Preliminary Site Investigation

Bendigo-Ophir Gold Project

5 August 2025

J-G-NZ0005-001-R-Rev3

PRELIMINARY SITE INVESTIGATION

Bendigo-Ophir Gold Project

Document Number: J-AU0005-001-R-Rev3

Document Date: 5 August 2025

Prepared for:

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REVISION	DATE	AUTHOR	RECORD OF REVIEW
RevA	02/11/2024	JP	PW
Rev0	17/02/2025	JP	PW
Rev 1	09/05/2025	JP	PW
Rev 2	09/06/2025	JP/VM	PW
Rev 3	05/08/2025	JP	PW

EXECUTIVE SUMMARY

Geocontam Risk Management Ltd (GRM) has undertaken a Preliminary Site Investigation (PSI) on behalf of Matakanui Gold Limited (MGL), a fully-owned subsidiary of Santana Minerals Limited, for the Bendigo-Ophir Gold Project (the Project), which is located in the Dunstan Mountains of Central Otago, New Zealand (NZ). This evaluation of the current and potential future site contamination risks associated with the development of the Project, has been undertaken to support the assessment of environmental effects (AEE) and meet regulatory obligations under the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health Regulations (NESCS) that arise from the recognition that historic and future mining operations associated with the project are defined in the Hazardous Activities and Industries List (HAIL) as a potentially contaminating land use (Category E7).

The report concludes that determining appropriate ecological background threshold values, and inclusion in site management plans, should ensure that future mining activities within the Project area that have the potential to release contaminants to the environment are appropriately managed. This has been integrated into the soil management plan to address this environmental aspect.

The purpose of this PSI is to identify any existing and potential future risks to receptors associated with the historic and proposed future land uses to ensure potential risks to receptors can be appropriately mitigated during the proposed mine development, operations, and closure stages. The key objectives of this PSI are therefore to:

- Define the existing and potential sources of contamination and their associated potential constituents of concern (PCOC) associated with historic land use and future mine development activities;
- Identify the pathways for PCOC migration and potential receptors that could be impacted; and
- Determine future requirements for further investigation or management of contamination risks.

The following scope of work was undertaken in accordance with the requirements of the Contaminated Land Management Guidelines (CLMG) (MfE, 2021) and included:

- A desktop review of the site history and environmental setting from site-specific reports and publicly available maps and databases;
- Completion of a site inspection and a review of the existing physical environment;
- Development of a conceptual site model (CSM) identifying areas of potential environmental concern (APECs), PCOC, potential migration and exposure pathways, and key receptors;
- Identification of data gaps in the context of future site development and land uses, and provision of recommendations for further detailed site investigation (DSI) and/or development of a site management plan (SMP); and
- Preparation of this PSI report.

The results of this PSI have identified the following site conditions and potential contamination risks associated with the historic land use and proposed future mining activities:

- The Project area is located within the Otago Schist belt, which comprises metasedimentary and metavolcanic rocks metamorphosed to greenschist facies. Gold mineralisation is widespread within the Otago Shists with the dominant mineralisation in the region generally associated with silica-siderite/ankerite alteration with minor arsenopyrite sulfides associated with the gold;
- There is no record of permanent Māori occupation within the Project area, however the Project area has a long history of pastoral occupation dating back to the late-1850s, and historic gold mining operations comprising alluvial sluicing and shallow mining of quartz reefs occurred in several areas across the site and surrounds between the 1860s through to the 1940s. Whilst pastoral land use has continued through to present day, only limited exploration activities have been undertaken since the 1980s;
- Detailed heritage mapping of the historic land use has been undertaken with numerous historic mining features, including prospecting pits, water races, mullock piles, tailings and dams, sluices areas, mine adits, turbines and batteries, alluvial workings, mapped as being present within the Project area. Several agricultural and pastoral features and one feature that may be associated with Māori activity have been identified within the broader mining lease area, however most are distal to the Project area;
- Baseline environmental studies have been undertaken within the Project area to assess the ecological values of the environment with respect to groundwater, surface water, and aquatic and terrestrial ecosystems. Based on these studies, few of the identified indigenous grasses and herbs are known to be rare or under any significant threat locally, regionally or nationally. Several indigenous habitats and protected wildlife species are present, but no threatened or At-Risk freshwater species have been identified;
- Notable evidence of the mining history is present within the Thomson Gorge along Rise and Shine Creek. Remnant impacts from the historic activities are visible within the Project area associated with the accumulation of sluicing debris and migration of tailings along creek beds, adits, mullock piles, and the former battery sites. Soil sampling and water quality monitoring around these areas has identified potentially elevated concentrations of metals in shallow soil (arsenic (As) and possibly cadmium (Cd)), surface water (As, cobalt (Co), copper (Cu), and iron (Fe)), and groundwater (As, Cr, Cu, Fe, strontium (Sr), thallium (Tl), and zinc (Zn)) within the project area;
- Arsenic (As) has been identified at concentrations above industrial land use human health protection criteria and above 60% and 80% Eco-SGV in shallow soils within the Project area, predominantly within the historic mining areas. Potentially complete exposure pathways may result from the disturbance of these soils during future mining activities. Cadmium (Cd) was found extensively above 80% Eco-SGV and may also warrant management during operations to meet post-closure land use objectives; and
- If not appropriately managed, future mining activities within the Project area have the potential to release contaminants to the environment, potentially resulting in adverse impacts to terrestrial and aquatic ecosystems. Future mine site features including the open pit, underground workings, an engineered landform (ELF), tailings storage facility (TSF),

processing plant, run-of-mine (ROM) pad, topsoil stockpiles, vehicle washdown and refuelling facilities, explosives magazine and emulsion factory, and mining fleet workshops will require appropriate facility design and management plans to minimise potential risks to human health and the environment.

Based on the findings of this PSI, the following recommendations are made:

- A detailed evaluation of the extensive soil dataset should be undertaken for the Rise and Shine Valley to better inform a risk assessment of the disturbance of soils with elevated As (and potentially Cd) concentrations during operations. Using the existing soil dataset, appropriate ecological background threshold values (BTV) should be derived using an appropriate industry-recognised methodology (e.g., upper tolerance limit (UTL)) for the Project area to support the assessment of environmental effects during operations and closure;
- A SMP should be developed in accordance with the requirements defined in the *Contaminated Land Guidelines No. 1* (MfE, 2021) to define the risks, control strategies, and management responsibilities associated with shallow soil management (i.e., arsenic impacted soils) within the Project area; and
- Management plans and associated conditions of consent should be developed to address operational risks associated with key mine sources that have the potential to adversely impact human health or ecological receptors. These should include procedures around waste rock and processing residues (e.g., tailings) to reduce environmental risks from AMD, dust management, chemical storage, spill response, and surface and groundwater monitoring.

SUITABLY QUALIFIED ENVIRONMENTAL PRACTITIONER – CERTIFYING STATEMENT

I certify that the site has been assessed in accordance with current New Zealand Regulations and guidance documents and that this report has been prepared in general accordance with the Ministry for the Environment's *Contaminated Land Management Guidelines No. 1: Reporting on Contaminated Sites in New Zealand*, 2021.

I am considered by Matakanui Gold Ltd to be a suitably qualified and experienced practitioner (SQEP) able to certify reports pursuant to the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011, based on the company's definition of a SQEP as given below.

Matakanui Gold Ltd requires that a SQEP has the following Qualifications / Experience:

- Tertiary science or engineering qualification relevant to environmental assessment.
- A minimum of 10 years of relevant experience.
- Registration with a professional body that assess and certifies environmental professionals in the competency criteria of training, experience, professional conduct and ethical behaviour.

Julie Palich, B.Sc., M.Sc., CEnvP #1883
5 August 2025

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1 INTRODUCTION

Geocontam Risk Management Limited (GRM) has undertaken a Preliminary Site Investigation (PSI) on behalf of Matakanui Gold Limited (MGL), a fully owned subsidiary of Santana Minerals Limited, for the Bendigo-Ophir Gold Project (the Project), which is located in the Dunstan Mountains of Central Otago, New Zealand (NZ) as depicted in Figure 1.

The Bendigo-Ophir mineral resource covers 251 square kilometres in the Central Otago goldfields and occurs in four deposits [Come-in-Time (CIT), Rise and Shine (RAS), Srex (SRX), Srex East (SRE)] that are inferred to extend in a northerly direction within the Rise and Shine Shear Zone (RSSZ), which hosts gold mineralisation over a recognised strike length of >20 km. The Bendigo-Ophir Gold Project (BOGP) area (Figure 2) has been mined since the late 1800s and there are numerous historic mine workings throughout the Project area, as identified in an archaeological survey (Lawrence et al., 2019). Further gold mining within this area is proposed by MGL, with approvals being sought through the New Zealand Fast Track Approval process.

1.1 Regulatory Framework

Disturbance of soil associated with developments on potentially contaminated land is a regulated activity under the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health - NESCS) Regulations 2011 (MfE, 2012).

Mine sites and associated workings are defined in the Hazardous Activities and Industries List (HAIL) under the NESCS. As such, a contaminated land assessment is required to ensure future potential disturbance of the land can be undertaken in a manner that does not pose a risk to human health and/or ecological receptors. The first stage of the contaminated sites assessment process is to prepare a PSI report that meets the requirements of the NESCS and is prepared in accordance with the Ministry for the Environment (MfE) Contaminated Land Management Guidelines (CLMG) No 1: Reporting on Contaminated Sites in New Zealand (MfE, 2021). A detailed site investigation (DSI) is not anticipated at this stage as it is likely that any mining operation will address legacy and future contamination risks under a site management plan (SMP) and mine closure plan.

1.2 Purpose and Scope

The purpose of this PSI is to address the regulatory requirements of the NESCS to identify any existing and potential future risks to receptors associated with the historic and proposed future land uses to ensure potential risks to receptors can be appropriately mitigated during the proposed mine development, operations and closure stages.

1.2.1 Objectives

The objectives of this PSI are to:

- Define the existing and potential sources of contamination and their associated potential constituents of concern (PCOC) associated with historic land use and future mine development activities;
- Identify the pathways for PCOC migration and potential receptors that could be impacted; and
- Determine future requirements for further investigation or management of contamination risks.

1.2.2 Scope of Work

The following scope of work was undertaken in accordance with requirements of the CLMG and included the following:

- A desktop review of the site history and environmental setting from site-specific reports and publicly available maps and databases;
- Completion of a site inspection and a review of existing physical environment;
- Development of a conceptual site model (CSM) identifying areas of potential environmental concern (APECs), PCOC, potential migration and exposure pathways, and key receptors;
- Identification of data gaps in the context of future site development and land uses, and provision of recommendations for further DSIs and/or development of a SMP; and
- Preparation of this PSI report.

1.3 Statement of Qualifications

GRM confirms that, in accordance with the requirements of the NESCS (2011), this PSI has been prepared in accordance with the current edition of the CLMG (MfE, 2021a), and has been reviewed and approved by a suitably qualified and experienced practitioner. Evidence of the qualifications and experience of the authors who have prepared and reviewed this report are provided in Table 1.

Table 1: Suitably qualified and experienced practitioner details.

ITEM	DETAILS
Author	
Name	Julie Palich, MSc, CEnvP (Certification #1883)
Job title	Principal Environmental Geoscientist
Years' industry experience	27
Reviewer	
Name	Paul Weber, PhD, MAusIMM CP(Env)
Job title	Principal Environmental Geochemist
Years' industry experience	26

1.4 Report Structure

The PSI has been structured in accordance with the guidance provided in the CLMG (MfE, 2021), with the subsequent sections organised as follows:

- Section 2: Site identification;
- Section 3: Environmental setting;
- Section 4: Site history;
- Section 5: Site condition and surrounding environment;
- Section 6: Site characterisation investigations;
- Section 7: Proposed site development;

- Section 8 Conceptual site model; and
- Section 9: Conclusions and recommendations.

Acronyms used in this report are summarised in Appendix A and figures are presented in Appendix B.

2 SITE IDENTIFICATION

2.1 Site Identification and Land Tenure

The site (Project area) is located in the Central Otago region of New Zealand, between the townships of Bendigo (northwest corner) and Ophir (southwest).

Land tenure across the Project area (Figure 3) is a combination of freehold, private land with Bendigo Station to the SW and Ardgour Station to the NE as summarised in Table 2. Adjacent to the Project area is freehold, private land owned by Cherri Holdings Limited to the NW; otherwise, the Project area is adjacent to Crown Land being the Bendigo Historic Reserve to the west, and the Ardgour Conservation Reserve to the east, both administered by the Department of Conservation (DOC), and Matakanui Station also to the east which is leasehold land administered by Land Information New Zealand (LINZ).

The Project area is located within two mineral exploration and prospecting permits issued by New Zealand Petroleum and Minerals (NZPM) (Figure 1). Table 3 presents the relevant site details as provided through the NZPM online database (accessed 24 July 2024).

Table 2: Land tenure.

<table>
<tr><th rowspan="2">LOCATION</th><th colspan="5">DESCRIPTION</th></tr>
<tr><th>TITLE NUMBER</th><th>TYPE</th><th>AREA (Ha)</th><th>OWNER</th><th>DESCRIPTION</th></tr>
<tr><td rowspan="5">Within BOGP Project Area</td><td>841663 (portion)</td><td>Freehold</td><td>262.68558</td><td rowspan="2">Ardgour Station Ltd</td><td>Lot 11 Deposited Plan 525588 and Lot 2 Deposited Plan 505064 and Section 18 Survey Office Plan 24641</td></tr>
<tr><td>841657</td><td>Freehold</td><td>78.1313</td><td>Lot 1 Deposited Plan 525588</td></tr>
<tr><td>808256 (portion)</td><td>Freehold</td><td>231.91924</td><td>Bendigo Station Ltd</td><td>Section 11-16, 23, 27, 37, 39 Survey Office Plan 24641 and Section 2 Survey Office Plan 332575 and Lot 6 Deposited Plan 517385</td></tr>
<tr><td>941795</td><td>Freehold</td><td>7.356</td><td>Cherri Holdings Ltd</td><td>Lot 14 Deposited Plan 548903</td></tr>
<tr><td>841228 (portion)</td><td>Freehold</td><td>237.4312</td><td>Bendigo Station Ltd</td><td>Lot 4-6 Deposited Plan 525495 and Part Lot 10 Deposited Plan 391334 and Lot 5 Deposited Plan 517385</td></tr>
<tr><td rowspan="4">Offsite (adjacent)</td><td>1071231</td><td>Freehold</td><td>19.7433</td><td rowspan="3">Cherri Holdings Ltd</td><td>Lot 13 Deposited Plan 548903 and Section 10, 15 Survey Office Plan 554095</td></tr>
<tr><td>1071232</td><td>Freehold</td><td>5.9833</td><td>Lot 15 Deposited Plan 548903 and Section 18 Survey Office Plan 554095</td></tr>
<tr><td>952819</td><td>Freehold</td><td>19.113</td><td>Lot 16 Deposited Plan 548903</td></tr>
<tr><td>767270</td><td>Freehold</td><td>239.1198</td><td>Tarras Farm Pty Ltd</td><td>Lot 1 Deposited Plan 505064</td></tr>
</table>

LOCATION	DESCRIPTION				
	TITLE NUMBER	TYPE	AREA (Ha)	OWNER	DESCRIPTION
	201479	Freehold	458.047	DOC Public Conservation Land	Section 10, 21, 25-26, 31 Survey Office Plan 24641 and Section 32 Block III Wakefield Survey District
	OT19C/127	Freehold	303.3	DOC Public Conservation Land	Section 1 Survey Office Plan 24604

Table 3: Summary of mineral permits.

ITEM	DESCRIPTION
Mineral Permit	MEP60311 – Minerals Exploration Permit, expires 12 April 2028 MPPA60882 (Ardgour) – Minerals Prospecting Permit, expires 30 November 2025
Owner	Matakanui Gold Ltd (100%)
Approximate Site Area	MEP60311 – 251.62 km^2 MPPA60882 – 40.292 km^2
Territorial Authority	Central Otago District Council
Current Site Use	Mineral exploration/prospecting (gold)
Proposed Site Use	Mining

2.2 HAIL Classification

A review of the Otago Regional Council (ORC) HAIL Site View Map was undertaken to identify sites of interest within 1 km of the site (ORC, 23 July 2024). The site is not a registered HAIL site and there are no HAIL sites located within the search radius.

Historic and proposed mining activities within the exploration permit area, however, meet the definition of HAIL Category E7 – Mining industries (excluding gravel extraction), including exposure of faces or release of groundwater containing hazardous contaminants, or the storage of hazardous wastes including waste dumps or dam tailings. The absence of a site from the HAIL register does not mean that environmental hazards are not present in association with the site and may only reflect that the site has not formally been reported to the regulator due to an absence of a regulatory requirement to do so or an absence of appropriate data to define its contamination status.

3 ENVIRONMENTAL SETTING

Details of the environmental setting for the site are presented in the following sections and have been informed through a review of:

- Local topography and surface water drainage to identify possible contaminant migration controls, pathways, and sensitive environmental receptors;
- Local and regional geology, hydrology, and hydrogeology maps and site-specific investigation reports to determine the likely soil type and water flow regimes;
- Registered groundwater monitoring bores and wells through the data.govt.nz database to evaluate the use and available groundwater quality within the vicinity of the site;
- Site-specific studies regarding flora and fauna to assist in evaluating potential ecological receptors associated with the site; and
- Site-specific archaeological studies to assist in evaluating features of potential heritage value.

3.1 Climate

The Central Otago region is the driest in New Zealand, receiving less than 400 mm of annual rainfall. Median summer air temperatures for the area are 16ºC to 17ºC and winter median temperatures are 5ºC to 6ºC. Climate information available from several nearby weather stations reports long-term average annual rainfall in the area between 390 mm and 550 mm (Table 4) with the highest rainfall reported in December and January and lowest rainfall in July and August. Rainfall is highest to the east of the Dunstan Ranges at Matakanui compared to the low-lying stations west of the range. The project site has two weather stations located at CIT and RAS. Measurements at RAS have been occurring since November 2022.

Table 4: Regional rainfall.

STATION	FROM	TO	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Tarras	1951	1980	45	35	49	39	46	31	29	36	38	41	41	42	472
Bendigo 1	1951	1980	41	32	47	39	44	32	25	31	38	42	35	40	446
Bendigo 2	1981	2010	39	32	45	28	31	35	31	26	18	35	29	43	390
Matakanui	1951	2020	58	46	50	46	41	37	31	29	36	51	49	61	535
Cromwell	1981	2010	48	33	43	33	33	38	28	27	26	36	41	52	437

Source: http://cliflo.niwa.co.nz/

3.2 Topography

The Project area sits on semi-arid grazing land with moderate topography (Figure 2). The mine sites and proposed plant site are located between incised valleys. The topography of the area rises from the Bendigo terraces at 370 mRL to the top of the RAS future pit crest at approximately 770 mRL. The head of Rise and Shine Valley is at 970 mRL and serves as a watershed divide into the Matakanui catchment to the east.

3.3 Geology, Mineralogy and Soils

The following information is sourced from Santana Minerals Limited (2024) unless otherwise referenced.

3.3.1 Regional Geology

The Project area is located within the Otago Schist belt comprising Permo-Triassic metasedimentary and metavolcanic rocks metamorphosed to greenschist facies with peak metamorphism in the Cretaceous period (Figure 4).

The Dunstan Mountains, located in the north and southeast of the Project area, are an uplifted block of the Otago Schists tilted to the northwest with remnants of a Cretaceous peneplain well preserved on its northern slopes. The Manuka Basin to the southeast is infilled by Cenozoic sediments, and the fluvio-glacial Tarras Terraces lay the northwestern margin of the Dunstan Range.

The Otago Schist is formed from sedimentary and minor intermediate volcanics and volcaniclastics of the Caples and Torlesse tectono-stratigraphic terranes. Greenschist facies rocks of the Otago Shist are sub-divided into four textural zones based on mineralogy and mineral textures. Gold mineralisation is widespread within the Otago Shists with over 5 million ounces of hard-rock gold and 8 million ounces of alluvial gold historically being won from the Otago Goldfields.

3.3.2 Deposit Geology

The North Dunstan Mountain sector of the Project area contains four discrete mineral occurrences – RAS, CIT, SRX, and SRE.

The RSSZ is an approximately 50 m thick, late metamorphic low angle shear zone dipping 20 – 30 degrees northeast and crosscutting the metamorphic foliation at a low angle (McKenzie and Craw 2010). From its outcrop in the Rise and Shine Valley, it has been traced for 1.7 km north-northeast beneath the unconforming TZ3 cover rocks with the bulk of the RAS mineralisation sitting beneath 150 m to 300 m of the benign cover rock.

The gently (25 degree) north-north-east plunging RAS deposit sits within a zone up to 400 m wide and can be up to 90 m in thickness (typically 30 m to 40 m). The RAS deposit is one of several zones of highly anomalous gold mineralisation truncated by the Thomson Gorge Fault (TGF). On a mine scale, the TGF is a post metamorphic, post mineralisation cataclastic fault zone developed predominantly along the hanging wall of the RSSZ. It separates chlorite rich, textural zone 3 (TZ3) schists in the hanging wall from biotite rich textural zone 4 (TZ4) schists in the shear zone and foot wall.

Within the 500 m wide zone of NNE trending mineralisation at RAS, a higher-grade core approximately 150 m to 200 m wide contains the majority of gold. The RAS deposit is primarily all fresh rock with subsurface oxidation variably extending from 5 m to 20 m depth.

The main mineralisation at RAS is associated with silica-siderite/ankerite alteration with minor arsenopyrite sulfides associated with the gold. In some areas a cataclastite (brecciated) network of anastomosing, post-metamorphic quartz, occurs with minor sulfide veins in a halo around the core mineralisation.

Gold occurs as free gold particles, typically up to 400 μm but with some coarser visible gold. A minor gold component occurs associated with the arsenopyrite grains, but typically not in solid solution, giving rise to the free milling and highly gravity recoverable components expressed by metallurgical testing.

3.3.3 Soils

According to the Landcare Research national soils dataset (S-Map) (Figure 6), the Project area and surrounding environment is mapped as comprising mature soils with well-developed topsoil and subsoil horizons that have developed in quartz-rich material that show the effects of climate. In accordance with the New Zealand Soil Classification system (Hewitt,1992), the southern portion of the Project area (higher elevations) is characterised as immature pallic soils. Further down the valley (to the northwest), soils transition to immature semiarid and argillic semiarid soils. Acid brown soils are mapped in the valley/lowest elevations in the northernmost extent of the Project area and into the grazing fields to surrounding the Project area. In general, these soil types are weakly to very-weakly weathered and weakly leached.

3.4 Hydrology

The following sections describe the surface water hydrology associated with the Project area.

3.4.1 Catchments

The site is located on the northeast side of Lake Dunstan in the Dunstan Mountains with catchments open to the northwest onto the intervening fluvio-glacial sediments of the Cromwell-Tarras Valley.

The site covers the Bendigo Creek Catchment (28.15 km^2) in the south and west, which includes the Rise and Shine Creek Sub-catchment. The Shepherds Creek Catchment (12.36 km^2) is present in the northeast.

3.4.2 Surface Water Bodies

There are no permanent surface water bodies within the Project area.

Over 30 locations, interpreted to be points of groundwater seepage, have been mapped along Shepherds Creek, Bendigo Stream and in an unnamed stream within the Lindis River Catchment (Figure 6).

3.4.3 Streams

The flow in the streams as they exit the mountains after passing through the MGL exploration permit and areas of potential mining interest are estimated to range from 48 L/s to 129 L/s (median) and 99 L/s to 236 L/s (mean), with mean of minimum 7-day flow of 19 L/s to 65 L/s despite catchment areas of approximately 11.5 km^2 to15.5 km^2 (https://shiny.niwa.co.nz/nzrivermaps/ , accessed 23/07/2024).

Mapped streams in the Project area have predominantly been mapped as perennial (e.g., Bendigo Creek, Shepherds Creek) or intermittent (e.g., Jean Creek) with ephemeral flow along smaller tributaries, at lower elevations and to the northwest of the Project area (Waterways, 2024). Streams can go to ground seasonally or consistently across reaches as a function of valley alluvium depths, local groundwater, and upstream flow (e3 Scientific, 2003). A hydrogeologic investigation in 2021 by Landpro Limited established that Bendigo Creek loses all of its flow into the ground following creek flow passing from schist into alluvium. It is inferred that the Bendigo Aquifer receives any net creek flow from Bendigo Creek after irrigation off-take and evapotranspiration (KSL, 2024a).

If/when streams do persist and flow onto the Bendigo Terrace, it is expected that they will experience transmission losses and go to ground, recharging local groundwater given the depth to terrace groundwater and coarse subsurface materials. Surface water flow is typically only intermittent across the valley with surface flows potentially reaching the Lindis and Clutha Rivers and Lake Dunstan approximately 5 kilometres to the north-west only during large events.

3.5 Hydrogeology

The following sections describe the regional aquifer systems and groundwater use associated with the Project area.

3.5.1 Aquifer Systems

The following description of the aquifer systems has been adapted from KSL (2024a)

Groundwater in the Bendigo district has two overarching domains:

- Alluvium or outwash sediments, generally coarse sandy gravels, and
- Saturated consolidated rocks such as schist basement.

Alluvium and voluminous outwash gravel deposits are concentrated within the valley systems such as the Lindis Valley and Upper Clutha Valley. The alluvium and outwash gravel deposits have high permeability and porosity, allowing the conveyance of copious quantities of groundwater through the deposits. Three such deposits are of note in the Project area: Lindus alluvium, Bendigo Creek alluvium, and Bendigo outwash.

Post-glacial outwash associated with the Hāwea and Albert Town glacial advances (and the advances' collapse) has accumulated between the Clutha River / Mata Au and the terrace riser of the Bendigo Terrace. The higher elevation (340 mAMSL) Bendigo Terrace is correlated with the Lindis Glacial Advance and the upper surfaces are generally separated by 80 m vertical between the Bendigo and Hāwea - Albert Town outwash deposits. The Hāwea and Albert Town outwash gravel deposits host the Bendigo Aquifer with a roughly triangular outline delineated by Bendigo Loop Road and the Clutha River. The Bendigo Aquifer has a measured mean depth of 33 m, and a mean depth to the water table of 12 m. Approximately 30 production bores are scattered across the surface of the Bendigo Aquifer. The Bendigo Aquifer has some of the highest well yields of aquifers in Otago Regional, up to 110 L/s. The water table is less volatile than the land surface across the aquifer with the water table elevation ranging between 195 mAMSL to 201 mAMSL in the core of the aquifer.

While there is appreciable passage of water through the fractured schist rock basement due to their wide and pervasive distribution across Central Otago, much of the potential groundwater recharge of excess precipitation is refused at the soil/regolith interface due to the generally low permeability of the fractured rock and feeds surface stream flow instead. Groundwater from this aquifer exhibits incidental emergence from rock fracture as diffuse seepage, spring flow and base flow in surface water courses. The fractured schist rock groundwater systems have had the depth to water measured in 80 separate locations across the RAS, CIT, and SRX gold deposits zones. The depth to water exhibits depths up to 42 m directly beneath steep ridges and tends to rise to near land surface at slope bottoms. Some flowing artesian pressures were also encountered, suggesting compartmentalisation or proximity to a groundwater seepage zone. The water table varies vertically across hundreds of metres of elevation in the Dunstan Range including within the Shepherds Creek and Bendigo Creek catchments. Overall, the water table tends to follow the land surface across areas of sharply undulating terrain. Groundwater transmission rates in the schist basement are considered to be low, especially within the intact parts of the schist basement rocks. There are few signs of surface water being significantly lost to groundwater nor making discrete gains from groundwater.

3.5.2 Groundwater Use

There has been substantial irrigation bore development of groundwater aquifers in the Hawea and Albert Town Advance gravel aquifers in the Bendigo – Tarras area with registered wells located at a distance of at least 1 km to the northwest of the Project area (Figure 7). Despite this only a single permanent ORC monitoring bore has been installed along the northern end of Bendigo Loop Road. No effective monitoring of Lindis alluvial groundwater system has been undertaken by ORC to date (KSL, 2024a).

3.6 Flora and Fauna

Several baseline ecology investigations have been undertaken in the Project area and investigations remain on-going. The following summary details the understanding of flora and fauna in the project area based on field investigations completed prior to 2025.

3.6.1 Vegetation and Ecology

The vegetation cover and ecology of the site varies considerably with altitude. As described by Central Environmental Services (2021):

- The lower altitudes, near the CIT mine, exhibit drier environmental conditions with depleted sunny aspects and moderately dense, scrub-covered shaded aspects and gullies on Bendigo Station. Further north onto Ardgour Station, the sunny aspects are severely rabbit-affected with considerable bare ground, extensive scab-weed and heavily browsed grasses and herbs;
- The mid-altitudes, around RAS and SRX, exhibit mixed short tussock and over-sown and top-dressed (OSTD) grassland (silver and fescue tussock, cocksfoot and clover) with sporadic scrub cover. North of the ridge and dipping down into Shepherds Creek/Ardgour Station most riparian areas have good scrub cover, phasing into depleted pastoral scabweed on exposed sunny aspects; and
- The higher elevations (900 mRL to 1,000 mRL), exhibit more typical sub-alpine vegetation with hawkweed-infested tussock grassland and taramea herbfield interspersed with low-growing matagouri scrub interspersed with scented tree-daisy, occasional mingimingi and kowhai.

The vegetation comprises a mixture of indigenous and introduced species resulting from a history of low input pastoral management and is ecologically quite typical of similar hill terrain throughout Central Otago. The upper section of the Rise and Shine and Shepherds Creek catchments were considered to be of average-good ecological and conservation value but is reduced on the depleted soils of the lower sunny slopes.

Few of the identified indigenous grasses and herbs that comprise much of the vegetation in the locality are known to be rare or under any significant threat locally, regionally or nationally. Plant species that have been confirmed to be present at the site that are referenced in the NZ Plant Conservation Network include:

- *Kunzea ericoides* (kanuka), *Kunzea robusta* (Rawirinui), *Kunzea serotina* (Makahikatoa), and *mysosotis brevis* (tiny forget-me-not) are listed as "Threatened – Nationally Vulnerable" and have been confirmed within the Project area along with several individual kowhai (not threatened but rare in this locality).
- Over 20 plant species listed as "At Risk – Declining" are confirmed to be present within the Project area. These include various species of Bidibid/piripiri (*Acaena buchananii*), sedge (*Carex sp.*), broom and mimiki (*Carmichaelia sp., Colobanthus, and Coprosma sp.),* scabweed (*Raoulia parkii sp.*), celadon mat daisy (*Rytidosperma buchananii, Styphelia nana*), thick-leaved mahoe (*Melicytus aff. Crassifolius, Olearia lineata, Pimelea aridula aridula)* and Matagouri / tamatakuru (*Discaria toumatou, Hypericum involutum*).
- *R. australis* and *R. parkii* are currently listed as "At Risk – Declining". Both are widespread in the Central Otago hill country;
- *Anthosachne (syn Elymus) aprica* (blue wheatgrass) is still listed as uncommon but is known to be quite widespread locally;
- *Carmichaelia petriei* (Petrie's broom) and *Pimelea aridula* (desert pimelea) are mainly present at the CIT and RAS and are largely sited away from areas of future disturbance; and
- Indigenous scrubs like *Melicytus alpina* (porcupine scrub), *Olearia odorata* (scented tree-daisy) and *Coprosma propinqua* (mingimingi) populations are at risk of decline in this region.

3.6.2 Terrestrial Ecology

As part of the preliminary assessment of ecological effects undertaken by Alliance Ecology (2025), a desktop study and field investigation were undertaken to determine habitat quality/value and the presence or likely presence of nationally 'Threatened', 'At Risk' or otherwise notable species for a range of terrestrial species including long-tailed bats, terrestrial birds, lizards, terrestrial invertebrates, and mammalian pests.

Several indigenous habitats and protected wildlife species were confirmed to be present in the Project area. These included:

- Avifauna including the Karearea (New Zealand falcon, *Falco novaeseelandiae*), which is listed as Nationally 'Threatened' – vulnerable, and Pihoiloi (New Zealand pipit, *Anthus novaeseelandiae*), which is listed as At Risk – Declining;
- Lizards including the Southern grass skink (*Oligosoma polychroma*) and Kawarrau gecko (*Woodworthia Cromwell*) which are nationally and regionally At Risk – Declining and the McCann's Skink (*Oligosoma maccanni*) which is Not Threatened;
- Terrestrial invertebrates including several moths (Lepidoptera - *Pseudocoremia cineracia*, *Ichneutica toroneura, Ichneutica Barbara*, and *Asaphodes recta*) which range from Nationally Threatened – vulnerable to Not Assessed – potentially threatened;
- Seven Coleptera beetle species of which all have been identified as undescribed species – possible new species that are Not Assessed – potentially threatened; and

- Six Arachnid spider species of which four have been identified as undescribed species – possible new species and two are Not Assessed – potentially threatened.

3.6.3 Freshwater Ecology

Baseline freshwater ecological studies have been completed by e3Scientific Ltd (2023) and Waterways (2024) including electric fishing, macroinvertebrate sampling, macrophyte assessment and a water quality sampling event across the RAS, Bendigo and Shepherds Creeks.

Freshwater ecological values are associated with the overall stream habitat and the macroinvertebrates present. Based on the investigation:

- No freshwater fish values were identified within Shepherds Creek and Rise and Shine Creek;
- In lower Bendigo Creek, *koaro galaxiid (spp.)* and brown trout markers were identified in eDNA sampling indicating fish are present within the wider Bendigo catchment but not within the RAS sub-catchment;
- Macroinvertebrate samples varied in community health and diversity, with water quality classifications ranging from "good" to "poor" within each stream suggesting a wide range of water quality and habitat conditions based on localised influences such as flow, stock access, and substrate;
- Macrophyte species observed across all sites were common, with the invasive *Lagarosiphon major* found present throughout the lower reaches of both Shepherds and Bendigo Creek catchments; and
- No Threatened or At-Risk freshwater species were identified during the surveys. *Koaro* is classified as a declining fish species.

Based on the survey findings, streams are considered ecologically integral freshwater resources and support the ecology of the area, including both terrestrial and in-water flora and fauna.

3.6.4 Stream State Assessment

Waterways (2024) undertook an assessment of stream state associated with channel modifications, and stock access and damage to physical habitat using hoof damage and cattle faeces along stream edges as a crude guide to impact.

Stream condition mapping noted channel modifications in Shepherd Creek, Rise and Shine Creek and the un-named Lindis River tributaries. In Shepherd Creek there is an unlined pond. The pond dam wall is partially broken, and the water impounded in the pond is limited. Upstream of the pond there is the stock water take point and occasional farm track crossings. Rise and Shine Creek appears to be heavily modified. There is a small pond downstream of the Thomson Gorge Road. Upstream of this the stream flows on a broad valley floor that is at least partially created by sediment deposition from historic gold mining activity. In this area there are water race channels along the valley edge and small dam structures extending across the valley floor and areas where the stream channel has been straightened or modified to flow through old dam structures.

There is no stock exclusion fencing in the Shepherd Creek and Rise and Shine Creek catchments. Shepherd Creek had nearly continuous hoof damage to varying degrees along its full length. In Jean Creek cattle and sheep damage was present in all perennial and intermittent flow areas. The single spring found was heavily damaged by stock. Stock were also using the dry/near dry stream channel as a pathway to move under the matagouri grey scrub. Rise and Shine Creek had low to moderate levels of stock impact in the upper reaches. Grazing (during the mapping period) was mainly sheep in the intermittent and ephemeral upper reaches. A fence line part way down the valley separated the upper reach area of lower impact from a higher impact area that extended downstream past the Rise and Shine pond. The cattle damage extended upslope along the small tributaries and included some localised areas of high damage associated with cattle resting areas and at the small springs. The wetland valley floor was less intensively impacted as cattle did not appear to graze the wetland area as intensively as the drier pasture grass hillslopes.

3.7 Heritage

A baseline survey of archaeological sites within the Project area has been undertaken (New Zealand Heritage Properties Ltd (NZHPL), 2019) using a combination of LiDAR imagery and historical photographs in tandem with other historical documents, previous archaeological investigations, and several site-specific archaeologic surveys to establish a detailed archaeological map for the site. A total of 59 archaeological sites (Figure 8) were identified within the archaeological survey area (although others may be present) and include:

- Historic – Domestic: Stone Huts (21 features);
- Mining – Gold: Prospecting pits, water races, mullock piles, tailings and dams, sluices areas, mine adits, turbines and batteries, alluvial workings (19 features/sites);
- Timber Milling: Terraces and Dam (4 features);
- Agricultural/Pastoral: Stone structures, stockyards and enclosures (3 features);
- Transport/Communication: historic roads and tracks (3 features);
- Unclassified: European midden (1), chimney and mineshaft (2); and
- Industrial: Forge (1 feature).

Table 5 presents summary of the features located within the Project area that may reflect a potential source of historic contamination. The locations of these features are presented in Figure 8.

Table 5: Heritage features that represent a potential source of historic contamination (NZHPL, 2019).

FEATURE ID	SITE TYPE	SITE DESCRIPTION	NZTM COORDINATES
G41/242	Mining – Gold	Clearwater Creek – alluvial gold working including stacked tailings 2m long by 500 mm high	E1316429, N5018239
G41/251	Mining – Gold	Come-in-Time Battery – 10-stamper battery, two adits, mullock, track, wall, and possible ore bin	E1316750, N5017894
G41/252	Mining – Gold	Eureka Mine and Battery – mine, battery, water race	E1316598, N5017711
G41/253	Mining – Gold	Alta Mine and battery – battery (mortar box) and adit linked by cutting to return wheel.	E1316487, N5017477
G41/264	Mining – Gold	Gold workings, water race, dam, adit, breastwork, tailings, terrace, and sluice faces	E1319112, N5015622
G41/269	Mining – Gold	Dam 10m wide	E1319033, N5015744

FEATURE ID	SITE TYPE	SITE DESCRIPTION	NZTM COORDINATES
G41/277	Mining – Gold	Rise and Shine Mine and Battery – Mine and battery site, adits, sluicing face, spoil, machine foundations, dam, stone faced terrace (possible dam)	E1317748, N5016974
G41/604	Mining – Gold	Turbine and battery	E1316877, N5018231
G41/604	Mining – Gold	Mine	E1316937, N5018011
G41/635	Mining – Gold	Collapsed schist hut with large standing chimney, built on slope of tributary to Thomsons Creek	E1321477, N5014039
G41/636	Mining – Gold	Gold mining tailing field along Thomsons Creek from Thomson Gorge Road	E1320774, N5014188
G41/669	Mining – Gold	Gold mine workings – sluiced area	E1319468, N5015649
G41/670	Mining – Gold	Tailings	E1318278, N5016214
G41/671	Mining – Gold	Dam	E1316650, N5017223
G41/672	Mining – Gold	Mullock Pile	E1316466, N5017988
G41/673	Mining – Gold	Water Race	E1317092, N5016614
G41/675	Mining – Gold	Prospecting Pit	E1321568, N5014033
G41/676	Mining – Gold	Prospecting Pit	E1321010, N5014087
G41/677	Mining – Gold	Water Race	E1317965, N5014354

The majority of the sites are associated with the intensive history of mining in the area although some huts, enclosures and transport features may be associated with pastoral use and mustering. Only one site within the survey area may be associated with Māori activity, namely a large pit previously identified as a possible umu. The assessed archaeological values indicate that there are a large number of medium and low value sites ranging from hut sites to expansive water races. Higher value sites include the larger sites recording battery and mines and a couple more prominent hut sites. Activities that risk disturbance of archaeological sites should consider their value and be undertaken under archaeological authority in accordance with Section 44 of the heritage New Zealand Pouhere Taonga.

4 SITE HISTORY

An evaluation of the site history has been undertaken through a review of the following:

- Literature review of the mining history in the Otago Valley;
- Historical aerial photo review (1950s and 1980s); and
- Review of previous relevant site investigation reports.

4.1 Iwi History

The Central Otago area was accessed by a network of ara tawhito (travel routes) that connected the coastal settlements with the inland lakes, Te Koroka (Dart River), and with Tai Poutini (West Coast). The Mata-au (Clutha River) was part of a mahinga kai trail that led inland and was used by Otago hapu including Kati Kuri, Ngai Ruahikihiki and Ngati Tuahuriri. The river was used as a highway to the interior, for transport of pounamu and provided many resources to sustain travellers.

Matakanui is the Māori name for the Dunstan Mountains. The people came from Moeraki to Makarora in the spring and remained for the summer catching eels and drying them in the winter. When iwi returned home, they floated down the Lake and Mata-au (Clutha River to Lindis on koradi rafts which they abandoned and made a short cut across the ranges, by what is since known as the Māori Pass (Thomson Pass in the Dunstan Range) (Aukaha, 2018).

There is no record of permanent Māori occupation within the Project area but a route that passed over Thomsons Saddle was used to provide access between seasonal camps at Moeraki and the inland lakes (NZHPL, 2019).

4.2 Pastoral Occupation

The following account of colonial pastoral occupation within the Project area is summarised from information provided by NZHPL (2019).

Pastoral occupation of the Project area first commenced in 1858. Run 223, which is known today as Matakanui Station, covered the area southeast of Thompson's saddle. Run 223 was operated by five different entities prior to 1914. The homestead for the run lies beyond the pastoral lease itself in the Manuherikia Valley.

On the other side of Thompson's Saddle, Run 238 (also known as the Morven Hills Station) was first granted in 1858 and extended from the Lindis Pass in the north to Cromwell Gorge in the south. A stone woolshed and farmstead were constructed in the Lindis Valley, whilst a secondary woolshed and associated stone buildings were constructed of corrugated iron off Ardgour Road, south of Tarras. In 1910 this run was subdivided into several smaller stations including Bendigo and Ardgour which lie within the current Project area.

It is noted that from the 1840's sheep-dipping to manage external parasites was required by law. From the 1840's through to the 1980's, arsenic was commonly used for parasite treatment and is recognised as a persistent chemical that has the potential to be present in elevated concentrations in soils near woolsheds of this era (MfE, 2006). Additionally, from 1945 to 1961, persistent organochlorine pesticides (OCPs) including DDT, lindane, dieldrin and aldrin were commonly used.

Pastoral land use has continued uninterrupted to current day with little change in surface features evident in the Project area on the 1950 and 1980 aerial photos.

4.3 Mining in Project Area – 1860s to 1940s

Mining activities commenced within and around the Project area from the mid-1860s. There are six main areas in which mining claims were focused: Rise and Shine, Alta, Eureka, Come-in-Time, Shepherds Creek, and Thomsons Creek (NZHPL, 2019). Multiple mining syndicates and companies have mined the various gold bearing reefs constructing new, and often recycling older, mines, batteries, water races and tramways from the 1860s through until the 1940s, the locations of which are presented in Figure 9.

Two mining methods have predominated in the Project area over the past century – alluvial sluicing and hard rock mining with battery stamping:

- Alluvial sluicing was a method used to separate the gold from alluvium whereby water was used to wash away stream beds or banks to expose alluvial gravels. These were then flushed through sluice boxes to separate any gold. Worked alluvium (the gravel that remained after this process) was typically returned to the sluiced area or deposited on surrounding ground; and
- Mining from the quartz reefs was undertaken by sinking a shaft or adit to access the gold-rich ore zones. The mined hard rock was carted by road or transported via tramway to the stamper battery for crushing. After the gold-bearing rock has been crushed, a mixture of water, pulverized ore, and any valuable minerals is passed over a series of tables or screens. The heavy minerals (like gold) settle to the bottom and are collected for further processing, while the lighter waste material is washed away.

The following account of mining activities within the Project area is summarised from information provided by NZHPL (2019).

4.3.1 Rise and Shine

The Rise and Shine Valley was developed for sluicing from 1864, when work began to construct a race sourcing water from the Tipperary Creek headwaters over Thomsons Saddle. Sluice-mining commenced in the Bendigo Creek following completion of the race over 11 miles in 1865. The Rise and Shine race held 12 sluice heads of water, and two areas of the Rise and Shine claim were worked with sluicing guns. By 1871, a scarcity of water led to a transition to box sluicing and subsequent construction of a dam in the lowest reaches of the claim by 1873. Prospecting shafts were sunk in 1871 on either end of their alluvial ground which found stone that was ‘very hard, but gold visible throughout’ that was not further developed. The Rise and Shine gold sluicing was the longest running in the Otago goldfields, lasting for a total of 35 years (Carpenter, 2013).

In 1888 a new venture commenced in the Rise and Shine Valley as a result of discovery of a new reef and established a shaft, adit and quarry within their claim. The Jubilee Company constructed a waterwheel to power a battery that operated for less than one year due to untenable returns. The company shifted its operation to a more favourable reef and shifted and refurbished a battery from Thomson Gorge; this mine was abandoned in the early 1890s.

Operations in the Rise and Shine Valley recommenced in 1932 with the reopening of the Eureka mine by the Bendigo Rise and Shine Company. Numerous workers huts and housing were established in the valley but with limited funds only built and installed a crusher, ball mill, berdan pan, Wilfley table and a 10-horsepower motor. Eventually the company also built an inclined tram line and installed the region's first roasting plant at Bendigo. Operations ceased in 1937 due to insufficient investment to gain profitable returns from the mine. In the same year the Shine Again Gold Mining Company began mining from the Rise and Shine reefs; positive gold returns led to their establishment of a 5-head quartz battery in 1938 and the construction of a new tramline in the lower reaches of the Rise and Shine valley between the mine and battery. Shine Again closed in 1942 due to declining ore quality.

4.3.2 The Alta and the Eureka

The Alta reef, situated between Bendigo and Rise and Shine Creeks was discovered in 1869. The Rise and Shine Company rented their tailwater to the new claim in 1870 and the Alta shareholder quickly purchased a new 10-stamp battery which was established on the ridgeline southwest of the Clearwater Creek, sunk a shaft, and widened the bridle track to facilitate the carting of ore to the Aurora public battery. A double-lined tramway was also constructed that ran from the main Alta adit to the battery enabling 25 tons of stone per day to be moved. Limited water yields along the Alta water race led to the closure of the mine in 1872 and the plant was sold in its entirety to the Eureka Syndicate in 1875. The Alta mine was opened a number of times for short periods between 1897 and 1913 and the Jubilee battery was operated near the Alta water race between 1903 and 1905; new adits were established however with lower gold yields mining focused on the extraction of scheelite and quartz.

The Eureka Syndicate established their mine in 1874, on their claim near the Rise and Shine adit, and established a mile-long tramway to the Alta battery. They further restored the Alta race and started a new adit. The mine and operations only ran until 1876, and the battery was shifted to Come-in-Time in 1880.

4.3.3 Come-In-Time

In mid-1880, another auriferous reef was discovered along the ridgeline between the Rise and Shine and Shepherds Creek which resulted in the establishment of the Come-in-Time mine and the relocation of the Eureka Battery to the other side of the valley. The tailwater for the Rise and Shine Company was redirected from the Alta and Eureka rack and fed the Come-in-Time's water wheel and battery but cutting a new race into the north face of the valley. Another small race was cut from Shepherds Creek to provide clean water for their tables. By 1881 works at Come-in-Time ceased and the battery was sold and moved to another mining area in the Otago region.

Come-in-Time reopened from 1908, and a new battery was moved into the valley. The operations closed due to poor gold returns in 1910. An attempt to mine an outcrop on the Shepherds Creek side of the Come-in-Time claim in 1914 was also unsuccessful and closed the next year. A final venture to establish the Come-in-Time mine was unsuccessfully instigated in 1933 and attempts to sell the Come-in-Time battery were unsuccessful; as a result, the dilapidated twentieth century battery still stands at Come-in-Time today.

4.3.4 Shepherds Creek

Limited information is available regarding mining up and down Shepherds Creek. The Koh-i-noor Syndicate worked in the Shepherds Creek valley from early 1865, successfully using box sluicing to mine the area. In 1866 they constructed a large dam to collect water, and they turned to ground-sluicing. A race was constructed from immediately beneath the outfall of the Alta Company's quartz mill and over the Rise and Shine spur to sluice the low-lying spurs between Shepherds Creek and

Bendigo. Other groups may also have been working this area between 1869 and 1871. Between 1872 and 1874 mining in this area gradually declined and ceased.

4.3.5 Thomsons Creek

Various gullies in Thomsons Creek appear to have been mined as early as 1863, although it is not known who mined the area beyond claims in early mining records noting 200 miners and working parties scattered through the various gullies. Residual gold mining tailings remain present along Thomsons Creek from Thomson Gorge Road.

4.3.6 Registered Abandoned Mines

Three abandoned, Crown mines are registered by NZPM on their NZ Mine Plans Database (accessed 24 July 2024) within the Project area as detailed in Table 6.

Table 6: Summary of registered abandoned mines.

SITE ID/ MINE NAME	OPERATOR NAME	OPERATION TYPE	COMMODITY	EASTING (NZTM2000)	NORTHING (NZTM2000)
O10222 – Cromwell Mine	The Cromwell Gold Company Ltd	Underground	Gold	1313529.112	5017300.952
O10228 – Bendigo	New Bendigo Gold Mining Company Ltd	Underground	Gold	1314856.763	5016778.193
O10601 – Rise and Shine	Bendigo Rise and Shine Gold Mining Company Ltd	Underground	Gold	1318759.990	5016181.155

4.4 Mining from 1980's

There have been several modern mining explorations over the Bendigo-Ophir Project area since the 1980s (NZHPL, 2019). Recent exploration work has focused on the Bendigo and RAS goldfields which have been recognised as similar to the successful Macraes gold mining deposit. Both Bendigo-Ophir and Macraes have gold concentrations and prospects within bedrock metamorphic schist with exploration concentrated along the known shear zones. These prospects occur in multiple north-west and south-east trending shear zones that extend intermittently for 30 km in strike length (NZHPL, 2019).

The exploration works have involved surface or underground data collection using soil, rock, stream-sediment sampling, pitting, trenching and drilling. This has been done using both hand (minimum impact activities) and mechanical drilling methods.

5 SITE CONDITION AND SURROUNDING ENVIRONMENT

A site walkover was undertaken of accessible areas on 26 August 2024 to evaluate the site condition and surrounding environment. Site photographs are presented in Appendix C (it is noted that due to limited reception, photographs were unable to be geospatially located). The following observations pertaining to the site condition and surrounding environment were made during the site walkover.

- Evidence of the historic gold sluicing and mining activities is prevalent within Bendigo Creek in Thompson's Gorge at the historic CIT, RAS, and SRX operations. This includes:
  - The presence of former buildings and gravelly wash (Photo C1) within the historic Bendigo sluicing area, located beyond the northwestern extent of the Project area;
  - CIT Battery, associated adits, and mine workings are located at the downstream end of the Rise and Shine Creek and Clearwater Creek (Photos C1 to C5). It is located on the southern extent of the Project area and borders the Department of Conservation Land that holds the Alta Battery;
  - The former RAS battery area is located further upstream along Rise and Shine Creek and includes evidence of the battery foundations, adits, mullock piles, and evidence of tailings and workings scattered around the RAS battery and upstream beside the Rise and Shine Creek. (Photos C6 to C11); and
  - The former SRX mining area, located still further upstream along Rise and Shine Creek, is represented by sluicing faces and sluicing debris (Photos C14 and C14). A water storage dam was constructed above the sluicing area and is bunded by a rock wall (Photos C15 and C16). The dam was constructed to hold water transported from Thomsons Creek via the water race overnight to supply the next day's sluicing. Tailings have been transported over time into the low-lying areas below Srex (Photo C17).
- Shepherds Creek, Jean Creek, Rise and Shine Creek and Bendigo Creek exhibited both dry and flowing segments;
- The RAS open pit will be excavated from the top of the hill between the Rise and Shine Creek and Shepherds Creek with future mining infrastructure proposed to be developed within Shepherds Valley. The terrain is steep and rocky but well-vegetated (Photos C18 to C24); and
- The pastoral use of the land for grazing was evident in the low-lying valley to the northwest of the Project area. This included a homestead and a water feature that is gravity fed by surface water from Bendigo Creek within the pastoral property, and a stock water dam supplied by bores. Cattle were observed to be present within the Project area, even at higher elevations.

6 PREVIOUS SITE INVESTIGATIONS

Several investigations have been conducted as part of the assessment of environmental effects of the project to characterise the existing geochemical conditions and potential future environmental risks associated with soil/rock, surface water and groundwater at the site. The key findings of these studies are detailed in the following sections.

6.1.1 Assessment Criteria

Table 7 details the environmental assessment criteria relevant to the Project and the rationale for adopting the criteria. These criteria are considered suitable as a preliminary screening tool for any future assessment of environmental risks associated with soil and water at the site.

Table 7: Relevant assessment criteria for the BOGP.

MEDIA	ASSESSMENT CRITERIA	REFERENCE NAME	APPLICABILITY
Soil	Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health (MfE, 2011) – guidelines for the protection of human health in an industrial land use scenario.	NES Soil-Industrial	Applicable for the assessment of risks to human health for commercial/industrial outdoor workers
	National Environmental Protection (Assessment of Site Contamination) Measure 1999 (NEPC, 2013) – human health investigation levels for an industrial land use scenario.	HIL-F	Adopted for metals for which there are no NES Soil guideline values
	Landcare Research New Zealand Ltd and Hawke's Bay Regional Council (2023) Determining Background Soil Concentrations of Trace Elements across New Zealand	Eco-SGV	Applicable for the assessment of risks to ecosystems in a range of land use settings.
	Site-specific soil background criteria may need to be derived for the site to assess potential ecological risks.	Background	Applicable for the risk to ecological receptors in consideration of the range of habitat and species diversity present pre-mining.
Rock	Global abundance index (GAI) (Förstner et al, 1993; INAP 2009).	GAI	Used for the preliminary screening assessment of enrichment of metals in rocks for acid and metalliferous drainage (AMD) risk assessment.
Surface Water	Australia and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality – 95% default guideline values (DGV) (ANZG, 2018)	95% ANZG DGV	Applicable for the assessment of potential impacts to the freshwater ecosystem in the Project area. 95% DGV is conservatively adopted in the absence of a site-specific catchment value assessment (in progress).
	Resource Management (National Environmental Standards for Freshwater) Regulations (MfE, 2020	NES Freshwater	Concentrations from the NPS have been adopted for nitrate as nitrogen (NO_3-N) and ammoniacal nitrogen (Amm-N)
	ANZECC Livestock Drinking Water guidelines (2023).	LDWG	Adopted for sulfate (SO_4) for the protection of livestock.
Groundwater	Australia and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality – 95% default guideline values (DGV) (ANZG, 2018)	95% ANZG DGV	Applicable for the assessment of potential impacts to the freshwater ecosystem from dewater effluent that may be discharged to the environment. 95% DGV is

MEDIA	ASSESSMENT CRITERIA	REFERENCE NAME	APPLICABILITY
			conservatively adopted in the absence of a site-specific catchment value assessment (in progress).
	Resource Management (National Environmental Standards for Freshwater) Regulations (MfE, 2020)	NES Freshwater	Concentrations from the NPS have been adopted for nitrate as nitrogen (NO_3-N) and ammoniacal nitrogen (Amm-N)
	ANZECC Livestock Drinking Water guidelines (2023)	LDWG	Adopted for sulfate (SO_4) for the protection of livestock.

A metal ecotoxicity quotient (MEQ) will also be used to identify PCOC for surface water and groundwater that may be elevated with respect to water quality guidelines (Weber and Olds, 2016). The MEQ value for a PCOC is determined by dividing the measured maximum concentration by the adopted assessment criteria. MEQ values greater than 1 indicate parameters that exceed the relevant assessment criteria. Conversely, MEQ values less than 1 are below the relevant assessment criteria. If any PCOC are within 50% of the assessment criteria (i.e., 1≥ MEQ ≥0.5) they are considered potentially elevated and ongoing monitoring is recommended to confirm trends and/or potential hazards. This approach is similar to using 50% of maximum acceptable value (MAV) for drinking water where it is used as a screening level for follow up action (Ministry of Health, 2018).

6.1.2 Geoenvironmental Hazards Assessment

An AMD source hazard assessment of materials to be generated and encountered as part of the proposed BOGP mining activities (e.g., waste rock, ore, low grade ore, tailings, and legacy materials) was undertaken by Mine Waste Management (MWM, 2025a) through the assessment of 1,608 samples from the Project area. Analysis included a combination of acid-base accounting (ABA), compositional, mineralogical, and leachate testwork as detailed in Table 8.

Table 8: Summary of the number of sample analysis for geochemical testwork.

PROSPECT/TYPE	ABA	4-ACID	pXRF	LEACHATE	XRD	TOTAL
RAS	377	266	774	9	3	1,426
SRX	0	32	20	0	0	52
SRE	0	15	26	0	0	41
CIT	0	4	32	0	0	36
TSD	0	0	5	0	0	5
QA/QC	11	32	0	0	0	43
Total	388	349	857	9	3	1,603

Key findings of the geochemical analysis and characterisation were:

- Total sulfur ABA data indicate that sulfur ranges from <0.005 wt% to 1.38%, although the average sulfur content is close to 0.094 wt% for waste rock (mixed TZ3, TZ4, and RSSZ) and 0.504 wt% for ore (based on 5 samples from the ABA dataset). This average sulfur content represents a maximum potential acidity (MPA) of 2.9 kg H_2SO_4/t for the waste rock, which is considered low risk for AMD (DFAT, 2016). The average MPA for the ore is 15.4 kg H_2SO_4/t;
- Average sulfur is higher in RSSZ and TZ4 waste rock compared to TZ3, which indicates these materials are a higher priority for management;

- NAG pH varied from 6.1 to 11, suggesting excess acid neutralising capacity (ANC) may be present in the materials. This was supported by the analytical results which reported ANC ranging from 9 kg H_2SO_4/t to 95 kg H_2SO_4/t. Average ANC was highest in the RSSZ (67.5 kg H_2SO_4/t) compared to the TZ3 (36.5 kg H_2SO_4/t) and TZ4 (65.9 kg H_2SO_4/t). The average ANC in the ore (75.3 kg H_2SO_4/t) was higher than in the waste rock (38.5 kg H_2SO_4/t);
- All geologic units (RSSZ, TZ3, and TZ4) and rock types (waste rock and ore) reported a negative net acid producing potential (NAPP) ranging from -91.67 kg H_2SO_4/t (TZ3) to -8.85 (TZ3) with the neutralisation potential ratio (NPR) of RSSZ, TZ3 and TZ4 indicating that all lithologies are non-acid forming (NAF) according to the Price (2009) classification system;
- Geochemical compositional analysis was undertaken on 317 samples for the determination of the concentration of 34 elements using ICP-MS found that arsenic (As), antimony (Sb), and sulfur (S) exhibit a global abundance index (GAI) value equal or greater than 3 (i.e., approximately at least 8 times the average crustal value) suggesting potential enrichment in the RSSZ and TZ4 lithologies;
- A total of 857 samples were tested by pXRF from the three geological units and found that As was consistently enriched in the RSSZ and TZ4 with 97% of samples reporting a GAI ≥ 3; in comparison the TZ3 only exhibited As enrichment in 21% of samples. Limited analysis (total of 15 samples) of antimony (Sb) suggested potential enrichment across all units, noting that Sb has a very low GAI and therefore concentrations above the GAI may not necessarily result in environmental impacts of concern. Other metals including cobalt, molybdenum, lead, and selenium reported limited exceedances of GAI ≥ 3, however, are considered insignificant because concentrations were at or below the limit of reporting (LOR) and therefore unlikely to have reliable concentrations determined through use of the pXRF; and
- Leachate testing using the static precipitation leaching procedure (SPLP) on the waste rock (using a 1:20 solid:liquid ratio) reported pH values between 9.72 and 9.18 and low sulfate (SO_4) concentrations (<1 to 4 mg/L) in the leachate. Metals including aluminium (Al), arsenic (As), and chromium (Cr) were reported at concentrations exceeding the ANZG (2018) 95% default guideline value (DGV) suggesting that they may pose a geoenvironmental hazard in leachate generated from future waste rock and tailings.

Based on the findings of the geoenvironmental hazard assessment. Table 9 summarises the key potential environmental risks for the geologic units associated with the project.

Table 9: Summary of AMD classifications and PCOC in key geologic units for the BOGP.

GEOLOGICAL UNIT	TYPE OF MATERIAL	AMD CLASSIFICATION	PCOC		
			GEOCHEMICAL COMPOSITION (BASED ON GAI [1])	LEACHATE TESTS	OTHER
TZ3	Waste Rock	NAF	As, Co, Sb	-	N-Compounds, SO_4

[1] *Geochemical Abundance Index*

GEOLOGICAL UNIT	TYPE OF MATERIAL	AMD CLASSIFICATION	PCOC		
			GEOCHEMICAL COMPOSITION (BASED ON GAI [1])	LEACHATE TESTS	OTHER
TZ4 & RSSZ	Waste Rock / Ore	NAF	As, S, Sb	Al, As, Cr, Zn	N-Compounds, SO_4
Soils	Soils	-	As	Al, As, Co, Cu, Fe, Zn	-

Note: Red PCOC may not be elevated, but current data suggests it cannot be excluded as a PCOC for the BOGP.

6.1.3 Soil Concentrations

Between 2013 and 2024, MGL undertook various field programs to determine metals concentrations in near surface soils, comprising the analysis of up to 1,589 samples described as loess, topsoil or outcrop, in the various prospect areas including CIT, RAS, SRX, SHE, and Thompson's Saddle (TSD). An additional investigation targeting the upper portion of Shepherd's Creek valley was undertaken in January 2025. Determination of soil concentrations was undertaken using a portable x-ray fluorescence (pXRF) which provided concentrations for a range of analytes (with N≥10) including: Ag, Al, As, Ba, Bi, Br, Ca, Cd, Co, Cr, Cu, Fe, Ge, Hf, Hg, Ir, K, Le, Mg, Mn, Mo, Nb, Nd, Ni, P, Pb, Pr, Pt, Rb, Rh, RS, Sb, Sc, Se, Si, Sr, Te, Th, Ti, U, V, W, Zn, and Zr (refer to Appendix A for chemical names).

For the purpose of this PSI, preliminary analysis of the data has been undertaken with respect to those metals for which the MfE has derived standards for contaminants in soil to protect human health and the environment in an outdoor worker, industrial land use setting (MfE, 2011), namely As, Cd, Cr, Cu, Hg, Pb, and Zn for the purpose of assessing risks to human health during mining operations. Comparison has also been made across the range of Eco-SGVs to assess potential risks to ecosystem at various levels of protection, namely 60% Eco-SGV (industrial landuse setting) which is suitable for assessment of risk during operations, and the 80% Eco-SGV (recreational land use) and 95% Eco-SGV (non-food production land) which may be applicable post-closure.

A summary of the soil data with comparison to these guidelines is provided in Table 10 (CIT, RAS, SRX, SHE, and TSD) and Table 11 (Shepherd's Creek).

Table 10: Summary of soil concentrations (in mg/kg) for As, Cd, Cr, Cu, Hg, Pb and Zn (CIT, RAS, SRX, SHE, and TSD)

DATA STATISTIC	ARSENIC	CADMIUM	TOTAL CHROMIUM	COPPER	MERCURY	LEAD	ZINC
SCS-Industrial	70	1,300	6,300	10,000	4,200	3,300	NA
ECO-SGV (60%)	150	33	660	640	NA	2,500	597
ECO-SGV (80%)	60	12	400	350	NA	900	361
ECO-SGV (95%)	20	1.5	200	135	NA	NA	203
No of Samples	1,607	19	741	1,239	249	1,254	1,255
Minimum	3	13	4	7	3	5	34
Maximum	3,477	46	189	149	21	99	274
Median	16	15	10	21	6	22	87
Mean	37	18	15	22	9	22	90
Exceedances of SCS-Industrial	122	0	0	0	0	0	NA
Exceedances of ECO-SGV Industrial (60%)	47	1	0	0	-	0	0
Exceedances of ECO-SGV Industrial (80%)	156	15	0	0	-	0	0
Exceedances of ECO-SGV Industrial (95%)	596	19	0	1	-	0	4

NA – no applicable guideline

Table 11: Summary of soil concentrations (in mg/kg) for As, Cd, Cr, Cu, Hg, Pb and Zn (Shepherd’s Creek)

DATA STATISTIC	ARSENIC	CADMIUM	TOTAL CHROMIUM	COPPER	MERCURY	LEAD	ZINC
SCS-Industrial	70	1,300	6,300	10,000	4,200	3,300	NA
ECO-SGV (60%)	150	33	660	640	NA	2,500	597
ECO-SGV (80%)	60	12	400	350	NA	900	361
ECO-SGV (95%)	20	1.5	200	135	NA	NA	203
No of Samples	72	4	72	72	7	72	72
Minimum	5	13	5	11	13	7	61

DATA STATISTIC	ARSENIC	CADMIUM	TOTAL CHROMIUM	COPPER	MERCURY	LEAD	ZINC
Maximum	38	15	37	57	21	48	143
Median	12	15	21	26	18	18	95
Mean	13	15	20	27	18	19	96
Exceedances of SCS-Industrial	0	0	0	0	0	0	NA
Exceedances of ECO-SGV Industrial (60%)	0	0	0	0	-	0	0
Exceedances of ECO-SGV Industrial (80%)	0	1	0	0	-	0	0
Exceedances of ECO-SGV Industrial (95%)	5	1	0	0	-	0	0

NA – no applicable guideline

The results of the preliminary investigation indicate that Cr, Cu, Hg Pb and Zn are predominantly not present in the shallow soils at concentrations that would not be considered to pose a risk to human health or ecosystem health in an industrial setting.

Arsenic (As) concentrations are above the SCS-Industrial guideline of 70 mg/kg in 7.7% of soils (Figure 10) as well as the 60%, 80% and 95% Eco-SGV guidelines. Arsenic (As) is a main pathfinder element for gold mineralisation and therefore is expected to be naturally present in elevated concentrations within the Project area, however, elevated As concentrations may also be present due to the historic alluvial mining practices. The elevated As concentrations above the SCS-Industrial guideline suggests that a management plan will be required to address potential risks to site workers. Further assessment of the data, which is beyond the scope of this PSI, could be warranted to differentiate between endemic and anthropogenic arsenic concentrations.

Cadmium (Cd) concentrations were reported above the Eco-SGV (95%) threshold for non-productive land use and Eco-SGV 80% but did not exceed the relevant human health criteria or the industrial Eco-SGV threshold (60%). Cadmium (Cd) is not typically associated with gold mineralisation within the Project area and therefore elevated cadmium concentrations in soils may be related to historical mining activity, where disturbance and oxidation of mineralised rock and mine waste may have mobilised trace metals into the surrounding environment. Although Cd poses less direct risk to human health via soil contact compared to As, Cd can pose long term ecological risks through uptake by plants and aquatic organisms and can be transported via leaching into surface or groundwater systems and may warrant management during operations to meet post-closure land use objectives.

Further evaluation of the soil dataset is recommended to differentiate between endemic and anthropogenic metals concentrations in the Rise and Shine valley, and if required, derive appropriate ecological background metals concentrations for the Project area. Given the duration of time that has passed since historic mining activities, it is possible that ecological populations within the catchments have adapted to historic mining impacts. Notwithstanding, deriving background metals concentrations in disturbed and undisturbed areas of the Project area will assist in the development of appropriate monitoring requirements and trigger values to assess potential effects on ecological receptors within the Project area during operations.

6.1.4 Surface Water Quality

As reported in the baseline water quality study report (MWM, 2025b), surface water quality data have been variably collected from 11 sites with the Project area between September 2022 and August 2024 as summarised in Table 12 and depicted in (Figure 4).

Table 12: Water quality sampling sites.

DOMAINS	SITE ID	EASTING	NORTHING	NUMBER OF SAMPLES	DESCRIPTION
Shepherds Creek	SC01	1315697	5019155	25	Shepherds Creek at Bendigo Terrace. Downstream monitoring site.
	SC03	1319246	5017638	21	Shepherds Creek below Rise and Shine. Just upstream from Jean Creek confluence.
	JC01	1319122	5017651	6	An intermittent tributary to Shepherds Creek.
Bendigo Creek	RSA1	1317903	5016873	25	Rise and Shine Adit. Historic workings.
	RS01	1317713	5016973	26	Immediately downstream of the Rise and Shine workings.
	RS02	1318918	5016027	26	Rise and Shine Creek above Rise and Shine workings. Upstream baseline.
	RS03	1316585	5017993	25	Rise and Shine Creek below Come-in-Time.
	RS04	1319364	5015799	14	Rise and Shine Creek above Rise and Shine workings. Upstream baseline.
	RSB	1317482	5016985	2	Water in Rise and Shine Creek at the historic Rise and Shine Battery.
	CC01	1317569	5016455	16	Water quality monitoring site in Clearwater Creek.
	LBA	1312968	5018094	18	Lower Bendigo Adit – historical working.

Source: E3 (2023) and Matakanui.

Surface water quality was analysed for a range of analytes as detailed in Table 13. It is noted that not all sites had all analyses completed.

Table 13: Surface water quality analysis suite.

MEASUREMENT TYPE		PARAMETER
Field		Flow (spot gauging), pH, redox potential (ORP), electrical conductivity (EC), temperature, turbidity, dissolved oxygen (DO)
Lab	Physical Parameters	pH, electrical conductivity (EC), total hardness, total dissolved solids (TDS), total suspended solids (TSS), turbidity
	Major Anions	Alkalinity – total, acidity[1], chloride (Cl), fluoride (F), bromide (Br), sulfate (SO_4), sum of anions
	Nutrients and Organics	Nitrate as nitrogen (NO_3-N), nitrite as nitrogen (NO_2-N) ammoniacal nitrogen (Amm-N), total nitrogen (TN), total phosphorus (TP), total cyanide (CN), dissolved silicon (DSi), silicon (Si), total organic carbon (TOC), dissolved organic carbon (DOC), total Kjeldahl nitrogen (TKN), dissolved reactive phosphorus (DRP)
	Total & Dissolved Metals	Aluminium (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), bismuth (Bi), boron (B), bromide (Br), cadmium (Cd), caesium (Cs), calcium (Ca), chromium (Cr), cobalt (Co), copper (Cu), germanium (Ge), iron (Fe), lanthanum (La), lead (Pb), lithium (Li), magnesium (Mg), manganese (Mn), mercury (Hg), molybdenum (Mo), nickel (Ni), phosphorus (P), potassium (K), rubidium (Rb), selenium (Se), sodium (Na), strontium (Sr), sulfur (S), titanium (Ti), thallium (Tl), tin (Sn), uranium (U), vanadium (V), yttrium (Y), zinc (Zn)

1 – Acidity titrations have been completed to pH 4,5,7,8.3.

6.1.4.1 Shepherds Creek Catchment

Based on the preliminary evaluation of the surface water quality data for the Shepherds Creek catchment, the following surface water conditions are present:

- The pH ranged from 5.40 to 8.50 across all Shepherd Creek sites. Surface water in the catchment has predominantly reported alkaline pH conditions;
- The EC ranged from 253 µS/cm to 626 µS/cm and TDS ranged from 120 mg/L to 380 mg/L across all surface water sites, which is indicative of freshwater conditions;
- TSS ranged from 3.00 mg/L to 122.0 mg/L and turbidity ranged from 0.170 NTU to 57.0 NTU indicating generally clear waters;
- Acidity (pH 8.3) concentrations ranged between 1.0 mg $CaCO_3$/L and 12.0 mg $CaCO_3$/L across all Shepherd Creek sites;
- Alkalinity ranged between 2.0 mg $CaCO_3$/L and 285 mg $CaCO_3$/L across all Shepherd Creek sites and indicates there is excess alkalinity in the surface waters compared to acidity;
- Average Fe concentrations were <0.100 mg/L
- SO_4 concentrations were mostly below 100 mg/L but were higher at SC01 compared to SC03, possibly reflecting the presence of mineralisation mid-catchment (e.g., the RAS deposit);
- TN ranged from 0.1 mg/L to 1.4 mg/L and largely comprised TKN. Concentrations of NO_3-N ranged from 0.001 mg/L to 0.040 mg/L.;
- TCN was reported at or below the LOR in all samples (LORs ranged from 0.001 mg/L to 0.005 mg/L);
- TOC ranged from total <0.500 mg/L to 6.30 mg/L;
- Copper (Cu) reported an MEQ>1 at JC01 indicating that the maximum concentrations for the parameter exceeded the DGV;
- Copper (Cu) and Sr reported maximum concentrations resulting in 0.5 ≤ MEQ < 1.0 indicating that a PCOC is potentially elevated but still below the respective DGV;
- Metals including Ag, Cd, Cr, Hg and Tl were analysed with LORs greater than the 95% ANZG DGV therefore calculated MEQ values were elevated and may not reflect actual risks to the environment. Lower LORs will be required for future monitoring to appropriately assess potential environmental risks; and
- All other PCOC had MEQ values <0.50.

The majority of parameters in the Shepherd Creek Catchment exhibited consistent concentrations across the monitoring events. Seasonal concentration fluctuations were observed for Fe, As, and Al.

E3 Scientific (2023) noted that concentrations of nutrients (e.g., NO_3-N and Amm-N) were elevated in Shepherds Creek and may be attributed to the presence of livestock. Similarly, TKN concentrations could be a result of animal waste inputs or rock weathering processes within those watersheds (E3 Scientific, 2023).

6.1.4.2 Bendigo Creek Catchment

Based on the preliminary evaluation of the surface water quality data for the Bendigo Creek catchment, the following surface water conditions are present:

- The pH ranged from 6.60 to 9.30 across all Bendigo Creek Catchment sites indicating slightly acidic to highly alkaline conditions. CC01 reported the lowest average pH (7.08) indicating it is more acidic than other monitoring locations in the catchment area;
- EC ranged from 21.8 µS/cm to 526 µS/cm, which is indicative of freshwater conditions;
- TSS and turbidity concentrations were consistent across all sites except for RS01, which had 1,200 mg/L and 750 NTU respectively;
- Acidity (pH 8.3) concentrations ranged from 1.00 mg $CaCO_3$/L to 53.0 mg $CaCO_3$/L across all Bendigo Creek sites;
- Alkalinity ranged from 7.40 mg $CaCO_3$/L to 242 mg $CaCO_3$/L and indicates there is excess alkalinity in the surface waters in the Bendigo Creek catchment compared to acidity;
- Average Fe concentrations were reported as being <0.1 mg/L, except for RSA1 which had an average Fe concentration of 0.205 mg/L;
- SO_4 concentrations were typically <100 mg/L, except at LBA which represents mine-impacted water;
- TN ranged from 0.047 mg/L to 2.40 mg/L and was predominantly present as TKN, which ranged from 0.1 mg/L to 2.350 mg/L. Concentrations of NO_3-N were considerably lower with a maximum concentration of 0.010 mg/L;
- TCN was reported at or below the LOR in all samples (LORs ranged from 0.001 mg/L to 0.005 mg/L);
- The following PCOC variable reported an MEQ>1 (indicating that the maximum concentrations for the parameter exceeded the DGV) at the monitoring sites: As, Co, Cu, and Fe;
- The following PCOC reported maximum concentrations resulting in 0.5 ≤ MEQ < 1.0 indicating that a PCOC is potentially elevated but still below the respective DGV: Al, As, Cu, Cr, Fe, Sr, and Zn;
- Metals including Ag, Cd, Cr, Hg and Tl were analysed with LORs greater than the 95% ANZG DGV therefore calculated MEQ values were elevated and may not reflect actual risks to the environment. Lower LORs will be required for future monitoring to appropriately assess potential environmental risks;
- One sample from site RSB (Rise and Shine Battery Site within the Rise and Shine Creek) recorded elevated manganese (Mn) of 2.76 mg/L, which is above the proposed water quality compliance limits of 2.5 mg/L. This sample was collected during preliminary fieldwork and involved sampling of the old battery site (MWM, 2024) where the stream vegetation (reeds) was disturbed mobilising a significant amount of Fe precipitates. Subsequent samples of this site were much lower (0.67 mg/L) and involved minor disturbance to the stream vegetation; and
- All other PCOC had MEQ values <0.50.

Due to the limited data, concentration trends for Bendigo Creek were unable to be determined, however concentration fluctuations have been observed for several analytes during the monitoring period.

6.1.5 Groundwater Quality

As reported in the baseline water quality study report (MWM 2025b), groundwater quality data have been collected from five sites with the Project area between September 2022 and August 2024 as summarised in Table 14 and depicted in (Figure 7). Groundwater from all three monitoring well is defined as artesian.

Table 14: Groundwater quality sampling sites.

SITE ID	EASTING	NORTHING	NO. OF SAMPLES	DESCRIPTION
MRC002	1318777	5016051	1	Groundwater from drillhole at the potential processing plant location. Drilled to 46 m.
MDD015	1318096	5017475	18	Drillhole within the potential pit footprint. Drilled to 294.9 m at a dip of -58.62°.
MDD302	1318985	5015814	12	Groundwater from drillhole in Rise and Shine Valley. Drilled to 55 m at a dip of -49.84°.
Base (from water supply)	Not known	Not known	1	At the downstream base. Example of water supply quality.

Source: E3 (2023) and Matakanui.

Groundwater quality was analysed for pH, EC, acidity (to pH 8.3), alkalinity, SO_4, NO_3-N, Amm-N, and metals (Ag, Al, As, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Tl, U, V, and Zn). Water quality results were compared to the 95% ANZG DGV and NPS (as applicable). The MEQ was calculated to identify PCOC that may be elevated with respect to water quality guidelines. Based on the evaluation of the groundwater quality the following groundwater conditions are present:

- The pH ranged from 7.7 to 8.7 across all monitoring sites indicating alkaline conditions;
- The EC ranged from 149 µS/cm to 550 µS/cm across all groundwater sites, which is indicative of freshwater conditions;
- Acidity (to pH 8.3) ranged from 1.0 mg $CaCO_3$/L to 11.7 mg $CaCO_3$/L;
- Alkalinity ranged from 81.4 mg $CaCO_3$/L to 251 mg $CaCO_3$/L across all groundwater sites, which indicates there is excess alkalinity in the groundwater system;
- Average Fe concentrations were reported as being <0.1 mg/L and SO_4 concentrations were reported <100 mg/L;
- The following PCOC variably reported an MEQ>1 (indicating that the maximum concentrations for the parameter exceeded the DGV): As, total Fe, Pb, Sr, Tl , V, and Zn;
- The following PCOC reported maximum concentrations resulting in 0.5 ≤ MEQ < 1.0 indicating that a PCOC is potentially elevated but still below the respective DGV: Amm-N (MDD015), Sr MRC002) and Zn (Office Base);
- Metals including Ag, Cd, Cr, Hg and Tl were analysed with LORs greater than the 95% ANZG DGV therefore calculated MEQ values were elevated and may not reflect actual risks to the

environment. Lower LORs will be required for future monitoring to appropriately assess potential environmental risks; and

- All other PCOC had MEQ values <0.5.

Further baseline monitoring is ongoing and will inform a more robust evaluation including the development of an understanding of seasonal trends.

7 PROPOSED SITE DEVELOPMENT

Table 15 provides a summary of the proposed site development components for the BOGP which is based upon the current Project Description (Santana Minerals, 2025). Figure 10 depicts the layout of the proposed future operations. The Project area is currently 1,300 Ha, on the basis that, until defined, all elements of the project could be located anywhere within this area.

Table 15: Proposed site development components.

COMPONENT	DESCRIPTION
Mining	The resources will be mined by both open pit (RAS, CIT, SRX, and SRE) and underground methods (RAS). Underground mining will use paste backfill, comprising a mixture of process tailings and cement. The open pit mine and underground mines will deliver to the processing with the majority of ore sourced from the RAS open pit. There is likely to be combined open cut and underground feed sources supplying the processing plant in later years.
Processing Plant	The process plant will be located in the lower Shepherds Creek Valley. The run-of-mine (ROM) pad for ore stockpiling and blending into the process plant will be positioned immediately east of the process plant. The processing plant will be a conventional hard rock gold processing plant (1.2 million tonnes per annum expandable to 1.8Mtpa) applying modern Carbon-in-Leach (CIL) technology. The plant will operate in a closed water circuit with the TSF. Residual chemicals in the tailings slurry will be detoxified and/or precipitated with specialist plant. The construction of the plant in the lower reaches of the Shepherds valley will include the realignment of Shepherds Creek.
Waste Rock Storage	Non-ore-bearing waste rock is planned to be backfilled into the CIT and SRE pits. The remainder of the waste rock is scheduled to be stored in an Engineered Landform (ELF).
ELFs	Waste rock from RAS will be emplaced in the upper/middle Shepherds Creek Valley (Shepherds ELF). Waste rock from SRX and SRE will have a separate dedicated ELF (SRX ELF) located in the Rise and Shine Valley. A small ELF (Western ELF) will be located between the CIT and RAS Pits. A construction and demolition waste landfill may be established within the Shepherds ELF. It is noted that the ELFs are significantly less feasibly contained than in-pit backfill in terms of toe seepage. Such toe seepage can be expected to contain potentially elevated concentrations of SO_4, NO_3-N, and various metals (KSL, 2024b).
Tailings Storage Facility (TSF)	The process tailings will be pumped to a conventional wet TSF facility (including clean water diversion drains) constructed in the upper reach of Shepherds Valley utilising waste rock from mining activities within the project site. The TSF will be buttressed by the Shepherds Creek ELF. Spigots will be placed to produce a decant pond at the eastern end of the TSF away from the embankments. Embankments will be constructed according to the International Committee of Large Dams (ICOLD) standards. Overburden from the RAS deposit will be used in the construction of the TSF embankment.
Topsoil Management	Temporary and permanent topsoil stockpiles and biological rehabilitation resource storage areas will be established around the project site Some topsoil in the Rise and Shine Valley floor contains elevated arsenic, particularly in the historic mining areas. These soils will be stripped and stockpiled in Rise and Shine Valley for rehabilitation in Rise and Shine Valley.
Site Infrastructure	Most site infrastructure will be located in the lower Shepherds Creek Valley and will include: • Processing plant and associated infrastructure; • Open pit and underground mining fleet workshops; • Vehicle washing and refuelling facilities; • Warehouses and laydown areas;

COMPONENT	DESCRIPTION
	• Open pit and underground mining offices, crew meeting, lunchroom, and ablutions; and • Water treatment plant facilities. The underground portals, workshops, and offices will be located upstream of the main infrastructure but downstream of the RAS pit and the ELF/TSF. The explosives magazines and emulsion factory will be located outside of the RAS and Shepherds valleys on the terraces. Non-operational infrastructure associated with the BOGP including an administration office, high voltage substation and temporary construction workers accommodation will be established on the Ardgour Terrace. The main explosives magazines and emulsion mixing facilities will be located outside the project site on Ardgour Station. Storage of hazardous substances will be undertaken in accordance with the requirements of the *Hazardous Substances and New Organisms Act 1996* (HSNO).
Water Supply	Service water will come from a borefield in the Bendigo aquifer and will be pumped via pipeline over a distance of approximately 7 km to a proposed water storage tank near the process plant. Once in operation return water from the TSF and substantially reduced dust suppression at times will support a reduction in the average water. Eventually pit and underground dewatering plus the collection of mine impacted water may result in borefield make-up water requirements being substantially reduced. Mine impacted water will be pumped to the TSF impoundment or reused as process water. Zero release of mine impacted waters is considered feasible due to the relatively low rainfall environment, high potential evaporation rates, a shortage of process water, and the significant water storage capacity of the TSF.
Roads	The main project will require upgrades to the Ardgour and Thomsons Gorge public roads from SH8 to the entry point of Shepherds valley, a new road from Thomsons Gorge station through the “neck of the lower Shepherds gorge into the process plant area, and realignment of the western portion of the Thomson Gorge Road via Ardgour Station to provide public access through to the Manuherikia Valley.
Power	A new 66 kV above-ground powerline will be installed from the existing Lindis Crossing sub-station to the processing plant site following the existing road reserve corridor.

8 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) describes the possible pathways through which exposure to potential contamination may occur. For an exposure risk to occur, a complete pathway must exist between the source of contamination and the receptor (e.g., the human or ecosystem potentially affected by the contamination) or result in a detrimental change to the potential beneficial use or value of a resource (e.g., the use of groundwater or preservation of cultural values). Where the exposure pathway is incomplete, exposure cannot occur, resulting in no risk via that pathway. A complete exposure pathway will typically consist of the following elements:

- A source of contamination (i.e., a point or area of potential concern (APEC) where contaminants were, are, or could be released to the environment);
- A transport pathway (e.g., migration in soil, leaching to water, emission to air);
- An exposure mechanism (e.g., inhalation, ingestion, absorption, biotic uptake); and
- A receptor (e.g., human or ecological community)

The following sections detail the key considerations that define the components of the CSM to identify the potentially complete exposure pathways. A graphical representation of the CSM is provided as Figures 12 and 13.

8.1 Sources and Potential Constituents of Concern

Sources of historic and potential future contamination are summarised in Table 16 with respect to potentially relevant PCOC. It is noted that PCOC include metals and chemicals that could be present in association with historic or future land use and have not been limited to those PCOC confirmed to be present during the baseline assessments. A qualitative inherent risk ranking has been assigned to the potential sources of contamination, prior to the implementation of any controls (i.e. resource consent conditions), using the following criteria:

INSIGNIFICANT	Unlikely for sources of contamination to be present.
LOW	May result in minor contamination of limited extent.
MODERATE	May result in contamination over a moderate area that can be contained on-site and managed or remediated in the short-term.
HIGH	May result in extensive contamination to multiple media with long-term environmental impact.

Table 16: Potential sources of contamination and PCOC.

APEC	DESCRIPTION	PCOC	STATUS	RISK
HISTORIC/EXISTING FEATURES				
CIT Historic Mining Area	Features include a 10-stamper battery, two adits, mullock, track, wall, and possible ore bin. (G41/251)	Sulfate (SO_4) Metals: Al, As, Fe, Cd, Co, Cu, Hg, Mn, Ni, Pb, Tl and Zn	An extensive pXRF characterisation survey for metals concentrations in shallow soils has been undertaken across the historic mining areas. Elevated concentrations of As and possibly Cd have been identified within the soils. Surface water monitoring at sites near the historic workings show evidence of AMD with elevated concentrations of metals including As, Cd, Cu, Cr, Mn, and Zn in Bendigo Creek. Based on limited data, groundwater exhibited potentially elevated concentrations of As, Co, Cu, and Amm-N. Mercury (Hg) was used as part of historic gold recovery methods but has not been identified in the catchment at elevated concentrations from limited surface water sampling.	MODERATE
Eureka Historic Mining Area	Features include an underground mine adits, battery, and water race. (G41/252)			
Alta Historic Mining Area	Mortar box battery, and adit linked by cutting to return wheel. (G41/253)			
RAS Historic Mining Area	Features include underground mine adits, battery, sluicing face, dam, and spoil piles (G41/277)			
Historic Sluicing Area	The historic sluicing area in the vicinity of the SRX deposit (G41/669) exhibits evidence of tailings fields.			
Historic Mine	Historic mine with turbine (G41/604) and battery (G41/605)			
Historic Tailings Fields	Gold mining tailing fields along Thomsons Creek (G41/636) from Thomson Gorge Road. Tailings piles (G41/670)			
Historic Water Races	Water races (G41/673 and G41/677) transported surface water to the sluicing areas. Portions of the water races transect several historic mining areas.			INSIGNIFICANT
Historic Dam	A constructed dam is present in the SRX deposit area to capture water from the water race. Construction involved the creation of a dam wall and creation of a basin behind it.	None identified	This feature is unlikely to be a source of contamination as it was used to capture rainwater. Healthy vegetation was observed in the dam during the site visit.	INSIGNIFICANT
Pastoral Land Use	The land has been used for pastoral purposes since the 1860s	Nitrogen compounds: NO_3, Amm-N	Nitrogen compounds were elevated in Shepherds Creek potentially associated with faecal matter from livestock associated with pastoral land use.	MODERATE
Woolsheds	Two historic woolsheds (circa 1860s) are present within the Run238N area but are located at some distance from proposed operations (Lindis Valley and Ardgour Rd south of Tarras). Sheep dipping practices were likely undertaken proximal to the woolsheds. Sheep dipping using As was required by law from the 1840s (MfE, 2006) and there are numerous historic sites within New Zealand that exhibit	Metals: As OCP, DDT, lindane, dieldrin and aldrin	Historic woolshed locations are not accurately known, and potential impacts are likely limited to localised hotspots. Woolshed areas are located outside the project disturbance area. Elevated As concentrations are naturally present in soils in the Project area in association with the natural lithologies suggesting potential ecologic	INSIGNIFICANT (Offsite - Not a source that will impact this project)

APEC	DESCRIPTION	PCOC	STATUS	RISK
	elevated As hotspots resulting from these practices. Use of OCPs at sheep dips was introduced in the early 1900's.		receptors may have a tolerance to elevated As concentrations.	
	FUTURE PROPOSED INFRASTRUCTURE			
Open Pits (RAS, CIT, SRX, SRE)	Open pit mining will be developed through blasting and excavation. Exposure of fresh rock faces may result in the oxidation of arsenopyrite and release of metals.	Nitrogen compounds: NO_3, Amm-N SO_4 Metals: Metals: Al, As, Fe, Cd, Co, Cu, Hg, Mn, Ni, Pb, Tl, and Zn Petroleum hydrocarbons: total recoverable hydrocarbons (TRH), monocyclic aromatic hydrocarbons (MAH including benzene, toluene, ethylbenzene, and xylenes (BTEX)), polycyclic aromatic hydrocarbons (PAH)	Open pit mining will progressively develop in line with the conditions of the Resource Consent to ensure future risks to the environment are minimised.	HIGH[1]
Underground Mine (RAS)	Underground mining will require blasting to develop stopes within the schist basement and dewatering to support the exposure of the gold-bearing reef. Exposure of fresh rock faces may result in the oxidation of arsenopyrite and result in the release of metals to the environment.		Underground mining will progressively develop following open pit mining of the RAS in line with the conditions of the Resource Consent to ensure future risks to the environment are minimised.	HIGH[1]
ROM Pad	The ROM pad receives the excavated or mined material prior to it being sent to the processing plant. This material may contain blast residue and residual explosives. Depending on retention time at the ROM, the oxidation of sulfide minerals may occur. During normal operations, the residence time of materials at the ROM pad is usually relatively short which limits the potential for oxidation of sulfide minerals, leaching and contaminant migration to the environment.	Nitrogen compounds: NO_3, Amm-N SO_4 Metals: Al, As, Fe, Cd, Co, Cu, Mn, Ni, Pb, Tl and Zn	This storage area is not currently constructed. Design of the ROM pad will be undertaken in accordance with the conditions of the Resource Consent to ensure future risks to the environment are minimised. Appropriate management plans will be prepared to define on-going obligations for the operation and maintenance of this attribute.	MODERATE[1]
Processing Plant	Processing is estimated to be a conventional single stage crush, single stage grind via a SAG mill, gravity gold recovery, with a follow up cyanide leach to carbon recovery then electro-winning and final smelting to produce ore on site. Material and chemical spills that may occur during operations but are generally small-scale pose limited risks	Cyanide (CN) SO_4 Metals: As, Cu	This facility is not currently constructed. Design of the facility will be undertaken in accordance with the conditions of the Resource Consent to ensure future risks to the environment are minimised. Appropriate management plans will	MODERATE[1]

APEC	DESCRIPTION	PCOC	STATUS	RISK
	to the environment if appropriately managed at the time of occurrence.		be prepared to define on-going obligations for the operation and maintenance of this attribute.	
Engineered Landform (ELF)	The ELF receives the non-ore bearing overburden and interburden from the mining operations. Due to limitations in mining methods and economic decisions on cut-off grades for mineralisation, TZ4 and RSSZ geologic units which contain sulfide minerals (including arsenopyrite) will inevitably be disposed of within the WRD. Oxidation of sulfide minerals can result in the generation of acidity and leaching of metals to the environment. Blast residues may also adhere to waste rock.	Nitrogen compounds: NO_3, Amm-N SO_4 Metals: Al, As, Fe, Cd, Co, Cu, Hg, Mn, Ni, Pb, Tl and Zn	These material storage areas are not currently constructed. Design of these area will be undertaken in accordance with the conditions of the Resource Consent to ensure future risks to the environment are minimised. Appropriate management plans will be prepared to define on-going obligations for the operation and maintenance of these attributes to reduce long-term environmental risk.	HIGH[1]
Tailings Storage Facility (TSF)	The TSF will receive the post-processed tailings. This fine-grained (sand, silt, and clay-type) waste material contains the presence of inorganic chemical residues from reagents used in the metallurgical extraction process and residual metals, minerals and sulfides not extracted from via processing. As a result, the mine tailings disposed to the TSF can represent a significant potential source of contamination both during operations and post-closure. Design attributes of the TSF will aim to mitigate these risks.	CN Nitrogen compounds: NO_3, Amm-N SO_4 Metals: Al, As, Fe, Cd, Co, Cu, Hg, Mn, Ni, Pb, Tl and Zn		HIGH[1]
Topsoil Stockpiles	Several topsoil stockpiles will be present to support future rehabilitation of the site. Some topsoil will be elevated in As and possibly Cd. Windborne particulates, and runoff from As/Cd-rich stockpiles may distribute contaminants to other portions of the Project area.	Metals: Al, As, Fe, Cd, Co, Cu, Hg, Mn, Ni, Pb, Tl and Zn	Stockpiles are not currently present. Stockpile management will be undertaken in accordance with the conditions of the Resource Consent to ensure future risks to the environment are minimised.	LOW
Vehicle Washdown and Refuelling Facilities	Vehicle washing and refuelling facilities will be appropriately constructed to prevent release of hydrocarbons to the environment. A triple interceptor trap will be installed at the washdown bay to filter out hydrocarbons facilitating recycling of water.	TRH, BTEX, PAH	These facilities are not currently constructed. Design of these facilities will be undertaken in accordance with the conditions of the Resource Consent to ensure future risks to the environment are minimised. Appropriate management plans will be prepared to define on-going obligations for the operation and maintenance of this attribute.	MODERATE[1]
Explosives Magazine and Emulsion Factory	Chemicals used to produce explosives and manufactured ANFO (ammonia nitrate fuel oil) will be stored within a designated area on the site. This area will be designed to regulatory requirements and produced material will be stored within an enclosed area. Over time, minor spillage of product through transport loading may occur.	Ammonium nitrate, TRH (diesel)		MODERATE[1]

APEC	DESCRIPTION	PCOC	STATUS	RISK
Open Pit and Underground mining fleet workshops	Maintenance of mine vehicles will be undertaken in designated and appropriately designed workshop areas to minimise risk of spills to the environment. Chemicals will be stored onsite in designated areas in accordance with the requirements defined in the HNSO.	Solvents, TRH, BTEX, PAH, metals, oils, and grease		MODERATE[1]

1. *Risk ranking is based on inherent contamination risk, prior to the establishment of management controls (i.e. resource consent conditions).*

8.2 Potential Migration Pathways and Exposure Mechanisms

Table 17 summarises the potential migration pathways relevant for the Project area.

Table 17: Potential migration pathways.

MIGRATION PATHWAYS	EXPOSURE MECHANISMS
Transport of contaminants by mechanical disturbance	Direct contact with contaminated media (soils)
Windborne contaminant transport	Inhalation of contaminated media
Volatilisation to air	Vapour inhalation
Leaching of contaminants through the soil profile to groundwater	Ingestion of or direct contact with abstracted groundwater
Transport of contaminants via surface water within the Bendigo and Shepherds Creek catchments	Ingestion of or direct contact with contaminated surface water
Uptake/bioaccumulation of contaminants by terrestrial biota	Ingestion
Precipitation of contaminants into sediments	Ingestion
Uptake/bioaccumulation by aquatic macrophytes	Ingestion

8.3 Potential Receptors

Table 18 summarises the potential current and future receptors relevant for the site.

Table 18: Potential receptors.

POTENTIAL RECEPTORS	DESCRIPTION
Site workers/site visitors	Site workers will reside offsite and work a 12-hour shift across a 4-panel roster which is less than the default exposure period for the derivation of default contaminant guidelines for industrial land use. Exposure to potential contamination risks can be mitigated through site management plans, training, and personal protective equipment (PPE).
Pastoral land users	Pastoral land users will have limited exposure to operational areas of the site where risks are highest.
Groundwater users	Abstraction of groundwater by pastoral land users is possible but it is unlikely to be used for potable water purposes.
Surface water users	Surface water in the Project area does not have a beneficial use.
Pastoral livestock	Pastoral livestock (e.g. cows, sheep) are present on the land. These livestock have access to a wide grazing area and may access perennial streams for drinking water.
Terrestrial fauna	A range of mammals, avifauna, lizards, and terrestrial invertebrates are present in the Project area. Some of these faunae are protected under the Wildlife Act and designated as being Nationally Threatened, At Risk, or Not Assessed – Potentially Threatened.
Aquatic fauna	Macroinvertebrates, macrophytes and freshwater fish are present in the catchments surrounding the site (no fish found onsite). Only one At-Risk freshwater species has been identified.
Native flora	A mix of indigenous and introduced species are present in the Project area resulting from a history of pastoral management. Several Threatened or At-Risk flora species have been identified onsite, however, few of the indigenous species are rare or under any significant threat.

8.4 Potentially Complete Exposure Pathways

The following potentially complete exposure pathways may currently be present in the Project area in association with elevated concentrations of arsenic, and other metals in near surface soils/sediments that have resulted from historic alluvial and underground mining, and gold-processing activities within the Thompson's Creek Valley:

- Inhalation of dust by site workers/visitors, pastoral workers, terrestrial fauna and livestock may result through mechanical disturbance or windborne transport of contaminated soils;
- Bioaccumulation of metals by terrestrial biota and ingestion by native fauna and livestock;
- Migration of impacted soil or leachable contaminants by surface water flow in the Bendigo Creek Catchment may result in the uptake/bioaccumulation of contaminants by aquatic macrophytes and aquatic biota and primary or secondary ingestion by native aquatic and/or terrestrial fauna and livestock; and
- Leaching of PCOC through the soil profile to groundwater with the potential for terrestrial biota uptake and/or direct contact/ingestion by pastoral land users and/or livestock in the event that groundwater is abstracted for irrigation/stock water purposes. It is noted that the likelihood of this exposure pathway being complete is low given the depth to groundwater and the extensive distance to the nearest groundwater abstraction bores.

It is noted that under present conditions terrestrial fauna and livestock have access to other nearby catchments (i.e., Jean Creek, Shepherds Creek) that are relatively undisturbed by historic mining activities and that represent a less impacted source of fresh water and vegetation. Future development of mining infrastructure within these catchments is likely to reduce the nearby clean water source options for terrestrial fauna and livestock.

The following potentially complete exposure pathways may occur in the Project area in association with the planned future development of the BOGP project:

- Generation and release of AMD (associated with the oxidation of arsenopyritic mineralisation) and nitrates (associated with unexploded ANFO residues) within underground mine workings to groundwater upon rebound of the water table, post-dewatering resulting in the degradation of the beneficial use of groundwater;
- Migration of AMD and nitrates generated within the open pit, ELF, TSF and ROM pad into the underlying groundwater aquifer with the potential for terrestrial biota uptake and/or direct contact/ingestion by pastoral land users and/or livestock in the event that groundwater is abstracted for irrigation/stock water purposes;
- Migration of AMD and nitrates generated within the ELF, TSF, underground workings, and ROM pad via toe seepage or run-off into surface water into Shepherds Creek and Rise and Shine Creek may result in the uptake/bioaccumulation of contaminants by aquatic macrophytes and aquatic biota and primary or secondary ingestion by native aquatic and/or terrestrial fauna and livestock;
- Potential for dermal contact, ingestion and vapour inhalation of PCOC by site workers in APECs including the processing plant, fuel storage/refuelling areas, vehicle washdown, workshops,

and explosives magazines with respect to the use and potential spillage of PCOC (including petroleum hydrocarbons and other hazardous materials) that are used and stored on site; and

- Potential for the migration of PCOC into surface water and groundwater from APECs including the processing plant, fuel storage/refuelling areas, vehicle washdown, workshops, and explosives magazines with respect the potential spillage of PCOC (including petroleum hydrocarbons and other hazardous materials) that are used and stored on site, resulting in the degradation of the beneficial use of soil and water resources and/or adverse impacts to terrestrial and aquatic biota and fauna through primary or secondary uptake of contaminated media.

9 CONCLUSIONS AND RECOMMENDATIONS

This evaluation of the current and potential future site contamination risks associated with the development of the Project, has been undertaken to support the AEE and meet regulatory obligations under the NESCS that arise from the recognition that historic and future mining operations are defined in the Hazardous Activities and Industries List (HAIL) as a potentially contaminating land use (Category E7).

9.1 Conclusions

Based on a desktop review of publicly available data, site walkover, and evaluation of preliminary findings associated with other environmental studies currently being undertaken as part of the AEE, the following conclusions are drawn with respect to the Project area:

- The Project area is located within the Otago Schist belt which comprises metasedimentary and metavolcanic rocks metamorphosed to greenschist facies. Gold mineralisation is widespread within the Otago Shists with main mineralisation in the region generally associated with silica-siderite/ankerite alteration with minor arsenopyrite sulfides associated with the gold;
- There is no record of permanent Māori occupation within the Project area, however the Project area has a long history of pastoral occupation dating back to the late-1850s, and historic gold mining operations comprising alluvial sluicing and shallow mining of quartz reefs that occurred in several areas across the site and surrounds between the 1960s through to the 1940s. Whilst pastoral land use has continued through to present day, only limited exploration activities have been undertaken since the 1980s;
- Detailed heritage mapping of the historic land use has been undertaken with numerous historic mining features, including prospecting pits, water races, mullock piles, tailings and dams, sluices areas, mine adits, turbines and batteries, alluvial workings, mapped as being present within the Project area. Several agricultural and pastoral features and one feature that may be associated with Māori activity have been identified within the broader mining lease area, however most are distal to the Project area;
- Baseline environmental studies have been undertaken within the Project area to assess the ecological values of the environment with respect to groundwater, surface water, and aquatic and terrestrial ecosystems. Based on these studies, several Threatened or At-Risk flora species have been identified onsite, however, few of the identified indigenous grasses and herbs are known to be rare or under any significant threat locally, regionally or nationally. Several indigenous habitats and protected wildlife species are present, but no threatened or At-Risk freshwater species have been identified;
- Notable evidence of the mining history is present within the Thomson Gorge along Rise and Shine Creek. Remnant impacts from the historic activities are visible within the Project area associated with the accumulation of sluicing debris and migration of tailings along creek beds, adits, mullock piles, and the former battery sites. Soil sampling and water quality monitoring around these areas has identified potentially elevated concentrations of metals in shallow soil (As and possibly Cd), surface water (As, Co, Cu, and Fe), and groundwater (As, Cr, Cu, Fe, Sr, Tl, and Zn) within the project area;

- Arsenic (As) has been identified at concentrations above industrial land use human health protection criteria and above 60% and 80% Eco-SGV in shallow soils within the Project area, predominantly within the historic mining areas. Potentially complete exposure pathways may result from the disturbance of these soils during future mining activities. Cadmium (Cd) was found extensively above 80% Eco-SGV and may also warrant management during operations to meet post-closure land use objectives; and
- If not appropriately managed, future mining activities within the Project area have the potential to release contaminants to the environment, potentially resulting in adverse impacts to terrestrial and aquatic ecosystems. Future mine site features including the open pit, underground workings, ELF, TSF, processing plant, ROM pad, topsoil stockpiles, vehicle washdown and refuelling facilities, explosives magazine and emulsion factory, and mining fleet workshops will require appropriate facility design and management plans to minimise potential risks to human health and the environment.

9.2 Recommendations

Based on the findings of this PSI, the following recommendations are made:

- A detailed evaluation of the extensive soil dataset should be undertaken for the Rise and Shine Valley to better inform a risk assessment of the disturbance of soils with elevated As (and potentially Cd) concentrations during operations. Using the existing soil dataset, appropriate ecological background threshold values (BTV) should be derived using an appropriate industry-recognised methodology (e.g., upper tolerance limit (UTL)) for the Project area to support the assessment of environmental effects during operations and closure;
- A SMP should be developed in accordance with the requirements defined in the *Contaminated Land Guidelines No. 1* (MfE, 2021) to define the risks, control strategies, and management responsibilities associated with shallow soil management (i.e. arsenic impacted soils) within the Project area; and
- Management plans and associated conditions of consent should be developed to address operational risks associated with key mine sources that have the potential to adversely impact human health or ecological receptors. These should include procedures around waste rock and processing residues (e.g., tailings) to reduce environmental risks from AMD, dust management, chemical storage, spill response, and surface and groundwater monitoring.

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11 LIMITATIONS

Attention is drawn to the document "Limitations", which is included in Appendix D of this report. The statements presented in this document are intended to provide advice on what the realistic expectations of this report should be, and to present recommendations on how to minimise the risks associated with this project. The document is not intended to reduce the level of responsibility accepted by Mine Waste Management, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in doing so.

APPENDIX A ABBREVIATIONS AND ACRONYMS

Table A-1: Abbreviations and acronyms

ABBREVIATION	DEFINITION
ABA	Acid base accounting
AMD	Acid and metalliferous drainage
ANC	Acid neutralising capacity
ANFO	Ammonia nitrate fuel oil
APEC	Areas of potential environmental concern
BGV	Background guideline value
BOGP	Bendigo-Ophir gold project
CIL	Carbon-in-leach
CIT	Come-in-Time deposit
CLMG	Contaminated land management guidelines
PCOC	Constituents of potential concern
CSM	Conceptual site model
DGV	Default guideline value
DOC	Department of Conservation
DSI	Detailed site investigation
ELF	Engineered landform
GAI	Global abundance index
GRM	Geocontam Risk Management Limited
HAIL	Hazardous activities and industries list
HSNO	*Hazardous Substances and New Organisms Act 1996*
ICOLD	International Committee of Large Dams
LINZ	Land Information NZ
MAV	Maximum acceptable value
MEQ	Metals ecotoxicity quotient
MfE	Ministry for Environment, NZ
MGL	Matakanui Gold Limited
MPA	Maximum potential acidity
NAF	Non-acid forming
NAG	Net acid generating
NAPP	Net acid producing potential
NESCS	Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011

ABBREVIATION	DEFINITION
NES Freshwater	Resource Management (National Environmental Standards for Freshwater) Regulations 2020
NES Soil	National environmental standard for contaminants in soil
NPR	Neutralisation potential ratio
NZ	New Zealand
NZHPL	New Zealand Heritage Properties Limited
NZPM	New Zealand Petroleum and Minerals
ORC	Otago Regional Council
OSTD	Over-sown and top-dressed
PAF	Potentially acid forming
PPE	Personal protective equipment
PSI	Preliminary site investigation
RAS	Rise and Shine deposit
ROM	Run-of-mine
RSSZ	Rise and Shine shear zone
SAG	Semi-autogenous grinding
SRX	Srex deposit
SMP	Site management plan
SPLP	Static precipitation leaching procedure
SQEP	Suitably qualified and experienced practitioner
SRE	Srex East deposit
TGF	Thomson gorge fault
TSD	Thomson's Saddle
TSF	Tailings storage facility
UTL	Upper tolerance limit
WRS	Waste rock storage
XRF	X-ray fluorescence

Table A-2: Chemical abbreviations

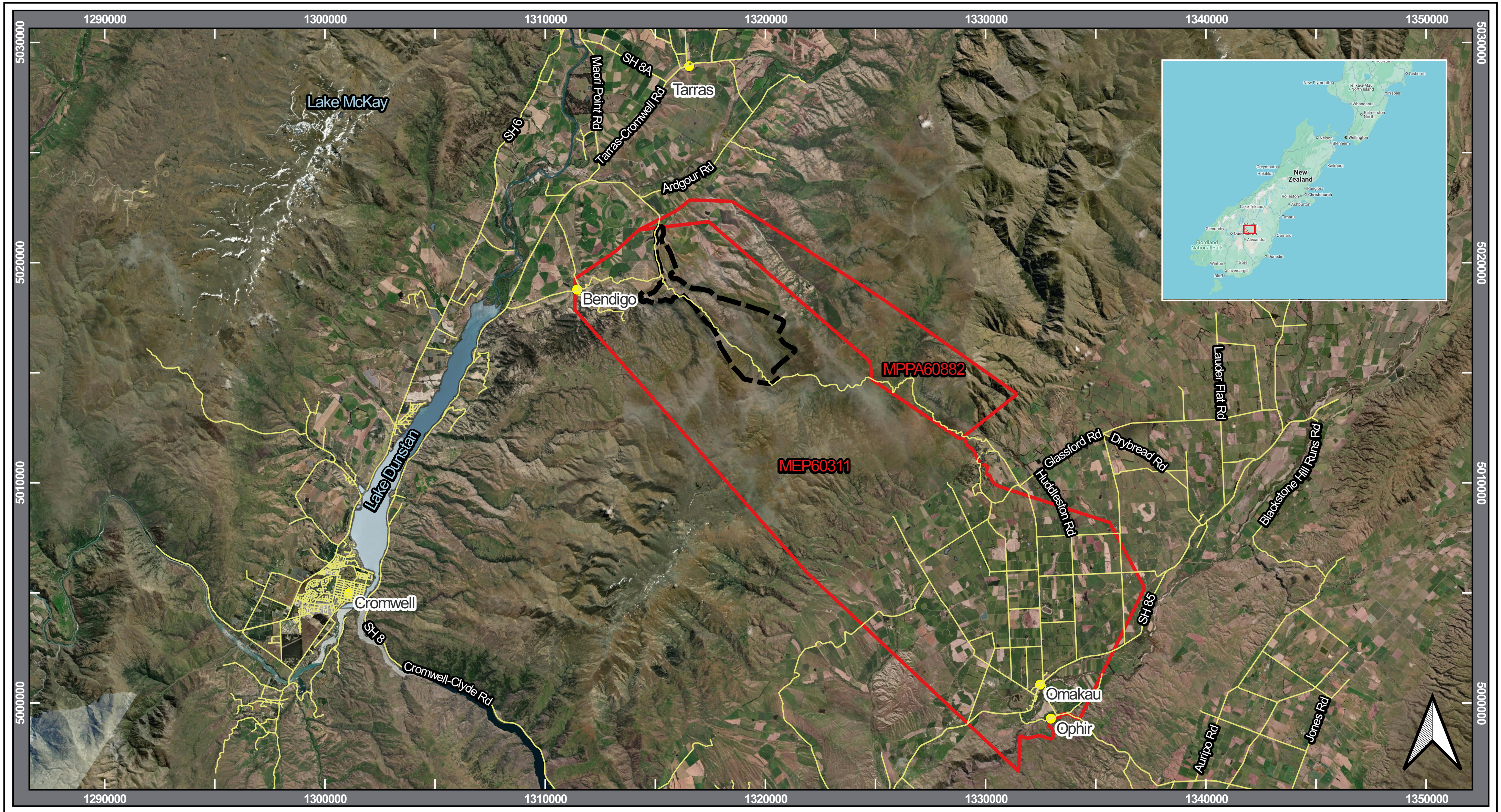
ABBREVIATION	CHEMICAL
Al	aluminium
Amm-N	ammoniacal nitrogen
As	arsenic
B	boron
Ba	barium
Be	beryllium
Bi	bismuth
Br	bromide
BTEX	benzene, toluene, ethylbenzene, and xylenes
Ca	calcium
Cd	cadmium
Cl	chloride
CN	cyanide
Co	cobalt
Cr	chromium
Cs	caesium
Cu	copper
DDT	dichloro-diphenyl-trichloroethane
DO	dissolved oxygen
DOC	dissolved organic carbon
DRP	dissolved reactive phosphorus
DSi	dissolved silicon
EC	electrical conductivity
F	fluoride
Fe	iron
Ge	germanium
Hg	mercury
La	lanthanum
Li	lithium
MAH	monocyclic aromatic hydrocarbons
Mg	magnesium
Mn	manganese
Mo	molybdenum

ABBREVIATION	CHEMICAL
Na	sodium
Ni	nickel
NO_3	nitrate
NO_3-N	nitrate reported as nitrogen
OCP	organochlorine pesticides
ORP	redox potential
PAH	polycyclic aromatic hydrocarbons
P	phosohorus
Pb	lead
Rb	rubidium
S	sulfur
Sb	antimony
Se	selenium
Si	silicon
Sn	tin
SO_4	sulfate
Sr	strontium
TDS	total dissolved solids
Ti	titanium
Tl	thallium
TN	total nitrogen
TKN	total Kjeldahl nitrogen
TOC	total organic carbon
TP	total phophorus
TRH	total recoverable hydrocarbons
TSS	total suspended solids
U	uranium
V	vanadium
Y	yttrium
Zn	zinc

Table A-3: Units of measure

ABBREVIATION	UNIT OF MEASURE
km	kilometres
kV	kilovolts
L/s	litres per second
m	metres
mAMSL	metres above mean sea level
mm	millimetres
µm	mircometres
mRL	metres relative to sea level
Mt	megatonnes
Mtpa	megatonnes per annum

APPENDIX B FIGURES



CLIENT
Matakanui Gold Ltd

PROJECT
Bendigo-Ophir Gold Project

Preliminary Site Investigation

FIGURE 1
Site Location

Legend

Mining Lease Boundary
Project Area
Roads

MATAKANUI GOLD LIMITED

NOTES

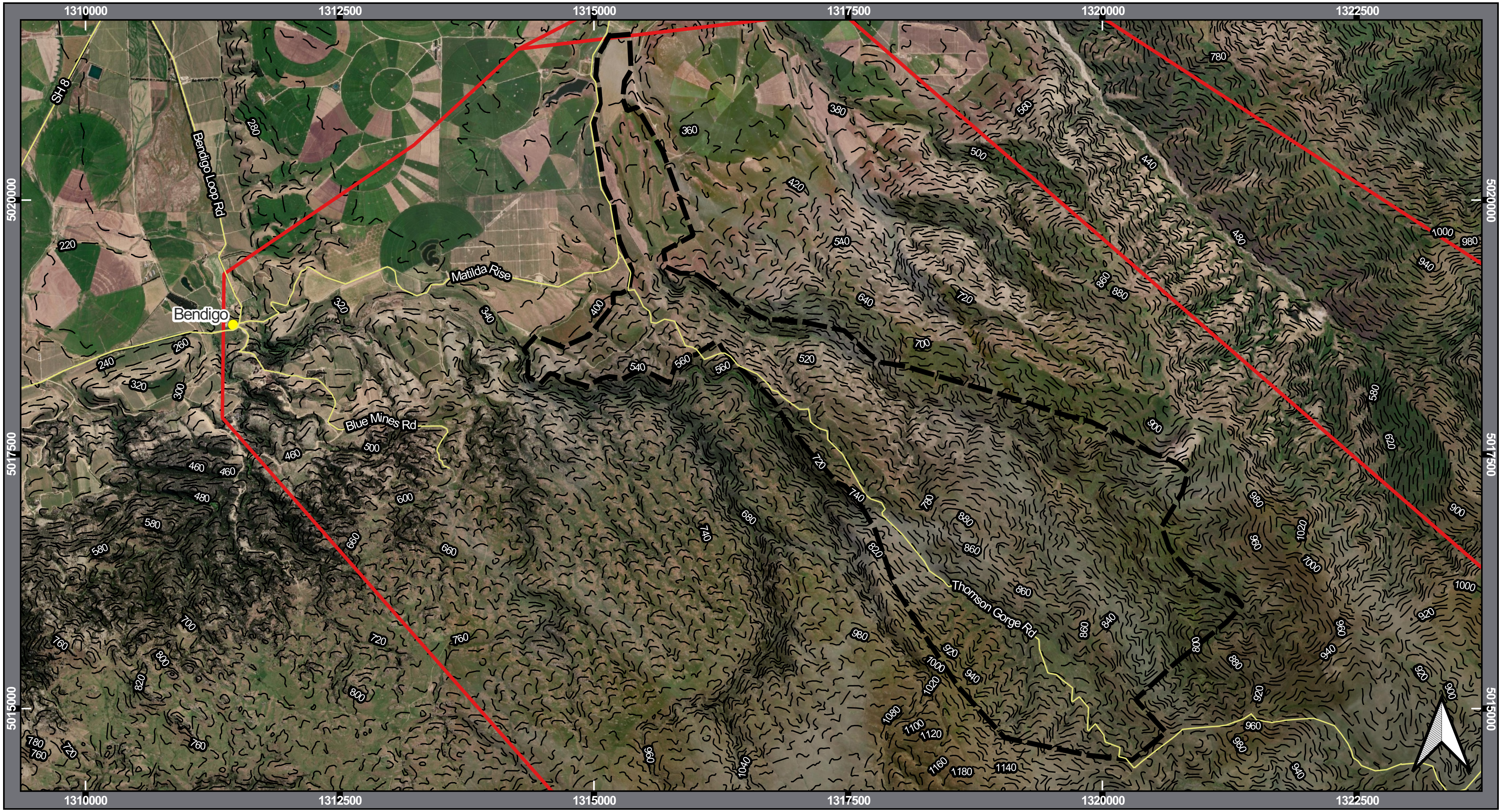
COORDINATE SYSTEM NZGD2000
AERIAL IMAGE ESRI 2024

0 2.5 5 7.5 10 km

PROJECT No.	CONTROL	REV	DATE
J-H-AU074	001 R	1	29/10/2024

PREPARED	REVIEW	APPROVED
VM	JP	JP

GEOCONTAM RISK MANAGEMENT



CLIENT
Matakanui Gold Ltd

PROJECT
Bendigo-Ophir Gold Project

Preliminary Site Investigation

FIGURE 2
Project Area

Legend

- Mining Lease Boundary
- Project Area
- Roads
- Topography

MATAKANUI GOLD LIMITED

NOTES

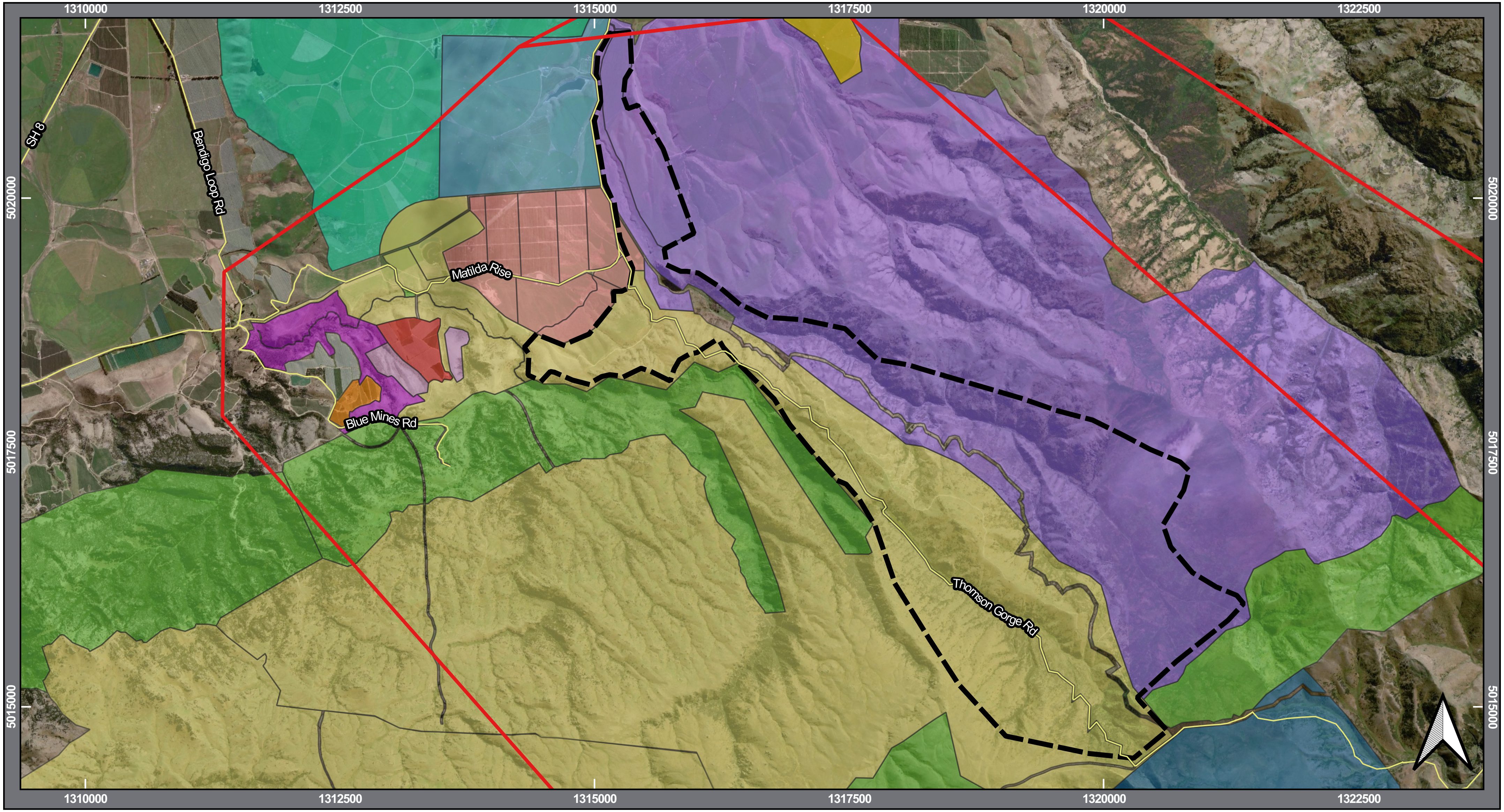
COORDINATE SYSTEM NZGD2000
AERIAL IMAGE ESRI 2024

0 1 2 km

PROJECT No.	CONTROL	REV	DATE
J-H-AU074	001 R	1	29/10/2024

PREPARED	REVIEW	APPROVED
VM	JP	JP

GEOCONTAM RISK MANAGEMENT



CLIENT
Matakanui Gold Ltd

PROJECT
Bendigo-Ophir Gold Project

Preliminary Site Investigation

FIGURE 3
Land Tenure

Legend

Mining Lease Boundary
Project Area

Land Tenure

- Bendigo Station Development Ltd
- Bendigo Station Ltd
- Bendigo Terrace Farming Pty Ltd
- Constellation Brannds NZ Ltd
- Fishtail Vineyards Ltd
- Sheperds Creek Ltd
- Tarras Farm Pty Ltd
- DOC Public Conservation Land
- Prunus Orchards Ltd
- Ardgour Station
- John Charles Perriam
- Matakanui Station Ltd

MATAKANUI
GOLD LIMITED

NOTES

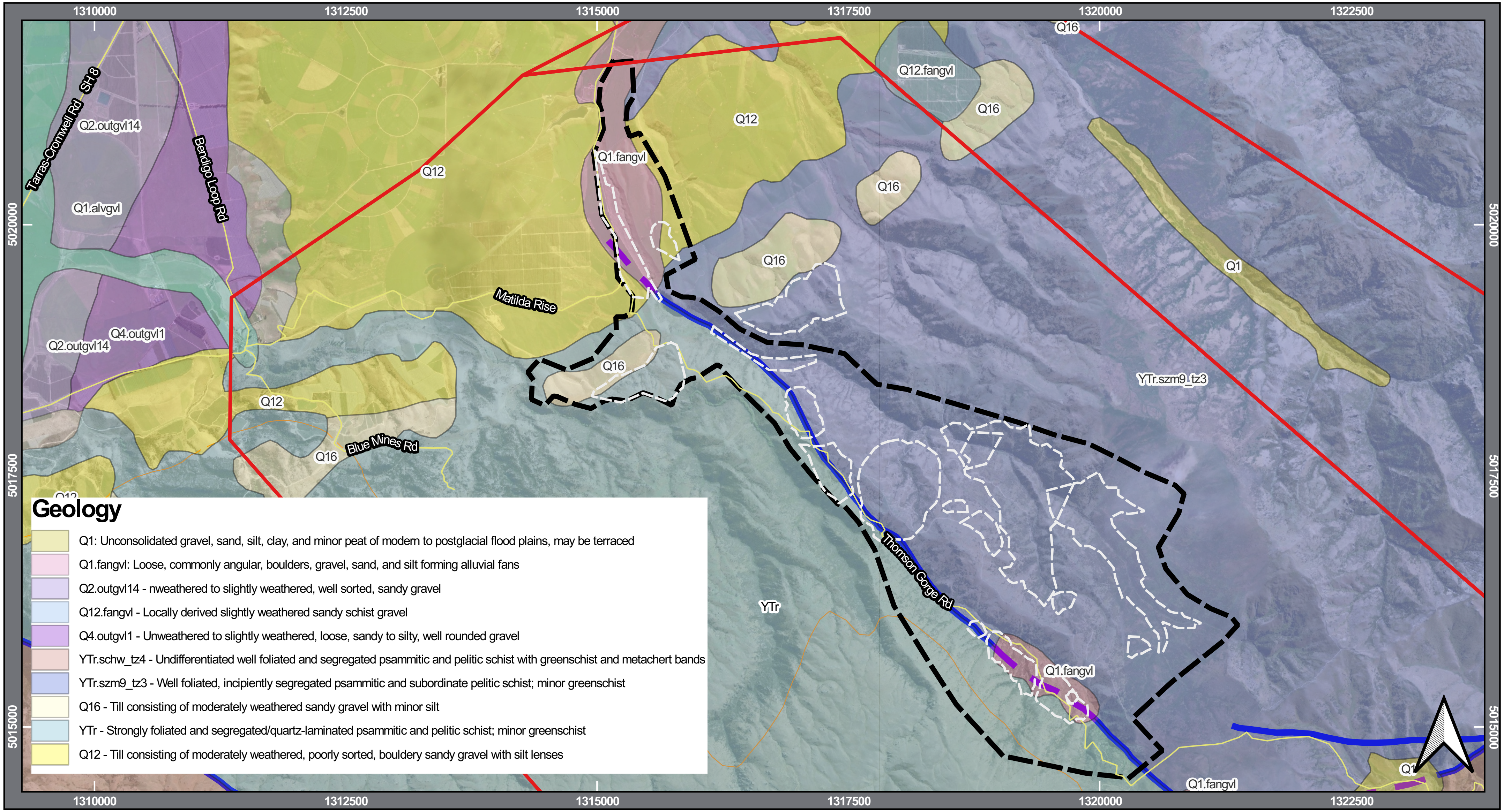
COORDINATE SYSTEM NZGD2000
AERIAL IMAGE ESRI 2024

0 1 2 km

PROJECT No.	CONTROL	REV	DATE
J-H-AU074	001 R	2	02/02/2025

PREPARED	REVIEW	APPROVED
VM	JP	JP

GEOCONTAM RISK MANAGEMENT



CLIENT
Matakanui Gold Ltd

PROJECT
Bendigo-Ophir Gold Project

Preliminary Site Investigation

FIGURE 4
Regional Geology

Legend

- Mining Lease Boundary
- Project Area
- Roads
- Proposed Development
- Inactive fold, exposed
- Inactive fault (accurately located)
- Inactive fault/thrust (approximately located)

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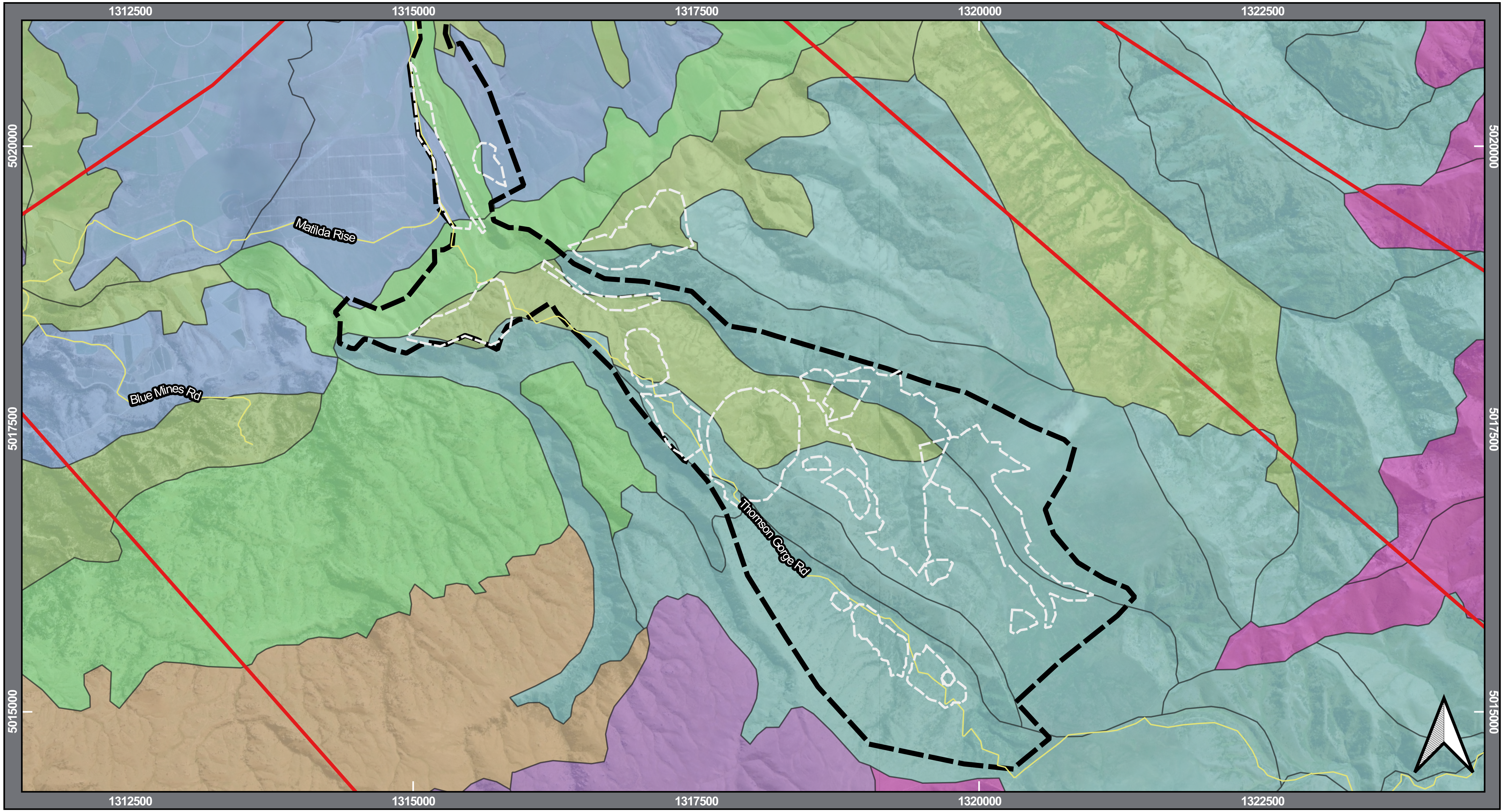
NOTES

COORDINATE SYSTEM NZGD2000
AERIAL IMAGE ESRI 2024

PROJECT No.	CONTROL	REV	DATE
J-H-AU074	001 R	2	09/05/2025

PREPARED	REVIEW	APPROVED
VM	JP	JP

GEOCONTAM RISK MANAGEMENT



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PROJECT
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Preliminary Site Investigation

FIGURE 5
Regional Soil Classification

Legend

- Mining Lease Boundary
- Project Area
- Proposed Development

Soil Classification

- BA - Acid Brown
- BO - Orthic Brown
- PI - Immature Pallic
- PJ - Argillic Pallic
- SA - Aged Semiarid
- SI - Immature Semiarid
- SJ - Argillic Semiarid

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NOTES

COORDINATE SYSTEM NZGD2000
AERIAL IMAGE ESRI 2024

0 1 2 km

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PREPARED	REVIEW	APPROVED
VM	JP	JP

GEOCONTAM RISK MANAGEMENT

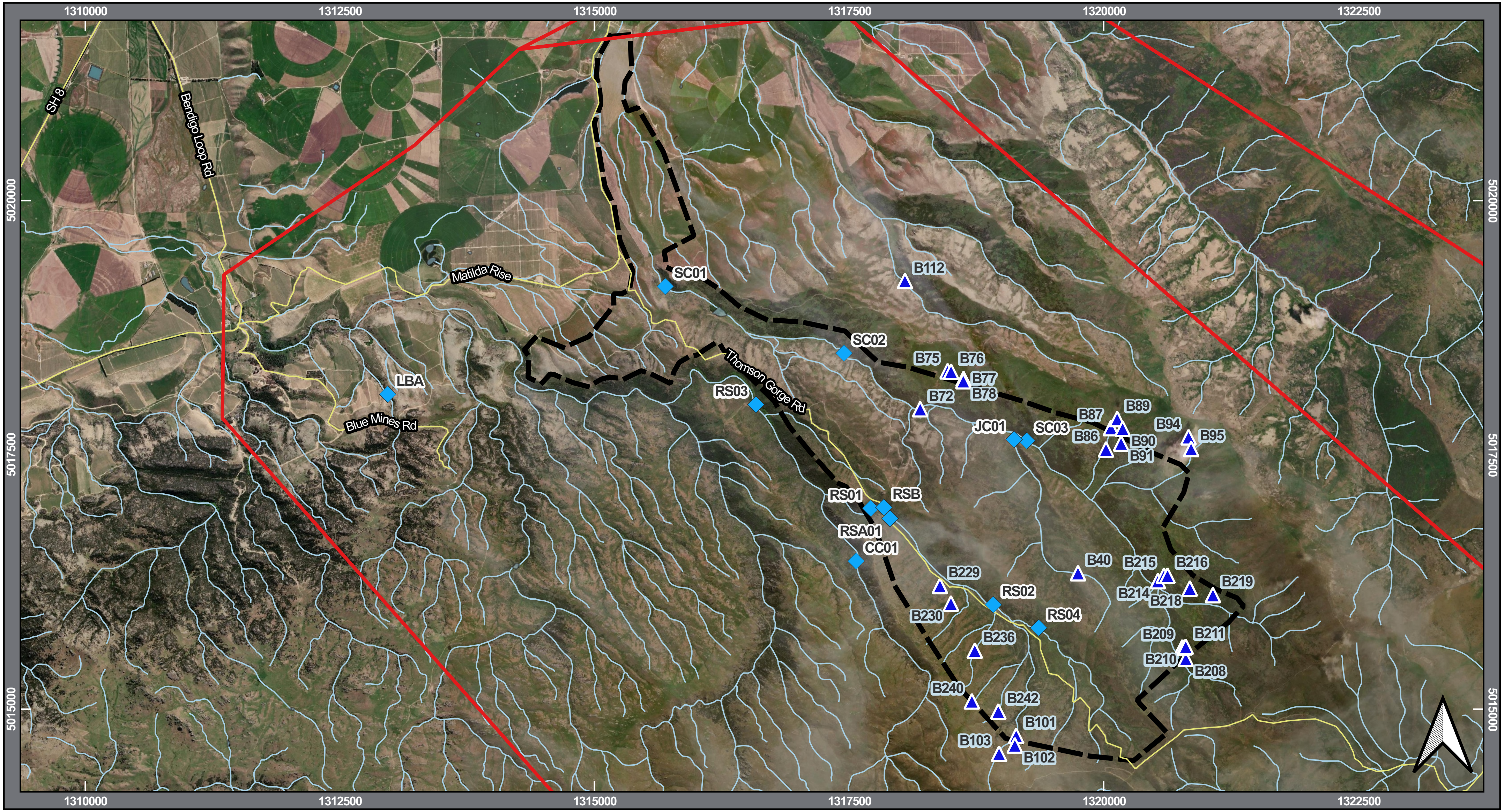

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FIGURE 6
Surface Water

Legend

- Mining Lease Boundary
- Project Area
- Roads
- Hydrology
- Water Monitoring Sites
- Bendigo Spring Locations

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COORDINATE SYSTEM NZGD2000
AERIAL IMAGE ESRI 2024

0 1 2 km

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VM	JP	JP	

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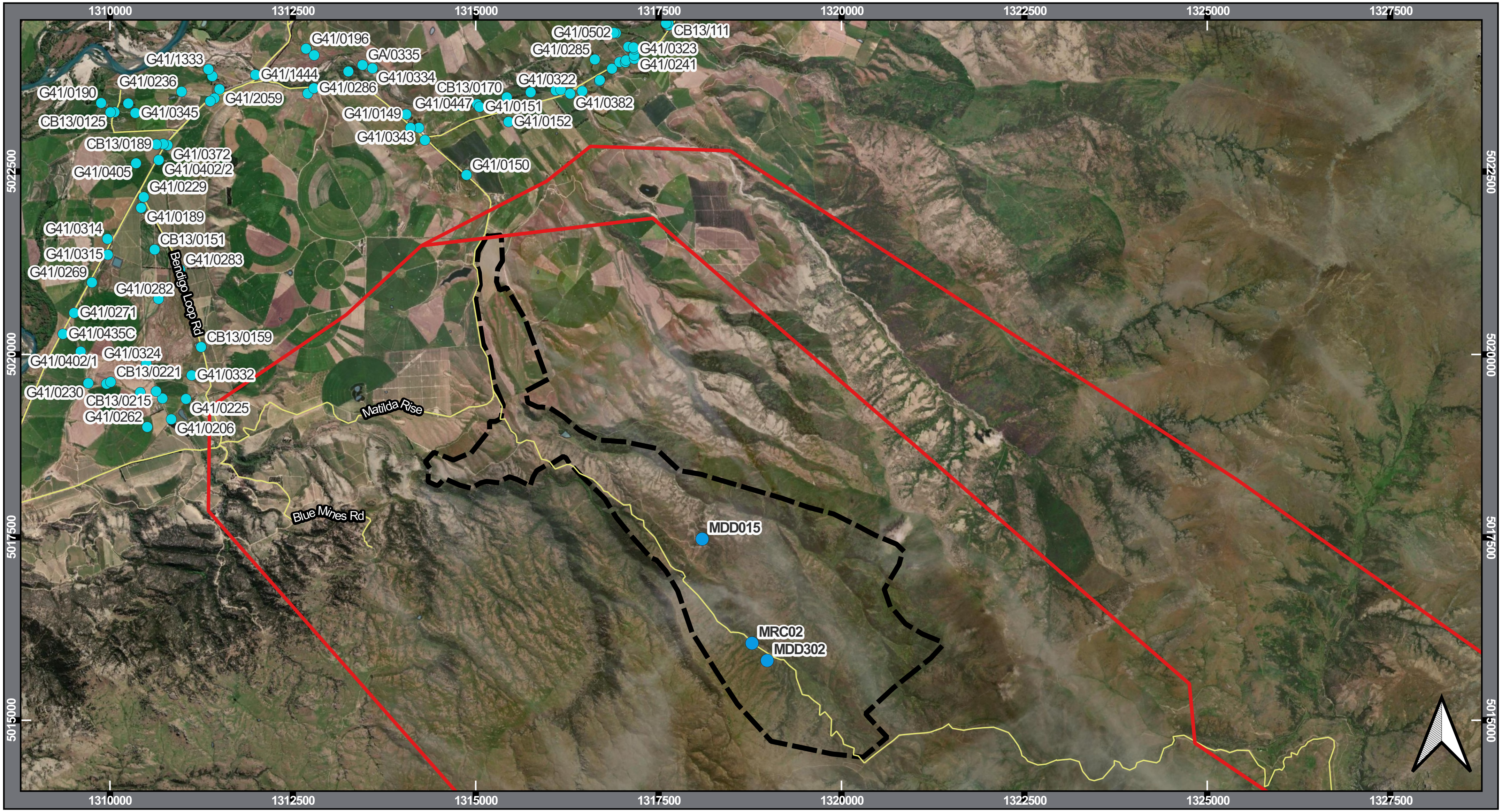

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FIGURE 7
Groundwater Use

Legend

- Mining Lease Boundary
- Project Area
- Roads
- Registered Groundwater Wells
- Groundwater Monitoring Sites

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COORDINATE SYSTEM NZGD2000
AERIAL IMAGE ESRI 2024

0 1 2 3 km

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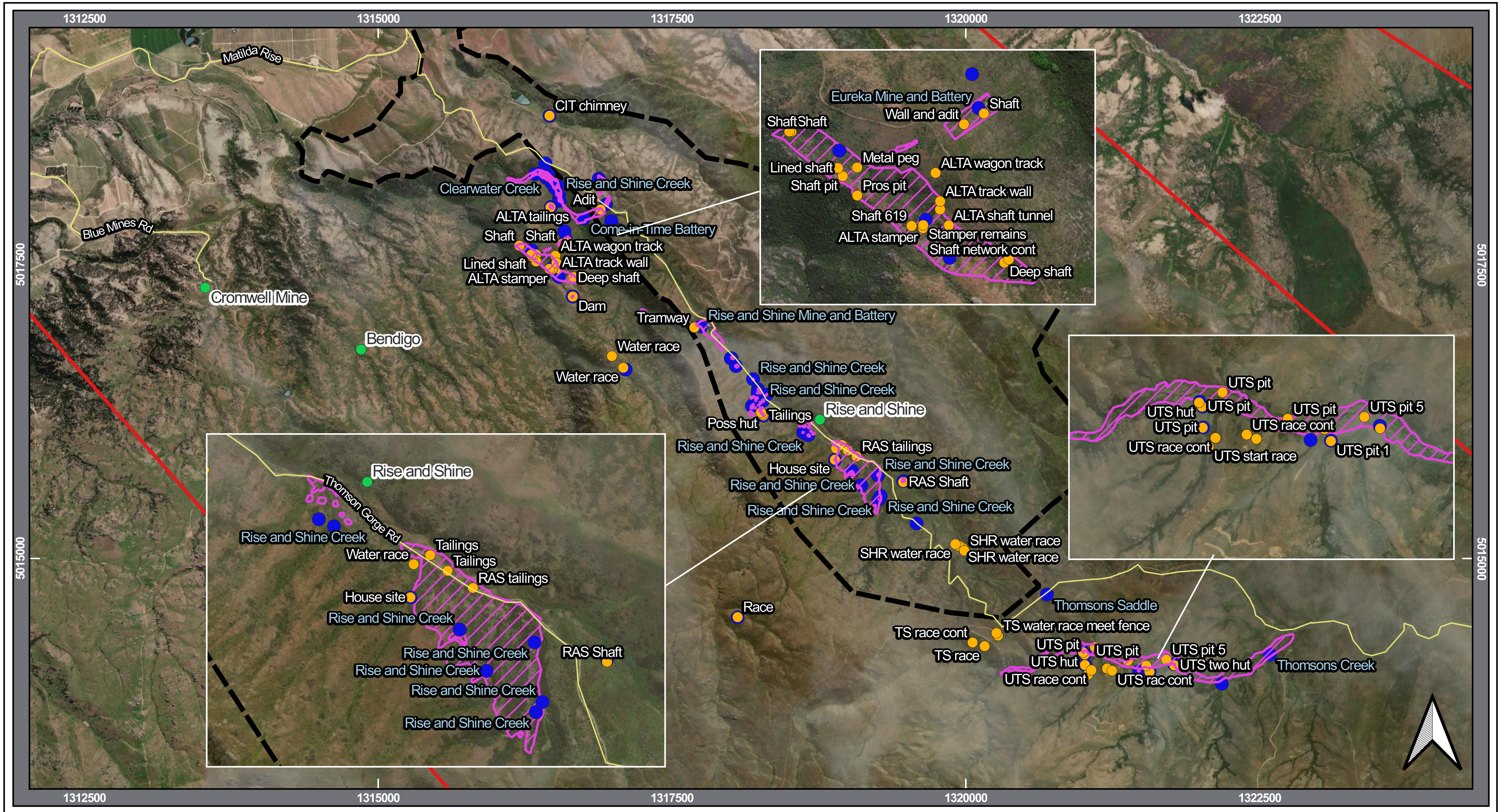

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FIGURE 8
Heritage Features

Legend

- Mining Lease Boundary
- Project Area
- Roads
- Historical mine workings
- Abandonned Mines
- Archaeological Survey Point
- Archsites

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0 1 2 km

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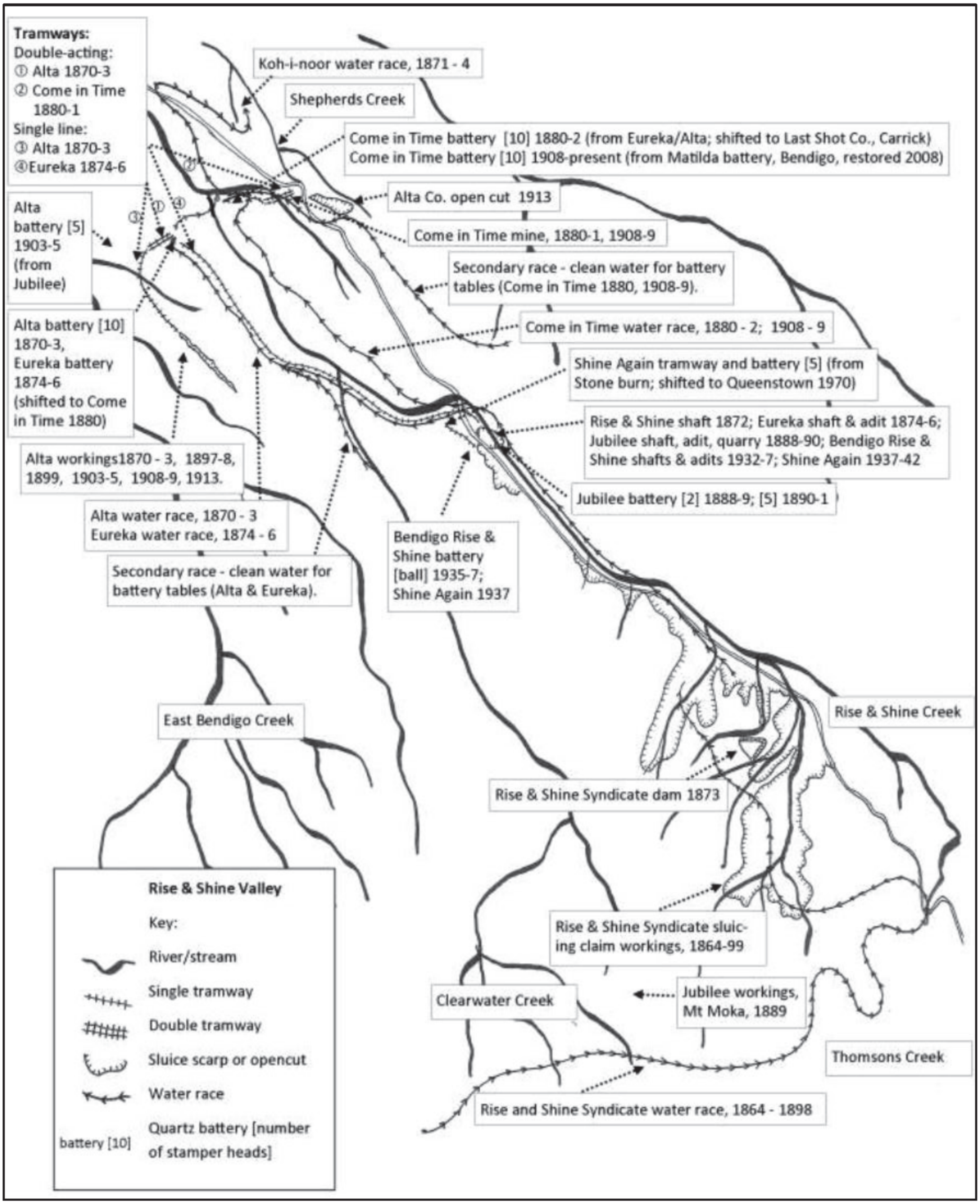
AERIAL IMAGE ESRI 2024



CLIENT Matakanui Gold Ltd		MATAKANUI GOLD LIMITED
PROJECT Bendigo-Ophir Gold Project **Preliminary Site Investigation**		Not to Scale
		PROJECT No. J-G-NZ0005-R-001 / CONTROL REV 1 / DATE 28/10/2024
		PREPARED VM / REVIEW JP / APPROVED JP
FIGURE 9 **Historic Mining Activities**	SOURCE Carpenter, L. 2013.*Specimens liberally studded with gold: the mining history of a remote Otago Valley.*	GEOCONTAM RISK MANAGEMENT

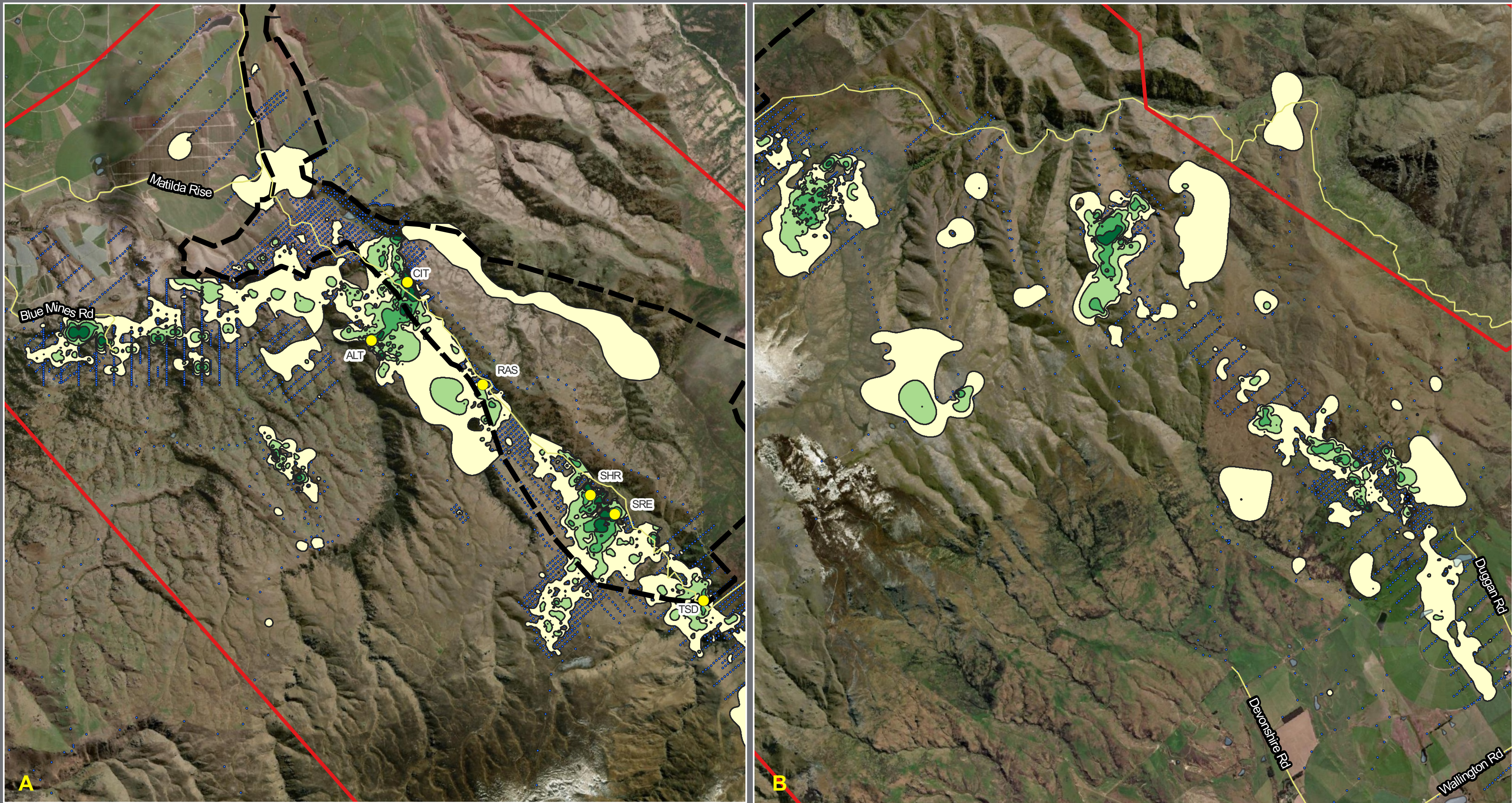


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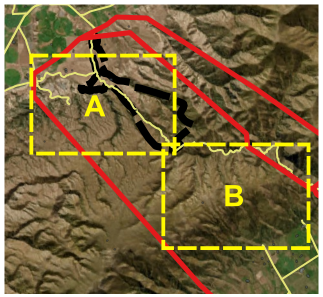
FIGURE 10
Soil Arsenic Concentrations

Legend

- Mining Lease Boundary
- Project Area
- Proposed Development
- Soil XRF Locations
- Gold deposit exploration areas

Soil arsenic concentrations (ppm)

- 20-50
- 50-150
- 150-500
- >500



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COORDINATE SYSTEM NZGD2000
AERIAL IMAGE ESRI 2024

0 1 2 km

PROJECT No.	CONTROL	REV	DATE
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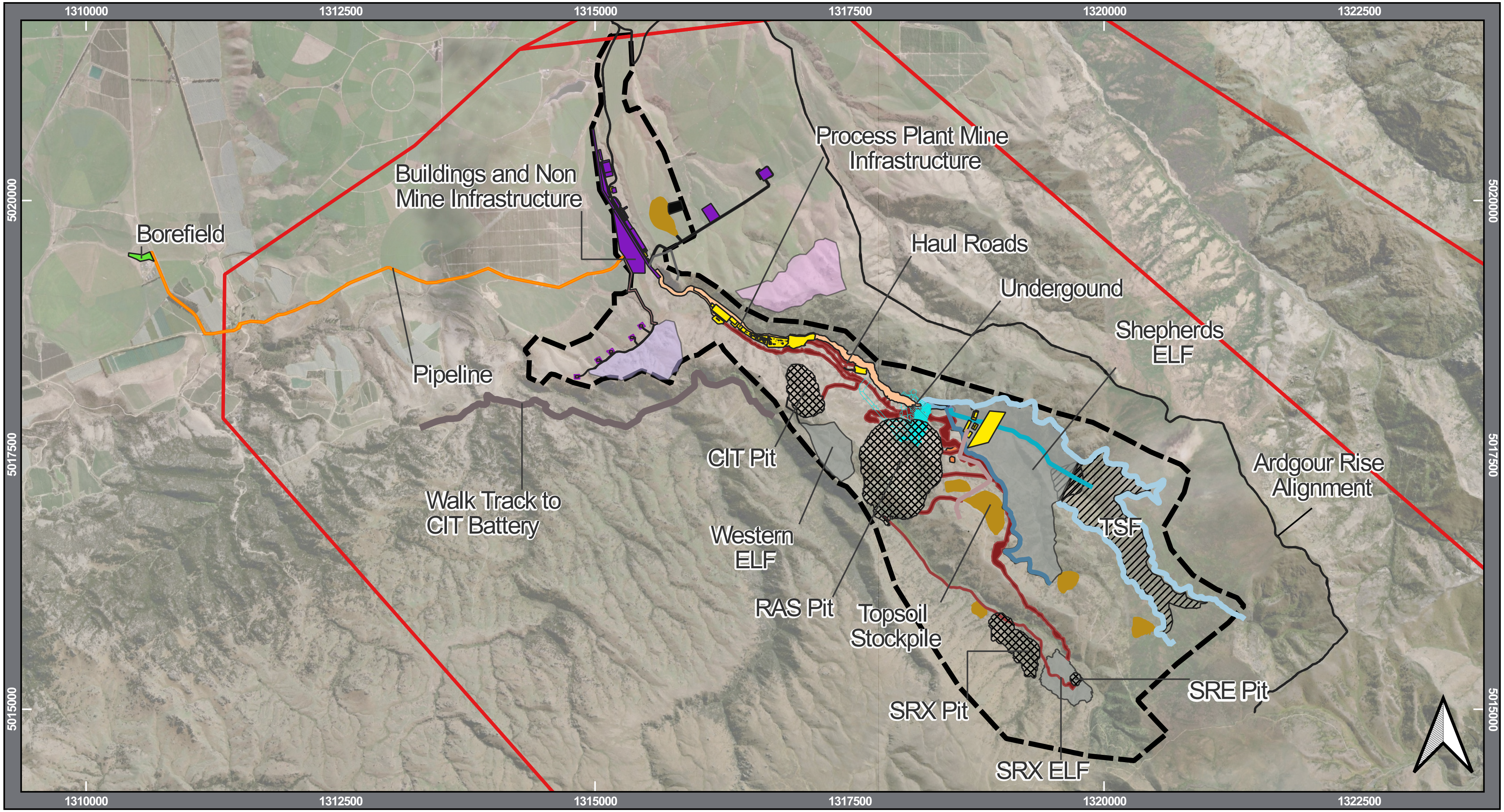

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FIGURE 11
Proposed Site Development

Legend

- Mining Lease Boundary
- Project Area
- Mining Pits
- ELF
- TSF
- Underground
- Bendigo Pest Exclusion Area
- Ardgour Pest Exclusion Area
- Topsoil Stockpile
- Haul Roads
- Process Plant Mine Infrastructure
- Quarry
- Borefield
- Buildings and Non Mine Infrastruc
- Clean Water Diversion Channel
- Dirty Water Diversion Channel
- Seepage Collection Pipe

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COORDINATE SYSTEM NZGD2000
AERIAL IMAGE ESRI 2024

0 1 2 km

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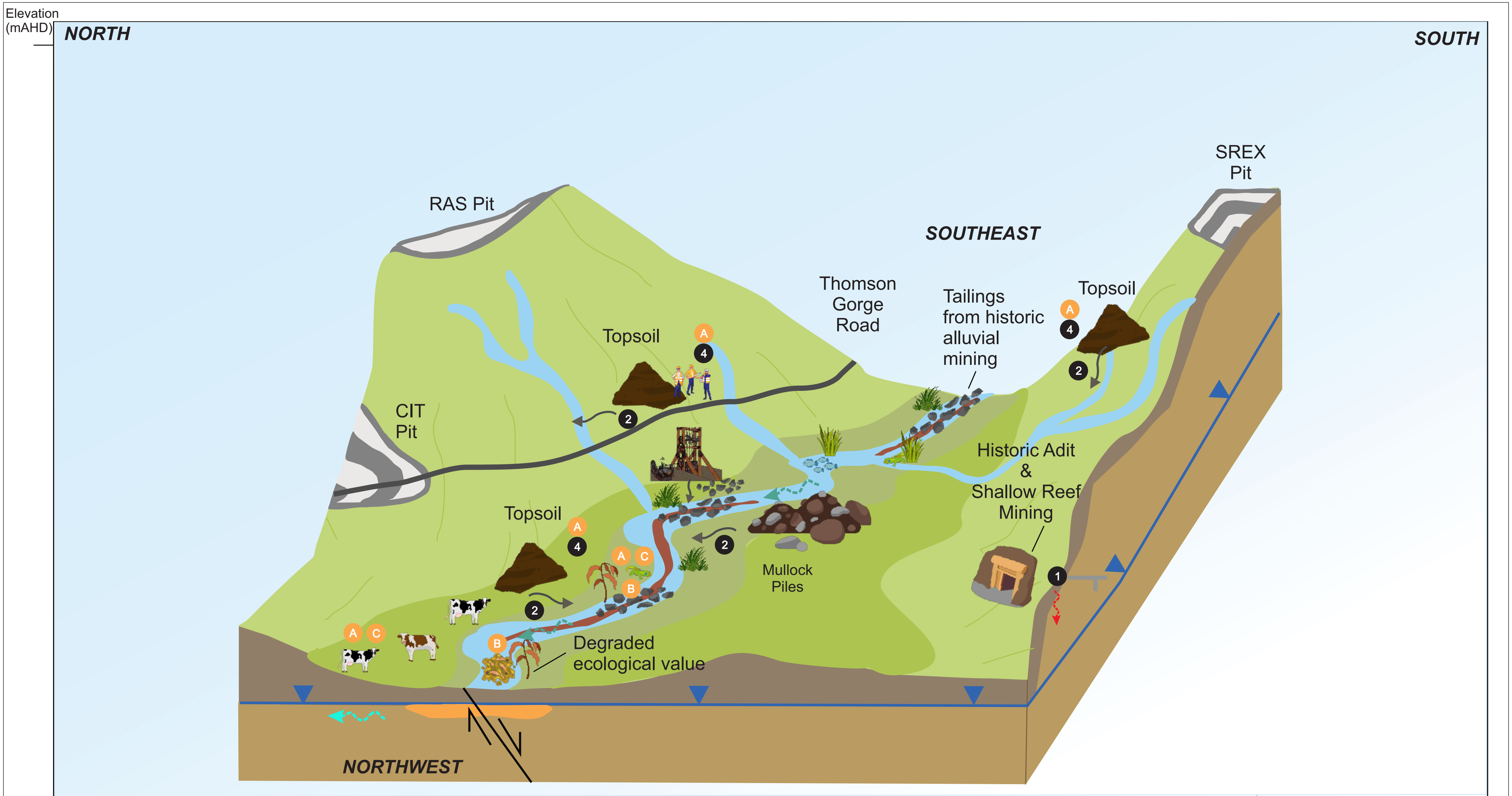
VM	JP	JP

GEOCONTAM RISK MANAGEMENT



CLIENT	Matakanui Gold Ltd
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	Preliminary Site Investigation
FIGURE 12	**CSM Rise and Shine Valley**

Legend

Geology

- Schist
- Alluvial and weathered rocks
- Groundwater Table
- Leachate from tailings
- AMD Leachate

Release Mechanism

1. Oxidation of sulfide minerals
2. Discharge of chemicals
3. Infiltration/leaching of discharge
4. Airborne Particulates

Migration Pathways

- Toe Seepage or vertical migration to groundwater
- Overflow/runoff
- Lateral Migration of dissolved contaminants via groundwater flow
- Downstream migration

Exposure Route

- A Inhalation
- B Biotic Uptake
- C Ingestion

Not to Scale

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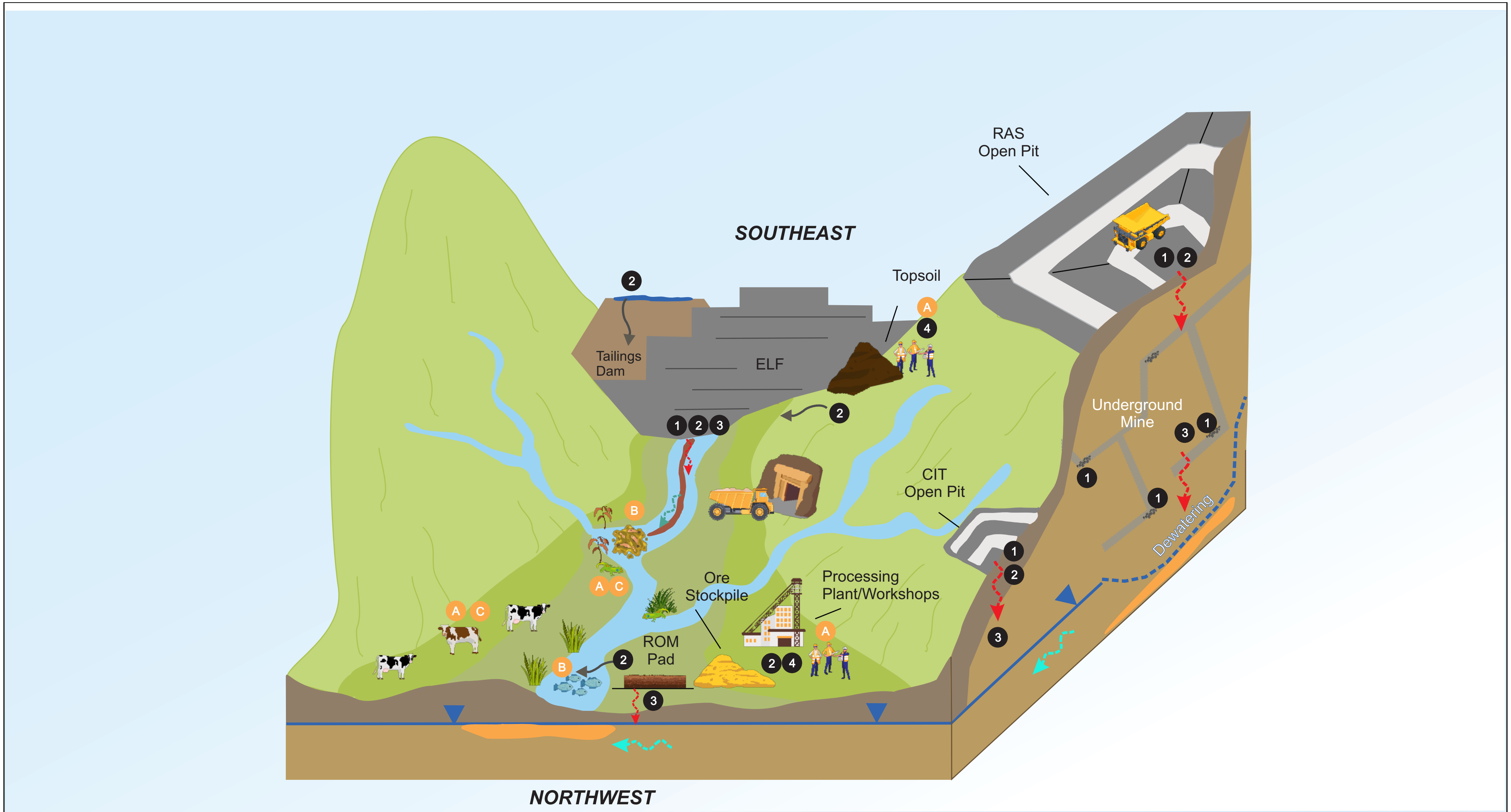

CLIENT	Matakanui Gold Ltd
PROJECT	Bendigo-Ophir Gold Project
	Preliminary Site Investigation
FIGURE 13	**CSM Shepherds Creek Valley**

Legend

Geology

- Schist
- Alluvial and weathered rocks
- Groundwater Table
- Leachate from tailings
- AMD Leachate

Release Mechanism

1. Oxidation of sulfide minerals
2. Discharge of chemicals
3. Infiltration/leaching of discharge
4. Airborne Particulates

Migration Pathways

- Toe Seepage or vertical migration to groundwater
- Overflow/runoff
- Lateral Migration of dissolved contaminants via groundwater flow
- Downstream migration

Exposure Route

- A Inhalation
- B Biotic Uptake
- C Ingestion

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PREPARED	REVIEW	APPROVED
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APPENDIX C SITE PHOTOS

Photo C1: Historic Bendigo sluicing area, offsite (looking east).

Photo C2: CIT historic battery (view from back).

Photo C3: CIT historic battery and water wheel.

Photo C4: CIT historic adit entry.

Photo C5: CIT former pit floor and adit (looking north towards Shepherds Creek).

Photo C6: RAS former battery area and farmer's dam.


Photo C7: RAS mullock pile.


Photo C8: Example of potential ore-bearing rock at RAS mullock pile.


Photo C9: RAS historic pit and adit (in gully)


Photo C10: Historic RAS battery location


Photo C11: Tailings washing area below former RAS battery.


Photo C12: Shreks historic tailings in low-lying creek bed.


Photo C13: Shreks historic sluicing face.


Photo C14: Washing residue in Shreks sluicing area.


Photo C15: Shreks historic water storage dam.


Photo C16: Rock wall above Shreks historic water dam.


Photo C17: Tailings in low-lying areas below Shreks sluicing area.


Figure C18: BOGP processing plant proposed to be constructed in valley (looking northeast, left side of photo)


Photo C19: Photo from on top of RAS deposit looking towards Shepherds Creek.


Photo C20: RAS pit area – hill crest and green valley(looking northwest)


Photo C21: View of valley that will contain the ELF (looking southeast).


Photo C22: Jeans Creek and DOC land beyond (looking southeast).


Photo C23: Schist outcrop on ridge peak at SE end of proposed mine development area.


Photo C24: View of Jeans Creek valley, northwest extent (looking north).

APPENDIX D LIMITATIONS

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