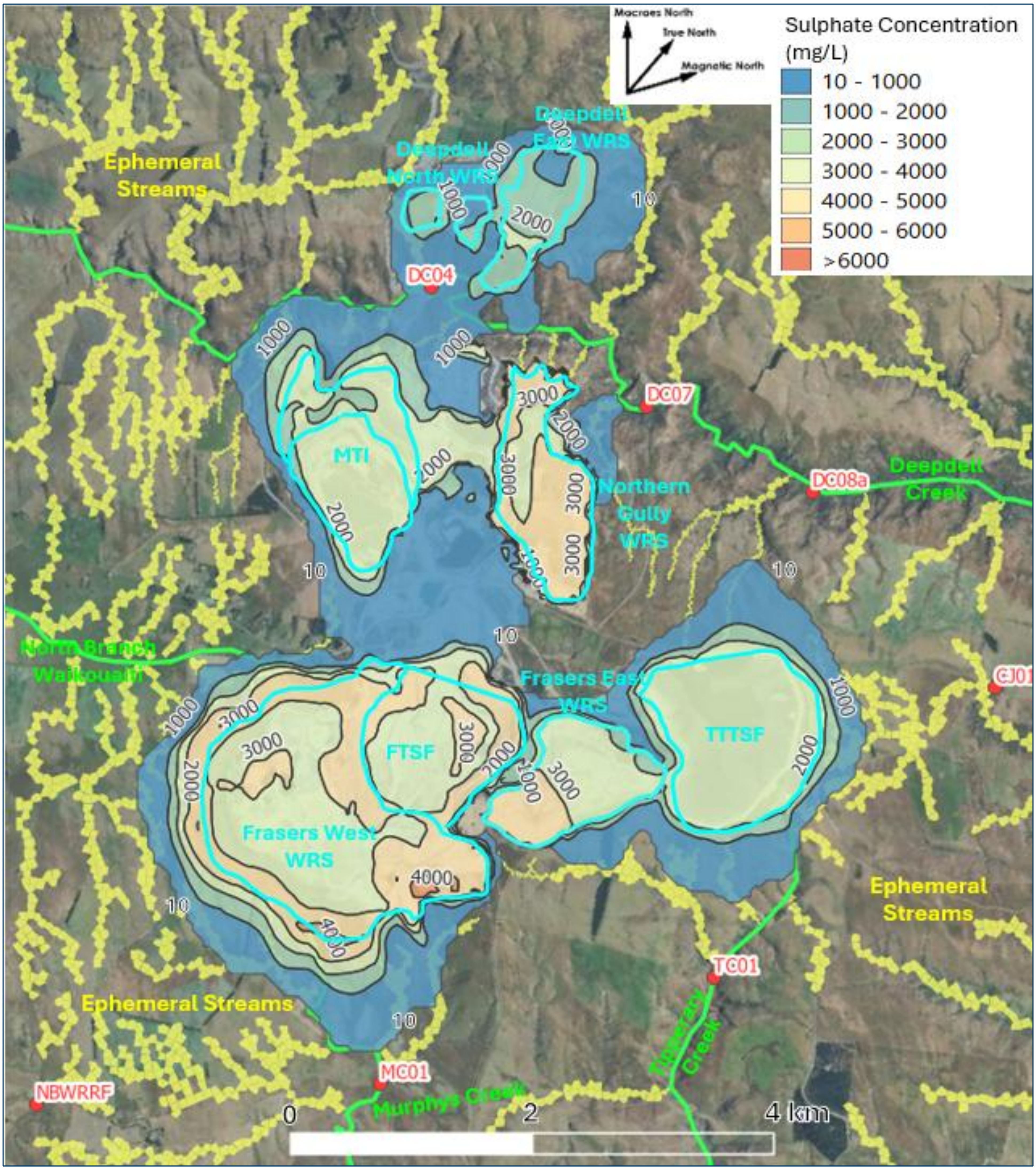
Contour plot showing sulphate plume extent at the end of the existing conditions model in model layer 3.



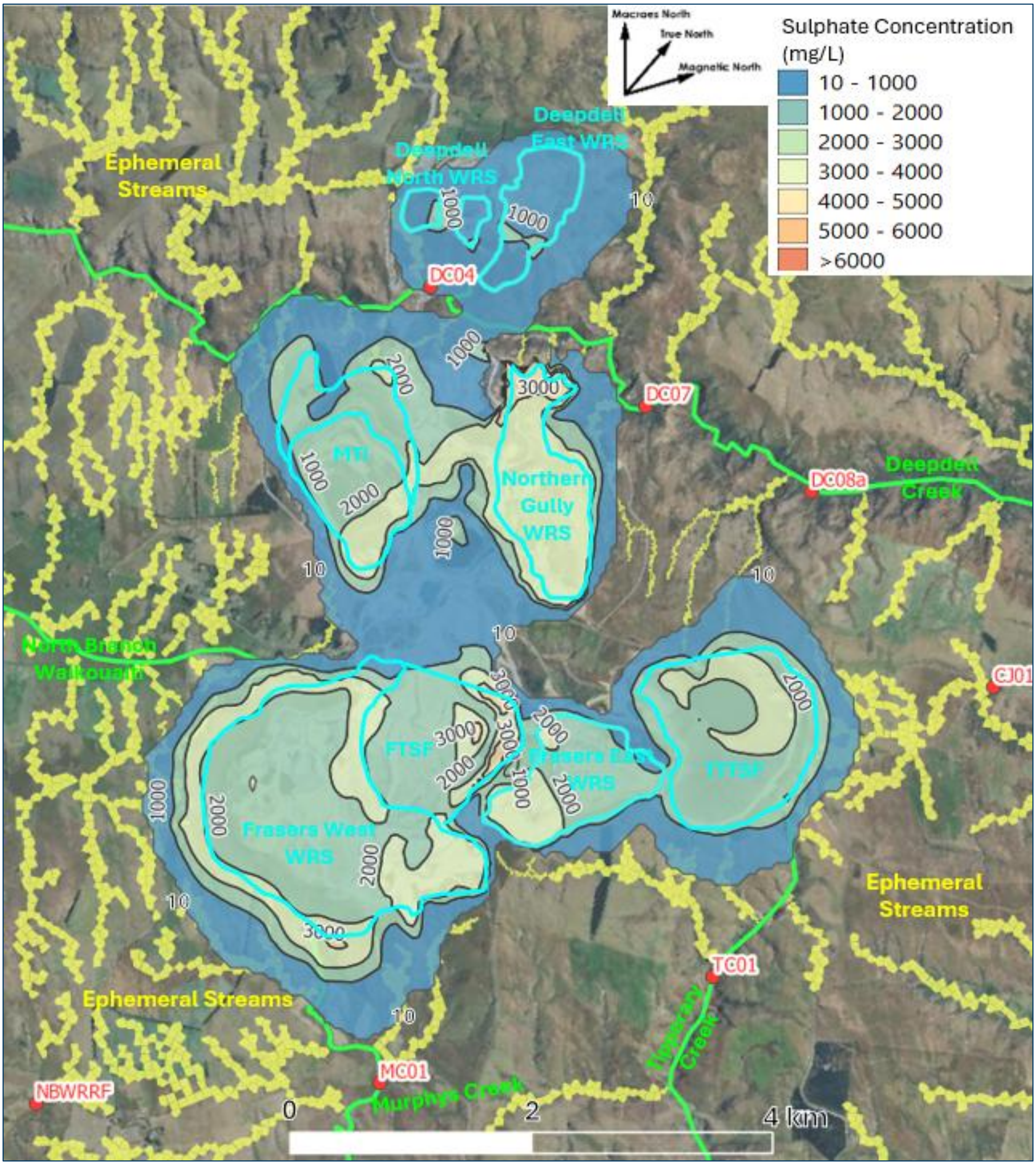
Contour plot showing sulphate plume extent at the end of the dewatering model (11 years of dewatering) in model layer 1.



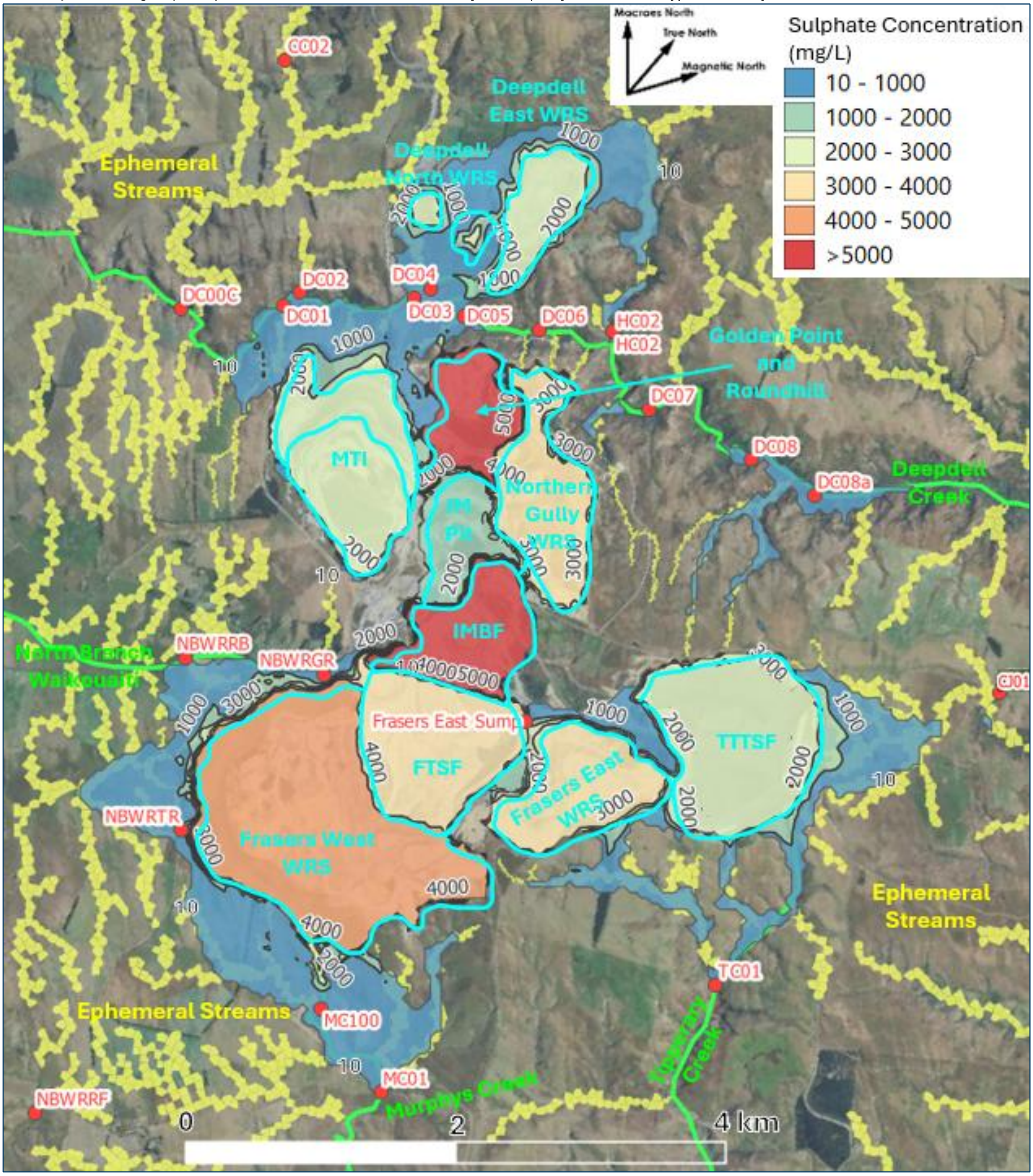
Contour plot showing sulphate plume extent at the end of the dewatering model (11 years of dewatering) in model layer 2.



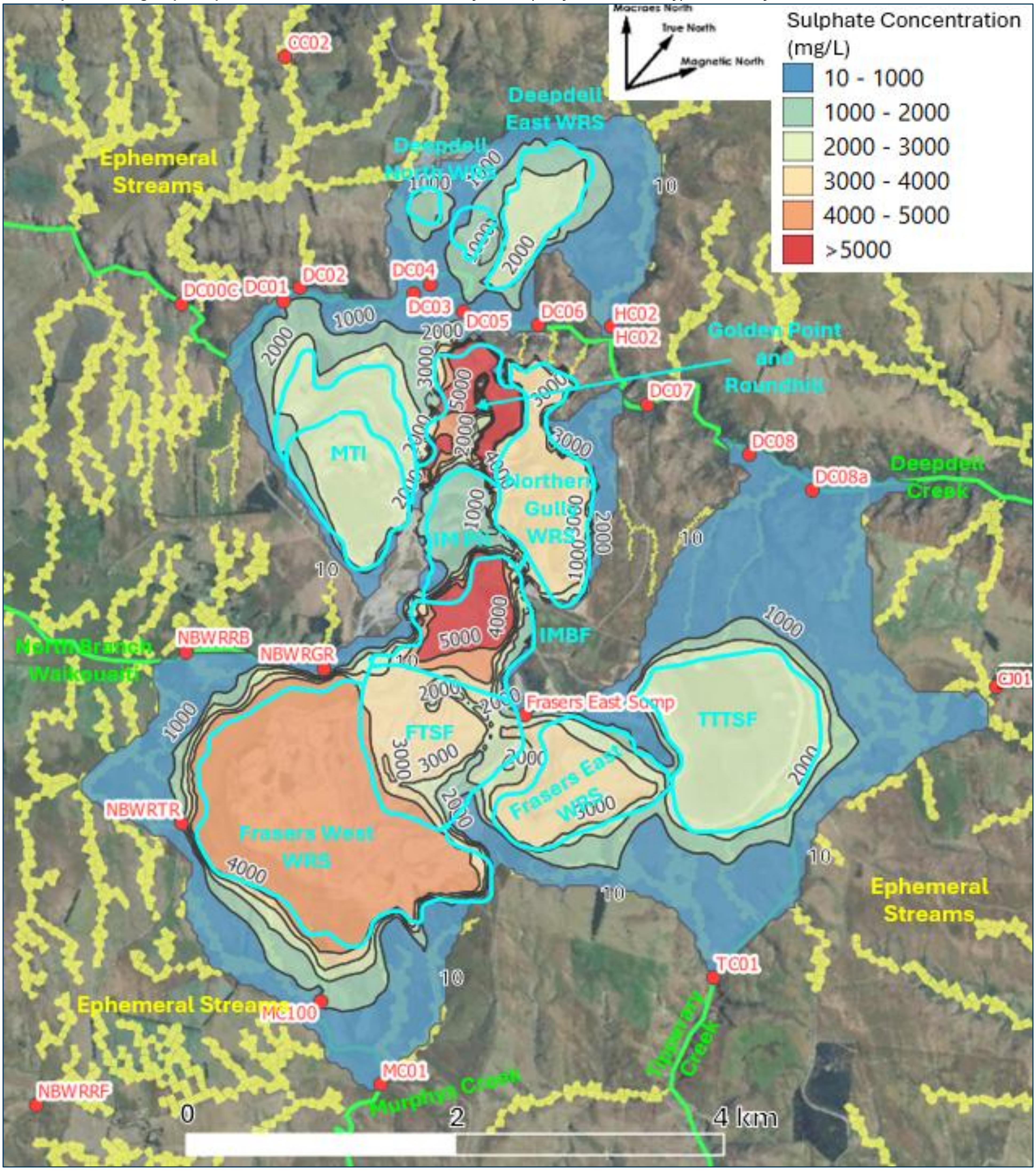
Contour plot showing sulphate plume extent at the end of the dewatering model (11 years of dewatering) in model layer 3.



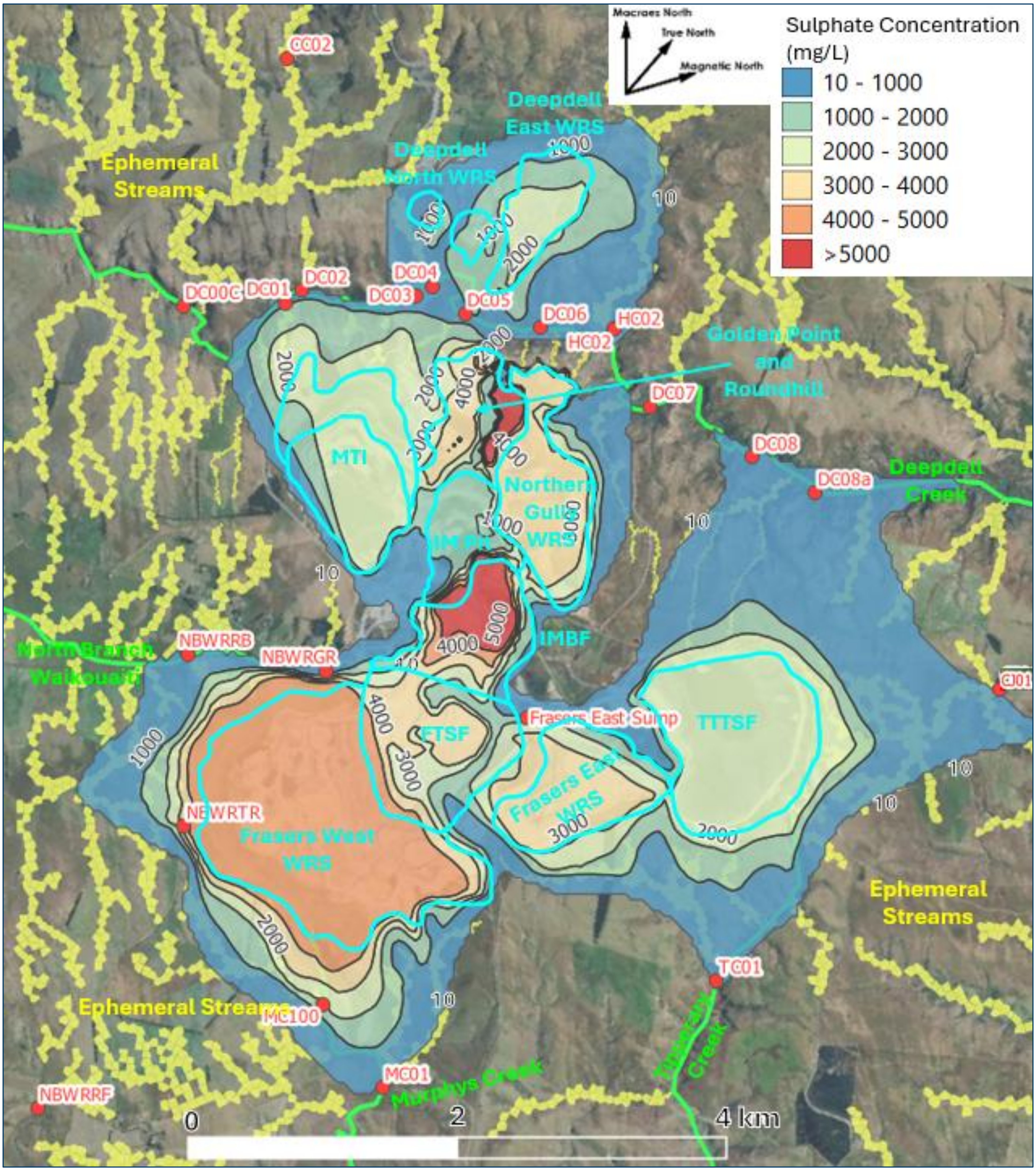
Contour plot showing sulphate plume extent at the end of the recovery model (400 years of recovery) in model layer 1.



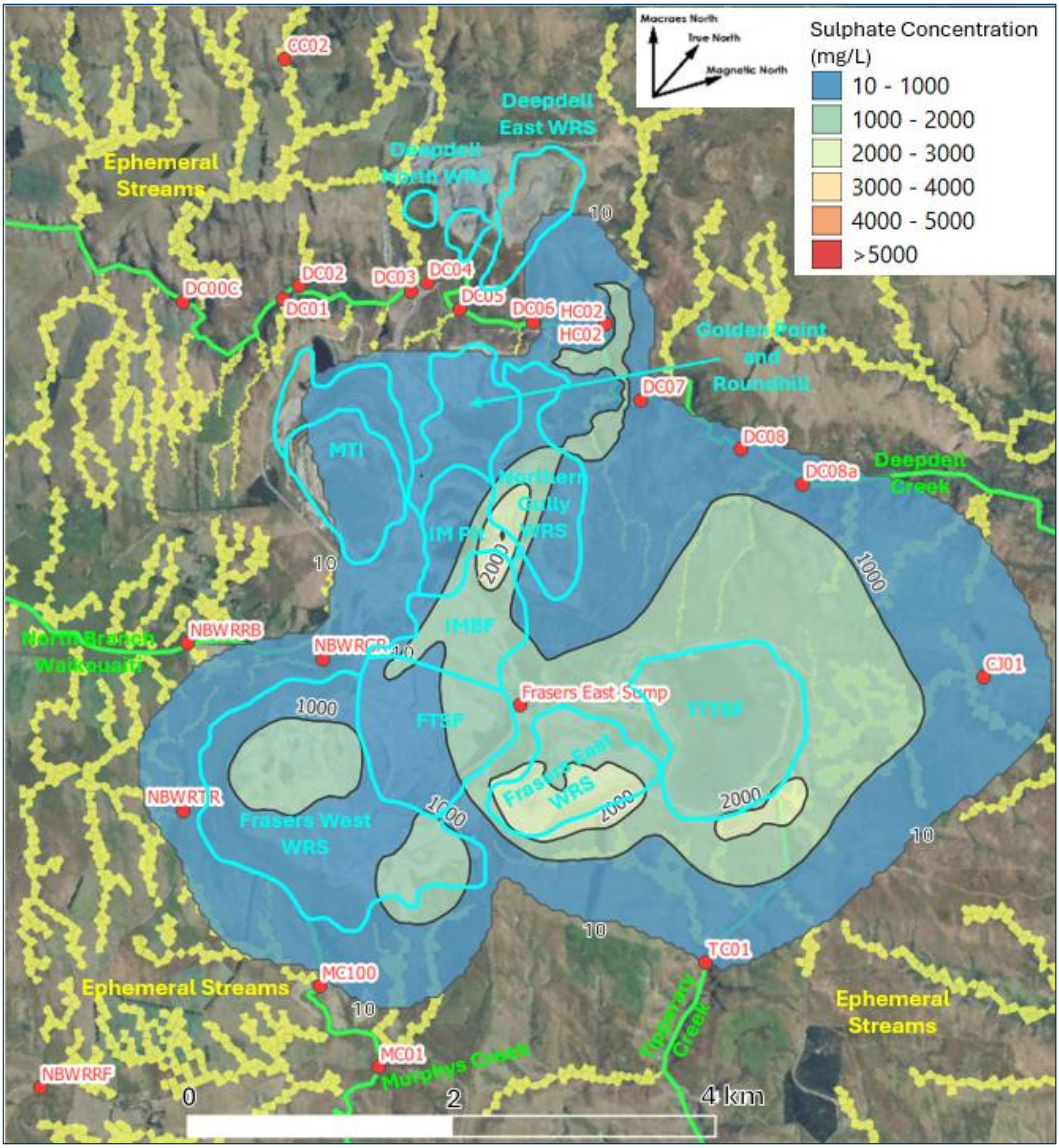
Contour plot showing sulphate plume extent at the end of the recovery model (400 years of recovery) in model layer 2.



Contour plot showing sulphate plume extent at the end of the recovery model (400 years of recovery) in model layer 3.



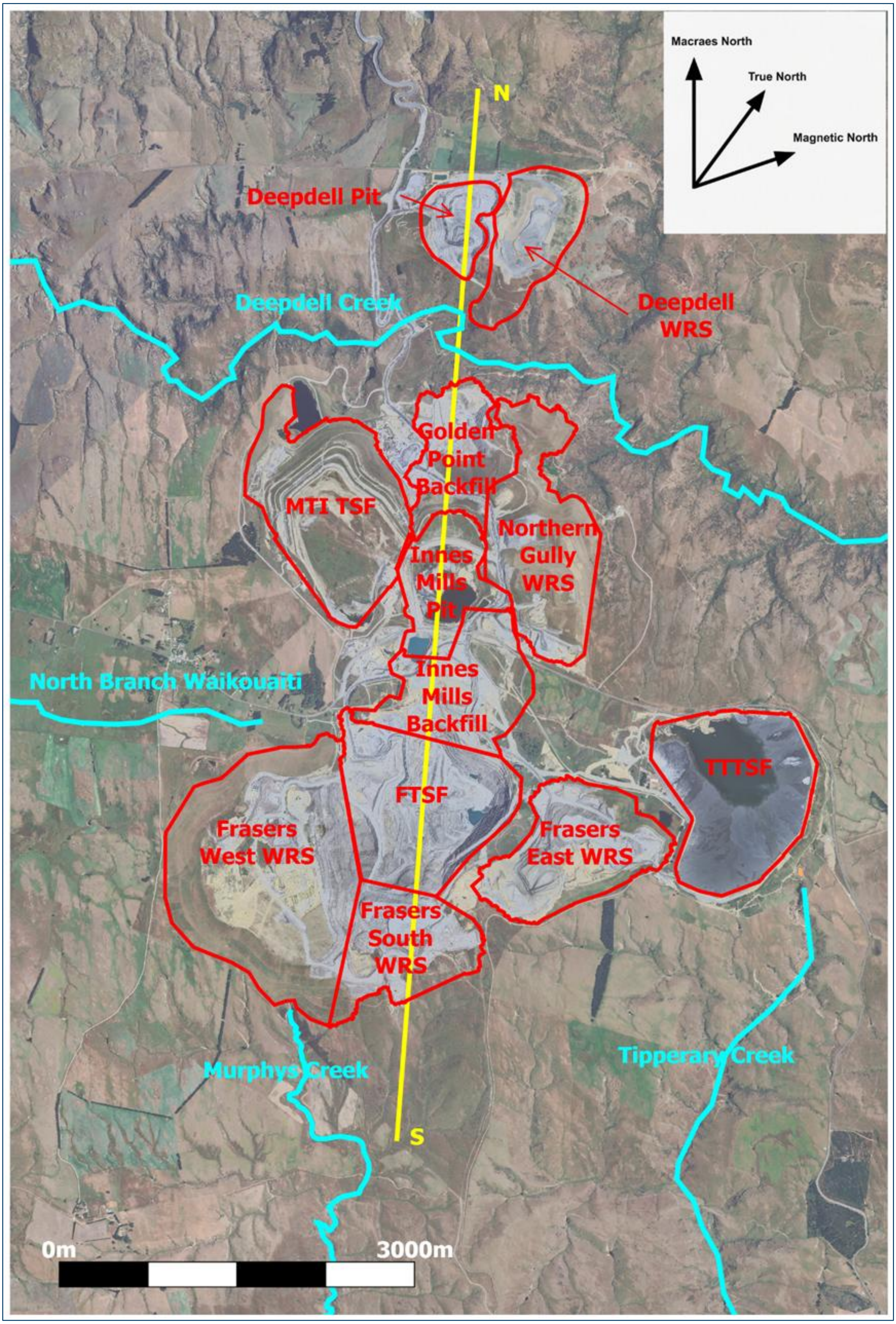
Contour plot showing sulphate plume extent at the end of the recovery model (400 years of recovery) in model layer 10.



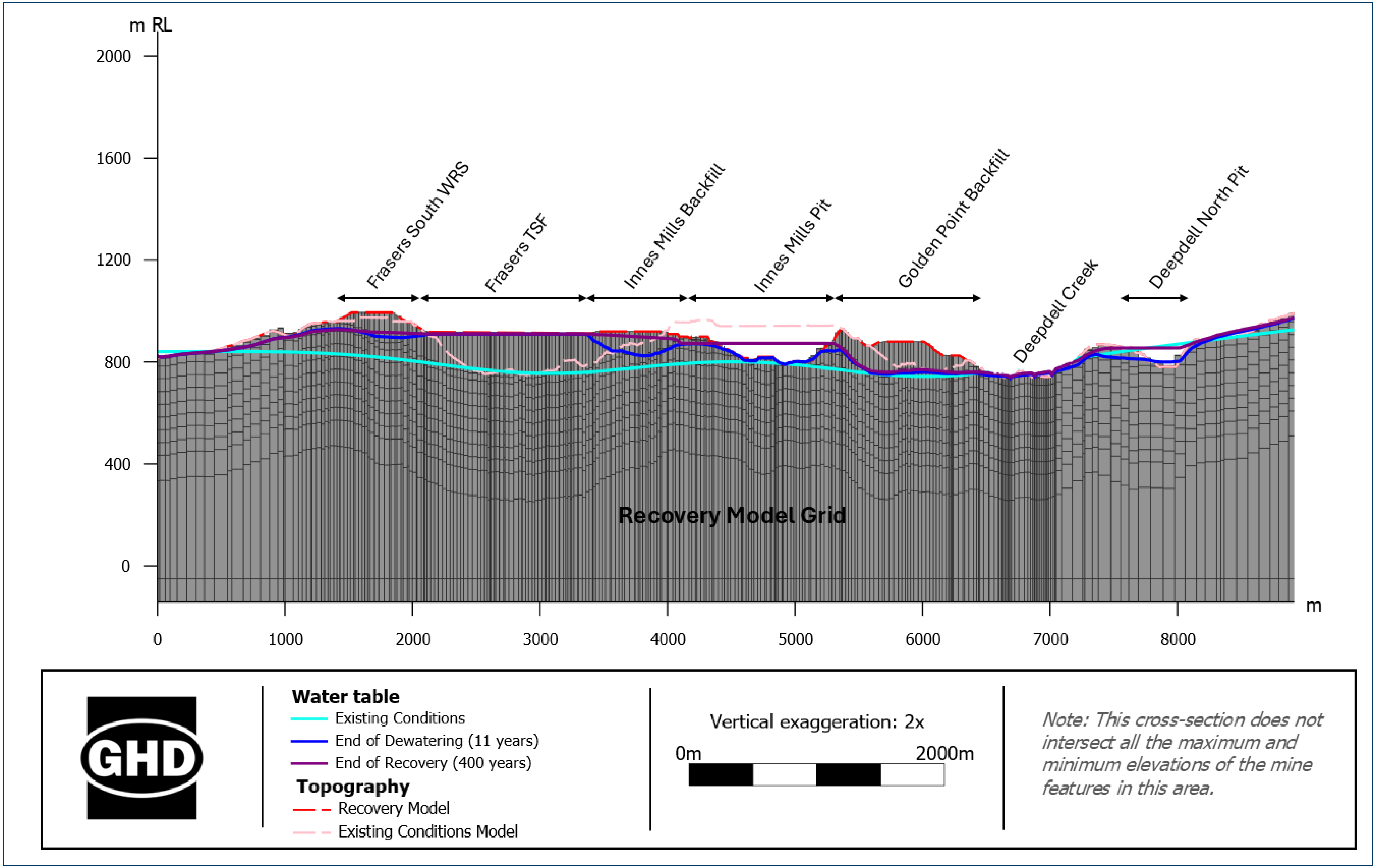
Attachment 4

South-North Cross Sections

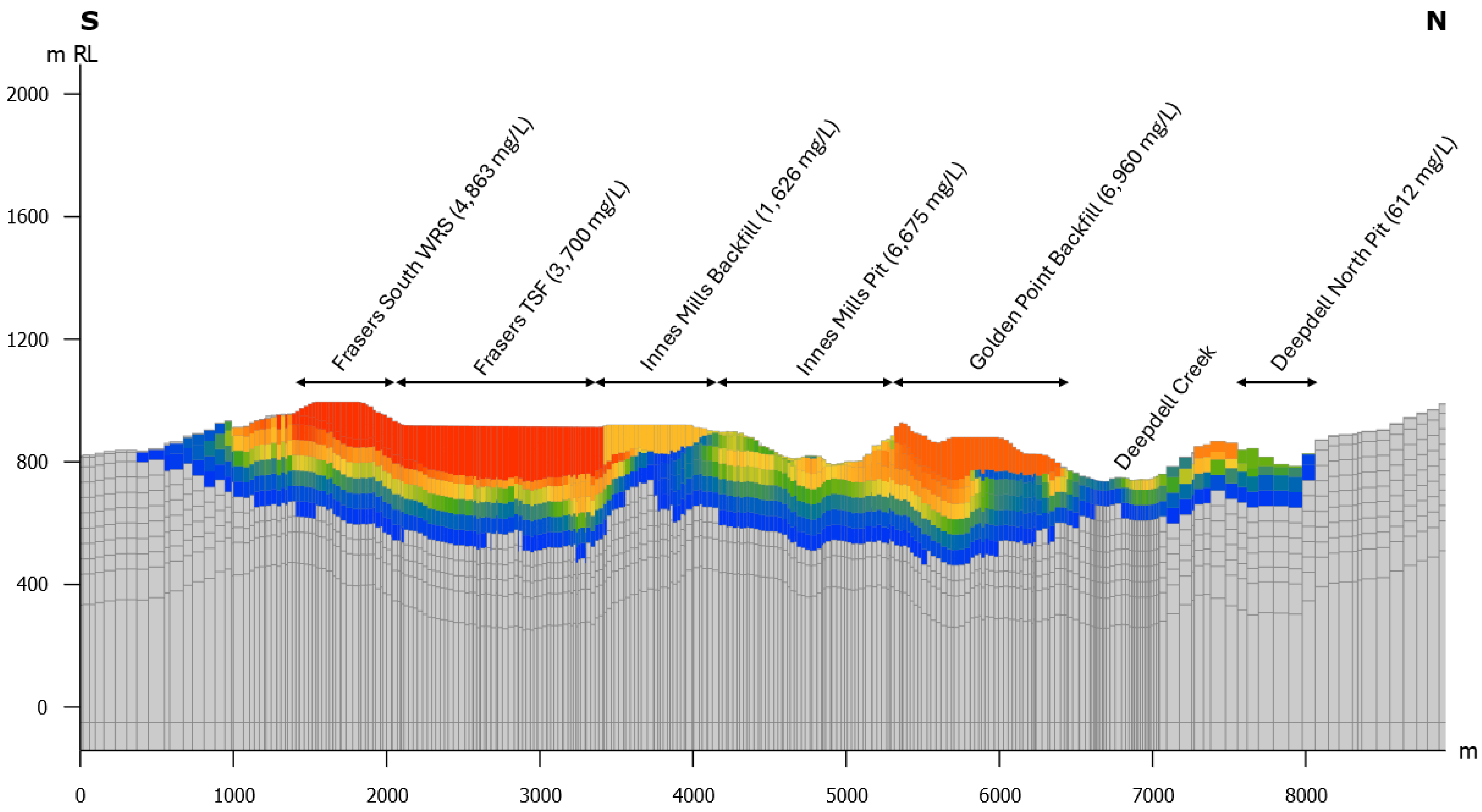
South-North Cross Sections Location



Water table estimated at different mining stages



Contamination plume estimated from the recovery model after 400 years



GHD

Concentration (mg/L)

10 800 1500 2300 3000

Vertical exaggeration: 2x

0m 2000m

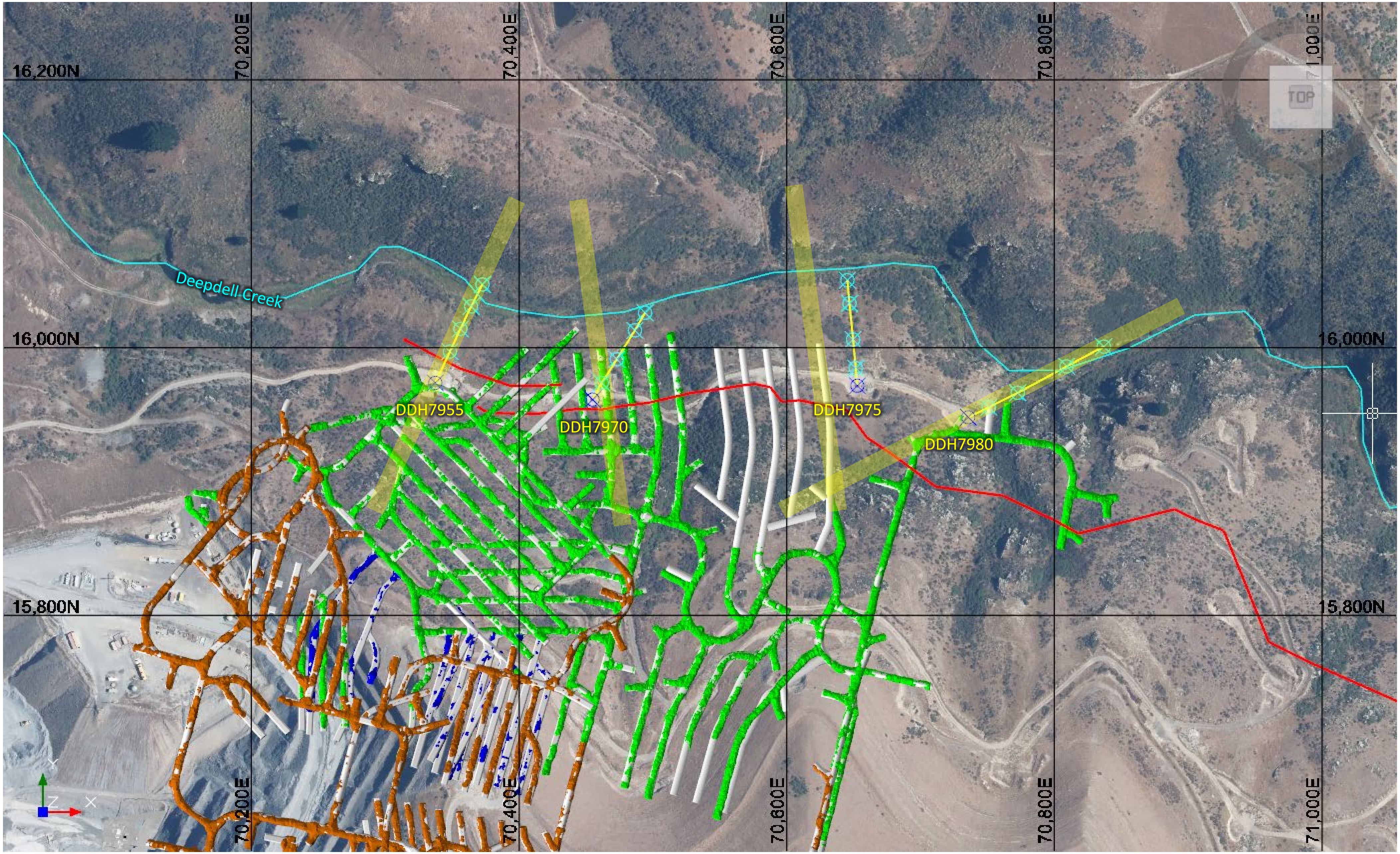
Note: This cross-section does not intersect all the maximum and minimum elevations of the mine features in this area.

Attachment 5

GPUG Vibrating Wire Piezometers near Deepdell Creek

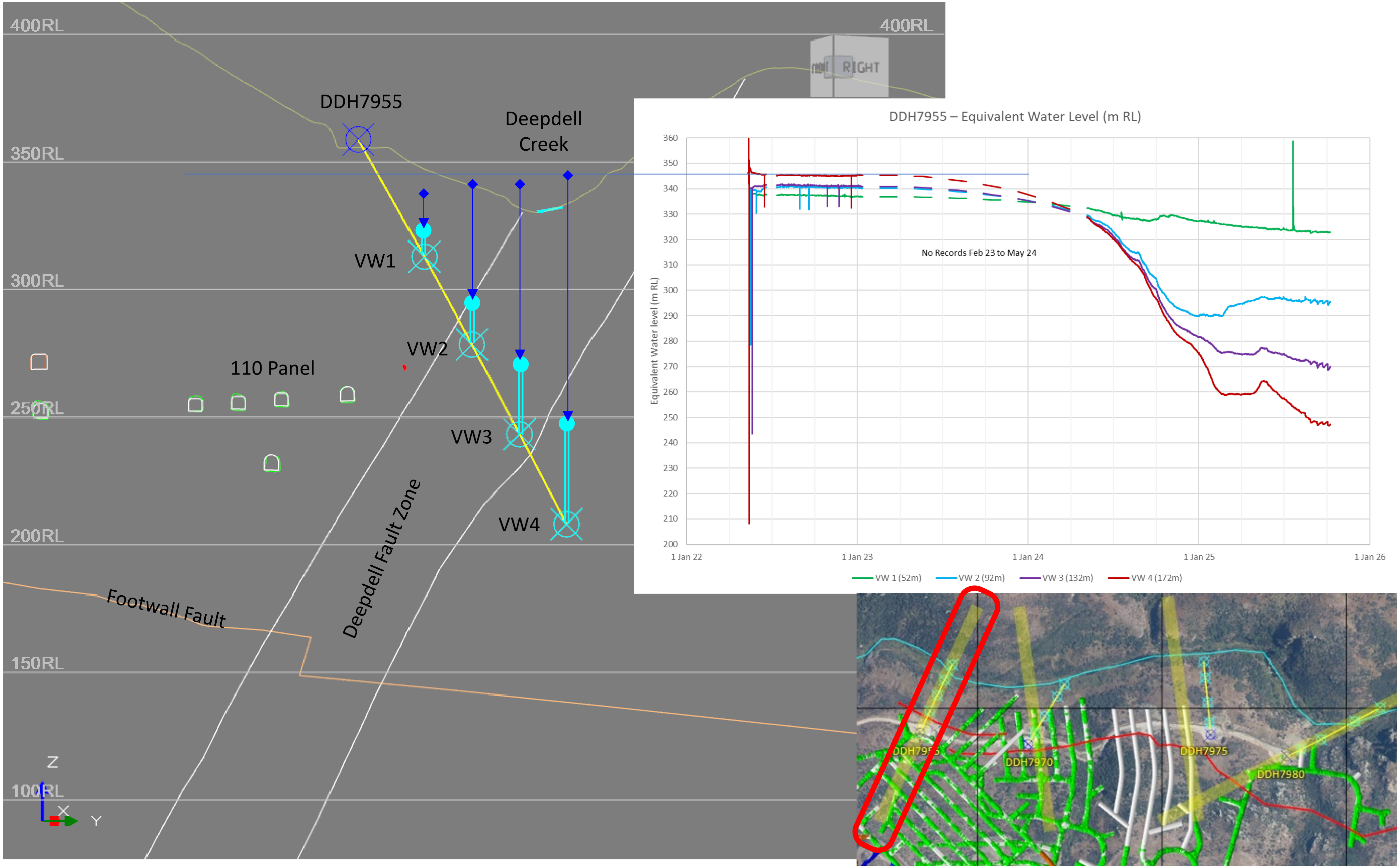
GPUG – Deepdell Creek Vibrating Wire Piezometers – 9 Oct 2025 Update

Site Plan – 4 Drillholes, each with 4 VWPs extending beneath the Creek



GPUG – Deepdell Creek Vibrating Wire Piezometers – 9 Oct 2025 Update

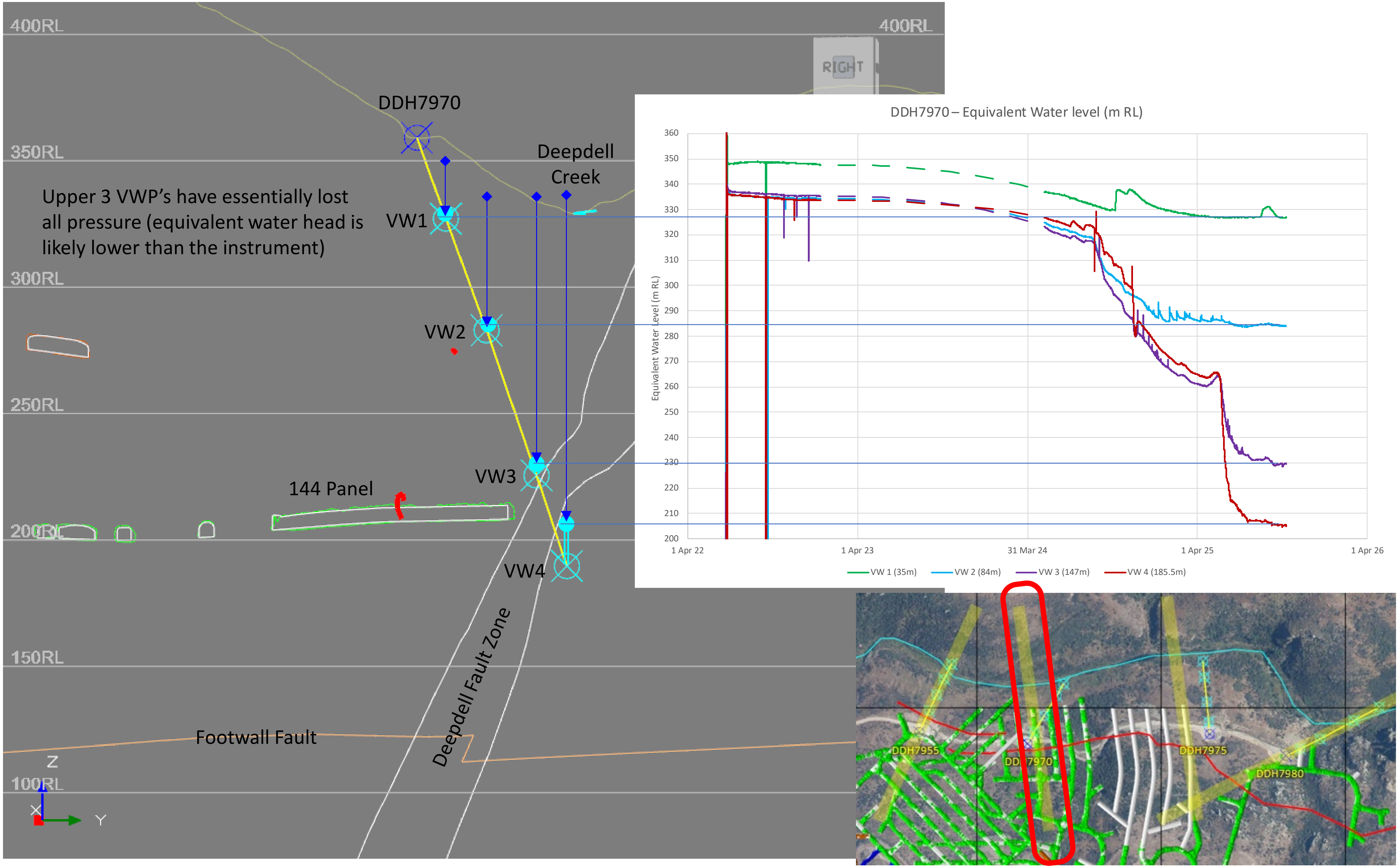
DDH7955 Cross Section



GPUG – Deepdell Creek Vibrating Wire Piezometers – 9 Oct 2025 Update

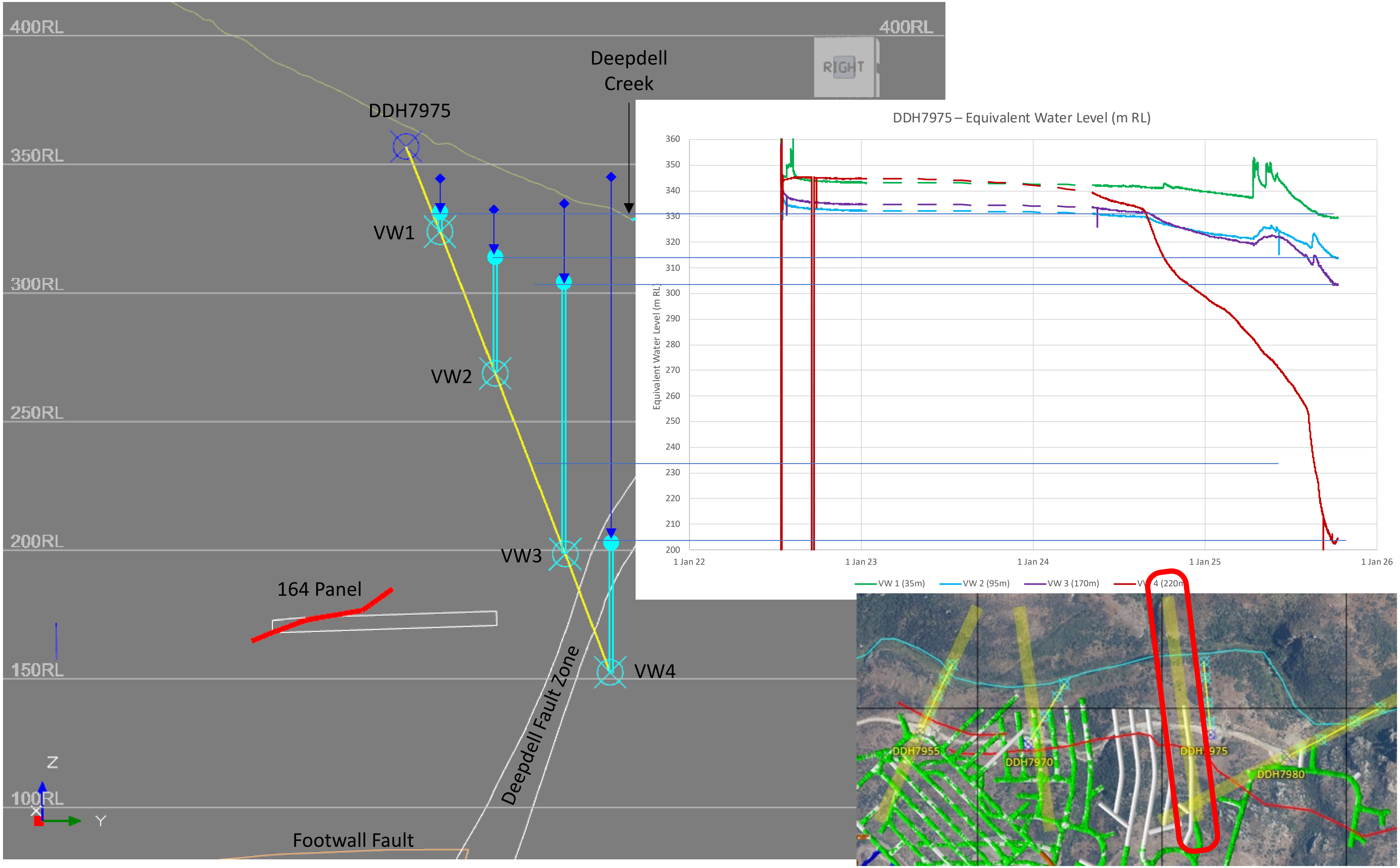
DDH7970 Cross Section – 144 Panel

OCEANAGOLD



GPUG – Deepdell Creek Vibrating Wire Piezometers – 9 Oct 2025 Update

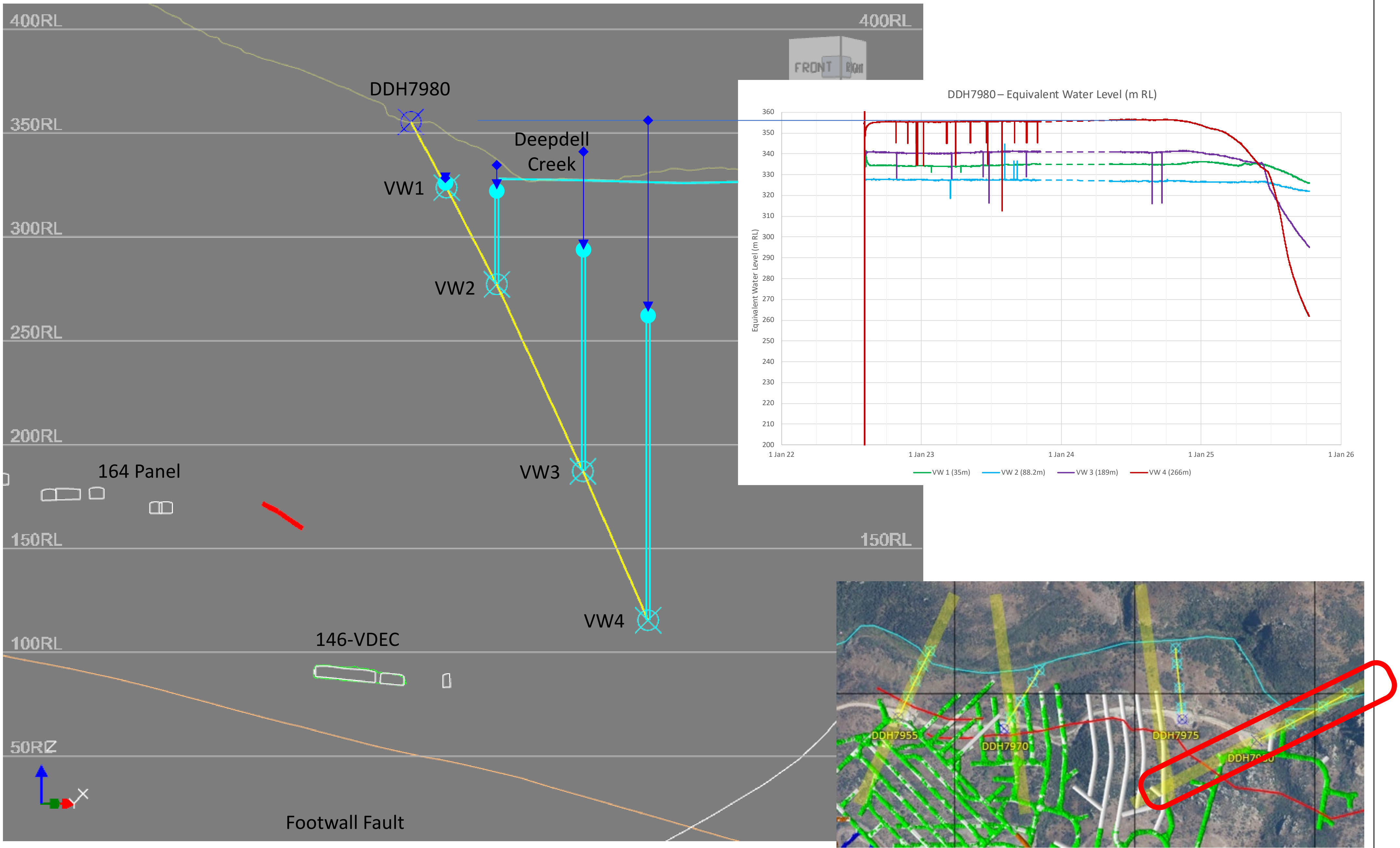
DDH7975 Cross Section – 164 Panel



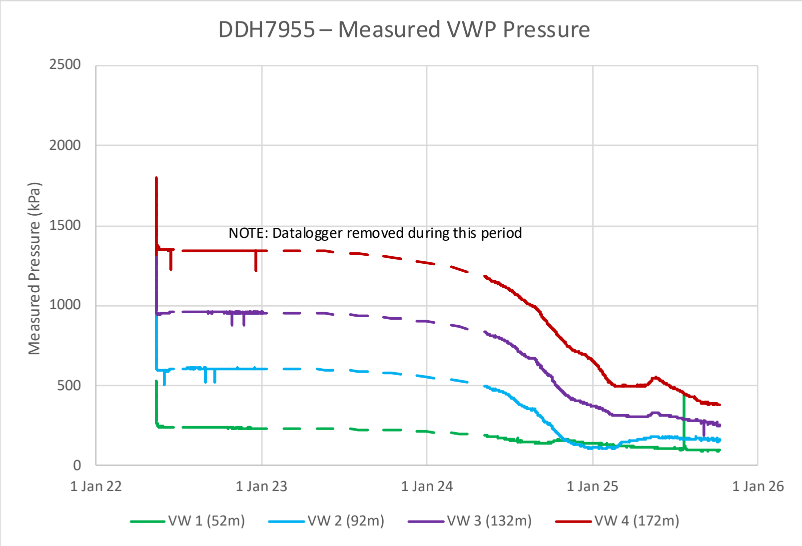
GPUG – Deepdell Creek Vibrating Wire Piezometers – 9 Oct 2025 Update

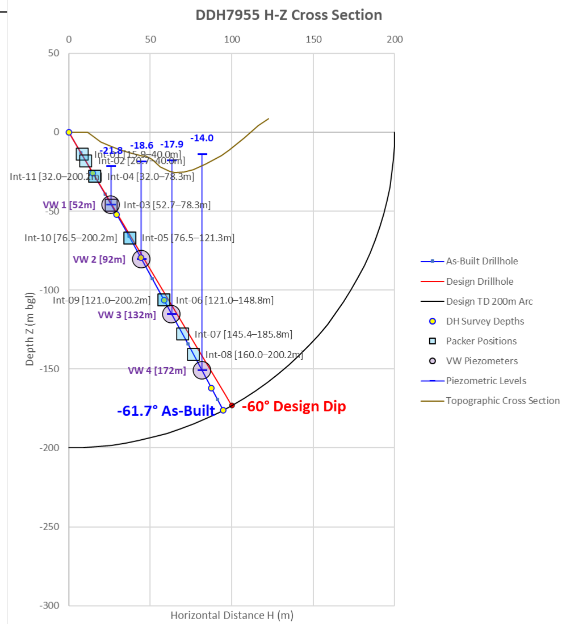
DDH7980 Cross Section

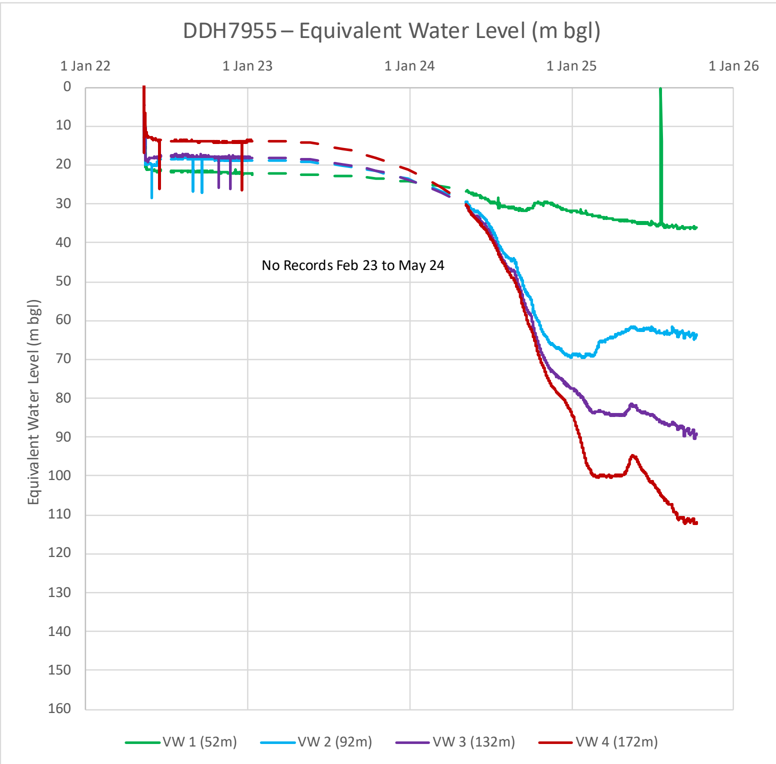
OCEANAGOLD

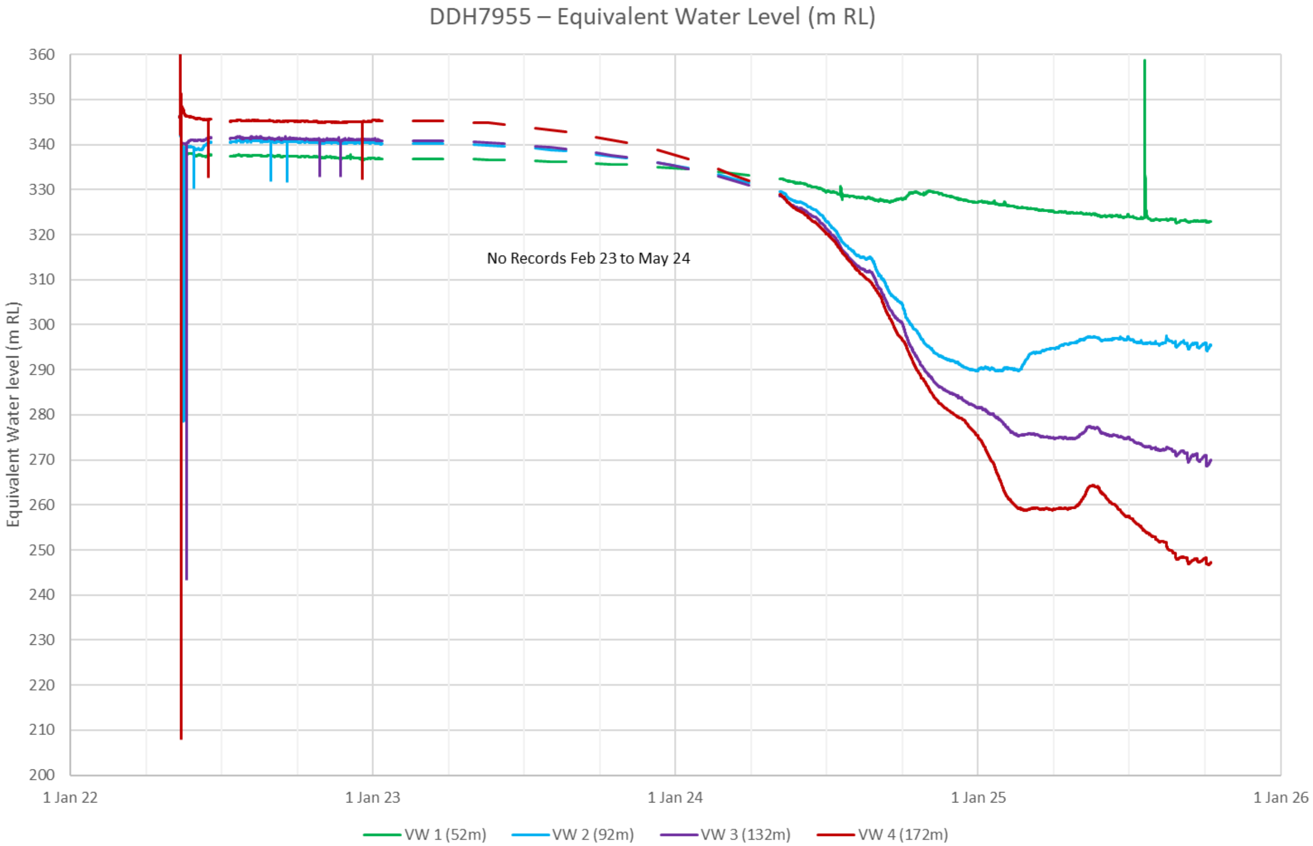


GPUG – Deepdell Creek Vibrating Wire Piezometers – 9 Oct 2025 Update

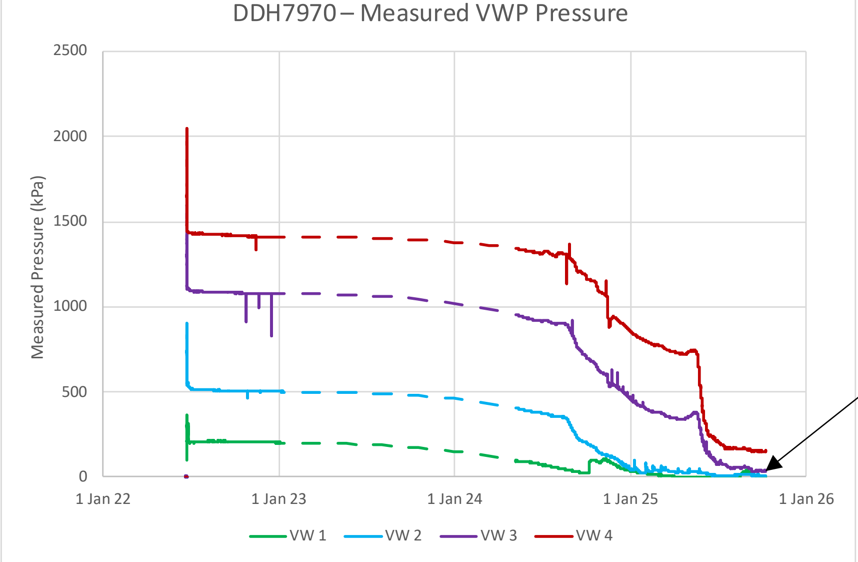




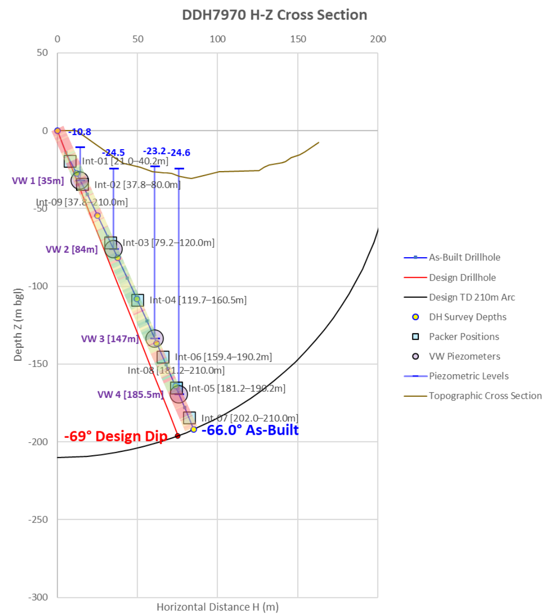


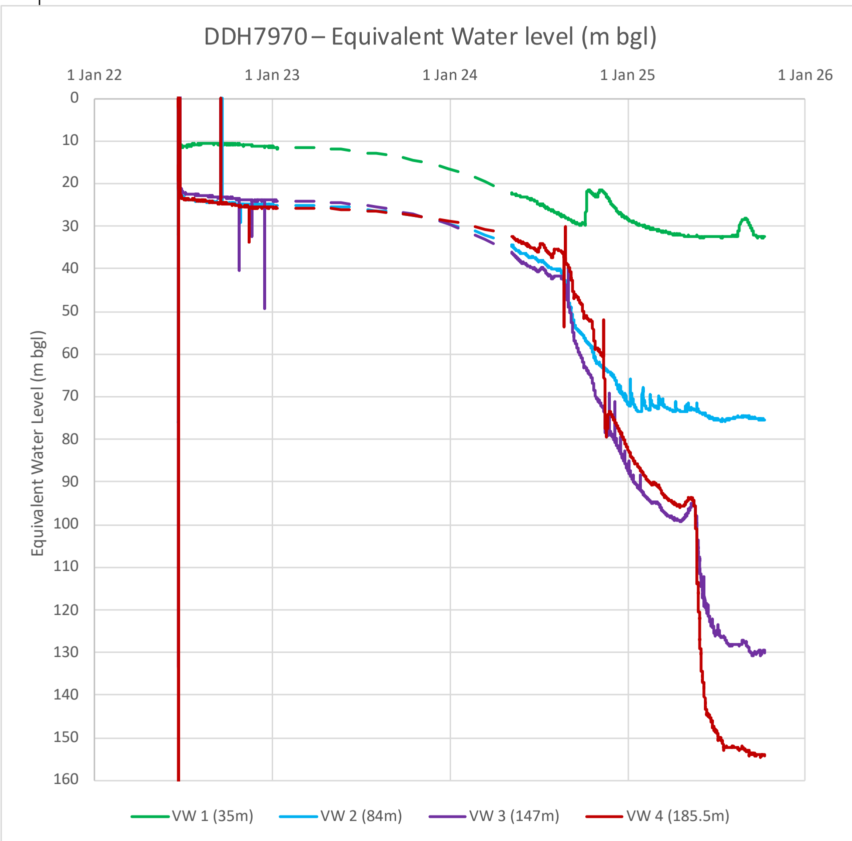


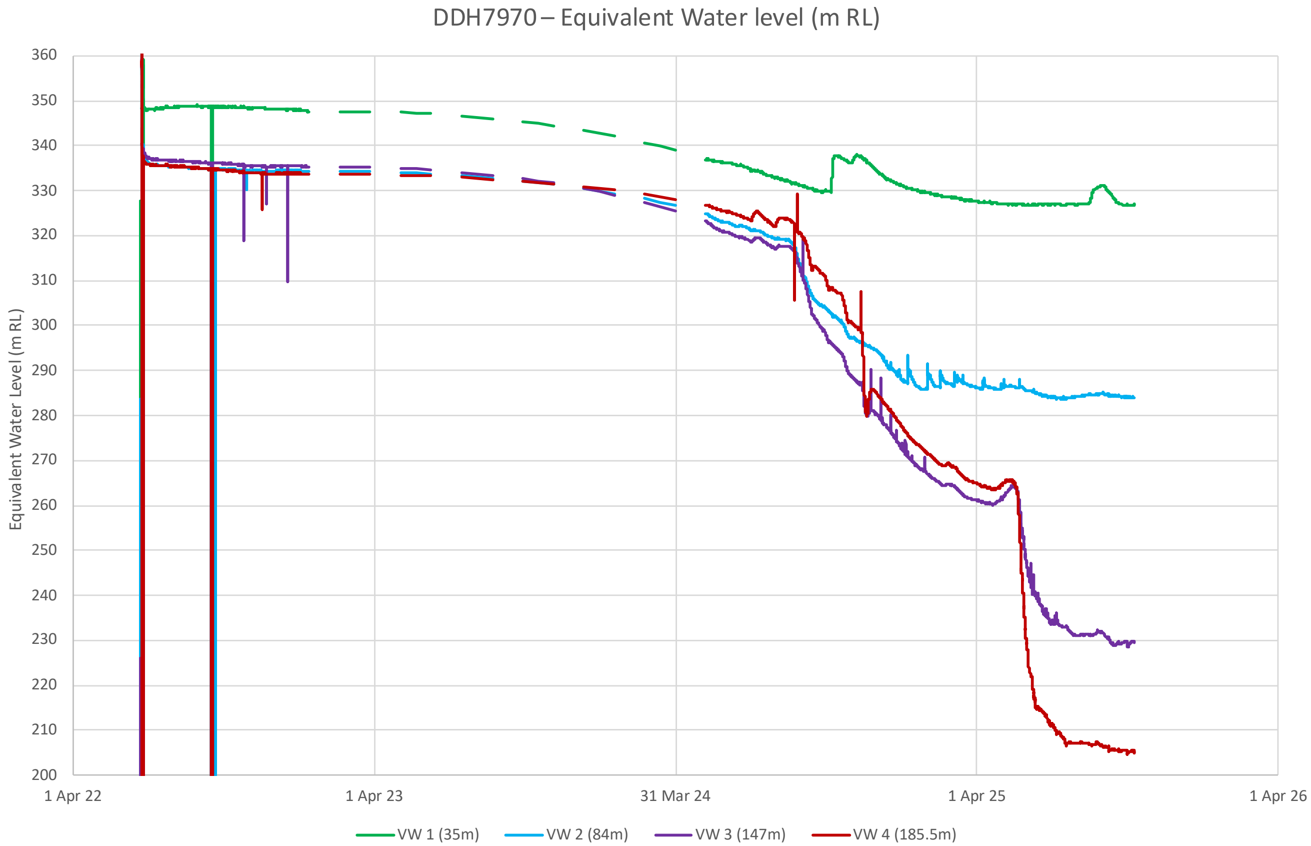
GPUG – Deepdell Creek Vibrating Wire Piezometers – 9 Oct 2025 Update



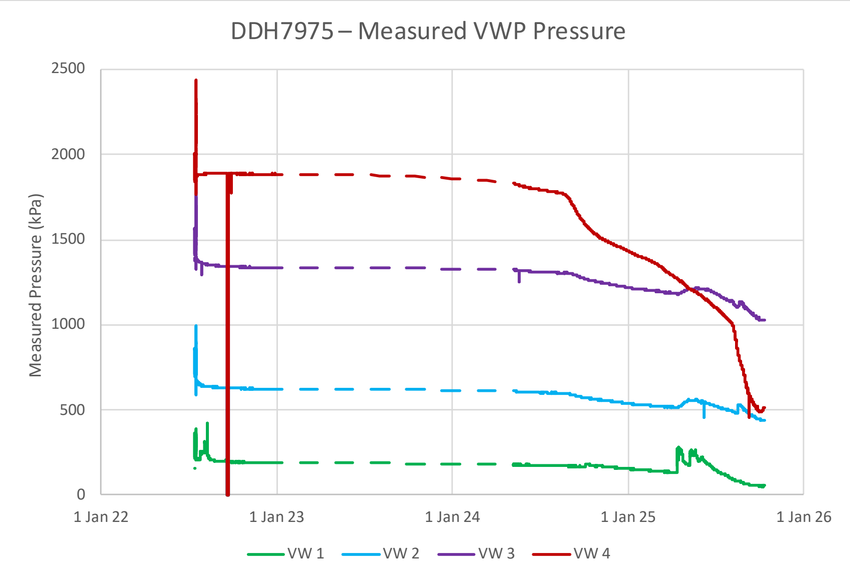
Upper 3 VWP's have essentially lost all pressure (equivalent water head is likely lower than the instrument)

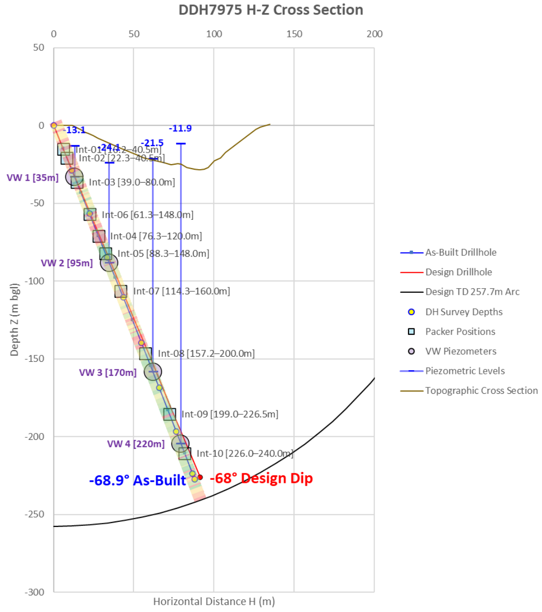


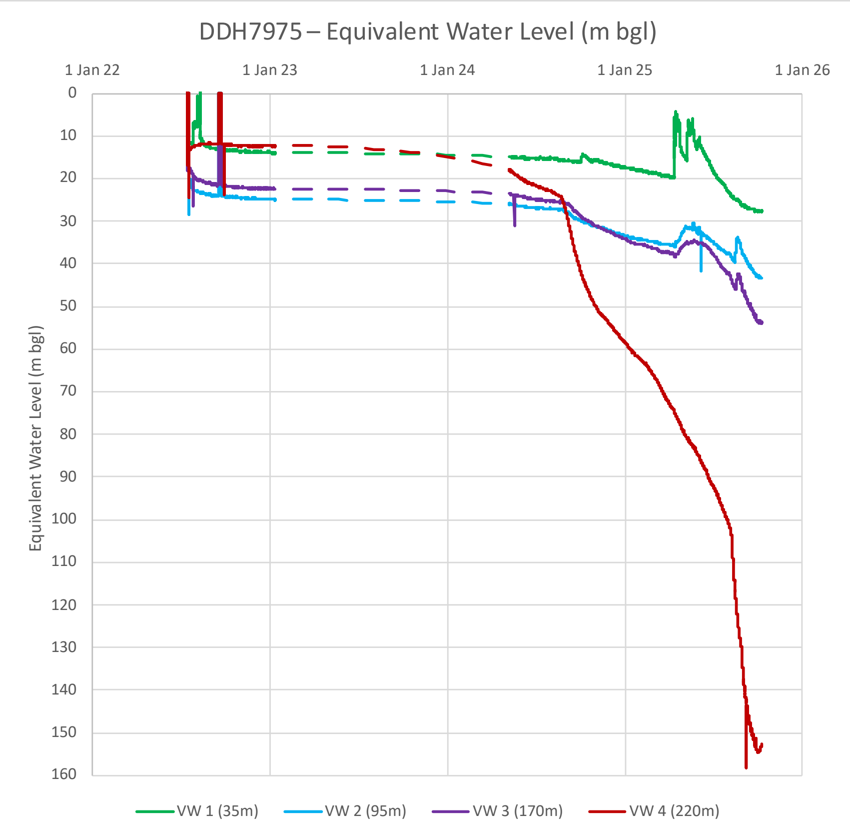


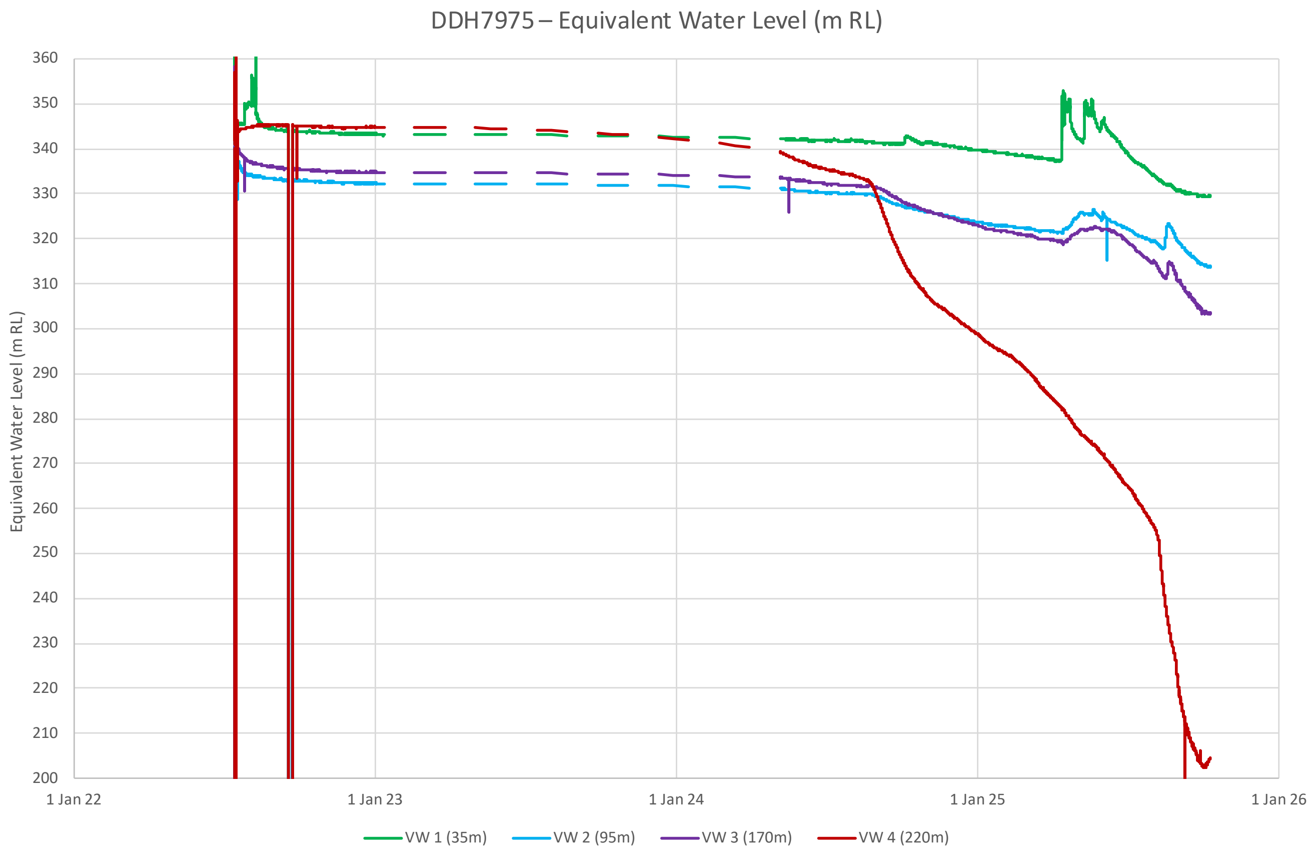


GPUG – Deepdell Creek Vibrating Wire Piezometers – 9 Oct 2025 Update









GPUG – Deepdell Creek Vibrating Wire Piezometers – 9 Oct 2025 Update