BEFORE A HEARINGS PANEL APPOINTED BY THE OTAGO REGIONAL COUNCIL

IN THE MATTER OF	the Resource Management Act 1991 ("the Act" or "the RMA")
AND	
IN THE MATTER OF	An application RM24.184 by Oceana Gold (New Zealand) Limited for various consents relating to the Macraes Phase Four mine expansion

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STATEMENT OF EVIDENCE OF
ALEXANDRA MACDONALD BADENHOP
ON BEHALF OF OTAGO REGIONAL COUNCIL

30 May 2025

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1 INTRODUCTION

1.1 My full name is Alexandra Macdonald Badenhop.

1.2 I am employed by e3Scientific Limited as the Technical Director for Water & Environmental Management, based in Arrowtown.

1.3 I have read the Code of Conduct for Expert Witnesses in giving evidence to the Environment Court. I agree to comply with that code when giving evidence to the Hearing Panel in this matter. All my evidence is within my expertise, and I have considered and stated all material facts known to me which might alter or qualify the opinions I express.

2 QUALIFICATIONS

2.1 I hold a Bachelor of Engineering (Environmental) (Hons) (1999) from the University of New South Wales (UNSW) and a Masters of Engineering Science (Groundwater Studies) from UNSW in 2008. The subjects completed for my masters also fulfilled criteria for Master of Engineering Science (Water Quality).

2.2 I have over 20 years of experience working in the water industry in Australia and New Zealand. My experience has encompassed a range of engineering studies including hydrogeology, hydrogeochemistry and water quality assessments, groundwater-surface water interactions and investigations to characterise site hydrology, and assessments of environmental effect for take and discharge consents across Otago and Southland.

2.3 I am a member of the New Zealand Hydrological Society and the International Association of Hydrogeologists.

2.4 I have acted as an Expert Witness in groundwater and environmental discharge related consent hearings in New Zealand for the past ten years. I have provided expertise in the fields of discharges hydrogeology, groundwater and surface water quality and environmental monitoring plan design.

3 ENGAGEMENT AND SCOPE OF EVIDENCE

3.1 In April 2024 I was engaged by Otago Regional Council (ORC) to undertake a technical review of groundwater and geochemistry aspects of the submitted application documents provided by Oceana Gold (NZ) Ltd (OGL).

3.2 I have read the surface water modelling reports to understand how groundwater has been incorporated into the models, however a detailed technical review of the surface water models was outside of my scope of works.

3.3 I have visited the site on two occasions. My most recent site visit on 12th June 2024 was for the purpose of understanding the MP4 proposal in conjunction with Torlesse Environmental, ORC and representatives from OGL. I have also been engaged by ORC to complete technical reviews of several other consents relating to the Macraes site and to complete compliance reviews of the quarterly water quality monitoring reports and water quality management plans for the site. I am familiar with the site layout, and surrounding environment.

3.4 In preparing this evidence I have reviewed the following documents:

a) OGL (2025). Macraes Phase 4 Project Resource Consent Application and Assessment of Environmental Effects- Post lodgement - with track changes

b) Appendix 8 - MWM (2024). Macraes Mine Phase 4.3 Environmental Geochemistry Assessment. 28 February 2024

c) Appendix 9 - Strata Geoscience (2023) Review of Macraes Mine Phase 4.3 Environmental Geochemistry for Oceana Gold Ltd

d) Appendix 11 - GHD (2024a). Macraes Phase IV – Coronation – Surface and Groundwater Assessment. 26 February 2024

e) Appendix 12 - GHD (2024b). Macraes Phase IV – Golden Bar – Surface and Groundwater Assessment. 26 March 2024

f) Appendix 13 - GHD (2024c). Macraes Phase IV – Frasers TSF - Innes Mills – Golden Point and Cumulative Surface and Groundwater Assessment. 26 March 2024

g) Appendix 14 - GHD (2023). Golden Bar Dewatering Assessment. 21 July 2023

h) Appendix 30 - WGA (2024). Technical Memorandum - MPIV Water Management Technical Documents Review Summary

i) Appendix 31 - Section 92 response to ORC, dated 15 October 2024. Planning and overarching responses including the following supporting information:

    i. Appendix 31 - Annexure 1: Macraes Water Quality Management Plan;

    ii. Appendix 31 - Annexure 2: Back Road WRS Geochemical Model – MWM;

    iii. Appendix 31 - Annexure 3: Back Road WRS Assessment – Surface water quality modelling – GHD;

    iv. Appendix 31 - Annexure 4: Responses to s92 requests prepared by

GHD in respect of surface and groundwater matters;

v. Appendix 31 - Annexure 6: Description of the Macraes Mine Water Management System;

vi. Appendix 31 - Annexure 7: Figures showing approximate locations of clean water diversions;

vii. Appendix 31 - Annexure 14: Responses to s92 requests prepared by MWM in respect of geochemical matters;

j) Appendix 33 - Section 92 response to ORC, dated 7 February 2025 . Planning and overarching responses including the following supporting information:

i. Appendix 33 - Annexure 1: Responses to s92 requests prepared by MWM in respect of geochemistry matters;

ii. Appendix 33 - Annexure 2: Responses to s92 requests prepared by GHD in respect of surface and groundwater matters

4 PROPOSED ACTIVITIES AS THEY RELATE TO GROUNDWATER QUALITY AND QUANTITY

4.1 OGL is seeking to expand their gold mining activities at Macraes Flat, North Otago. The expansion activities are referred to as Macraes Phase 4 (MP4) and include:

a) Life of mine tailings storage Frasers Pit (Frasers Tailings Storage Facility - FTSF) and development of the open pit mining extensions in the Innes Mills Open Pit (IMOP);

b) An expansion of the Coronation Pit with waste infilling of the Coronation North Open Pit (situated approximately 4 km to the northwest of IMOP);

c) An expansion of the Golden Bar Pit and the associated Golden Bar WRS (situated approximately 6 km to the southeast of IMOP); and

d) Rehandle of waste rock from the rehabilitated Northern Gully Waste Rock Stack to the Golden Point Pit

4.2 The following activities associated with the resource consent have the potential to affect groundwater quantity:

a) Dewatering Golden Bar Pit

b) Dewatering Coronation Pit and Coronation North Pit

c) Dewatering additional areas to be mined within Innes Mills Pit

d) Increasing the depth and extent of mining pits – Golden Bar, Coronation, Innes

Mills

e) Sealing underground mine workings

4.3 The following activities associated with the resource consent have the potential to affect groundwater quality:

a) Tailings storage within Frasers Open Pit

b) Additional waste rock storage in the waste rocks stacks (WRS) around the mine area – Coronation, Coronation North, Trimbells, Back Road, and Clydesdale WRS

c) Additional waste rock storage in pits – Coronation, Coronation North and Golden Bar

d) Groundwater seepage from pit lakes

5 MODEL CONCEPTUALISATION

5.1 Geochemical models were completed by MWM to predict pit lake water quality, and to provide water quality source terms for the groundwater and surface water modelling. Clear conceptual models have been provided within the geochemical modelling documentation with source term data explained. Sensitivity analysis has been completed for elements of the modelling, such as the impact of groundwater inflows to the pits being contaminated etc, which helps to improve confidence in the models. The waste rock stack relationships were based on water quality monitoring data up to March 2022.

5.2 Three separate groundwater models were established by GHD and have been run to assess the impacts of proposed activities. The three models are:

a) Coronation Area

b) Golden Bar Area

c) Frasers/Innes Mills/TTTSF area (Central Mining Area)

5.3 The groundwater flow models were used to predict groundwater inflows into and out of the existing and proposed pits, and to model groundwater level recovery over 400 years. They were also used to estimate the stream depletion effects of groundwater drawdown from pit dewatering. Within the model, larger creeks are modelled using the ‘River’ function which can both gain and lose water from/to groundwater, and smaller tributaries are modelled as ‘drains’, which can only gain water from groundwater.

5.4 The groundwater contaminant transport models are run with the assumption of mine closure conditions i.e. they assume that all structures are fully constructed, waste rock stacks are rehabilitated, and sulphate concentrations are applied based on the full surface

areas of the relevant mine elements at mine closure. The models were then run over 400-year periods. This simplified approach ignores earlier-built structures (i.e. waste rock stacks, tailings storage facilities and open pits) and any pre-existing seepage or transport before mine closure i.e. there are no background concentrations of contaminants considered. There has been no calibration/validation of the contaminant transport within the models.

5.5 The Back Road Waste Rock Stack was not included in the Central Mining Area groundwater contaminant transport modelling.

5.6 Modelling of WRS uses infiltration rates of 29 mm/year which are equivalent to the expected groundwater recharge rate across the site for the rehabilitated surfaces.

5.7 Groundwater modelling does not allow for capture of waste rock seepage in silt ponds i.e. Waste rock seepage all infiltrates to and migrates within groundwater. This means that the groundwater transport modelling may be conservative for long-term groundwater concentrations after rehabilitation if mine water management elements such as silt ponds and water recirculation into pits are continued after mine closure, and if the model adequately approximates contaminant transport within the groundwater system.

5.8 There is one water balance model for the site, however groundwater modelling outputs have not been used consistently in the water balance model across the site. The descriptions and reporting are broken down into the same three areas as the groundwater models:

a) Coronation Area

b) Golden Bar Area

c) Frasers/Innes Mills/TTTSF area (Central Mining Area)

5.9 Groundwater model outputs have been used in terms of groundwater flows into and out of the pits across the whole site.

5.10 Within the Coronation and Golden Bar areas, and the NBWR catchment of the Central Mining Area the groundwater contaminant flux calculated from the groundwater model is not included in the water balance model i.e. there is no constant groundwater baseflow to streams. Rather waste rock stack seepage is assumed to all be captured in silt ponds and managed via the mine water management system then discharged via overflow or stored in pits. Contaminant losses to groundwater from pit lakes are not specifically included the model. Consequently, during low flow conditions in streams, when groundwater baseflow is a high percentage of the stream flow, the water balance model may underestimate stream concentrations.

5.11 Deepdell Creek is the only creek for which the water balance model is stated to incorporate

the groundwater contaminant flux calculated by the groundwater model, specifically the contaminant flux associated with pit seepage component from Coronation, Golden Point, MTI and SP11 and other WRSs reporting to Deepdell.

5.12 Losses to groundwater from TTTSF are included in modelling at Cranky Jims Creek (CJ01) and Tipperary Creek (TC01).

6 AREAS OF AGREEMENT

6.1 Waste rock sampling across the site concludes that waste rock is generally non-acid forming.

6.2 The key sources of contaminants to groundwater are waste rock stacks, pit lakes and tailing storage facilities.

6.3 The key contaminants of concern for the project are arsenic, nitrogenous compounds (due to ammonium-nitrate-based blasting residues), and sulphate, with Fe, Zn, and Cu (and Pb) also being of concern.

6.4 The Draindown model appears to be an acceptable method for estimating ongoing seepage from the TTTSF, and provides reasonable results in comparison to measured seepage from MTI and SP11.

6.5 The groundwater flow models have been developed consistently with past groundwater models and use reasonable values of hydraulic conductivity and storage to simulate groundwater flow. The model has been calibrated in steady state to a very limited water level data set.

6.6 Water quality source terms have been appropriately derived from available water quality datasets and differentiate between key landuses.

6.7 Management/sealing of historic workings is required to reduce effects on groundwater.

7 AREAS OF DISAGREEMENT

7.1 Groundwater models assume no existing plume of contaminants. This may be appropriate for long term estimates, but not for short term (20 years) given the operation of existing site. Whilst Annexure 4, Appendix C[1] mapping of median sulphate concentrations does show that elevated sulphate concentrations are within close proximity to site infrastructure, the extent of the plumes is unknown. Concentrations indicate that in some areas, e.g. north of Frasers West WRS, the plume has travelled further than would be expected within the timeframes of the site operation, relative to the modelled concentrations after 400 years of

[1] Appendix 31 - Annexure 4: Responses to s92 requests prepared by GHD in respect of surface and groundwater matters (GHD, 24/09/2024);

transport. No calibration/validation of the contaminant transport model has been performed based on contaminant plume movement.

7.2 Water balance modelling is unlikely to be conservative during low flows as it assumes that all WRS seepage can be captured and managed in silt ponds, i.e. that there is no recharge to groundwater occurring beneath the waste rock stacks. This means that groundwater baseflows occurring to the streams during low flows do not contribute contaminants to streams, only the silt pond discharges.

7.3 Deepdell Creek is the only creek for which the water balance model is stated to incorporate the groundwater contaminant flux calculated by the groundwater model, specifically the contaminant flux associated with pit seepage component from Coronation, Golden Point, MTI and SP11 and other WRSs reporting to Deepdell. In the long term, this should provide a more conservative assessment of baseflow water quality in streams[2], however given that groundwater was modelled with no existing contamination, the short-term assessments (20 years) will not be conservative.

8 AREAS OF REMAINING UNCERTAINTY

8.1 Groundwater models have been run assuming mine closure conditions (e.g. rehabilitated WRS) with no background concentrations of contaminants, and therefore short term (during mining) effects are less certain and cannot be compared with the surface water model. This means they may be adequate for long-term predictions, but not for short-term predictions i.e. the 20-year predictions.

8.2 The impact of climate change on groundwater modelling, in particular groundwater recharge rates, has not been assessed.

8.3 There is some uncertainty regarding the conceptualization of the Coronation area within the groundwater model. It seems that the Coronation North Pit WRS is not modelled as a contaminant source to its base, only within Layer 1 of the groundwater model. Based on the requested consents there is also the possibility that Coronation North Pit could be a lake rather than an above ground waste rock stack. The further use of the Coronation WRS, Coronation North WRS and Trimbells WRS as indicated in the updated AEE may change the contaminant loading in the model, which would increase the contaminant loads into the catchment. In addition, the proposed discharge of waste rock material into Coronation Pit has not been incorporated into the pit lake water quality model for Coronation Pit. Therefore, there are additional sources of contaminants that are likely to increase the risk to groundwater and surface water that have not been included in the models.

[2] However, if the sulphate flux from the groundwater modelling has been incorporated into the WBM, it is unclear how the WBM can result in a modelled lower sulphate flux than the groundwater model within Deepdell Creek (see Table 18 of Appendix 13).

8.4 The cumulative dewatering impacts of Coronation North Pit on Mare Burn Creek have not been assessed.

8.5 It is not clear from the reporting whether the WRS representation in the modelling is based on the maximum consented WRS dimensions, or the current WRS dimensions for those WRS that are now intended for further use e.g. Coronation, Coronation North, Trimbells and Golden Bar.

8.6 The Back Road Waste Rock Stack was not included in the groundwater modelling (therefore comparisons of loads between groundwater and water balance modelling do not account for this).

8.7 Consent has been requested to discharge waste rock into Golden Bar Pit, which was not included in the pit lake water quality model.

8.8 Water quality effects are to be managed adaptively based on technologies that are still to be tested. Short-term testing of feasibility may not be indicative of long-term performance or the long-term fate of immobilised sulphur. Efficacy of passive and active treatment measures, particularly in the long-term is not yet known.

8.9 Long-term management of seepage from tailings facilities is unclear. Surface water modelling assumes that seepage from tailings facilities continues to be captured and treated and therefore is not discharging to the environment, but the draindown model assumes that it is captured and returned to FROP for 20 years and then managed alternatively as drainage systems are likely to be clogged.

8.10 Sulphides have not previously been monitored but could be problematic in anoxic groundwaters.

8.11 The location of DC08 used in the modelling assessment appears to be different to the current compliance monitoring location, as provided in response to Question 4.18 in Appendix 31 - Section 92 response to ORC, dated 15 October 2024. This will affect the catchment area that reports to the WBM model node (see Figure A5 of Appendix 13 - GHD (2024c), and also indicates that some of the mining activities e.g. BRWRS, may impact Deepdell Creek downstream of the DC08 compliance point. A comparison of the locations is provided in Attachment A.

9 ASSESSMENT OF EFFECTS – GROUNDWATER QUANTITY

9.1 Groundwater quantity will be affected by dewatering of pit lakes and during pit lake filling.

9.2 Dewatering of Golden Bar Pit is likely to have negligible effects on groundwater contributions to McCormicks Creek and Murphy's Creek flows.

9.3 Within the Central Mining Area, baseflow to Deepdell Creek is expected to be reduced by

3 L/s at DC07. The reduction of baseflow to smaller creeks (represented as drains) may be 11 L/s, but it is not clear where these impacts will occur.

9.4 Within the Coronation area, groundwater baseflow to the Mare Burn is expected to be reduced by 1 L/s due to Coronation pit dewatering. This is approximately 4.5% of the total groundwater contribution estimated by the model.

10 ASSESSMENT OF EFFECTS – GROUNDWATER QUALITY

10.1 Sulphate concentrations have been used to model the groundwater contaminant plume as concentrations are elevated by the mining activities and have low potential to attenuate. The modelling assumes no background concentrations.

10.2 Whilst sulphate concentrations in groundwater can be used to indicate the rate of transport of contaminants, the relationship between sulphate and other contaminants cannot be inferred with confidence in groundwater. Within the water quality models, representative water quality compositions were derived for different sources of contaminants. Whilst these are clearly justified, when contaminated groundwater mixes with other sources and native groundwater, these relationships will not be maintained. The modelled sulphate concentration may give an indication of the dilution of the source water at the discharge points, which could be used to indicate the likely concentration of other contaminants if the background concentrations are known, but this work has not been completed. The key sources of contaminants are as follows:

a) Waste Rock Stacks – an empirical relationship was derived to forecast maximum sulphate concentrations based on average waste rock stack height. Linear relationships were then developed to predict concentrations of other parameters (Calcium, Magnesium and Sodium) based on the predicted sulphate concentration for which a reasonable correlation existed (R^2>0.5). Most contaminant concentrations (Nitrate, chloride, iron, copper and arsenic) were not statistically related to the sulphate concentration; for these contaminants the median value of the contaminant concentration from all waste rock seepage monitoring across the site (Deepdell North, North Gully East, North Gully West, Frasers West, Coronation, Coronation North, and Golden Bar) was used for the time-period during which values of sulphate are quasi-stable.

b) Tailings Storage Facilities – water quality from actual monitoring data for MTI/SP11 and from previous reporting for TTTSF.

c) Pit lakes – A geochemical mixing and reaction model was developed for Golden Bar calibrated to current water quality within the pit lake. Source terms for the model were based on water quality datasets from analogue catchment landuses. This model was then used as an analogue to forecast the future water quality within the extended Golden

Bar Pit Lake, Coronation Pit Lake and FRIM Pit Lake.

10.3 Groundwater contaminant plumes are expected to migrate slowly through the low permeability bedrock; therefore, it will be many years before concentrations of contaminants peak in groundwater discharging to streams across the mine domain. The groundwater modelling indicates that concentrations will still be rising after 400 years.

10.4 Whilst the source terms for the groundwater contaminant model have been reasonably defined based on the data sets used, there is some uncertainty regarding the rate of contaminant transport based on the extent of current groundwater contamination across the mining area.

10.5 Within the Coronation Area, contaminants will discharge to the Mare Burn catchment. The groundwater contaminant plume from the WRSs and the Coronation Pit Lake is predicted to reach a maximum extent of approximately 1,600 m to the northwest and approximately 1,000 m to the southeast from these sources over 400 years. The estimate of sulphate flux (of groundwater discharging to surface water up stream of the compliance monitoring location MB02) is estimated to be 183 kg/day (20 years post closure) and 696 kg/day (230 years post closure). The groundwater modelling plots included in Appendix 11 indicate that groundwater discharging to Trimbells Gully is likely to have concentrations of ~2000 mg/L and Māori Hen Creek[3] of ~1000 mg/L after 400 years. Existing groundwater monitoring in this area with which to validate the rate of contaminant transport is very limited, and there are no clear consent conditions proposed which require more.

10.6 Within the Golden Bar area, the groundwater model indicates that almost all dissolved contaminants transported in groundwater from the Golden Bar Stage 2 Pit and GBWRS will eventually discharge to receiving waters upstream from the NB03 compliance monitoring point. The groundwater contaminant plume is modelled to reach a maximum extent of approximately 800 m (from the GBWRS) to the south-west and 900 m (from the pit lake) to the south-east direction over a period of 400 years. The total modelled contaminant (sulphate) mass estimated to discharge into the creeks in the NBWR catchments have been estimated as approximately 26 kg/day 20 years post closure, 76 kg/day 230 years post closure, and 80 kg/day 400 years post closure. The groundwater modelling plots included in Appendix 12 indicate that groundwater discharging to the northern end of Clydesdale Creek is likely to have concentrations of ~1200 mg/L after 400 years. Groundwater monitoring in this area with which to validate the rate of contaminant transport is very limited. The only bore that has been consistently sampled is the control bore.

10.7 Within the Central Mining Area, the groundwater contaminant plume is modelled to primarily impact Deepdell Creek with an estimated sulphate seepage flux of between 24 and 861

[3] Note Coal Creek incorrectly labelled as Māori Hen Creek in figures.

kg/day (20- and 200-years post closure respectively). The NBWR is modelled to receive an estimated sulphate seepage flux of between 5 and 116 kg/day (20- and 200-years post closure respectively). The Back Road Waste Rock Stack was not included in the groundwater modelling. The modelling relies on historical Golden Point mine workings being sealed and precluded from discharge. The groundwater modelling plots included in Appendix 13 indicate that groundwater discharging to some parts of Deepdell Creek downgradient of the mining activities may have concentrations ~ 2000 mg/L after 400 years.

10.8 Within the Central Mining Area, groundwater discharging to the headwaters of the NBWR and Murphy's Creek are modelled to have sulphate concentrations ~1000-2000 mg/L after 400 years. However, groundwater concentrations of up to 5000 mg/L sulphate have been recorded from some bores within the NBWR catchment. This indicates that the rate of contaminant transport may have been significantly underestimated in some areas.

11 ASSESSMENT OF EFFECTS – EFFECTS ON USE OF GROUNDWATER

11.1 GHD provided an assessment of potential adverse groundwater effects on groundwater users. Based on groundwater drawdown and contamination modelling, mining is unlikely to render groundwater unsuitable for groundwater users (NZ drinking water guideline for sulphate is 250 mg/L based on taste threshold, and 1000 mg/L for stock watering). The 400-year modelled contaminant plume extent does not extend over any known non-OGL groundwater bores.

11.2 The closest groundwater users to the mining activities are situated within Macraes township within the NBWR catchment. Whilst water quality monitoring within neighbouring wells (Vickery & MMCL_HB) has not shown any impacts, compliance monitoring of groundwater adjacent to Frasers West Waste Rock Stack has measured sulphate concentrations that exceed the taste threshold for sulphate in monitoring bores ~400 m from the edge of the waste rock stack, and up to 4,700 mg/L 100 m distant. The current extent of the plume beyond these monitoring bores is unknown. Modelled groundwater quality impacts in this area do not appear to be consistent with current contamination occurring, therefore there is uncertainty as to whether groundwater users will be affected.

12 PROPOSED CONSENT CONDITIONS

12.1 If the consent is to be granted, groundwater monitoring can be used to determine the efficacy of mitigation measures such as WRS seepage collection systems, silt ponds and tailings seepage collection systems. Groundwater monitoring can also be used to calibrate and validate groundwater flow and contaminant models. However, once groundwater contamination has occurred, there are limited remediation/mitigation strategies improve groundwater or to prevent eventual discharge to streams as baseflow.

12.2 The proposed waste rock stack discharge consent conditions (Coronation – RM24.184.08,

Coronation North - RM24.184.11, Golden Bar – RM24.184.23, RM24184.28) do not specify monitoring locations, parameters, frequency or compliance conditions for water quality, rather they state that the consents must be operated in accordance with Operations and Management Plans which must include, for example from RM24.184.11 proposed Condition 13 (a).

iv. An assessment of all potential environmental effects and the measures in place to avoid, remedy or mitigate these environmental effects;

v. A description of water management at the site, including procedures for controlling adverse effects of runoff and seepage on groundwater and surface water bodies in accordance with the Water Quality Management Plan…

vi. A plan showing all monitoring locations relevant to this consent, a description of monitoring frequency, parameters analysed and relevant compliance limits and details of all measuring, recording, sampling and testing methods including any relevant standards or accreditations".

There is no corresponding requirement included in the proposed conditions for the discharge of tailings to Fraser TSF (RM24.184.01).

12.3 Further to the Operations and Management Plan required by those consents, each year a Project Overview and Annual Work and Rehabilitation Plan must be submitted that would include e.g. RM24.184.11 proposed Condition 15 (a):

vii. A description and analysis of any unexpected adverse effects on the environment that have arisen as a result of the exercise of the consent in the last 12 months and the steps taken to deal with it and the results of those steps;

viii. A description and analysis of any non-compliance events that have occurred in the last 12 months and the steps taken to deal with it and the results of those steps;

ix. A full report describing and evaluating the mitigation measures used in the last 12 months and any that are proposed to be implemented in the next 12 months. This should detail where further mitigation has been proposed as a result of a non-compliance event and/or any adverse effects on the environment;

x. Details of the annual review of any Management Plans or Manuals, including, but not limited to; Tailings Storage Facility Operations, Maintenance and Surveillance Manuals, Tailings Storage Facility

Emergency Action Plans, Erosion and Sediment Control Plans, Waste Rock Stack Operations and Management Plans, Water Quality Management Plans and the Dust Management Plan;

xi. An overview of the monitoring and reporting programme for the previous 12 months and any changes proposed for the next 12 months;

The same requirements are included for the proposed discharge of tailings to Fraser TSF (RM24.184.01), and for the discharge of contaminated water from Golden Bar Pit into Golden Bar Creek (RM24.184.18), the discharge of waste rock to Golden bar Pit (RM24.184.20)

12.4 The proposed conditions also include the requirement for a Site Decommissioning Plan to be submitted 12 months before the completion of mining that includes "Details of management, any ongoing maintenance, monitoring and reporting proposed by the Consent Holder to ensure post-closure compliance with numerical standards and mitigation plans"

12.5 A Water Quality Management Plan is required specifically for RM24.148.18 Discharge Permit to discharge water containing contaminants to Golden Bar Creek for the purpose of disposing of water from dewatering of Golden Bar Pit, Condition 10, and RM24184.28. The WQMP requires surface and groundwater monitoring in the NBWR catchment and for details to be specified in the plan, including concentrations which would trigger a mitigation response. A compliance and monitoring schedule has been proposed for these consents, however no specific groundwater monitoring locations. No compliance limits have been proposed for surrounding groundwater.

12.6 In summary, the proposed consent conditions are reliant on the development of additional plans and do not contain any details regarding groundwater monitoring. The consent conditions should contain greater clarity regarding groundwater monitoring. Additional monitoring should be installed as soon as possible to determine baseline conditions and the rate of plume movement when contamination occurs.

12.7 GHD recommended the following monitoring be implemented as soon as possible (GHD, 2025[4]. Appendix 33 - Annexure 2)

a) "Groundwater monitoring should be installed within modelled contaminant plume extent… This will aid in improving the understanding of contaminant mobilisation and transport within the underlying aquifer, assist in future model calibration and confirm the envelope of assessed effects. Areas in which there is insufficient coverage…are located down hydraulic gradient of the existing Frasers WRS and the proposed Frasers TSF, and to the south of Deepdell

[4] Document is dated 4th February, 2024 but should be dated 2025).

Creek in the vicinity of the proposed BRWRS.

b) Flow and water quality monitoring at locations targeting specific seepage discharges to better confirm site specific contributions and enable targeted mitigation. Toe construction of future WRSs should allow for seepage flows to be captured at discrete / cumulative locations for monitoring (i.e. a pipe capturing seepage flows that concentrate at WRS toes in valleys, prior to mixing with surface water runoff). [5]

c) Continuous flow monitoring should be installed within the North Branch Waikouaiti River (NBWR), Deepdell Creek and Mare Burn below the mine site.

d) Continuous electrical conductivity monitoring should be installed in the North Branch Waikouaiti River, Deepdell Creek and Mare Burn catchments to better understand the current range and distribution of water quality parameters within these surface water bodies and catchments.

e) A control site for background water quality monitoring within the NBWR be investigated".

12.8 In addition to the monitoring recommended by GHD, monitoring should also include:

a) Monitoring within the contaminant plume towards Clydesdale Creek from Golden Bar WRS, and in the vicinity of plume migration for Coronation North WRS and Trimbells WRS.

b) Continuous groundwater level monitoring within the areas of pit development and tailings storage. Currently continuous water level monitoring is limited to a very small area between the MTI and Golden Point Pit.

12.9 Given the anticipated slow travel time within groundwater, new monitoring bores should be installed within 25 m of waste rock stack toes or the distance the plume is expected to travel within 10 years. Suggested locations for proposed monitoring bores are provided in Attachment B.

12.10 Given the high concentration of sulphate in groundwater near the Macraes Flat township, additional monitoring bores should be installed to delineate the extent of the contamination plume (vertically and laterally).

12.11 Consent conditions should include a requirement to update groundwater modelling and contaminant transport based on groundwater monitoring of water levels and quality, including validation of groundwater transport times, as recommended by the GHD reports.

[5] Flow monitoring is required for Coronation North consents but has not yet been installed, and should also be required for the Frasers WRS.

12.12 A requirement has been specified to “construct a barrier or other suitable structure at the Trimbells Waste Rock Stack to minimise the advective flow of air or flow of pit lake water in the basal layers of the waste rock stack for the purpose of preventing deterioration in the quality of water from the Coronation Pit Lake as it seeps through Trimbells Waste Rock Stack”.

12.13 There are no specific other conditions included that require waste rock stacks to be constructed in a manner that reduces active ingress of oxygen. Source control methods are the most protective of groundwater and should be specified for the construction of waste rock stacks. MWM noted the following methods to reduce sulphide oxidation – limiting waste rock stack tiphead heights to 10 m, placing interburden waste rock in the core of WRS, progressive rehabilitation and capping, and construction of highly compacted, low permeability advective layers in front of basal rubble layers at the toe of WRS.

12.14 Bonds are required to continue monitoring for a period of 20 years after the expiry of the consent. It is not clear how this will operate if impacts are not evident in streams prior to the cessation of these bonds, which may be the case due to slow plume movement.

13 SUBMISSIONS

13.1 I have reviewed the eight submissions received on the application, six of which included concerns regarding groundwater quality and quantity. My comments on points relevant to groundwater quality and quantity are below.

13.2 The submission from **Dean Parata and Trevor Hay** raises the following concerns:

a) The quality of sampling conducted for monitoring purposes

b) Arsenic concentrations

c) Long term governance

I have the same concerns and have noted the need for increased clarity around monitoring conditions.

13.3 The submission from the **Department of Conservation** raises the following concerns:

a) Freshwater quality

b) Robust monitoring and compliance

c) Effects managed in a coordinated way with overall mine development

I have the same concerns and have addressed them in my evidence.

13.4 The submission from **Fish and Game** raises the following concerns:

a) Water quality compliance limits should be established that are protective of aquatic ecosystems and sports fisheries. As noted by the Regional Council's consent officer, the current compliance limits set a low bar that allows for significant adverse effects.

b) Certainty regarding the implementation of all mitigation measures, including those that may require future consenting or extend beyond the 35-year maximum consent term permitted by the RMA.

c) Cumulative water quality effects in degraded catchments.

I have the same concerns and have addressed these issues with respect to groundwater in my evidence above.

13.5 The submission from **Forest & Bird** raises the following concerns:

a) There is substantial uncertainty about the scale of effects.

b) Concerns listed as per my review

I have the same concerns and have addressed all of these issues where they pertain to groundwater in my evidence above so will not repeat them here.

13.6 The submission from **Kā Rūnaka** raises the following concerns:

a) Effects on water quality arising from the Application, including cumulative effects;

b) Provision for appropriate and meaningful management of long term environmental effects;

c) Uncertainty of ongoing and long-term nature of effects;

d) Durability and sustainability of proposed offsets and mitigation;

I have the same concerns and have addressed all of these issues as they pertain to groundwater in my evidence above so will not repeat them here.

13.7 The submission from **Richard Geels** is concerned with pollution near private dwellings. I have addressed this concern in my evidence as it pertains to groundwater.

Alexandra Badenhop

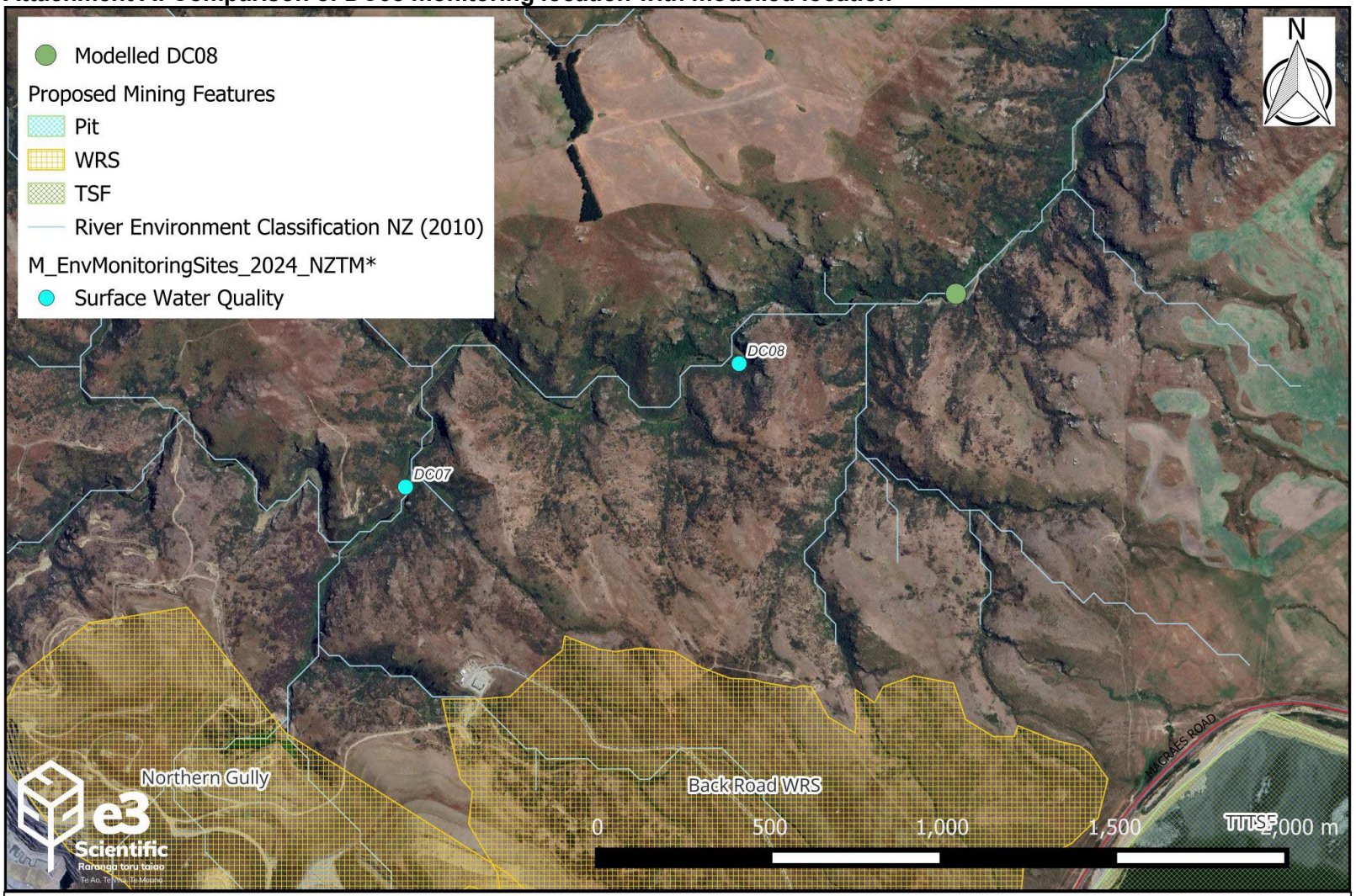
30 May 2025

Attachments

Attachment A: Comparison of DC08 monitoring location with modelled location

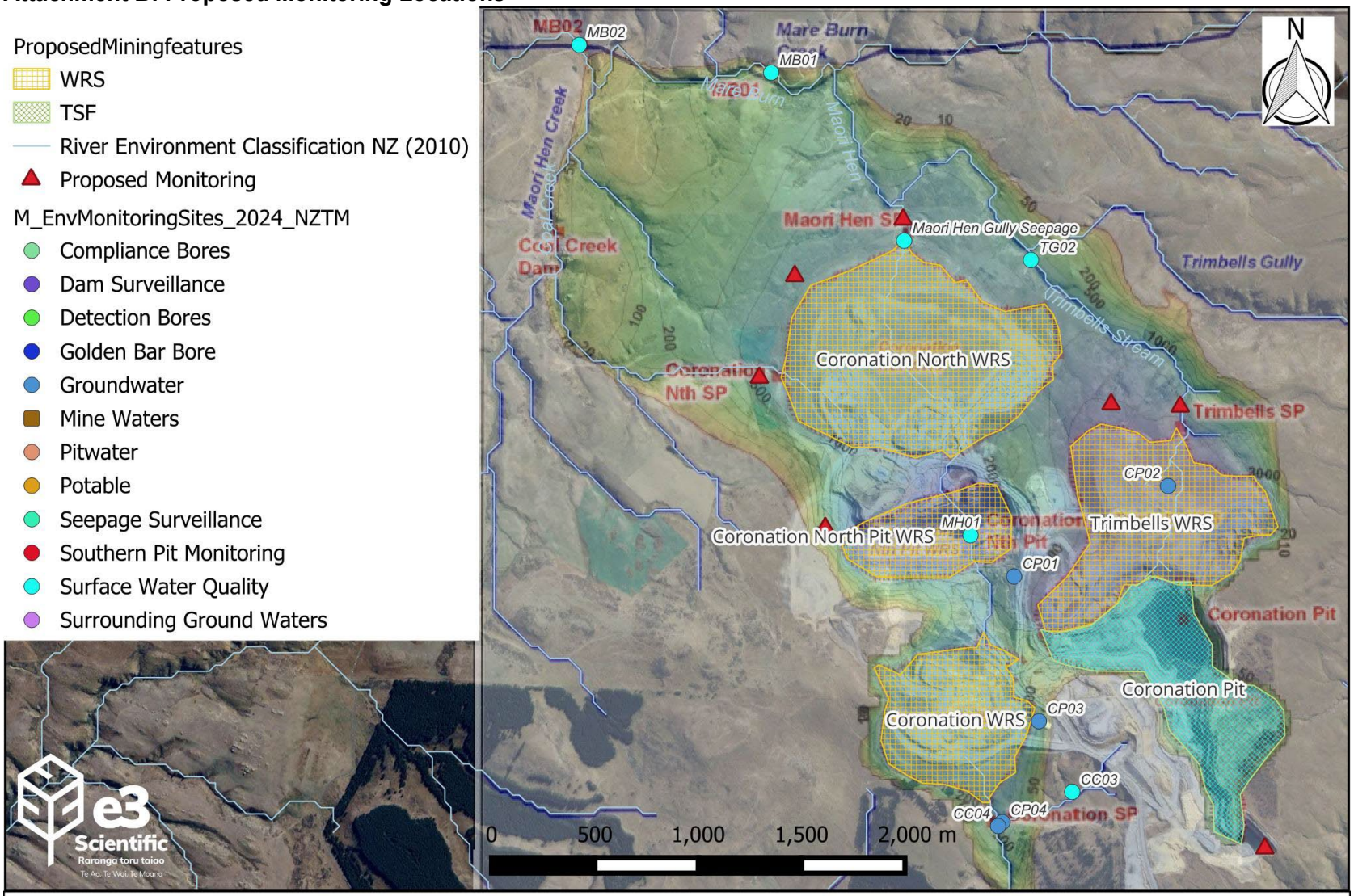
Attachment B: Proposed Monitoring Locations

Attachment A: Comparison of DC08 monitoring location with modelled location



NZ Road Centre line NZ River Centrelines (Topo, 1:50k) sourced from the LINZ Data Service http://data.linz.govt.nz/ and licensed by LINZ for re-use under the Creative Commons Attribution 4.0 New Zealand licence. Extent of Back Road WRS and modelled DC08 location digitised from maps provided in Appendix 31 - Annexure 2: Back Road WRS Geochemical Model – MWM. Extent of other modelled activities digitised from Appendix 11 - GHD (2024a), Appendix 12 - GHD (2024b) and Appendix 13 - GHD (2024c). Monitoring locations provided in response to Question 4.18 in Appendix 31 - Section 92 response to ORC, dated 15 October 2024. Aerial Imagery sourced from Google Satellite.

Attachment B: Proposed Monitoring Locations



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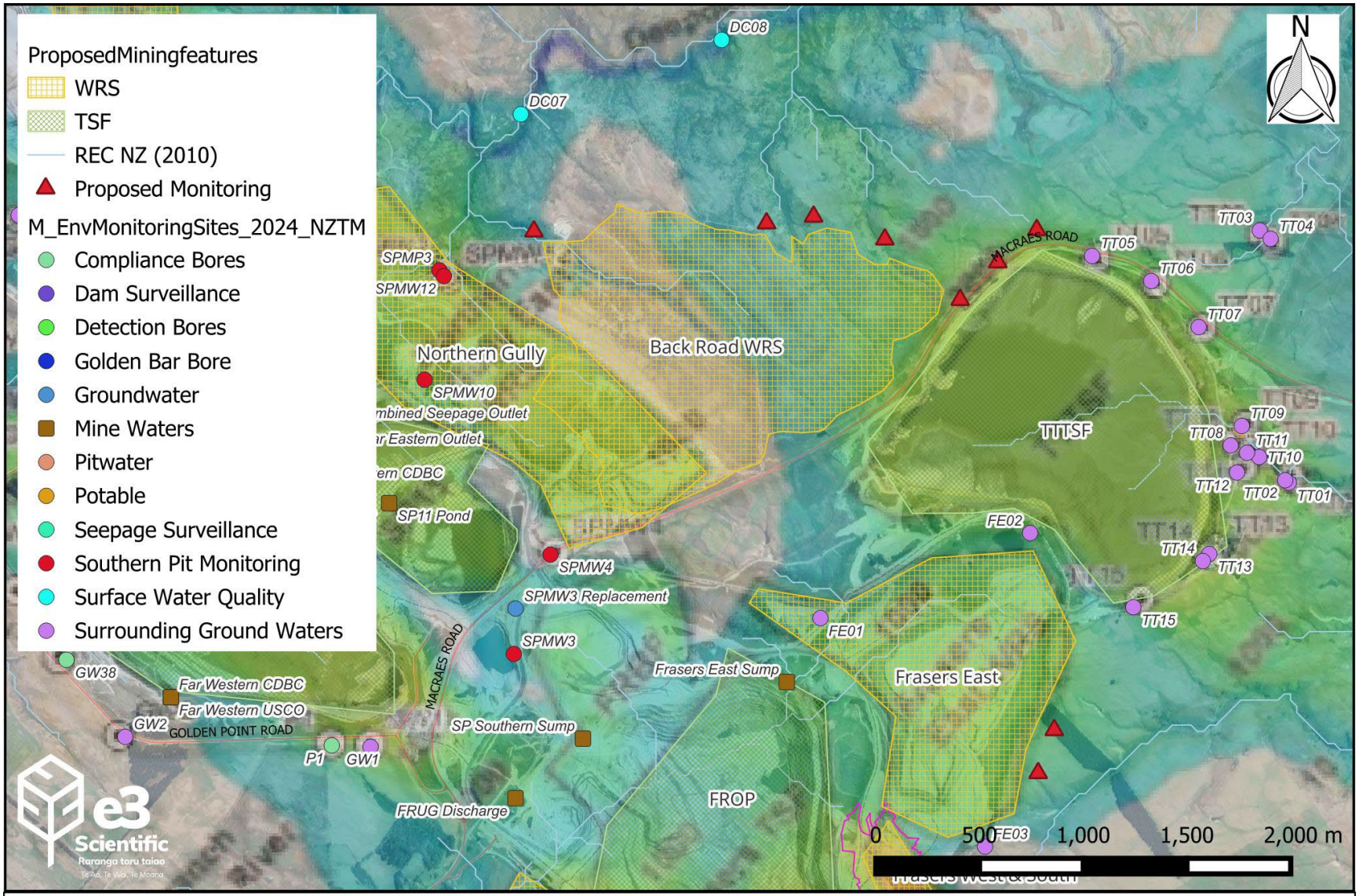
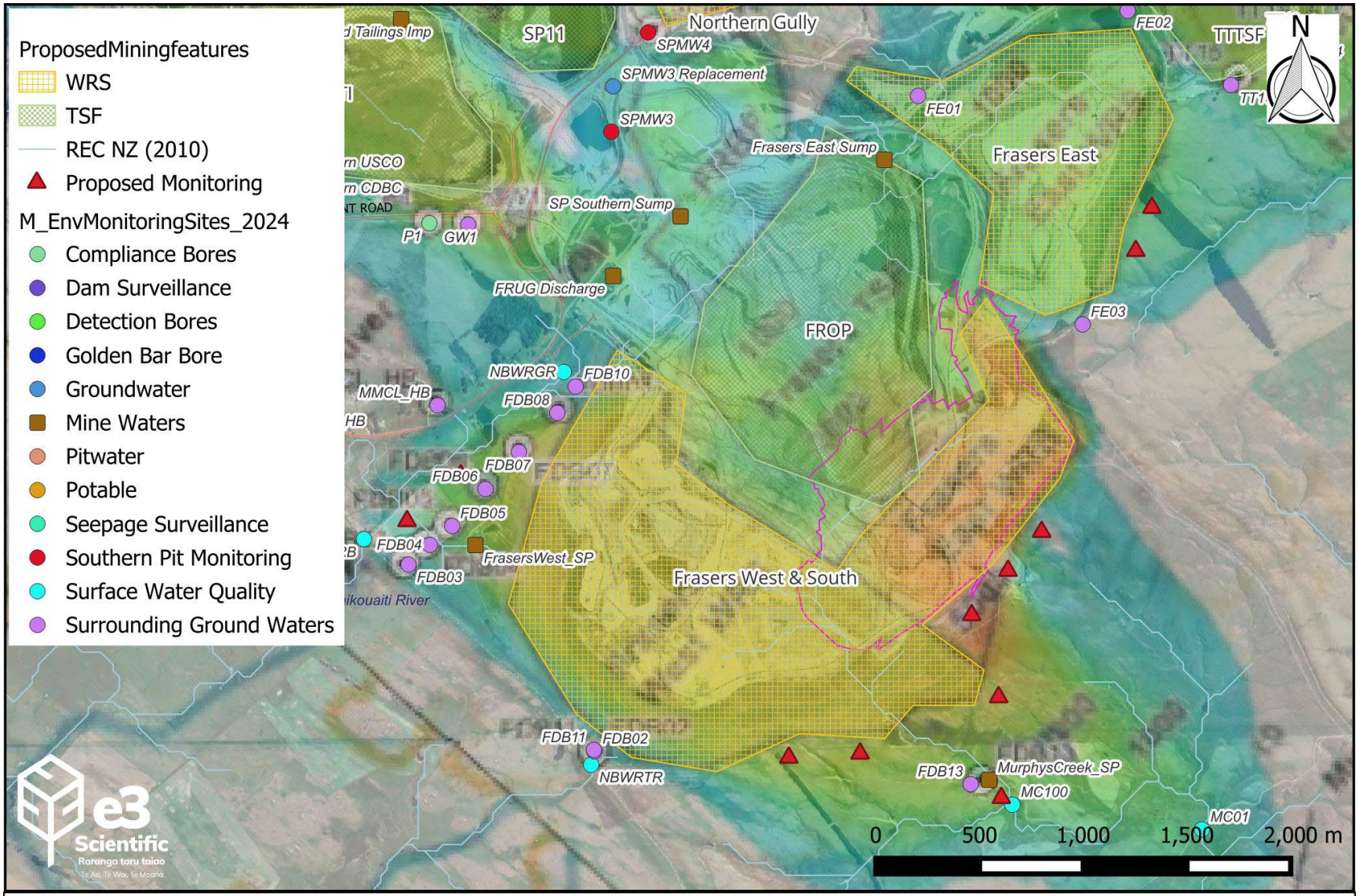


NZ Road Centre line NZ River Environment Classification sourced from the LINZ Data Service http://data.linz.govt.nz/ and licensed by LINZ for re-use under the Creative Commons Attribution 4.0 New Zealand licence. Extent of Back Road WRS digitised from maps provided in Appendix 31 - Annexure 2: Back Road WRS Geochemical Model – MWM. Extent of other modelled activities and modelled plume extents digitised from Appendix 11 - GHD (2024a), Appendix 12 - GHD (2024b) and Appendix 13 - GHD (2024c). Monitoring locations provided in response to Question 4.18 in Appendix 31 - Section 92 response to ORC, dated 15 October 2024. Aerial Imagery sourced from Google Satellite.



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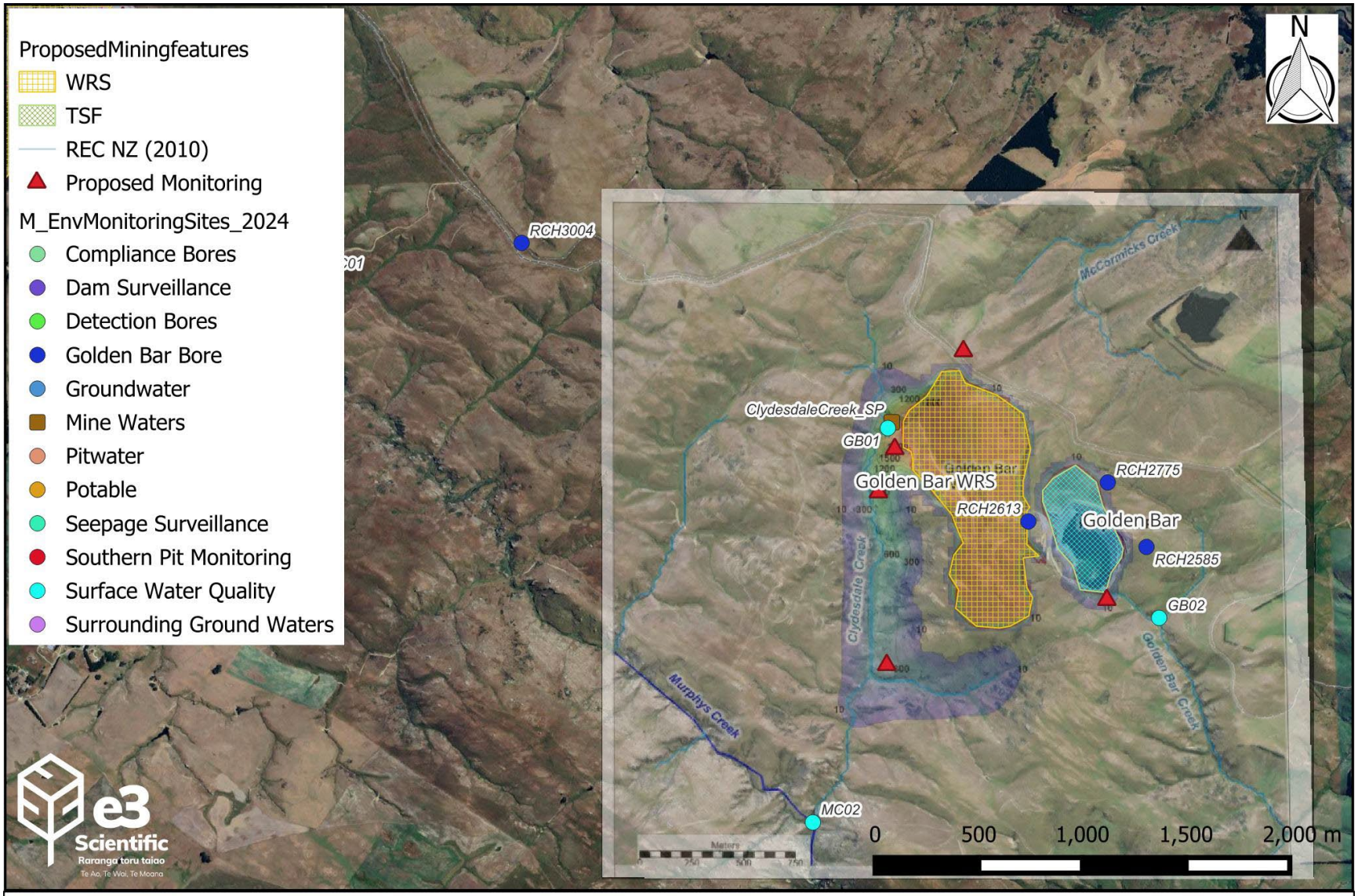

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