



TRANSITIONAL PROGRESSIVE REHABILITATION AND CLOSURE PLAN

ALICE RIVER GOLD PROJECT

PREPARED FOR
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Cover Page

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Table of Contents

1	Introduction	1
2	Scope and objective	2
3	Project planning	3
3.1	Project location and description	3
3.1.1	Mining tenements	3
3.1.2	Project and ownership history	5
3.1.3	Current operations and site layout	6
3.2	Existing rehabilitation	9
3.3	Baseline information	11
3.3.1	Climate	11
3.3.2	Geological setting	12
3.3.3	Topography	18
3.3.4	Surface hydrology	19
3.3.5	Groundwater	23
3.3.6	Land tenure and land use	26
3.3.7	Soil types and properties	27
3.3.8	Flora	27
3.3.9	Fauna	30
4	Community consultation	33
4.1	Previous engagement activities	33
4.2	Stakeholder engagement plan	33
4.2.1	Key objectives	34
4.2.2	Stakeholder groups	34
4.2.3	Engagement methods	34
4.3	Engagement record keeping and reporting	35
5	Post-mining land use	37
5.1	Land outcome documents	37
5.2	Planning scheme conformance	39
5.3	Post-mining land use	39
6	Rehabilitation management methodology	42
6.1	Rehabilitation objectives	42
6.2	Rehabilitation areas	42
6.3	Rehabilitation milestones and milestone criteria	45
6.3.1	Justification for when land becomes available for rehabilitation	45

6.3.2	Rehabilitation milestones.....	46
6.3.3	Rehabilitation milestone criteria	51
6.4	General rehabilitation practice	58
6.4.1	Hydrogeology	58
6.4.2	Flooding.....	77
6.4.3	Soil material assessment	80
6.4.4	Waste characterisation	82
6.4.5	Water management	84
6.4.6	Revegetation	86
6.4.7	Final landform design.....	88
7	Risk assessment	101
7.1	Risk assessment requirements.....	101
7.2	Risk assessment process.....	101
7.3	Risk assessment schema.....	101
7.4	Risk assessment outcomes and management	104
7.5	Risk Register	105
8	Monitoring and maintenance.....	106
8.1	Analogue sites.....	106
8.2	Monitoring and maintenance program	110
8.2.1	Vegetation monitoring	117
8.2.2	Photographic monitoring	119
8.2.3	Erosion monitoring.....	119
8.2.4	Water quality monitoring.....	120
8.2.5	Soil sampling	126
8.2.6	Landform design closure	126
8.3	Monitoring Schedule	127
8.3.1	Timing and frequency.....	127
9	Record keeping	128
10	References	129

List of Appendices

Appendix A.	Reference Map and Final Site Design
Appendix B.	PRCP Schedule
Appendix C.	Rehabilitation Risk Assessment
Appendix D.	Provided technical studies
Appendix E.	Landholder Agreements
Appendix F.	Alice River Stage Plans
Appendix G.	Alice River Mine Rehabilitation Design Report

List of Figures

Figure 3-1:	Regional context and mining lease locations.....	4
Figure 3-2:	Site layout	8
Figure 3-3:	Existing rehabilitation	10
Figure 3-4:	Average monthly climate data for Alice River Gold Mine.....	12
Figure 3-5:	Regional geology for the Project (Queensland Geology Map Series, 2018)	14
Figure 3-6:	Geophysical and geochemical anomaly along shear zone across Pacgold tenements	15
Figure 3-7:	Alice River shear zone, mineralisation structures and water intersections from drilling	16
Figure 3-8:	Global abundance index (GAI) enrichment, Alice River	17
Figure 3-9:	Alice River Site elevation and terrain	19
Figure 3-10:	Local watercourses by Strahler stream order	22
Figure 3-11:	Drainage basin, hydrogeology environment, mineralisation types and BOM weather stations.....	25
Figure 3-12:	Remnant Regional Ecosystem communities at the Project site.....	29
Figure 3-13:	Freshwater Tiger Crab population in One Mile Creek (MP1/MP2) and Alice River (MP3/MP4).....	30
Figure 3-14:	Golden-shouldered Parrot nesting habitat and observed occurrences	32
Figure 5-1:	Post-mining land uses	41
Figure 6-1:	Rehabilitation areas	44
Figure 6-2:	Registered groundwater bores	59
Figure 6-3:	Analytical range estimates of inflow into pit lake	60
Figure 6-4:	Groundwater standing water levels and Alice Queen pit lake relative water levels	61
Figure 6-5:	Groundwater surface for February 2025	62
Figure 6-6:	Alice Queen pit water survey - EC and TDS.....	65
Figure 6-7:	Alice Queen pit water survey - silica and sulphate	66
Figure 6-8:	Alice Queen pit water survey - metals (where detected)	66
Figure 6-9:	Alice Queen pit water survey - organics and nutrients.....	67
Figure 6-10:	Alice Queen pit water survey - arsenic and antimony	67
Figure 6-11:	Alice Queen pit water survey - arsenic speciation	68
Figure 6-12:	Conceptual groundwater model for Alice River Mine (source: SeeBuilt Earth 2025).....	75
Figure 6-13:	Flood velocity in 0.1% AEP flood event.....	78
Figure 6-14:	Flood depth in 0.1% AEP flood event.....	79
Figure 6-15:	Soil quality parameters for soil, mine waste (waste rock and tailings).....	80
Figure 6-16:	Soil water characteristics curves (SWCC)	81
Figure 6-17:	Rengasamy soil classification for dispersion	81
Figure 6-18:	Dry Grading PSD and hydrometer results	84
Figure 6-19:	Alice Queen pit lake (July 2022)	89
Figure 6-20:	Elevation model of tailings storage facility	92
Figure 6-21:	Cross-section of infilled TSF embankment used in stability assessment	93
Figure 6-22:	Rehabilitated historical exploration areas	99
Figure 8-1:	Analogue monitoring site locations	109
Figure 8-2:	Rehabilitation Monitoring Sites	116
Figure 8-3:	Ground cover percentage sampling.....	118
Figure 8-4:	Guide to monitoring canopy cover (after Eyre et al. 2017)	119
Figure 8-5:	Proposed surface water and groundwater monitoring network	124

List of Tables

Table 3-1:	Project tenements.....	3
Table 3-2:	Surface water quality trends.....	24
Table 3-3:	Remnant regional ecosystems	28
Table 4-1:	Stakeholder engagement plan objectives.....	34
Table 4-2:	Community consultation register template.....	36
Table 5-1:	Final land use and rehabilitation approval schedule (EA Schedule F—Table 1)	37
Table 6-1:	Nominated rehabilitation areas and post-mining land use	42
Table 6-2:	Rehabilitation milestone criteria.....	52
Table 6-3:	Arsenic sources and potential connection between Alice Queen pit lake and MW07	69
Table 6-4:	Arsenic sources and potential hydraulic connection key findings	71
Table 6-5:	Groundwater risk review and risk recommendations.....	76
Table 6-6:	Anticipated rehabilitation topsoil requirements	82
Table 6-7:	Contaminant source summary.....	85
Table 6-8:	Seed mix and application rate.....	87
Table 6-9:	Alice Queen Mine Pit hydrology outcomes.....	90
Table 7-1:	Control effectiveness ranking	102
Table 7-2:	Likelihood of exposure to the hazard	102
Table 7-3:	Consequence classification descriptors	103
Table 7-4:	Risk level classification matrix.....	104
Table 7-5:	Risk assessment outcomes by rehabilitation area	104
Table 8-1:	Analogue site locations	106
Table 8-2:	PRCP AS1 ecological details.....	107
Table 8-3:	PRCP AS2 ecological details.....	108
Table 8-4:	Rehabilitation milestone monitoring and management measures	111
Table 8-5:	Rehabilitation Monitoring Sites	114
Table 8-6:	Erosion classification framework	120
Table 8-7:	Water quality limits.....	121
Table 8-8:	Water quality and stream sediment monitoring sites	125
Table 8-9:	Chemical and physical parameters for topsoil testing.....	126

Table of Abbreviations

AARC	AARC Environmental Solutions Pty Ltd
ABA	Acid base count
AEP	Annual exceedance probability
AF	Acid forming
ANC _T	Total Acid Neutralising Capacity
AQP	Adequate Qualified Person
ARSZ	Alice River Shear Zone
BHWE	Base of weathering
BOM	Bureau of Meteorology
CIP	Carbon-in-Pulp
CRS	Sulphide sulphur
CYLC	Cape York Land Council
DES	Department of Environment and Science
DESI	Department of Environment, Science and Innovation (former name of DETSI)
DM	Dry Matter
DNRME	Department of Natural Resources, Mines and Energy
DO	Dissolved Oxygen
DTM	Digital terrain modelling
EA	Environmental Authority
EC	Electrical conductivity
EP Act	<i>Environmental Protection Act 1994</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EPP	Environmental Protection Policy
ERA	Environmentally relevant activity
ERC	Estimated rehabilitation cost
ESA	Erosion Stability Assessment
ESP	Exchangeable sodium percentage
FoS	Factor of Safety
GAB	Great Artesian Basin
GAI	Global Abundance Index
INAP	International Network for Acid Prevention
IUCN	International Union for Conservation of Nature
LOD	Land outcome document
LoR	Limit of reporting
MERFP Act	Mineral and Energy Resources Act 2018
MSES	Matter of State Environmental Significance
ML	Mining Lease

NAF	Non-acid forming
NAF _{LC}	Non-Acid Forming (Low Capacity)
NATA	National Association of Testing Authorities
NUMA	Non-use management area
PAF	Potential-acid forming
PAF _{LC}	Potential-acid forming (Low Capacity)
PMLU	Post-mining land use
PRC	Progressive rehabilitation and closure
PRCP	Progressive rehabilitation and closure plan
PSD	Particle size distribution
RA	Rehabilitation area
RE	Regional ecosystem
RM	Rehabilitation milestone
ROM	Run-of-mine
SEP	Stakeholder engagement plan
SFE	Shake Flask Extraction
SILO	Scientific Information for Land Owners
SMART	Specific, Measurable, Achievable, Realistic and Timely
SMU	Soil management unit
SQP	Suitably Qualified Person
SWCC	Soil Water Characteristic Curve
TOC	Total Organic Carbon
TSF	Tailings Storage Facility
VM	<i>Vegetation Management (VM) Act 1999</i>
WEPP	Water Erosion Prediction Project
WMP	Water Management Plan
WQO	Water quality objectives
WRD	Waste Rock Dump

1 Introduction

AARC Environmental Solutions Pty Ltd (AARC) has been commissioned by Pacgold Limited (Pacgold) to develop a Progressive Rehabilitation and Closure Plan (PRCP) as per the transitional processes of the *Environmental Protection Act 1994* (EP Act) for the Alice River Gold Project (the Project).

This transitional PRCP applies to mining leases (MLs) associated with the Alice River Gold Project, namely, ML2901, ML2902, ML2907, ML2908, ML2958, ML2957, ML3010 and ML3011. The Project's environmental authority (EA) (EPML00870113) was issued on 27 July 2017 to Pacgold, the owner of the Project. The EA was updated on 10 September 2025 to ensure the PRCP and EA were aligned.

The Project is small in extent, with very low volumes of mine waste, low grade ore, and tailings, that require managing. The depth of the tailings dam is less than 2.5 m, and the geochemical properties of the mine waste are all considered to be low risk.

The EA authorises the environmentally relevant activity (ERA) of ERA 16 mining gold ore under the Environmental Protection Regulation 2008 Schedule 2A. Schedule A—Table A1 (Authorised Activities and Locations) identifies the following mine domains and mine features authorised on the MLs:

- infrastructure—plant area, roads and tracks, scrap yards, topsoil stockpiles, cleared areas;
- tailings—tailings dam;
- overburden and waste—mullock dumps and ROM pad;
- pits—mine pit; and
- exploration—exploration areas and drill holes.

Following acceptance of the submitted PRCP (C-EATPRCP-100176043), an information request was made by the then Department of Environment and Science, and on 25 January 2023, a notice was issued to Pacgold requiring a response to the information request to be submitted by 31 July 2024. An extension of the information request response date to 21 March 2025 was granted on 21 February 2025. The PRCP was updated in response to the information requested in January 2023. Following approval of the PRCP schedule (P-PRCP-100883321) on 2 February 2026 (attached as Appendix B), the plan was revised to align with agreed criteria, milestones, and timeframes. The PRCP was also revised to ensure the EA and PRCP are aligned.

2 Scope and objective

The purpose of this PRCP is to describe how progressive rehabilitation will be carried out for the resource activity. The PRCP has been developed in accordance with the requirements of the 'Progressive Rehabilitation and Closure Plan Guideline' (the Guideline; DES 2021, DESI 2024), which states that the PRCP must include the following parts:

1) Rehabilitation Planning Part:

The purpose of the rehabilitation planning part of the PRCP is to support and justify the development of the proposed PRCP schedule. This part must detail how progressive rehabilitation and closure will be carried out over the entire Project site and on a rehabilitation area and improvement area basis. The key components of the Planning Part for the Project are:

- community consultation information (refer to Section 4);
- post-mining land use (PMLU) (refer to Section 5);
- the rehabilitation and management methodology being implemented (refer to Section 6);
- a rehabilitation risk assessment (refer to Section 7); and
- a monitoring and maintenance program (refer to Section 8).

2) Rehabilitation Schedule Part:

The development and implementation of the Schedule Part is an essential element of a PRCP. Once approved, the Schedule Part becomes a legally binding and enforceable instrument with which the Project must comply. The Schedule Part must include:

- nomination of either a PMLU or NUMA for all land within the relevant resource tenures, including undisturbed land;
- identification of when land becomes available for rehabilitation or improvement;
- rehabilitation or management milestones to achieve the PMLU or NUMA outcomes;
- milestone criteria that demonstrate when each milestone has been completed;
- completion dates for each milestone to be achieved; and
- any conditions considered necessary or desirable.

The administering authority may impose a condition on a draft PRCP schedule or a PRCP schedule if it considers the condition is necessary or desirable (Section 4.2 of the Guideline). Two deemed conditions are to be included in all PRCP schedules in accordance with section 206A of the EP Act. The first condition states that when carrying out a relevant activity under the PRCP schedule, the holder must comply with a requirement stated in the EA relevant to carrying out the activity. The second condition states that the holder must comply with the following matters stated in the schedule:

- each rehabilitation milestone and management milestone, and
- when each rehabilitation milestone and management milestone is to be achieved.

3 Project planning

3.1 Project location and description

The Alice River Gold Project is a historic open-cut gold mine located approximately 140 km west northwest of Laura in the southern Cape York Peninsula area of north Queensland (Figure 3-1).

3.1.1 Mining tenements

The site is comprised of eight MLs (Table 3-1) covering approximately 60 ha, with two small historical mines (Alice Queen and Peninsula King) (Figure 3-2). Peninsula King now consists of the Peninsula King historical mining pit and the Big Blow historical mining pit, located on ML2908 and ML2902. These mine workings undertaken 120 years ago have been excluded from the activities to be rehabilitated as they precede the mining lease.

The leases lie within the boundary of Alice River Station. The Alice River Homestead is situated approximately 3 km south of the Peninsula King mining lease (ML2908).

Table 3-1: Project tenements

Tenement	Permit Name	Grant Date	Expiry Date	Area (ha)	Underlying Land Parcel
ML2901	Alice Queen	3 June 1982	29 April 2045	2.88	11 SP266613
ML2902	German Jack	29 April 1982	30 April 2045	2.88	
ML2907	Eureka	3 June 1982	30 April 2045	2.05	
ML2908	Peninsula King	3 June 1982	30 April 2045	4.03	
ML2957	Julie Ann	7 March 1985	31 March 2027	1.60	
ML2958	Alice	10 April 1986	30 April 2045	11.43	
ML3010	One Mile	25 January 1990	30 April 2045	29.52	
ML3011	Airstrip Block	1 October 1987	30 April 2045	4.40	

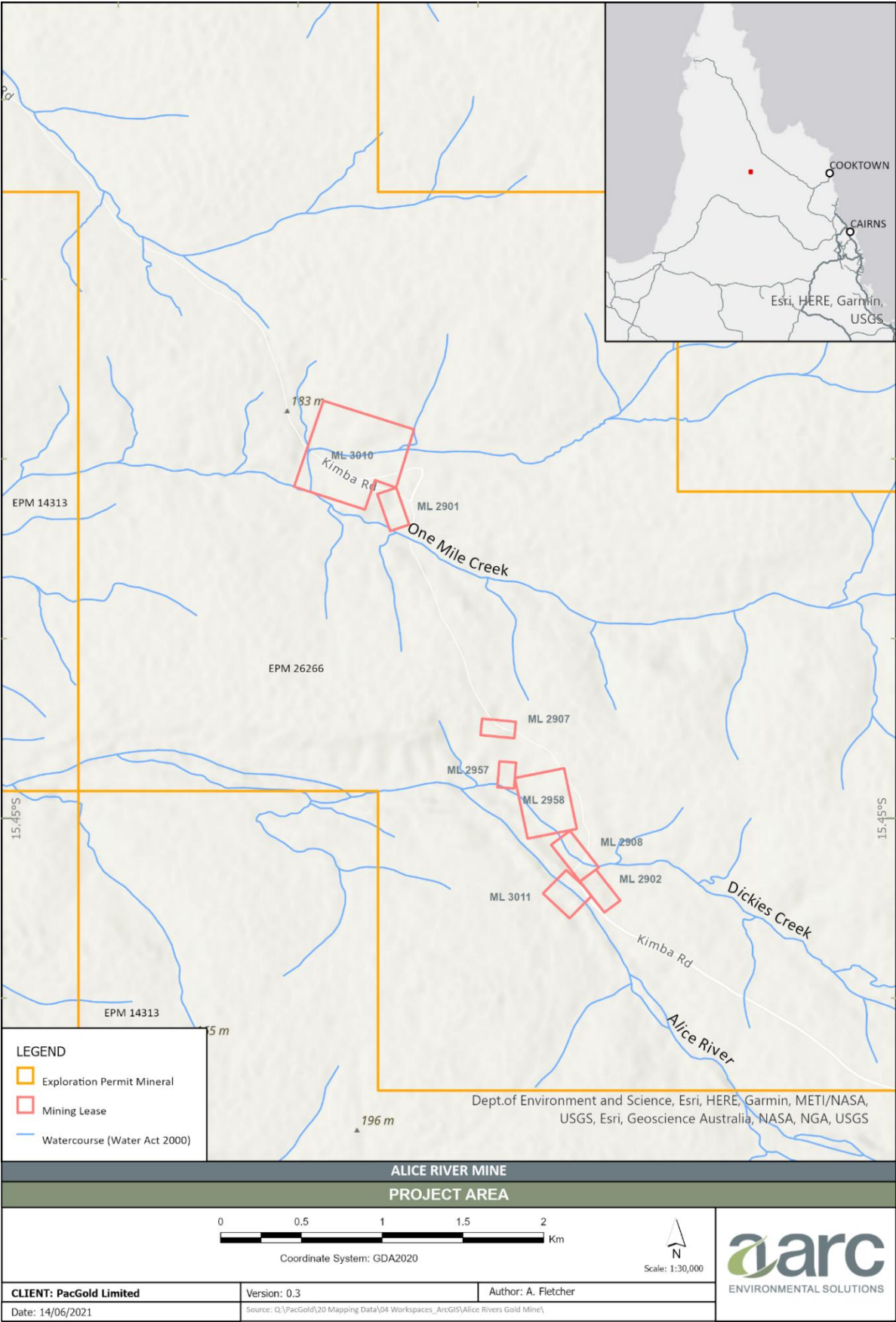


Figure 3-1: Regional context and mining lease locations

3.1.2 Project and ownership history

Alice River Station, formerly Imooya Station, was originally designated and surveyed as a gold mining area and has a long history of prospecting, mining and exploration work. Gold was initially discovered at Alice River by John Dickie in 1903. Remnants of this early small-scale mining work includes a boiler and stamper battery remaining on the leases.

During the 1980s and 1990s exploration was undertaken by several entities:

- Cyprus Gold Australia;
- Beckstar Pty Ltd (Beckstar); and
- Goldminco.

During the late 1990s Beckstar developed a small open-cut mine as well as associated infrastructure that included a Carbon-in-Pulp (CIP) processing plant, waste rock dumps, tailings dam and a camp. The company mined and stockpiled approximately 6,000 tonnes of ore from the Alice Queen deposit prior to going into receivership in 2000. The main open-cut pit (Alice Queen Mine Pit) was created during this period.

The quantity of ore that was processed in the small plant remaining on site is unknown, however, the total amount of ore processed is thought to be less than 80,000 t. The residue of the processed ore is now held in the tailings dam located on the One Mile lease (ML3010) (see Figure 3-2).

The Alice River Gold Project was purchased by Tinpitch in 2001. Tinpitch carried out minor exploration work and sampling over several of the leases, and also undertook trial mining and processing.

Between 2001 to 2005 further investment to the mine infrastructure occurred, including an upgrade to the camp. However, no mining of ore occurred during this time. In 2012, Tinpitch went into administration; the Alice River ML were purchased from the administrators in 2013 by a new Joint Venture partner, Admiral Gold, to undertake exploration and resource evaluation work.

In 2017, an EA amendment was approved which authorised continued exploration activities on the Alice River ML.

During October 2017 Spitfire Materials (a Joint Venture Partner) conducted a reverse circulation drilling program around the western perimeter of the Alice Queen Mine Pit on ML2901 and ML3010. The drilling program consisted of 14 holes for a total of 2,397 m of drilling.

In 2018, exploration activities ceased while an Exploration Agreement was negotiated with the Olkola Aboriginal Corporation for the MLs and the Exploration Permit held by Tinpitch. Since 2018, works within the ML have been limited to care and maintenance, exploration, and environmental monitoring and sampling.

In February 2021, Pacgold acquired the eight MLs that comprise the Project area.

3.1.3 Current operations and site layout

Following the introduction of the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act), the Project undertook the first Estimated Rehabilitation Cost (ERC) application in January 2022 under Queensland's new financial provisioning scheme. The current ERC is valid for 5 years from 19 March 2022 to 19 March 2027 (inclusive). The activities undertaken on site during the current ERC period predominantly comprise exploration and environmental monitoring activities.

The following EP Act Schedule 3 Notifiable Activities are deemed likely to have been conducted at the Project site:

- Item 7—Chemical storage (other than petroleum products or oil under item 29)—storing more than 10 tonnes (t) of chemicals (other than compressed or liquefied gases) that are dangerous goods under the dangerous goods code;
- Item 20—Landfill—disposing of waste (excluding inert construction and demolition waste);
- Item 24—Mine wastes:
 - a) storing hazardous mine or exploration wastes, including, for example, tailings dams, overburden or waste rock dumps containing hazardous contaminants; or
 - b) exploring for, or mining or processing, minerals in a way that exposes faces, or releases groundwater, containing hazardous contaminants.
- Item 29—Petroleum product or oil storage—storing petroleum products or oil:
 - a) in underground tanks with more than 200 litre (L) capacity; or
 - b) in above ground tanks with:
 - i) for petroleum products or oil in class 3 in packaging groups 1 and 2 of the dangerous goods code—more than 2,500 L capacity; or
 - ii) for petroleum products or oil in class 3 in packaging groups 3 of the dangerous goods code—more than 5,000 L capacity; or
 - iii) for petroleum products that are combustible liquids in class C1 or C2 in Australian Standard AS 1940, 'The storage and handling of flammable and combustible liquids' published by Standards Australia—more than 25,000 L capacity.

3.1.3.1 Current infrastructure, mining operations, and land disturbances

Since acquiring the Project, in addition to undertaking necessary environmental monitoring and sampling activities, Pacgold has commenced an exploration program to better understand and optimise the available gold resource at the site.

The exploration program applies contemporary exploration methods, including geophysical analysis, to identify and evaluate the potential resource on site. The program has identified a high-grade discovery within the central target area (adjacent to the existing Alice Queen Mine Pit) with intersections between 6 m and 200 m in depth. The drilling success has created an excellent platform to build a substantial resource base.

For three to five years from 2023, the exploration program is expected to focus on improved resource definition, including infill drilling to support future detailed mine planning work.

As outlined in section 3.1.2, previous mining activities have been undertaken on the ML. The key mine disturbance areas and infrastructure are described in the following sections and shown in Figure 3-2.

Tailings dam

The existing 'turkey's nest' style tailings dam (dimensions approximately 150 m x 210 m) was designed and used for storage of tailings from past processing activities. A single spigot pipe was moved frequently around the perimeter of the walls to ensure the formation of a beach, with fines segregating to the middle of the dam.

The tailings dam walls have now been colonised by local grass and shrub species. The tailings sediment has been colonised naturally by local tree species, such as *Melaleuca spp.* and *Acacia spp.* on approximately 50% of the tailings surface.

Run-of-mine Pad and waste rock dumps

A stockpile of oxide ore material (approximately 6,000 t) and another of sulphide material (approximately 6,000 t) is located on the Run-of-mine (ROM) pad. There is no visual sign of acid or contaminated leachate from these stockpiles. The sulphides are incorporated in siliceous veins within the rock. The ROM pad footprint is inside the ML boundary. The temporary waste rock dump is partially outside the ML. This PRCP and the schedule are only applicable to the portion in the ML.

Alice Queen Mine Pit

A small gold mine pit was developed during the 1990s, the development of which created the existing Alice Queen Mine Pit. The pit is shallow in depth (approximately 40 m) and is 520 m in circumference. The mine pit is accessible by stock, and pit water currently meets Australian and New Zealand Environment Conservation Council 2000 (ANZECC) Livestock Drinking Water Guidelines values.

Mullock dumps

There are some small waste rock dumps present in the vicinity of the Alice Queen Mine Pit and plant area. These waste dumps contain fragments of the granite host rock, with no visual evidence of acid rock drainage.

Plant area

The two-story cyanide processing plants, with a 60,000 tpa capacity, incorporates two ball mills, cyanide storage tank, CIP tanks, bulk diesel fuel storage, concrete slabs, workshop, and office. These are located in the infrastructure area.

Ancillary infrastructure

Support infrastructure for the mining activities includes tracks, concrete pads, fuel and water tanks.

Other historical Exploration areas and Mining Pits/Costeans

There are several small historical exploration areas and historical mining pits/costeans/stockpiles ranging in area from 0.4 ha to 5.8 ha located on the southern mining leases (M2908/ML2958/ML2902/ML3010), which precede the mining lease and are excluded from this plan.

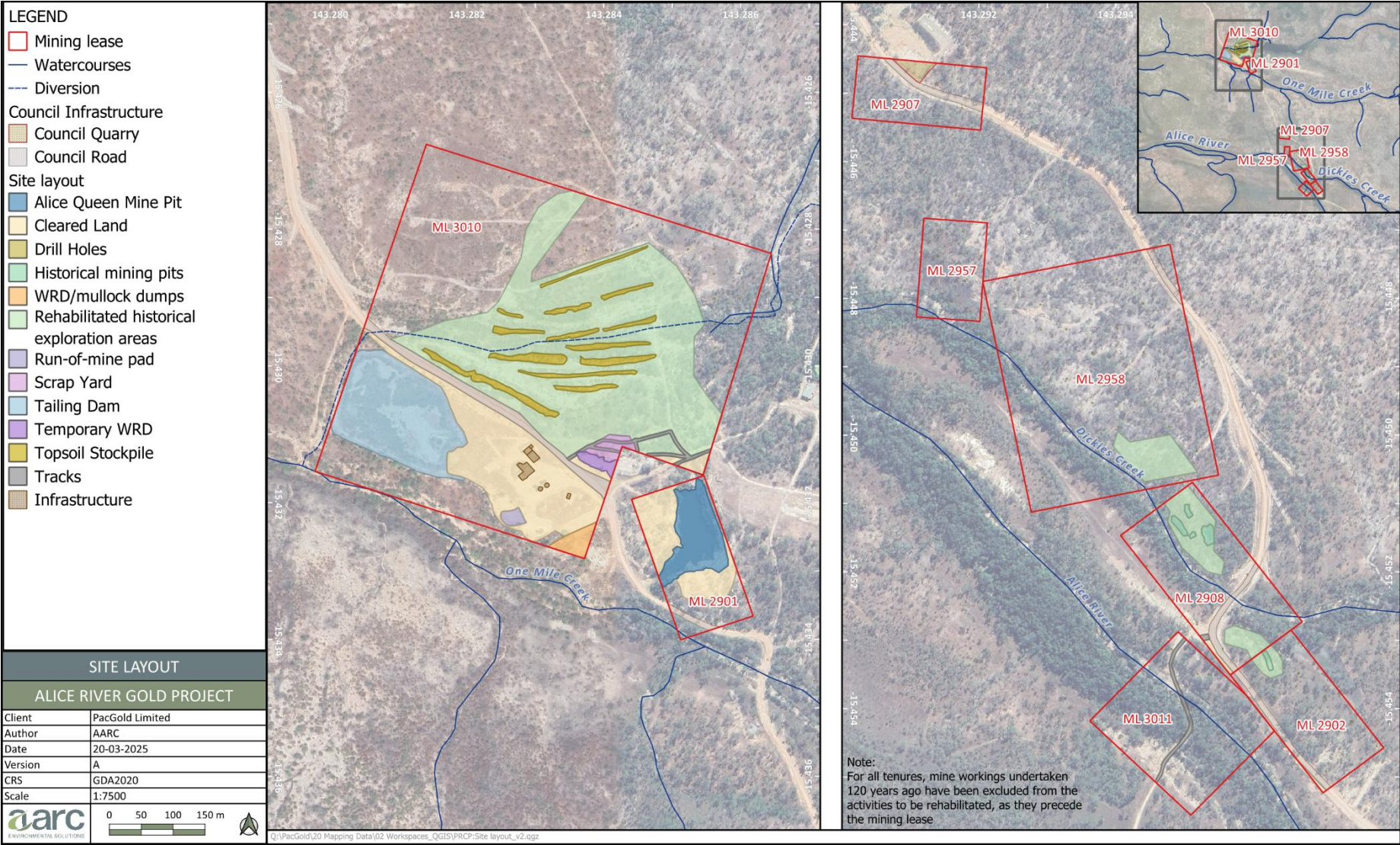


Figure 3-2: Site layout

3.2 Existing rehabilitation

Historic rehabilitation has occurred in areas that were previously cleared and where extensive exploration activities were conducted under previous owners, with 11.5 ha of rehabilitation mapped across the Project area (Figure 3-3). These areas have been undergoing natural rehabilitation for 20 years. Based on the findings of the progressive rehabilitation monitoring of these areas, undertaken in May 2021 (AARC 2021a; Appendix D), the rehabilitation is progressing towards achieving the stated rehabilitation completion criteria, as described in the Rehabilitation Design Report (AARC 2019; Appendix G) submitted to the Department in 2019 (Section 5.1). However, it is anticipated that further rehabilitation work, such as infill planting, may be required to reach target pasture productivity and erosion rates for these areas.

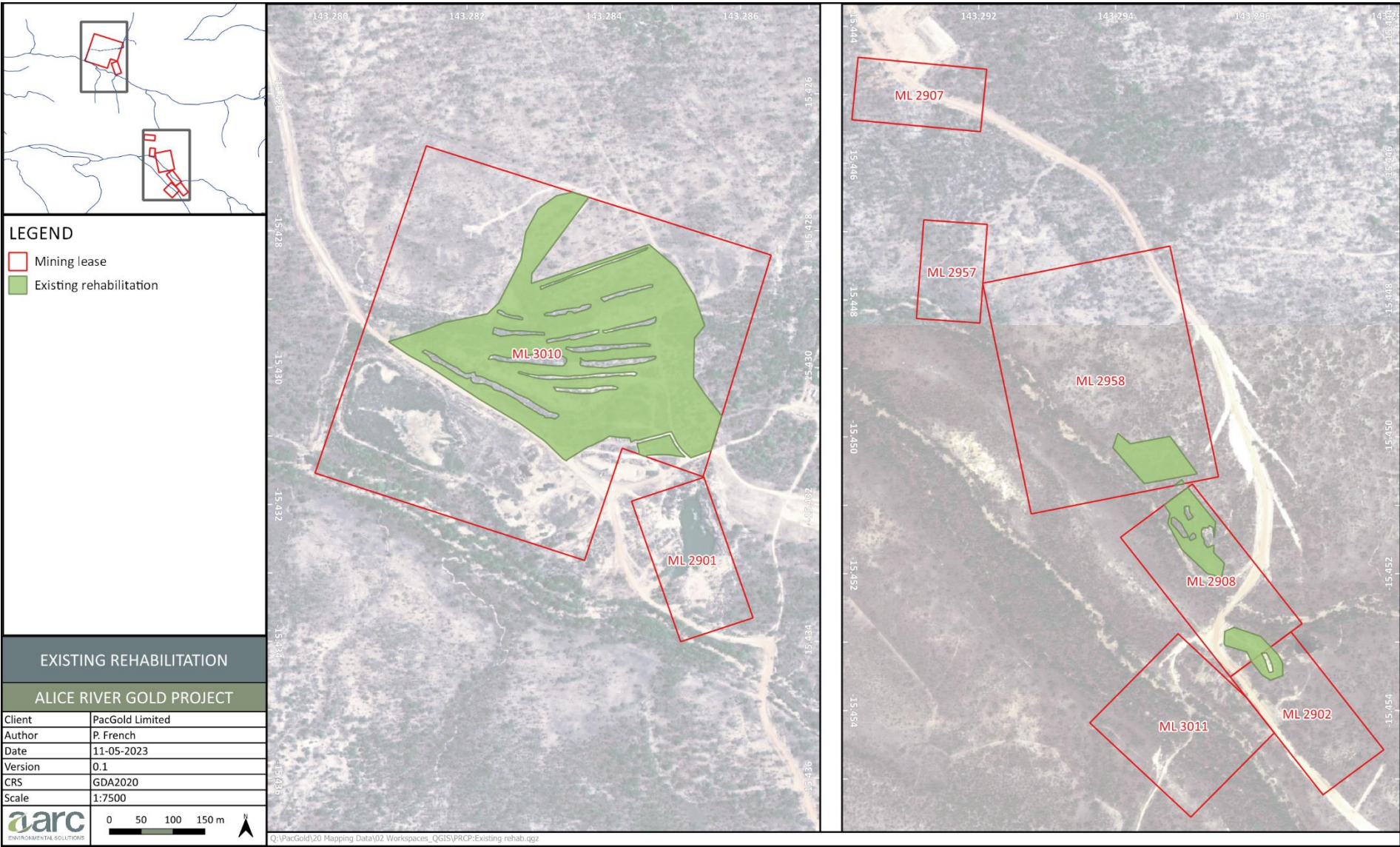


Figure 3-3: Existing rehabilitation

3.3 Baseline information

Key environmental values and site characteristics that are relevant to the Project rehabilitation and closure have been identified and are discussed in the following sections.

3.3.1 Climate

The typical climate associated with the Project will influence the timing and sequencing of rehabilitation activities.

The Project is located within the Cape York region which has a tropical climate with high to very high temperatures throughout the year (DES 2019). The rainfall is highly seasonal, with most of it occurring during the wet season (October-March) either as heavy thunderstorms, monsoonal lows or tropical cyclones (DES 2019). Average annual climate data for the Project area is presented in Figure 3-4.

Rainfall data is drawn from several Bureau of Meteorology (BOM) stations. Rainfall data is drawn from the BOM Kimba Weather Station (Station Number 28027) (located approximately 29 km west of the Project site), the closest weather station that collects long-term rainfall data. Since late 2023, rainfall has been measured at Alice River Homestead at a real time weather station, and that data has been utilised in the water studies. Temperature and evaporation data is not available from weather stations any closer to the Project area. As an alternative, the Queensland Government's climate database SILO (Scientific Information for Land Owners), provides datasets which use observational data as well as mathematical interpolation techniques to infill gaps in time series.

The climate of the Project area is generally hot and humid with a distinct wet season (November to March) and dry season (April to October). Average monthly rainfall in the wet season is between 175 mm and 320 mm, and in the driest months (June to September) is generally less than 10 mm. The warmest months are September to December. Average temperatures range from 15.6°C (min.) to 30.8°C (max.) in July to 22.5°C (min.) to 36.5°C (mx.) in November.

The recorded mean annual rainfall at Kimba Weather Station between 1973 and 2019 was 1,129.6 mm. The mean annual evaporation estimated from the SILO Alice River grid is 2,172.86 mm, approximately two times higher the average annual rainfall. Evaporation data for the Alice River Mine derived from pan evaporation measurements at Palmerville, which is the nearest available BOM station with pan evaporation rates, is estimated to be ~2,298 mm. Both estimates significantly exceed the mean annual rainfall, indicating a strongly negative simple water balance.

Long-term climate projections predict that conditions will become warmer, with hotter and more frequent hot days. Rainfall events are predicted to become more intense, and tropical cyclones are predicted to become less frequent, but more intense (DES 2019).

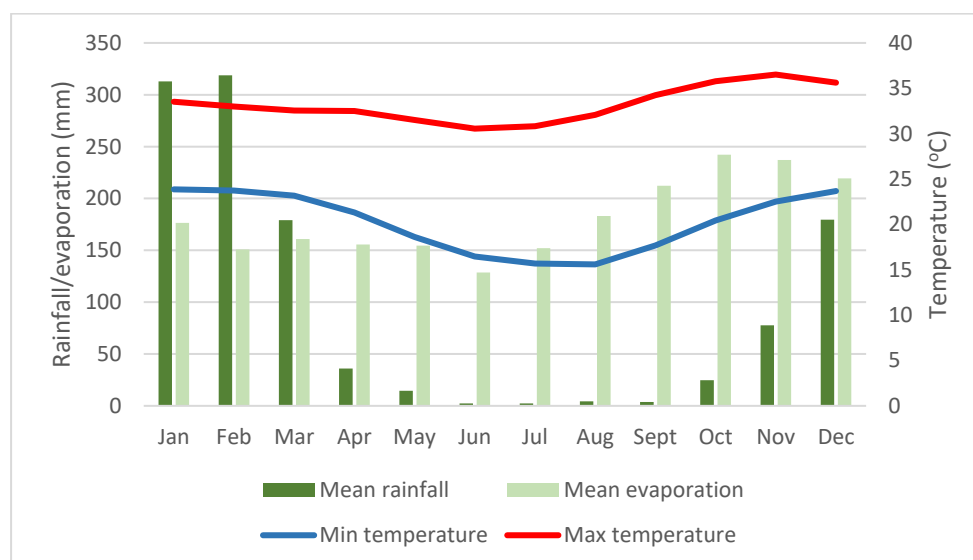


Figure 3-4: Average monthly climate data for Alice River Gold Mine

3.3.2 Geological setting

3.3.2.1 Regional geology

The Project is located within the Savannah Province and is part of a broader mineralised province across northern Australia. Mineralisation is common across the region, the upper reaches of One Mile Creek contain historical gold, copper, and antimony occurrences.

The geology itself comprises Late Silurian to Devonian granitic and granodioritic crystalline bedrock (Figure 3-5). The primary basement unit is the Imooya Granite, part of the Kintore Granite Supersuite. The regional geology consists of highly crystalline, discontinuous, and massive igneous and metamorphic rocks: granites, pegmatites, and schist to the north. These rocks host minimal groundwater as they have formed through heat and pressure with minimal pore space. Where present, groundwater is only likely to occur in fracture zones and contacts where secondary porosity (or void space) exists. It may or may not be continuous or connected to other faults.

The dominant structure is the Alice River Shear Zone (ARSZ), a major shear zone and unconformity which is likely an influence in forming a structural boundary to the Great Artesian Basin (GAB). The ARSZ forms a wide regional shear and fault zone striking northwest to southeast as a sequence and package of faults through the granite (Figure 3-5, Figure 3-6).

The ARSZ plays a role in the mineralisation of the Alice River and related deposits and is a key line of inquiry in identifying further mineralisation. Geophysical surveys conducted by Pacgold have specifically identified a 12 km-long sub-surface gold-arsenic-antimony (Au-As-Sb) anomaly along the strike direction of the shear zone as an exploration target (Figure 3-6). In the landscape, this anomaly crosses tributaries of One Mile Creek and the creek itself and shows the regional nature of mineral enrichment associated with structures for the region. This suggests naturally elevated arsenic and antimony concentrations in local sediments, groundwater, and surface water will exist as a naturally occurring condition in mineralised terrain and province and will require a site-specific approach to establishing meaningful water performance criteria.

The regional state geology and mapping also identifies how ephemeral flow occurs during the wet season and high rainfall across the entire region, forming broad, low flow velocity, depositional sandy and organic-rich drainage lines over the crystalline country rocks, sometimes referred to as dry marsh areas (refer Figure 3-5).

Weathering across the region is shallow, with limited saprolite or laterite development, as indicated by Queensland geology database records and drillhole data (Pacgold 2024a; Queensland Government, 2018 in SeeBuiltEarth 2025; Appendix D). The weathering profile suggests erosion has removed much of the regolith, leaving a thin, variably developed zone over fractured basement rock to outcrop.

3.3.2.2 Alice River site geology

The Alice River site is dominated by the Imooya Granite, a massive, crystalline unit cut by northwest-southeast trending faults and shear zones as part of the ARSZ. The shear corridor extends east of the Alice Queen pit to west of the tailings storage facility (TSF) and hosts fractures, faults, breccias, and mineralised quartz veins, with diorite intrusions in places. Shear zones vary in strike length, width, and depth across the ML and may host diorite dykes, altered chalcedony/silica, milled faults, or brecciated quartz, particularly around the Alice Queen ore zone (Davis 2024 in SeeBuiltEarth 2025; Appendix D).

The Alice River deposit is an epizonal intrusion-related gold system. Gold, arsenopyrite, and stibnite occur in quartz veins and minor breccias. Alteration is typically confined to zones adjacent to mineralised veins, although in some areas, green-white quartz-sericite-epidote alteration extends up to 70 m.

The weathering surface is variable and undulating, exposing outcrops of fresh and partially weathered bedrock in places. Elsewhere, the paleo-weathering profile can extend up to 10–15 m below the surface, particularly on hills like those seen in Alice Queen pit walls. There are minor and isolated remnants of Jurassic limey sandstone, which occur in isolated remnants up to 2 m thick in the northern tributary creek line to the west of the TSF.

The Alice Queen pit is the most detailed area of known geology. It was developed along a northwest-southeast-trending shear zone that runs through the base of the pit, trending north-northwest to south-southeast. The shear zone hosts cross-cutting veins and breccias between sub-parallel faults, with discontinuous and variable mineralisation. Minor sulphides (pyrite, arsenopyrite, and stibnite) are fine-grained disseminations or narrow bands in quartz and breccia (photo). There is a close link between gold mineralisation, arsenopyrite (As) and stibnite (Sb).

Mapping shows the shear zone at the surface in Figure 3-7. The shear extends north and south of the pit and outcrops through the riverbed of One Mile Creek and the northern tributary. This means surface water and creek sediments interact with the mineralised structure, with sulphide oxidation visible near the surface.

Given the crystalline, igneous nature of the Imooya Granite, the prevailing geology at Alice River has low primary permeability, limiting groundwater movement except where fractures provide localised porosity. Shear zones and fault breccias form weakened zones, but permeability is further restricted by infill and alteration.

Drilling logs from the Pacgold database (2024, in SeeBuiltEarth 2025; Appendix D) were examined to investigate water presence across the field. Only limited instances of water occurrence were recorded, noted as wet chip samples (RC) or mentions of water presence. Figure 3-7 shows the locations and depths of water intersections, projected to the surface. The data indicate no consistent pattern in depth or alignment. Despite extensive drilling, water is limited to isolated fractures with no evidence of a connected groundwater system. Where water is intersected, it generally occurs at depths of 90 m or more, at depths well below current mining footprints or access. Water is rarely noticeably present at shallow depths (<15m).

Near-surface sulphide oxidation affects geochemistry but does not indicate large-scale groundwater flow. Brittle faults and WNW-trending veins may offer some structural continuity but do not appear to support significant groundwater movement. Where fractures remain open, they may act as localised conduits, but mineralisation and infill commonly reduce connectivity.

Code	Colour	Rock type
Dggy	Dggy/l	Pale grey to white granite, pegmatite, aplite
Ph/2	Dgr	Grey, medium to coarse grained schist and gneiss, quartzite
Dgpc	Dgwu	Grey, fine grained granite
Dgwu	Dgpc	Medium to dark grey monzonite, often weathered
Dgr	Ph/2	Undifferentiated miscellaneous granitoids
Dgg/l	Dggy	Pale grey to white granite, leucogranite, pegmatite, aplite

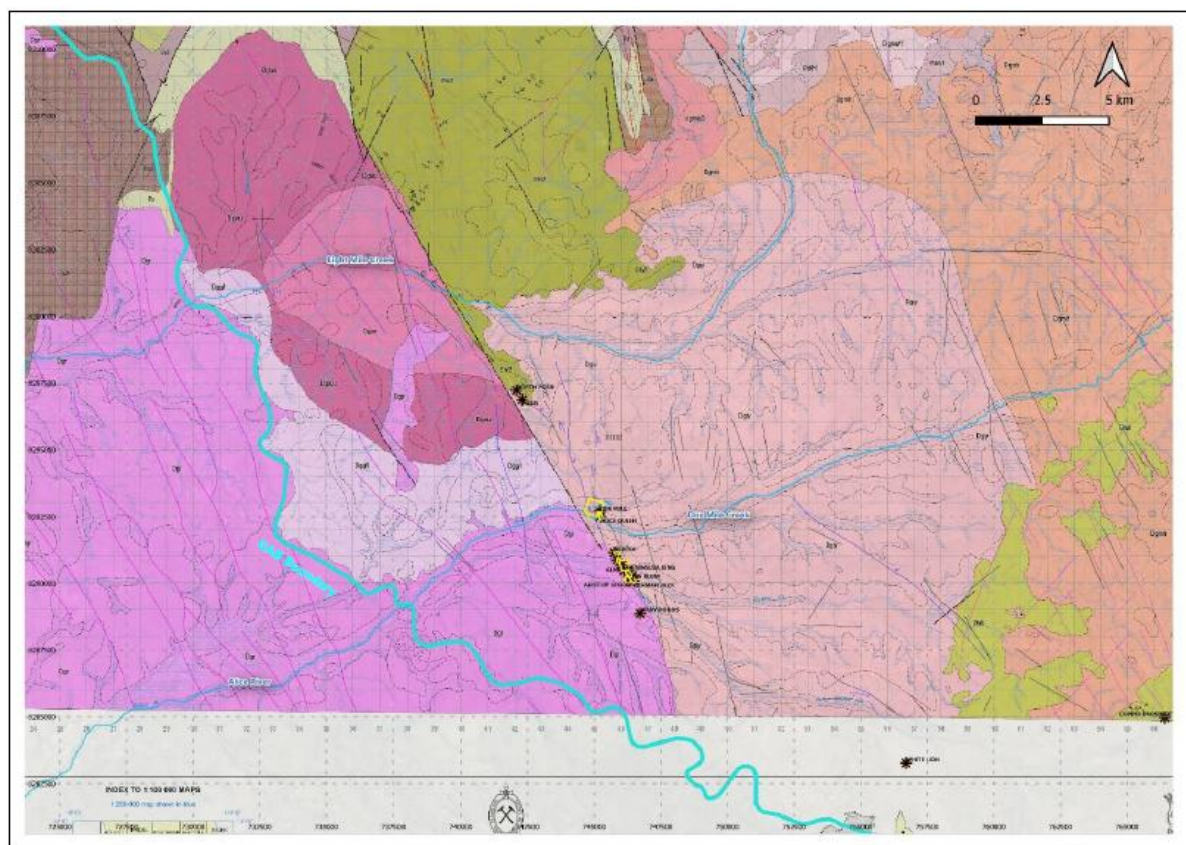


Figure 3-5: Regional geology for the Project (Queensland Geology Map Series, 2018)

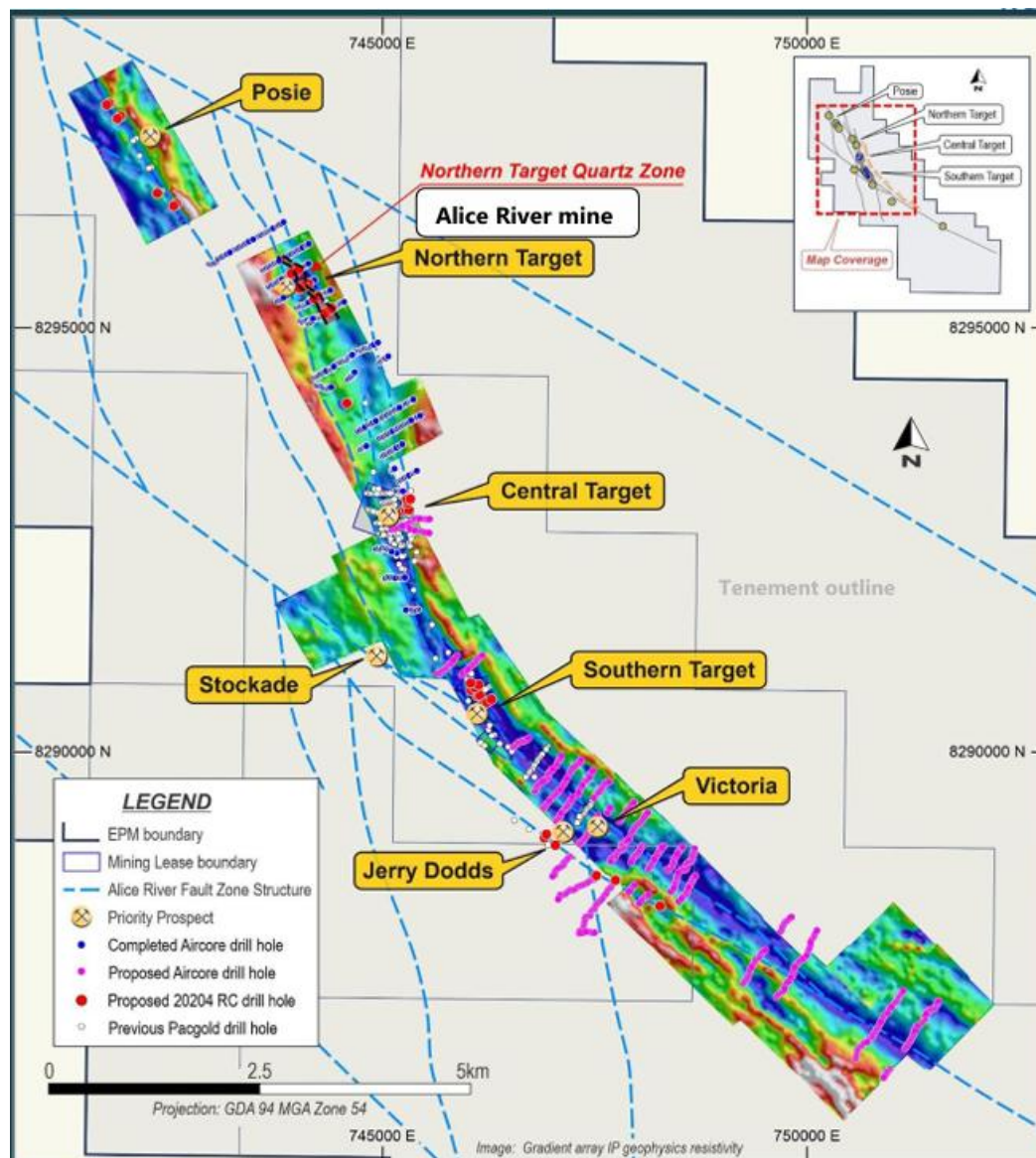


Figure 3-6: Geophysical and geochemical anomaly along shear zone across Pacgold tenements



Figure 3-7: Alice River shear zone, mineralisation structures and water intersections from drilling

Natural elemental abundance

An investigation was undertaken by SeeBuiltEarth (2025; Appendix D) to assess the Project area's natural elemental abundance using the global abundance index (GAI). The GAI assesses an area's enrichment by comparing element concentrations to values of global crustal abundance to identify what elements are higher at Alice River as a mineralised province than non-mineralised areas as natural background. All elements in the dataset were assessed as a statistical population, using percentile thresholds (99.5th and 0.5th percentiles) to define the upper and lower bounds of natural variation. The results (Figure 3-8) indicate enrichment of elements available for Alice River, including:

- Strong enrichment: Gold (Au), Silver (Ag), Aluminium (Al), Arsenic (As), Bismuth (Bi), Calcium (Ca), Iron (Fe), Potassium (K), Magnesium (Mg), Sodium (Na), Sulphur (S), Antimony (Sb), Selenium (Se), Tellurium (Te), Titanium (Ti).
- Moderate enrichment: Barium (Ba), Caesium (Cs), Lithium (Li), Lead (Pb), Rubidium (Rb), Tungsten (W).

Therefore, it is concluded that Alice River, regionally, and as a site, is a mineralised province, with naturally elevated concentrations of metals and other elements, potentially influencing water quality. However, not all elements will be mobile. Elements identified align with work of RGS (2022, 2023; Appendix D) highlighting low sulphur, and an enrichment of many epithermal metals, of which arsenic and antimony are expected to be mobile. The enrichment profile provides a background and context to indicate a site-specific approach to understanding the Alice River's natural baseline and background water quality for determining water quality criteria and the relevant thresholds to protect environmental value.

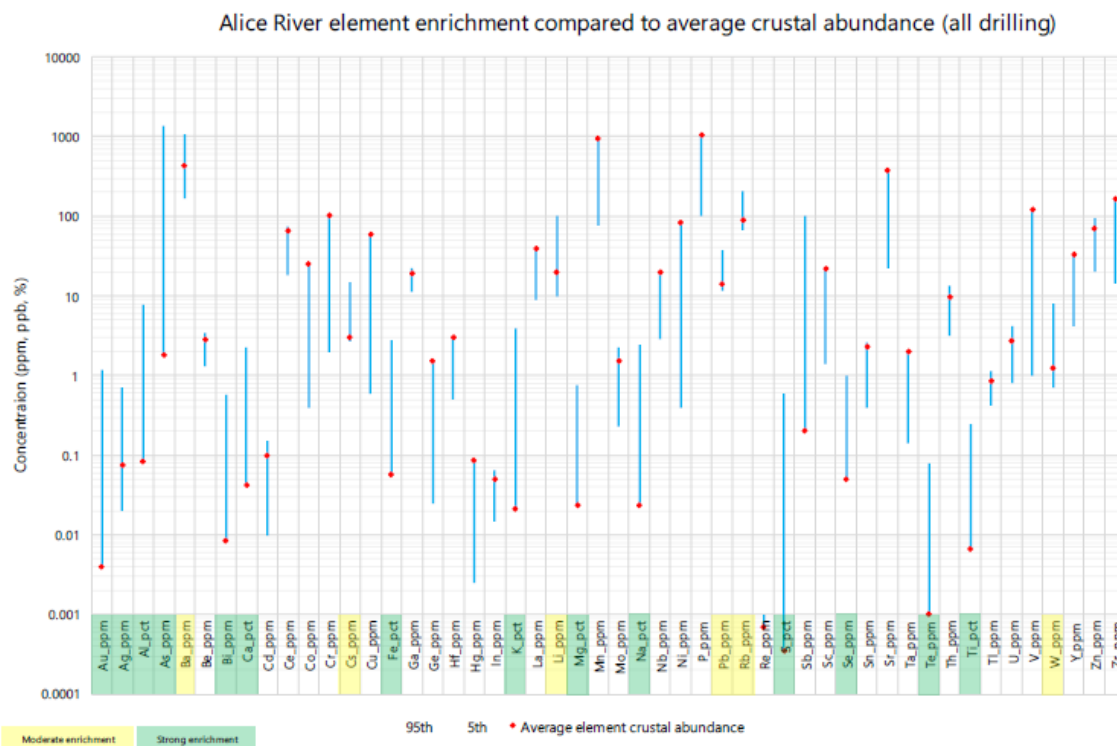


Figure 3-8: Global abundance index (GAI) enrichment, Alice River

3.3.2.3 Geotechnical stability

The geology of the site was investigated as part of the geotechnical assessment and is summarised below, for further information see the Geotechnical Assessment Report (BMS 2022; Appendix D).

The Project site is underlain by the Imooya Granite with a thin partial covering of Quaternary sediments adjacent to the Alice River system, with the site-specific geology summarised as:

- quaternary sediments comprising clay, silt and gravel compositions, typical of floodplain alluvium;

- early Devonian aged Imooya Granite which is typically a pale grey to white muscovite-biotite to biotite-muscovite granite and leucogranite. Forms colluvial deposits at lower elevations; and
- an ore zone which comprises silica rich shears.

Based on analysis of core photos, the weathered Imooya Granite horizon is typically degraded comprising altered and decomposed feldspars (sericite clay) and coarse-grained quartz crystals. Below the base of weathering (BHWE), the unweathered Imooya Granite is likely to be high to very high strength with high rock quality designation, with widely spaced jointing.

BMS (2022; Appendix D) estimated the depth of weathering for the Imooya Granite from the Alice Queen Mine Pit void surface. The break in slope between shallow (30° to 50°) batter angle in the upper portion of the void and the steeper (70°) batter angle for the lower portion of the void to floor, assumed as the BHWE. This equates to a 10 m to 12 m depth of weathering and a reduced level weathered to fresh boundary at approximately 115 m reduced level (RL) (in the Alice Queen Mine Pit void vicinity).

The ore zone is generally a narrow shear/fault zone trending north - south. The expression of this geological structure is identified as a topographically lower channel feature that acts as a preferred surface water pathway.

Quaternary sediments within the location of the Alice Queen Mine Pit void and waste rock dump are estimated to be thin; 1 m to 1.5 m thick at most sequences and limited to the fringes of the Alice River channel.

Geomorphological interpretation of the drone acquired point cloud and resulting elevation model suggested an erosional feature (possibly fault-induced) extended to the north of the Alice Queen Mine Pit void. This was later verified as the mineralised altered zone within the Imooya Granite that forms the ore body.

3.3.3 Topography

The Alice River Mine Project area is located near the upper reaches of the Mitchell River drainage basin, within the Alice River catchment, on the western side of the Great Dividing Range. The topography consists of predominantly low-relief granite rangelands, forming a broad watershed divide.

The region's drainage systems are broad, low-gradient, and predominantly ephemeral, with flow occurring only after significant rainfall, leaving dry riverbeds during the dry season and extended low-rainfall periods. The rivers in this area are aggrading, with extensive alluvial sands and gravels shaping braided and shifting channels.

The Project area is broad and low-relief, with natural ground levels varying by several metres. This results in large, gently drained areas, often characterised by sandy banks and rocky rises. The mine site area is highly flood-prone during the wet season, significantly constraining access. Digital terrain modelling (DTM) analysis indicates that the topography influences surface water retention and flow distribution (Figure 3-9). The western section of One Mile Creek (downstream of the site) is higher elevation than the eastern portions, creating a lower-lying area upstream of the site where surface water is likely to pool following rainfall events. This topographic variation contributes to the widening of surface water flows, supporting localised sediment deposition and braided channel formation (SeeBuiltEarth 2025: Appendix D).

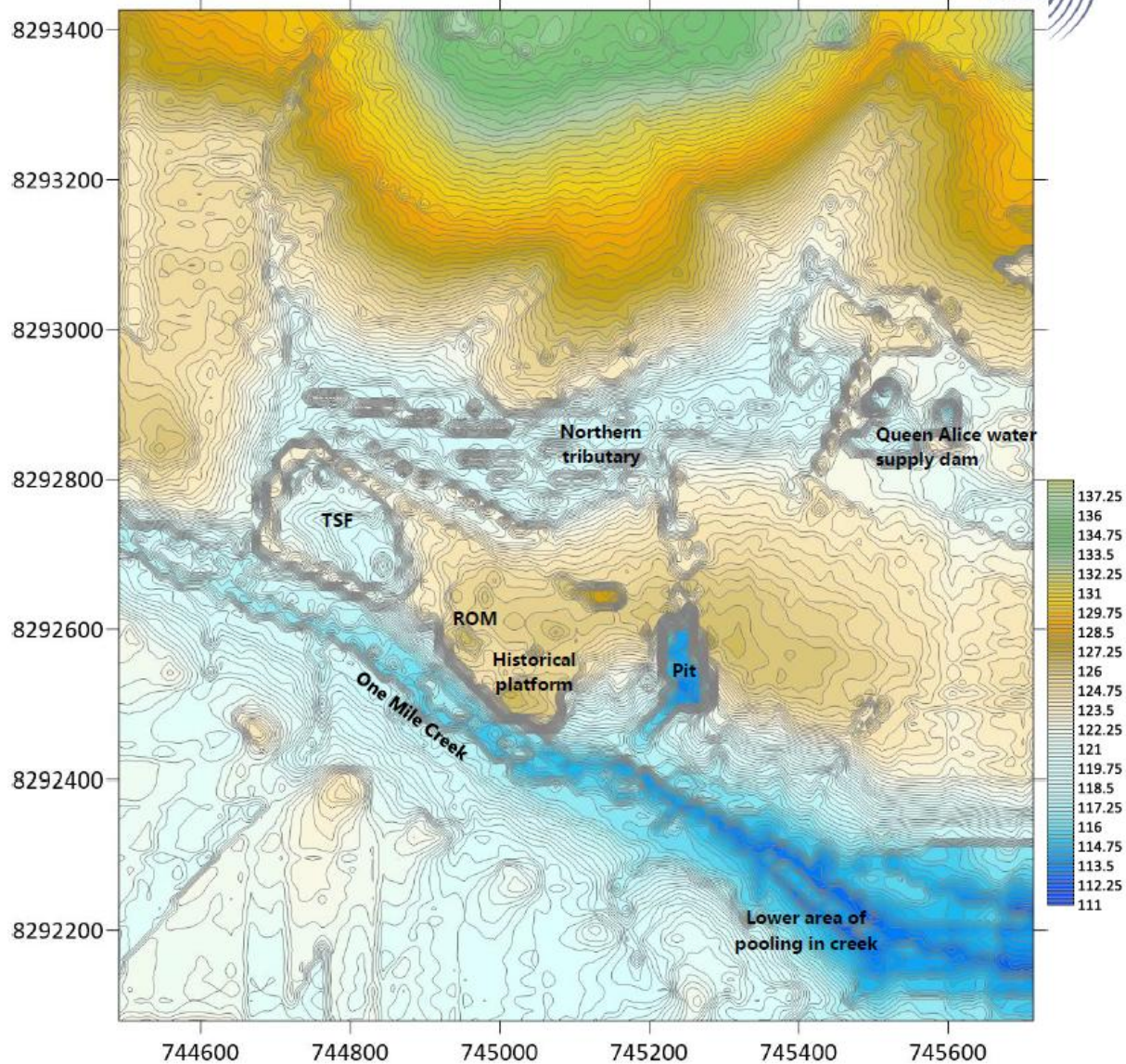


Figure 3-9: Alice River Site elevation and terrain

3.3.4 Surface hydrology

The Project area is intersected by the Alice River (and associated tributaries), Dickies Creek (southern MLs) and One Mile Creek (ML3010 and ML2901) (Figure 3-10).

3.3.4.1 Alice River

The Alice River (a fifth order stream) flows in a north-westerly direction through ML3011. From this point the Alice River flows in a south-westerly and then north-westerly direction to its confluence with the Mitchell River, which ultimately discharges into the Gulf of Carpentaria, approximately 200 km west. It is the receiving waterway for Dickies Creek and One Mile Creek, and as such all runoff discharged from the Project will end up in the Alice River. Alice River transitions from an ephemeral to intermittent waterway as it approaches the confluence of the Mitchell River. Various persistent rock pools, water holes and lakes form along the Alice River, however, there are no surface water licences applicable to this system (Engeny 2025; Appendix D).

3.3.4.2 One Mile Creek

One Mile Creek (a fourth order stream) is an ephemeral waterway that flows along the southern edge of ML3010 and ML2901 before it converges with the Alice River approximately 5.5 km west of the Project area. ML3010 is traversed by an unnamed tributary (a second order stream) of One Mile Creek that was historically dammed upstream of mining activities. Historic mining activities (prior to the current proponent) redirected this stream to flow around the western perimeter of the tailings dam to redirect flow away from the tailings dam (Figure 3-2, Figure 3-10). Some erosion is evident on the diverted stream banks, and further erosion is considered likely to occur without installing controls.

The Project is located near the top of the One Mile Creek catchment, with little to no upstream contributions outside major rainfall events coming down the catchment. The One Mile streambed generally consists of aggrading, sandy, and sediment-rich deposits, promoting dispersed infiltration into underlying sediments rather than maintaining continuous downstream flow. One Mile Creek functions as a losing stream, where surface water infiltrates into the underlying sediments, recharging groundwater when the water table is lower than the streambed. The presence of disconnected water storages within the river sediments suggests that pools or localised waterholes may persist for a time following flow events but are unlikely to be sustained as permanent features. As a losing stream with a thick sandy base, it is likely water is stored within the subsurface within the river sediments. An exception to sandy beds occurs west of the TSF, where limey sandstone formations along the northern tributary have formed a boxy incised channel extending 50 to 100 m.

The topography of the site also influences flow and water retention. The western section of the creek, downstream of the site, sits at a higher elevation than the eastern portions, resulting in a lower-lying area upstream to the site where surface water is likely to pool following rainfall, and resulting in widening of surface water flows.

The One Mile Creek and tributary catchment drains a mineralised province, hosting gold (Au), copper (Cu), and antimony (Sb) mineralisation. Mineralised structures also cut across the riverbed and are visible in One Mile Creek and the northern tributary. As a result, sediment and surface water transported during flow events may contain elevated trace metals, influenced by both natural weathering and historical mining activity in the region.

Over time, One Mile Creek channel morphology shifts, with flow pathways adjusting in response to sediment deposition, vegetation growth, and flood-driven reworking. This dynamic movement is influenced by the creek's low-gradient nature and the presence of alluvial deposits, which contribute to the redistribution of flow across multiple minor channels during wet periods. During major rainfall events, such as those associated with monsoonal systems or cyclonic activity, the creek transforms into a high-energy system. Significant water movement reshapes the streambed and deposits large volumes of sediment and organic material from upstream.

The hydrological behaviour of One Mile Creek is defined by the combination of intermittent surface water flow, aggrading sandy sediments, and organic-rich transport. These characteristics influence local water availability and connectivity with groundwater, shaping the broader surface water dynamics in this part of the Alice River catchment (SeeBuiltEarth 2025; Appendix D).

3.3.4.3 Dickies Creek

Dickie Creek (a fourth order stream) is an ephemeral waterway fed by a network of tributaries to the east of the Project. It flows in a norther-westerly direction through ML2908, ML2958, and ML2957; before discharging into the Alice River 200 m west of ML2957.

3.3.4.4 Environmental values

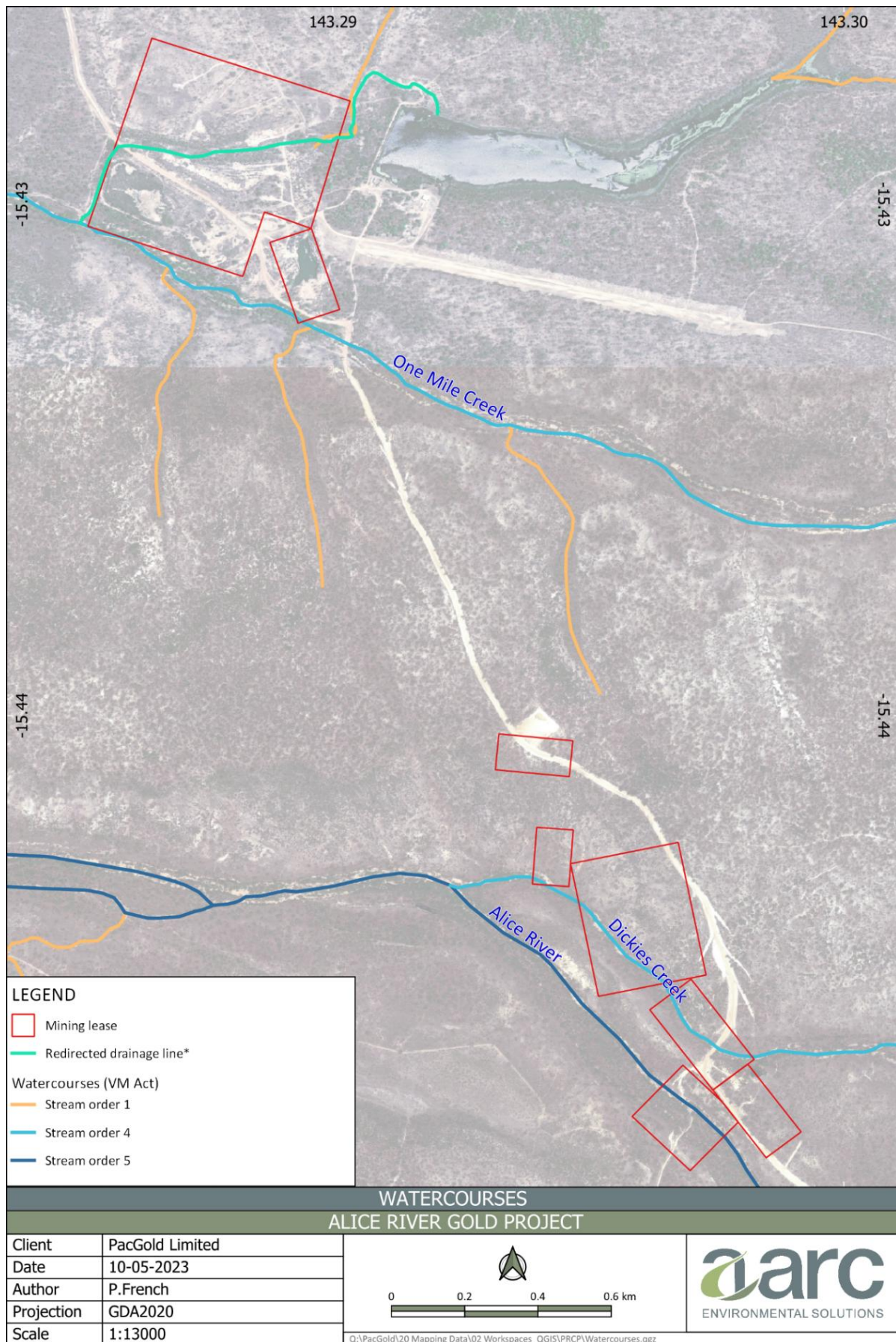
The Project area lies within the Alice sub-catchment of the Department of Natural Resources, Mines and Energy (DNRME) Water Plan (Mitchell) 2007, written under the *Water Act 2000*. There are no published environmental values for the Project area catchment under the Environmental Protection (Water and Wetland Biodiversity) Policy, which provides general water quality objectives (WQOs) for surface waters in the broader

region. The EPP Water outlines locally relevant WQOs for parameters such as pH, salinity, turbidity, nutrients, and contaminants, ensuring water management aligns with environmental protection and sustainability goals.

However, considering that the predominant land use in the vicinity of the Project is grazing, stock may have access to these waterways downstream of the Project. Further, water releases from the Project have the potential to impact local and downstream environmental values applicable to the Mitchell River Basin catchment. The following perceived environmental values for the Project surface waters have been proposed based on all available information and legislative requirements (Engeny 2025; Appendix D):

- aquatic ecosystem;
- agriculture;
- primary and secondary recreational use;
- aesthetic values; and
- cultural and spiritual values.

Descriptions and justification for the proposed environmental values are provided in the Surface Water Assessment (Engeny 2025; Appendix D).



*Second order stream redirected around tailings dam

Figure 3-10: Local watercourses by Strahler stream order

3.3.4.1 Surface water quality

Surface water quality has been monitored since the closure of 1990s mining operations, with records extending from 2002 to the present. Given that surface water flow only occurs during the wet season or after significant rainfall, the monitoring record needs to be regarded as intermittent, with gaps between years, and extended periods where sampling is not possible (and be representative). Additionally, variations in flow rates and conditions suggest expected differences in water quality would be expected under different creek flow rates regimes (SeeBuiltEarth 2025; Appendix D).

The province's mineralised nature and the presence of cross-cutting mineralised structures in both One Mile Creek and its tributary directly around the site means that naturally elevated background levels of some metals are expected. Surface water monitoring locations include:

- W1 as a background water quality site upgradient of the site. Note, this site is located in the deeper ponded area of the creek based on the topography;
- W2/W3, which is located downstream of the pit and historical landforms; and
- W4 and W7, which capture water quality from both One Mile Creek and its tributary downgradient of the site.

Water quality results (SeeBuiltEarth 2025; Appendix D) (Table 3-2) for pH, conductivity, arsenic, antimony, copper, and zinc for the site indicate the following:

- pH remains stable, generally around 6–7, consistent with organic loading in surface water, particularly at lower flow rates;
- there is low salinity and electrical conductivity;
- copper and antimony are generally not detected in both total and dissolved concentrations. There is some low-level background copper at W1 and downstream W4, but overall is generally stable;
- sporadic arsenic spikes in both dissolved and total concentrations were observed between 2014 and 2019, but these have significantly reduced in recent years and have remained stable at low levels since. The total and dissolved metals indicate arsenic being carried is particulate and in solution, suggesting a source-related to runoff or sediments;
- lead was largely not detected across all periods, except for 2019–2021, with detection and a peak, both at W1 as background and W4 (though the background W1 was lower). Both total and dissolved lead follow a similar pattern, again suggesting a runoff or stream sediment source. The peak has not proven repeatable in sampling since, and since 2021, has not been detected;
- there is a background presence of zinc at W1, with low levels observed at other sites, and;
- water quality has remained stable since 2019, including during significant rainfall events.

3.3.5 Groundwater

The Project site is not in the DNRME delineated GAB boundary. The area is in a localised flow system of low productivity (Figure 3-11). The nearest water user is Alice River Station, directly adjacent to and underlying the ML. Given the high ground and shallow basement around Alice River, groundwater is not well developed in the region. State registers record a single well along the main road between the leases, with the next closest well more than 12 km away from the site. Alice Queen lake (to the north-east of the Project area) is identified as a lacustrine feature, and no other features are recorded in the area.

There are no RAMSAR wetlands in the region. The nearest arid spring or groundwater mounds in the area is 30 km to the south or north. Areas considered to be wetlands occur approximately 40 km downstream.

Table 3-2: Surface water quality trends

	W1	W2	W3	W4	W7	Note
Location	Background, upstream of site	Mid-site at pit ramp, after outcrop in creek	Mid-site, alongside TSF	Edge of mine lease	Edge of mine lease	
pH	Stable – neutral to slightly acid	Stable – neutral to slightly acid	Stable – neutral to slightly acid	Stable – neutral to slightly acid	Stable – neutral to slightly acid	Reasonable with higher organics in water
Electrical conductivity	<200 µS/cm, stable since 2019	<200 µS/cm, stable since 2019	<200 µS/cm, stable since 2019	<200 µS/cm, stable since 2019	<200 µS/cm, stable since 2019	
Sulphate	Not detected	Not detected	Not detected	Not detected	Not detected	
Antimony (dissolved)	Not detected	Not detected	Not detected	Not detected	Not detected	
Arsenic (dissolved)	Low levels (<0.01 mg/L) since 2019	Low levels (<0.01 mg/L) since 2019, minor increase from before post lease	Low levels (<0.01 mg/L) since 2019, minor increase from before post lease	Low levels (<0.01 mg/L) since 2019, minor increase from before post lease	Low levels (<0.01 mg/L) since 2019, minor increase from before post lease	Life may be from site, OR from contact with mineralised area (outcrops in the creek)
Copper (dissolved)	Not detected since 2014	Not detected since 2014	Not detected since 2014	Not detected since 2014	Not detected since 2014	
Lead (dissolved)	Largely not detected except for period 2019-2021. Present in background.	Largely not detected. Where present, also in background.	Largely not detected. Where present, also in background.	Largely not detected since and before 2021.	Not detected.	Peak may be an error or isolated event as not repeatable.
Zinc (dissolved)	Not detected to occasional low background levels	Not detected to occasional low background levels	Not detected to occasional low background levels	Not detected to occasional low background levels	Not detected to occasional low background levels	

Environmental values for regional groundwater may include aquatic ecosystem habitat and as a source for irrigation and stock watering.

Groundwater occurrence, hydraulic conductivity, groundwater levels and the conceptual groundwater model are in Section 6.4.1.

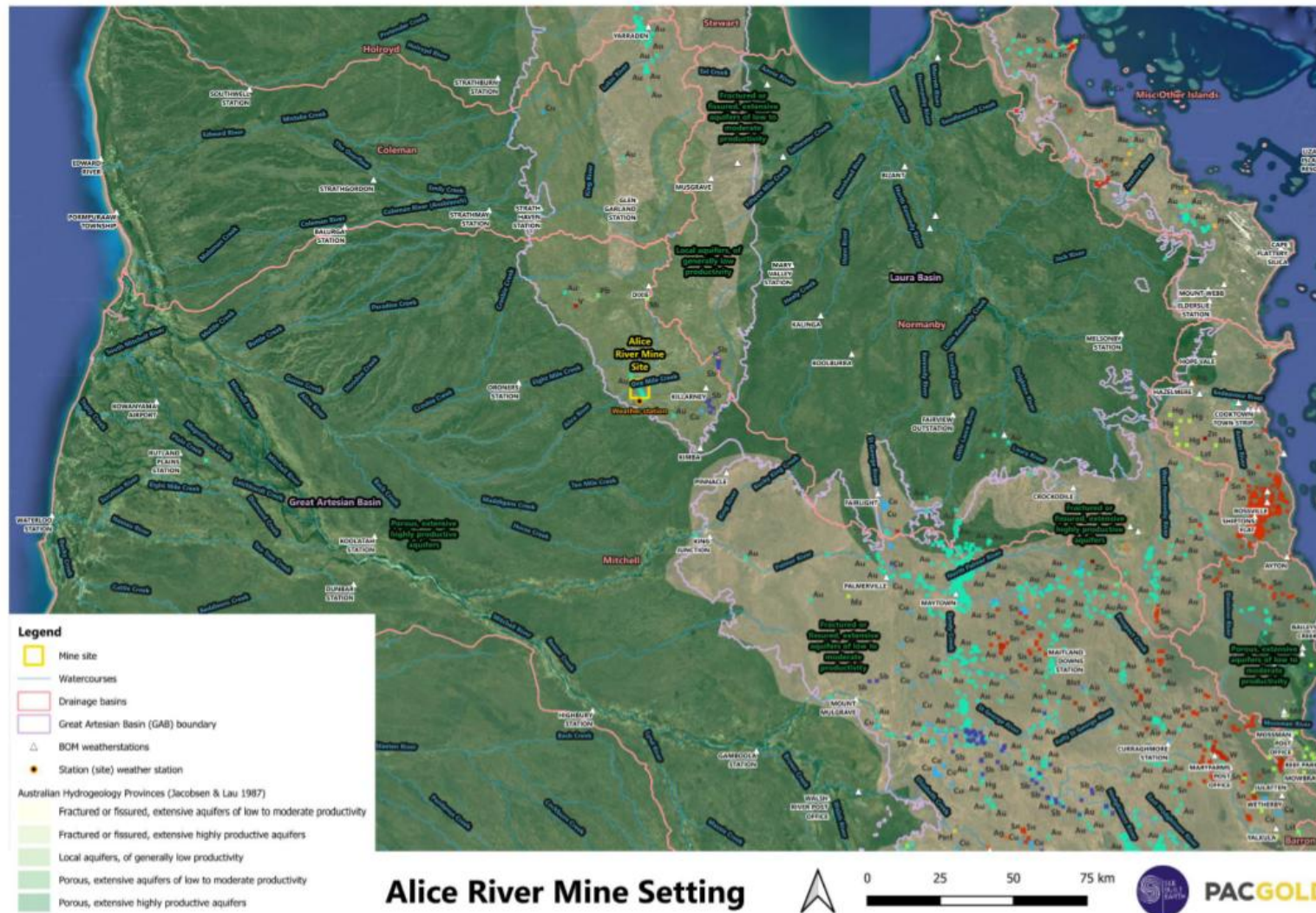


Figure 3-11: Drainage basin, hydrogeology environment, mineralisation types and BOM weather stations

3.3.6 Land tenure and land use

3.3.6.1 Underlying landholders and sensitive receptors

The Project disturbance area is located on one pastoral holding lease, Lot 11 on SP266613.

One sensitive receptor has been identified. The Alice River Homestead is situated approximately three kilometres south of the Peninsula King mining lease (ML2908). This is the homestead of the landholder with which the landholder agreement (Appendix E) has been reached.

There are no protected areas located within or on land adjacent to the Project. The closest national park is Olkola National Park, located approximately two kilometres to the west of the Project site.

The Project is not located in a Priority Agricultural Area or a Strategic Cropping Area as defined in the *Regional Planning Interests Act 2014*. There are no stock routes within the Project MLs, however, an unused stock route runs past the Project site, the closest point is approximately 200 m east of ML3010.

A council-maintained road traverses ML3010, ML2901, ML2907, ML2958, ML2908 and ML2902, and a council-run quarry is partially located on ML2907.

3.3.6.2 Native Title

The Olkola People are the traditional owners for the land on which the Project area is located. Native title has been determined to exist across the lands of the Project area and surrounds (NNTT No. QC2014/008). The Olkola Aboriginal Corporation has been established as the legal entity to manage the Olkola Traditional Lands.

3.3.6.3 Existing land use

Queensland Land Use Mapping (DES 2020) classifies the current land use Project area as ‘production from relatively natural environment—grazing native vegetation’ with pockets of ‘intensive uses—residential and mining’. ‘Grazing Native Vegetation’ is defined as (ABARES 2016):

Land uses based on grazing domestic stock on native vegetation where there has been limited or no deliberate attempt at pasture modification.

Dominant land uses of the region are grazing native vegetation and nature conservation.

3.3.7 Soil types and properties

The soils are sandy and of low fertility, supporting open woodland vegetation, with native sorghum (*Sorghum plumosum*), dominated by *Eucalyptus spp.* in the upper storey. The soils are deep sands having a 0-200 millimetres (mm) thick organic sandy layer, overlying 200-800 mm of sand and gravel, overlying weathered and decomposed granite. These soils support low quality pastures with low grazing carrying capacity.

A soil investigation of analogue sites and existing rehabilitation sites was completed by AARC in 2021 (AARC 2021a and RGS 2023, Appendix D). The soils are naturally acidic, prone to dispersion, and lacking in exchangeable phosphorous and nitrogen. Organic matter levels are generally low to very low, meaning that the soil has poor structural condition and low structural stability. Soils across the site have a high concentration of coarse sand and gravel, indicating reduced water holding capacity. A comparison of rehabilitated sites and analogue sites showed very little variability in the physical and chemical parameters. Further information relating to the soil material assessment is in section 6.4.3.

The topsoil stockpiles on the mine site in Figure 3-2 were created in 2006. The windrows are covered in vegetation (groundcover, shrubs and small trees) and leaf litter. There is evidence of historic erosion, likely from when the windrows were first placed; but no recent erosion is evident, indicating that the soil has stabilised. Analysis of topsoil stockpiles was undertaken as part of the geochemical assessment of mine waste materials (RGS 2023). The topsoil is sandy silt, and the key soil quality findings are that the Exchangeable Sodium Potential (ESP) and Electrical Conductivity (EC) is low, total nitrogen is rate limiting for growth and there is no deficiency of Cowell fractionated phosphorus. Vegetation is growing on the stockpiles, indicating that deficiencies are not limiting to plant growth.

3.3.8 Flora

A desktop search of the Version 12.0 Queensland Government Vegetation management regional ecosystem mapping (DES 2022) identified eight (8) regional ecosystems (REs) on the Project site; listed in Table 3-3. All remnant REs mapped within the site are listed as Least Concern and No Concern at Present under the Vegetation Management Regulation and *Vegetation Management (VM) Act 1999* respectively, except for the subdominant RE underlying ML2907, being RE 3.12.46 that is listed as Of Concern. The distribution of REs (DES 2020) in the vicinity of the Project are shown in Figure 3-12.

Given that the watercourses that run through the north of the Project area (One Mile Creek and a second order unnamed tributary) and the south of the Project area (Alice River and Dickies Creek) are relevant watercourses or drainage features as identified on the vegetation management watercourse and drainage feature map, a regional ecosystem with the defined distance of a defining bank of these watercourses is a Matter of State Environmental Significance (MSES) (regulated vegetation defined watercourse).

The mapped vegetation across ML2907 includes a regional ecosystem with a VM Act class of 'Of concern'. A regional ecosystem (RE 3.12.46) that is an 'Of concern' regional ecosystem is an MSES. As such the vegetation with ML2907 could be an MSES (further vegetation mapping at an appropriate spatial resolution would be required to confirm this).

Table 3-3: Remnant regional ecosystems

Regional Ecosystem	Short Description	VM Class	Biodiversity Status
3.12.10 / 3.12.42	<i>Eucalyptus cullenii</i> +/- <i>Corymbia clarksoniana</i> woodland or <i>E. chlorophylla</i> woodland on granitic ranges / <i>Eucalyptus tetradonta</i> woodland on low to undulating granite hills	Least Concern / Least Concern	No Concern at Present / No Concern at Present
3.12.42 / 3.12.10	<i>Eucalyptus tetradonta</i> woodland on low to undulating granite hills / <i>Eucalyptus cullenii</i> +/- <i>Corymbia clarksoniana</i> woodland or <i>E. chlorophylla</i> woodland on granitic ranges	Least Concern / Least Concern	No Concern at Present / No Concern at Present
3.3.20 / 3.3.49	<i>Corymbia clarksoniana</i> or <i>C. novoguineensis</i> woodland on alluvial plains / <i>Melaleuca viridiflora</i> +/- <i>Corymbia clarksoniana</i> low open woodland on floodplains and alluvial plains	Least Concern / Least Concern	No Concern at Present / No Concern at Present
3.3.49 / 3.3.16	<i>Melaleuca viridiflora</i> +/- <i>Corymbia clarksoniana</i> low open woodland on floodplains and alluvial plains / <i>Eucalyptus chlorophylla</i> +/- <i>Corymbia clarksoniana</i> woodland on alluvial plains	Least Concern / Least Concern	No Concern at Present / No Concern at Present
3.5.39	<i>Eucalyptus tetradonta</i> +/- <i>Corymbia clarksoniana</i> woodland on sand plains	Least Concern	No Concern at Present
3.5.39 / 3.12.46	<i>Eucalyptus tetradonta</i> +/- <i>Corymbia clarksoniana</i> woodland on sand plains / <i>Melaleuca stenostachya</i> shrubland on exposed igneous headlands and hills	Least Concern / Of Concern	No Concern at Present / Of Concern
3.5.39 / 3.5.38	<i>Eucalyptus tetradonta</i> +/- <i>Corymbia clarksoniana</i> woodland on sand plains / <i>Eucalyptus tetradonta</i> +/- <i>E. cullenii</i> , <i>Corymbia stockeri</i> and <i>Melaleuca</i> spp. woodland on remnant surfaces	Least Concern / Least Concern	No Concern at Present / No Concern at Present

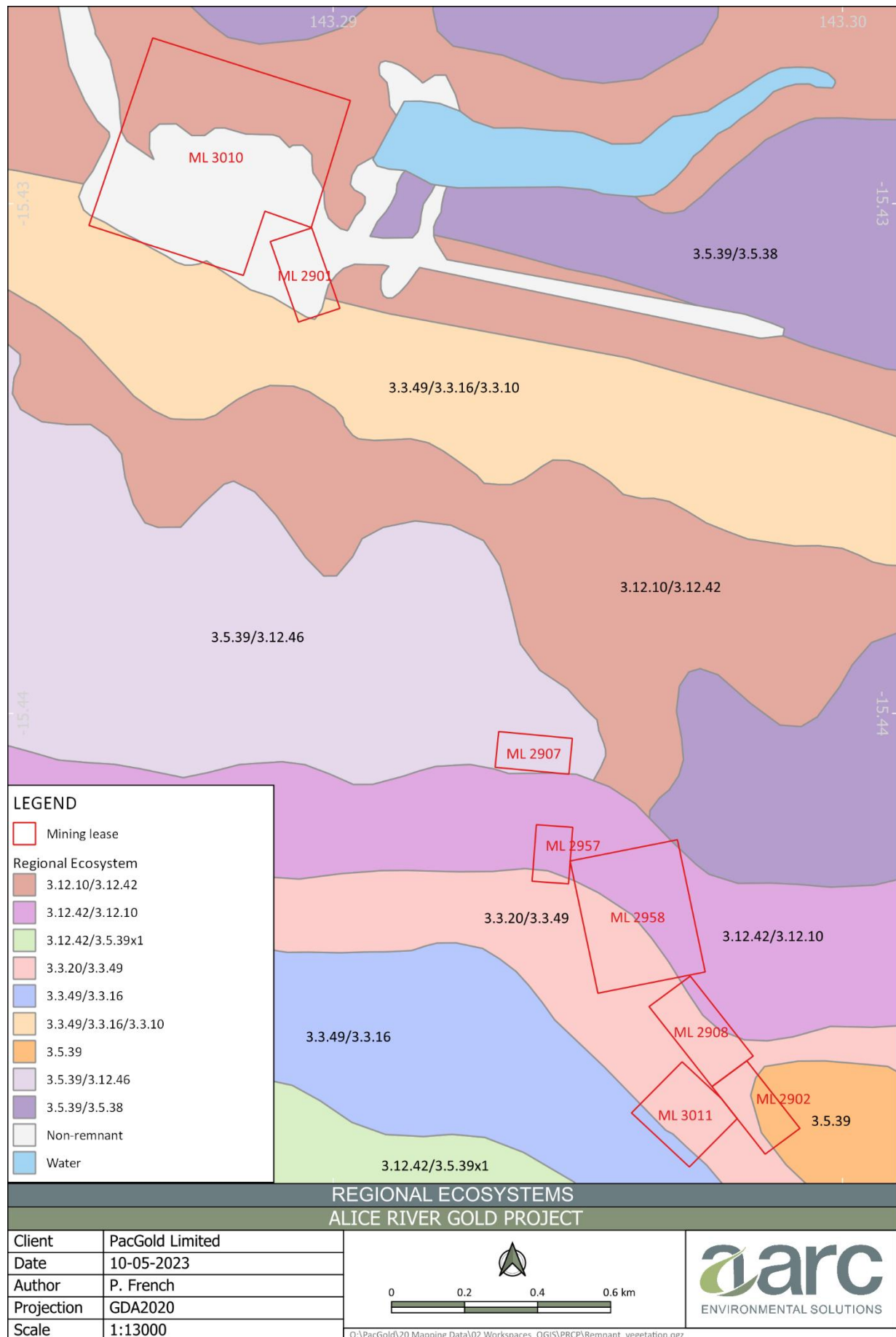


Figure 3-12: Remnant Regional Ecosystem communities at the Project site

3.3.9 Fauna

Two species of conservation significance are known to occur in the region around the Project area—the Freshwater Tiger Crab (*Austrothelphusa tigrina*) and the Golden-shouldered Parrot (*Psephotus chrysopterygius*). Results of monitoring and surveys conducted to assess and map the occurrence and habitat for these two species are described in the following sections.

3.3.9.1 Freshwater Tiger Crab

The Freshwater Tiger Crab is not listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) or the Nature Conservation (Animals) Regulation 2020. However, the IUCN Red List of Threatened Species lists the Freshwater Tiger Crab as Vulnerable. The Freshwater Tiger Crab Management Plan, produced in compliance with condition A7-1 of the Project EA (AARC 2017; Appendix D), includes monitoring Freshwater Tiger Crab populations and water quality monitoring.

Due to the long history of mining at the Project site, there is no information available regarding the pre-mining population abundance or distribution of the species. However, surveys conducted in recent years can give some indication of distribution and population changes over time (Figure 3-13; data unpublished at time of writing). It has been recorded in One Mile Creek and Alice River, and anecdotal reports indicate that it also inhabits Eight Mile Creek (a fifth order stream approximately 6km north of ML3010) and an unnamed tributary of the Coleman River that is 70 km north of the Project (AARC 2017; Appendix D).

Monitoring of Freshwater Tiger Crab populations is conducted annually in One Mile Creek and Alice River to fulfil the requirements of the Management Plan. The 2024 monitoring period recorded a decrease in estimated population size relative to the previous monitoring year at three monitoring points (MP1, MP3 and MP4), and a slight increase at one monitoring point (MP2). On average, the estimated population for Tiger Crabs in 2024 decreased by approximately 42% from 2023, but increased by 92%, 369% and 116% from 2019, 2021 and 2022, respectively. The estimated biomass and the percentage of juvenile Tiger Crabs also decreased on average from 2023, but generally increased compared to previous years. This indicates that the higher population estimate in 2023 may have been an anomaly due to a population boom resulting in a higher proportion of juvenile individuals in the population. The 2024 results indicated that the decrease in population may be a result of the natural breeding cycle of the crabs, rather than a lower survival rate of juveniles based on competition for resources. When compared to previous monitoring periods, there is no obvious trend in decline in the Tiger Crab population in the catchment (Figure 3-13).

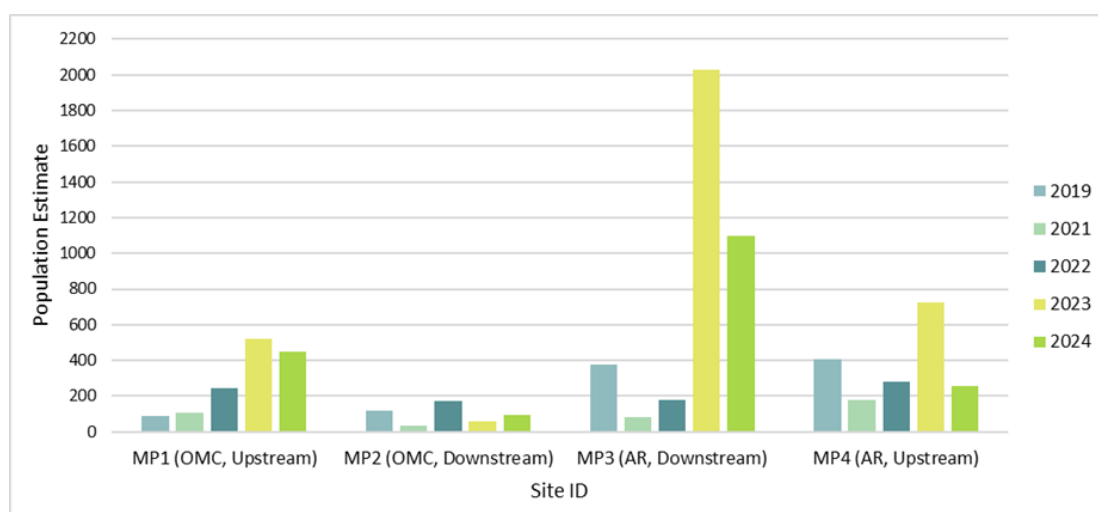


Figure 3-13: Freshwater Tiger Crab population in One Mile Creek (MP1/MP2) and Alice River (MP3/MP4)

3.3.9.2 Golden-shouldered Parrot

The Golden-shouldered Parrot is listed as 'Endangered' under the *Nature Conservation Act 1992* (NC Act) and the EPBC Act, and a Management Plan (AARC 2018; Appendix D) has been developed to assess and protect this species from potential impacts of mining.

The Golden-shouldered Parrot is a granivore, feeding prominently on a range of annual and perennial grasses (Garnett & Crowley 2002). Foraging habitat for the Golden-shouldered Parrot is considered to include open savanna woodlands dominated by *Melaleuca* or *Eucalyptus* species, with an understorey dominated by *Schizachyrium*, *Thaumastachloa*, *Sorghum plumosum* or *Eriachne burkit*. Throughout the dry season, this species feeds on abundant fallen seed, particularly Firegrass (*Schizachyrium spp*; Garnett & Crowley 2002). Seed availability abruptly declines at the onset of the wet season as seeds begin to germinate in response to rain. Cockatoo grass (*Alloteropsis semialata*) seed production commences around six weeks after the first heavy rains, providing critical food supply until other grass species start seeding a few weeks later. This species is also known to feed on Caribbean stylo (*Stylosanthes hamata*; AARC 2021b; Appendix D) and the growth buds and flowers of *Melaleuca viridiflora* (Garnett & Crowley 2002).

The Golden-shouldered Parrot nests in conical-shaped termite mounds in grassy areas, with breeding primarily occurring from March to June after termites have stopped building (at the end of the wet season) and while grass seed is still available. Previous studies have shown that the species is limited by the availability of suitable nest sites, as the Golden-shouldered Parrot is known to rarely reuse the same mound, and the 30-50-year construction time for a mound to be suitably sized as a nesting habitat (Cape York NRM n.d.; Levy 2004). A nesting habitat assessment conducted in May 2021 (AARC 2021b; Appendix D) found no suitable (areas containing large conical termite mounds) or potential future (areas containing small conical termite mounds) nesting sites within the Project MLs. Areas identified as containing a high density of suitably sized conical termite mounds coincided with areas of loam sandy soils, mapped as RE 3.3.49/3.3.16 (Figure 3-12). Golden-shouldered Parrots were observed within proximity of the study area during the survey. Suitable nesting habitat and sightings are shown in Figure 3-14.

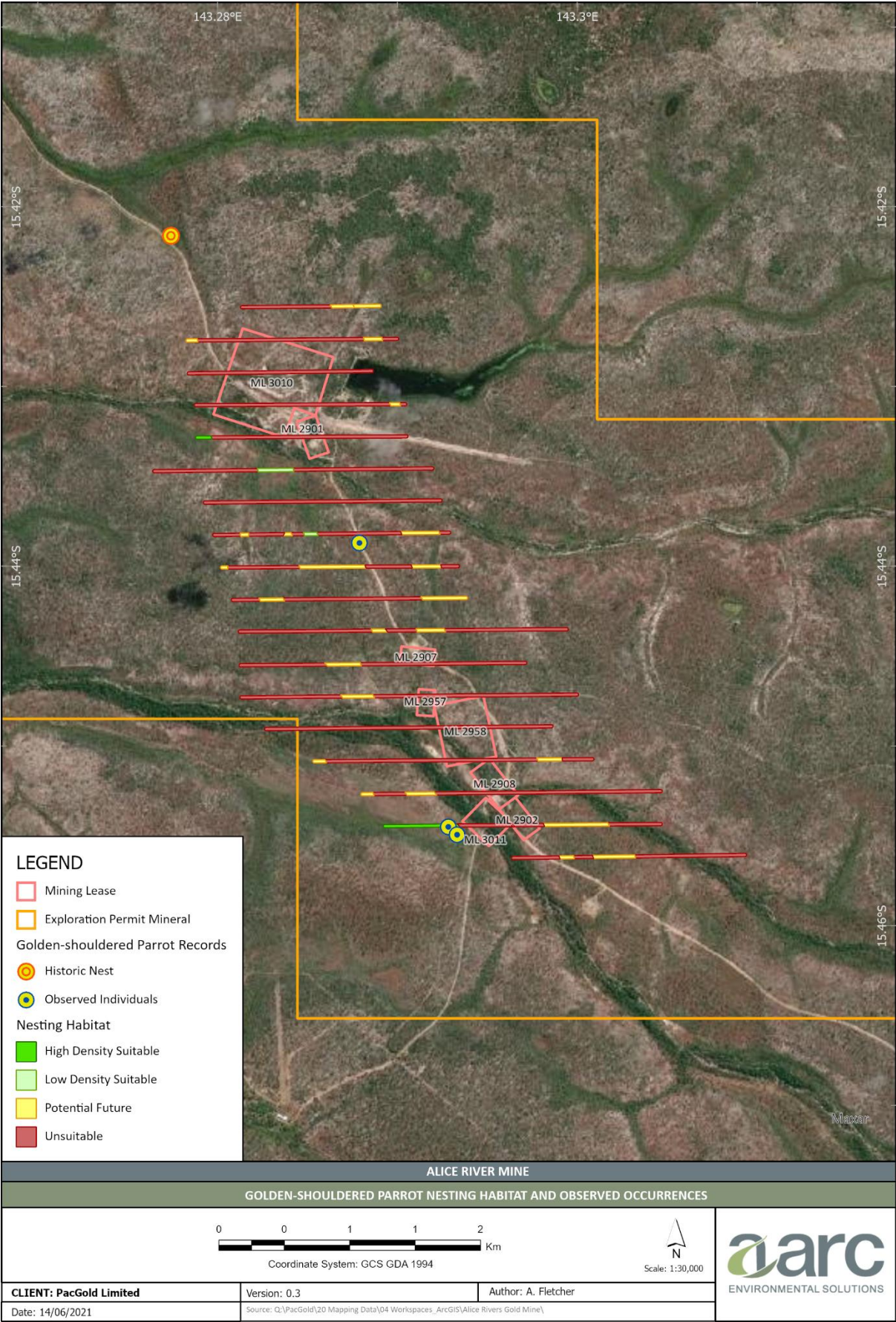


Figure 3-14: Golden-shouldered Parrot nesting habitat and observed occurrences

4 Community consultation

4.1 Previous engagement activities

The Project is located on a remote site and the key stakeholders are limited to the underlying landholder, the Cape York Land Council (CYLC), the Olkola Aboriginal Corporation, and the Cook Shire Council as responsible for maintaining the road traversing the Project site and the council-run quarry partially located on ML2907. Consultation with these stakeholders is undertaken as required.

Previous engagement with the landholders of Alice River Station (the underlying landholder) has included discussion of rehabilitation and PMLU. Through this engagement, the previous tenement holder, Tinpitch Pty Ltd, received written agreement on 28 June 2017 for the retention of certain improvements consistent with the PMLU of grazing (Appendix E). The landholder is aware that this PRCP is in development, and that they will be provided with the PRCP for comment, particularly regarding PMLU, proposed retained infrastructure and the PRC schedule timeframes.

A discussion with the landholder was undertaken on the 4th of November 2022 by AARC personnel regarding rehabilitation and closure planning. Key rehabilitation discussion points and outcomes were that:

- all erosion gullies should be reprofiled so that no steep drops remain post-mining;
- preferred species for revegetating flat areas to be retained per landholder agreement are Stylo and Wynn Cassia, as cattle feed;
- two cement slabs are to be retained at closure, identified in Figure 5-1; and
- bunding around the highwall of the Alice Queen Mine Pit extends only part-way, bunding should be extended to prevent water from entering the pit and fencing installed around the highwall;

Pacgold is currently undertaking active consultation with the CYLC, as the representative of the Olkola Aboriginal Corporation, to develop a Cultural Heritage Management Plan. This has provided ample opportunity to address rehabilitation and closure matters. Rehabilitation and PMLU has been discussed during these sessions, but not recorded, and no concerns have been raised regarding the current plan to rehabilitate the land to the PMLU nominated in the land outcome document (refer to Section 5.1). The CYLC is aware of the development of this PRCP and will be provided with the PRCP for comment.

4.2 Stakeholder engagement plan

To meet the requirements of section 126C(1)(c)(iv) of the EP Act, and the PRCP Guideline, Pacgold has developed the following stakeholder engagement plan (SEP) that aims to build upon existing engagement activities. The SEP is intended to act as a framework to guide consultation and ensure stakeholders are provided the opportunity to engage on, among other things, rehabilitation and closure matters relating to the Project.

The SEP, including the list of identified stakeholders, will be reviewed following any Project changes.

4.2.1 Key objectives

The objectives of the SEP and their relevance to PRC planning are detailed in Table 4-1.

Table 4-1: Stakeholder engagement plan objectives

SEP Objective	Description
Strengthen corporate social responsibility and maintain ongoing community relationships and trust.	Stakeholder interests and concerns will continue to be incorporated into rehabilitation planning and management. Where relevant documents or outcomes have been developed, these will be communicated to the relevant stakeholder upon completion.
Ensure transparent, open and informative stakeholder communication.	Communication of information to stakeholders will be undertaken in an appropriate format to ensure a common understanding of outcomes, objectives and any potential concerns or issues. Where appropriate, information will be made available promptly.
Inform and liaise with key stakeholders to ensure rehabilitation activities are undertaken to achieve the nominated PMLU.	Engagement will be undertaken on an <i>ad hoc</i> basis on the status of rehabilitation and the progression towards achieving the nominated PMLU. Stakeholders will be informed when key rehabilitation milestones are achieved.
Maintain key communication channels that stakeholders can utilise to provide feedback on Project rehabilitation activities.	Existing communication channels available to the key stakeholders will continue to be made available, such as primary engagement methods (face-to-face meetings and email). Additional communication methods will be implemented as and if required.
Identify processes for Pacgold to respond to community concerns and appropriately manage stakeholder expectations.	Feedback protocols will be adopted as part of a comprehensive response process to ensure community concerns (received in all formats - email, phone call, text or meeting) are responded to promptly and with the correct information. All forms of feedback will be recorded within a register to identify any stakeholder engagement trends which can be appropriately responded to, managed and addressed.

4.2.2 Stakeholder groups

The identification of all relevant stakeholders, such as interested and affected, government bodies and referral agencies is important to ensure regional concerns and issues of the Project are adequately addressed during rehabilitation activities and relinquishment of the EA.

Due to the isolated nature of the Project area, the small population and current status of the Project, there are only a small number of key stakeholders. These stakeholders are detailed below:

- Underlying landholders of Alice River Station property;
- CYLC;
- Olkola Aboriginal Corporation;
- Department of Environment and Science; and
- Cook Shire Council.

4.2.3 Engagement methods

Face-to-face meetings or phone calls will be the principal engagement method during both the operational and rehabilitation phases. These meetings will offer stakeholders the opportunity to discuss any concerns or issues relating to rehabilitation and closure in accordance with the PRCP.

Consultation will be undertaken on an *ad hoc* basis. Stakeholders will be kept informed of relevant aspects of rehabilitation and closure and will be notified of any changes to the schedule or post-mining land outcomes.

4.3 Engagement record keeping and reporting

In accordance with section 126C(1)(c)(iii) of the EP Act, and the PRCP Guideline, Pacgold has developed a community consultation register as part of the approval requirements for the PRCP.

Following the approval of the PRCP, the register will be maintained to document each stakeholder consultation event (including all meetings, presentations, feedback, phone calls and written submissions). Information recorded on the register will include consultation dates, engaged community member(s), communication type, the information provided, key issues raised, response actions and/or outcomes and any commitments made by Pacgold. The register will provide an efficient mechanism to track, respond to and report on any feedback received, as well as provide a mechanism to measure stakeholder perception and views.

Pacgold is focused on maintaining a two-way conversation with stakeholders and the wider community and will actively seek feedback on the Project's impacts and benefits. The register will be in the format of an Excel spreadsheet accessible to those with a consultation role responsibility. Key messages and outcomes identified by the ongoing register will be communicated internally as a precautionary measure to guide future stakeholders and rehabilitation management.

A community consultation register template will be maintained throughout the life of the mine through to closure (Table 4-2).

Table 4-2: Community consultation register template

Date	Community Members	Consultation Type	Information Supplied	Issues Raised/Discussed	Response and Outcome
28/6/ 2017	Alice River landholder			access tracks and haul roads; flat areas around the old plant; cement slabs (except the slab under the plant); flat benches on the waste rock dumps; and the Alice Queen Mine Pit (which should be made safe for cattle and personnel).	Agreement relating to infrastructure to be retained.
4/11/2022	Alice River landholder	Face-to-face		All erosion gullies should be reprofiled so that no steep drops remain post-mining; Preferred species for revegetating flat areas to be retained per landholder agreement are Stylo and Wynn Cassia, as cattle feed; two cement slabs are to be retained at closure, identified in Figure 5-1; bunding around the highwall of the Alice Queen Mine Pit extends only part-way, bunding should be extended to prevent water from entering the pit and fencing installed around the highwall.	Signed landholder agreement to be adhered to.
09/09/2025	Alice River landholder	Information email & Face-to-Face		Agreement that the tailings dam PLMU will be grassland, rather than a grazing PLMU	Written record of agreement (signed 28/10/2025).

5 Post-mining land use

This Section of the PRCP describes and discusses the PMLUs proposed for the Project in accordance with section 126C(1)(d) of the EP Act.

In accordance with the Queensland Government's policy objectives defined in the *Mined land rehabilitation policy* (Queensland Government 2018), the general rehabilitation goals for the Project are to leave an area that is safe, stable, does not cause environmental harm and is able to sustain the PMLU.

5.1 Land outcome documents

Schedule F - Table 1 of the Project EA identifies various disturbance types, along with the projected disturbance areas, relevant post-mine land description and land capability classes for each disturbance type.

Schedule I - Figure 1 and Schedule I - Figure 2 of the EA also specify the locations of the various disturbance types. Consequently, the EA is considered to define the transitional land outcomes and is considered to satisfy the definition of a land outcome document (LOD) as per section 750 of the EP Act. These land outcomes form the basis of this PRCP. Schedule F - Table 1 of the EA has been reproduced as Table 5-1. Schedule I - Figure 1 and Schedule I - Figure 2 of the EA have been reproduced as Figure 5-1.

The disturbance types identified in the resource activity EA are generally equivalent to the rehabilitation areas (RAs) nominated in Section 6.2 and the post-mining land descriptions are interpreted as intended to be equivalent to the PMLUs discussed in Section 5.3.

Table 5-1: Final land use and rehabilitation approval schedule (EA Schedule F—Table 1)

Disturbance type	Maximum disturbance area (ha)	Pre-mining land description	Post-mine land description	Pre-mine land capability classification	Post-mine land capability classification	Analogue identification
Mine pit	2.0	Low Intensity Grazing	Stock water point	VII	VII	AS1 and AS2
Mullock dumps / waste rock dump	0.3	Low Intensity Grazing	Low Intensity Grazing	VII	VII	AS1 and AS2
Tailings dam	3.0	Low Intensity Grazing	Native Grassland	VII	VII	AS1 and AS2
Run-of-Mine pad	1	Low Intensity Grazing	Low Intensity Grazing	VII	VII	AS1 and AS2
Plant area	3.2	Low Intensity Grazing	Low Intensity Grazing	VII	VII	AS1 and AS2
Roads/tracks and concrete pads	0.8	Low Intensity Grazing	Low Intensity Grazing	VII	VII	AS1 and AS2
Scrap yards	0.14	Low Intensity Grazing	Low Intensity Grazing	VII	VII	AS1 and AS2

Disturbance type	Maximum disturbance area (ha)	Pre-mining land description	Post-mine land description	Pre-mine land capability classification	Post-mine land capability classification	Analogue identification
Topsoil stockpiles	1.1	Low Intensity Grazing	Low Intensity Grazing	VII	VII	AS1 and AS2
Infrastructure/Cleared areas	0.63	Low Intensity Grazing	Low Intensity Grazing	VII	VII	AS1 and AS2
Rehabilitated historical exploration areas	11.5	Low Intensity Grazing	Low Intensity Grazing	VII	VII	AS1 and AS2
Exploration	3.0	In accordance with condition A9-1*				

* Condition A9-1: All exploration activities carried out on the relevant mining tenure must comply with each of the standard environmental conditions contained in the most recent version of the Eligibility criteria and standard conditions for exploration and mineral development projects.

Condition F2-2 of the resource activity EA requires the EA holder to complete an investigation into rehabilitation of disturbed areas and submit a report to the administering authority proposing acceptance criteria to meet the grazing pasture outcomes and landform design criteria specified in the EA. The Rehabilitation Design Report (AARC 2019; Appendix G) was submitted to the administering authority in 2019, and the acceptance criteria form the basis of the final rehabilitation milestone criteria (refer to Section 6.3.3). The acceptance criteria for the mullock/waste rock dump(s) includes final landform parameters as specified in the EA. Specifically, Schedule F—Table 3 (Landform design) includes the projective surface area (ha) and the slope range (1(V):3(H)) which the waste rock dumps must meet. At closure, the waste rock material contained in any waste rock dumps (including mullock piles) on site will be placed into the tailings dam. This will have a twofold benefit, namely, it will assist in creating a final TSF that is a water shedding structure, and result in a relatively flat landform across the remaining Project area, which in turn will minimise the potential for erosion and landform failures. It is understood that the slope range criteria specified in the EA is an upper limit for the final slope of the waste rock dumps (i.e. a slope of 1(V): <3(H)) would meet the specified landform design criteria). Subsequently, the landform design criteria for slope range and projective surface area of the waste rock dump specified in the EA are considered to be met where the waste rock dump is removed and the land reprofiled to the surrounding condition.

Condition F2-1 of the EA requires that rehabilitated areas be comparable to two analogue sites, for a range of parameters. The two analogue sites are nominated in the EA, identified as AS1 and AS2, with condition F2-1(a) and F2-1(d) identifying the locations of the sites. However, during a site inspection in May 2019 undertaken while developing the Rehabilitation Design Report (AARC 2019; Appendix G), analogue site AS1 was found to occur within a previously disturbed area, making it unsuitable as an analogue location. Subsequently, it was recommended in the Rehabilitation Design Report that AS1 be relocated to an undisturbed area. Both of the EA analogue site locations AS1 and AS2 are located adjacent to a watercourse and are therefore not characteristic of the vegetation being rehabilitated. The selected revised locations are more appropriate to be used as representative sites for comparison with rehabilitating vegetation (refer to Section 8.2.2).

Monitoring of the analogue sites was undertaken in May 2021, and the following results were recorded in the rehabilitation report (AARC 2021a; Appendix D):

- Mean groundcover was found to comprise 32.8% live cover (excluding weeds), 36.6% organic litter, 28.5% bare ground, and 2.1% weed cover.
- Mean species richness (excluding weeds) was 21.5.
- Mean woody stem density was 700 per hectare.
- Mean canopy cover was 54% for trees and 7% for shrubs.

- Erosion at both sites was classified as 'Minor' (refer to Section 8.2.3 for erosion classification schema).

The new locations proposed in the Rehabilitation Design Report were selected to be representative of the natural topography and vegetation type in the area, and with a land use of 'low intensity grazing', consistent with the PMLU of rehabilitated areas. The updated locations (refer to Section 8.2.2) are proposed to be used to provide the benchmark for measuring rehabilitation performance of some rehabilitation milestone criteria (see Section 6.3.3). The EA will be amended to revise the location of the monitoring point AS1 and AS2, conforming with the location in this plan.

5.2 Planning scheme conformance

The Cook Shire Council Planning Scheme (2017) identifies the Project area as being within the Rural Zone which has a purpose defined as:

- a) provide for rural uses and activities;*
- b) provide for other uses and activities that are compatible with –*
 - i) existing and future rural uses and activities; and*
 - ii) the character and environmental features of the zone; and*
- c) maintain the capacity of the land for rural uses and activities by protecting and managing significant natural resources and processes.*

The Rural Zone accommodates a range of rural uses, including agriculture, and the Scheme encourages the retention and enhancement of natural features and protection of scenic landscape values.

5.3 Post-mining land use

In accordance with condition F1 of the EA, all areas disturbed by mining activities must be rehabilitated in accordance with Schedule F—Table 1 of the EA (refer to Table 5-1).

The PMLU for the Project has been approved as low intensity grazing, grassland, and stock water point. The goal of rehabilitation is that each area is to be rehabilitated to a standard safe to humans and wildlife, stable, non-polluting and able to sustain an agreed post-mine land use, in accordance with the rehabilitation completion criteria described in the Rehabilitation Design Report (AARC 2019; Appendix G). The RAs and PMLUs are outlined in Table 6-1 and shown in Figure 5-1.

As per the signed landholder agreement (Appendix E), some infrastructure will remain on site post-closure. The agreement states the holder of the EA (EPML00870113) may leave the following infrastructure features in situ on lot 11 on SP266613:

- access tracks and haul roads;
- flat areas around the old plant;
- cement slabs (except the slab under the plant);
- flat benches on the waste rock dumps; and
- the Alice Queen Mine Pit (which should be made safe for cattle and personnel).

This agreement was signed on the 28th of June 2017 and remains valid. The retention of these infrastructure features is consistent with grazing and therefore retains the PMLU of low intensity grazing designated in the Project EA. The waste rock dump will be removed at closure leaving a flat area; this area and the areas around

the plant will be seeded with pasture species (see Section 6.4.6.3). Two concrete slabs will be retained at closure, as per the landholder's instructions (refer to Figure 3-2 for their location).

A second agreement between the landholder and Pacgold was agreed on 28th October 2025, in which the landholder agreed that the Tailings Dam that will be backfilled with waste dump material near the camp gate, fenced and seeded to be a grassland (excluding cattle) (Appendix E).

The Land Capability Classification System uses an eight-class system to describe the levels of adaptability and freedom of choice of potential land uses (Classes I—VIII). The higher the rating number, the higher the number of limiting factors and constraints. Class VII applies across the entire the Project area. Class VII is defined as land not suitable for cultivation but on which pastoral use is possible only with careful management (Rosser *et al.* 1974). Given the general land use of grazing across the broader Project region, the proposed rehabilitation approach, that is primarily to rehabilitate the land to low intensity grazing pastures, is considered suitable for the Project.

Milestone criteria have been developed to track progress of rehabilitation towards achievement of the nominated PMLUs (see Section 6.3.3). The milestone criteria include measures of vegetation characteristics, reflective of the required rehabilitation outcomes. Rehabilitation monitoring and maintenance activities will include soil health assessment of prepared surfaces to demonstrate soil is suitable for vegetation establishment consistent with low intensity grazing and the land class capabilities of the land (see Section 8.2.5). Target vegetation will be achieved using seed mixes appropriate for grassland and low intensity pasture grazing (see Section 6.4.6.3), and revegetation will be monitored using statistical methods to verify that rehabilitated land will sustain the nominated land use (see Section 8.2). Final rehabilitated land will achieve post-mine land capabilities by ensuring land management inputs are not significantly greater than the surrounding equivalent land uses.

Existing rehabilitation is progressing towards achieving the stated rehabilitation completion criteria, as described in the Rehabilitation Design Report (AARC 2019; Appendix G), demonstrating the feasibility of rehabilitating the land to the nominated PMLUs.

In summary, the proposed PMLUs are consistent with the approved post-mining land description described in the Project EA (the LOD), the local Planning Scheme, the surrounding land use, and the expectations of the landholder. Therefore, the PMLUs of low intensity grazing and stock water point:

- are considered viable, having regard to the use of land in the surrounding region and the demonstrated rehabilitation success on the site;
- are consistent with how the land was used before the mining activity was carried out on the land;
- are consistent with authorised land uses; and
- will deliver, or aim to deliver, a beneficial environmental outcome.

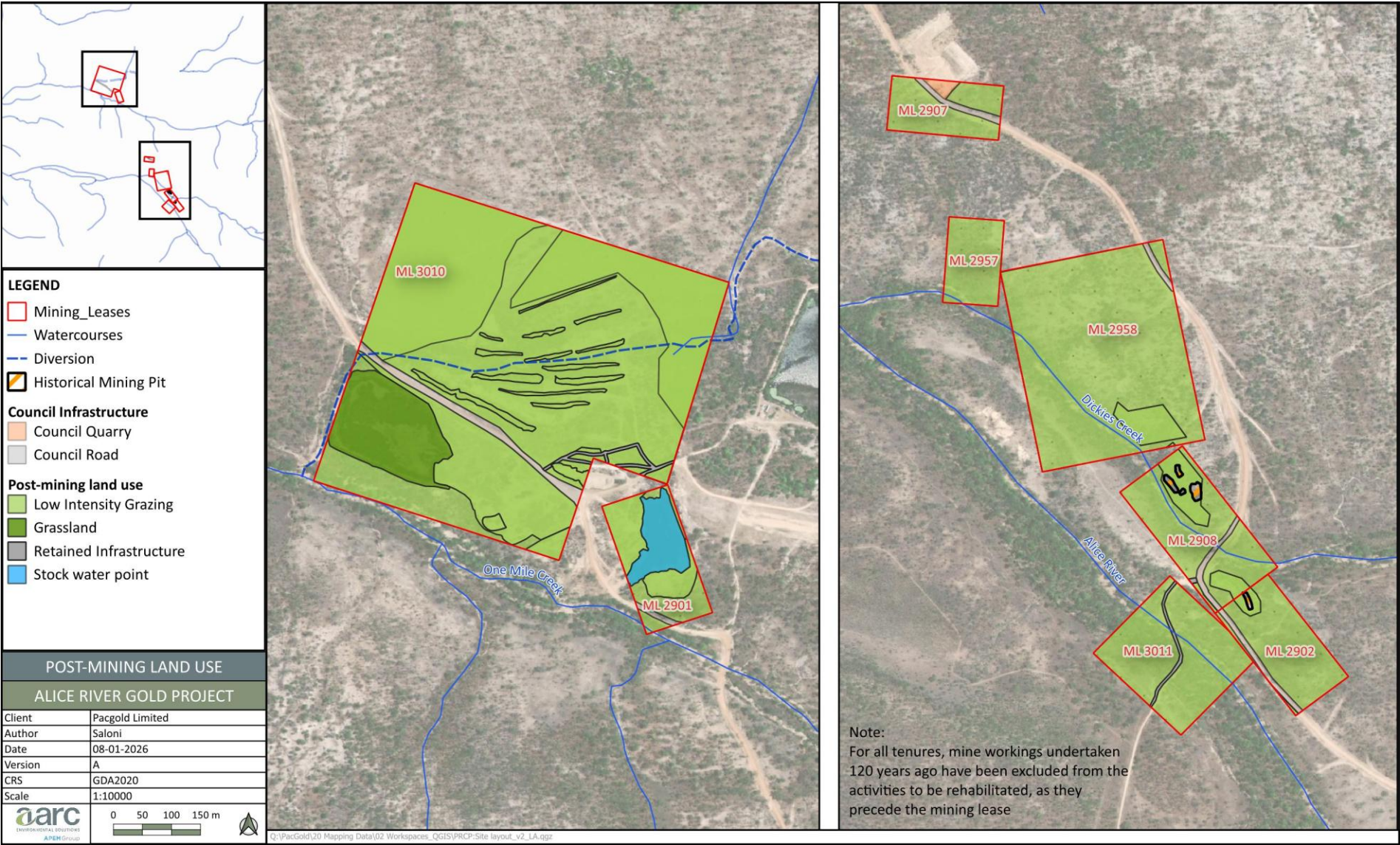


Figure 5-1: Post-mining land uses

6 Rehabilitation management methodology

6.1 Rehabilitation objectives

In Queensland, mine rehabilitation is required under the EP Act. Amendments to the EP Act in late 2018 implemented key elements (Section 111A of the EP Act) of the State Government's Mined Land Rehabilitation Policy (Queensland Government 2018) which intends to ensure that, for land disturbed by mining activities:

- the land is safe and structurally stable;
- there is no environmental harm being caused by anything on or in the land; and
- the land can sustain a PMLU.

These three objectives are the general rehabilitation goals for all areas disturbed by mining in Queensland.

6.2 Rehabilitation areas

To allow the development of a PRC schedule that satisfies the requirements of the PRCP Guideline, discrete rehabilitation areas (RAs) have been defined for the Project. RAs have been nominated for each area of disturbance within the Project area with consideration for the disturbance type, applicable rehabilitation activities and proposed PMLU. The RAs nominated for the Project area are detailed in Table 6-1 and shown in Figure 6-1. Notably, roads and tracks, and some concrete pads will be retained at closure, consistent with the landholder agreement (Appendix E).

The remaining surface area within the Alice River MLs will remain undisturbed for the duration of mining. As such, no RA is defined for this area and the existing land use will be retained post-closure (Figure 5-1).

Table 6-1: Nominated rehabilitation areas and post-mining land use

Rehabilitation area	Description	Post-mining land use	Post-mine land use classification	Post-mine land capability
RA1	Mullock dumps / waste rock dump	Low Intensity Grazing	VII	Low Intensity Grazing
RA2	Scrap yards	Low Intensity Grazing	VII	Low Intensity Grazing
RA3	Tailings Dam	Native Grassland	VII	Native Grassland
RA4	Topsoil Stockpiles	Low Intensity Grazing	VII	Low Intensity Grazing
RA5	Rehabilitated historical exploration areas	Low Intensity Grazing	VII	Low Intensity Grazing
RA6	Alice Queen Mine Pit	Stock water point	VII	Stock water point

Rehabilitation area	Description	Post-mining land use	Post-mine land use classification	Post-mine land capability
RA7	Run-of-Mine pad	Low Intensity Grazing	VII	Low Intensity Grazing
RA8	Roads/tracks and concrete pads	Low Intensity Grazing (retained Infrastructure – road/tracks and cleared land)	VII	Not applicable
RA9	Infrastructure/Cleared areas	Low Intensity Grazing	VII	Low intensity Grazing

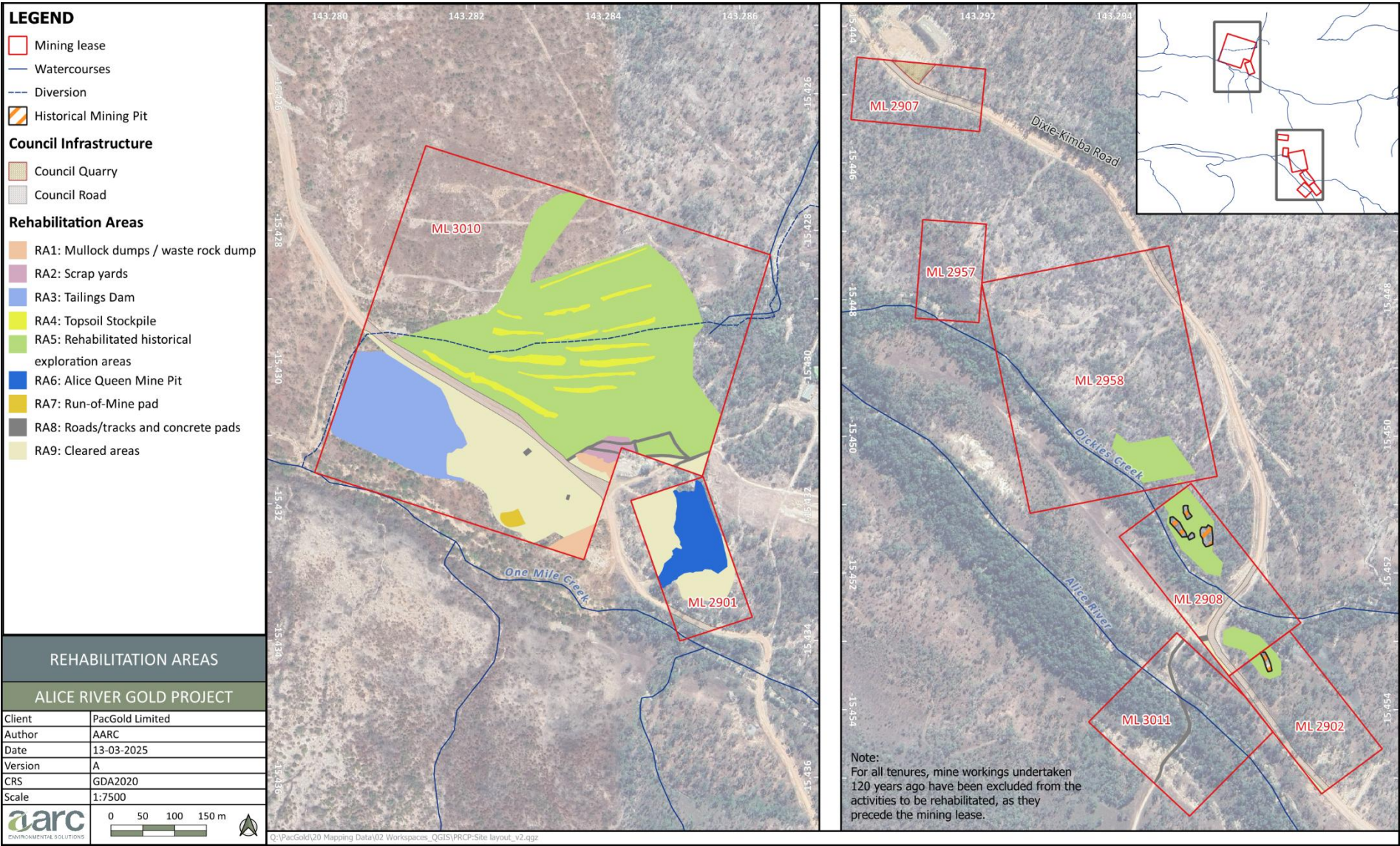


Figure 6-1: Rehabilitation areas

6.3 Rehabilitation milestones and milestone criteria

Rehabilitation milestones (RMs) are defined as each significant event or step necessary to rehabilitate an area of land to a stable condition (section 112, EP Act). Key to assessing the success of rehabilitation is the definition of milestone criteria. Milestone criteria must be consistent with the SMART (specific, measurable, achievable, realistic and timely) principles. They should:

- be outcome-based (linked to the end land use);
- be flexible to adapt to changing circumstances;
- be able to evolve as the mine life progresses;
- include metrics suitable to demonstrate that rehabilitation is trending positively;
- undergo periodic review; and
- include a measurement approach that details how the criterion will have been met (CoA 2016; ANZMEC and MCA 2000).

A set of milestone criteria has been identified for the Project to provide a clear definition of milestone completion and successful rehabilitation for each rehabilitation area. The milestone criteria demonstrate the completion of progressive rehabilitation steps and events. The completion criteria for each PMLU will be used as the milestone criteria for the final milestone in the proposed schedule, which shows achievement of the PMLU to a stable condition at surrender.

Rehabilitation milestone timeframes have been developed with consideration for the size of the rehabilitation area, the activities applicable to the milestone and the risk of achieving the milestone criteria within the nominated timeframe. Notably, milestones that involve revegetation activities, including monitoring of revegetation, make provision for unfavourable growing seasons and unforeseen extreme weather events such as droughts or storms that could negatively impact vegetation establishment, requiring longer timeframes for the milestone to be achieved. The nominated rehabilitation timeframes considered for scheduling the rehabilitation milestones (RMs) are justified in Section 6.3.2 and shown in Table 6-2.

6.3.1 Justification for when land becomes available for rehabilitation

The RMs must be achieved as soon as practicable after land becomes available for rehabilitation. Disturbed land is considered to become available for rehabilitation when the land is not being mined, unless, as per section 126D(5) of the EP Act:

- a) the land is being used for operating infrastructure or machinery for mining, including, for example, a dam or water storage facility, or*
- b) the land is identified in the proposed PRCP schedule or the application for an EA for relevant activities to which the schedule relates as containing a probable or proved ore reserve that is to be mined within 10 years after the land would otherwise have become available for rehabilitation, or*
- c) the land is required for the mining of a probable or proved ore reserve mentioned in (b), or*
- d) the land contains permanent infrastructure identified in the proposed PRCP schedule as remaining on the land for a PMLU.*

The Project site is currently under care and maintenance while Pacgold conducts exploration activities, with the intent of resuming mining in the future. Historical Resource data is provided in Pacgold is currently undertaking validation drilling to upgrade this historical Resource to JORC 2012 Compliant quality, including Probable and Proved categories. Monitoring and maintenance activities will continue to be undertaken in the interim.

Areas of RA4, which contains topsoil stockpiles will be in use until topsoil is relocated to other areas as part of rehabilitation activities. Consequently, these areas will not become available for rehabilitation until other RAs requiring topsoil have achieved RM4 (2032).

The roads, tracks and concrete pads (RA8) will be retained at closure, as per the landholder agreement (Appendix E), and will continue to be used by personnel to access the site for rehabilitation activities. The remainder of RA8 (cleared areas around the plant) will become available for rehabilitation in 2026.

Completion of the groundwater drilling program is scheduled for 2025. Most of the water bores were drilled in 2023 and 2024 to improve the understanding of groundwater, and connectivity. One bore, requiring native title approval, is scheduled to be drilled in 2025.

For each rehabilitation area, the rehabilitation milestone criteria will be achieved:

- for the cumulative area available specified in the PRCP schedule; and
- by the milestone completion date specified in the PRCP schedule.

Where land becomes ‘available for rehabilitation’ earlier than the date nominated in the PRCP schedule, Pacgold will:

- notify the administering authority in writing within 30 days of the land becoming ‘available for rehabilitation’; and
- describe in the notification why or why not it considers that it would be reasonable and appropriate to amend the PRCP schedule; and
- unless otherwise agreed to by the administering authority in writing, amend the PRCP schedule in a way that maximises the progressive rehabilitation to a stable condition within the timeframe specified by the administering authority.

Once a rehabilitation milestone has been achieved, the milestone criteria will continue to be met, until a surrender is approved.

6.3.2 Rehabilitation milestones

6.3.2.1 Rehabilitation Milestone 1: Infrastructure decommissioning and removal

RM 1 represents the rehabilitation milestone whereby the rehabilitation area has been cleared of any infrastructure or material that does not form part of the nominated PMLU. Infrastructure decommissioning and removal will involve disconnecting and removal (or sale and removal, if appropriate) of all infrastructure including pipelines, fences not a part of the PMLU, buildings, machinery, equipment, road base, concrete slabs, waste material not authorised to be disposed on-site under EA and water management structures, except for infrastructure to be retained per written agreement with the landholder (Appendix E). Infrastructure to be retained includes roads, tracks and two concrete slabs, as shown in Figure 5-1.

Decommissioning activities are considered low risk and are expected to take no longer than 2 years.

RM 1 applies to RA1, RA2, RA3, RA4, RA6, RA7, RA8, and RA9.

6.3.2.2 Rehabilitation Milestone 2: Management of contaminated land

RM 2 represents the rehabilitation milestone whereby contaminated material likely to cause environmental harm has been identified and managed. A contaminated land investigation of relevant areas will be undertaken by an appropriately qualified person to determine the presence and nature of any contaminants. Where the assessment finds evidence that contamination is from past mining activities (as distinct from naturally occurring elevated geochemistry backgrounds), contaminated material will be remediated in situ or placed in the tailings dam prior to closure or removed from site.

A validation report will be prepared, detailing the remediation of contaminated land and, if required, a site investigation report prepared by a suitably qualified person that states that the land is suitable for use according to the nominated PMLU. Where required, a validation report and/or a draft site management plan will be prepared. A suitably person will be required to certify that no contamination unsuitable for the PLMU remains or is occurring.

A timeframe of 1 year allows sufficient time to undertake contaminated land assessments and to address contamination if identified.

RM 2 applies to RA1, RA2, RA3, RA7, RA8 and RA9.

6.3.2.3 Rehabilitation Milestone 3: Landform development (reshaping/reprofiling)

RM 3 represents the rehabilitation milestone whereby all bulk earthworks are completed, and the rehabilitated landform has achieved the nominated design criteria, where applicable. Material from the waste rock dump and mullock dumps (RA1) and the ROM pad (RA7) will be pushed to backfill the tailings dam (RA3). Where required, disturbed land will be reprofiled to suit the surrounding landform and minimise slopes to less than 1:3.

Landform development of the Alice Queen Mine Pit (RA6) will include extending the existing earthen bund to prevent surface runoff from the surrounding landform from entering the pit and vehicle access. Fencing will be installed along the highwall. The wall of the void will be the angle of mining and achieving a Factor of Safety >1.5.

For the tailings dam (RA3), this will include constructing a low slope angle scalloped landform that will be self-draining (water shedding) and enable surface runoff to flow off the surface (discussed in detail in Section 6.4.7.2). The relevant structures will be consistent with the landform closure design report, which is to be prepared. Unless removed, the waste rock dump will have a slope percentage range $\leq 1(V): 3 (H)$. Fencing will be installed to prevent stock impacting the cover system.

A geotechnical assessment will be undertaken by an appropriately qualified person to confirm that the remaining structures, being the tailings dam (RA3) and the Alice Queen Mine Pit (RA6), are geotechnically stable.

A landform closure design report will be prepared for the relevant structures, that will include the following:

- Design aims and objectives of final landform, including the cover system and batters;
- All actions recommended within the RGS Soil capping and mine waste assessment and tailings dam rehabilitation report (RGS 2023) to verify the validity of the proposed cover and the mass of Ca(OH)_2 and CaCO_3 required to achieve design objective;
- All actions recommended within the Alice River Gold Project Progressive Rehabilitation and Closure Plan Geotechnical Assessment Report (AARC 2022);
- How the cover system achieves a performance outcome equivalent to or better than the design provided in the PRC Plan dated 21 March 2025 (v5);
- How the cover system performance will be demonstrated;
- The intended design life of the component parts of each relevant structure including the cover, plateau, batters, access points, water management, and associated monitoring network;

- Quality assurance and quality control required during construction;
- How the landform achieves acceptable geotechnical and erosional stability;
- How the landform achieves an acceptable water quality outcome;
- How redundancy of the monitoring network has been identified and built into the final design;
- How the design, including the component parts supports the achievement of the grassland PMLU;
- The critical design elements and associated assessment that support the achievement of a stable condition;
- Where any assumed or inferred material properties have been used in the design or its assessment (inclusive of modelling), detailed discussion justifying why actual/measured properties were not used, how uncertainties regarding material properties may affect performance, and how those uncertainties are managed.
- Details of the minimum monitoring required, including the type of monitoring, location/s, frequency and performance indicators, to demonstrate ongoing stability and performance in support of achieving a stable condition.

The documents will be peer reviewed by an independent appropriately qualified person to certify that the landform closure design report is fit for purpose, and will achieve a stable condition in a post closure context.

On completion of construction and reprofiling of the final landform, inspection and reporting will be undertaken to ensure the landform development and reshaping have been undertaken per the accepted final landform design criteria.

For the tailings dam, the following activities will be undertaken:

- A low slope angle scalloped landform will be constructed, that will be self-draining/water shedding (will not store surface water) and enable surface runoff to flow off the surface of the tailings dam.
- Ore stockpiles, mullock pile waste and all other ex-pit mine materials will be recovered. They will be screened to < 200 mm particle size diameter using a grizzly to retain the > 200 mm particle size distribution (PSD) material. The screening will assist with constructing and placing material.
- The < 200 mm PSD material from the ore stockpiles, mullock pile waste and other material will be placed into the tailings dam void.
- The vegetation, and 100 to 200 mm of the surface profile of the tailings, will be graded off the surface of the tailings dam to either side of the tailings dam and stockpiled as tailings growth medium.
- If additional material is required to achieve a water shedding design, it will be sourced from regolith material taken from the Alice Queen Mine Pit.
- The surface tailings material and vegetation will be replaced over the shaped tailings profile.
- Material reserved from the regolith strata in Queens Pit and other regolith material from the mullock piles and ore stockpiles (PSD material > 200mm particle size), will be spread over the surface of the tailings growth medium.
- The drainage line along the base of the scalloped profile will be a 50 to 75% surface cover of rock.

The most significant bulk earthworks will involve moving material from the waste rock dump (RA1) and ROM pad (RA7) into the tailings dam (RA3), which is expected to take no longer than 1 year. If additional material is required for the tailings dam to achieve a water shedding design (discussed further in Section 6.4.7.2), this will be sourced from regolith material taken from the Alice Queen Mine pit (RA6).

RM 3 applies to RA1, RA2, RA3, RA4, RA6, RA7 and RA9.

6.3.2.4 Rehabilitation Milestone 4: Surface preparation (topsoiling/contouring/soil amelioration)

RM 4 represents the rehabilitation milestone whereby the rehabilitation area has been prepared to a standard that is conducive to seed germination and plant growth.

A soil health and suitability assessment will be completed by a suitably qualified person to verify that the growth medium is suitable for achieving the intended PMLU. If required, soil ameliorants will be applied at the recommended rates to ensure sodicity, salinity, pH and fertility levels are suitable to achieve the relevant PMLU. Final landforms will be topsoiled to achieve a depth of at least 100 mm, and ameliorants applied and incorporated into the surface; and the soil surface will be deep ripped along the contour of slopes to produce favourable conditions for seed germination and plant growth.

Surface drainage features will be installed where necessary.

At least one year of surface and groundwater monitoring will have been undertaken.

RM 4 applies to RA1, RA2, RA3, RA4, RA7 and RA9.

6.3.2.5 Rehabilitation Milestone 5: Revegetation (seeding and/or planting)

RM 5 represents the rehabilitation milestone whereby the rehabilitation area has been completely seeded with the appropriate seed mix and/or planted with tube stock. Following seeding/planting of target species (Table 6-8), the rehabilitation area will be monitored for evidence of seed germination and seedling survival.

Records of revegetation activities will be maintained, and documentation of the following details will be used to indicate completion of the milestone:

- GIS files of the areas where seeding and planting have occurred, where areas of different soil material, seed mixes, or dates of planting are mapped separately;
- date the seed mix was applied, or planting of tube stock was carried out;
- if seeding, the seed mix and rate of seeding applied; and
- if planting, the number and species of tube stock planted.

The seed mix will include at least five grass species that are the food source of the Golden-Shouldered Parrot. Seeding/planting is expected to occur in conjunction with, or closely following, surface preparation activities. Planting must be timed to coincide with favourable climatic conditions; therefore, a timeframe of 2 years has been allocated to achieve both RM4 and RM5. Stock exclusion fencing will be established to prevent stock from grazing newly seeded areas.

RM 5 applies to RA1, RA2, RA3, RA4, RA7 and RA9.

6.3.2.6 Rehabilitation Milestone 6: Achievement of surface requirements

RM 6 represents the rehabilitation milestone whereby the surface of the rehabilitation area has achieved the intended groundcover and erosional stability for the nominated PMLU. Rehabilitated areas will be assessed against target criteria and compared to analogue sites of similar characteristics and land use. Analogue sites are discussed further in Section 8.1.

Total live groundcover and species richness in understorey will be monitored to meet consistently over three years, comparable to analogue sites (AS1, AS2). Pacgold will monitor the rehabilitation area for evidence of at least four target species and will monitor to ensure weed cover is lower than analogue site for consistently three years. As achieving target revegetation criteria is dependent on good climatic conditions, poor growing seasons and extreme weather events can hinder vegetation establishment and may require maintenance actions such as reseeding or infill planting. Pacgold will monitor for evidence of no 'severe' or 'extreme' erosion and will analyse the surface water runoff quality from the TSF during surface flow events. A TSF technical review report will be completed by an appropriately qualified person to verify that the TSF is progressing to achieve a stable condition. A timeframe of 5 years is considered sufficient to achieve the target criteria for

three consecutive years while allowing some leeway for environmental factors that may hinder vegetation establishment.

RM 6 applies to RA1, RA2, RA3, RA4, RA5, RA7 and RA9.

6.3.2.7 Rehabilitation Milestone 7: Achievement of low intensity grazing and grassland PMLUs to a stable condition

RM 7 represents the rehabilitation milestone whereby the landform has achieved all requirements of the target PMLU.

Target criteria for low intensity grazing PMLU includes, but is not limited to, pasture productivity by pasture mass (kg DM/ha) is statistically comparable to analogue sites on the same soil management unit (SMU), consistently over three years. Pasture mass within this metric is a standard unit of measuring productivity (Cayley, JWD & Bird PR, 1996; Meat & Livestock Australia, 2009).

To successfully achieve this milestone of the target PMLU, a timeframe of 20 years (an additional 15 years from the completion of RM6) is considered necessary from the date of surface preparation and seeding. This timeframe considers the time required to establish self-sustaining vegetation with canopy cover approaching that at analogue sites. Monitoring data should demonstrate that the land is safe, structurally stable, does not cause environmental harm, and can sustain the PMLU. The evidence will include weed cover, species richness in overstorey, utilisation of native fauna. An appropriately qualified person will undertake a land capability assessment to ensure the land has achieved a minimum of Class VII. Pacgold will monitor to ensure there is no 'severe' or 'extreme' erosion, wherein erosion gullies will be lower than 0.3 m deep. For the grazing PMLU, species composition, species distribution, and dry matter (kg/ha) will need to be comparable to analogue sites.

Groundwater monitoring will be undertaken to ensure that environmental risks are managed and there are no adverse impacts on groundwater quality.

Surface water and stream sediment quality will be measured monthly during flows to check if the receiving environment is consistent with the upstream levels.

An appropriately qualified person will undertake assessment of hazard and safety to verify that the hazards in each rehabilitation area are consistent with the type and severity of the hazards typical of the adjacent equivalent land use. The hazard assessment will verify that TSF is structurally stable and erosionally stable.

The density of woody stems will be monitored to remain at least similar to the analogue sites for RA1, RA2, RA4, RA5, RA7 and RA9.

Exploration activities will be rehabilitated based on the latest Eligibility criteria and standard conditions for exploration and mineral development projects.

Allowance is also given for potential risk management and adverse weather conditions that may drive additional maintenance works or infill planting.

RM 7 applies to RA1, RA2, RA3, RA4, RA5, RA7 and RA9.

6.3.2.8 Rehabilitation Milestone 8: Achievement of stock water point PMLU to stable condition

RM 8 represents the rehabilitation milestone whereby the landform has achieved all requirements of the target PMLU.

Monitoring data should demonstrate that the water point is safe and stable and certified by an appropriately qualified person. Where required, the surface water quality will be measured to check its consistency with upstream levels. Pacgold will monitor water quality in the pit to ensure it meets the water quality limits mentioned in Table 8-7.

An appropriately qualified person will monitor and certify if pit walls achieve an appropriate Factor of Safety of at least 1.5. The depth and quality of the water in the voids will be monitored to check if the void is stable and

non-polluting by a suitably qualified person. Pacgold will monitor to ensure all slopes are geotechnically stable and certified. Where required, pit will be fenced to ensure safe access for stock watering. Visual aids that measure depth will be installed to monitor water levels.

A timeframe of 10 years has been assigned to successfully achieve this milestone of the target PMLU. This timeframe assumes that the pit will take 15 years (maximum) from the date the land becomes available to refill to a level safe for livestock access, and for water quality to meet livestock drinking water quality guideline criteria.

RM 8 applies to RA6.

6.3.2.9 Rehabilitation Milestone 9: Achievement of retained infrastructure PMLU to stable condition

RM 9 represents the rehabilitation milestone whereby the landform has achieved all requirements of the target PMLU.

To successfully achieve this milestone, a timeframe of 1 year is considered adequate to conduct a Hazard and Safety Assessment and to confirm that all retained infrastructure forms part of a landholder agreement.

Pacgold will monitor to ensure appropriate paths are in place for drainage and that there is no 'moderate' or 'severe' erosion. A survey will be undertaken to confirm there are no additional built structures.

RM 9 applies to RA7, RA8 and RA9.

6.3.3 Rehabilitation milestone criteria

A set of completion criteria have been developed for each RM, as shown in Table 6-2. It should be noted that not all RMs apply to each RA; the RA(s) to which each RM applies are indicated in Table 6-2.

Table 6-2: Rehabilitation milestone criteria

Code	Milestone	Completion criteria	Applicable rehabilitation areas	Typical timeframe
RM 1	Infrastructure decommissioning/removal	- With the exception of any infrastructure to remain as part of the PMLU or where infrastructure is agreed to be retained by the landholder as evidenced by a signed landholder agreement, the following are complete: - All services disconnected, terminated and removed. - All hardstand, concrete, bitumen and gravel roads removed. - All pipelines drained and removed. - All fencing and associated foundations that is not part of the PMLU removed. - All buildings demolished and removed off-site or have otherwise been removed from site. - All machinery and equipment, not required for rehabilitation works, removed. - All surface water drainage infrastructure removed, excluding permanent features that form part of the final landform. - All waste not authorised to be disposed of on-site under Environmental Authority EA EPML00870113 removed.	RA1, RA2, RA3, RA4, RA6, RA7, RA8, RA9	1 year
RM 2	Management of contaminated land	- A contaminated land investigation assessment to be completed in accordance with the <i>Environmental Protection Act 1994</i>, including a site investigation report, and, where required, a Validation Report and/or a draft Site Management Plan is prepared. - A SQP certifies that no contamination unsuitable for the PMLU remains or is occurring.	RA1, RA2, RA3, RA7, RA8, RA9	1 year
RM 3	Landform development (reshaping/reprofiling)	- All bulk earthworks and landform reshaping/reprofiling works complete in accordance with the design specification provided by an AQP. - Relevant structures developed and/or reshaped, such that they are consistent with the landform closure design report. - Final landform of Waste Rock Dump (RA1) meets the design parameters unless otherwise removed for rehabilitation:	RA1, RA2, RA3, RA4, RA6, RA7, RA9	1 year

Code	Milestone	Completion criteria	Applicable rehabilitation areas	Typical timeframe
		- o slope range (%) ≤ 1 (V): 3 (H) • Final landform of Alice Queen Mine Pit (RA6) meets the following design parameters: - o void wall – competent rock slope = Angle of mining; - o void wall – incompetent rock slope = Angle of mining; - o achieves a Factor of Safety >1.5; - o bunding constructed around the highwall prevents vehicle access and surface runoff from entering the pit; - o fencing installed around the highwall; - o low wall ramp provides stock access to pit lake. • Final landform of the tailings dam (RA3) meets the following design parameters: - o slope range within perimeter of embankment = 3-5 %; - o achieves a water shedding design; - o fence installed to prevent stock impacting cover system. • Geotechnical assessment by an AQP confirms long-term geotechnical stability with a factor of stability (FOS) >1.5 has been achieved for each relevant landform. • An “As-Constructed Report” prepared which details and justifies all variations to the design, including a certification that such variations will not affect the design performance. • All landforms are shape to be water shedding. • AQP has certified the achievement of RM3.1-3.8.		
RM 4	Surface preparation (topsoiling/contouring/soil amelioration)	• Soil/growth media health and suitability is assessed and documented by an AQP as suitable to achieve PMLU. • Where the growth media health and suitability assessment identify a deficiency, a recommendation is made for ameliorants to ensure sodicity, salinity, pH and fertility levels are suitable to achieve the relevant PMLU. • Where required, topsoil placed to achieve a target depth of ≥ 100mm and ameliorants applied and incorporated into surface, as identified in RM4.2.	RA1, RA2, RA3, RA4, RA7, RA9	2 years to achieve RM4 and RM5

Code	Milestone	Completion criteria	Applicable rehabilitation areas	Typical timeframe
		- Ripping undertaken along the contour of slopes. - Following amelioration as per criteria RM4.2, representative soil testing of growth media and assessment by an AQP confirms sodicity, salinity, pH and fertility levels are suitable to achieve the relevant PMLU. - The surface and groundwater monitoring has commenced (at least one year of sampling undertaken).		
RM 5	Revegetation (seeding and/or planting)	- Seeding topsoil surfaces by seeding/planting target species as specified in Table 6-8: Seed mix and application rate¹. - For each PMLU, the seed mix should comprise a minimum of five grass species, including two 3P species, and three species known to be the food source of the Golden-Shouldered Parrot. - Stock exclusion fencing has been established to prevent stock from grazing newly seeded areas.	RA1, RA2, RA3, RA4, RA7, RA9	
RM 6	Achievement of surface requirements	- Minimum four (4) target species established. - Total live groundcover (excluding weeds) is consistently² similar to, or higher than analogue sites (AS1, AS2) (Table 8-1). - Species richness in understorey is consistently² similar to, or higher than analogue sites (AS1, AS2) (Table 8-1). - Weed cover is similar or consistently² lower than analogue sites (AS1, AS2) (Table 8-1). - No evidence of erosion classified as 'moderate' or 'severe', as defined by Table 8-6: Erosion classification framework. - Surface water runoff has been collected from TSF when surface flows occur and it is safe to do so. - Surface water runoff complies with Table 8-7 - Surface water quality limits. - The growth media (topsoil and subsoil) physical, chemical and biological properties does not limit vegetation cover performance or restrict the potential effective depth of rooting. - Monitoring data collected per final landform design report and technical assessments indicate that the TSF is on a trajectory to achieve a stable condition. - An AQP has inspected the TSF and following a review of all relevant material has certified, via a technical review report:	RA1, RA2, RA3, RA4, RA5, RA7, RA9	5 years

Code	Milestone	Completion criteria	Applicable rehabilitation areas	Typical timeframe
		- o the design aims and objectives as per PRCP15 have been demonstrated to have been achieved; - o all monitoring data has been collected per landform design report; - o the TSF is erosionally stable; - o surface water runoff exhibits stable or decreasing trends and no adverse environmental impacts to receiving waters is occurring; and - o The TSF is on a trajectory to achieve a stable condition.		
RM 7	Achievement of low intensity grazing and grassland PMLUs to a stable condition	• Hazard and safety assessment completed by an AQP demonstrates that hazards in RAs are consistent with the type and severity of hazards typical of the adjacent equivalent land use. Remaining hazards are considered to be low risk with no significant increase in risk expected over time. • The land is structurally and erosionally stable. • Total vegetative groundcover $\geq$ 50% established and persistent. • Species used in revegetation show evidence of natural recruitment in rehabilitation monitoring data. • Weed cover is similar or consistently² lower than analogue sites (AS1, AS2) (Table 8-1). • Restricted invasive plants (as defined in the <i>Biosecurity Act 2014</i>) comprise $\leq$5% of vegetation groundcover. • Evidence of overstorey species recruitment in low intensity grazing PMLU. • Canopy cover similar to, or higher than analogue sites (AS1, AS2) (Table 8-1) in low intensity grazing PMLU. • Woody stem density is consistently² similar to, or higher than analogue sites (AS1, AS2) (Table 8-1) for RA1, RA2, RA4, RA5, RA7, RA9. • No evidence of erosion classified as 'moderate' or 'severe', as defined by Table 8-6 – Erosion classification framework. • Any erosion present will not compromise the achievement of a PMLU to a stable condition. • Evidence of native fauna utilisation. • Grazing pastures achieve the following outcomes:	RA1, RA2, RA3, RA4, RA5, RA7, RA9	15 years

Code	Milestone	Completion criteria	Applicable rehabilitation areas	Typical timeframe
		- o a self-sustaining vegetation with projective cover, species composition and species distribution comparable to analogue sites; - o a measure of productivity dry matter (kg/ha) estimated to be comparable to analogue sites for low intensity grazing PLMU areas. • Land capability assessment undertaken by an AQP confirms that land has achieved a minimum of Class VII. • Exploration activities are rehabilitated in accordance with the latest version of the Eligibility criteria and standard conditions for exploration and mineral development projects (ESR/2016/1985). • Surface water quality results monitored monthly during flow and releases from the Alice Queen Pit but not limited to, downstream locations specified in Table 8-8; must not exceed the limits in Table 8-7, for a minimum of 5 consecutive years. • If the surface water quality exceeds criteria RM7.18, the applicable upstream site must be compared to the downstream site result; and quality result measured at a downstream site must be equal to or less than the quality result measured at the applicable upstream site¹. • Stream sediment quality monitored at, but not limited to, monitoring locations specified in Table 8-8; undertaken twice a year (at end of wet season and end of dry season) complies with ANZECC/ARMCANZ (2000) Interim Sediment Quality Guidelines – low, for a minimum of 5 consecutive years. • For a minimum of five consecutive years groundwater quality must be monitored quarterly at, but not limited to, locations specified in Table 8-5, for all quality characteristics listed in Table 8-7. • Groundwater quality results must not exceed the limits in Table 8-7, for 3 consecutive results. • AQP has reviewed all relevant material and has certified via a technical report that the TSF has achieved a stable condition.		

Code	Milestone	Completion criteria	Applicable rehabilitation areas	Typical timeframe
RM 8	Achievement of stock watering point PMLU to stable condition	- Retained stock watering storage water quality is below the trigger values for livestock drinking water defined in ANZECC & ARMCANZ 2000, for a minimum of 5 years. - Water point is safe and stable. - Hazard and safety assessment completed by an AQP demonstrates hazards in RAs are consistent with the type and severity of hazards typical of the adjacent equivalent land use. Remaining hazards are considered to be low risk with no significant increase in risk expected over time. - Pits walls to achieve an appropriate Factor of Safety (FoS) greater than, or equal to 1.5. - All slopes are geotechnically stable. - Depth measuring visual aids installed in the void and water levels are monitored. - Water storage is fenced to exclude cattle and people where unsafe, and ensure safe access for stock water via direct access or piped stock watering point. - AQP certifies achievement of RM8.1-8.7.	RA6	10 years
RM 9	Achievement of retained infrastructure PMLU to stable condition	- Certification from an AQP that a final landform survey confirms no infrastructure remain other than those that form part of a landholder agreement and all retained infrastructure onsite is safe, stable and will not cause environmental harm. - Hazard and Safety Assessment completed by an AQP demonstrates hazards in RAs are consistent with the type and severity of hazards typical of neighbouring equivalent land use. Remaining hazards are considered to be low risk with no significant increase in risk expected over time.	RA7, RA8, RA9	1 year

1 The Tailings Dam (RA3) is to be revegetated with Native Grass, Pasture Grass and Native Forb/Herbaceous only. Cleared areas (RA9) are to be revegetated with Pasture Grass species only. Refer to table Grazing PMLU seed mix.

2 *Consistently* means that the criterion is met for a minimum of three consecutive years.

6.4 General rehabilitation practice

Rehabilitation objectives and rehabilitation milestone criteria for the Project are detailed in Section 6.1 and Section 6.3.3 respectively. The following overarching principles are considered key for successful rehabilitation delivery:

- Ensuring that reshaped areas proposed for rehabilitation meet the required landform design principles, that prepared areas meet the rehabilitation design specification for the area, and that local site drainage has been considered and surrounding areas graded to mitigate any rainfall runoff from adjacent areas to run-on to prepared RAs.
- Utilising topdressing materials, final surface preparation methods and soil amelioration activities to support vegetative growth.
- Selecting revegetation species, seeding and/or planting methods, and fertiliser applications to target rapid vegetative ground cover effective at mitigating soil erosion, during the period of initial revegetation when areas are most at risk.
- Conducting ongoing monitoring to assess rehabilitated area performance against milestone criteria, and to adapt rehabilitation practices to improve outcomes, and to identify maintenance or modification requirements such that RAs are proceeding along a trajectory towards the nominated PMLU.

6.4.1 Hydrogeology

6.4.1.1 Groundwater occurrence

The Project area's geology severely constrains groundwater's presence, yield and connectivity across the Project area. The site is dominated by highly crystalline, massive, igneous intrusive rocks such as granite and diorite, which allow little to no groundwater development, except in structures, fractures, contacts or other sources of secondary porosity. The variable nature and extent of structures with infill, healing and veining mean groundwater presence is highly variable (as in may not be present) and disconnected laterally and with depth across the site.

The poor development and limited presence of groundwater development (SeeBuiltEarth 2025; Appendix D) is indicated through the conceptual model, but also supported by:

- Site drillhole records indicating limited groundwater intersections (Figure 3-7), and when they do occur are typically at depths, with no evidence of laterally extensive aquifers. Groundwater presence is highly variable and appears structurally controlled, forming isolated and irregular water instances rather than forming a continuous groundwater system. There is also limited instances of water loss, vugs or voids reported.
- Drilling logs of recent bores described as dry bores with no water intersections, with verbal confirmation from driller personnel (B Turner (Centurion Drilling), pers communication 2024 in SeeBuiltEarth 2025; Appendix D): all bores drilled have encountered similar ground. The monitoring bores are shallow, low yield, and generally constructed as dry bores in the weathered profile, likely representing pore pressure storage and/or localised groundwater.
- Historical records describe some groundwater inflow during development of the shafts in the early years of Alice River in the 1900s, suggesting there may be limited water within the mineralised primary shear running through the modern day Alice Queen pit.
- Review of registered groundwater bores (QGlobe 2025) indicates the site is in a groundwater "desert", with a single well registered on the tributary to the south of One Mile, and no others until 72 km downstream (Figure 6-2). Locations of the few bores further afield correlate to alluvial areas. Bores developed up to 30 km upstream from the site at the top of the catchment suggest a different style of

groundwater occurrence associated with the Corella Formation, a limestone-rich formation present across the top of the catchment.

- Alignment of the site observations and characterisation aligning to the hydrogeological province as a localised flow system of low productivity (Figure 3-11).
- The ephemeral flow nature of One Mile Creek is dry for most of the year: if groundwater were a contributor to surface water and One Mile, persistent pooling or longer term within the creek would be observed.

Characterisation of groundwater occurrence for the Alice River site can therefore be described as occurring in three environments:

- Structure-controlled: Groundwater is uncommon, but where it does occur, when found, is in faults, fractures, and contacts within the bedrock where secondary porosity exists, including in mineralised structures. Groundwater in structures is highly localised, low yield, and disconnected across the field, likely creating compartmentalisation of groundwater.
- Weathering profiles: Groundwater is largely transient and undetectable when drilling. Bores in the weathered profile are dry on drilling and given low yield fill over time, reflecting pore pressure, with rises driven by rainfall infiltration.
- Alluvial zones: Within the One Mile Creek and outside of the mining areas, shallow subsurface groundwater may exist in alluvial zones. These likely occur in isolated pockets and are recharged by stream flow during wet seasons.

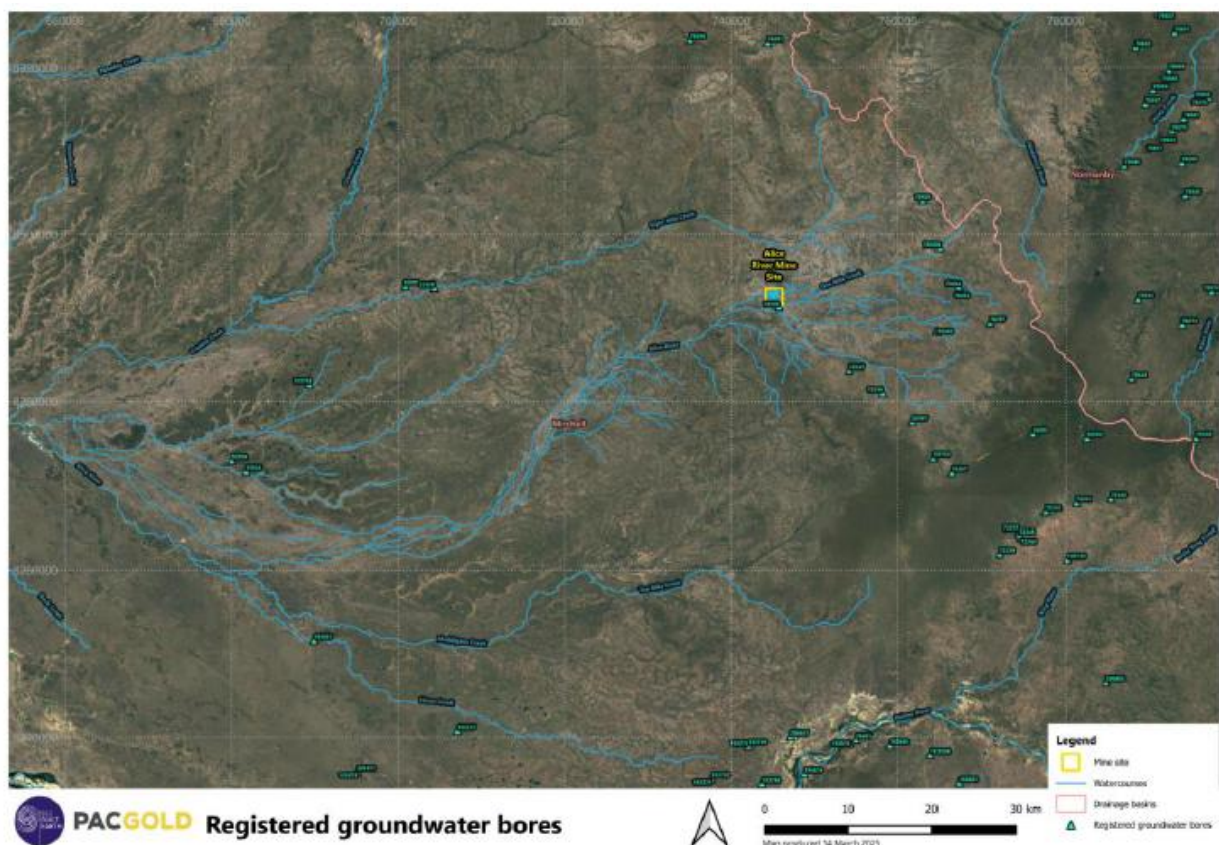


Figure 6-2: Registered groundwater bores

6.4.1.2 Hydraulic conductivity

With the crystalline geology, severely limited groundwater occurrence, and limited to absent yields during drilling of monitoring bores and drilling at the Alice River site; the hydraulic conductivity of groundwater is expected to be very constrained.

Recognised ranges by rock type in Figure 6-3 provided expected conductivities of 10^{-8} to 10^{-5} with some fractures, equating to the effect of clay (Freeze and Cherry 1979). This is outside of the disconnection of fractures across the field.

A basic adaptation of Darcy's Law using to the 2D hydraulic gradient of the December 2024 groundwater levels above the pit indicates flow rates of 10^{-4} to 10^{-8} into the pit lake. Engeny (2025: Appendix D) undertook a calibration exercise as a mass balance for the pit lake and identified balance at an inflow rate of 0.01l/s, equating to an effective conductivity of 10^{-7} .

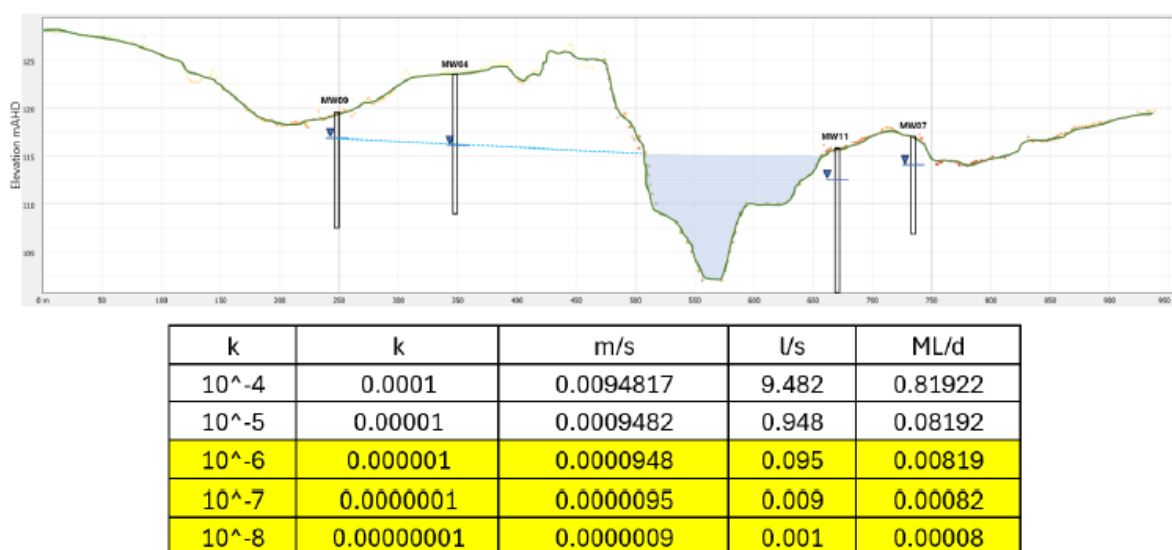


Figure 6-3: Analytical range estimates of inflow into pit lake

6.4.1.3 Groundwater levels and surface

Groundwater levels are monitored across ten bores. They were installed in three phases: late 2022, mid-2023, and late 2024. The results (Figure 6-4) provide insight into groundwater behaviour: the standing water levels (depth from surface); and groundwater elevations relative to key landscape features, including the pit lake; key elevations; and rainfall. Given the low and sparse occurrence, yield and connectivity of groundwater across the Project, groundwater levels are considered as representative of the potentiometric surface rather than a continuous groundwater surface.

Groundwater levels are generally shallow across the site, with seasonal fluctuations of 0.5-2 m depending on the bore and location, influenced by rainfall. Several bores (MW01, MW05, and MW07) exhibit a muted response with a smaller magnitude of fluctuation, while others show a more significant response to wet and dry conditions. Notably, bores MW08, MW09, and MW10 rose to within 2 m of the surface during the 2024-2025 wet season. These differing responses suggest two distinct environments: the muted bores are closer to the valley and exhibit lower relative water levels, while the others, located higher in the topography, show water level variations driven by rainfall under draining conditions.

The construction of historical pit levels from imagery suggests that the pit responds similarly to the lower wells, with fluctuations of only around 1 m, based on available records (noting significant time gaps between readings), and the consistency of an established tree line around the pit perimeter. The rate of variance in levels is far less than expected from evaporation over the dry season, and it indicates there is some ongoing groundwater baseflow into the pit, which equilibrates pit water levels.

The groundwater surface in Figure 6-5 shows a potentiometric surface capable of delivering some groundwater flow into the pit from the north, west and east (noting MW01 and MW07 are excluded based on proximity to One Mile Creek). Groundwater inflow is also supported by the presence of silica and strontium in pit lake water chemistry. The gradient continues to the south, and there is some potential for seepage from the pit to One Mile Creek based on potentiometric elevation.

The surface also illustrates a strong compartmentalisation for water levels across the site, particularly around the mineralised structure, and shows the disconnection formed by structures. However, the potential seepage would rely on hydraulic connectivity from the pit to the creek, and does not appear to be the case based on evidence of:

- Pit water levels are relatively constant over time, both in recent measurements and the consistent vegetation line around the lake perimeter. There would be more variation in water levels if leakage or drainage were occurring, particularly over dry spells.
- There is no observable evidence of seepage or leakage in the creek, either as seepage, moisture, or changes in vegetation near the area of intersection.
- Engeny (2025; Appendix D) pit lake water balance achieved calibration to level measurements with minor groundwater inflow and no leakage as a mass balance.
- Groundwater bore quality south of the pit differs from pit lake water quality.
- The initial assessment of water level loggers installed in the pit and MW07 in 2024 demonstrated variation in water level responses and recharge sources.
- There is potential for the “hard rock” potentiometric surface to pass below the base of One Mile Creek (MW12, MW07 and MW05), with the alluvial and creek bed sitting on top as a separate aquifer or potential for water storage (refer to section 6.4.1.6) as a perched system.

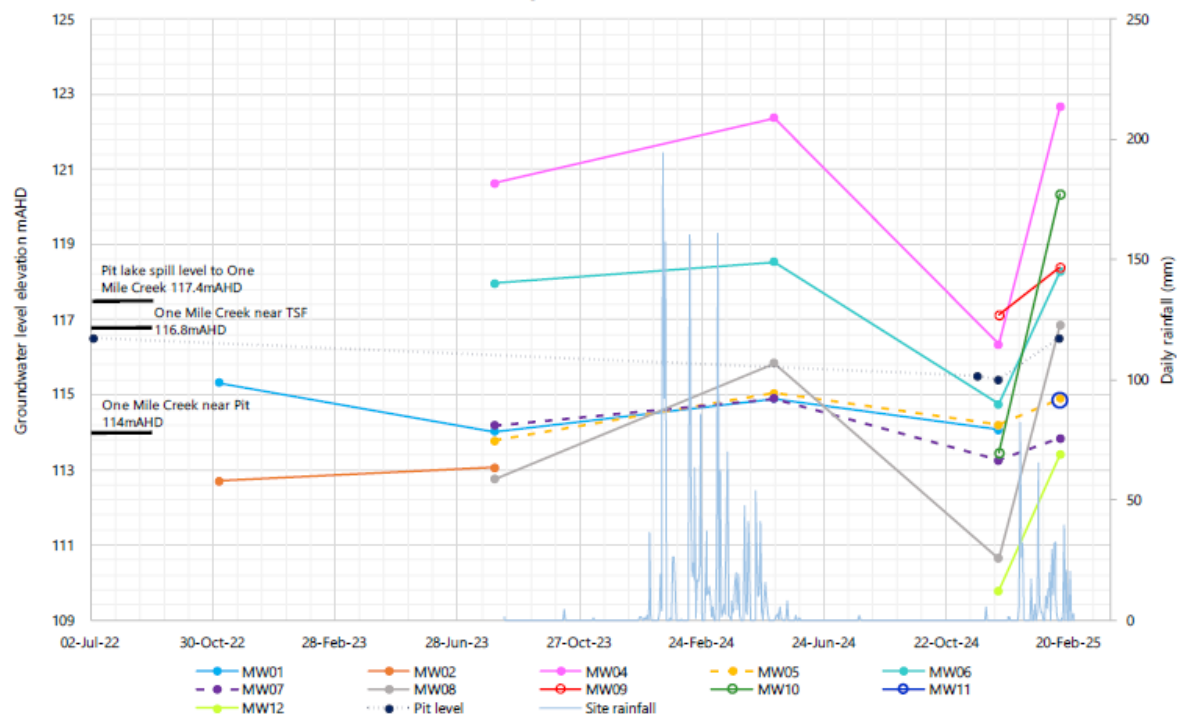


Figure 6-4: Groundwater standing water levels and Alice Queen pit lake relative water levels

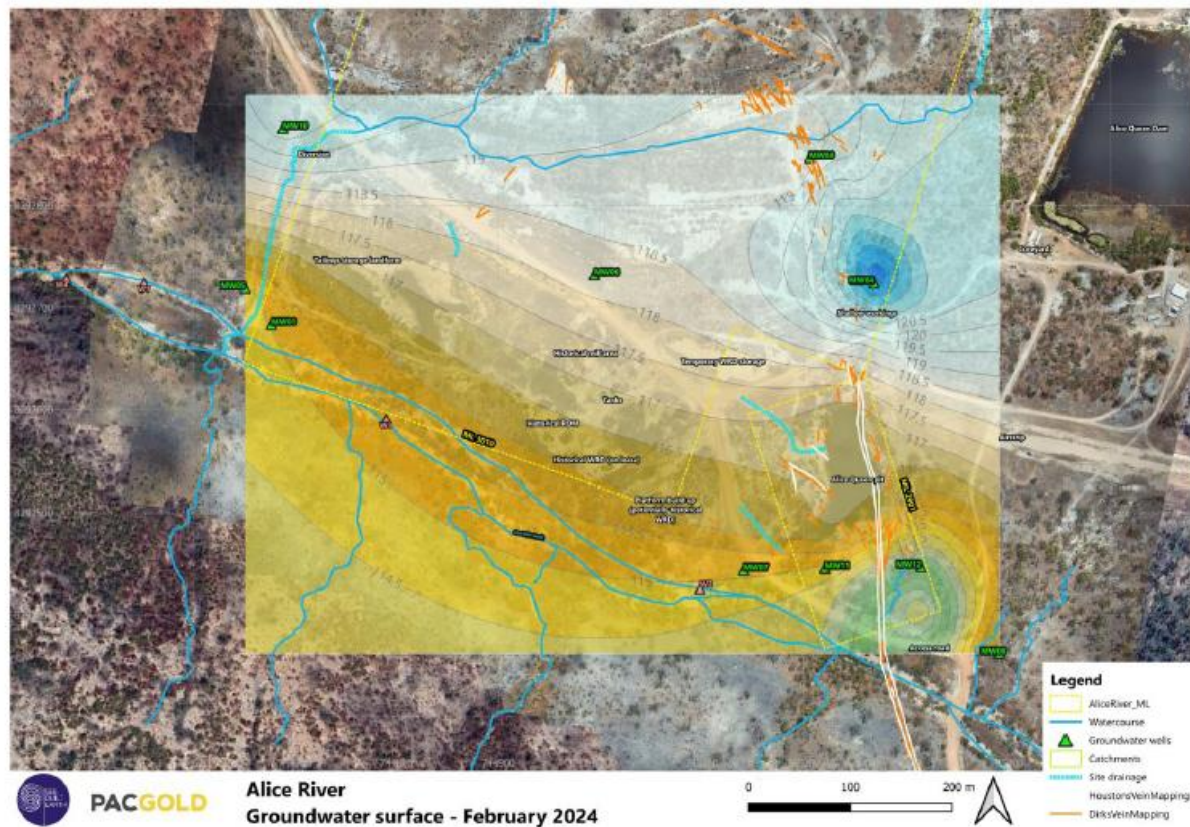


Figure 6-5: Groundwater surface for February 2025

6.4.1.4 Groundwater quality over time

Groundwater quality has been monitored across multiple locations to assess natural background conditions, interactions with mineralised zones, and potential influences from historical mining activities.

Current groundwater monitoring locations include:

- MW08 and MW09 represent background groundwater conditions, with MW09 situated within the mineralised ore zone. MW09 exhibits the highest natural arsenic and antimony concentrations, consistent with the mineralised setting.
- MW01, MW05, and MW07 are located near the ephemeral creek, suggesting potential for surface water-groundwater interactions, particularly after significant rainfall. These wells show variations in hydrochemistry, including pH and bicarbonate, which may reflect recharge conditions and interactions with subsurface materials. MW05 is near an outcrop of limestone.
- MW11 is located downgradient of the pit and within the mineralised zone, providing a reference for groundwater quality from the pit.
- MW04, MW06, MW10, and MW12 provide broader spatial coverage of groundwater chemistry variations across the site and surrounding areas: MW04 and MW12 lie in the mineralised area, and MW06 and MW10 upgrade the TSF.

SeeBuiltEarth 2025 (Appendix D) provides time series trends for key analytes, including pH, EC, bicarbonate (HCO_3^-), sulphate (SO_4^{2-}), chloride (Cl^-), total organic carbon (TOC), silica (SiO_2), antimony (Sb), arsenic (As), strontium (Sr), copper (Cu) and zinc (Zn). Key observations include:

- Groundwater across the site is fresh, with low EC and chloride concentrations, indicating a strong connection to rainfall recharge rather than evaporation-driven concentration. Though they are still fresh, Wells MW04, MW05, MW06, MW08 appear more groundwater based.
- pH is generally stable across the site, with neutral to slightly alkaline conditions, though some variability is observed in response to recharge events.
- Bicarbonate concentrations vary between wells, with higher levels in MW07, MW01, and MW05, suggesting carbonate interactions and buffering capacity. Surface water sampling near MW07 and MW05 recorded higher bicarbonate concentrations than in other locations.
- TOC is elevated in multiple wells, with MW05, MW07, and MW12 showing the highest concentrations. This suggests variability in organic inputs, possibly from surface water interactions, subsurface organic matter, or microbial activity.
- Sulphate is generally low, though episodic variations occur in MW05, indicating potential mineral interaction or recharge influences.
- Silica concentrations are highest in MW05, MW04, MW08, and MW06. This suggests localised dissolution of silica-bearing minerals, which may reflect varying groundwater residence times or geological influences in these areas.
- Arsenic and antimony are highest in MW09 due to its location within the mineralised ore zone: arsenic concentrations in MW01, MW05, and MW07 remain below the highest background levels observed at MW09, however, are elevated compared to other bores.
- Strontium is slightly elevated in MW05 and MW07, which may be related to groundwater interacting with carbonate rocks or variations in water-rock interaction pathways.
- Copper (Cu) and zinc (Zn) concentrations are generally low across the site.

6.4.1.5 Water system investigations

Water quality patterns across the site

An investigation was conducted to assess water quality patterns across the site, examining groundwater, pit water, creek water, and runoff sources. This was done to identify the hydrochemical characteristics of the Alice River site and identify differences and examine potential water quality influences from geology, hydrology and site activities.

Conclusions:

All water samples fall within the sodium-bicarbonate facies, indicating interaction with weathered granite and bicarbonate buffering. Variations between sample types are largely due to ionic strength rather than distinct geochemical processes.

- Groundwater has higher EC (380–1,200 $\mu\text{S}/\text{cm}$) and is neutral to slightly alkaline (pH 6.9–8.6). Chemistry shows weathered granite, minor carbonate, and fault-related minerals, with low sulphate (<20 mg/L), indicating minimal sulphide oxidation influence. Bicarbonate concentrations are elevated, supporting groundwater evolution via feldspar weathering and cation exchange.
- Pit water is rainfall-driven and does not show acidity. It has low salinity (EC 42–45 $\mu\text{S}/\text{cm}$) with depth-related differences. Deeper water is more alkaline (pH ~8.1–8.6), while shallow water is slightly acidic (pH ~5.8–6.9), suggesting differences in gas exchange, CO_2 equilibrium, and microbial activity rather than significant water-rock interaction. Nutrients, particularly nitrogen and phosphorus, increase with depth. This is potentially due to organic matter breakdown and limited mixing at depth.
- One Mile Creek and runoff are rainfall-driven with low EC (10–45 $\mu\text{S}/\text{cm}$) and slightly acidic pH (~6.3–6.6). There are minor differences between the two, linked to organic input and shallow surface interactions, rather than distinct geochemical processes. One Mile Creek is more influenced by organic matter,

contributing to bicarbonate buffering and slightly lower pH. Meanwhile, runoff sources may interact with waste rock or ROM materials, but chemical differences are minor.

Alice Queen pit lake water quality profile

A dedicated pit lake investigation was conducted to assess the hydrology, water chemistry, and stratification of the Alice Queen pit lake at the Alice River site. The lake receives direct rainfall and surface runoff, with limited groundwater interaction. During high rainfall events, inflow from One Mile Creek is possible when water levels exceed approximately 117.5 m AHD.

Routine monitoring identified elevated arsenic concentrations, prompting further investigation into:

- Water quality, including arsenic and antimony concentrations.
- Stratification and seasonal variations in water chemistry.
- Potential geochemical controls on metal mobilisation.
- Hydrological influences, including catchment contributions and limited groundwater interaction.

The investigation involved a structured water sampling and profiling program across six locations in the pit lake as described in SeeBuiltEarth (2025; Appendix D).

The investigation found that water quality is controlled by runoff and catchment, not pit wall interaction. Pit lake stratification is weak but influences water chemistry. Arsenic mobilisation at depth is linked to reducing conditions, driven by iron reduction in organic-rich sediments. Antimony remains stable but shows minor surface influence. Flood events likely introduce organic material into the pit lake. The risk of water quality changes depends on whether the pit lake remains contained within the pit void. Potential long-term water quality impacts should consider hydrological containment and evaporation balance.

The following conclusions were drawn:

- Hydrology and water levels:
 - The pit lake has a maximum depth of 10–12 m, with steep eastern and northern walls.
 - Rainfall and surface runoff dominate the water balance, with limited groundwater input (supported by low salinity and silica trends, Figure 6-7).
 - Low sulphate (<7 mg/L) suggests minimal sulphide oxidation, indicating runoff, not pit wall interaction, as the primary control on water chemistry.
- Water chemistry and stratification:
 - Stratification is weak but influences water quality, with small but distinct differences between shallow (~1.5 m) and deep (~7.5 m) water (Figure 6-6). Shallow water is well-oxygenated (DO ~8.5 mg/L), while deeper waters show reducing conditions (DO: ~2–3 mg/L, ORP: ~ -125– -135 mV). Deeper waters are slightly acidic and contains elevated arsenic.
 - Bicarbonate and organic carbon increase at depth, supporting microbial activity.
- Arsenic and antimony trends:
 - Arsenic concentrations remain low in shallow water (~<0.02 mg/L) where oxidising conditions stabilise (Figure 6-10, Figure 6-11).
 - Arsenic conditions are elevated in deeper water (0.15–0.3 mg/L), exceeding ANZG (2018) guidelines (0.024 mg/L for arsenic (V)). The elevated levels are driven by microbial breakdown of organic material and iron reduction, releasing As(III) from sediments.
 - Antimony concentrations are stable across all depths with slightly higher concentrations in shallow water, indicating potential contributions from surface runoff.

- **Metals and nutrients**
 - Iron and manganese are very low overall but increase slightly at depth, consistent with weak reductive dissolution (Figure 6-8).
 - Creek inflows are likely the main source of organic material, supporting microbial activity and influencing metal mobility.
 - Nutrients (total nitrogen and ammonia) rise at depth, linked to organic matter breakdown under anoxic conditions (Figure 6-9).
- **Key correlations**
 - Arsenic concentrations are strongly linked to redox conditions, with As(III) increasing as ORP decreases.
 - pH is slightly lower at depth, consistent with organic degradation and weak acidification from microbial activity.
 - Iron and manganese trends suggest minimal sulphide oxidation, supporting the runoff driven water balance model.

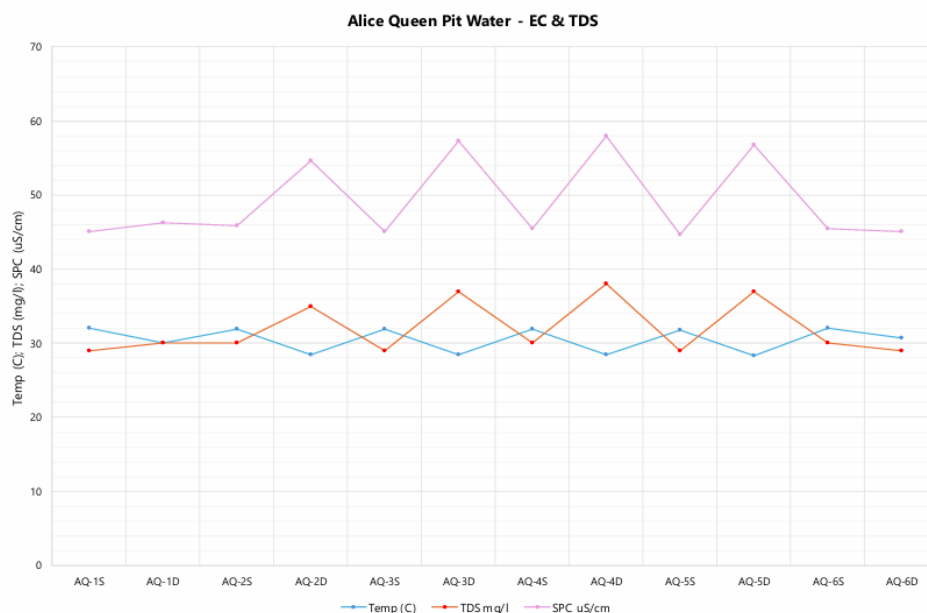


Figure 6-6: Alice Queen pit water survey - EC and TDS

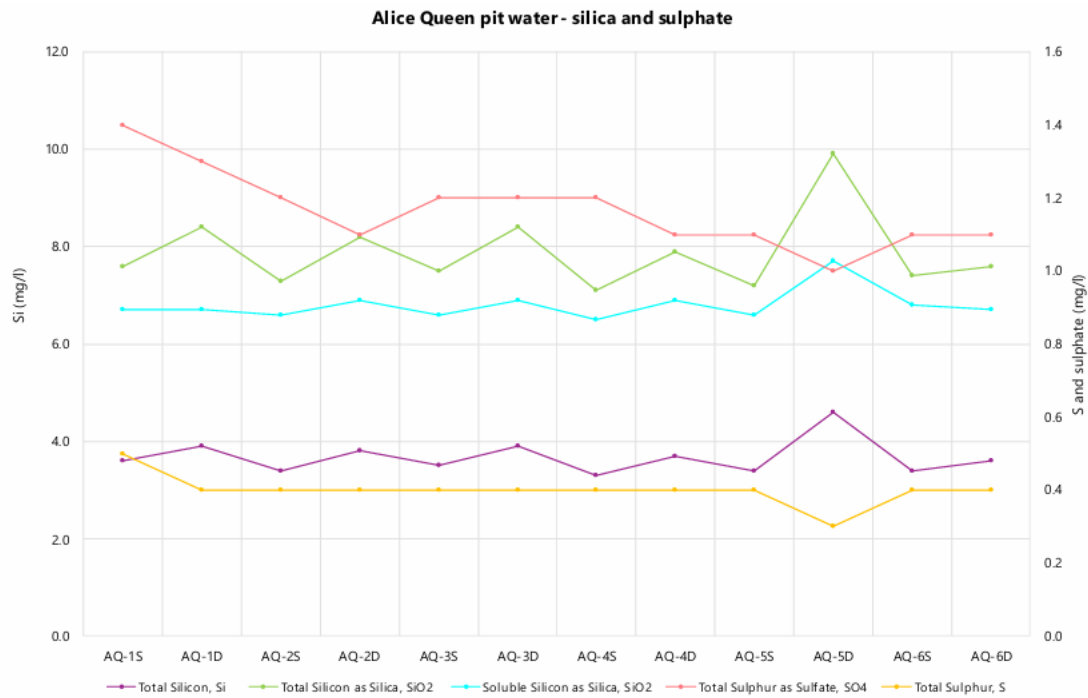


Figure 6-7: Alice Queen pit water survey - silica and sulphate

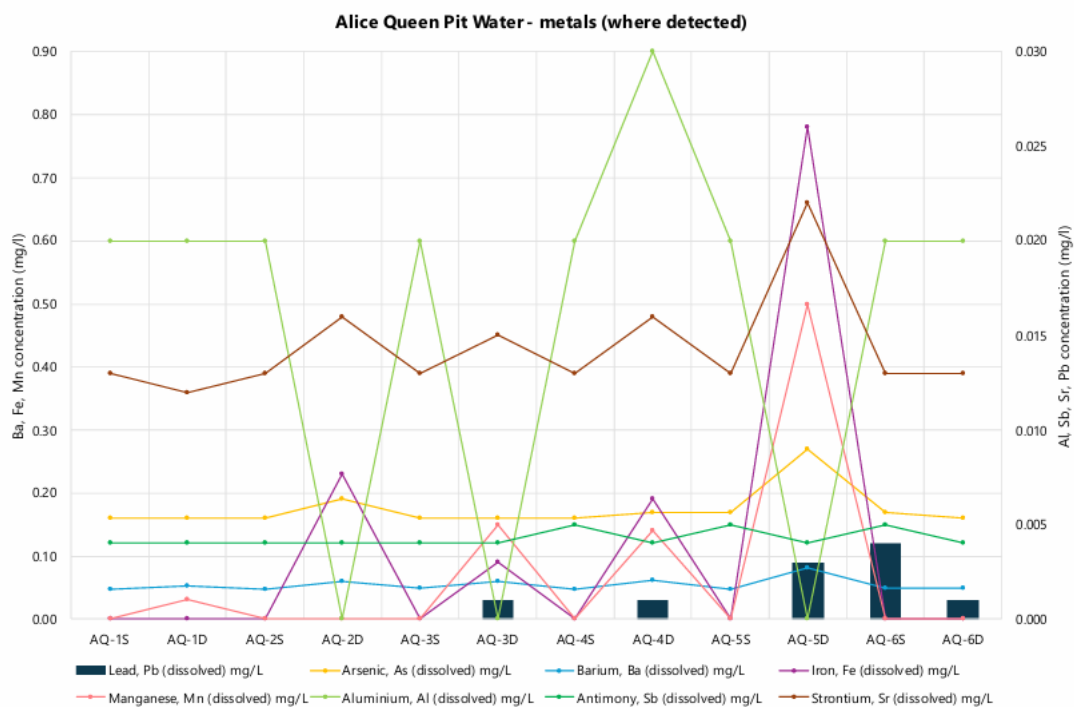


Figure 6-8: Alice Queen pit water survey - metals (where detected)

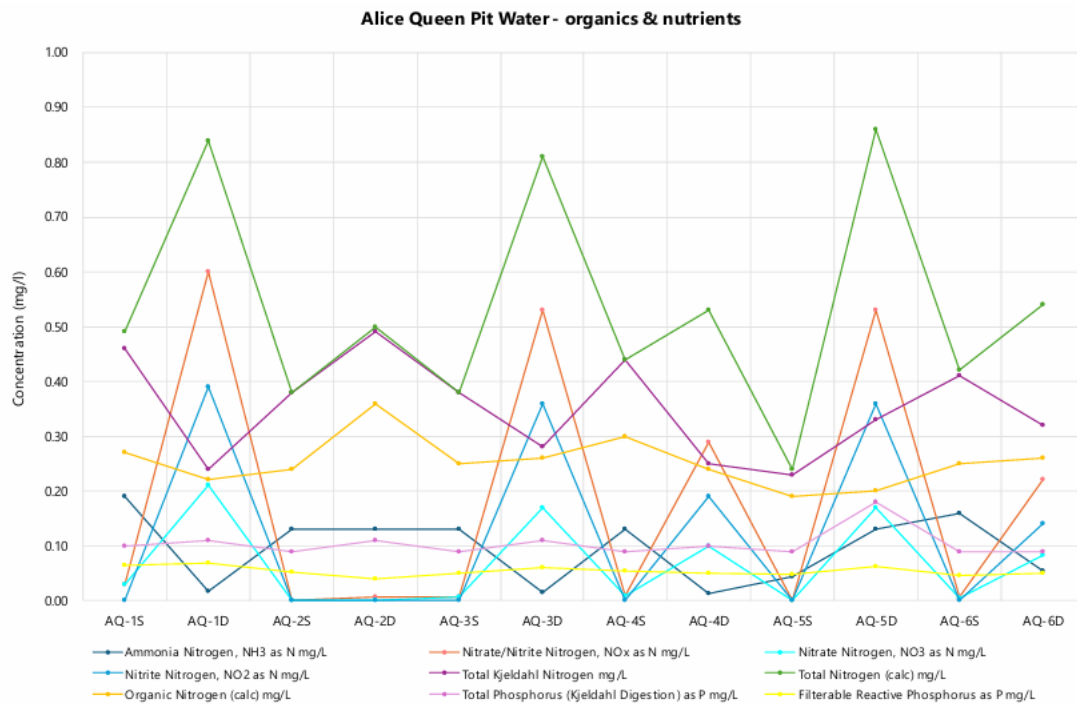


Figure 6-9: Alice Queen pit water survey - organics and nutrients

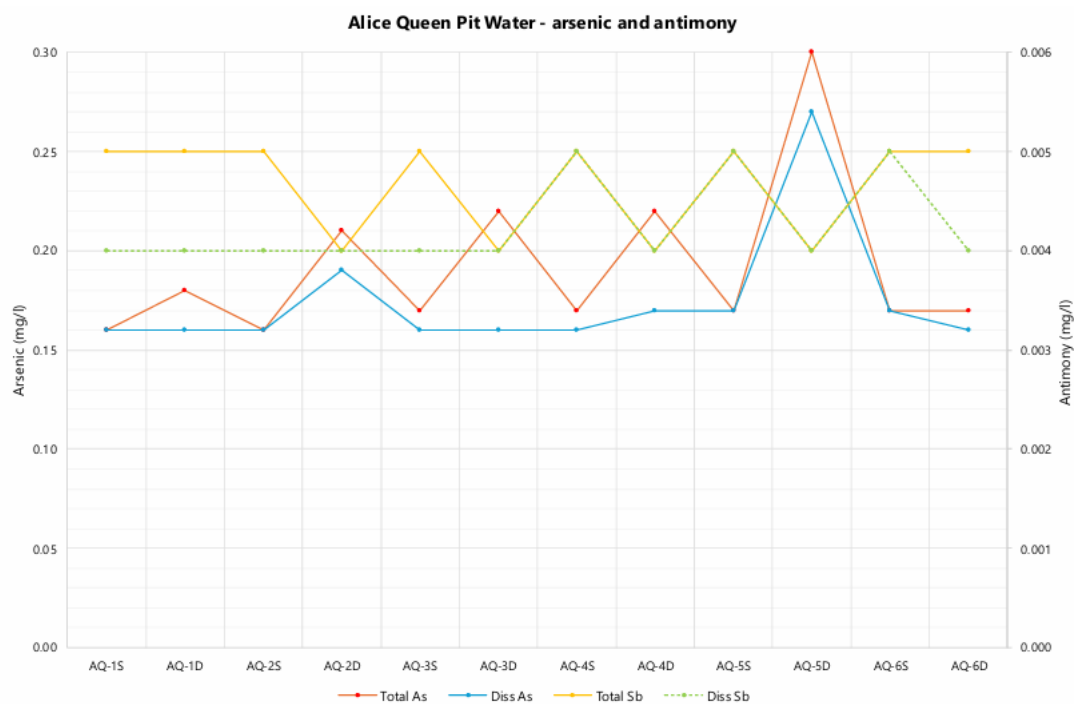


Figure 6-10: Alice Queen pit water survey - arsenic and antimony

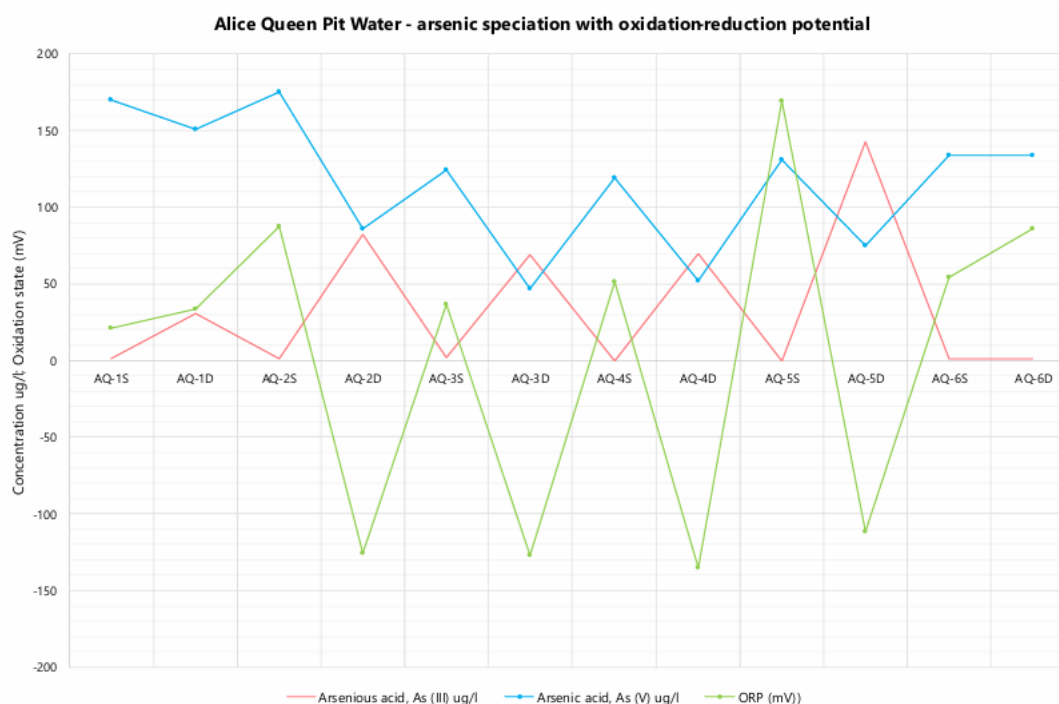


Figure 6-11: Alice Queen pit water survey - arsenic speciation

Recharge and potential hydraulic connection between Alice Queen pit and MW07 (loggers)

An investigation was conducted to assess initial results from water level loggers installed in groundwater (MW07) and the Alice Queen pit lake, following rainfall events recorded in the past three months at two locations. It is significant to understand Alice Queen pit lake responses for hydrological modelling, improving automated pit water level tracking, and gaining insights into pit and groundwater interactions over time. The objective of this investigation is to:

- Monitor water levels over time to understand the hydrological responses and connectivity of MW07 and the Alice Queen pit lake.
- Quantify the relationship between rainfall and groundwater/pit lake level changes to support hydrological modelling.
- Determine whether a hydraulic connection exists between the Alice Queen pit lake and MW07.

Conclusions:

- MW07 is recharged by both delayed infiltration and creek flow.
 - The first rise in December was gradual, likely from slow infiltration or drainage from the raised platform and stockpile. No strong correlation with rainfall at any specific lag indicates a slow recharge process rather than a direct response.
 - The second rise (January/February) was faster, confirming that MW07 is influenced by creek flow from upstream rainfall. Both local infiltration and creek recharge influence groundwater's response.
- Alice Queen pit lake is rainfall-driven and does not directly influence MW07.
 - The pit lake responded immediately to rainfall, confirming it is controlled by surface water inputs from direct rainfall and runoff from the surrounding catchment.
 - Once the pit level rises, it does not reduce quickly, indicating a lack of significant seepage or loss. This suggests the pit lake is a relatively closed system with limited drainage or groundwater outflow.

- No clear evidence suggests the pit affects MW07, but delayed seepage or seepage at certain lake water levels such as higher elevations remain possible.
 - MW07 and the pit lake show different response patterns, with MW07 rising before local rainfall events, while the pit lake rises immediately after.
 - While MW07 is not directly linked to the pit, it may receive slow recharge from the bore catchment (historical stockpiles) or potentially pit seepage via levels over time. However, the pit lake's slow recession suggests minimal water loss, making it less likely to be a significant recharge source for MW07.
 - Further monitoring is needed to confirm if any delayed interactions exist.

Arsenic sources and potential hydraulic connection between Alice Queen pit lake and MW07

An investigation was conducted to examine whether MW07 and the Alice Queen pit lake (AQ pit) are hydraulically connected and whether arsenic mobilisation in these systems has a common or distinct source. MW07 has been identified as having elevated arsenic levels, and its geochemical conditions suggest potential groundwater interactions. The AQ pit, in contrast, shows arsenic behaviour influenced by redox conditions at depth. The study evaluates whether these features indicate direct hydraulic connection or distinct geochemical evolution pathways. MW07 is situated between One Mile Creek and the AQ Pit, is likely constructed in dolerite and mineralisation, and also receives runoff from the historical platform material. This investigation aims to answer:

- Is there a hydraulic gradient strong enough to drive water movement between MW07 and AQ pit?
- Do arsenic concentrations and speciation suggest a common or separate source?
- What geochemical indicators (e.g., bicarbonate, silica, sulphate) support or refute a connection?

The key results are summarised in Table 6-3.

Table 6-3: Arsenic sources and potential connection between Alice Queen pit lake and MW07

Quality area	Key findings
Water chemistry and arsenic speciation	• MW07 is oxidising (ORP ~164 mV), with arsenic predominantly in the oxidised As(V) form (~1.3 mg/L) despite the field ORP of -64 mV. • The AQ pit shows lower arsenic concentrations (0.16–0.27 mg/L) at the surface, increasing at depth under reducing conditions. • ORP measurements in the AQ pit are negative at depth, coinciding with arsenic present as As(III), likely due to microbial iron reduction. • These results indicate that the same redox processes do not mobilise MW07's arsenic as in the pit lake.
Bicarbonate and silica as groundwater indicators	• MW07 has significantly higher bicarbonate (400 mg/L) compared to the AQ pit (~22–26 mg/L). • MW07 also has higher silica (14 mg/L) than the AQ pit (~4 mg/L), suggesting greater silicate weathering influence. • If there is a presence of dolerite near MW07, then bicarbonate may be sourced from: ○ silicate weathering of plagioclase feldspar in dolerite; ○ carbonate dissolution within secondary alteration minerals in mafic rocks; and ○ CO₂-rich groundwater interacting with MW07, further enhancing bicarbonate concentrations. • These differences suggest that MW07 is influenced by deeper groundwater, whereas the AQ pit's chemistry is more surface-driven.

Quality area	Key findings
Sulphate and pit wall contributions	- Sulphate concentrations are low in MW07 and the AQ pit (1–8 mg/L), suggesting arsenic is not sourced from sulphide oxidation. If arsenic were from pit wall weathering, higher sulphate and iron would be expected, but this is not observed across the lake. - MW07's arsenic is not correlated with TOC (~38 mg/L), while deeper pit lake water has higher TOC (~75 mg/L). This suggests organic matter influences arsenic release in the pit lake but not in MW07. - These findings indicate that arsenic mobilisation in MW07 is geologically controlled, not from pit wall weathering, pit leakage or surface runoff.
Hydraulic connection likelihood	- MW07's water level (113.9 m AHD) is lower than the AQ pit lake (~116.5 m AHD), creating a 2.6 m hydraulic gradient. - However, given the weak gradient and contrasting water chemistry, there is no evidence of active flow between MW07 and the AQ pit. - MW07's higher bicarbonate, higher silica, and more oxidising conditions contrast with the AQ pit's lower bicarbonate, lower silica, and reducing conditions at depth. - These findings indicate MW07 is influenced by deeper groundwater sources rather than direct inflow from the pit lake.

Conclusions:

- MW07 and the AQ pit lake are unlikely to be hydraulically connected.
 - The 2.6 m hydraulic gradient is weak and does not indicate active groundwater flow.
 - Differences in water chemistry (bicarbonate, silica, redox conditions) suggest MW07 and the pit lake have different sources.
- Arsenic in MW07 is likely mobilised through silicate weathering, not sulphide oxidation or pit wall interactions.
 - High bicarbonate and silica suggest groundwater interaction with dolerite.
 - Low sulphate and iron do not support sulphide oxidation as a major source.
- Microbial processes drive the pit lake's arsenic concentrations at depth (lower concentrations in shallow waters).
 - Higher TOC at depth (~75 mg/L) correlates with microbial iron reduction and As(III) release.
 - Surface runoff and organic matter appears to drive arsenic mobilisation at depth.

Arsenic sources and potential hydraulic connection between tailings storage facility and two groundwater monitoring locations

An investigation was conducted to examine arsenic sources in two groundwater monitoring locations (MW05 and MW01) near a historical TSF. MW05 is located across a tributary from the TSF, near limey sandstone outcrops, while MW01 is on the One Mile Creek side and is regularly flooded. MW10, located upgradient of MW05, serves as a reference point for background groundwater conditions. The objectives are to:

- Assess whether arsenic in MW05 and MW01 is influenced by TSF seepage or natural geochemical processes.
- Compare groundwater quality with MW10 (as a background bore upgradient of MW05 and the TSF) and W7 (creek sample) as potential sources.
- Evaluate key water chemistry parameters, including arsenic speciation, sulphate, bicarbonate, redox-sensitive elements, organic carbon, and associated metals (Sb, Pb, Cu, Zn, Sr).

The key results are summarised in Table 6-4.

Table 6-4: Arsenic sources and potential hydraulic connection key findings

Area	Key findings
Arsenic trends and speciation	- MW05 has elevated dissolved arsenic (0.65 mg/L), predominantly as As(V) (194 µg/L). - MW10, upgradient of MW05, has lower dissolved arsenic (0.047 mg/L), mostly as As(V) (44 µg/L). - MW01 has no detectable dissolved arsenic, but total arsenic (370 µg/L) suggests particulate-bound arsenic. - W7, a creek sample, has very low dissolved arsenic (0.002 mg/L) and minimal As(III) (1 µg/L), confirming no significant arsenic transport to surface water. - Arsenic concentrations are highest in MW05 but remain in the oxidised (V) form, suggesting mobilisation through geochemical conditions rather than strong reductive dissolution from a source like the TSF.
General water chemistry and Redox indicators	- MW05 has higher EC (1,200 µS/cm) and bicarbonate (400 mg/L) than MW10 (EC 620 µS/cm, HCO₃ 370 mg/L) and MW01 (EC 770 µS/cm, HCO₃ 309 mg/L). - MW05's sulphate (180 mg/L) is elevated, while MW10 has moderate sulphate (17 mg/L) and MW01 has low sulphate (5 mg/L), suggesting a geochemical source rather than TSF influence. - Manganese is slightly higher in MW05 (0.68 mg/L) than MW10 (0.17 mg/L), but iron remains low (0.04 mg/L in MW05, 0.18 mg/L in MW10). - MW05 has high TOC/DOC (130 mg/L), compared to MW10 (TOC 12 mg/L, DOC 11 mg/L), suggesting more active organic processes in MW05. - MW05 has slightly reducing conditions, evidenced by elevated manganese, but not fully reducing, as iron remains low. High TOC/DOC suggests microbial activity, potentially influencing arsenic solubility.
Associated metals: antimony, lead, copper, zinc, and strontium	- Antimony is detected in MW05 (0.003 mg/L) but not in MW10, MW01, or W7. - Lead, copper, and zinc were not detected in MW05, MW10, MW01, or W7, further ruling out a TSF-related metal signal. - Strontium (0.21 mg/L in MW05 and 0.28 mg/L in MW10) suggests carbonate weathering as a contributing factor. - MW05's chemistry aligns, suggesting a strong potential for natural carbonate interactions, and no clear TSF-related metal signature was observed as a system response.
Comparison to MW10 and W7	- MW10 has lower arsenic, bicarbonate, and sulphate than MW05, suggesting MW05 is experiencing additional geochemical effects. - W7 has very low arsenic (0.002 mg/L) and sulphate (0.6 mg/L), confirming localised arsenic in groundwater in MW05.

Conclusion:

- No strong evidence of TSF-related arsenic mobilisation has been identified at MW05 or MW01, but some uncertainties remain.
 - MW05 contains elevated dissolved arsenic (predominantly As(V)), with no evidence of strong reductive dissolution.
 - Higher bicarbonate and sulphate levels at MW05, compared to MW10 and MW01, suggest geochemical interactions rather than TSF seepage.
 - MW01, closer to the TSF, lacks dissolved arsenic and has low sulphate, further ruling out widespread TSF influence.
 - MW10 has arsenic and sulphate but at lower levels, suggesting a potential background of arsenic in groundwater, but with potential further mobilisation in MW05 by local groundwater processes.
 - W7 does not show arsenic or metal trends linking MW05 to surface water, suggesting no significant surface discharge.

6.4.1.6 Conceptual groundwater model

Overview

The conceptual water system model for the Alice River site integrates groundwater, geology, surface water, geochemistry, and landform interactions to describe water movement, chemistry, and interactions with mining landforms. Since mining ceased over 20 years ago, the site has been relatively stable, allowing for an assessment of current hydrological and geochemical conditions. The conceptual groundwater model is illustrated in Figure 6-12. Further hydrogeological risks and recommendations are provided in Table 6-5.

The Alice River site presents several challenges due to its complex geology, historical mining legacy, and extreme climate conditions that are outlined in this section.

- Geology is highly variable, with mineralised structures that naturally contain arsenic-bearing minerals as a background state across other non-mineralised zones. This geology cuts across both the northern tributary and One Mile Creek, and it is foreseeable there may be a level of natural anomaly in sediments and surface water as a natural outcome (this is the process of stream sediment and water sampling used across the industry for exploration).
- The site has an extensive mining history, with past operations conducted under very different regulatory settings and practices. The current site has been mapped in detail to learn how the system behaves in the present day.
- Climate extremes create a water environment of extremes for the site: prolonged and substantial dry conditions dominate most of the year, punctuated by intense rainfall and flooding during the wet season.
- Groundwater is poorly developed, with limited connectivity and compartmentalisation.

Water at Alice River occurs within four key domains:

- 1) Surface water (REMP monitoring locations): One Mile Creek and the northern tributary are ephemeral, with flow driven by wet season rainfall.
- 2) Runoff water (catchment-based flow): localised surface drainage from mining landforms and undisturbed terrain.
- 3) Groundwater: hosted in fractured granite, with movement controlled by structural features.
- 4) Pit lake water: the Alice Queen pit lake is a semi-isolated waterbody with limited interaction with groundwater.

Water occurrence and flow

Water movement at Alice River is controlled by seasonal rainfall, with limited groundwater connectivity between different water types. Evaporation (approximately 2,300 mm annually) significantly exceeds rainfall (approximately 700–1,400 mm), creating a strongly net negative water balance, influencing surface water availability and groundwater recharge potential.

Surface water (One Mile Creek and Northern Tributary)

Surface water is ephemeral, with flow occurring only after significant rainfall in the catchment above. One Mile Creek and the northern tributary act as losing streams, where water infiltrates into sandy alluvial sediments formed along the low-gradient drainage lines.

Monitoring at REMP sites indicates episodic variability in arsenic and other trace elements, particularly following rainfall events. These variations are consistent with a mineralised terrain, where natural geochemical contributions from weathered bedrock and shear zones are expected. However, distinguishing between natural background and potential mining-related influences requires ongoing monitoring.

Where the surface water quality at the downstream site exceeds the upstream site result as per PRCP criteria RM7 - 14, an AQP must complete an assessment of the risk of rehabilitation not achieving a stable condition within the schedule timeframe and:

- a) Where there is low risk to achieving a stable condition, then no further action is to be taken; or
- b) Where there is a risk greater than low to achieving a stable condition, then an assessment of potential environment harm and any changes or rectification actions to rehabilitation activities must be determined and implemented.

The assessment/s under PRCP11 must be completed and provided to the administering authority within 3 months of receiving the relevant sampling results. PRCP11 must not be triggered more than 3 times over 5 consecutive years.

Runoff and catchment-driven flow

Runoff follows site topography and modified drainage pathways. Key flow pathways include:

- Surface drains cut into access roads, particularly directing flow towards Alice Queen pit.
- Localised ponding in depressions within the TSF following rainfall, and potential for overflows to be released from the TSF landform (fully vegetated) to the northern tributary.
- Runoff from waste rock areas, though no sustained changes in downstream water quality have been recorded.

Groundwater movement and hydraulic properties

Groundwater is hosted within a fractured granite system with low porosity and low hydraulic conductivity. It moves primarily along discrete structural pathways rather than through a continuous aquifer.

Key observations from monitoring bores include:

- Limited lateral connectivity, with groundwater movement restricted to fractures.
- The groundwater monitoring network is relatively new and requires further monitoring over different climatic conditions and time to assess natural variability and system responses.

Pit Lake water and potential connectivity

- The Alice Queen pit lake receives direct rainfall and local runoff, with limited groundwater inflow. Water levels fluctuate 2–3 m annually, consistent with wet season inflows and dry season evaporation and an ongoing baseflow of water into the pit from higher gradients.
- MW07, located downgradient of the pit, does not appear to be hydraulic connected.
 - Pit lake chemistry is distinct from surrounding groundwater, but potential slow rock water interactions require further characterisation.
 - Water level stability suggests limited hydraulic connectivity.
 - There is an absence of seepage or vegetation growth in One Mile Creek to suggest an ongoing seepage flow.

Geochemistry

The Alice River site lies within a mineralised terrain, with a natural background of arsenic and other trace elements. Both natural geological conditions and historical mining activities influence geochemical processes.

General water quality observations

- The geochemical system appears relatively stable.
- pH remains neutral to slightly acidic (6–7) across all water domains.

- Sulphate concentrations are low (except MW05) with no strong evidence of active acid generation.
- EC is consistently low (<200 $\mu\text{S}/\text{cm}$).
- Variability in arsenic and metals appears to align with known nor likely mineralised zones but requires continued assessment.

Arsenic and trace metals

- MW09 confirms naturally elevated arsenic in groundwater, consistent with mineralised shear zones.
- MW07 and MW05 show elevated arsenic, which could reflect interaction with mineralised structures or slow-moving groundwater transport.
- Surface water occasionally records arsenic variability and requires further investigation.

Interaction of landforms (TSF, Alice Queen pit) with water

Mining landforms influence local hydrology but do not exhibit clear, ongoing groundwater interactions. However, further monitoring is needed to confirm long-term trends.

Tailings Storage Facility (TSF)

- There is no active drainage or observed seepage around the TSF.
- Some ponding occurs within depressions with the current landform state, which acts as a potential driver for percolation.
- While existing data suggests minimal TSF influence on groundwater, long-term monitoring remains necessary to confirm this trend. Planned rehabilitation will reshape the TSF to reduce infiltration potential.

Alice Queen pit

- Pit lake levels are controlled by rainfall, runoff and evaporation, with no clear hydraulic connection to MW07.
- The pit lake appears to function largely as a closed system and will have ongoing monitoring to review across multiple seasons.
- Arsenic concentrations at depth in the pit lake are slightly higher than in groundwater but are stable and are driven by runoff from temporary waste rock areas, mineralised structure drainage and microbial processes occurring at depth. Microbial processes are breaking down organic material deposited in the pit from runoff and creek flood inflow, and the reducing conditions encourage arsenic to be in solution.
- Planned rehabilitation of moving the temporary waste rock dump and changed drainage.

Other landforms (Waste Rock and ROM Areas)

- Runoff follows expected drainage patterns, with no clear groundwater impact observed.
- Planned rehabilitation of moving all historical stockpiles (WRD and ROM) to storage within the TSF will limiting interaction potential.

Alice River Conceptual Model

As @ February 2025

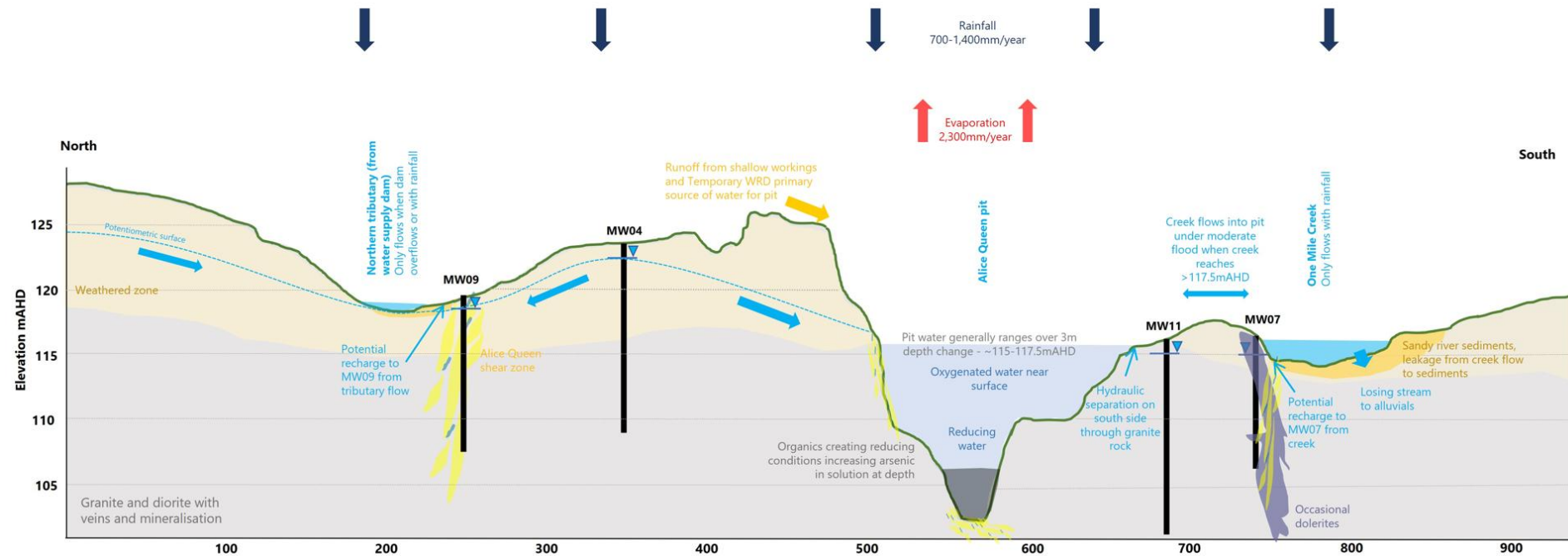


Figure 6-12: Conceptual groundwater model for Alice River Mine (source: SeeBuilt Earth 2025)

Table 6-5: Groundwater risk review and risk recommendations

Landform	Groundwater related risk	Stability and risk review	recommendations
All of site	How will groundwater work across the site at closure? Are there any values impacted? What performance should we expect in quality and quantity?	Indications site and water system is stable: 1) Pit water quality and levels is negligible risk as surface water quality. 2) Tailings system water quality is changeable is yet to be determined, with surface water indications there is periodic saline, pH and some metals movement. Conversion of the landform into a water shedding structure at closure will dramatically reduce risk. Indications the region is naturally elevated in Cu, Pb and Zn as ambient water quality, potentially as an outcome of the presence of gold and sulphides mineralisation. No other values in the region.	- Establish groundwater level and quality sampling for at least 3 data points (6-9 months). - Installation of 1-2 additional wells around tailings facility to enable construction of groundwater surface and detection of groundwater quality. - Introduce practice of recording drilling water intersections and water quality sampling. - Undertake at least 2 sampling events with full cation/anion analyte suite to inform water populations. - Following groundwater quality testing, determine water closure criteria for closure.
Alice Queen pit	What contribution does groundwater make to the pit water balance, and will that change over time?	Water quality is stable and similar to receiving environment quality. Even if pit has leakage from surface water to groundwater, will not impact quality. No indication of ARD/AMD occurring.	- Track pit water relative levels to inform groundwater contribution. - Undertake ARD/AMD static and kinetic testing of pit wall materials.
Tailings storage landform	Will there be any residual groundwater quality issues from percolation through tailings?	Unknown at this stage.	Undertake ARD/AMD static and kinetic testing of tailings.
Waste rock landforms and ROM	Will there be any residual groundwater quality issues from the WRD location?	Unknown at this stage.	- Undertake ARD/AMD static and kinetic testing of waste rock. - Review requirement for a monitoring well in the waste rock location.

6.4.2 Flooding

A hydrologic model of the One Mile Creek and Alice River systems has been developed to assess the post-mining flood risk of the Project site for a range of flood events. The flood assessment forms part of the Surface Water Impact Assessment (Engeny 2025; Appendix D). The results of the model are summarised in this section.

6.4.2.1 Impact of flood events on residual void

The Alice Queen Mine Pit residual void is proposed to be retained at closure as a stock water point, in accordance with the Project EA. The residual void is located within the One Mile Creek floodplain extent and is inundated in flood events more frequent than the 50% annual exceedance probability (AEP). Peak flood velocities at the flood inflow location (the pit ramp, located on the south-eastern perimeter of the pit) remain below 2.2 m/s in the 0.1% AEP flood event (Figure 6-13), indicating minimal risk of erosion or failure. The equilibrium level of the pit lake is approximately 116.2 m AHD and the pit is expected to receive up to 60 ML of water when inundated by One Mile Creek floodwaters. This is less than 1% of the critical 50% AEP 12-hour design event hydrograph volume (> 7 GL), indicating that volumes harvested by the pit lake are negligible and are not expected to have downstream impacts.

The flooding inundation provides flushing of the pit lake, improving water quality which supports the post-mining land use of a stock water point. If the final landform design was to exclude floodwaters from the pit, there is potential for evapo-concentration of the pit lake to increase contaminant concentrations, which could result in water not of sufficient quality to support the designated PMLU. Water quality of the retained Alice Queen Mine Pit is discussed further in Section 6.4.5.1 and Section 6.4.7.1.

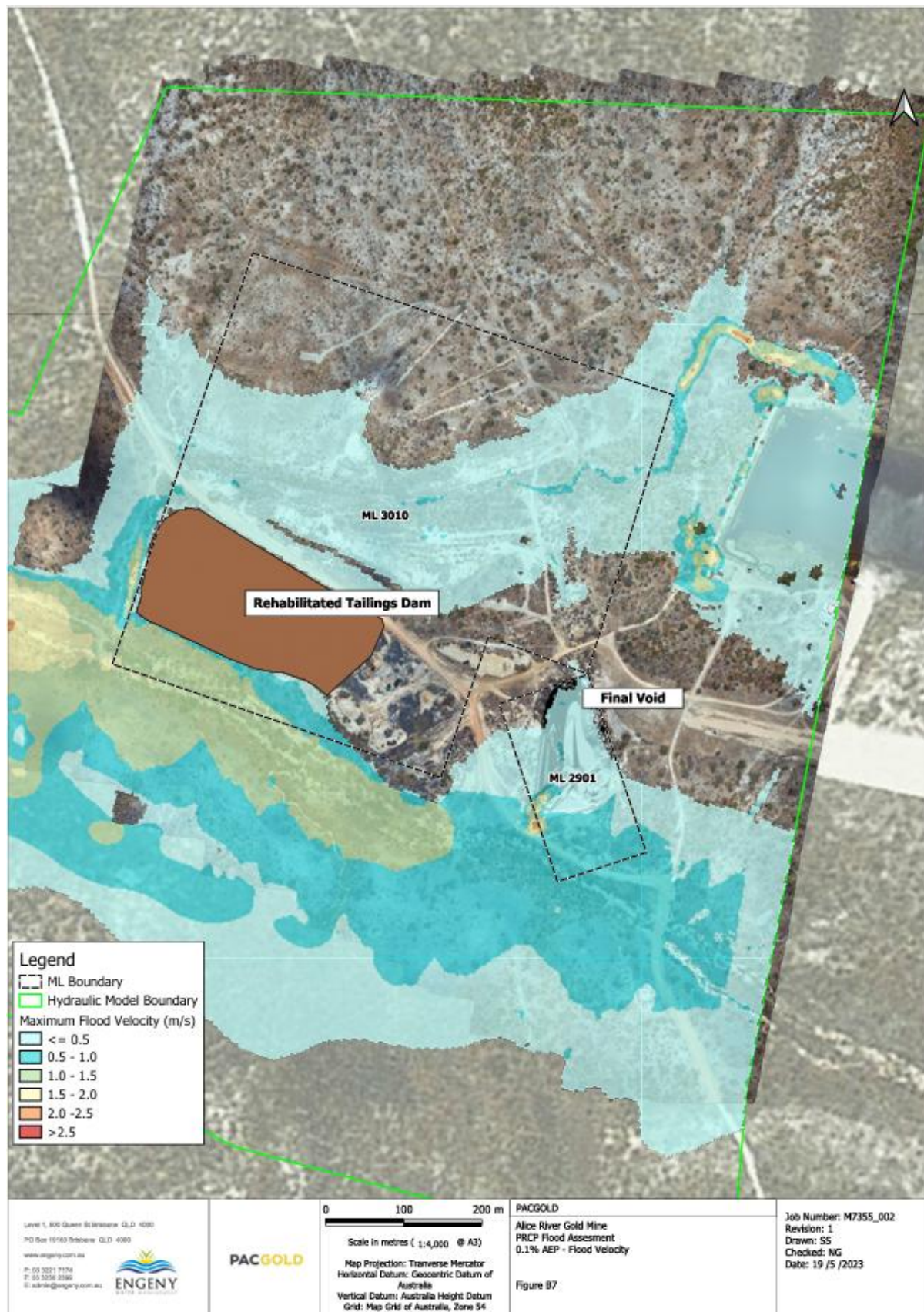


Figure 6-13: Flood velocity in 0.1% AEP flood event

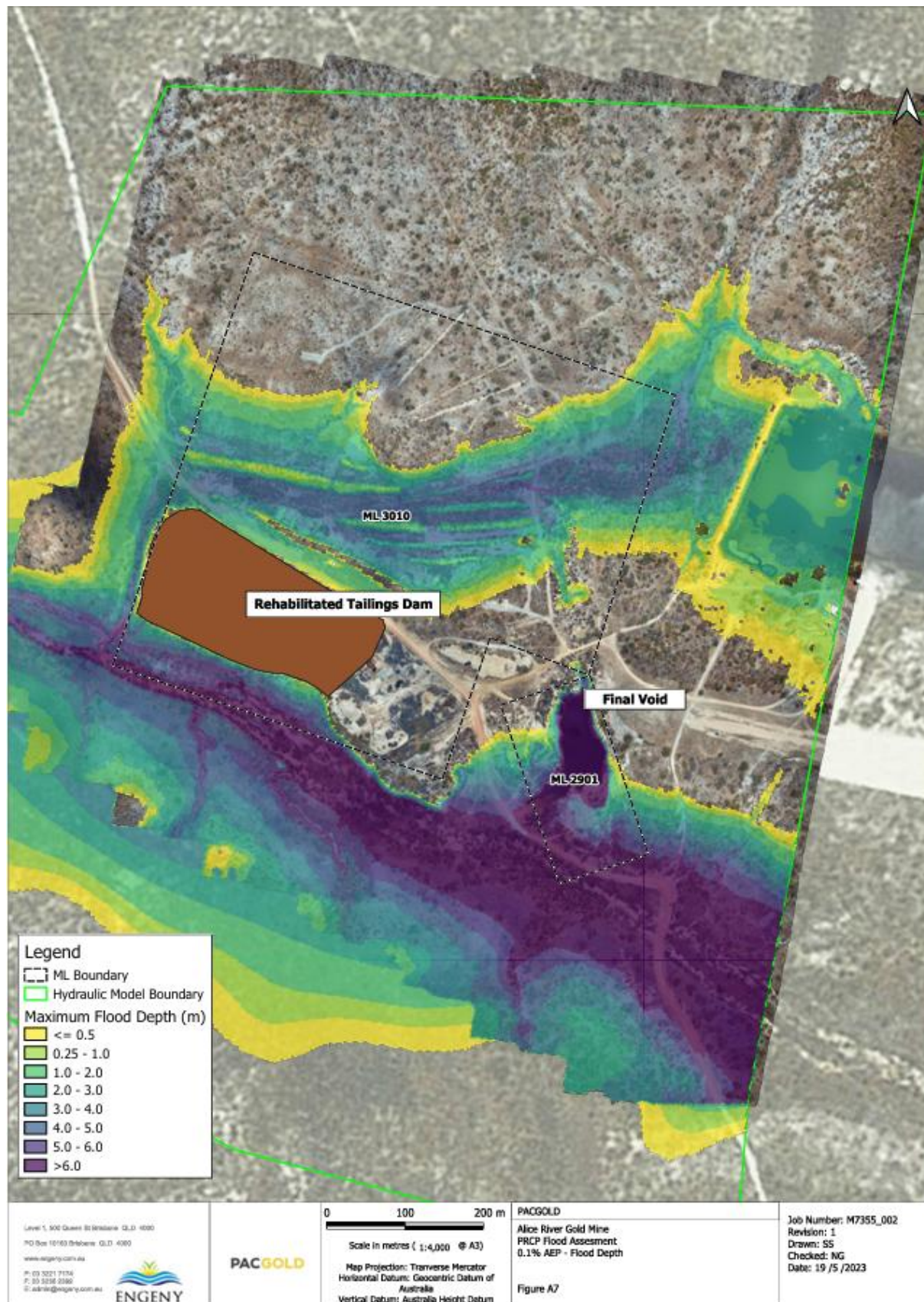


Figure 6-14: Flood depth in 0.1% AEP flood event

6.4.2.2 General flooding risk

The rehabilitated tailings dam and other remaining landforms will not be inundated in the flood events up to the 0.1% AEP (Figure 6-14). Peak velocities against the rehabilitated tailings dam remain below 1.3 m/s in the 0.1% AEP flood event (Figure 6-13), indicating a low risk of erosion. Modelled peak velocities across other RAs remain low (< 1.0 m/s) and are expected to have a low risk of erosion. Other modelled flood events are provided in the Surface Water Assessment (Engeny 2025; Appendix D).

6.4.3 Soil material assessment

The 'Lands of the Mitchell-Normanby Area, Queensland' (R.W. Galloway, R.H Gunn and R. Story 1970) noted that due to the high resistant Palaeozoic granitic underlying the Project area there is scant soil cover. This observation is supported by the progressive rehabilitation monitoring of analogue transects completed in 2021 to 2024, which also noted scant topsoil cover (AARC 2021a; Appendix D). Therefore, a topsoil spreading depth of 100 mm is considered sufficient to support the target vegetation.

Using a spreading depth of 100 mm in all areas, except 200 mm for the tailings dam, the predicted topsoil amounts required for rehabilitation are presented in Table 6-6. The available topsoil resources have been calculated from a spatial survey of topsoil resources. Approximately 11,480 m³ of topsoil is stockpiled on site (Figure 3-2 for stockpile locations). There is sufficient topsoil on site for rehabilitation purposes, and it is anticipated that all topsoil material required for rehabilitation will be sourced from the Project area. It is anticipated that the excess topsoil will be used in rehabilitation, either through spreading particular areas to a greater cover depth or in follow up remediation works.

One topsoil stockpile was sampled during the May 2021 progressive rehabilitation monitoring. Analysis of the sample confirmed that that topsoil presented similar characteristics and quality to the analogue sites sampled (AARC 2021a, Appendix D). A subsequent sampling program from six soil samples was undertaken by RGS (2023, Appendix D). The shake flask extraction (SFE) results for water soluble metal(loid)s in the soil were low with most of the results below the relevant limit of reporting. The concentration of the elements above detection represents optimal conditions for rehabilitated land i.e., water soluble arsenic in the soil was 0.007 to 0.036 mg/L, which is in the same range as freshwater aquatic ecosystem guideline values. Key soil fertility results found that exchangeable sodium percentage and EC was low in all samples, total nitrogen was rate limiting for growth, and there was no deficiency in Cowell fractionated phosphorus (Figure 6-15).

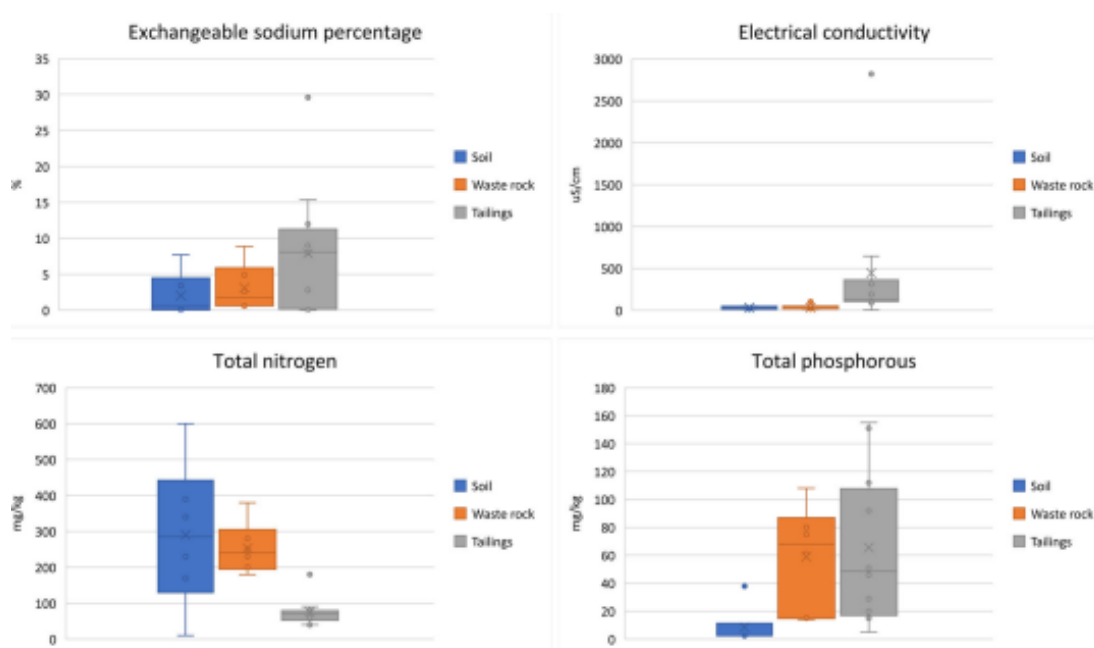


Figure 6-15: Soil quality parameters for soil, mine waste (waste rock and tailings)

The soil water characteristic curve (SWCC), which measures the limit of water storage capacity of materials. There is an upper limit (field capacity) and a lower limit (permanent wilting point), with plant available water between those points. The SWCC for soil is reduced.

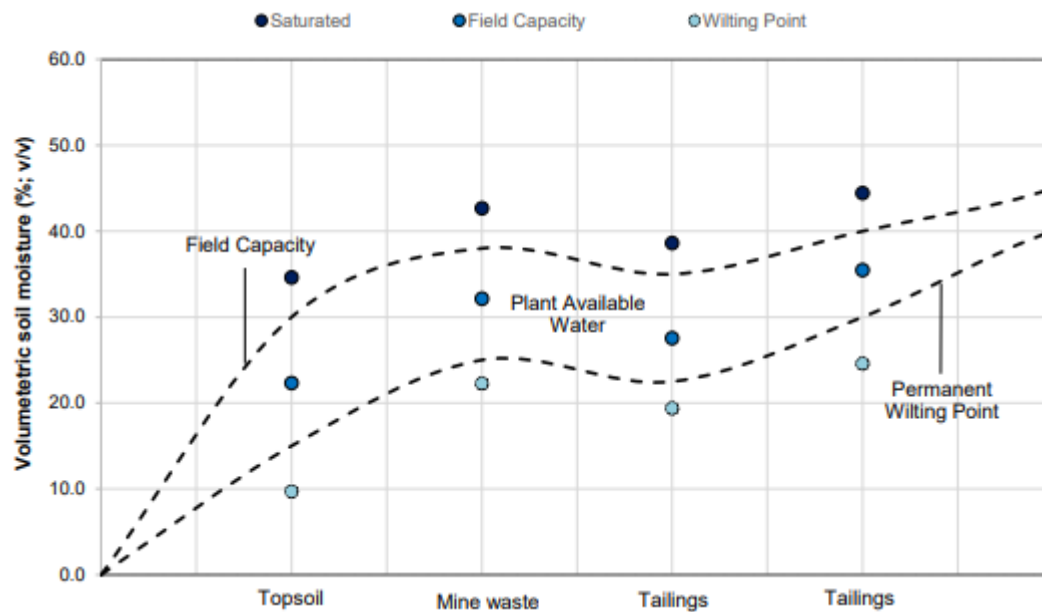


Figure 6-16: Soil water characteristics curves (SWCC)

The permeability results verified that the soil samples had low permeability, leading to a high resistance to water flow, reducing seepage potential. Pinhole dispersion analysis classified the soil as highly dispersive, and all soil samples were class 2A and have dispersive characteristics (Figure 6-17). Class 2a soils will have few structural problems if managed using minimum tillage techniques or if maintained under continuous pasture growth.

Soils were classed as Emerson class 3, described to have some dispersion characteristics at field capacity water content.

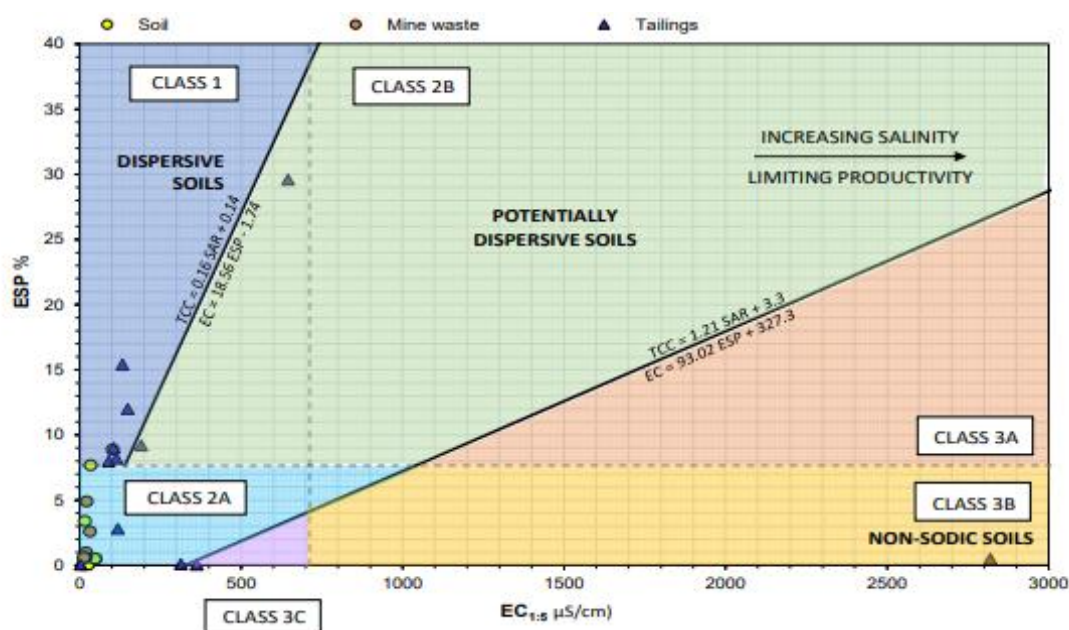


Figure 6-17: Rengasamy soil classification for dispersion

Soil will require amelioration prior to spreading to establish a growth medium conducive to plant germination and growth. Prior to use in rehabilitation, a soil health assessment will be conducted, and ameliorants recommended where required, including products and application rates. Refer to section 6.4.6.1.

Table 6-6: Anticipated rehabilitation topsoil requirements

Rehabilitation area	Area (ha)	Depth (mm)	Predicted topsoil requirements (m ³)
RA1 - Waste rock dump	0.3	100 mm	300
RA8 - Infrastructure areas (Roads/tracks and concrete pads)	0.36	100 mm	360
RA3 - Tailings dam	2.75	200 mm	5,500
RA9 - Cleared areas	4.48	100 mm	4,480
RA7 - ROM pad	0.08	100 mm	80
Total requirement			10,720

6.4.4 Waste characterisation

6.4.4.1 Waste geochemical analysis

A geochemical assessment of mine waste (waste rock and low-grade ore) and tailings was undertaken to characterise geochemical and physical properties of waste material (RGS 2023). Static geochemical analyses were completed to quantify the bulk chemical attributes of mine materials for parameters such as acidity (pH1:5), salinity (EC1:5), total sulphur, sulphide sulphur (CRS), total acid neutralising capacity (ANC_T), whole-rock and water-soluble element concentrations, and mineralogy. The analyses evaluated the potential for AMD.

The geochemical classification, represented by samples received, verifies that mine waste is non-acid forming (low capacity) (NAF_{LC}) to potentially acid forming (low capacity) (PAFL_C); and tailings are predominantly NAF_{LC} to PAFL_C, with one sample classified as potentially acid forming (PAF). Results are discussed in detail in the following sections.

Net acid producing potential

The net acid producing potential was calculated using the acid base account (ABA) for the mine waste (n=21) and tailings (n=36) samples. The geochemical classification represented by samples received verified that mine waste is non-acid forming (low capacity) (NAF_{LC}) to potentially acid forming (low capacity) (PAFL_C), and tailings are predominantly NAF_{LC} to PAFL_C, with one sample classified as potentially acid forming (PAF).

Saline and sulphate drainage potential

Mine waste has a very low to low hazard ranking for saline drainage, and the majority of the tailings have a low to moderate hazard ranking. The tailings sample with an increased hazard ranking is the sample geochemically classified as PAF.

Sulphate drainage potential refers to the potential of mine materials to generate acid drainage as a result of the oxidation of sulphide minerals. The low sulphate values suggest that the ions have weathered out of the samples; as surface material is exposed to oxygen and water allowing oxidation of sulphide minerals and release of sulphate. All samples were classed as low risk for sulphate drainage potential.

Metalliferous drainage potential

When compared to the median crustal abundance of metal(oids) in unmineralised soils, tailings were enriched (GAI > 3) in As, Ag, Au, Cd, Cu, Te, Zn, and S. Enriched metal(oids) in the tailings are associated with the geology/mineralisation of the deposit.

Water soluble multi-element analysis quantified the concentrations of 49 metal(loid)s on water extracts from the mine waste and tailings samples to provide an indication of the environmental mobility and degree of risk associated with major, minor, and trace elements from mine site material represented by the samples.

Some elements with enriched values from the whole-rock analysis of tailings were below the limit of reporting (LoR) (silver and tellurium) or low (zinc) in the water extracts. This suggested that these metal(loid)s have low to no mobility in the current pH conditions and have a low risk of metalliferous drainage potential. Antimony and arsenic are enriched in the water extracts from the tailings and have high risk of metalliferous drainage potential.

The water soluble metal(loid)s in the mine waste were approximately one order of magnitude higher than the soil concentrations, but in the low to moderate range with most of the results below the relevant laboratory LoR.

The water soluble metal(loid)s in the tailings were enriched, and one to two orders of magnitude higher than the waste rock and soil. The arsenic and antimony concentrations were particularly elevated and are attributed to the long-term oxidation and weathering of the primary sulphide minerals that has released these elements into more mobile fractions.

Waste physical analysis

Physical analyses determine geotechnical properties that are also important for interpreting and quantifying geochemical properties. For example, the PSD of mine material has a direct effect on the geochemical properties and reactivity of the material. This is due to differences in sulphide grain size and associated surface area; and pore space and the associated availability of water and oxygen to move through. Physical analyses included PSD with hydrometer, Emerson Class, shrink-swell, pinhole dispersion, permeability and maximum dry density, and settling columns. The results of the physical analysis informed the conceptual cover design for the tailings dam (refer to Section 6.4.7.2). The waste materials have the following physical characteristics:

- Waste rock is classified as gravelly sand (Figure 6-18).
- Tailings is classified as sandy silt (surface tailings) and silty clay (deeper tailings) (Figure 6-18).
- Waste rock and tailings are considered to have low potential for shrinkage and swelling and will have minimal changes in volume when exposed to wetting and drying cycles.
- Waste rock and tailings have low permeability and high resistance to water flow, and consequently have reduced seepage potential. Tailings and soil are less permeable than mine waste.
- Pinhole dispersion analysis indicated that the majority of the tailings samples are classified as highly dispersive; with two samples classified as non-dispersive (Figure 6-17).
- The majority of waste rock samples are classified as having dispersive characteristics; with one sample classified as dispersive (Figure 6-17). Meanwhile, the pinhole dispersion analysis classed mine waste as completely erosion resistant, indicating the material has characteristics contributing to its stability such as low clay content.
- Majority of tailings samples were indicated to have low to moderate EC, whereas mine waste was indicated to have very low to low EC.
- Majority of the mine waste sample (n=6) was classified as having low ESP and one sample was classified as having moderate ESP value. Meanwhile, majority of the Tailings samples were classified as having low to moderate ESP values, whereas two samples were classified as having high ESP values (Figure 6-17).

- Tailings and Mine waste are both described to have an Emerson class number of 2, indicating it has slaking and some dispersive characteristics.

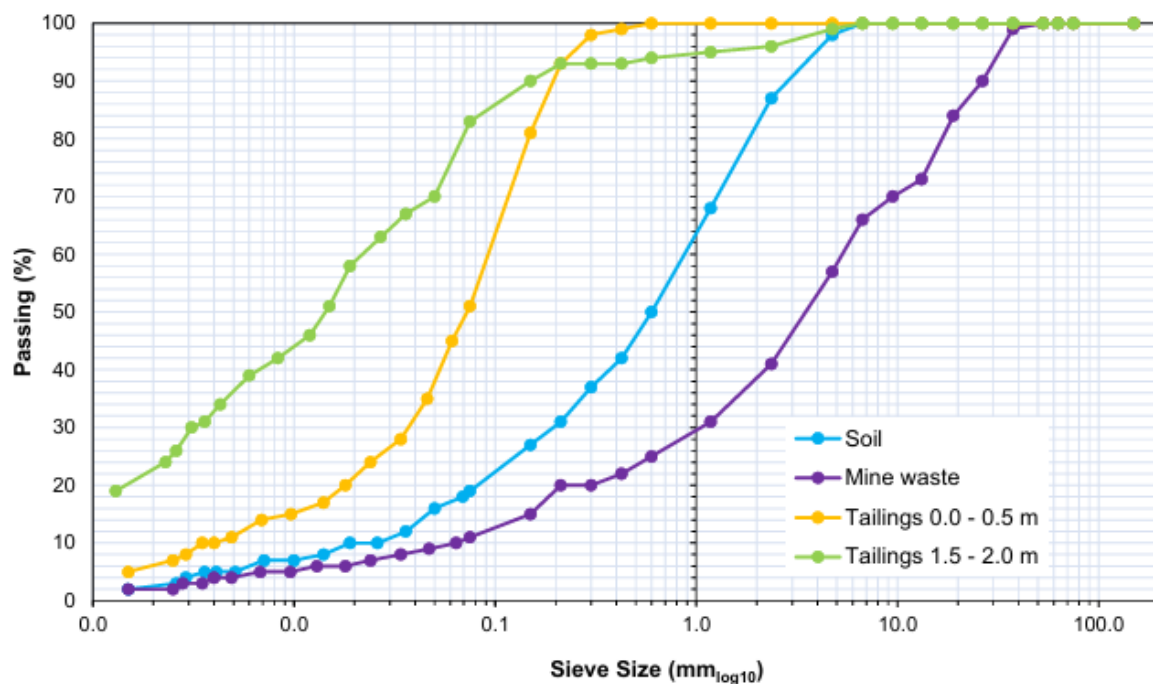


Figure 6-18: Dry Grading PSD and hydrometer results

6.4.5 Water management

6.4.5.1 Alice Queen Mine Pit lake

Post-closure, the Alice Queen Mine Pit lake will receive inflows from its local catchment, and seepage and flood ingress inflows from One Mile Creek. This will provide flushing of the pit lake and maintain a freshwater quality. There is limited groundwater interaction. The water quality of the pit lake is not expected to deteriorate unless the clean water inflows from seepage and flood ingress are removed, which may result in evapo-concentration of the pit lake increasing contaminant concentrations.

6.4.5.2 Tailings storage facility

The TSF is proposed to be backfilled and reprofiled to create a water shedding structure and revegetated with shallow-rooted species to prevent rainfall infiltration and erosion of the rehabilitated landform. Refer to Section 6.4.7.2 for the tailings dam storage facility design.

6.4.5.1 Post-closure contaminant sources and potential impacts

Post-closure contaminant sources and their potential impacts have been investigated through the Surface Water Impact Assessment and the Groundwater characterisation and site water performance (Engeny 2025 and SeeBuiltEarth 2025; Appendix D). The outcomes of the assessment are summarised in this section.

The rehabilitated TSF and Alice Queen Mine Pit are the main sources of contaminants post-closure. The areas not draining to the Alice Queen Mine Pit will be revegetated to prevent contaminants being generated, except for the cleared areas and roads/tracks to be retained as per the landholder agreement (Appendix E).

A summary of the post-closure contaminant sources, flow paths and destinations are summarised in Table 6-7.

Table 6-7: Contaminant source summary

Source	Potential Transport mechanism	Receiving system	Key contaminant
Final void (Alice Queen Mine Pit)	Seepage into groundwater system	Groundwater system	Low pH, heavy metals and soluble salts
	Overtopping due to local hydrological inflows and outflows	Receiving waters	Low pH, heavy metals and soluble salts
	Overtopping due to flood ingress resulting in the void overfilling	Receiving waters	Low pH, heavy metals and soluble salts
Rehabilitated tailings dam	Seepage from rainfall infiltration	Receiving waters	Low pH, heavy metals and soluble salts
	Rainfall runoff causing erosion of the landform exposing tailings material	Receiving waters	Low pH, heavy metals and soluble salts
Rehabilitated mine landforms (draining to waterways)	Rainfall runoff causing erosion	Receiving waters	Sediment

The potential impacts of the Project on surface and groundwater environmental values were identified, based on the known contaminants, their sources, and the performance of the site water management system. These potential impacts are expected to include:

- Releasing contaminants through overflows from the Alice Queen Mine Pit (from local runoff or flood inflows) with the potential for accumulation within the receiving waters during dry periods. Potential impacts to stock, riparian, and aquatic ecosystems.
- Releasing contaminants from the rehabilitated tailings dam to One Mile Creek through either seepage or erosion failure of the landform with the potential for accumulation within the receiving waters during dry periods. Potential impacts to stock, riparian, and aquatic ecosystems.
- Erosion or instability of the rehabilitated final landform resulting in generation and release of sediments to receiving waters potentially impacting downstream riparian vegetation and waterway condition.
- Potential impacts of the Project final landform on groundwater environmental values have been identified in the PRCP groundwater assessment report.

Water quality of the retained Alice Queen Mine Pit is discussed further in Section 6.4.7.1. The rehabilitation strategy for the tailings dam is further discussed in Section 6.4.7.2. The rehabilitation of the remaining RAs is discussed in Section 6.4.7.

6.4.5.2 Surface drainage

The surface drainage of the post-mining landform has been designed to reduce the catchment area reporting to the Alice Queen Mine Pit. The surface drainage has been designed so that:

- The tailings dam will be backfilled and reprofiled to create a water shedding structure.
- The Alice Queen Mine Pit will drain internally to the pit lake with no significant external catchment.
- Water will sheet across rehabilitated surfaces, to either existing drainage gullies or constructed drains.

- Catchment runoff will be directed away from site so that stability of the existing waterways and drainage gullies are not impacted.
- Where drains are required, they will be constructed at a suitable longitudinal grade and correctional area to convey the upstream catchment, without causing erosion or instability.
- Where high velocity is expected (step sections of drain or tie in locations with existing drainage features), rock armouring will be installed to prevent erosion.

6.4.5.3 Redirected drainage line

The historic redirected drainage line traversing ML3010 (Figure 3-10) is proposed to be retained at closure to direct water flow around the foot of the rehabilitated tailings dam. Rehabilitation of the drainage line may include stabilising the bed and banks with vegetation or rock armouring to reduce erosion risk. The drainage line will be monitored and, where necessary, undergo interim rehabilitation works prior to the area becoming available for rehabilitation to prevent further erosion.

6.4.6 Revegetation

The primary objective of the revegetation plan is to establish self-sustaining vegetation communities suitable for the target PMLU of grazing. Plant species have been selected with the aim of creating open pasture suitable for grazing, with native tree species to provide shade for livestock. Consideration has also been given to creating foraging habitat for the Golden-shouldered Parrot (Section 3.3.9.2).

6.4.6.1 Growth media and ameliorants

Soils in the Project area are acidic and prone to dispersion, with low fertility. Prior to topsoil application and seeding in RAs, soil nutrient status will be confirmed, and fertiliser applied at recommended rates where soil nutrient status is limiting to revegetation success. Erosion-prone soils should be treated with gypsum to overcome dispersive properties. Soil ameliorants will also be utilised where necessary to bring soil pH values within the range of 5.5–9.0, the range most suitable for plant growth (Hazelton and Murphy 2016).

6.4.6.2 Surface preparation

Following land reshaping and reprofiling (where applicable), topsoil will be placed to achieve a minimum thickness of 100 mm. Soil will then be deep ripped to increase water infiltration, trap runoff, reduce erosion and compaction as well as produce favourable germination conditions for seeds. Ripping will either be done along the contour to avoid low spots susceptible to erosion or sloped to a natural surface to facilitate runoff of excess water.

6.4.6.3 Seed mix and application

To maximise revegetation success, revegetation activities will be scheduled during spring, prior to the onset of heavy wet season rainfall. Seeding may also be undertaken during the summer months, depending on rainfall. Vegetation will be sown using direct seeding or tube stock, depending on the species.

Low intensity grazing and grassland PMLU areas will be evenly seeded with the pasture grass and native species indicated in Table 6-8. The species listed in Table 6-8 are a selection of pasture and native grasses known to occur on the Project site or the analogue sites. Preference has been given to Golden-shouldered Parrot critical food sources identified in the Management Plan (AARC 2018). All species listed suit the climate and site-specific environmental conditions. In addition to grass species, seeds of native overstory trees may be sown to provide shade for livestock.

Two sources of seed may be utilised for revegetation. Seed will either be collected on site by a suitably qualified person or sourced from a specialised supplier. When sourcing the native seed stock, the use of local provenance native seed will be prioritised, being better adapted to the edaphoclimatic conditions. The locally

sourced seed will be applied at a rate of 15kg/ha. Local seed may also be sourced locally, if it becomes available.

Should the local supplier method not be available, a list of suitable plant species for the mine site (Table 6-8) will be sourced from Queensland Native Seeds, specialising in native and pasture grass seeds, forbs and native trees, for mine rehabilitation in Queensland. The seed sowing rate should be more than 15 kg/ha, using species selected from Table 6-8. The seed mix will preferentially select a minimum of five grass species, including two 3P species, and three species known to be the food source of the Golden-shouldered Parrot. Where identified, overstorey and forb species will also be incorporated. Suitable species may be substituted based on availability at the time of sowing.

Once seeded, areas will be fenced to exclude stock grazing of newly seeded or planted areas.

The tailings dam (RA3) will be revegetated with shallow-rooted species, and grasses and forb/herbaceous species only (Table 6-8) for the grassland PLMU.

Cleared areas (RA9) will be revegetated with grass species only (Table 6-8).

Table 6-8: Seed mix and application rate

Scientific name	Common name	Growth type	Golden-shouldered Parrot critical food source	Suitable for RA3 (tailings dam)	Suitable for RA9 (cleared areas)	Suitable for grazing PMLUs	Indicative seed rate kg/ha
<i>Alloteropsis semialata</i>	Cockatoo grass	Native Grass	✓	✓	✓	✓	2 kg/ha
<i>Chamaecrista rotundifolia</i> [^]	Wynn Cassia	Pasture Grass			✓	✓	2 kg/ha
<i>Chrysopogon fallax</i>	Golden Beard grass	Native Grass (3P)	✓	✓	✓	✓	2 kg/ha
<i>Eriachne obtusa</i>	Northern Wanderie grass	Native Grass	✓	✓	✓	✓	2 kg/ha
<i>Eualia aurea</i>	Silky Browntop	Native Grass		✓	✓	✓	2 kg/ha
<i>Heteropogon triticeus</i>	Giant Spear grass	Native Grass (3P)		✓	✓	✓	2 kg/ha
<i>Schizachyrium fragile</i>	Firegrass	Native Grass	✓	✓	✓	✓	4 kg/ha
<i>Corymbia clarksoniana</i> [*]	Clarkson's Bloodwood	Native Tree				✓	0.5 kg/ha
<i>Corymbia dallachiana</i> [*]	Dallachy's Gum	Native Tree				✓	0.5 kg/ha
<i>Erythrophleum chlorostachys</i> [*]	Cooktown Ironwood	Native Tree				✓	0.5 kg/ha
<i>Melaleuca viridiflora</i> [*]	Broad Leaved Paperbark	Native Tree	✓			✓	0.5 kg/ha

Scientific name	Common name	Growth type	Golden-shouldered Parrot critical food source	Suitable for RA3 (tailings dam)	Suitable for RA9 (cleared areas)	Suitable for grazing PMLUs	Indicative seed rate kg/ha
<i>Goodenia armitiana</i>	Fine Goodenia	Native Forb/Herbaceous		✓		✓	0.5 kg/ha
<i>Phyllanthus maderspatensis</i>	Spurge	Native Forb/Herbaceous	✓	✓		✓	0.5 kg/ha

^ Only applicable to Cleared areas (RA9)

* Not applicable to Tailings Dam (RA3)

3P palatable, perennial, and productive

6.4.6.4 Weed control

Competition from weeds presents a serious challenge to successful vegetation establishment. Weeds may invade freshly re-worked surfaces of the rehabilitation area or might already be present in the topsoil used. Weeds compete with native plants for light, soil nutrients and moisture, and invasion during vegetation establishment may affect the overall capacity for the site to develop ecological resilience. It is likely that topsoiled surfaces will contain both native and exotic species seeds. Weeds should be controlled wherever they dominate to the exclusion of desirable plants. Weed control will be undertaken as needed in response to monitoring programs using an adaptive and strategic weed management plan.

6.4.7 Final landform design

The final landform design and the sequencing of landform development (and hence also the resultant rehabilitation milestone schedules) are strongly influenced the previous mining activity and historical mine workings at the site. Where possible, built structures (e.g., waste rock dump) in the final landform have been minimised by relocating material from such structures to the tailing storage facility.

Landform design principles and rehabilitation methods for each of the key RAs are discussed in Section 6.4.7.1 to Section 6.4.7.9.

6.4.7.1 Final void

The Alice Queen pit lake is a non-operational pit that has served as a pit lake for about 24 years since mining ceased in 2001. Over this period, the historical pit lake levels and water quality have been consistently observed, making them reliable indicators of future pit lake behaviour. The pit lake receives inflows from its local catchment and also benefits from seepage inflows and flood ingress inflows from One Mile Creek, which contribute to maintaining good water quality within the pit.

The pit void is approximately 130 m long x 50 m wide and approximately 40 m below ground level (mbgl), from the model data supplied (Figure 6-19). The Alice Queen Mine Pit will be retained at closure as a permanent landform and will be utilised by the landowner as a stock water point. Fences will be erected around the high wall sections to prevent access by people and livestock, and signage will be posted every 100 m along the fence.

In the Quaternary and weathered granite horizons, batter angles range between 30° and 60°, and extend to a remnant catch bench located at approximately 115 m RL. Between the remnant catch berm and the modelled pit floor (a further approximately 20 vertical metres), the remainder of the void is below the current water level and the pit walls are presumed to comprise slightly weathered and fresh granite.

The void walls for the designated PMLU will be at the angle of mining for both competent rock slope and incompetent rock slope.



Figure 6-19: Alice Queen pit lake (July 2022)

Stability assessment

Geotechnical stability assessments were conducted under a range of scenarios to ensure that the final pit void was geotechnically stable. The scenarios are described in the Geotechnical Assessment Report (BMS 2022; Appendix D), and include two sections encompassing the as-built pit:

- Section 1 – as-built Alice Queen Mine Pit void southern wall profile adjacent to the ramp; and
- Section 3 – west to east section through the Alice Queen Mine Pit void immediately north of the access ramp.

Pit slope stability analyses were carried out for the following scenarios:

- Failure scenarios:
 - weathered horizon failure; and
 - global slope failure (crest to toe).
- Groundwater scenario:
 - no groundwater – representing pit drainage for cutback access and end-of-mining condition; and
 - mean groundwater level – approximately 117 m RL (i.e. post-closure condition).

All slope stability scenarios analyses exceeded the minimum required Factor of Safety (FoS) value for long-term geotechnical stability of 1.5. Therefore, the pit void is unlikely to pose a significant long-term slope stability risk, based on the defined scenarios and assumptions.

It is acknowledged that although the results of the limit equilibrium analyses justify suitably stable structures within the current landform, the results assume the applied material properties and lithological boundaries modelled for the pit are representative of actual site conditions. Rock mass defect information for the pit

slopes was not available at the time of modelling, the influence of which could change the outcome of the analyses. Based on a review of available core photos, rock mass structural conditions suggest that kinematic failure mechanisms would be possible; however, any failures of this type would report directly to the void and are unlikely to present a significant geotechnical risk post-closure.

Further assessment of rock mass structure and pit slope defects will be carried out post-dewatering and prior to end of mining.

Void water balance

The design of the final landform is premised on the Alice Queen Mine Pit being retained and holding water of suitable quality to be utilised as a stock water point. A water balance model has been developed to assess the behaviour of the pit lake (Engeny 2025; Appendix D). The outputs of the model are summarised in Table 6-9).

Table 6-9: Alice Queen Mine Pit hydrology outcomes

Parameter	Modelled outcome
Total catchment area (ha)	3.7
Floor level (m AHD)	95
Full supply volume (ML)	83.0
Spill elevation (m AHD)	117.4
Equilibrium level (m AHD)	116.2

The groundwater model and water quality analysis (SeeBuiltEarth 2025; Appendix D) suggest that the Alice Queen Mine Pit likely receives low permeability groundwater and is therefore not expected to have seepage outflows; however, there is limited groundwater level monitoring data to determine the rate of inflow. The water balance model assessed potential groundwater inflow rates to three pit lake level records between October 2021 to December 2024, determining an inflow rate of 0.01 L/s (with no outflows). The validated rate of inflow for the groundwater was adopted for the final void hydrology assessment since the future and current Queen pit arrangement is very similar.

The local landholder's observed knowledge aligns with the post-mining flooding assessment, indicating that One Mile Creek inundates the current pit lake during flood flows. Currently, the Alice Queen pit has a spill level of 117.4 m, standing 4 m above the One Mile Creek invert, situated immediately adjacent to the pit void.

The Alice Queen Mine Pit is expected to be inundated by floodwaters in One Mile Creek inflow events more frequent than the 50% AEP. However, this interaction has been excluded from the daily water balance model. The flooding interaction with One Mile Creek results in freshwater inflows and flushing of the pit lake, which will improve water quality in the long term.

Final void flood modelling

To model the impact of flood impacts, two model scenarios were simulated for the final void assessment using the GoldSim model (Engeny 2025; Appendix D). A base case and a sensitivity case, were simulated, as outlined:

- Base Case — One Mile Creek flood inflows occur based on a 50% AEP daily rainfall event, consistent with the flooding assessment outcomes detailed in 6.4.2.1.
- Sensitivity Case— Reduced annual frequency of flood inflows from One Mile Creek to less than 10%, to assess variability in void lake behaviour from less frequent creek flooding inflows.

At cessation of mining, the pit will be allowed to fill. The water balance model assessment indicates the following:

- Modelled equilibrium pit lake level for the base case is approximately 116.6 m AHD. This aligns with a historical site surveyed water level between 115.8 m AHD and 116.5 m AHD. The sensitivity analysis of reduced frequency of One Mile Creek flood inflows also shows an approximate modelled equilibrium level of 116.4 m AHD.
- For the base case, the water balance model shows the pit lake overflowing in approximately 71% of the years where approximately 50% of the overflow events coincide with modelled flood ingress from One Mile Creek and 21% of years are expected to overflow independent of modelled interaction of the One Mile Creek.
- Under the base case scenario, the water balance model predicts a filling period of 1 year under median climate conditions (<1 to 3 years for 10th and 90th percentile climate periods respectively).
- The existing pit lake water quality data shows a freshwater quality with similar contaminant concentrations as the receiving waterways.
- The model under the sensitivity case scenario indicates that the pit lake overflowing in approximately 53% of the years where approximately 7% of the overflow events coincide with modelled flood ingress from One Mile Creek and 45% of years are expected to overflow independent of modelled interaction of the One Mile Creek.
- For the sensitivity case, the model predicts a filling period of 5 years under median climate conditions (1 to 9 years for 10th and 90th percentile climate periods respectively).

Water quality parameters for closure

A pit water study was undertaken investigating water quality (refer to Section 6.4.1).

A comparison of water quality parameters between the pit lake and monitoring sites (upstream of the pit on One Mile Creek, for pH, Dissolved Oxygen, Turbidity, EC, Sulphate, Arsenic (III), Arsenic (V), Total Arsenic, Antimony, Copper, Lead, Zinc and Total Cyanide, was undertaken (Engeny 2025; Appendix D). The comparison indicated:

- There is a close alignment in water quality between the W1 monitoring point (300 m upstream of the pit on One Mile Creek) and the Queen pit in nearly all parameters with the exception of total Arsenic:
 - Although, the recorded monitoring data for total Arsenic in Queen pit from 2014 to current suggest elevated concentrations in comparison to background monitoring point, W1 (refer to Figure 8-2), the total Arsenic values downstream recorded at W2 (70 m downstream of Pit) and W4 (approximately 800 m downstream of the Pit) show generally low concentrations with clear evidence of dilution along the stream.
 - The total Arsenic concentration at W4 monitoring point (refer to Figure 8-2) is below the trigger level of the WQO and consequently no environmental harm is likely to be caused by the overflows from the pit lake.

The data suggests no deterioration of water quality since 2013, supporting regular ingress from the One Mile Creek.

The pit lake water quality is within the trigger levels for the PMLU of stock water and is generally within the WQO limits. Frequent freshwater inflows from One Mile Creek are expected to keep salinity levels low, ranging between 35 and 60 $\mu\text{S}/\text{cm}$. The WQOs are described in Section 8.2.4.

6.4.7.2 Tailings storage facility (TSF)

The tailings dam is located approximately 500 m northwest of the Alice Queen Mine Pit. It covers an area approximately 150 m x 210 m and is impounded by an engineered (or assumed to be) embankment between 4 m and 5 m high. The facility is partially filled 3 m to 4 m deep with tailings.

The tailings dam embankment walls have been naturally colonised by local grass, shrub and tree species (*Melaleuca spp.* and *Acacia spp.*) over the past 20 years. It is estimated approximately 50% of the tailings surface is covered by vegetation.

A constructed drainage channel at the western toe of the tailings dam appears to be maintained (refer to section 3.3.4.2), which would divert water away from the impoundment to the Alice River system. An elevation model from drone capture is shown as Figure 6-20.

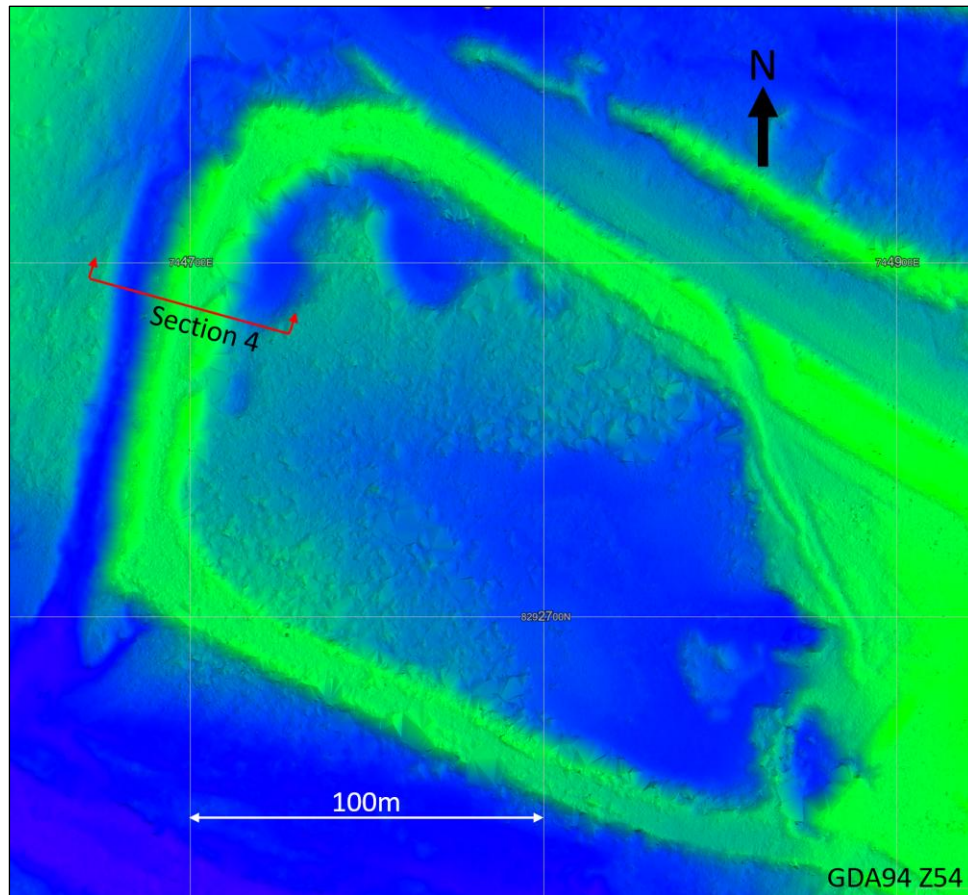


Figure 6-20: Elevation model of tailings storage facility

Stability assessment

The height of the tailings dam, from toe to crest, is very low and is unlikely to present a significant risk from a geotechnical stability perspective. There are no tailings dam construction records (BMS 2022; Appendix D), therefore it has been assumed (based on site geological conditions and material) that the structure has been constructed from weathered granitic rock spoil that is generally sandy but contains some clay component. This is supported by the geochemical analysis undertaken by RGS (Refer to Section 6.4.4). Such ageing embankments are likely to be susceptible to erosion from surface runoff with a possibility of loss of fines, predominantly on the downstream face of the embankment. In these instances, this would result in fines reporting to the drainage system, which would flow into the Alice River, which is unlikely to have a significant effect on geotechnical stability (Ward 2016).

The Geotechnical Assessment Report (BMS 2022; Appendix D) includes assessment of the geotechnical stability of the tailings dam, focusing on a representative section through the downstream embankment of the structure (Figure 6-20). Slope stability analyses was carried out under the 'as-built' scenario where the tailings dam is currently partially filled and a worst case water level applied, and an 'Infilled' scenario to exemplify the potential further use of the facility as additional waste material storage filled to the maximum height of the embankment. A cross-section of the embankment used in the infilled scenario is shown in Figure 6-21.

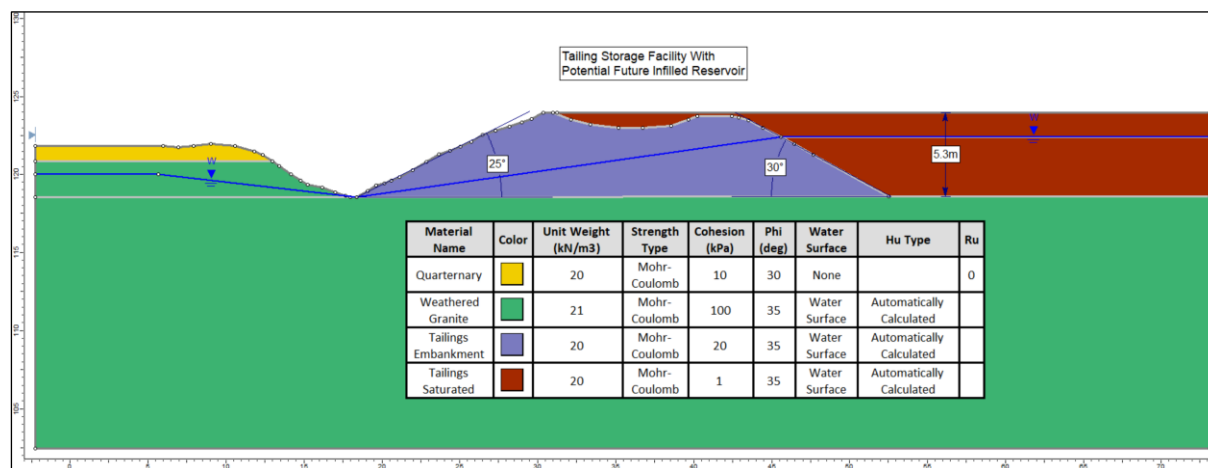


Figure 6-21: Cross-section of infilled TSF embankment used in stability assessment

Under all scenarios, the slope stability analyses exceeded the minimum required FoS (1.5) value for long-term geotechnical stability. Therefore, the tailings dam slopes are unlikely to pose a significant long-term slope stability risk based on the scenarios and assumptions.

Tailing storage facility design

To ensure stability of the TSF, the following methods and management, prepared by RGS and BMV, will be undertaken.

Landform closure design report

A landform closure design report (section 6.3.2.3), will be prepared to demonstrate how the proposed cover and design by RGS (2023, Appendix D) will achieve the objectives of the grassland PMLU.

The landform closure design report will be provided to the Department; confirming that it will achieve a stable condition that can be sustained in a post-closure context. It will include detailed engineering designs and will be prepared by an AQP geotechnical engineer. The documents for the report will be independently reviewed, and certified by both the AQP geotechnical engineer and the independent reviewer. The landform closure design report will be revised as necessary to ensure currency.

The landform closure design report must, at a minimum for the relevant structures, include:

- Design aims and objectives of final landform, including the cover system and batters,
- All actions recommended within the RGS Soil capping and mine waste assessment and tailings dam rehabilitation report (RGS 2023) to verify the validity of the proposed cover and the mass of Ca(OH)₂ and CaCO₃ required to achieve design objective,
- All actions recommended within the Alice River Gold Project Progressive Rehabilitation and Closure Plan Geotechnical Assessment Report (AARC 2022)
- How the cover system achieves a performance outcome equivalent to or better than the design provided in the PRC Plan dated 21 March 2025 (v5),
- How the cover system performance will be demonstrated,
- The intended design life of the component parts of each relevant structure including the cover, plateau, batters, access points, water management, and associated monitoring network.
- Quality assurance and quality control required during construction,

- h) How the landform achieves acceptable geotechnical and erosional stability,
- i) How the landform achieves an acceptable water quality outcome,
- j) How redundancy of the monitoring network has been identified and built into the final design,
- k) How the design, including the component parts supports the achievement of the grassland PMLU,
- l) the critical design elements and associated assessment that support the achievement of a stable condition,
- m) Where any assumed or inferred material properties have been used in the design or its assessment (inclusive of modelling), detailed discussion justifying why actual/measured properties were not used, how uncertainties regarding material properties may affect performance, and how those uncertainties are managed.
- n) Details of the minimum monitoring required, including the type of monitoring, location/s, frequency and performance indicators, to demonstrate ongoing stability and performance in support of achieving a stable condition.

Once mining activities are completed, the structure will be backfilled and reprofiled to create a water shedding structure, and rehabilitated to a safe, stable and not-polluting final landform. The general process of rehabilitation is outlined below:

- A low slope angle scalloped landform will be constructed, that will be self-draining (will not store surface water) and enable surface runoff to flow off the surface of the tailings dam.
- Ore stockpiles, mullock pile waste and all other ex-pit mine materials will be recovered. They will be screened to < 200 mm particle size diameter using a grizzly to retain the > 200 mm PSD material. The screening will assist with constructing and placing material.
- The < 200 mm PSD material from the ore stockpiles, mullock pile waste and other material will be placed into the tailings dam void.
- The vegetation, and 100 to 200 mm of the surface profile of the tailings, will be graded off the surface of the tailings dam to either side of the tailings dam and stockpiled as tailings growth medium.
- If additional material is required to achieve a water shedding design, it will be sourced from regolith material taken from the Alice Queen Mine Pit.
- The surface tailings material and vegetation will be replaced over the shaped tailings profile.
- Material reserved from the regolith strata in Queen pit and other regolith material from the mullock piles and ore stockpiles (PSD material > 200mm particle size), will be spread over the surface of the tailings growth medium.
- The drainage line along the base of the scalloped profile will be a 50 to 75% surface cover of rock.

Tailings cover design

The following tailings cover was designed by RGS (2023, Appendix D). The in situ rehabilitation process for the tailings dam and mine waste differs from the standard approach of placing soil and regolith units on top of tailings or waste rock. The in-situ rehabilitation process is a viable approach because the tailings do not contain significant amounts of pyrite that could oxidise and produce additional acid. The principle applied to the rehabilitation of the tailings at the Alice River Mine is to utilise neutralisation and in situ remediation to convert acid forming (AF) tailings into non-acid forming (NAF) tailings that can support vegetation. In situ remediation trials undertaken at Mount Carrington in New South Wales (RGS 2023) were viewed by the International Network for Acid Prevention (INAP) board members in 2022 and were described as leading industry practice. This type of approach is referenced in the Office of the Queensland Mine Rehabilitation Commissioner:

Research Brief – research scoping and stakeholder feedback: February 2022. The proposed in situ cover for the TSF will utilise the following materials:

- Soil: site soils have low potential for dispersion and are suitable to be incorporated into the tailings to create a soil cover system.
- Surface mine waste: AF mine waste containing (or contained) low sulphide mineral concentrations that oxidised and produced acid through to NAF_{LC} mine waste that retains circum-neutral to mildly alkaline pH, low residual ANCT and unoxidised sulphide minerals, that have the potential to become acid in the future.
- Tailings:
 - The tailings dam and depth of the tailings is likely to be < 2.5 m.
 - The tailings geochemical properties range from NAF_{LC} to AF with low residual sulphide content and PAFLC. Although the actual acidity in the solid tailings mass was not measured the pH range infer that the actual acidity concentration is low range.
 - The tailings are low permeability, with low shrink-swell capacity and high potential to retain soil moisture to support vegetation.
 - The high proportion of clay size fractions and low permeability of the tailings induces higher runoff relative to percolation and these factors are responsible for the retention of water-soluble arsenic and antimony and other metal(lids) in the solid fraction of the tailings matrix.
 - Water soluble arsenic and antimony is present in the tailings because of the fine-grained nature of the tailings, high clay content and low permeability of water through the tailings. The chemical and physical characteristics of the tailings make it unlikely that these elements are being leached from the tailings dam.
 - The actual acidity can be neutralised with Ca(OH)_2 and CaCO_3 to increase the pH of the tailings to 8 to 9 and ensure that any oxidation and acid production in the underlying tailings can be neutralised to maintain neutral to mildly alkaline pH.

The following objectives of the tailings cover will be implemented (RGS 2023):

- AF low sulphide bearing tailings will be neutralised with Ca(OH)_2 and CaCO_3 so the soluble and exchangeable Al and Mn that induce root toxicity and necrosis tailings can be precipitated in the tailings cover thereby supporting revegetation.
- AF to NAF_{LC} mine waste will be co-mingled into the top 0.5 m of the tailings, to minimise the potential for the mine waste to oxidise and produce additional acidity.
- Soil will be incorporated into the neutralised tailings and rock cover to produce a “soil cover” system that can support vegetation.
- A low slope will be created on the reshaped surface profile that will direct surface runoff from the perimeter of the tailings dam to a NAF rock armoured release point, into the receiving environment.
- The surface on the tailings dam that will include exposed rock infilled with pockets of neutralised tailings and topsoil will retain moisture and nutrients and support vegetation.
- A tailings surface that will resist erosion by surface runoff and wind should be constructed.

Cover design performance monitoring

The proposed in situ remediation may be verified with a bench scale kinetic leach column analysis, by combining acid tailings with Ca(OH)_2 and CaCO_3 with mine waste and tailings and then leaching the “cover system” with water to verify how it will perform.

Where required, the laboratory assessment will be supplemented with field measurements such as k_{sat} t using double ring infiltrometer and Guelph Permeameter analysis. Where detailed design is required, LIDAR data will be run for the site to verify the tailings dam surface, the tailings dam void, and mine waste material balance to be reclaimed and placed into the TSF. The LIDAR surface will also be used for detailed design drawings. The

measured parameters from the field, LIDAR data, and soil quality, geochemical and physical analyses in (RGS 2023) can be used to develop a detailed design and SEEPW numerical cover modelling to forecast future performance.

Erosion stability modelling of the tailings storage facility landform design

An Erosion Stability Assessment (ESA) for the Alice River TSF located at the Alice River Gold Project (the Project) was undertaken by AARC (2024a; Appendix D). Erosion modelling was undertaken to predict the long-term stability of the existing and final downstream slope of the tailings facility embankment. Erosional stability for the Project has been assessed using the Water Erosion Prediction Project (WEPP) model. The WEPP model was used to predict long-term stability of the existing and proposed final landform designs of the TSF.

The WEPP model is a process-based, distributed parameter, continuous simulation erosion prediction model. It considers various factors including slope design, climate information, vegetation management structures and soil parameters (National Soil Erosion Research Laboratory 1995).

WEPP modelling was used to assess the erosional stability of various representative rehabilitated slopes, as identified in the proposed final landform. WEPP soil profiles were generated using a combination of topsoil and subsoil samples collected from two distinct sampling programs. The first program, conducted for the Annual Rehabilitation Monitoring Report (AARC 2021), involved extracting data from a topsoil sample taken at an analogue site that accurately represents the natural topography, vegetation type, and post-mine land use designated as 'low intensity grazing'. The second program focused on a geochemical assessment to support the Project's PRCP (RGS 2023) and involved six topsoil samples sourced from existing soil stockpiles. The sampling for the first program took place in May 2021, while the second program was conducted in December 2022. In total, 72 combined soil profiles were created for the WEPP model by combining the topsoil and subsoil profiles.

Hillslopes for WEPP analysis were generated based on the current and final landform design for the TSF. Final landform conditions were based on the stability assessment conducted for the TSF in the Geotechnical Assessment Report (Blackrock 2022) elaborated for the Pacgold PRCP. This report establishes two long-term stability scenarios for the tailing's embankment. In the first 'as-built' scenario, the tailings dam is partially filled with water and in the second 'infilled' scenario the facility is used as waste material storage filled to the maximum height of the embankment.

Simulated vegetation cover was produced based on the proposed RMs and PMLUs for the Alice River PRCP of low intensity grazing management. A total of 11 scenarios were nominated under different vegetation covers that ranged from 50% to 100%.

As expected, results for all topsoil profiles showed decreasing soil loss rates as vegetation cover increased under the representative final slope gradient. As derived from existing studies, an erosion rate of 5 t/ha/year at any point on the slope of the TSF has been adopted as the target acceptable erosion rate and the basis for assessment (Landloch 2013, Howard and Loch 2019 in AARC 2024a: Appendix D). However, some studies suggest that a maximum tolerable erosion rate of 10 t/ha/year may be acceptable for mining rehabilitation (Lu 2001, in AARC 2024a; Appendix D).

All simulations with the 70% vegetation cover achieved the target erosion rate of ≤ 5 t/ha/year for both maximum on-slope and annual total soil loss, except for the representative final slope that exceeded the target by a marginal 0.01 t/ha/year—well within the model accuracy. No simulations exceeded the maximum tolerable erosion rate (10 t/ha/year). The median annual soil loss rate under current conditions at 70% vegetation cover is 4.5 t/ha/year, with a maximum on-slope soil loss of 0.9 t/ha/year.

For simulations with 70% vegetation cover under current slope conditions, 122 of the 126 simulations (97%) returned annual soil loss values within the 5 t/ha/year target tolerable rate, with four simulations (3%) returning annual soil loss values within the 10 t/ha/year maximum tolerable rate. When considering average maximum on-slope soil loss, all simulations returned values within the 5 t/ha/year target tolerable rate.

Overall, the information provided estimates that under current slope conditions and vegetation cover of 70%, the proposed final land use will meet the requirements outlined in the rehabilitation criteria. Given these findings, it is recommended that vegetation cover be maintained at greater than or equal to 70% under the representative future slope conditions to ensure that erosion rates remain below the target threshold. Where

vegetation cover is less than 70%, there remains a chance of some level of erosional instability on the slope and excessive erosion leading to rehabilitation failure. The major factors affecting erosion of the landforms within the design considerations are the vegetation cover present, the slope length and the slope gradient.

6.4.7.3 ROM Pad and waste rock dumps/mullock dumps

Material from the ROM pad and waste rock dump/mullock dumps will be bulk pushed into the tailings dam prior to closure resulting in a relatively flat final landform. (Refer to section 6.4.7.2 Tailings storage facility – rehabilitation strategy and cover designs.)

A Phase 1 land contamination investigation will be undertaken by an appropriately qualified person and any identified contaminated material incompatible with the proposed PMLU (including carbonaceous or metalliferous material) will be either treated in situ or disposed of in the tailings dam prior to closure.

General reshaping and trimming shall be undertaken to achieve final landform design. The area will then undergo surface preparation and revegetation in accordance with the methodology described in Section 6.4.6.

6.4.7.4 Historical mining pits

The historical mining pits were mined approximately 120 year ago. Their location is indicated in Figure 3-2, and they are on ML2908 and ML2902. These pits precede the mining lease and are therefore not included in this PRC plan.

6.4.7.5 Cleared land

Following the removal of any infrastructure, cleared areas may require minor landform reshaping to blend with the surrounding land and reduce slopes to minimise erosion risk. The area will then undergo surface preparation and revegetation in accordance with the methods described in Section 6.4.6.

6.4.7.6 Topsoil stockpiles

This RA includes areas containing topsoil stockpiles (Figure 3-2). Topsoil will be transported to other RAs as they become available for rehabilitation; once 100 mm of topsoil remains, the areas will be ripped and revegetated in accordance with the methods described in Section 6.4.6.

In areas where vegetation has naturally regenerated (Figure 3-3), further works may be required to meet contemporary rehabilitation standards, including minor earthworks and ongoing maintenance.

6.4.7.7 Exploration drill holes

All currently identified historical exploration drill holes have been rehabilitated in the ML. The surface area of each drill hole is relatively small, and it is expected that vegetation will naturally regenerate following the removal of infrastructure. Where a drill hole is identified, the following rehabilitation methods will be undertaken:

- demobilise the drill rig;
- facilitate a drying out period to allow water to evaporate from the drilling muds in the sumps;
- backfill drill sumps;
- permanently plug all drill holes that are no longer required;
- rip the disturbed area; and
- seed the disturbed area in accordance with the methods described in Section 6.4.6.3. Drill holes will be rehabilitated in accordance with the standard conditions for exploration and mineral development projects.

6.4.7.8 Rehabilitated historical exploration areas

The mining area, and the EA (Schedule I – Site Maps and Plans, Figure 1 (Authorised Activities and Locations – Northern mining leases), and Figure 2 (Authorised Activities and Locations – Southern Mining Leases), recognise existing areas on the ML that have previously been rehabilitated (refer to 6.4.6

In some small, localised areas, following the removal of any infrastructure, cleared areas will undergo minor landform reshaping if required to blend with the surrounding land and reduce slopes to minimise erosion risk. Surface preparation will be undertaken, followed by revegetation in accordance with the methods described in Section 6.4.6.

There are some costeans located on ML3010 to be rehabilitated. The costeans will undergo landform reshaping to blend with the surrounding landform and be made safe for people and livestock. The area will then undergo surface preparation and revegetation in accordance with the methodology described in Section 6.4.6.



Figure 6-22: Rehabilitated historical exploration areas

6.4.7.9 Built infrastructure

At the completion of mining activities, all infrastructure constructed by, or for the operation of, Pacgold will be removed from the site prior to surrender, except where agreed in writing by the post-mining land owner/holder and the administering authority. Areas where infrastructure is removed, or those areas surrounding infrastructure that will remain, will be returned to low intensity grazing consistent with the pre-mining and surrounding environment and PMLU.

At all times throughout the decommissioning process, the removal of infrastructure will adhere to the waste management hierarchy (i.e., in order of preference: reuse, recycle, energy recovery and disposal).

Contaminated land assessments will be undertaken to identify potential remediation requirements.

Surface infrastructure to be decommissioned at closure includes: a plant area, above ground tanks, a historic mill area and historic mining equipment, and tracks. The methodology used to decommission and rehabilitate the infrastructure is to:

- disconnect and terminate (i.e., de-energise) plant and equipment to make safe;
- remove all liquids, fuels, lubricants and decontaminate plant and equipment;
- decommission and remove all surface infrastructure, unless requested otherwise in writing by the underlying landholder (underground services will remain buried and surface interface points will be sealed);
- assess areas for contaminated lands and remediate identified areas;
- deep rip to aerate the compacted soil material; and
- seed disturbed areas with suitable pasture species.

Retained infrastructure

Infrastructure to be retained per the landholder agreement (Appendix E) includes roads and tracks, and two cement slabs within the plant area (Figure 5-1). The roads and tracks will be assessed to confirm that the land is stable and erosion is consistent with or better than that recorded at analogue sites, and that drainage follows appropriate paths to reduce erosion risk and minimise maintenance requirements.

The tracks on ML3010 will be maintained by the landholder post-closure. The land will be used for light grazing post-mining, and all retained infrastructure is consistent with this land use and with the intent of the landholder.

The council-maintained roads traversing through the MLs, including to the council quarry, will continue to be maintained by the council post-closure.

7 Risk assessment

7.1 Risk assessment requirements

In accordance with section 126C(1)(f) of the EP Act, this PRCP assesses the risks of rehabilitation objectives not being achieved for the Project and addresses Pacgold's intents to manage or minimise the risk.

A risk assessment has been carried out per the following standards:

- AS/NZS ISO 31000:2018 Risk management - Guidelines; and
- HB203:2012 Managing environment-related risk.

This risk assessment has informed the scope of the planning part of this PRCP, as well as the development of comprehensive rehabilitation success criteria. Where higher risks were identified for the Project, the scope of the PRCP was expanded to provide confidence in the rehabilitation methods to achieve the objectives and milestones proposed.

7.2 Risk assessment process

Any risk assessment needs to be undertaken with consideration of the scope, context, and criteria relevant to the assessment. For this risk assessment, the following scope and purpose were discussed and agreed to:

"The purpose of this risk analysis is to identify and assess the risks of a stable condition for the land not being achieved for the agreed post-mining land uses nominated, and any related potential for environmental harm. The risk analysis will also identify the approaches to be taken to manage and minimise the identified risks".

For this risk assessment, risk scenarios (or 'threats') were considered for each rehabilitation area associated with the Project. The causes attributable to each risk scenario were documented as well as the potential impacts. Existing controls were noted, defined as those reasonably expected to be in place for a Project of this nature and having appropriate and contemporary management systems.

Each risk scenario was assessed with respect to health, safety, the environment, and compliance against the risk assessment scheme outlined in Section 7.3. The risk assessment was completed through a workshop process including input from key persons responsible for mine planning and environmental management.

7.3 Risk assessment schema

Risks specific to the rehabilitation of the Alice River site have been classified per the risk classification schema which is described below. The risk assessment schema used is representative of those used widely within the mining industry. For this risk assessment, the schema comprised the following components:

- a control effectiveness ranking (Table 7-1) used for assessing the operational controls expected to be in place for a project of this type;
- a likelihood classification descriptors table (Table 7-2); and
- a consequence classification descriptors table (Table 7-3) is intended to guide a consistent assessment of consequence.

Following a consensus determination of likelihood and consequence, the risk level was determined using the matrix shown in Table 7-4. For any risks classified as 'significant' or above, mitigation and management measures were identified and documented.

Table 7-1: Control effectiveness ranking

Control Rank	Description	Guidance
C1	Substantially effective/adequate design	Controls are considered adequately designed and are operating effectively on almost all occasions
C2	Mostly effective/adequate design	Controls are considered adequately designed and are operating effectively on most occasions
C3	Inadequate design/partially effective	Controls are considered inadequately designed or are only operating to partial effectiveness on most occasions
C4	No controls/ineffective	There are no controls designed or the existing controls are operating ineffectively on all occasions

Table 7-2: Likelihood of exposure to the hazard

Level of Risk Probability	Descriptive Guidance	Probability	Frequency
Almost certain	The event is expected to occur in most circumstances.	Higher than 25%	The event and consequence is expected to occur at least twice per year
Likely	The event will probably occur in most circumstances.	From 10% up to 25%	The event and consequence is expected to occur at least once to twice every year
Possible	The event could occur at some time.	From 1% up to 10%	The event and consequence is expected to occur at least once in 1 to 10 years
Unlikely	Not expected but the event may occur at some time in the future.	From 0.1% up to 1%	The event and consequence is expected to occur at least once in 10 to 100 years
Rare	The event may occur only in exceptional circumstances.	Less than 0.1%	The event and consequence is expected to occur less than once in every 1000 years

Table 7-3: Consequence classification descriptors

Category	Consequence Scale				
	Very Low	Low	Moderate	High	Very High
Safety	- Low level short term subjective inconvenience or symptoms. - First aid treatment.	- Reversible injuries requiring treatment, but do not lead to restricted duties. - Medical treatment.	- Reversible injury or moderate irreversible damage or impairment to one or more persons. - Lost time injury.	Single fatality and/or severe irreversible damage or severe impairment to one or more persons.	Multiple fatalities or permanent damage to multiple people.
Environmental	Near-source confined and promptly reversible impact (days).	Near-source confined and short term reversible impact (a week).	Near-source confined and medium-term recovery impact (weeks - month).	The impact is unconfined and requiring long-term recovery, leaving residual damage (months - years).	The impact is widespread unconfined and requiring long-term recovery, leaving major residual damage (typically years).
Compliance	- Non-conformance with internal requirement with very low potential for impact. - Non-compliance with community commitment goes unnoticed by external party/parties, requiring minimal effort to correct.	- Non-compliance with external or internal requirement with low potential for impact. - Formal censure. - Non-compliance with community commitment, requiring limited effort to correct.	- Non-compliance with internal or external requirement with moderate impact. - Moderate penalties for breach of legislation, contract, permit or licence. - Non-compliance with community commitment reported formally, with significant effort to correct.	- Breach of licence(s), legislation, regulation-high potential for prosecution. Contract breach-significant penalty. - Systemic internal standards breach-high impact. - Community commitment breach-high potential business impact-significant effort to fix.	- Suspended or severely reduced operations imposed by regulators. - Breach of community commitment results in direct loss of established consents with widespread secondary effects.

Table 7-4: Risk level classification matrix

Likelihood	Consequence				
	Very Low	Low	Moderate	High	Very High
A. Almost Certain	Class II	Class III	Class IV	Class IV	Class IV
B. Likely	Class II	Class III	Class III	Class IV	Class IV
C. Possible	Class I	Class II	Class III	Class IV	Class IV
D. Unlikely	Class I	Class I	Class II	Class II	Class IV
E. Rare	Class I	Class I	Class II	Class II	Class II

7.4 Risk assessment outcomes and management

For this Project, a total of 34 individual risk scenarios were identified and assessed, resulting in no risk scenarios classified as Class IV (high risk), 1 classified as Class III (significant risk), 13 classified as Class II (moderate risk) and 20 classified as Class I (low risk). A summary of the risk outcomes is shown in Table 7-5. Detailed risk assessment outcomes are provided at Appendix C.

Table 7-5: Risk assessment outcomes by rehabilitation area

Rehabilitation area	Risk level				
	Class I	Class II	Class III	Class IV	Total
Waste rock dump	5	2	0	0	7
Final void	3	1	1	0	5
Tailings dam	2	4	0	0	6
Infrastructure and plant area	4	1	0	0	5
Historical mining pits/exploration areas	3	2	0	0	5
Run-of-Mine pad	3	3	0	0	6
Total	20	13	1	0	34

The risk scenario classified as Class III (significant risk) is the risk associated with the accessibility of the highwall areas of the final void by humans and/or fauna. The probability of an event occurring was determined to be 'rare', as existing controls – exclusion fencing around high wall areas, and the low likelihood of access by the public due to the remoteness of the site – are considered adequate and effective. However, potential consequences of the event happening are considered 'high', meaning that a fatality and/or severe irreversible damage may occur to a person. Therefore, the residual risk for this event is significant despite all the control measures implemented by the Project to reduce its likelihood.

7.5 Risk Register

A risk register, identifying the risks to not achieving a stable condition for post-mining land uses, will continue to be maintained. It will identify how the risks are being managed or minimised.

The risk register will be reviewed every three years. It will consider the outcomes of monitoring data.

8 Monitoring and maintenance

The intent of the rehabilitation monitoring and maintenance program, as per the PRC Plan Guidelines, is to demonstrate that progressive rehabilitation and closure is occurring and that completion criteria have been achieved. The monitoring and maintenance program in this section will be implemented, with the purpose of demonstrating each rehabilitation milestone has been achieved and continues to be achieved. Where there is an inconsistency between the PRCP Schedule and this section, the Schedule will prevail.

8.1 Analogue sites

Two analogue sites have been established at the locations in Table 8-2 and Table 8-3. The analogue sites will be monitored at the same time as RAs where rehabilitation milestone criteria require comparison against analogue sites.

The locations for the analogue sites have been revised from the EA analogue site locations that are proposed to be amended (Table 8-1). The selected revised locations are more appropriate as they are representative of the natural topography, coarse quartz sandy substrate, vegetation type and PMLU (AARC 2019) (Table 8-2 and Table 8-3).

Both of the EA analogue site locations are located adjacent to a watercourse and are therefore not characteristic of the vegetation being rehabilitated. Secondly, AS1 location in the EA was noted to be disturbed since 2019. The revised analogue site locations have been surveyed for the past few years.

Table 8-1: Analogue site locations

Site name	EA location*		Site location used for PRCP and rehabilitation monitoring (GDA 2020, Zone 54)		
	Eastings	Northings	Eastings	Northings	Notes for PRCP locations
AS1	744882	8292570	745206	8293122	North of ML3010
AS2	745297	8292349	745424	8292500	East of ML3010

Note: *The EA analogue locations are not on EA Schedule I – Figure 1.

Table 8-2: PRCP AS1 ecological details

		
Government Mapped RE(s)	3.12.10/3.12.42/3.3.49	
Associated RE	3.12.10	
Remnant Status	Remnant	
Landform Description	Site occurred on Land zone 12 with signs of intrusive granite. Soil was primarily composed of coarse quartz grains.	
Erosion Present	No erosion present at site, no rills or disturbance recorded.	
Tree Layer	Broad Leaved Paperbark (<i>Melaleuca viridiflora</i>), Clarkson's Bloodwood (<i>Corymbia clarksoniana</i>), False Sandalwood (<i>Eremophila mitchellii</i>), Cooktown Ironwood (<i>Erythrophleum chlorostachys</i>), Golden Parrot Tree (<i>Grevillea pteridifolia</i>), Dallachy's Gum (<i>Corymbia dallachiana</i>).	
Shrub Layer	Soapbush (<i>Alphitonia pomaderroides</i>), Silver Wattle (<i>Acacia holosericea</i>), <i>Acacia</i> sp.	
Ground Layer	Giant Speargrass (<i>Heteropogon triticeus</i>), Cockatoo Grass (<i>Alloteropsis semialata</i>), Lesser Joyweed (<i>Alternanthera 107id asp107ate</i>), Firegrass (<i>Schizachyrium fragile</i>), <i>107id asp</i> .	
Structure Category	Sparse	
Introduced Species	No Introduced species recorded.	
Disturbance Notes	Remnant open woodland, some signs of light grazing and stock access present.	
Flora Species Diversity	14 Species (5 native trees, 4 native shrubs, 3 native grasses, 2 native forbs).	
Canopy Cover (%)	Crown – 16%	Shrub – 4%
Average Ground Cover (%)	Bare Ground – 40.2% Rock – 0%	Organic Litter – 34% Native Cover – 25.8%

Table 8-3: PRCP AS2 ecological details

		
Government Mapped RE(s)	3.12.10/3.12.42/3.3.49	
Associated RE	3.12.10	
Remnant Status	Remnant	
Landform Description	Site occurred on Land zone 12 with signs of intrusive granite. Soil was primarily composed of coarse quartz grains.	
Erosion Present	No erosion present at site, no rills or disturbance recorded.	
Tree Layer	Clarkson's Bloodwood, Cullen's Ironbark (<i>Eucalyptus cullenii</i>), False Sandalwood, Dallachy's Gum, Darwin's Stringybark (<i>Eucalyptus tetradonta</i>).	
Shrub Layer	Northern Forest Grass Tree (<i>Xanthorrhoea johnsonii</i>).	
Ground Layer	Giant Speargrass, Pigeon Grass (<i>Setaria surgens</i>), Barbed-wire Grass (<i>Cymbopogon refractus</i>), Feathertop Wiregrass (<i>Aristida latifolia</i>), Dark Wiregrass (<i>Aristida calycina</i>), Native Millet (<i>Panicum decompositum</i>), <i>Acacia humisfusa</i> , <i>Aristida</i> sp.	
Structure Category	Sparse	
Introduced Species	Two introduced species identified: Malvastrum and Guinea Grass. Guinea Grass is a known pasture species and is common throughout the region. Malvastrum is an environmental weed known to occur widely across Queensland and has been recorded within the region previously.	
Disturbance Notes	Remnant open woodland, some signs of light grazing and stock access present.	
Flora Species Diversity	16 Species (7 native grasses, 5 native trees, 2 introduced species, 2 native shrub).	
Canopy Cover (%)	Crown – 57%	Shrub – 0.2%
Average Ground Cover (%)	Bare Ground – 41.7% Rock – 0%	Organic Litter – 46% Native Cover – 10.8%

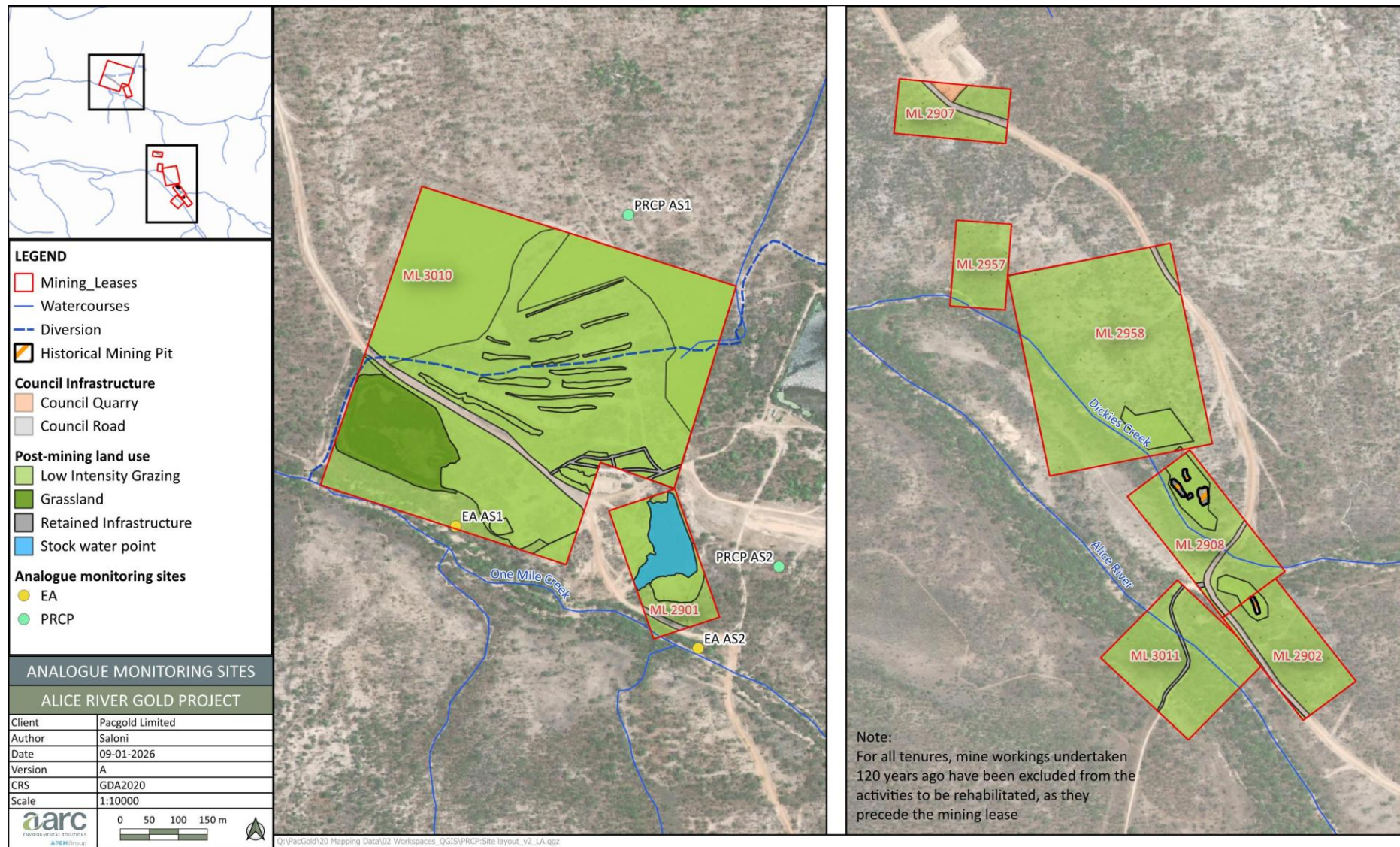


Figure 8-1: Analogue monitoring site locations

8.2 Monitoring and maintenance program

To develop the PRCP schedule, nine RMs have been proposed as being applicable for the Project. The PRCP Guideline (DES 2021) requires consideration of measures to be undertaken to demonstrate that milestones and milestone criteria have been achieved.

With respect to determining the achievement of RMs, a clear definition of milestone criteria have been developed for each rehabilitation milestone (Section 6.3.3). Assessment of RAs against completion criteria will be incorporated into the ongoing environmental management for the Project. Assessment of RAs against the milestone criteria that pertain to vegetation and achievement of PMLUs will be undertaken as part of the annual rehabilitation monitoring program that exists for the Project. Monitoring of rehabilitation will commence following completion of activities of the first rehabilitation milestone applicable to the relevant rehabilitation area.

The completion criteria for each PMLU will be used as the milestone criteria for the final milestone in the proposed schedule, which shows achievement of the PMLU to a stable condition at surrender. When the final rehabilitation milestone applicable to the rehabilitation area is deemed to be satisfied, a final rehabilitation assessment will be undertaken before an application for progressive certification or ML surrender is made. Table 8-4 provides a summary of the measures to be undertaken to determine the achievement of each rehabilitation milestone. Determination of the boundary of an area reaching a given rehabilitation milestone at a given point in time will utilise standard survey techniques, including land-based survey and airborne survey at an appropriate frequency – nominally annually – to achieve satisfactory geolocation of areas.

The location of proposed rehabilitation and closure monitoring sites are illustrated in Figure 8-2 and presented in Table 8-5.

Table 8-4: Rehabilitation milestone monitoring and management measures

Rehabilitation milestone	Description / criteria	Proposed monitoring and management measure(s)
RM1: Infrastructure decommissioning/removal	Applicable to all infrastructure identified to be decommissioned/removed from site. Considered to be met when the only remaining infrastructure forms part of a landholder agreement. All waste not authorised to be disposed of on site is removed.	Infrastructure decommissioned/removed at closure will be subject to relevant environment and safety planning requirements including completion inspections. A visual inspection(s) will be conducted to determine that no unauthorised waste has been disposed of on-site and that no infrastructure remains that does not form part of a Landholder Agreement.
RM2: Management of contaminated land	Applicable to the waste rock dump area, mine infrastructure areas, the tailings dam area and the ROM pad (i.e. where notifiable activities have been carried out) and, at a minimum, involves the completion of a Phase 1 contaminated land investigation undertaken by an appropriately qualified person. Considered to be met when contaminated material has been placed in the tailings dam, removed from site, or remediated in situ, a validation report has been completed, and, if required, a site suitability statement has been prepared.	A completed Phase 1 contaminated land investigation report, as well as any consequent reports, where required. Visual inspection of potential sites or sources of contaminated material will be conducted, and samples collected as required. The contaminated land investigation will determine the presence of any contaminants. Remediation activities will be undertaken if required following consultation on appropriate remediation activities. A validation report will detail the remediation of contaminated land and, if required, a site suitability statement prepared by an appropriately qualified person that states that the land is suitable for use according to the nominated PMLU.
RM3: Landform development (reshaping/reprofiling)	Applicable to all areas where bulk earthworks and other grading are required to achieve the target landform. Considered to be met when material from the waste rock dump has been pushed to the tailings dam area, the tailings dam area is water shedding, and all other applicable disturbance areas have been reprofiled to suit the surrounding landform. Additionally, a geotechnical assessment will be conducted to confirm that long-term geotechnical stability has been achieved. A landform closure design report will be prepared for the TSF landform.	Land-based and/or remote sensing survey techniques will be employed to confirm that graded slopes meet design specifications. Additionally, visual inspections will be done to determine if any future maintenance/repair action is required. A geotechnical assessment will be conducted by an appropriately qualified person to confirm that long-term stability has been achieved for all relevant landforms. Any other monitoring outcomes from the Landform closure design report will be undertaken.
RM4: Surface preparation (topsoiling/contouring/soil amelioration)	Applicable to all areas requiring revegetation. Includes final profiling and application of topsoil materials, soil testing, and soil amelioration, where required.	A soil health assessment will be conducted by an appropriately qualified person prior to each rehabilitation event to determine soil health and suitability, and recommendations made for ameliorants where required.

Rehabilitation milestone	Description / criteria	Proposed monitoring and management measure(s)
	Considered to be met when surface preparation activities have been completed and soil condition is conducive to target plant germination and growth.	Records of topsoil placement and photographic evidence indicating achievement of a target depth of the ≥ 0.1 m. Records to include any ameliorants applied, including types, rates and timing of applications. Surface and groundwater monitoring will be undertaken. Visual inspections and documentation of contour ripping, including depth, spacing and machinery used.
RM5: Revegetation (seeding and/or planting)	Applicable to all areas requiring revegetation. Includes seeding and/or planting of target revegetation species. Considered to be met when records demonstrate that seeding and/or planting of target species has been completed, with the understanding that remedial works such as reseeding or infill planting may be necessary to meet target vegetation completion criteria.	Records of seeded and/or planted species consistent with the species listed in Table 6-8. Visual inspections to determine if temporary fencing will assist plant establishment.
RM6: Achievement of surface requirements	Applicable to all areas that have been revegetated. Involves monitoring activities and remediation works if monitoring identifies risks to the rehabilitation milestone being achieved. Considered to be met when monitoring data collected over three consecutive years demonstrates that grassland establishment, pasture productivity, and erosion is comparable to analogue sites (AS1, AS2), and that water quality in the receiving environment is comparable to upstream levels.	Field surveys will be undertaken annually to assess the trajectory of rehabilitation towards a stable condition. Rehabilitated areas will be assessed against target vegetation criteria and statistically compared to analogue sites (AS1, AS2). The following data will be collected in accordance with the methodology described in Section 8.2: • vegetation species diversity (including species richness and composition); • erosion rates; • ground cover; and • invasive weed diversity. The TSF will be inspected to assess its progressing towards achieving a stable condition. Recommendations for remedial works will be made where required, and remedial activities undertaken as soon as practicable.
RM7: Achievement of low intensity grazing and grassland PMLUs to a stable condition	Final milestone applicable to all areas rehabilitated to low intensity grazing and grassland PMLU. Involves monitoring and remediation works if monitoring identifies risks to the final rehabilitation criteria being achieved.	A land capability assessment will be undertaken by an appropriately qualified person to certify that the land has achieved a minimum of Class VII. A visual inspection of RAs will be undertaken by an appropriately qualified person to identify any remaining hazards or safety concerns.

Rehabilitation milestone	Description / criteria	Proposed monitoring and management measure(s)
	Considered to be met when all completion criteria have been achieved and land is safe, stable, does not cause environmental harm and can sustain the nominated PMLU.	Rehabilitated areas will be assessed against target vegetation criteria and a final rehabilitation report produced. The following data will be collected in accordance with the methodology described in Section 8.2.1: • pasture productivity; • vegetation species diversity (including species richness and composition); • recruitment; and • ground cover. Water samples will be collected from upstream and the receiving environment. Water quality in the receiving environment will be compared with upstream water quality. Recommendations for remedial works will be made where required, and remedial activities undertaken as soon as practicable.
RM8: Achievement of stock watering point PMLU to stable condition	Final milestone applicable to all areas rehabilitated to stock watering point PMLU. Involves monitoring and remediation works if monitoring identifies risks to the final rehabilitation criteria being achieved. Considered to be met when all completion criteria have been achieved and land is safe, stable, does not cause environmental harm and can sustain the nominated PMLU.	Water samples will be collected from retained water storage(s) and sent to a NATA certified laboratory for analysis of water quality parameters specified in the ANZECC (2000) Guidelines. Results for the relevant parameters will be assessed against livestock drinking water guidelines values. A visual inspection of RAs will be undertaken by an appropriately qualified person to identify any remaining hazards or safety concerns. Water samples will be collected from upstream and the receiving environment. Water quality in the receiving environment will be compared with upstream water quality. A land capability assessment will be undertaken by an appropriately qualified person to certify that the land has achieved a minimum of Class VII. Recommendations for remedial works will be made where required, and remedial activities undertaken as soon as practicable.
RA9: Achievement of retained infrastructure PMLU to stable condition	Final milestone applicable to all areas nominated as retained infrastructure. Involves monitoring and remediation works if monitoring identifies risks to the final rehabilitation criteria being achieved. Considered to be met when all completion criteria have been achieved and land is safe, stable, does not cause environmental harm and can sustain the nominated PMLU.	A Hazard and Safety Assessment will be undertaken by an appropriately qualified person, and a final landform survey will be undertaken to confirm that retained infrastructure forms part of a landholder agreement. Recommendations for remedial works will be made where required, and remedial activities undertaken as soon as practicable.

Table 8-5: Rehabilitation Monitoring Sites

	Reference Sites	Easting (GDA 2020 - Zone 54)	Northing (GDA 2020 - Zone 54)	Biodiversity	Land Classification	Water Quality	Final Landform
Surface Water Monitoring	W1	745442	8292259			✓	
	W2	745108	8292426			✓	
	W3	744795	8292592			✓	
	W4	744270	8292718			✓	
	W7	744550	8292697			✓	
AQ pit lake monitoring	AQ-1	745248	8292592			✓	
	AQ-2	745254	8292552			✓	
	AQ-3	745262	8292516			✓	
	AQ-4	745234	8292574			✓	
	AQ-5	745239	8292536			✓	
	AQ-6	745240	8292504			✓	
Sediment Monitoring	S1	745443	8292260			✓	
	S2	744271	8292719			✓	
Ground Water Monitoring	MW01	744678	8292685			✓	
	MW04	745270	8292726			✓	
	MW05	744652	82927211			✓	
	MW06	744995	8292734			✓	
	MW07	745142	8292446			✓	
	MW08	745394	8292364			✓	
	MW09	745207	8292848			✓	

	Reference Sites	Easting (GDA 2020 - Zone 54)	Northing (GDA 2020 - Zone 54)	Biodiversity	Land Classification	Water Quality	Final Landform
	MW10	744689	8292877			✓	
	MW11	745222	8292447			✓	
	MW12	745316	8292449			✓	
PMLU Reference Sites	AS1	745206	8293122	✓	✓		
	AS2	745424	8292500	✓	✓		

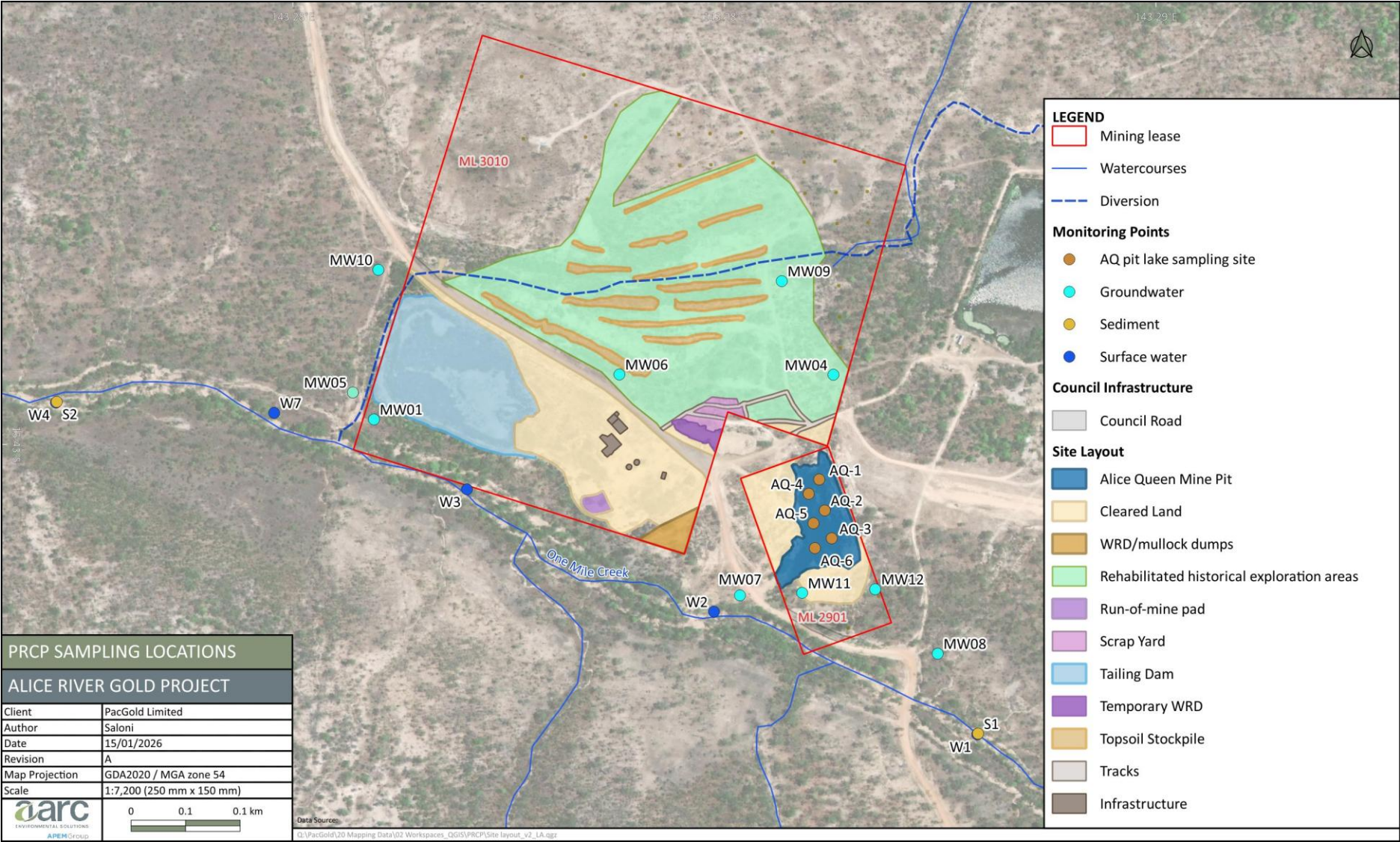


Figure 8-2: Rehabilitation Monitoring Sites

8.2.1 Vegetation monitoring

Vegetation monitoring will occur across permanent vegetation transects which involves the collection of quantitative data on ground cover composition, species richness, woody stem density, and canopy cover. At each monitoring site a 50 m tape will be run out to establish a transect and observations/measurements taken every five metres on either side of the transect, thereby representing a plot size of 50 m x 10 m. A star picket is installed at each end point of the transect, to consistently and precisely identify the permanent transect location.

Across each transect groundcover, species richness, woody stem and canopy cover will be monitored. The survey methodologies outlined below have been adapted from the Queensland Herbarium survey technique (*Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland* (Version 5.0)) (Neldner *et al.* 2019) and the *Method for the Establishment and Survey of Reference Sites for BioCondition* (Eyre *et al.* 2017).

8.2.1.1 Ground cover monitoring

Percentage ground cover for each species is recorded within ten 1 m by 1 m quadrats placed on alternating sides every 5 m along the 50 m transect, commencing at 0 m on the left and the final quadrat at 45 m (see Figure 8-3). In each quadrat the percentage cover of rock, bare ground, organic litter and live plant species present is recorded. Live plant species are classified into one of the following six groups for reporting purposes:

- native pasture grasses;
- exotic pasture grasses;
- non-pasture grasses;
- forb and other non-grass species;
- shrubs; and
- restricted invasive plants as listed in the *Biosecurity Act 2014* (QLD).

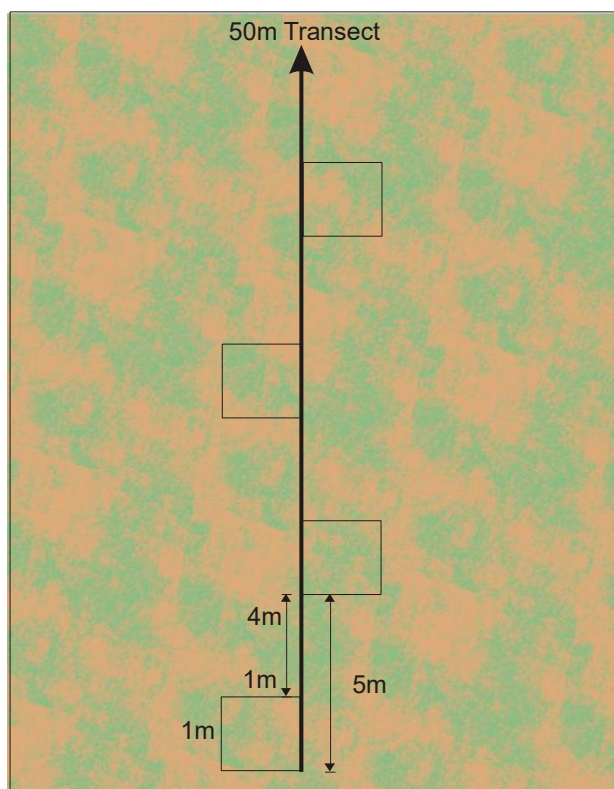


Figure 8-3: Ground cover percentage sampling

8.2.1.2 Species richness

Species richness is assessed using the method outlined in Eyre *et al.* (2017), where all vascular plants occurring within a 10 m x 50 m plot are recorded. The surveyor walks along each side of the 50 m transect centreline and records all trees, shrubs, forbs/other species and grasses occurring within 5 m either side of the centreline.

8.2.1.3 Woody stem density

Woody stem density is calculated using methodology adapted from *the Method for the Establishment and Survey of Reference Sites for BioCondition* (Eyre *et al.* 2017). All woody stems for each tree and shrub species is counted within the 10 m x 50 m plot area (i.e. 5 m either side of each 50 m transect). From this data, both total woody stem density, as well as the density of each individual tree or shrub species can be calculated. The density of species and growth forms on the monitoring sites is then calculated using the following equation:

$$\text{Density per hectare (ha)} = \text{Number of stems recorded within the transect} \times 20.$$

8.2.1.4 Canopy cover

Tree canopy cover can be used to characterise stand productivity and the distribution and abundance of biomass (Eyre *et al.* 2017). It refers to the estimation of the percentage canopy cover of the living, native tree layer along a 50 m transect, using the line intercept method (Greig-Smith *et al.* 1964). For this attribute, the vertical projection of tree canopy cover of the species making up the tree canopy cover was assessed. The vertical projection of the tree canopy over the 50 m transect was recorded as illustrated in Figure 8-4. The total length of the projected canopy of each layer is then divided by the total length of the tape to give an estimate of percentage canopy cover on the site.

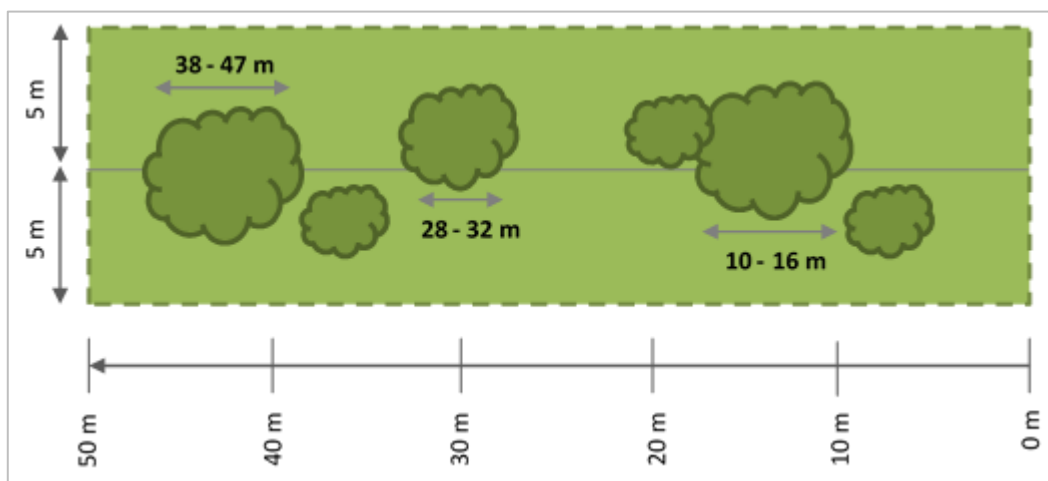


Figure 8-4: Guide to monitoring canopy cover (after Eyre et al. 2017)

8.2.1.5 Pasture productivity

In order to assess the quantity of pasture available for grazing a calculation of herbage mass is to be conducted at each site. Herbage mass refers to the total amount of pasture present; including both green and dead material and is expressed as a form of kilograms of dry matter per hectare (kg DM/ha).

A pasture meter (plate meter) will be used every 5 m along the 50 m monitoring transect to provide a measure of kg DM/ha for that site. These observations are then averaged to provide an estimate of the mean quantity of dry matter. This method is a non-destructive measure. The plate meter uses a weight disc to assess the settled height above ground to pasture mass beneath the disc. The disc is gently lowered onto the pasture after the central rod is placed on the ground surface. The height of the disc is recorded after approximately 5 to 10 seconds of settling time.

Alternatively, if the disc is not available, sites should be matched to the photo standards published by Future Beef and the corresponding estimate of kg/ha.

8.2.1.6 Recruitment

Recruitment is assessed within the 10 m x 50 m transect (5 m either side of each 50 m transect). Within this plot, the proportion of dominant species found to be regenerating are counted. A regenerating individual is identified as a woody stem species at breast height, with a diameter of < 5 cm.

8.2.2 Photographic monitoring

Photographic monitoring at monitoring sites shows a visual comparison over time of the vegetation, ground cover, erosion and general appearance of each monitoring site. The process consisted of taking one photograph from the start of the transect (0 m) facing towards the end of the transect, and another from the end of the transect (50 m) facing towards the beginning.

8.2.3 Erosion monitoring

Erosion at the survey sites is monitored through visual assessment over time. Assessment is undertaken by traversing the 100 metres (m) transect on foot, parallel to the contour/ not downslope, and recording the number and average depth of any erosion features or rill lines. However, the placement of the permanent transects does not adequately capture the level of erosion across the entire rehabilitation landforms, and observations during the surveys have also been considered for the preparation of each monitoring report.

Classification of observations will be undertaken using the criteria outlined in Table 8-6. The overall classification of the erosion on each transect is determined by the higher classification attributed to either

the number of rills, or the average depth. This is to recognise that while a transect may present only one or two rills, if such rills are recorded as being 30 centimetres (cm) deep, it will lead to a classification of 'Moderate' erosion.

Table 8-6: Erosion classification framework

Erosion classification	Minor	Moderate	Severe
Sheet erosion	Shallow soil deposits downslope.	Partial exposure of roots; moderate soil deposits downslope.	Loss of surface horizon; subsoil exposure; root exposure; substantial soil deposits downslope.
Rill/gully erosion	<15 rills per transect* and <0.3m deep	15-30 rills per transect* and <0.3m deep	>30 rills per transect* and/or any >0.3m deep
Tunnel erosion	Absent	Absent	Present
Mass movement	Absent	Absent	Present

Source: NCST (2009) Australian Soil and Land Survey Field Handbook, 3rd edition. The National Committee on Soil and Terrain. CSIRO Publishing, Collingwood, Australia.

*Transect 100 m across the contour (Source: Tongway, D. J. and Hindley, N. L. 2005. Landscape Function Analysis: Procedures for Monitoring and Assessing Landscapes. CSIRO Publishing, Canberra, Australia.)

In addition, high-resolution satellite imagery may be used to monitor and identify changes in erosion features over time.

8.2.4 Water quality monitoring

Given the natural variability of host materials, land use, and the water system setting at Alice River, water performance criteria must be informed by site-specific data. This means recognising natural background conditions and identifying different sources or influences on water to distinguish between natural background variability and potential mining-related impacts.

In the short term, and considering the prevailing land use, it is recommended that the ANZG (2018) stock water guidelines be adopted as interim water quality criteria. At the same time, a site-specific derivation process following the Queensland Water Quality Guidelines (QWQG, 2009) will be used to establish final water quality thresholds. This will be based on monitoring data collected over 18–24 months to ensure the criteria are practical and reflective of site conditions for closure. Water quality samples are to be analysed under laboratory testing conditions for the parameters listed in Table 8-7.

Water quality criteria and monitoring data will be reviewed at:

- 6–12 months – Initial assessment of expanded groundwater dataset.
- 18–24 months – Finalisation of site-specific water quality criteria.
- Post-closure reviews.

Each review will evaluate:

- Changes in water quality trends and natural variability baselines;
- Long-term seepage risks from TSF and WRD;
- Hydrological stability of rehabilitated landforms;
- Potential for environmental harm downgradient from the site; and

- Requirements for monitoring network and program to rationalise longer term monitoring once characterisation is reached where possible whilst maintaining effective and representative monitoring for water related risk.

As part of the PRCP, site-specific WQOs will be developed for closure for stock water based on site specific water quality monitoring. Water monitoring is proposed to be undertaken over a three-year period to collate site-specific WQOs. This is discussed in milestone 8 (Section 6.3.2.8).

Table 8-7: Water quality limits

Quality characteristic (units)	Limit	Comment on limit
Surface water		
pH	6 – 8	ANZECC/ARMCANZ (2000) for slightly to moderately disturbed aquatic ecosystem
Dissolved Oxygen (% saturation)	90 – 120	Environmental authority EPML00870113
Electrical Conductivity (µS/cm)	60	Site-specific
Turbidity (NTU)	15	ANZECC/ARMCANZ (2000) for slightly to moderately disturbed aquatic ecosystem
Sulphate (mg/L)		Site-specific
Aluminium – dissolved (µg/L)	55	ANZG 2018
Antimony (µg/L)	9	ANZG 2018
Arsenic (AsIII) (µg/L)	24	ANZG 2018
Arsenic (AsV) (µg/L)	13	ANZG 2018
Copper – dissolved (µg/L)	1.4	ANZG 2018
Iron (µg/L)	300	ANZG 2018
Lead (µg/L)	3.4	ANZG 2018
Manganese – dissolved (µg/L)	1,900	ANZG 2018
Molybdenum – dissolved (µg/L)	34	ANZG 2018
Selenium – dissolved (µg/L)	5	ANZG 2018
Strontium	For interpretation purposes only	-
Zinc – dissolved (µg/L)	8	ANZG 2018
Cyanide (µg/L)	7	ANZG 2018
Ammonia (µg/L)	900	ANZG 2018
Nitrate (µg/L)	1100	-
Total recoverable hydrocarbons (C6-C9) (µg/L)	20	-
Total recoverable hydrocarbons (C10-C36) (µg/L)	100	-

Quality characteristic (units)	Limit	Comment on limit
Major ions (mg/L) Calcium, chloride, potassium, magnesium, sodium, bicarbonate, carbonate	For interpretation purposes only	-
Hardness (mg/L)	For interpretation purposes only	-
Groundwater		
pH	6 – 8.5	Site-specific
Electrical Conductivity (µS/cm)	800	Site-specific
Sulphate (mg/L)	20	Site-specific
Aluminium – dissolved (µg/L)	55	ANZG 2018
Antimony (µg/L)	9	ANZG 2018
Arsenic (AsIII) (µg/L)	24	ANZG 2018
Arsenic (AsV) (µg/L)	13	ANZG 2018
Copper – dissolved (µg/L)	1.4	ANZG 2018
Iron (µg/L)	300	-
Lead (µg/L)	3.4	ANZG 2018
Manganese – dissolved (µg/L)	1,900	ANZG 2018
Molybdenum – dissolved (µg/L)	34	ANZG 2018
Selenium – dissolved (µg/L)	5	ANZG 2018
Strontium	For interpretation purposes only	-
Zinc – dissolved (µg/L)	8	-
Cyanide (µg/L)	7	-
Major ions (mg/L) Calcium, chloride, potassium, magnesium, sodium, bicarbonate, carbonate	For interpretation purposes only	-
Hardness (mg/L)	For interpretation purposes only	-
Pit lake quality		
pH	6.5 – 7.5	-
Electrical Conductivity (µS/cm)	200 - 500	-
Sulphate (mg/L)	<400	-
Arsenic (µg/L)	<500	-
Metals (diss and total) (Al, Cu, Zn, Fe, Mn, Mo, Pb, Se, Sr, Sb)	No increasing trend	-

Quality characteristic (units)	Limit	Comment on limit
Cation/anions (Ca, Mg, Na, K, Cl, HCO ₃ , CO ₃ , SO ₄).	-	-
SiO ₂ , TOC, DOC	For interpretation only	-
TSF and potential pit seepage (if present)		
Annual inspections of TSF embankment and One Mile Creek after wet season	Visual assessment of seepage and embankment stability	-

Notes:

- All metals and metalloids must be measured as 'dissolved' (from analysis of a field filtered sample) and total (unfiltered).
- Limits for metals and metalloids apply to dissolved results
- ANZG (2018) Aquatic ecosystem protection for moderately disturbed system (95% protection).



Figure 8-5: Proposed surface water and groundwater monitoring network

Water quality and stream sediment monitoring will be undertaken at the locations and frequency specified in Table 8-8, based on Table 1 (Receiving Water Monitoring Locations and Frequency) and Table 6 (Receiving Stream Sediment Monitoring Locations and Frequency) in schedule C of the EA.

Table 8-8: Water quality and stream sediment monitoring sites

Monitoring point	Location		
	Easting (GDA2020 – Zone 54)	Northing (GDA2020 – Zone 54)	Monitoring frequency
Water quality monitoring			
W1: Within One Mile Creek, at least 300m upstream of the open pit, and at a site unaffected by this activity.	745442	8292259	Monthly; and Weekly when there is a discharge from the tailings dam, voids or processing area, to any surface waters.
W2: Within One Mile Creek, approximately 70m downstream of the open pit. (W2 must also be located between the open pit and the waste rock dump).	745108	8292426	Monthly; and Weekly when there is a discharge from the tailings dam, voids or processing area, to any surface waters.
W3: Within One Mile Creek, approximately 80m downstream of the waste rock dump	744795	8292592	Monthly; and Weekly when there is a discharge from the tailings dam, voids or processing area, to any surface waters.
W4: Within One Mile Creek, approximately 300m downstream of the tailings dam	744270	8292718	Monthly; and Weekly when there is a discharge from the tailings dam, voids or processing area, to any surface waters.
W7: Within One Mile Creek, approximately 140m downstream of the tailings dam	744551	8292698	Monthly; and Weekly when there is a discharge from the tailings dam, voids or processing area, to any surface waters.
Stream sediment monitoring			
S1: Within One Mile Creek, approximately 300m upstream of the open pit, at a site unaffected by this activity.	745443	8292260	At least once every 6 months. Sampling is to be conducted during the months of February to April and August to October and must be representative of the in-stream sediment quality for the period towards the end of the dry and wet seasons.
S2: Within One Mile Creek, approximately 300m downstream of the tailings dam.	744271	8292719	At least once every 6 months. Sampling is to be conducted during the months of February to April and August to October and must be representative of the in-stream sediment quality for the period towards the end of the dry and wet seasons.

8.2.5 Soil sampling

Soil monitoring involves the collection of topsoil samples from a maximum depth of 10 cm to obtain quantitative data on the chemical and physical properties of soil. Soil sampling methodology has been adapted from *Monitoring and Sampling Manual: Environmental Protection (Water) Policy 2009* (DES 2018). Soil sampling is conducted by collecting approximately 200 g samples with a clean non-metallic shovel and bucket every 10 m along the 50 m transect. The first sample is collected at 0 m. The five samples are then mixed in the bucket. The final 200 g soil sample is taken from the mix and placed into plastic sample bag. Samples are sent to a NATA certified laboratory for full suite analysis of topsoil indicators of soil nutrition and chemistry. Chemical and physical parameters that should be measured are outlined in Table 8-9.

Table 8-9: Chemical and physical parameters for topsoil testing

Analytes	
Physical Parameters	Moisture Content
	Organic Matter (Organic Carbon)
	Soil Particle Density (Gravel/Clay/Silt/Coarse Sand/Fine Sand)
General Soil Characteristics	pH value
	Electrical Conductivity @ 25°C
	Chloride
Exchangeable Cations	Exchangeable Calcium
	Exchangeable Magnesium
	Exchangeable Potassium
	Exchangeable Sodium
	Cation Exchange Capacity
	Exchangeable Sodium Percent (ESP)
	Calcium/Magnesium Ratio
Exchangeable N ₂ , P	Nitrite + Nitrate as N (Sol.)
	Bicarbonate Ext. P (Colwell)
	Bicarbonate Ext. K (Colwell)

Soil moisture content is measured for interpretive purposes only and will not be assessed in determining rehabilitation performance.

Ideally, rehabilitation site data should reflect that of analogue sites, though data indicating a trajectory to meet performance criteria may be sufficient in supporting the chosen PMLU.

8.2.6 Landform design closure

Monitoring will be undertaken as per the monitoring specified in section 6.4.7.2

8.3 Monitoring Schedule

8.3.1 Timing and frequency

Rehabilitation will be monitored on an annual basis, with the survey period occurring post-wet season, as monitoring at this time allows for more accurate identification of the species present and a clearer understanding of species richness on site. Where sufficient data is acquired that demonstrates that rehabilitation is clearly on a trajectory to achieve milestone criteria, the frequency of monitoring may be reviewed and reduced.

The rehabilitation monitoring program aims to achieve data collection at sufficient spatial and temporal resolution to ensure statistically valid results. The following methods are employed at each monitoring site and described in detail in the following sections:

- permanent vegetation monitoring transects (ground cover monitoring and species richness);
- photographic monitoring;
- erosion monitoring; and
- topsoil characterisation (every 2–3 years).

In conjunction with walking between transects, RAs will be visually assessed to identify signs of fauna utilisation, noticeable issues such as erosion, vegetation cover deficiencies, or weed and / or pest infestations. Satellite imagery technology may also be employed. These observations are incorporated with the results of each rehabilitation progress report.

9 Record keeping

Records will be kept for the following:

- Achieving each rehabilitation milestone;
- Maintenance of each rehabilitation milestone and results of maintenance activities;
- Rehabilitation activities and the results of those activities (including but not limited to, actions taken, date, location, methods, data collected, QA/QC, photos, waste tracking and disposal records, appropriately qualified person details and assumptions);
- Rehabilitation monitoring and the results of monitoring;
- Designs, drawings, specifications and any documents developed in accordance with good professional practice in relation to rehabilitation milestones or milestone criteria;
- Documents required in the PRCP Schedule, including reports (e.g. site investigation report), statements (e.g. site suitability statement), certifications, assessments, investigations, inspections, audits or any similar documents developed in relation to rehabilitation milestones or milestone criteria;
- Landholder agreements; and
- Details of community consultation in the community consultation register relating to rehabilitation and closure activities.

The records will be kept until the relevant environmental authority has been surrendered or cancelled.

Records will be provided to the administering authority in the specified format within 10 business days of a written request.

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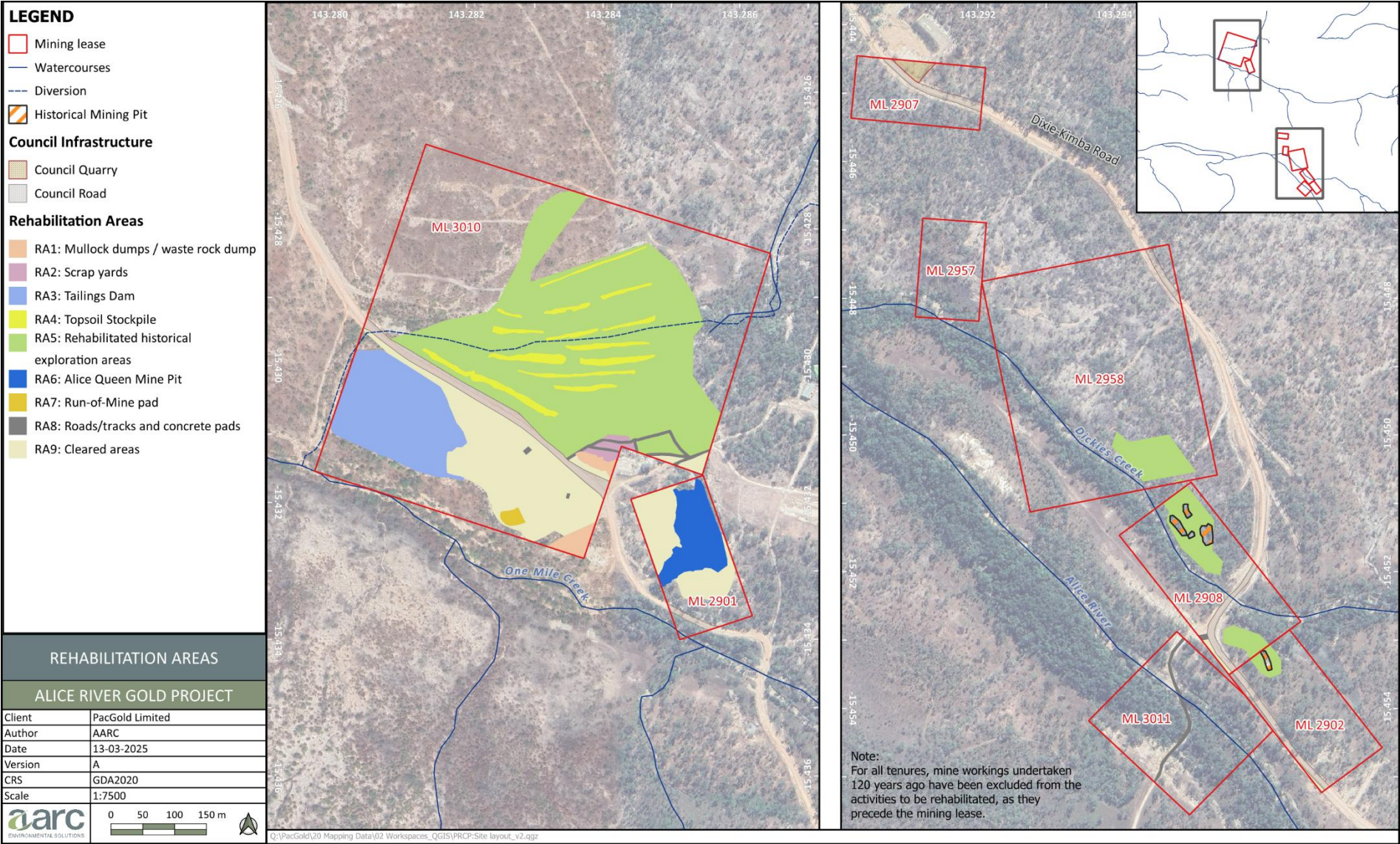
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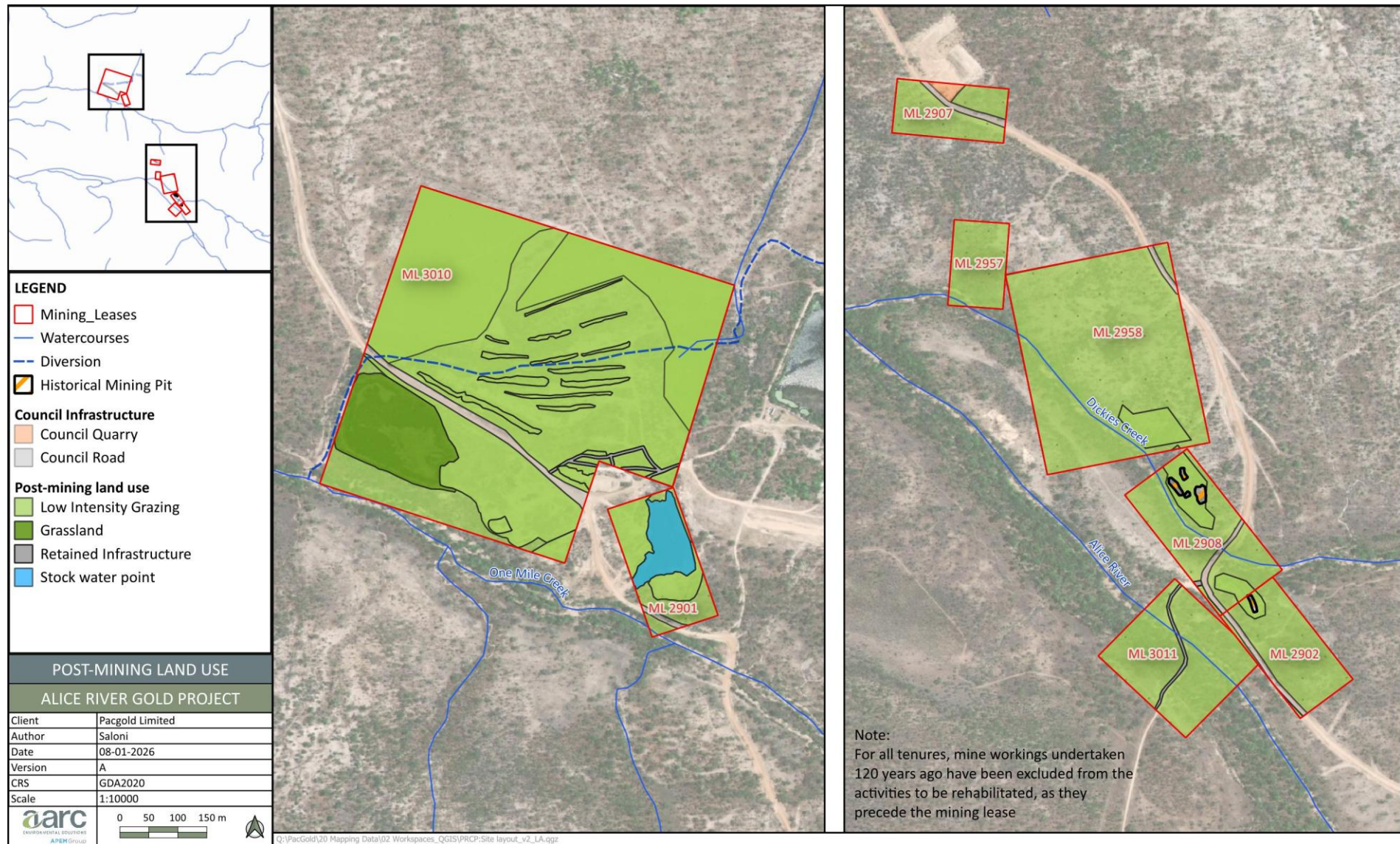
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Appendix A. Reference Map and Final Site Design





Appendix B. PRCP Schedule

The PRC schedule has been developed with consideration for current and anticipated mining activities, and rehabilitation activities. Stage plans have been developed for years 2032, 2037, 2039, 2049 and 2059 to show the progression of rehabilitation (refer.

The RMs and their applicability to the RAs are shown in Table B-1. It should be noted that not all RMs are applicable to all RAs.

Table B-1: Rehabilitation milestones and their applicability to rehabilitation areas

Milestone reference	Description	Applicability								
		RA1	RA2	RA3	RA4	RA5	RA6	RA7	RA8	RA9
RM1	Infrastructure decommissioning/removal	✓	✓	✓	✓		✓	✓	✓	✓
RM2	Management of contaminated land	✓	✓	✓				✓	✓	✓
RM3	Landform development (reshaping/reprofiling)	✓	✓	✓	✓		✓	✓		✓
RM4	Surface preparation (topsoiling/contouring/soil amelioration)	✓	✓	✓	✓			✓		✓
RM5	Revegetation (seeding and/or planting)	✓	✓	✓	✓			✓		✓
RM6	Achievement of target pasture productivity criteria for grazing PMLU	✓	✓	✓	✓	✓		✓		✓
RM7	Achievement of low intensity grazing and grassland PMLUs to a stable condition	✓	✓	✓	✓	✓		✓		✓
RM8	Achievement of stock watering point PMLU to stable condition						✓			
RM9	Achievement of retained infrastructure PMLU to stable condition							✓	✓	✓

Section C – Post mining land uses

(RA1) Rehabilitation area 1

Post-mining land uses (PMLU)							
Rehabilitation area	RA1						
Relevant activities	Mullock dumps / waste rock dump						
Total rehabilitation area size (ha)	0.3						
Commencement of first milestone: RM1	10/01/2026						
PMLU	Low Intensity Grazing						
Date area is available	10/01/2026	11/12/2027	11/12/2028	11/12/2029	11/12/2030	11/12/2031	11/12/2036
Cumulative area available (ha)	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Milestone completed by	10/12/2027	10/12/2028	10/12/2029	10/12/2030	10/12/2031	10/12/2036	10/12/2051
Milestone Reference	Cumulative area achieved (ha)						
RM1	0.3						
RM2		0.3					
RM3			0.3				
RM4				0.3			
RM5					0.3		
RM6						0.3	
RM7							0.3

(RA2) Rehabilitation area 2

Post-mining land uses (PMLU)							
Rehabilitation area	RA2						
Relevant activities	Scrap yards						
Total rehabilitation area size (ha)	0.14						
Commencement of first milestone: RM1	10/01/2026						
PMLU	Low Intensity Grazing						
Date area is available	10/01/2026	11/12/2027	11/12/2028	11/12/2029	11/12/2030	11/12/2031	11/12/2036
Cumulative area available (ha)	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Milestone completed by	10/12/2027	10/12/2028	10/12/2029	10/12/2030	10/12/2031	10/12/2036	10/12/2051
Milestone Reference	Cumulative area achieved (ha)						
RM1	0.14						
RM2		0.14					
RM3			0.14				
RM4				0.14			
RM5					0.14		
RM6						0.14	
RM7							0.14

(RA3) Rehabilitation area 3

Post-mining land uses (PMLU)							
Rehabilitation area	RA3						
Relevant activities	Tailings Dam						
Total rehabilitation area size (ha)	2.75						
Commencement of first milestone: RM1	10/01/2026						
PMLU	Grassland						
Date area is available	10/01/2026	11/12/2027	11/12/2028	11/12/2029	11/12/2030	11/12/2031	11/12/2036
Cumulative area available (ha)	2.75	2.75	2.75	2.75	2.75	2.75	2.75
Milestone completed by	10/12/2027	10/12/2028	10/12/2029	10/12/2030	10/12/2031	10/12/2036	10/12/2051
Milestone Reference	Cumulative area achieved (ha)						
RM1	2.75						
RM2		2.75					
RM3			2.75				
RM4				2.75			
RM5					2.75		
RM6						2.75	
RM7							2.75

(RA4) Rehabilitation area 4

Post-mining land uses (PMLU)						
Rehabilitation area	RA4					
Relevant activities	Topsoil Stockpiles					
Total rehabilitation area size (ha)	1.06					
Commencement of first milestone: RM1	10/01/2026					
PMLU	Low Intensity Grazing					
Date area is available	10/01/2031	11/12/2032	11/12/2033	11/12/2034	11/12/2035	11/12/2040
Cumulative area available (ha)	1.06	1.06	1.06	1.06	1.06	1.06
Milestone completed by	10/12/2032	10/12/2033	10/12/2034	10/12/2035	10/12/2040	10/12/2055
Milestone Reference	Cumulative area achieved (ha)					
RM1	1.06					
RM3		1.06				
RM4			1.06			
RM5				1.06		
RM6					1.06	
RM7						1.06

(RA5) Rehabilitation area 5

Post-mining land uses (PMLU)		
Rehabilitation area	RA5	
Relevant activities	Rehabilitated Historical Exploration Areas	
Total rehabilitation area size (ha)	11.5	
Commencement of first milestone: RM6	10/01/2025	
PMLU	Low Intensity Grazing	
Date area is available	10/01/2025	10/12/2030
Cumulative area available (ha)	11.5	11.5
Milestone completed by	10/12/2030	10/12/2044
Milestone Reference	Cumulative area achieved (ha)	
RM6	11.5	
RM7		11.5

(RA6) Rehabilitation area 6

Post-mining land uses (PMLU)			
Rehabilitation area	RA6		
Relevant activities	Alice Queen Mine pit		
Total rehabilitation area size (ha)	2		
Commencement of first milestone: RM1	10/01/2026		
PMLU	Stock Water Point		
Date area is available	10/01/2026	11/12/2027	11/12/2028
Cumulative area available (ha)	2	2	2
Milestone completed by	10/12/2027	10/12/2028	10/12/2038
Milestone Reference	Cumulative area achieved (ha)		
RM1	2		
RM3		2	
RM8			2

(RA7) Rehabilitation area 7

Post-mining land uses (PMLU)								
Rehabilitation area	RA7							
Relevant activities	Run-of-Mine pad							
Total rehabilitation area size (ha)	0.08							
Commencement of first milestone: RM1	10/01/2026							
PMLU	Low Intensity Grazing							
Date area is available	10/01/2026	11/12/2027	11/12/2028	11/12/2029	11/12/2030	11/12/2031	11/12/2036	11/12/2051
Cumulative area available (ha)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Milestone completed by	10/12/2027	10/12/2028	10/12/2029	10/12/2030	10/12/2031	10/12/2036	10/12/2051	10/12/2052
Milestone Reference	Cumulative area achieved (ha)							
RM1	0.08							
RM2		0.08						
RM3			0.08					
RM4				0.08				
RM5					0.08			
RM6						0.08		
RM7							0.08	
RM9								0.08

(RA8) Rehabilitation area 8

Post-mining land uses (PMLU)			
Rehabilitation area	RA8		
Relevant activities	Roads/tracks and concrete pads		
Total rehabilitation area size (ha)	0.36		
Commencement of first milestone: RM1	10/01/2026		
PMLU	Low Intensity Grazing (retained infrastructure - roads/tracks and cleared land)		
Date area is available	10/01/2026	11/12/2027	11/12/2028
Cumulative area available (ha)	0.36	0.36	0.36
Milestone completed by	10/12/2027	10/12/2028	10/12/2029
Milestone Reference	Cumulative area achieved (ha)		
RM1	0.36		
RM2		0.36	
RM9			0.36

(RA9) Rehabilitation area 9

Post-mining land uses (PMLU)								
Rehabilitation area	RA9							
Relevant activities	Infrastructure/Cleared areas							
Total rehabilitation area size (ha)	4.48							
Commencement of first milestone: RM1	10/01/2026							
PMLU	Low Intensity Grazing							
Date area is available	10/01/2026	11/12/2027	11/12/2028	11/12/2029	11/12/2030	11/12/2031	11/12/2036	11/12/2051
Cumulative area available (ha)	4.48	4.48	4.48	4.48	4.48	4.48	4.48	4.48
Milestone completed by	10/12/2027	10/12/2028	10/12/2029	10/12/2030	10/12/2031	10/12/2036	10/12/2051	10/12/2052
Milestone Reference	Cumulative area achieved (ha)							
RM1	4.48							
RM2		4.48						
RM3			4.48					
RM4				4.48				
RM5					4.48			
RM6						4.48		
RM7							4.48	
RM9								4.48

Appendix C. Rehabilitation Risk Assessment

Risk Description				Evaluation Likelihood - Probability	Rating			Final Risk Rating
Threat Title	Causes (Triggers / Indicators)	Impacts (Consequences)	Existing Controls		Safety	Environment	Compliance	
Waste rock dump								
Safe								
Surface roughness (rockiness, depressions) in excess of that expected for the PMLU	Challenging subsoils/ topsoils, inadequate surface preparation, localised settlement, erosion gullies	Safety hazard for personnel, stock or wildlife	Surface preparation measures, monitoring, maintenance measures and rehabilitation repairs as required	U	L			I
Slope steepness in excess of that expected for the PMLU	Inappropriate landform design	Safety hazard for personnel, stock or wildlife	Material from waste rock dump pushed to tailings dam; landform will be rehabilitated to level ground matching surrounding profile	R	VL			I
Stable - geotechnical risk								
Not applicable	Not applicable	Not applicable	Material from waste rock dump pushed to tailings dam; landform will be rehabilitated to level ground matching surrounding profile					
Stable - erosional risk								
Ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Erodible topsoils and subsoils, adverse weather events	Localised land impacts and downstream water quality impacts rehabilitation failure	Landform design moderating slope, adequate/effective subsoil and topsoil amelioration where required, prompt revegetation establishment, revegetation monitoring and management as required	U		VL		I
Ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Adverse climatic events and/or climatic sequences beyond design capacity	Localised land impacts and downstream water quality impacts	Revegetation, monitoring and maintenance	R		VL		I
Non-polluting - geochemical risk								
Acid and saline drainage of waste rock	Not applicable	Not applicable	There is no evidence of acid rock drainage in waste rock material					
Non-polluting - other environmental harm								
Drainage of waste rock dump to creek	Surface contaminants within waste rock dump final landform	Sedimentation and water quality impacts	Erosion sediment controls	U		L		I
Sustainable - PMLU								
Inadequate species density/diversity of vegetation for grazing open pasture	Weather, poor soil characteristics, poor management practices impacting germination and vegetation establishment	Increased risk of not achieving PMLU	Rehabilitation implementation, rehabilitation performance monitoring and maintenance activities as required	U		M	M	II
Pests and weeds	Poor local, regional or site property management practices.	Increased risk of not achieving designated PMLU	Pest and weed management practices, monitoring programs to allow early detection and management	U		M	L	II
Alice Queen Mine pit (final void)								
Safe								
Highwall areas accessible by public / fauna	Insufficient warnings, barriers preventing access to hazardous areas (highwalls, pit lake)	Falls, slips, trips impacting humans, livestock, fauna	Exclusion fencing of retained pit area or safe access to stock watering point; remoteness	R	H			III
Stable - geotechnical risk								
Significant slope failure	Excessive slopes, not constructed to design, adverse rainfall event	Localised land impacts and downstream water quality impacts	Slope stability analysis confirms long-term geotechnical stability exceeds 1.5 FoS; assessment at closure to confirm long-term geotechnical stability	R		L		I
Stable - erosional risk								
Gully erosion on void walls	Drainage of adjacent catchment areas to the pit	Sedimentation of pit water	Pit is internally draining, landform design promotes drainage away from pit	L		VL		II
Non-polluting - geochemical risk								

Risk Description				Likelihood - Probability	Evaluation			Rating			Final Risk Rating
Threat Title	Causes (Triggers / Indicators)	Impacts (Consequences)	Existing Controls		Safety	Environment	Compliance	Safety	Environment	Compliance	
Decreased water quality in pit lake	Adverse geochemistry with pit water	Decreased water quality	Geochemistry is not adverse, water quality monitoring	R		L			I		I
Non-polluting - other environmental harm											
Pit and creek hydrological interaction	Extreme rainfall events beyond the hydrological model predicted, insufficient monitoring of water level	Downstream water quality impacts	Pit water quality expected to be below stock water quality trigger values, water quality monitoring	U		VL			I		I
Tailings dam											
Safe											
Surface roughness (rockiness, depressions) in excess of that expected for the PMLU	Challenging subsoils/ topsoils, inadequate surface preparation, localised settlement, erosion gullies	Safety hazard for personnel, stock and wildlife	Surface preparation measures (initial), monitoring, maintenance controls (pre-closure)	U	L				I		I
Stable - geotechnical risk											
Failure of tailings storage facility	Adverse weather conditions, natural ground instability, TSF construction materials	Sedimentation and downstream water quality impacts	Geotechnical assessment of TSF stability, design of TSF to be water shedding	R		M			II		II
Stable - erosional risk											
Ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Erodible topsoils and subsoils, adverse weather events, excess slope and inadequate drainage	Localised land impacts, impacts to downstream qater quality	Adequate/effective subsoil and topsoil amelioration, prompt revegetation establishment, revegetation monitoring and management as required, adequate drainage design	P		L			II		II
Non-polluting - geochemical risk											
Drainage and or seepage from the tailings facility	Adverse geochemistry in tailings, inappropriate capping design	Decreased water quality	Design of structure to be water shedding, hazard and safety assessment, geochemical characterisation program, water monitoring program	U		L			I		I
Non-polluting - other environmental harm											
Not applicable											
Sustainable - PMLU											
Insufficient pasture productivity or density/diversity of vegetation in native PMLU	Weather, poor soil characteristics, poor management practices impacting germination and vegetation establishment	Increased risk of not achieving PMLU.	Rehabilitation implementation, rehabilitation performance monitoring and maintenance acitivities as required	U		M	M		II	II	II
Pests and weeds	Poor local, regional or site property management practices.	Increased risk of not achieving designated PMLU	Pest and weed management practices, monitoring programs to allow early detection and management	U		M	L		II	I	II
Mine infrastructure and plant area											
Safe											
Hazards associated with retained infrastructure	Infstructure retained outside that specified in landholder agreement, retained infrastructure not made safe for people and livestock	Safety hazard for personnel, stock and wildlife	Removal of infrastructure, hazard and safety assessment, visual assessment that retained infrastructure is included in landholder agreement	U	L		L		I	I	I
Surface roughness (rockiness, depressions) in excess of that expected for PMLU	Inadequate surface preparation, localised settlement, erosion gullies	Safety hazard for personnel, stock and wildlife	Surface preparation measures (initial), monitoring, maintenance controls (pre-closure)	R	L				I		I
Stable - geotechnical risk											
Not applicable											
Stable - erosional risk											

Risk Description				Likelihood - Probability	Evaluation			Rating			Final Risk Rating
Threat Title	Causes (Triggers / Indicators)	Impacts (Consequences)	Existing Controls		Safety	Environment	Compliance	Safety	Environment	Compliance	
Ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Erodible topsoils and subsoils, adverse weather events	Localised land impacts, sedimentation of downstream water courses	Adequate/effective subsoil and topsoil amelioration, prompt revegetation establishment, revegetation monitoring and management as required	U		L			I		I
Non-polluting - geochemical risk											
Contaminants from buildings/workshop areas and laydown areas	Hydrocarbon or heavy metal contamination from operational activities at infrastructure areas	Impacts to downstream water quality Poor revegetation of rehabilitation area as a result of contaminants	Contaminated land investigation, removal or remediation of contaminated material as required	U		L			I		I
Non-polluting - other environmental harm											
Not applicable											
Sustainable - PMLU											
Pests and weeds	Poor local, regional or site property management practices.	Increased risk of not achieving designated PMLU	Pest and weed management practices, monitoring programs to allow early detection and management	U		M			II		II
Borrow pits / exploration areas											
Safe											
Surface roughness (rockiness, depressions) in excess of that expected for the PMLU	Challenging subsoils/ topsoils, inadequate surface preparation, localised settlement, erosion gullies	Safety hazard for personnel, stock or wildlife	Surface preparation measures, monitoring, maintenance measures and rehabilitation repairs as required	U	L			I			I
Stable - geotechnical risk											
Not applicable											
Stable - erosional risk											
Ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Erodible topsoils and subsoils, adverse weather events	Localised land impacts and downstream water quality impacts rehabilitation failure	Landform design moderating slope, adequate/effective subsoil and topsoil amelioration where required, prompt revegetation establishment, revegetation monitoring and management as required	U		VL			I		I
Ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Adverse climatic events and/or climatic sequences beyond design capacity	Localised land impacts and downstream water quality impacts	Revegetation, monitoring and maintenance	R		VL			I		I
Non-polluting - geochemical risk											
Not applicable											
Non-polluting - other environmental harm											
Not applicable											
Sustainable - PMLU											
Inadequate species density/diversity of vegetation for grazing open pasture	Weather, poor soil characteristics, poor management practices impacting germination and vegetation establishment	Increased risk of not achieving PMLU.	Rehabilitation implementation, rehabilitation performance monitoring and maintenance acitivities as required	U		M	M		II	II	II
Pests and weeds	Poor local, regional or site property management practices.	Increased risk of not achieving designated PMLU	Pest and weed management practices, monitoring programs to allow early detection and management	U		M	L		II	I	II
ROM pad											
Safe											

Risk Description				Evaluation			Rating				
				Likelihood - Probability	Safety	Environment	Compliance	Safety	Environment	Compliance	Final Risk Rating
Threat Title	Causes (Triggers / Indicators)	Impacts (Consequences)	Existing Controls								
Surface roughness (rockiness, depressions) in excess of that expected for the PMLU	Challenging subsoils/ topsoils, inadequate surface preparation, localised settlement, erosion gullies	Safety hazard for personnel, stock or wildlife	Surface preparation measures, monitoring, maintenance measures and rehabilitation repairs as required	U	L			I			I
Stable - geotechnical risk											
Not applicable	Not applicable	Not applicable	Material from the ROM pad will be pushed to tailings dam; landform will be rehabilitated to level ground matching surrounding profile								
Stable - erosional risk											
Ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Erodible topsoils and subsoils, adverse weather events	Localised land impacts and downstream water quality impacts rehabilitation failure	Landform design moderating slope, adequate/effective subsoil and topsoil amelioration where required, prompt revegetation establishment, revegetation monitoring and management as required	U		VL			I		I
Ongoing gully, pipe and/or sheet erosion of rehabilitated areas	Adverse climatic events and/or climatic sequences beyond design capacity	Localised land impacts and downstream water quality impacts	Revegetation, monitoring and maintenance	R		VL			I		I
Non-polluting - geochemical risk											
Contaminants from ROM pad material	Residual carbonaceous or metalliferous material	Impacts to downstream water quality; poor revegetation of rehabilitation area as a result of contaminants	Soils will be tested for residual carbonaceous or metalliferous material; contaminated soils will either be removed or remediated	U		M			II		II
Non-polluting - other environmental harm											
Not applicable											
Sustainable - PMLU											
Inadequate species density/diversity of vegetation for grazing open pasture	Weather, poor soil characteristics, poor management practices impacting germination and vegetation establishment	Increased risk of not achieving PMLU.	Rehabilitation implementation, rehabilitation performance monitoring and maintenance acitivities as required	U		M	M		II	II	II
Pests and weeds	Poor local, regional or site property management practices.	Increased risk of not achieving designated PMLU	Pest and weed management practices, monitoring programs to allow early detection and management	U		M	L		II	I	II
End of record											

Appendix D. Provided technical studies

Additional documents that have been referenced throughout the PRCP Planning Part have been provided electronically to the DES, and include the following:

- AARC Environmental Solutions 2017, *Alice River Gold Project: Freshwater Tiger Crab Management Plan*, report prepared for Pacgold Limited.
- AARC Environmental Solutions 2024, *Alice River Gold Project: Freshwater Tiger Crab Management Plan*, report prepared for Pacgold Limited.
- AARC Environmental Solutions 2024a, *Alice River Gold Project: Erosion Stability Assessment: Tailings Storage Facility Report*, report prepared for Pacgold Limited.
- AARC Environmental Solutions 2018, *Alice River Gold Project: Golden-shouldered Parrot Exploration Management Plan*, report prepared for Spitfire Materials Ltd.
- AARC Environmental Solutions 2021a, *Alice River Rehabilitation Report*, report prepared for Pacgold Limited.
- AARC Environmental Solutions 2021b, *Golden-shouldered Parrot Nesting Habitat Assessment*, report prepared for Pacgold Limited.
- Blackrock Mining Solutions (BMS) 2022, *Progressive Rehabilitation & Closure Planning Geotechnical Assessment Report*, report prepared for Pacgold Limited.
- Engeny 2025, *Progressive Rehabilitation and Closure Plan Surface Water Assessment Report*, report prepared for Pacgold Limited.
- RGS 2023, *Soil Capping and Mine Waste Assessment and Tailings Dam Rehabilitation Report*, report prepared for Pacgold Limited.
- SeeBuiltEarth 2025, *Groundwater Performance of Alice River Landscape at Closure Report*, report prepared for Pacgold Limited.

ALICE RIVER GOLD PROJECT
Freshwater Tiger Crab Management Plan

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1.0	INTRODUCTION	1
1.1	SCOPE.....	1
1.2	CONDITIONS OF THE ENVIRONMENTAL AUTHORITY.....	1
1.3	PROJECT BACKGROUND.....	1
1.4	PROJECT LOCATION	2
2.0	TIGER CRAB ECOLOGY.....	5
2.1	DESCRIPTION.....	5
2.2	BIOLOGY AND REPRODUCTION	5
2.3	HABITAT.....	5
2.4	DISTRIBUTION.....	5
2.5	CURRENT THREATS.....	5
2.6	CONSERVATION STATUS.....	6
3.0	MONITORING REGIME	7
3.1	ANNUAL SURVEY	7
3.1.1	Monitoring Schedule	9
3.1.2	Mark-recapture.....	9
3.1.3	Active Searches	7
3.1.4	Water Quality Monitoring	7
3.2	REGIONAL SURVEY	7
3.2.1	Methods	7
3.2.2	Results and Conclusion	8
4.0	ACCOUNTABILITY	11
4.1	PROCEDURE FOR NOTIFICATION.....	11
4.2	CONTINGENCY PLAN.....	11
5.0	REFERENCES	12

LIST OF FIGURES

Figure 1	Project Locality.....	3
Figure 2	Mining Leases and Associated Watercourses.....	4
Figure 3	Freshwater Tiger Crab (<i>Austrothelphusa tigrina</i>) Dorsal View (photo courtesy of the Queensland Museum)	6
Figure 4	Monitoring Locations.....	10

LIST OF TABLES

Table 1	Freshwater Tiger Crab Monitoring Points	10
Table 2	Water Quality Monitoring Points	7

LIST OF ABBREVIATIONS

AARC	-	AARC Environmental Solutions Pty Ltd
EA	-	Environmental Authority
EC	-	Electrical Conductivity
g	-	gram
IUCN	-	International Union for Conservation of Nature
km	-	kilometre
km ²	-	square kilometre
m	-	metre
ML	-	Mining Lease
mm	-	millimetre
PacGold	-	PacGold Pty Ltd

1.0 INTRODUCTION

AARC Environmental Solutions Pty Ltd (AARC) was commissioned by PacGold Pty Ltd (PacGold) to prepare a Management Plan for the Freshwater Tiger Crab (*Austrothelphusa tigrina*) for the Alice River Gold Project (the Project).

1.1 SCOPE

This document has been produced to provide information on the ecology and conservation status of the Freshwater Tiger Crab, suggest monitoring methodologies and determine the local and regional abundance and distribution of the Freshwater Tiger Crab.

1.2 CONDITIONS OF THE ENVIRONMENTAL AUTHORITY

The following conditions, as outlined in the Project's Environmental Authority (EA) (EPML00870113), must be met in this management plan:

- a) *information about the current, pre-mining population of the Tiger Crab, including abundance and distribution; and*
- b) *information about the status of the population during operation of the mine, including:*
 - i. *progressive monitoring of the Tiger crab's abundance and distribution; and*
 - ii. *a timetable for monitoring of the population, taking into account any diurnal or seasonal variations; and*
 - iii. *contemporaneous monitoring of the water quality within One Mile Creek, in accordance with requirements set out in Schedule C; and*
 - iv. *procedures for notification of the administering authority in the event that any decline in population of the tiger crab, that is, or may be attributable to the mining activity, is detected; and*
 - v. *contingency plans in the event that any decline in the population of the tiger crab, that is, or may be attributable to the mining activity, is detected.*

1.3 PROJECT BACKGROUND

The Freshwater Tiger crab is not well documented in its distribution, life history, ecology, behaviour, population dynamics or abundance. It has been listed as Vulnerable under the International Union for the Conservation of Nature (IUCN) Red List Assessment, based on its restricted distribution.

Previous reports suggested that the crab is locally abundant in One Mile Creek, but more recent, anecdotal reports indicate that the crab also inhabits Eight Mile Creek and an unnamed tributary of the Coleman River 70 km north of the Project. At the Alice River Gold mine site, there is no information regarding pre-mining population abundance or distribution. The crab is only active during flow events in the wet season and has been previously described as locally abundant. To avoid desiccation during the dry season, the crabs burrow amongst roots of fringing Melaleuca trees (Short, 2012).

Limited monitoring data gathered by Landline Consulting indicates that the crabs are present immediately upstream and downstream of the mine site. Further monitoring is required to better understand the health, abundance and distribution of this species during the wet season within the Alice River catchment and particularly the mine site area.

1.4 PROJECT LOCATION

The Project is located approximately 470 kilometres (km) north-west of Cairns in on the southern Cape York Peninsula. Figure 1 shows the location of the Alice River Gold Project.

The Project consists of eight granted Mining Leases (MLs), and has a total area of 808 square kilometres (km²). Surrounding the MLs are a network of creeks and tributaries which link to the Alice River.

Figure 2 outlines the locations of the MLs within the project as well as the associated watercourses.

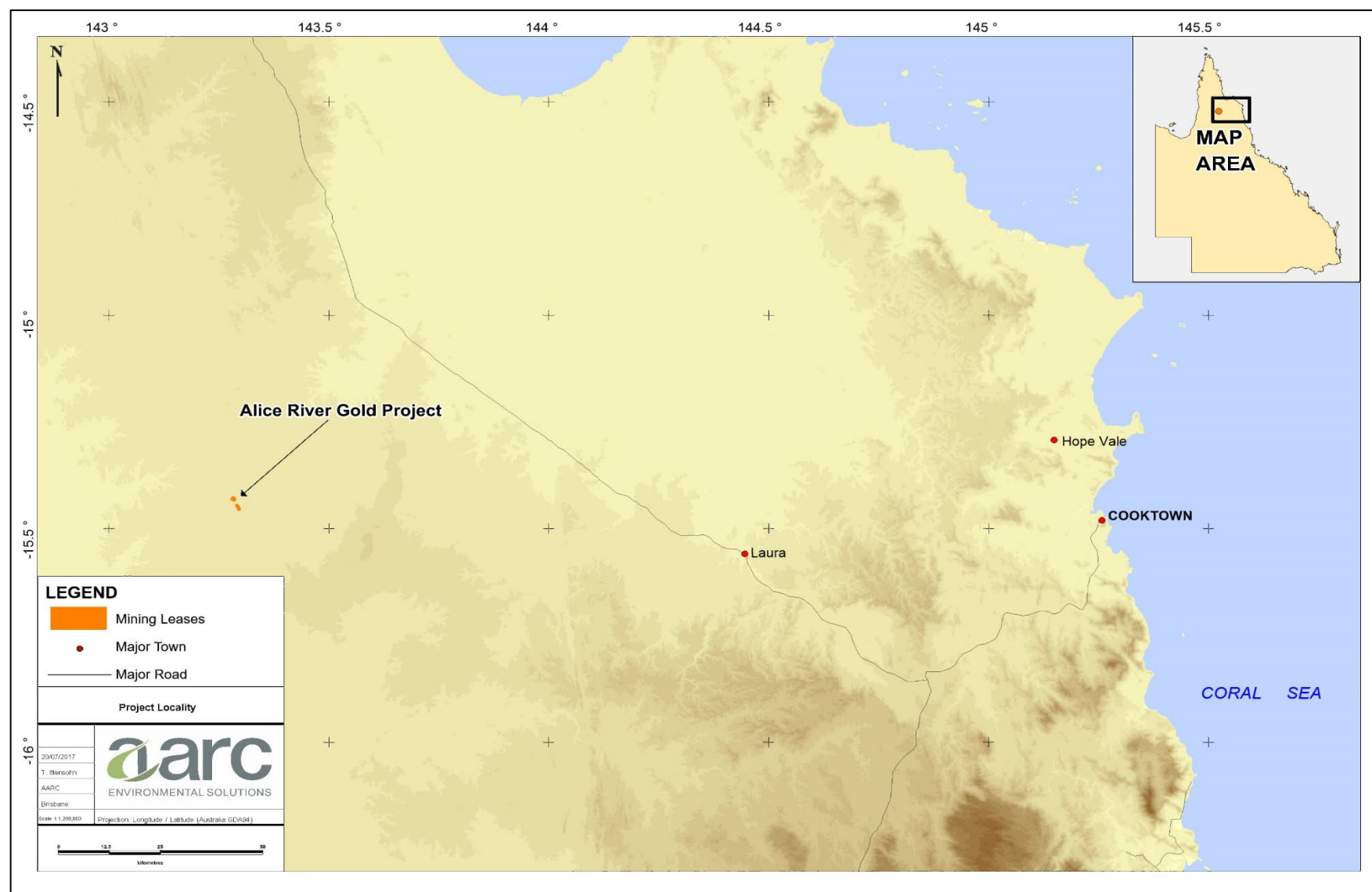


Figure 1 Project Locality



Figure 2 Mining Leases and Associated Watercourses

2.0 TIGER CRAB ECOLOGY

2.1 DESCRIPTION

The Freshwater Tiger Crab is a small crustacean from the Gecarcinucidae family. The carapace is tan with black striations including a long band behind the frontal margin (Curtis, 2012). Carapace length varies in adults but is most common at a breadth of 36 millimetres (mm) (Curtis, 2012). Claws are cream with black striations occurring at the joints which fade into purple fingers (Short, 1994). The bold striations that give this species its name make the Freshwater Tiger Crab conspicuous on sand substrates, where they are most abundant giving little value for camouflage. A black stripe occurs on the eyestalk longitudinally distinguishing it from other species of the *Austrothelphusa* genus (Curtis, 2012).

2.2 BIOLOGY AND REPRODUCTION

Little is known of the biology and reproduction of the Freshwater Tiger Crab. However, an article published in 1994 as part of the “*Memoirs of the Queensland Museum*” journal comments on what is known of this species’ biology and reproduction. Females become sexually active by the time they reach 13 mm wide with adult crabs growing to a full size of 36 mm wide (Short, 1994). They have abbreviated larval development giving birth to juvenile crabs (Curtis, 2012).

The current population size is not known and there is limited information regarding the biology of this species.

2.3 HABITAT

As the water in the tributaries of the Alice River recedes in the dry season, the Freshwater Tiger Crab evades desiccation by burrowing into the sand at the base of Melaleuca trees (*Melaleuca spp.*) (Curtis, 2012). Researchers from the Queensland Museum record seeing this species in great abundance on sandy flats during the wet season in One Mile Creek and noted that they are highly docile during the wet season (Short, 1994). Other freshwater crabs occupy this habitat also but are much rarer, occurring in the order of one specimen for every 100 specimens of the Freshwater Tiger Crab (Short, 1994).

2.4 DISTRIBUTION

This species has been recorded in three locations to date; One Mile Creek, Eight Mile Creek and in an unnamed tributary of the Coleman River, approximately 70 km north of the Project. One Mile Creek and Eight Mile Creek are seasonally flowing tributaries of the Alice River.

2.5 CURRENT THREATS

The major threats to the decline in the population of this species are both directly and indirectly attributable to humans. Freshwater Tiger Crabs have been sold in the pet shop trade since 1991 along with other freshwater crabs. Consequently, collection from the wild for the pet shop trade is a direct threat to an unknown population size. Residual environmental impacts from gold mining has the potential to diminish the population of Freshwater Tiger Crabs within their known distribution. This threat can be managed using systematic management plans and further research into the species’ ecology. Extended periods of drought have the potential to reduce the population of this species as they rely on the presence and flow of water for various stages of their lifecycle.

2.6 CONSERVATION STATUS

Under the IUCN Red List of Threatened Species, the Freshwater Tiger Crab is listed as Vulnerable (VU).



Figure 3 Freshwater Tiger Crab (*Austrothelphusa tigrina*) Dorsal View (photo courtesy of the Queensland Museum)

3.0 MONITORING REGIME

3.1 REGIONAL SURVEY

Prior to regular monitoring, a comprehensive investigation of the Freshwater Tiger Crab's regional distribution and abundance was performed. In 2017 and 2018 (May of each year) surveys were performed in the surrounding tributaries and streams to determine how significant the Freshwater Tiger Crab population is within the region. These results will be compared to the findings of the regular monitoring giving an indication of the extent of the population immediately associated with the Project.

3.1.1 Methods

The regional survey has been completed by CSIRO together with James Cook University. The survey area captured several regional sites including Alice River, Dickies Creek, Jerry Dodds Creek, Dingo Creek and One Mile Creek, up to 30 km away from the mine (Table 3). One representative site in each of these waterbodies was established with typically 10 replicate opera-house type traps (640 mm L, 470 mm W, and 235 mm H, 22 mm stretched mesh, 90 mm aperture of entrances) (Ebner & Wundersitz 2018). These traps were each baited with a sardine fillet (from a can) and spaced approximately 20 m apart (and with some of the trap above the water line) (Ebner & Wundersitz 2018). At road crossings, typically five traps were set upstream and five downstream of the road (Ebner & Wundersitz 2018). Each opera-house trap was retrieved by sliding a fine-mesh, frame-net underneath the to ensure collection of small crabs that were under or on the trap or that slipped through the coarse mesh (Ebner & Wundersitz 2018).

Table 1 Survey site locations and dates (Table adapted from Ebner & Wundersitz 2018).

Site	Description	Dates
One Mile Creek Crossing S 15 26.075, E 143 17.181	Depositional stream (large, ephemeral)	19/05/2017 15/05/2018
Dickies Creek Crossing S 15 27.145, E 143 17.741	Depositional stream (large, ephemeral)	19/05/2017 15/05/2018
Alice River at Alice River Station S 15 27.241, E 143 17.705	Depositional stream (large, ephemeral)	15/05/2018
Spillway downstream of Large Dam S 15 25.679, E 143 17.256	Modified stream (large, ephemeral)	20/05/2017 17/05/2018
Alice River Homestead Dam S 15 28.281, E 143 17.002	Reservoir (small, permanent)	16/05/2018
Jerry Dodds Creek, Kimba-1 S 15 30.423, E 143 24.873	Depositional stream (large, ephemeral)	20/05/2017 17/05/2018

Site	Description	Dates
Jerry Dodds Creek, Kimba-2 S 15 30.275, E 143 23.521	Depositional stream (large, ephemeral)	20/05/2017 17/05/2018
Dingo Creek S 15.49704, E 143.34613	Depositional stream (moderately large, ephemeral)	21/05/2017 18/05/2018
Boundary Creek S 15.49776, E 143.34451	Erosional stream (moderately large, ephemeral)	21/05/2017

3.1.2 Results

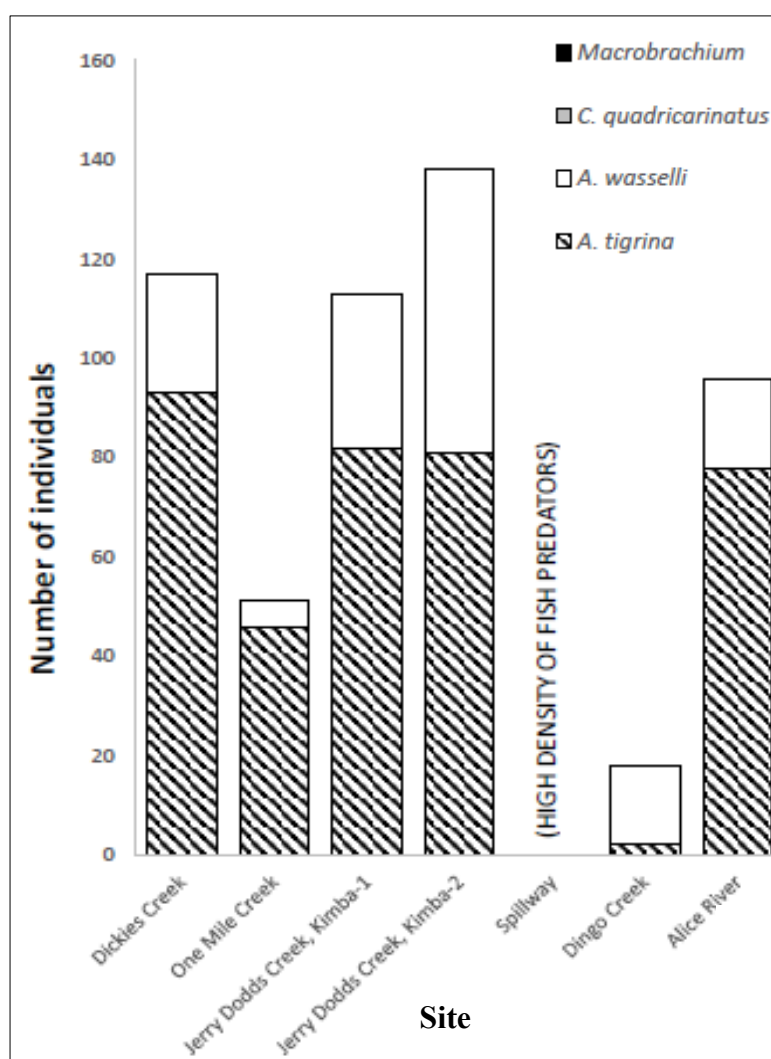


Figure 4 Macrocrustacean distribution and mesohabitat association in the landscape based on proportional catches of species in the upper Alice River catchment in May 2018 (Figure adapted from Ebner & Wundersitz 2018).

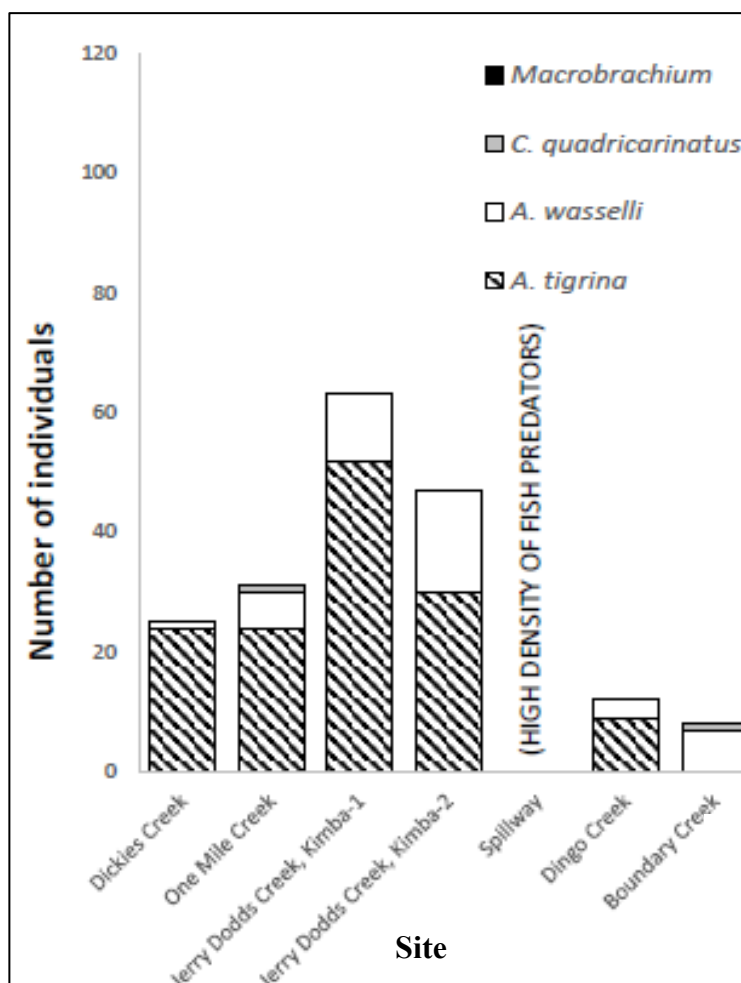


Figure 5 Macrocrustacean distribution and mesohabitat association in the landscape based on proportional catches of species in the upper Alice River catchment in May 2017 (Figure adapted from Ebner & Wundersitz 2018).

Pursuant to Condition A7-1 (a), information regarding the pre-mining population and distribution of the Tiger Crab is required to be included in the management plan. Figure 4 and Figure 5 lists the earliest comprehensive population and distribution data of the Tiger Crab.

3.2 ANNUAL SURVEY

3.2.1 Monitoring Schedule

The population of Freshwater Tiger Crabs surrounding the Project will be monitored annually during the wet season (late wet season) when the crabs are most abundant. The late wet season survey will ascertain maximum opportunity to detect presence and model distribution. In addition data collected during the wet season survey will provide further understanding of the seasonal abundance and habitat preference for future management.

3.2.2 Mark-recapture

During the survey, “Opera House” traps will be set for two, 24-hour periods. As feeding habits are not well understood for this species, day and night trapping will be conducted. Traps will be set early in the

morning and checked late in the afternoon, then re-baited and set in the late afternoon to be checked in the early morning. Four monitoring sites were chosen for this survey; two located on One Mile Creek, either side of the Northern MLs, and two located on the Alice River, either side of the Southern MLs. Exact locations of these sites will be determined at each site based on habitat suitability. At each monitoring site, three replicate traps will be set with a minimum of 20 m between each trap. Bait used in the traps will consist of a meat based product. The proposed locations of the monitoring sites are displayed in Figure 4 and described in Table 1.

Table 2 Freshwater Tiger Crab Monitoring Points

Monitoring Point	Easting (GDA94 54K)	Northing (and again)
MP1	745236	8292166
MP2	744969	8292292
MP3	745634	8290796
MP4	746387	8290048

*GDA94 – Zone 54

A mark-recapture method of estimating population size will be adopted for this assessment. The initial catch will be marked with a small amount of temporary marker and released after recording specific details of the individual. Using the ratio of marked to unmarked individuals in the second survey, an estimation of the population size of Freshwater Tiger Crabs can be established.

An estimation of the population size will be determined using the following formula:

$$N = \frac{Mn}{m}$$

- N = The estimated population size
- M = The number of individuals marked in the first capture
- n = The number of individuals in the second capture
- m = The number of individuals of the second capture that are already marked

During the mark-recapture process, individual Freshwater Tiger Crabs caught in the traps will have the following recorded:

- Date and time of capture;
- Sex;
- Maturity;
- Breeding status;
- Weight (g)
- Width (mm)
- Claw Dominance;
- Dorsal photographs;
- Carapace discoloration;
- Signs of disease;
- Location of trap;
- Number of crabs in trap;
- Burrowing Presence; and
- Presence of other species.

3.2.3 Active Searches

While traps are set during the day, active searches will be conducted within the vicinity of each monitoring location. Each site will be searched for one hour per during the survey for Freshwater Tiger Crabs recording burrows, tracks or any sign of the presence of the crabs. If a crab is spotted during an active search, it will be captured by hand with the above parameters (except number of crabs in traps) recorded. The crab will then be released at its point of capture. Distinctive colouration makes this species conspicuous on sandy substrates (Short, 1994).

3.2.4 Water Quality Monitoring

Water quality in One Mile Creek will be monitored at six monitoring locations during both wet season surveys. The locations of the water quality monitoring points are outlined in Table 2 and mapped at Figure 4.

Table 3 Water Quality Monitoring Points

Water Quality Monitoring Point	Easting	Northing
W1 – Within One Mile Creek at least 300 m upstream of the open pit, and at a site unaffected by this activity.	745236	8292166
W2 - Within One Mile Creek, approximately 70 m downstream of the open pit. (W2 must also be located between the open pit and the waste rock dump).	744969	8292292
W3 – Within One Mile Creek, approximately 80 m downstream of the waste rock dump.	744672	8292575
W4 – Within One Mile Creek, approximately 300 m downstream of the tailings dam.	744345	8292575
W5 – Within the Alice River, approximately 100 m downstream of ML2957.	745634	8290796
W6 – Within the Alice River approximately 50 m upstream of ML3011	746387	8290048

*GDA94 – Zone 54

The parameters listed below will be tested as outlined in the Project's EA.

- pH;
- Dissolved Oxygen;
- Turbidity;
- Electrical Conductivity;
- Arsenic (As V);
- Arsenic (As III)
- Zinc
- Cyanide (total);
- Antimony
- Copper
- Lead
- Sulfate;

Results from water quality testing will be compared with the abundance and distribution of Freshwater Tiger Crabs within the receiving environment of the Project. Water quality data will give an indication of ecological health to model trends and outline variances in the data. Water quality data that is collected from monitoring sites will be used for continuous monitoring of ecological health. A representation of water quality trends over time will assist in gaining an understanding of how this species reacts to variation in ecological conditions.

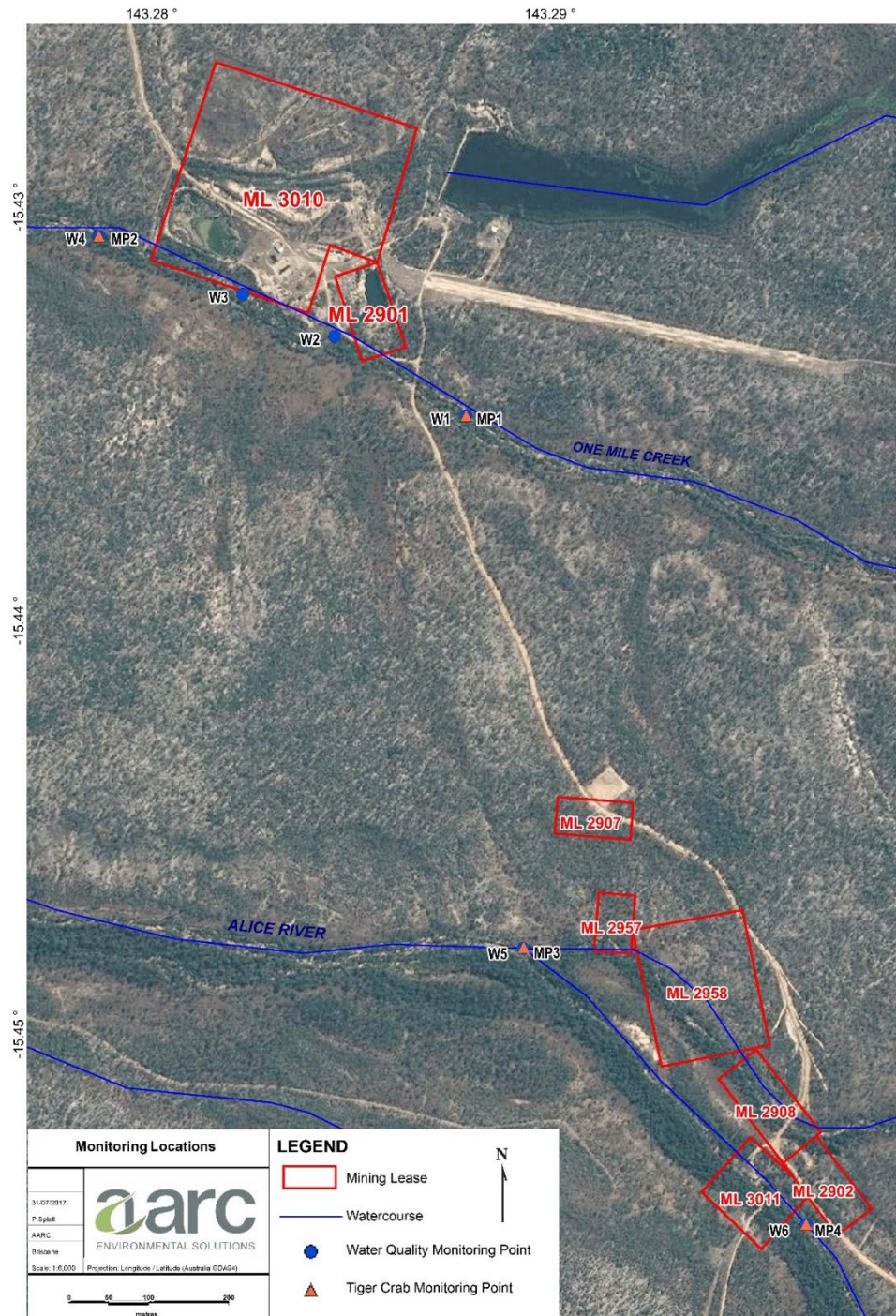


Figure 6 Monitoring Locations

6.1 CURRENT MONITORING RESULTS

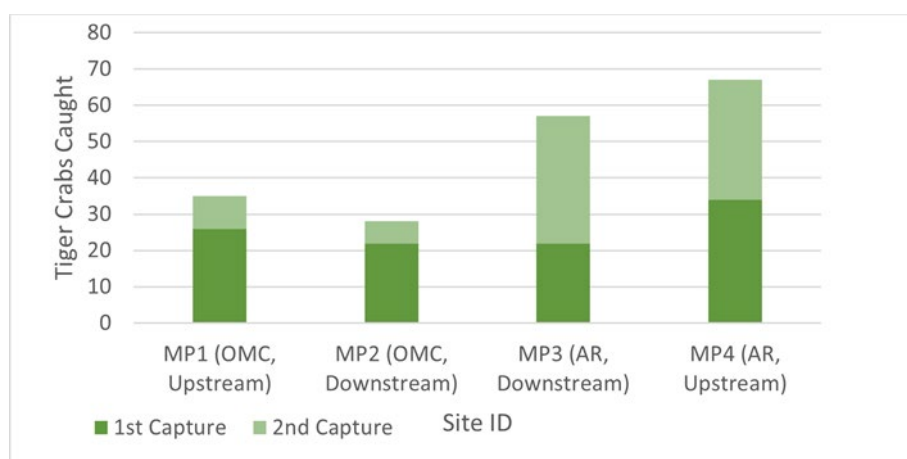


Figure 7 Tiger crabs caught at each monitoring point (Figure from AARC 2021)

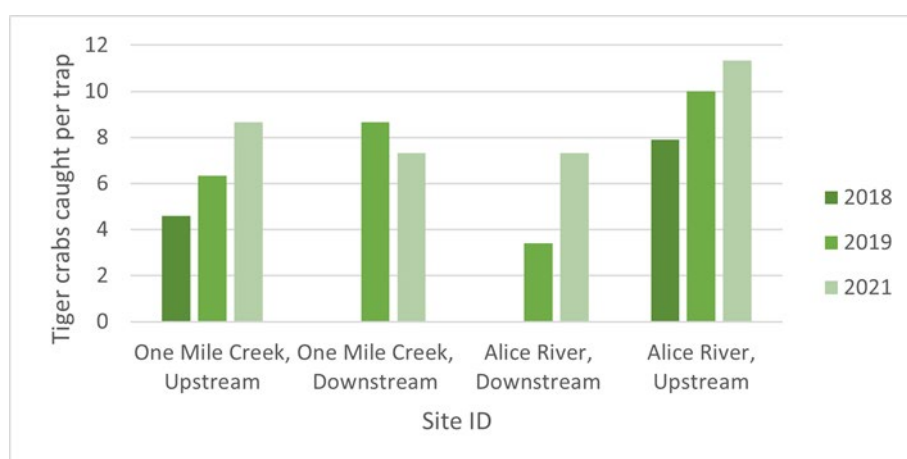


Figure 8 Tiger crabs caught per trap in the first 24 hours at each monitoring point (Figure from AARC 2021)

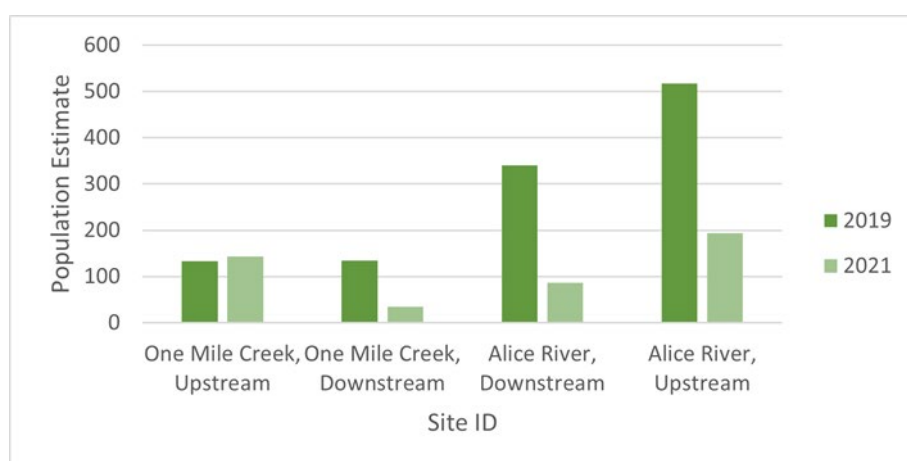


Figure 9 Tiger crab population estimates per site (Figure from AARC 2021)

Pursuant to Condition A7-1 (a), information regarding the current population and distribution of the Tiger Crab is required to be included in the management plan. Figure 7, Figure 8 and Figure 9 lists the most recent population and distribution data of the Tiger Crab.

For the full context regarding the tiger crab population, please consult the currently drafted Alice River Gold Mine Tiger Crab Monitoring Report (2021).

Condition A7-1 (a) of the Project's EA states that information regarding the current, pre-mining population of the Freshwater Tiger Crab, including abundance and distribution must be sought and outlined in the management plan. Data collected and presented at Figure 4, Figure 5, Figure 7, Figure 8 and Figure 9 has satisfied this condition and Figure 4 and Figure 5 will continue to be used as a baseline data set to compare with results from regular monitoring.

4.0 ACCOUNTABILITY

4.1 PROCEDURE FOR NOTIFICATION

In the event that any decline in the population of Freshwater Tiger Crabs from mining activities is noted during regular monitoring, the administering authority will be notified via notification letter within 14 days.

4.2 CONTINGENCY PLAN

A contingency plan based on the noticed decline of the Freshwater Tiger Crab caused by mining activity has been established to maintain the abundance and diversity of this species.

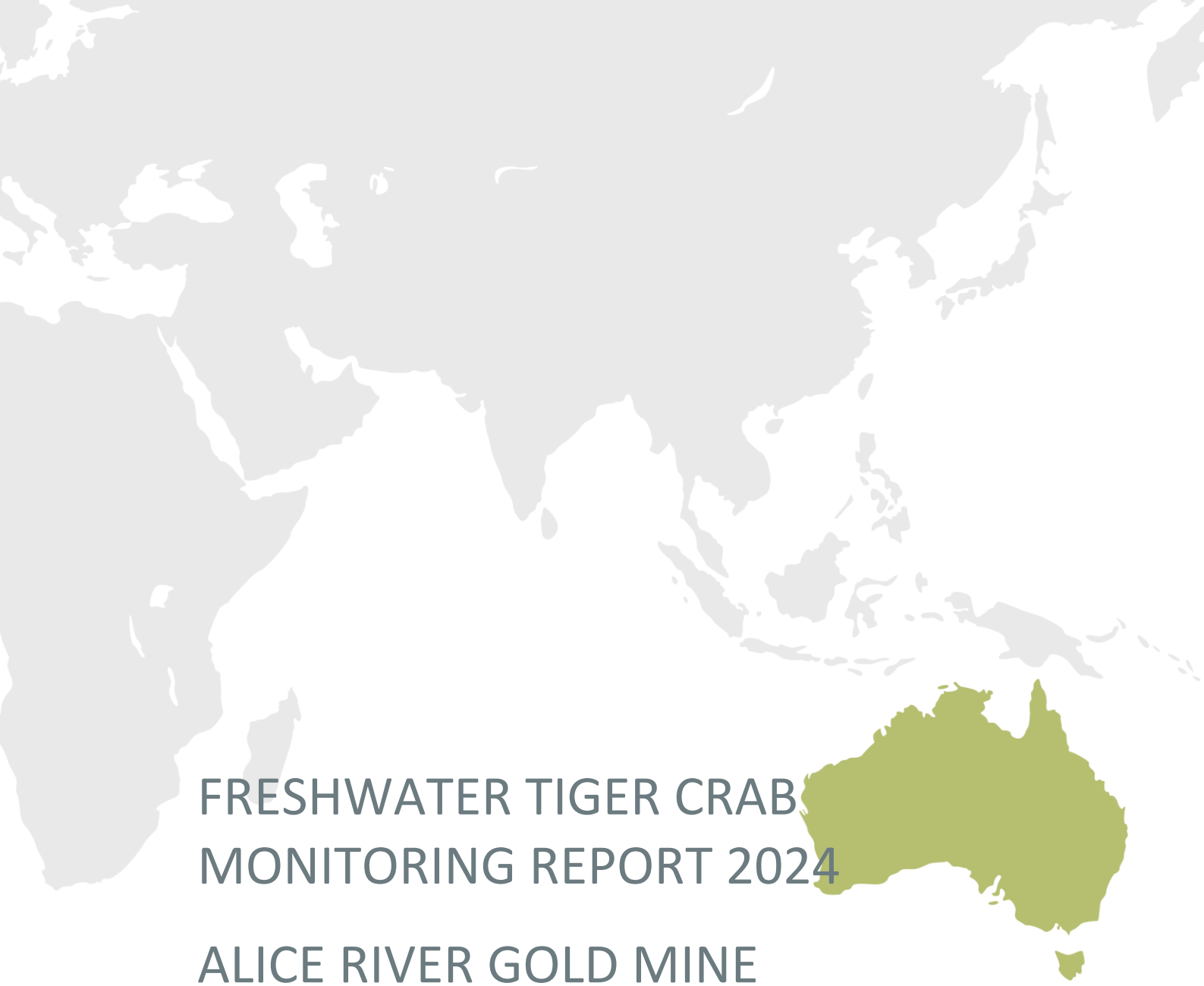
Following the noticed decline in the population's abundance and diversity attributed to mining activity, an investigation into the causes of the decline will be required. As little is known about the sensitivity of this species to contaminants in soil and water, a thorough study of the soil and water quality characteristics surrounding the mine will take place. The study will compare data from upstream with data from downstream of the Project to highlight any anomalous features. This study will also determine the cause of the decline in the population.

If it is established that the variation in soil or water quality characteristics triggered by mining activity are the cause of the decline, strategies to mitigate and resolve the issues will be addressed in consultation with the administering authority. If no significant correlations in soil and water quality characteristics can be attributed to the decline, further investigative studies into any other possible variances will be conducted.

An annual review process will be undertaken for this management plan assessing current monitoring methodology and amendments to the Project's EA.

5.0 REFERENCES

1. AARC. (2021). Alice River Gold Mine Tiger Crab Monitoring Report. (draft)
2. Ebner, C. & Wundersitz, V. (2018). Fish and crustacean surveys of Kimba and Alice River stations, Cape York, CSIRO.
3. Curtis, L. K. (2012). *Queensland's Threatened Animals*. CSIRO publishing
4. Short, J. W. (1994). A new species of freshwater crab (Sundathelphusi-dae) from Cape York Peninsula. *Memoirs of the Queensland Museum*, 35(1), 235-240.



FRESHWATER TIGER CRAB MONITORING REPORT 2024

ALICE RIVER GOLD MINE

PREPARED FOR
PACGOLD LIMITED

AUGUST 2024

Document Control

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Client:	Pacgold Limited
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Table of Contents

1	Introduction	1
1.1	Scope.....	1
1.2	Project location	1
2	Freshwater Tiger Crab	3
2.1	Literature review	3
2.2	Description	5
2.3	Biology and reproduction	5
2.4	Habitat	5
2.5	Distribution	6
2.6	Threats	7
2.7	Conservation status.....	7
3	Methodology	8
3.1	2023-2024 wet season rainfall.....	8
3.2	Survey timing	8
3.3	Monitoring site locations	8
3.3.1	Monitoring point 1	11
3.3.2	Monitoring point 2	11
3.3.3	Monitoring point 3	12
3.3.4	Monitoring point 4	12
3.4	Data collection	13
3.5	Water quality monitoring	14
4	Results	17
4.1.1	Local population size	17
4.1.2	Size variation	18
4.1.3	Sexual composition and maturity.....	20
4.1.4	Missing and damaged limbs	21
4.1.5	Non-target species	21
4.1.6	Habitat search	22
4.2	Water quality monitoring	23
4.2.1	Natural watercourses	23
4.2.2	Mine water storages	25
5	Discussion	26
5.1	Tiger Crab population.....	26
5.2	Water quality	27
6	References	28

List of Figures

Figure 1-1:	Project locality	2
Figure 2-1:	CSIRO Tiger Crab monitoring locations	4
Figure 2-2:	Macrocrustacean distribution and mesohabitat association in May 2017	6
Figure 2-3:	Macrocrustacean distribution and mesohabitat association in May 2018	6
Figure 3-1:	Interpolated rainfall data from Pinnacle weather station (SILO 2024)	8
Figure 3-2:	Tiger Crab monitoring locations	10
Figure 3-3:	Water sampling locations	16
Figure 4-1:	Population estimates at each monitoring point per monitoring year	18
Figure 4-2:	Estimated biomass at each monitoring point per monitoring year	18
Figure 4-3:	Average Tiger Crab width at each monitoring point per monitoring year	19
Figure 4-4:	Distribution of Tiger Crab mass at each monitoring point across years	20
Figure 4-5:	pH values during 2023 and 2024 water quality monitoring	24
Figure 4-6:	Dissolved oxygen (DO%) values during 2023 and 2024 water quality monitoring	24
Figure 4-7:	Turbidity (NTU) values during 2023 and 2024 water quality monitoring	25

List of Plates

Plate 1:	Female Tiger Crab caught at MP3 during the 2024 survey	5
Plate 2:	MP1 site conditions, upstream of Alice River mine pit	11
Plate 3:	MP2 site conditions, downstream of the northern MLs	11
Plate 4:	MP3 site conditions, downstream of the southern MLs, Alice River	12
Plate 5:	MP4 in 2023, upstream of the southern MLs, Alice River	12
Plate 6:	'Moderate' Tiger Crab burrows at MP2	22
Plate 7:	Small area of pig damage recorded at MP2	22

List of Tables

Table 3-1:	Tiger Crab monitoring points	9
Table 3-2:	Water quality monitoring locations	14
Table 3-3:	EA Schedule C - Table 2 (Receiving Water Contaminant Limits)	15
Table 4-1:	Summary of Tiger Crab monitoring effort	17
Table 4-2:	Average Tiger Crab width recorded each year	19
Table 4-3:	Male to female ratio recorded at each site across all monitoring years	20
Table 4-4:	Percentage of juvenile Tiger crabs recorded at each site across all monitoring years	21
Table 4-5:	Percentage of Tiger Crabs missing limbs at each site across years	21
Table 4-6:	Non-target species recorded during the 2024 monitoring period	21
Table 4-7:	May 2024 receiving water quality data	23
Table 4-8:	May 2024 tailings and pit water quality	25

1 Introduction

AARC Environmental Solutions Pty Ltd (AARC) was commissioned by Pacgold Limited (Pacgold) to prepare a monitoring report for the Freshwater Tiger Crab (*Austrothelphusa tigrina*; Tiger Crab), for the Alice River Gold Mine (the Project). Monitoring was completed in May 2024 in accordance with the Freshwater Tiger Crab Management Plan (the Management Plan) methodology (AARC 2021).

1.1 Scope

The aim of this assessment is to continue the Tiger Crab monitoring as per the Management Plan (AARC 2021) in compliance with condition A7-1 of the Project's Environmental Authority (EA) (EPML00870113). To do this, AARC has undertaken the following scope of works:

- a field survey to collect environmental and population data at monitoring locations within waterways associated with the Project site; and
- preparation of a monitoring report outlining the findings of the field survey.

This monitoring report builds on the findings from previous Tiger Crab monitoring surveys that have been presented in previous reports in 2021, 2022 and 2023, as well as historic studies from the region and mine site.

1.2 Project location

The Project is located approximately 470 km north-west of Cairns on the southern Cape York Peninsula (refer Figure 1-1). The Project consists of eight granted Mining Leases (MLs) with a total area of 80.8 ha. The MLs are ML 2907, ML 3010, ML 2902, ML 2902, ML 2958, ML 2957, ML 2908 and ML 3011. Surrounding the MLs are a network of creeks and tributaries linked to the Alice River, including One Mile Creek. No mining or processing activities have taken place at the Project since the year 2000, and the mine has fundamentally been in care and maintenance for 23 years. Pacgold also holds numerous Exploration Permits for Minerals (EPMs) that surround the eight MLs.

Figure 1-1 outlines the locations of the Project MLs.

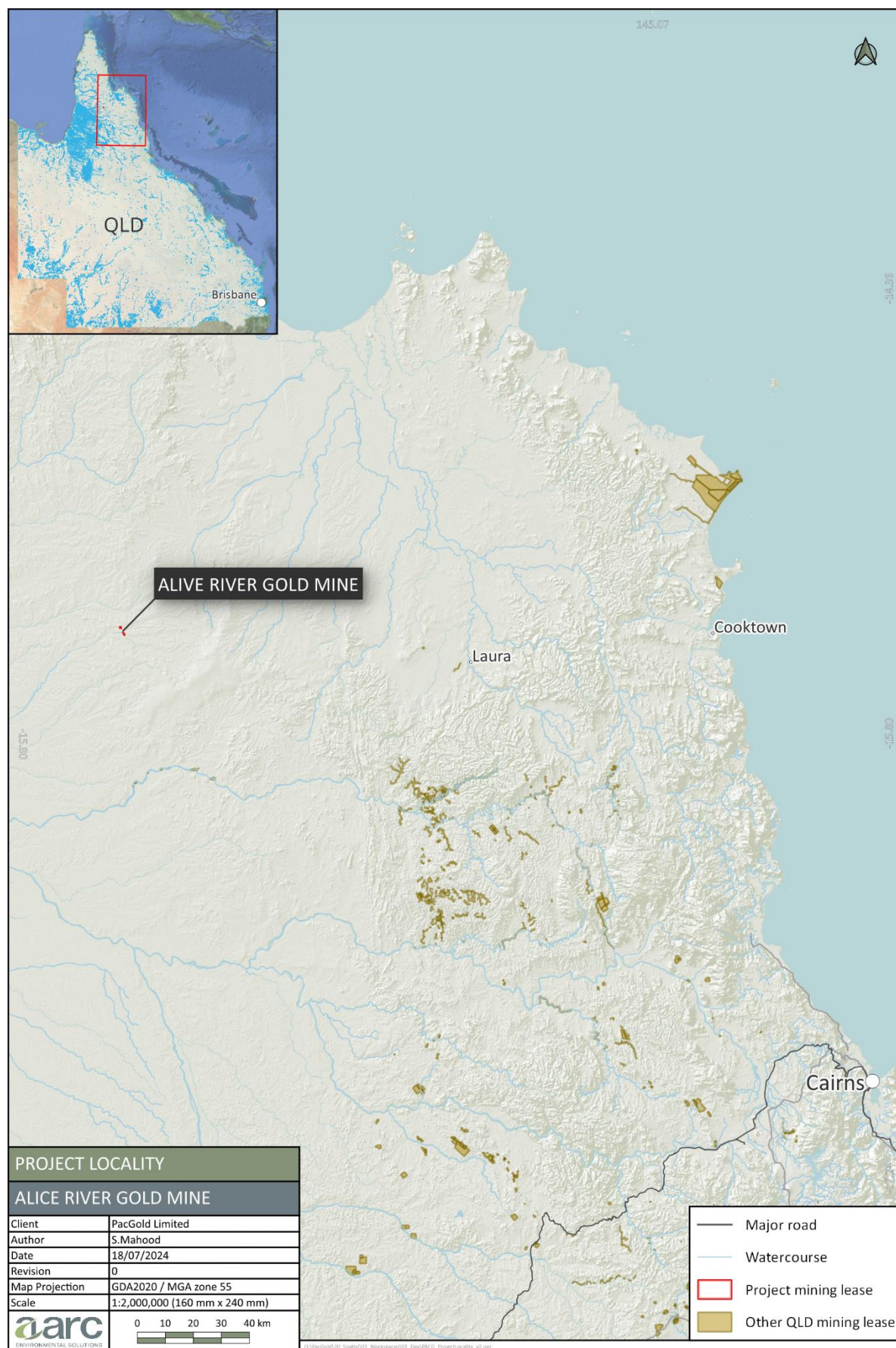


Figure 1-1: Project locality

2 Freshwater Tiger Crab

2.1 Literature review

A literature review was undertaken for the Tiger Crab (*Austrothelphusa tigrina*) as a preliminary investigation to understand the spatial extent of this species and provide additional data for assessment based in the little available information. This literature review included the following studies:

- 'Fish and crustacean surveys of Kimba and Alice River stations, Cape York', CSIRO (2018); and
- 'A new species of freshwater crab (Sundathelphusi-dae) from Cape York Peninsula. Memoirs of the Queensland Museum', 35(1), 235-240 by Short, J. W. (1994).

Little research has been undertaken to determine the ecology of the Tiger Crab within its natural distribution. In the CSIRO study from June 2018, Ebner and Wundersitz compared the abundance and diversity of freshwater crustaceans before, and after fencing for livestock, was installed around Jerry Dodds Creek (Ebner and Wundersitz 2018). The study aimed to identify the effects of reduced livestock activity within Jerry Dodds Creek on the assemblages of freshwater crustaceans. Two aquatic field surveys were undertaken in May 2017 and May 2018 focusing on the Tiger Crab (*Austrothelphusa tigrina*) and the Inland Freshwater Crab (*Austrothelphusa wasselli*).

During this study, baited opera-house traps were set overnight at sites within the Alice River, Dickies Creek, Jerry Dodds Creek, Dingo Creek and One Mile Creek. The Tiger Crab was abundant in all creeks surveyed, except Dingo Creek, where it was considered moderately abundant. The survey recorded a total of 522 Tiger Crabs during the sampling events. All individuals were exclusively found in larger deposition creeks rather than smaller erosional streams. This study provided regional context to the relative abundance, sex, size, and structure of the Tiger Crab in the Mitchell Basin. The study concluded that cattle damage to stream banks is unlikely to be the primary threat to this species. A more likely contribution to the decline of this species was disturbance by feral pigs in areas with high burrow density.

The location of the local and regional monitoring sites used in this study is depicted in Figure 2-1.

Monitoring completed by Pacgold in 2019 and from 2021 to 2024 has added to the known distribution of the Tiger Crab in Queensland.

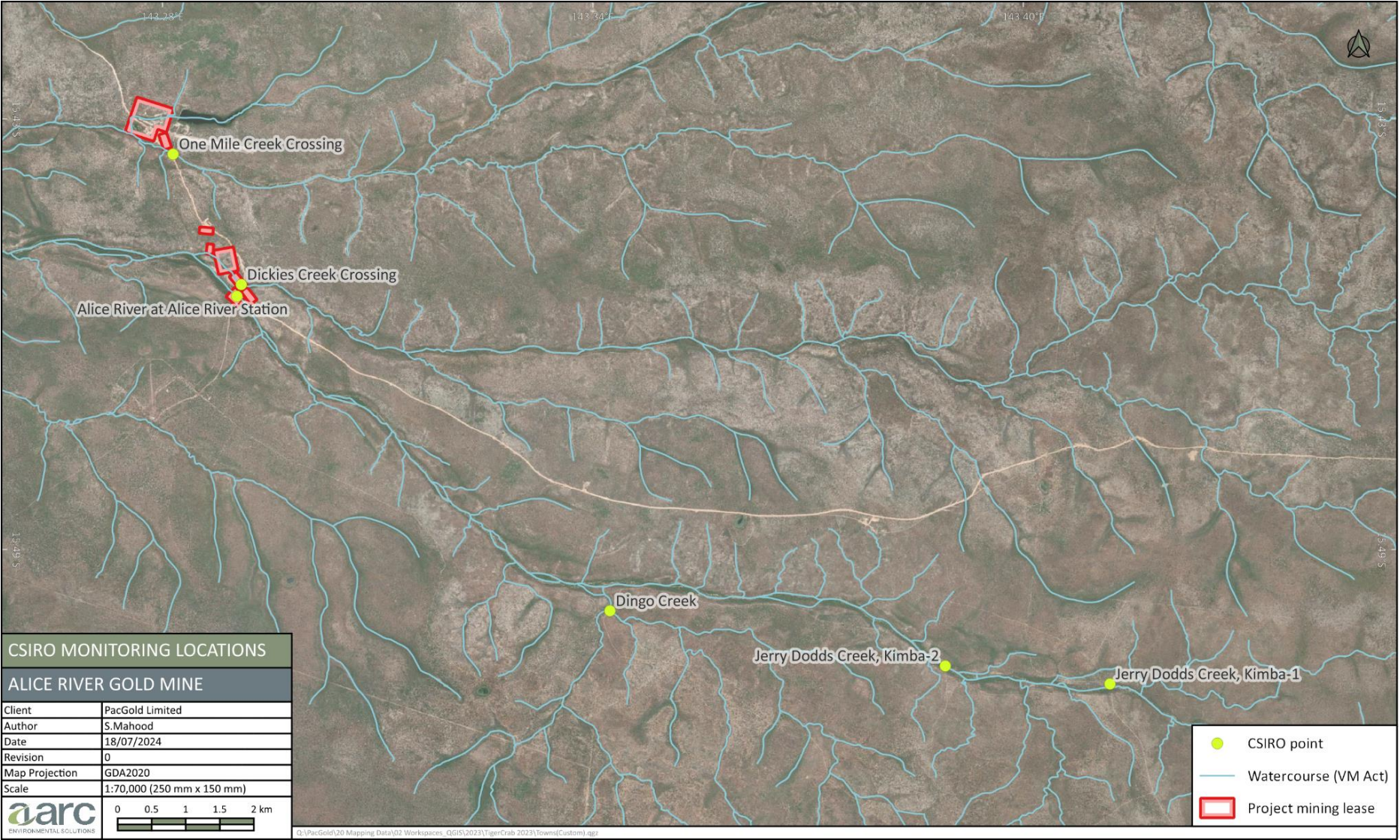


Figure 2-1: CSIRO Tiger Crab monitoring locations (Ebner and Wundersitz 2018)

2.2 Description

The Freshwater Tiger Crab is a small crustacean from the Gecarcinucidae family. The carapace is tan in colour with black striations including a long band behind the frontal margin (Curtis 2012) (Plate 1). Carapace length varies in adults but is most common at a breadth of 36 mm (Curtis 2012). Claws are cream coloured with black striations occurring at the joints that fade into purple fingers (Short 1994). The bold striations that give this species its name provide camouflage against debris in creeks, where they are most abundant. A black stripe occurs on the eyestalk longitudinally distinguishing it from other species of the *Austrothelphusa* genus (Curtis 2012).



Plate 1: Female Tiger Crab caught at MP3 during the 2024 survey

2.3 Biology and reproduction

Little is known of the biology and reproduction of the Tiger Crab. However, an article published in 1994 as part of the 'Memoirs of the Queensland Museum' journal comments on the knowledge that currently exists. Females reach sexual maturity by the time they are 13 mm wide with adult crabs growing to a full size of 36 mm wide (Short 1994). They have an abbreviated larval development, giving birth to juvenile crabs (Curtis 2012).

2.4 Habitat

As the water in the tributaries of the Alice River recedes in the dry season, the Tiger Crab avoids desiccation by burrowing into the sand at the base of Melaleuca trees (*Melaleuca* spp.) (Curtis 2012). Researchers from the Queensland Museum recorded this species in great abundance on sandy flats during the wet season in One Mile Creek and that they were highly docile during the wet season (Short 1994). Other crustaceans occupy this habitat, including the Inland Freshwater Crab (*Austrothelphusa transversa*) and Long-armed Freshwater prawns (*Macrobrachium* spp.) (Short 1994).

2.5 Distribution

Historical literature suggests that the Tiger Crab is only known from One Mile Creek (Short 1994). However, in May 2017 and May 2018, CSIRO, together with James Cook University, surveyed several regional sites. The sites included the Alice River, Dickies Creek, Jerry Dodds Creek, Dingo Creek and One Mile Creek; up to 30 km away from the Project (Ebner and Wundersitz 2018). It was confirmed that the Tiger Crab had a greater distribution than previous studies indicated.

The CSIRO survey identified one representative site in each of the waterbodies, shown in Figure 2-1. They installed ten replicate opera-house type traps (640 mm L, 470 mm W, and 235 mm H, 22 mm stretched mesh, 90 mm aperture of entrances) (Ebner and Wundersitz 2018). The traps were each baited with canned sardines and spaced approximately 20 m apart (and with some of the trap above the water line) (Ebner and Wundersitz 2018). Typically, at road crossings, five traps were set upstream and five downstream of the road (Ebner and Wundersitz 2018). Each opera-house trap was retrieved by sliding a fine-mesh, frame-net underneath the trap to ensure small crabs that were under, on the trap, or that slipped through the coarse mesh were collected (Ebner and Wundersitz 2018).

The results of this study are presented in Figure 2-2 and Figure 2-3.

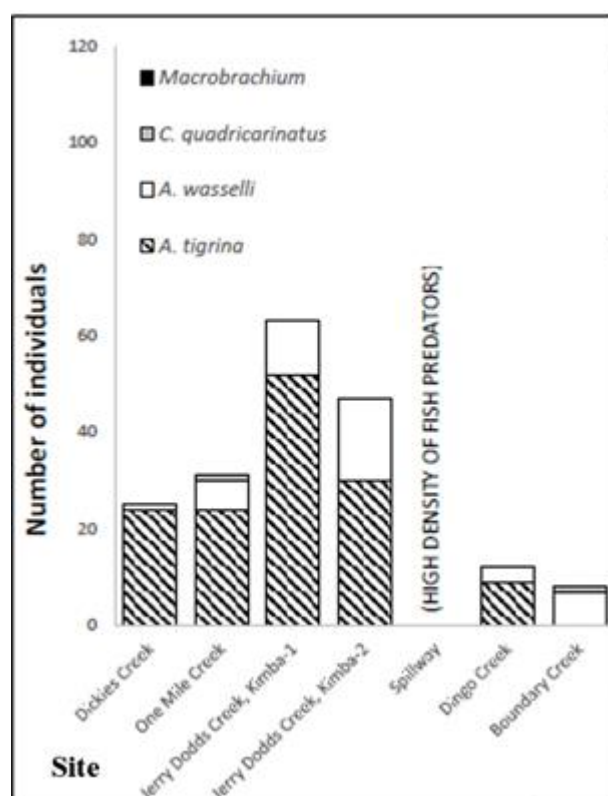


Figure 2-2: Macrocrustacean distribution and mesohabitat association in May 2017 based on proportional catches of species in the upper Alice River catchment (adapted from Ebner and Wundersitz 2018)

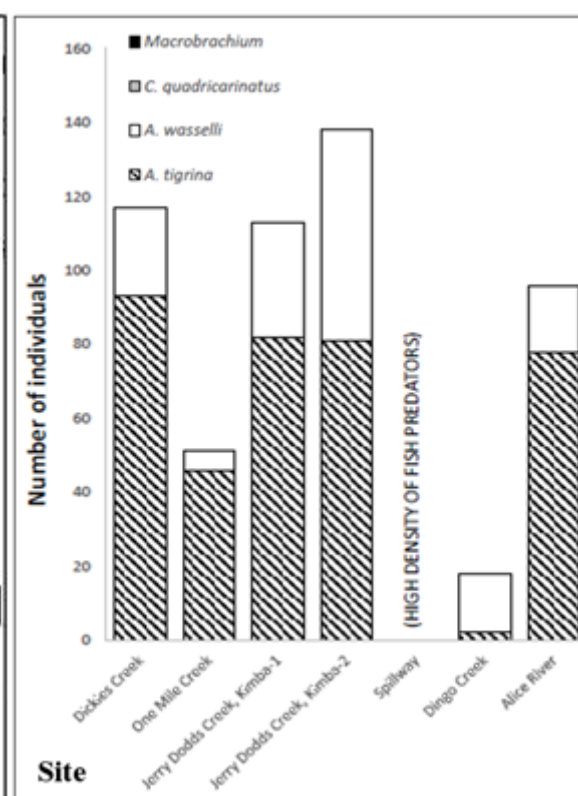


Figure 2-3: Macrocrustacean distribution and mesohabitat association in May 2018 based on proportional catches of species in the upper Alice River catchment (adapted from Ebner and Wundersitz 2018)

Due to the extensive history of mining operations on the Alice River MLs and the lack of historical survey data on the Tiger Crab, a pre-mining population—as required by Condition A7-1 (a) of the Project’s EA—could not be determined. Therefore, AARC will use the outcomes of this survey to inform population changes over time and aid in the understanding of distribution of the Tiger Crab in the region.

However, a direct comparison between monitoring data collected under the Management Plan and the outcomes of the CSIRO survey cannot be drawn as:

- The CSIRO and Pacgold Tiger Crab monitoring locations are not the same;
- The CSIRO survey used ten traps per monitoring location, while the Freshwater Tiger Crab Monitoring Plan only requires three traps per monitoring location;
- The CSIRO survey did not record data relating to variables such as mass, breeding and maturity status, or the presence of damage and disease, all of which could be potentially used to measure the health of the Tiger Crab population; and
- The CSIRO survey was completed using a single 24-hour capture period, while the Freshwater Tiger Crab Monitoring Plan requires two 24-hour capture periods; and implementing a mark-recapture procedure, allowing for thorough population estimates to be completed.

2.6 Threats

The major threats to the decline in the population of this species are both directly and indirectly attributable to humans and introduced animals. Tiger Crabs were historically sold in the pet trade, and consequently collection from the wild remains a potential threat to the species (Ebner and Wundersitz 2018).

Residual environmental impacts from gold mining have the potential to impact the population of Tiger Crabs in the area around the mine. This potential threat can be managed using systematic management plans and further research into the species’ ecology and extending future surveys to define its true distribution.

Extended periods of drought have the potential to reduce the population of this species as they rely on the presence and flow of water for various stages of their lifecycle.

The presence of pigs is also a significant threat. During the past surveys, evidence of wild pigs digging up crab burrows in the creek banks was observed at many study sites. Ebner and Wundersitz (2018) also noted that significant pig damage was noted at a number of the Tiger Crab monitoring sites.

2.7 Conservation status

The IUCN Red List of Threatened Species classifies the Tiger Crab as vulnerable (Esser and Cumberlidge 2008). This species is not listed as threatened under the Nature Conservation (Animals) Regulation 2020 or the *Environment Protection and Biodiversity Conservation Act 1999*.

3 Methodology

This section describes the survey methodology designed to fulfill the annual monitoring requirements of the Freshwater Tiger Crab Management Plan (AARC 2021, produced in compliance with condition A7-1 of the Project's EA). Survey methodologies include trapping (with mark-recapture) and water quality monitoring.

3.1 2023-2024 wet season rainfall

Rainfall data was collated from the Queensland Government's climate database SILO (Scientific Information for Land Owners) that operates by interpolating data from the Commonwealth Bureau of Meteorology (BoM) into a single point data drill. Rainfall data from the SILO grid point -15.45, 143.30 (SILO 2024) (Figure 3-1), compares the total monthly rainfall from May 2023 to April 2024 with the 10-year total monthly rainfall average (2013-2023).

Total monthly rainfall exceeded the ten-year average during the 2023-2024 wet season (October to April) by approximately 21%. Higher than average rainfall was recorded in December and January which led to a flooding event at the site, while February and March were comparable to the ten-year average. April recorded below-average rainfall prior to the survey period in May, however the effects of flooding persisted, due to flooding, until the survey.

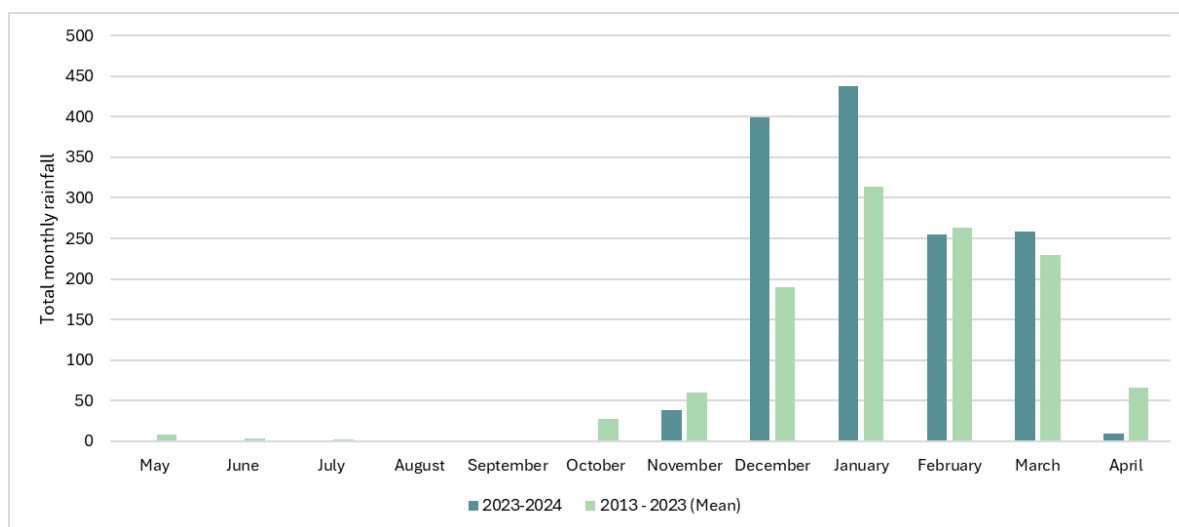


Figure 3-1: Interpolated rainfall data from Pinnacle weather station (SILO 2024)

3.2 Survey timing

The 2024 Tiger Crab monitoring was undertaken from the 9th to the 11th of May, after the wet season. This was conducted just outside of the period outlined in the Management Plan (January to April). The site was inaccessible prior to the survey period due to a flooding event. The timing of the 2024 survey is generally consistent with the monitoring periods of the previous years. A sustained flow was present in both One Mile Creek and Alice River during the survey period, providing suitable conditions for trapping Tiger Crabs.

3.3 Monitoring site locations

Four monitoring site locations were selected in accordance with the requirements of the Management Plan; two were located on One Mile Creek, one upstream and one downstream of the northern MLs; and two were located on the Alice River, one upstream and one downstream of the southern MLs. These monitoring locations have remained consistent across annual surveys. Locations of the Tiger Crab monitoring sites are in Figure 3-2, and the coordinates are provided in Table 3-1.

All monitoring points were located in similar habitats consisting of sandy stream beds, sandy/clay banks, with mature *Melaleuca* trees present within the stream and along the edges. Photographs taken from each monitoring point are provided in sections 3.3.1 to 3.3.4.

Table 3-1: *Tiger Crab monitoring points*

Monitoring Point	Easting GDA2020	Northing GDA2020
MP1	745493	8292220
MP2	744510	8292712
MP3	745633	8290796
MP4	746386	8290048



Figure 3-2: Tiger Crab monitoring locations

3.3.1 Monitoring point 1

MP1 is located in One Mile Creek and is associated with the northern MLs, upstream of the Alice Queen Pit. A photograph from MP1 is provided in Plate 2.



Plate 2: MP1 site conditions, upstream of Alice River mine pit

3.3.2 Monitoring point 2

MP2 is located downstream of mining activities (northern MLs), in One Mile Creek. It is also downstream of a public gravel road maintained by the council (Plate 3).



Plate 3: MP2 site conditions, downstream of the northern MLs

3.3.3 Monitoring point 3

MP3 is located downstream of the southern MLs in the Alice River. A photograph from MP3 is provided in Plate 4.



Plate 4: MP3 site conditions, downstream of the southern MLs, Alice River

3.3.4 Monitoring point 4

MP4 is located upstream of the southern MLs in the Alice River. A photograph from MP4 is provided in Plate 5.



Plate 5: MP4 in 2023, upstream of the southern MLs, Alice River

3.4 Data collection

Trapping was conducted by setting five opera-house traps approximately 20 m apart, in suitable locations for the monitoring duration at each site. Traps were not fully submerged, allowing non-target air-breathing aquatic species to breathe if caught, between trap checks. Traps were baited and checked approximately 24-hours later, when the traps were rebaited for checking the following day.

In addition to recording the number of Tiger Crabs captured at each site, a mark-recapture method was used to ascertain a population estimate at each location. This method is a commonly used in ecological surveys with great success to monitor crustaceans. Mark-recapture methods enable large numbers of crustaceans to be captured and marked without causing harm (Fonseca *et al* 2008). Specimens caught in the first 24-hour trapping period were temporarily marked with a non-toxic permanent marker and released, with the following information about the individual and site recorded:

- date and time of capture;
- sex;
- maturity;
- breeding status;
- weight (g);
- width (mm);
- claw dominance;
- dorsal photographs;
- carapace discolouration;
- signs of disease;
- location of trap;
- number of crabs in trap;
- burrowing presence; and
- presence of other species.

During the second monitoring period, the number of marked to unmarked individuals was counted, allowing the local population size of Tiger Crabs to be calculated. Population estimates were calculated using the Chapman Estimator, a modified version of the Lincoln-Peterson model, used widely in population ecology (Fonseca *et al* 2008, Wei and Gill 1991). This modified equation has been demonstrated to predict population size more accurately if the recapture rate is low, and is represented as:

$$N = \frac{(M + 1)(n + 1)}{(m + 1)} - 1$$

Where:

- N = estimated population size;
- M = number of individuals marked in the first capture;
- n = number of individuals in the second capture; and
- m = number of individuals of the second capture that are already marked.

Ebner and Wundersitz (2018) observed a large increase in the number of caught Tiger Crabs, which coincided with a decrease in the average size of the crabs. This may imply that population may change throughout the breeding cycle of the crabs, or that carrying capacity of the environment is reached with fewer, larger, crabs relying on more resources. This has been considered by calculating the estimated biomass, by multiplying the estimated population by the average weight of crabs at each site.

3.5 Water quality monitoring

Water quality in the receiving environment was monitored at four locations along One Mile Creek and two locations along the Alice River. Additionally, water samples were taken from mining activity water storage sites, including the two tailings dams and residual pits. The locations of these water quality monitoring points are shown in Figure 3-3 and outlined in Table 3-2.

Results from water quality testing were compared with the abundance and distribution of Tiger Crabs in the receiving environment of the Project. Water quality data provides an indication of ecological health, potentially used to model trends in Tiger Crab populations and explain annual variability.

Table 3-2: Water quality monitoring locations

Water quality monitoring site location	Corresponding Tiger Crab monitoring site	Easting GDA2020	Northing GDA2020
W1 – Within One Mile Creek, approximately 450 m upstream of the open pit	MP1	745539	8292201
W2 – Within One Mile Creek, within 50 m of the open pit, slightly downstream between the pit and the waste rock dump	Downstream of MP1	745140	8292434
W3 – Within One Mile Creek, < 100 m downstream of the waste rock dump	Downstream of MP1	744786	8292574
W4 – Within One Mile Creek, approximately 300 m downstream of the tailings dam	MP2	744512	8292720
W5 – Within the Alice River where it converges with Dickies Creek, downstream of mining activity	MP3	745634	8290796
W6 – Within the Alice River, upstream of mining activity	MP4	746388	8290048
TD1 – Tailings Dam, southeast corner	-	744825	8292659
TD2 – Tailings Dam, northwest corner	-	744783	8292805
Queen Pit – Residual Alice Queen pit	-	745175	8292464
ML2902 Pit – Residual pit in ML2902	-	746390	8290229

Schedule C – Table 2 of the Project EA outlines receiving water contaminant limits (refer to Table 3-3). These limits were sourced from the ANZECC Australian and New Zealand Guidelines of Fresh and Marine Water Quality trigger value for 95% species protection (ANZECC 2000). Water samples were collected in accordance with the Monitoring and Sampling Manual (DES 2018) and tested for the parameters outlined in Table 3-3.

It should be noted that while the EA refers to the 'background' level as values obtained at W1 during the sample period, it does not include W5 and W6. In keeping with the intention of the EA, this report has used W6 to serve as the background level for W5, because it is upstream of the mining activity and W5.

Water quality data provides an indication of ecological health, potentially used to model trends in Tiger Crab populations and explain annual variability. Results from water quality testing were used to support inferences, when comparing the abundance and distribution of Tiger Crabs within the receiving environment of the Project.

Table 3-3: EA Schedule C - Table 2 (Receiving Water Contaminant Limits)

Parameter	Units	Minimum	Maximum
pH	pH units	Background -0.5 pH units or 6.0 whichever is the lower	Background ¹ +0.5 pH units or 7.5 whichever is the higher
Dissolved oxygen	% saturation	90	120
Turbidity	NTU	N/A	Background ¹ +10% or 15 whichever is the higher
EC	µS/cm	N/A	250
Sulphate	mg/L	N/A	1,000
Arsenic (As III)	µg/L	N/A	24
Arsenic (As V)	µg/L	N/A	13
Antimony	µg/L	N/A	Background ¹ +10%
Copper	µg/L	N/A	1.4
Zinc	µg/L	N/A	8
Lead	µg/L	N/A	3.4
Cyanide total	µg/L	N/A	7

Note: ¹ 'Background' refers to the values obtained at sample location W1 – At least 300 m upstream of the open pit within One Mile Creek.

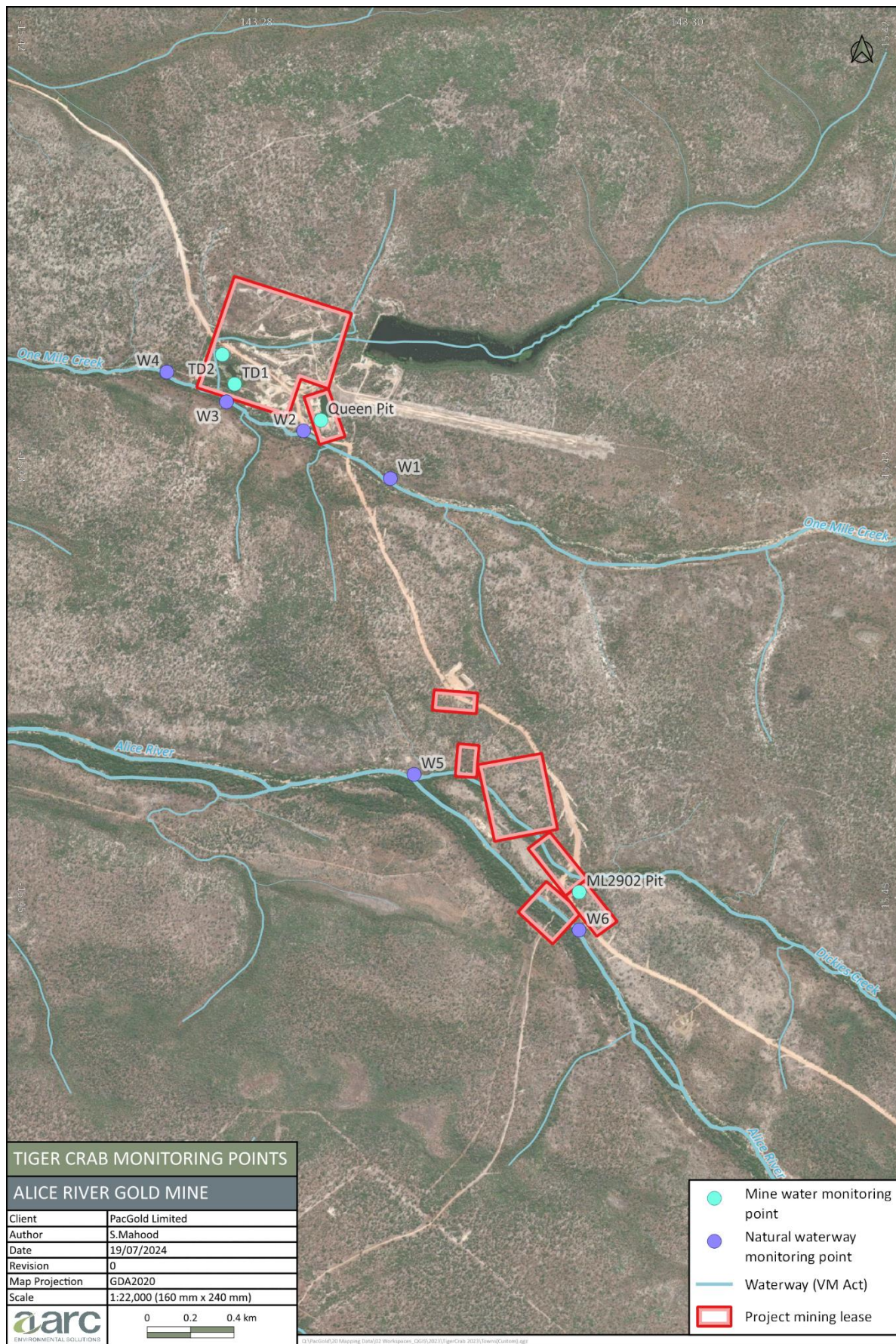


Figure 3-3: Water sampling locations

4 Results

During the two-day trapping period, 372 individual Tiger Crabs were captured in 2024, which is higher than previous monitoring years (292 in 2023 and 160 in 2022) (Table 4-1).

Table 4-1: Summary of Tiger Crab monitoring effort

	One Mile Creek		Alice River	
	MP1 – upstream	MP2 – downstream	MP3 – downstream	MP4 – upstream
Individuals in the first capture (M)	38	20	86	47
Individuals captured in the second capture (n)	45	8	100	47
Marked individuals in the second capture (m)	3	1	7	8
Total individuals captured (M + n - m)	80	27	179	86
Population estimate (N) (calculated by formula)	447.5	93.5	1097.4	255

4.1.1 Local population size

Estimated populations were lower than all previous years (Figure 4-1), except for downstream of One Mile Creek (MP2) which had a population estimated to be slightly higher than the previous year. The upstream population of One Mile Creek (MP1) was slightly lower but comparable to the previous year. Compared to the previous year, there were more individual crabs captured, however a higher number of recaptured individuals during the second monitoring day resulted in a lower population estimate overall in 2024.

The downstream population of the Alice River (MP3) was estimated to be 1097.4 which was lower than the 2023 population, although the 2023 result was significantly higher than any previous record with an estimate of 2,029 (refer Figure 4-1). Upstream of the Alice River, MP4, was found to have a population estimate of 255 which was also lower than the estimated 2023 population and most other historical populations, except for the 2021 population estimate.

The downstream population of One Mile Creek at MP2 was estimated to be approximately 4.8 times lower than the upstream population at MP1, while the downstream population of Alice River at MP3 was estimated to be approximately 4.3 times higher than the upstream population at MP4.

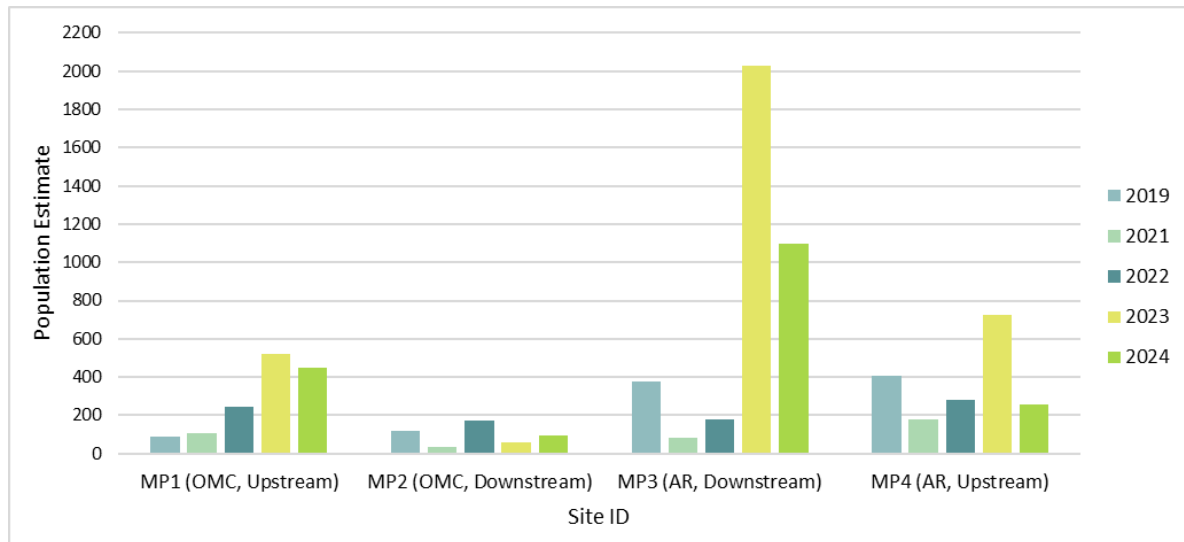


Figure 4-1: Population estimates at each monitoring point per monitoring year

Each caught crab was weighed prior to release. When crab weight was converted to estimated biomass per site, similar trends can be seen (Figure 4-2). The most significant variance was the change in biomass at MP3 from 2023 to 2024, which decreased by 35% from 2023, as opposed to a decrease of 46% from 2023 for the estimated population. This indicates that while the population in 2023 at MP3 was estimated to be much higher than 2024, the population was likely made up of smaller juvenile individuals in 2023 while the 2024 population at MP3 was made up of larger, more mature individuals.

Observations on biomass at all other sites followed similar trends to observations relating to population estimates from 2023 to 2024.

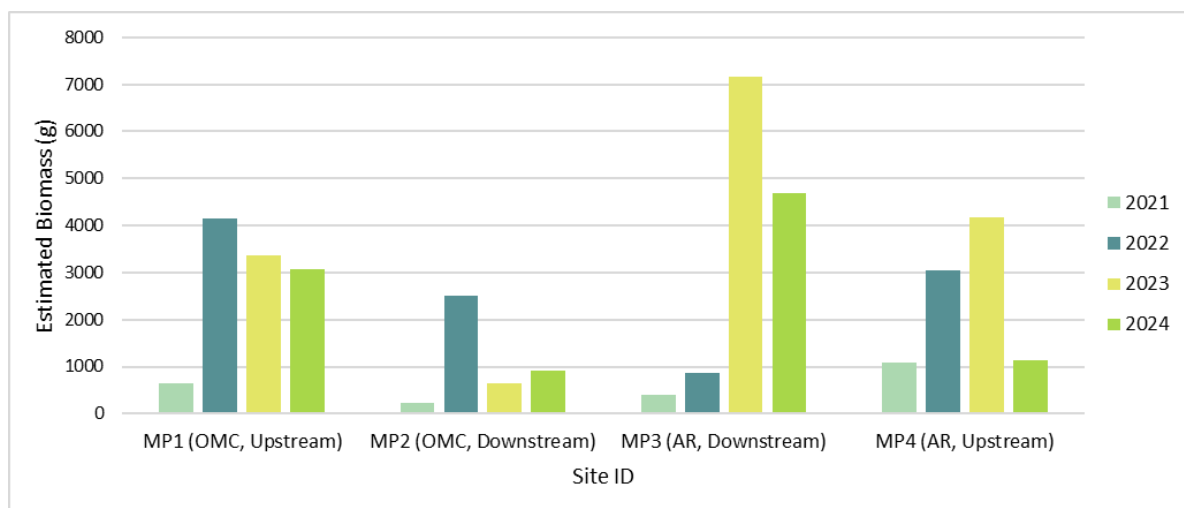


Figure 4-2: Estimated biomass at each monitoring point per monitoring year

4.1.2 Size variation

The average carapace width of Tiger Crabs across all sites was 24.7 mm, which was 0.2 mm (0.009%) higher than the previous year. Both the average width and the change in width recorded in 2024 are within the historical ranges set by previous monitoring periods, which have demonstrated considerable fluctuation (refer to Table 4-2).

Table 4-2: Average Tiger Crab width recorded each year

Year	Average width (mm)	Change in width (mm)
2017 ¹	24.7	N/A
2018 ¹	18.4	-6.3
2019	25.7	7.3
2021	26.1	0.4
2022	28.7	2.6
2023	24.5	-4.2
2024	24.7	0.2

Note: ¹ Data for 2017 and 2018 was obtained from the 2018 study by CSIRO, 'Fish and crustacean surveys of Kimba and Alice River stations, Cape York'

Average widths for Tiger Crabs at each site from all monitoring years are indicated in Figure 4-3. When subjected to a Kruskal-Wallis statistical test, there was no statistically significant difference in carapace widths between upstream and downstream sites within the same watercourse. The 2024 carapace width results for downstream sites were compared to the 2023 results using a Wilcoxon sign-ranked test. This test found no statistical significance between the years for the downstream One Mile Creek site (MP2), however the downstream Alice River site had significantly larger carapace widths in 2024 compared to 2023 ($p < 0.01$). The result further indicates that the 2024 population at MP3 was made up of more mature individuals compared to 2023, which consisted of a larger number of juvenile individuals. No statistically significant changes occurred between 2023 and 2024, at MP1 and MP4.

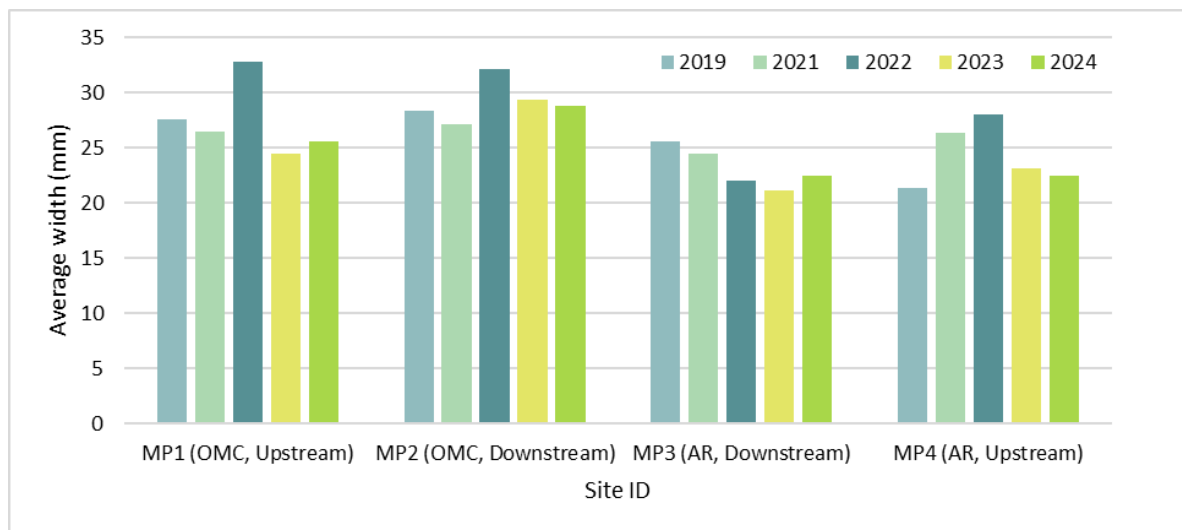


Figure 4-3: Average Tiger Crab width at each monitoring point per monitoring year

Statistical comparisons between sites using a Wilcoxon signed-rank test found that Tiger Crabs at MP3 weighed significantly more than those found in 2023 at MP3 (p -value < 0.01). This result is consistent with the site having a significant increase in carapace size, indicating more mature individuals found at the site compared to the previous year. No statistically significant difference was found between the weights of crabs occurring upstream and downstream within the same watercourse, when subjected to a Kruskal-Wallis test. The distribution of Tiger Crab weights for each site over the four monitoring years is indicated in Figure 4-4. There

was a significant change in the weight of individuals between sites from 2022 to 2023, and the weight distribution in 2024 is more similar to the weight distribution in 2023.

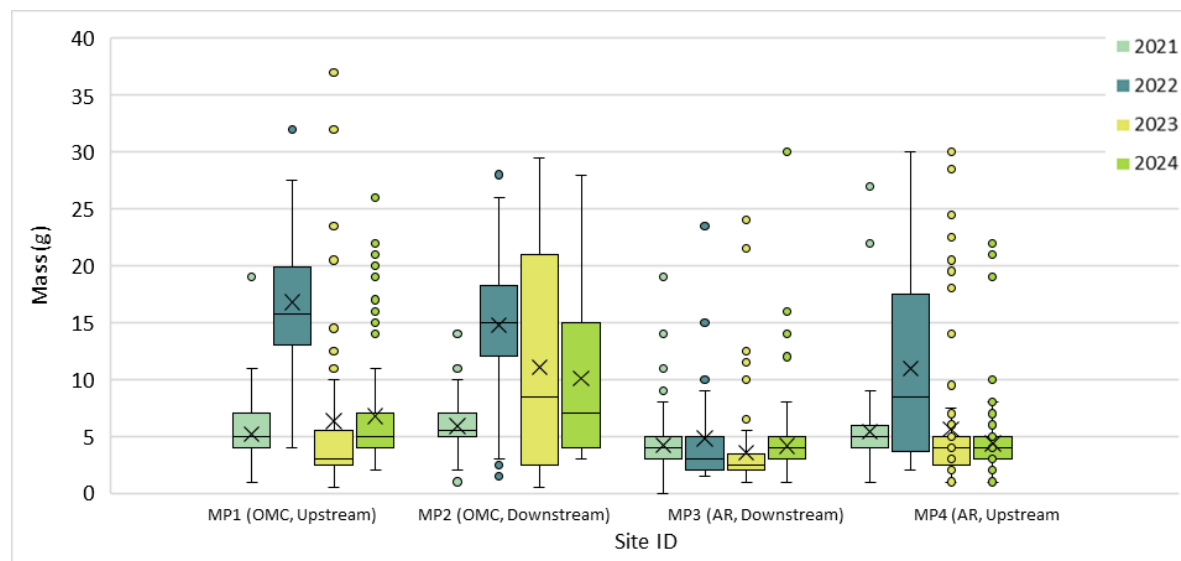


Figure 4-4: Distribution of Tiger Crab mass at each monitoring point across years

4.1.3 Sexual composition and maturity

Both sites within One Mile Creek recorded a lower male to female Tiger Crab ratio compared to 2023, while both sites in the Alice River recorded a higher male to female Tiger Crab ratio (Table 4-3). The results showed that there was a higher number of males than females at the downstream site at both watercourses compared to the respective upstream sites.

MP2 recorded a significantly higher proportion of male Tiger Crabs in 2023; almost six males for every female, which was the highest ratio recorded. The 2024 male to female Tiger Crab ratio recorded at MP2 was 2.4, which was comparable to the result from 2022 (2.8). Historical data indicates that the number of males relative to females fluctuates year to year.

All sites recorded a lower percentage of juvenile crabs compared to 2023 (Table 4-4). Both sites in One Mile Creek recorded a lower percentage of juvenile crabs (reduced by 30%); while MP3 and MP4 recorded a 21% and 14% reduction in the percentage of juvenile crabs, respectively. No statistical significance was recorded between years when subjected to a Chi-squared test, except at MP3 which has a significantly lower proportion of juveniles when compared with 2023 ($p < 0.01$).

Sexual composition and maturity data was subjected to a Chi-squared test to compare the upstream and downstream sites within the same watercourse. Statistical analysis showed no significant difference between MP1 and MP2 in One Mile Creek and MP3 and MP4 in the Alice River for sexual composition and maturity.

Table 4-3: Male to female ratio recorded at each site across all monitoring years

Year	MP1 (OMC, upstream)	MP2 (OMC, downstream)	MP3 (AR, downstream)	MP4 (AR, upstream)
2019	1.5	1.9	1.3	1.4
2021	1.7	1.6	1.0	1.2
2022	2.4	2.8	1.5	2.6

Year	MP1 (OMC, upstream)	MP2 (OMC, downstream)	MP3 (AR, downstream)	MP4 (AR, upstream)
2023	1.7	5.7	1.0	0.9
2024	1.6	2.4	1.1	1.2

Table 4-4: Percentage of juvenile Tiger Crabs recorded at each site across all monitoring years

Year	MP1 (OMC, upstream)	MP2 (OMC, downstream)	MP3 (AR, downstream)	MP4 (AR, upstream)
2021	13%	4%	16%	3%
2022	5%	6%	60%	28%
2023	56%	45%	74%	57%
2024	26%	15%	53%	43%

4.1.4 Missing and damaged limbs

The percentage of Tiger Crabs with missing limbs varied in both quantity and severity across the monitoring sites (Table 4-5). The results estimated an average of 33.3%, which is higher than all previous years. No statistically significant differences were noted when comparing monitoring sites, or between watercourses. No statistically significant differences were found at monitoring sites between 2023 and 2024, except at MP4, which had a significantly higher percentage of crabs with missing limbs.

No signs of disease were observed in the individuals captured, and there were very few instances of carapace discolouration noted, likely attributed to healed wounds.

Table 4-5: Percentage of Tiger Crabs missing limbs at each site across years

Year	MP1 (OMC, upstream)	MP2 (OMC, downstream)	MP3 (AR, downstream)	MP4 (AR, upstream)
2021	12.9%	33.3%	30.6%	27.7%
2022	13.6%	30.6%	14.3%	18.8%
2023	28.4%	25.0%	24.2%	15.1%
2024	27.5%	29.6%	26.82%	31.4%

4.1.5 Non-target species

Several non-target aquatic species were found in the traps, which were identified and released back into their respective watercourses (Table 4-6). High numbers of the Sevenspot Archerfish (*Toxotes chatareus*), Eastern Rainbow Fish (*Melanotaenia splendida splendida*) and Redclaw (*Cherax quadricarinatus*) were caught incidentally. No non-native species were identified.

Table 4-6: Non-target species recorded during the 2024 monitoring period

Species Name	Common Name	Count
Crustacean		
<i>Austrothelphusa</i> sp.	Freshwater Crab sp.	1
<i>Cherax quadricarinatus</i>	Redclaw	44
<i>Macrobrachium australiense</i>	Freshwater Prawn	10
<i>Macrobrachium spinipes</i>	Giant River Prawn	3
Fish		
<i>Ambassis agassizii</i>	Agassiz's Glassfish	28
<i>Glossamia aprion</i>	Mouth Almighty	2
<i>Hephaestus fuliginosus</i>	Sooty Grunter	2
<i>Leiopotherapon unicolor</i>	Spangled Perch	23
<i>Melanotaenia splendida splendida</i>	Eastern Rainbow Fish	44
<i>Neosilurus hyrtl</i>	Hyrtl's Catfish	2
<i>Toxotes chatareus</i>	Sevenspot Archerfish	50

4.1.6 Habitat search

The habitat searches found that all sites recorded moderate to high numbers of Tiger Crab burrows on both banks (Plate 6), except upstream site MP4 that had a moderate number of holes on the western bank, but a low number of holes on the eastern bank where there was sandier sediment.

Minor cattle damage was recorded at all sites except for MP3, which had no cattle damage. No evidence of pig activity was recorded at MP1 and MP3; however downstream site MP2 had a small area of pig damage (Plate 7), and MP4 recorded a low level of pig damage.

Observations during the 2023 monitoring period noted that channel alteration had occurred since the previous monitoring period, particularly at upstream site MP1. The 2024 monitoring period found that the channel at all sites continued to display variation in flow and structure over time. This has resulted in burrows that were previously along the water edge being separated from the remaining channel.



Plate 6: 'Moderate' Tiger Crab burrows at MP2



Plate 7: Small area of pig damage recorded at MP2

4.2 Water quality monitoring

4.2.1 Natural watercourses

Water quality data recorded during the 2024 monitoring program is presented in Table 4-7. No exceedances of the EA limits were recorded for physiochemical parameters and dissolved metals, except for the following instances:

- pH at receiving site W4 was 5.62, which was 0.06 pH units lower than the background value (W1) minus 10% as per the EA (pH 5.68);
- Dissolved oxygen at receiving site W3 was 69.5%, which was 20.5% below the EA range (90-120%); and
- Turbidity at receiving site W4 was 15.4 NTU, which was 0.4 NTU higher than the EA trigger level of 15 NTU.

Figure 4-5, Figure 4-6 and Figure 4-7 have been included to show changes in pH, dissolved oxygen and turbidity between each water quality monitoring period.

From 2023 to 2024, there was a slight reduction in pH across all sites at One Mile Creek and the Alice River. The results indicate that the low pH value recorded at W4 is not likely to be of concern and may be indicative of a trend across the whole catchment, rather than a result of the mining activity. Furthermore, pH has fluctuated between years, particularly in 2022.

Dissolved oxygen at W3 in 2024 was 30% lower than in 2023. It was also below the trends seen historically across all monitoring sites. This indicates that there may have been an increase in the quantity of debris in the downstream Alice River site and thus an increase in the amount of bacteria breaking down organic matter, though site observations do not indicate significant degradation in bank vegetation at the site.

Turbidity was generally lower than previous years, however, turbidity at receiving site W4 was slightly above the EA limit. This value was lower than all turbidity values for One Mile Creek in 2023, which indicates the turbidity level at W4 may be decreasing from a previously high level and is in line with the trend for turbidity in 2024.

Table 4-7: May 2024 receiving water quality data

Parameter	Units	LOR	EA limit	W1	W2	W3	W4	W5	W6
Physicochemical parameters									
pH	pH. Units	N/A	Background ¹ ± 0.5 units, or 6 and 7.5, whichever is lower or higher	6.18	6.19	6.23	5.62	6.25	6.37
Dissolved Oxygen	%	N/A	90 - 120	108	108	69.5	102.2	104.1	100.7
EC	µS/cm	N/A	250	25.6	25.4	79.7	17.4	30.2	38.2
Turbidity	NTU	N/A	Background ¹ +10% or 15, whichever is higher	6.5	6.3	0.46	15.4	8.5	5.8
Sulphate	mg/L	1	1000	<1	<1	<1	<1	<1	<1
Cyanide Total	mg/L	0.004	0.007	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Dissolved metals									
Antimony	mg/L	0.0002	Background ¹ +10%	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Arsenic	mg/L	0.001	0.013	<0.001	0.001	0.002	<0.001	<0.001	<0.001

Parameter	Units	LOR	EA limit	W1	W2	W3	W4	W5	W6
Copper	mg/L	0.001	0.0014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	mg/L	0.001	0.0034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

Note: ¹ The EA states that the background is W1, however the EA does not include W5 and W6. In keeping with the intention of the EA, W6 serves as the background level for W5.

Results shaded in orange indicate an exceedance of the EA trigger level.

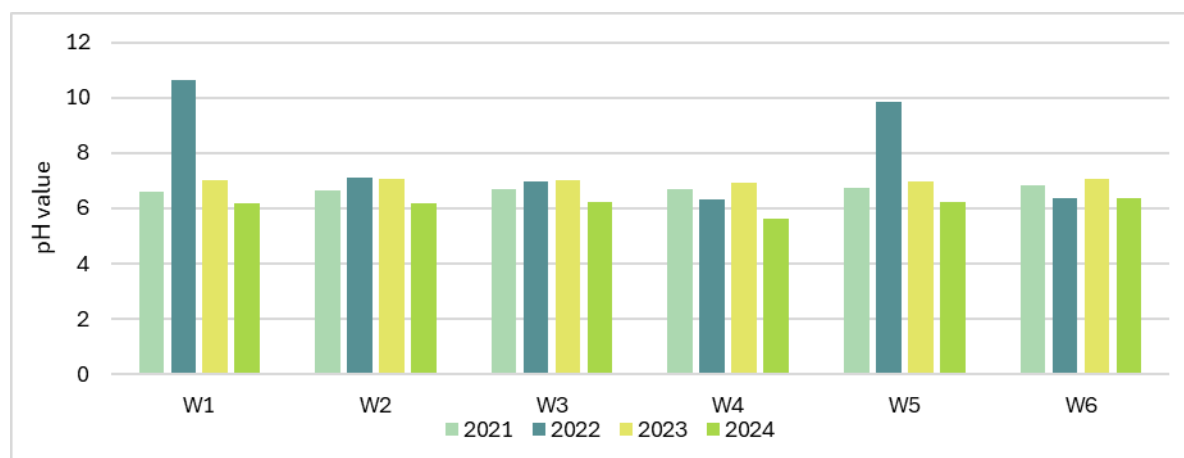


Figure 4-5: pH values during 2023 and 2024 water quality monitoring

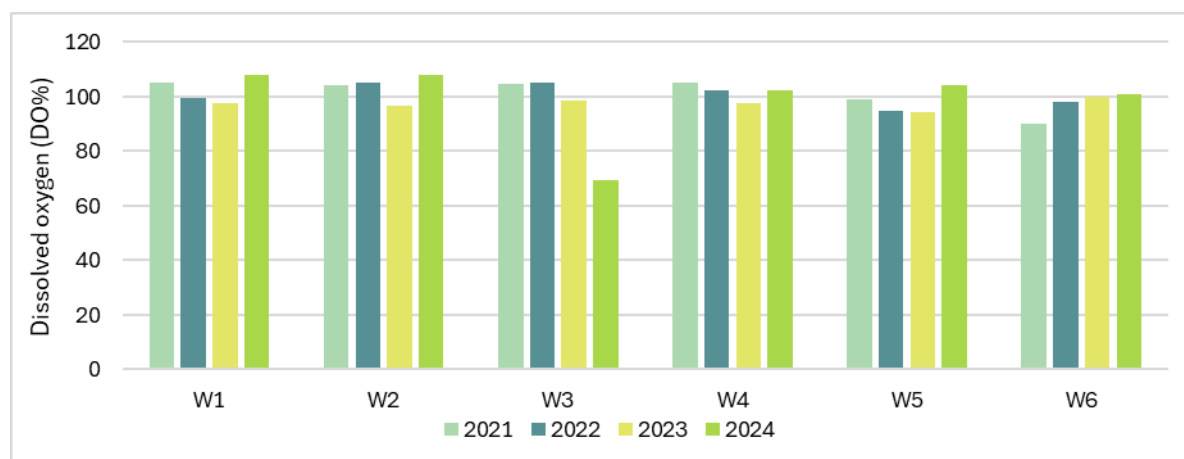


Figure 4-6: Dissolved oxygen (DO%) values during 2023 and 2024 water quality monitoring

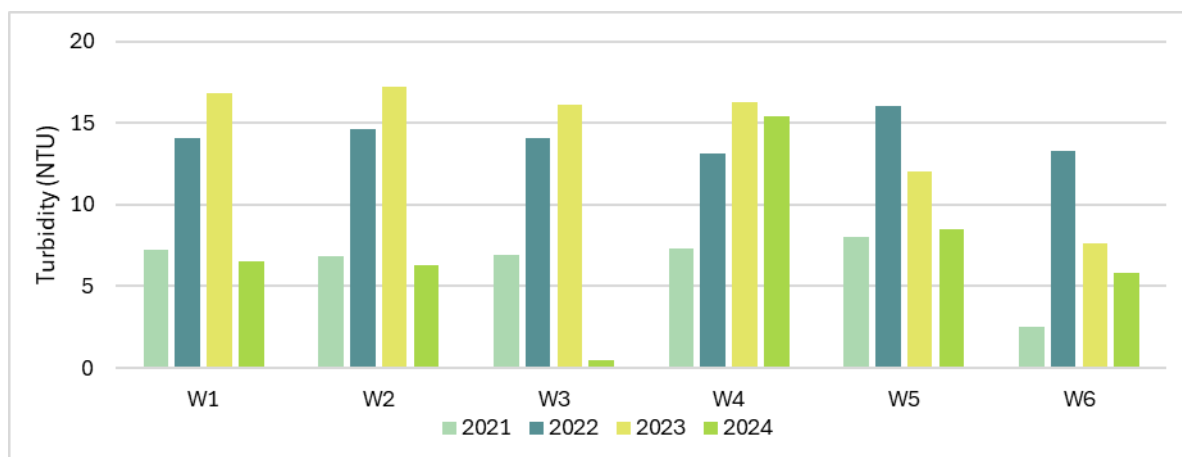


Figure 4-7: Turbidity (NTU) values during 2023 and 2024 water quality monitoring

4.2.2 Mine water storages

Water quality data recorded during the 2024 monitoring program is presented in Table 4-8. No exceedances of the EA limits were recorded for physiochemical parameters and dissolved metals. Dissolved arsenic at the tailings dam sites TD1 and TD2 was close to, but below, the EA limit of 0.5 mg/L (0.406 mg/L and 0.446 mg/L, respectively), which is consistent with findings from 2023 at these sites.

Table 4-8: May 2024 tailings and pit water quality

Parameter	Units	LOR	EA limit	TD1	TD2	ML2902 Pit	Alice Queen Pit
Physicochemical Parameters							
pH	pH. Units	N/A	-	5.47	6.37	5.94	6.03
Dissolved Oxygen	%	N/A	-	94.4	62.5	79.2	77
EC	µS/cm	N/A	-	20.2	81.8	45.6	32.5
Turbidity	NTU	N/A	-	2.07	0.86	13.89	2.63
Sulphate	mg/L	1	1000	1	2	<1	<1
Cyanide Total	mg/L	0.004	0.08	<0.004	<0.004	<0.004	<0.004
Dissolved Metals							
Arsenic	mg/L	0.001	0.5	0.406	0.446	0.015	0.121
Copper	mg/L	0.001	1	<0.001	<0.001	<0.001	<0.001
Lead	mg/L	0.001	0.1	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	20	<0.005	<0.005	<0.005	<0.005

5 Discussion

5.1 Tiger Crab population

The 2024 monitoring period recorded a decrease in estimated population size relative to the previous monitoring year at MP1, MP3 and MP4, and a slight increase at MP2. On average, the estimated population for Tiger Crabs in 2024 decreased by approximately 42% from 2023, but increased by 92%, 369% and 116% from 2019, 2021 and 2022, respectively. The estimated biomass and the percentage of juvenile Tiger Crabs also decreased on average from 2023, but generally increased compared to previous years. This indicates that the higher population estimate in 2023 may have been an anomaly due to a population boom resulting in a higher proportion of juvenile individuals in the population, however more data would be needed to confirm this. There were similarities between the wet season rainfall recorded for 2023 and 2024 that would suggest similar conditions and resource availability for both years. The 2024 results indicate that the decrease in population may be a result of the natural breeding cycle of the crabs, rather than a lower survival rate of juveniles based on competition for resources. When compared to previous monitoring periods, there is no obvious trend in decline in the Tiger Crab population in the catchment.

Furthermore, water quality results did not indicate any deviations in catchment-wide trends compared to previous years, or across the sites, that would likely have affected Tiger Crab populations in 2024. Water quality is further discussed in section 5.2. The water results, in conjunction with Tiger Crab population results, indicate that the fluctuation in the estimated population of Tiger Crabs is likely indicative of natural breeding cycles rather than other factors.

A comparison of each Tiger Crab monitoring site to the previous monitoring period found few statistically significant changes. The downstream Alice River site MP3 recorded a statistically significant increase in the individual animal weight and width of crabs from 2023 to 2024 as well as a significant decrease in the proportion of juvenile individuals at the site, indicating that this population is made up of larger, more mature individuals as opposed to smaller juveniles that made up the population in 2023. These results follow the catchment-wide trend. Due to the large number of individuals caught at this site across both years compared to other sites, this change may have considerably influenced the decrease in the average population estimate for the catchment in 2024.

When comparing the upstream and downstream Tiger Crab populations in the same watercourse, no statistically significant differences were found. However, comparisons between the watercourses found that crabs within the Alice River sites had significantly lower individual weights and carapace widths than crabs at One Mile Creek. Considering the higher population estimate and percentage of juvenile individuals at Alice River, this result would suggest that the Alice River contains more suitable breeding habitat than One Mile Creek.

The ratio of male to female individuals was higher at the downstream One Mile Creek site compared to the upstream site, and lower at the downstream Alice River site compared to the upstream site. No statistical significance was found for these results indicating a natural fluctuation in sexual composition of the population, possibly related to the fluctuation in the breeding cycle.

Evidence of pig activity appears to have decreased since previous monitoring years, with no evidence recorded at MP1 and MP3, and decreased activity recorded at MP2 and MP4. These results do not appear to correlate to population estimate changes at the sites between years and comparing upstream and downstream sites in the same watercourse. However, a statistically significant increase in the percentage of crabs with missing limbs was found at the upstream Alice River site MP4, which may be attributed to the presence of pigs recorded at the site.

Another possible factor that may have influenced Tiger Crab populations is the flooding event that occurred in the wet season prior to the monitoring event. However, 2023 recorded a flooding event during a similar time period prior to the monitoring, indicating that flooding may not significantly impact the ecology of the crabs.

5.2 Water quality

Water quality physiochemical parameters measured during the 2024 monitoring period at One Mile Creek and the Alice River were generally below the EA trigger level and aligned with historic levels. Parameters exceed the EA trigger levels for dissolved oxygen at W3; and pH and turbidity at W4. These sites are both downstream sites at One Mile Creek. All dissolved metal concentrations were below the EA trigger level across all sites. No exceedances of EA limits were recorded at the mine water storage sites, however dissolved arsenic at the tailings dam sites TD1 and TD2 was close to the EA limit, which is consistent with findings from previous years at these sites. Low dissolved arsenic levels at the natural watercourse sites indicate that mine affected water is unlikely to be affecting these watercourses.

The low pH recorded at W4 is consistent with catchment-wide trends in 2024, however the low dissolved oxygen at W3, and high turbidity at W4, diverge from catchment-wide trends. No statistically significant changes occurred in the Tiger Crab population at MP2 (downstream of W3 and at W4) indicating that these deviations have not had any effect on the Tiger Crab population. Continued monitoring of these values is recommended to obtain long term data and derive water quality trends.

The water quality data collected in the 2024 monitoring event indicate no water quality parameters have impacted the Tiger Crab population at One Mile Creek and the Alice River.

Further water quality monitoring during the next monitoring period will add to the historic dataset and continue to inform water quality trends that may emerge.

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ALICE RIVER GOLD PROJECT EROSION STABILITY ASSESSMENT: TAILINGS STORAGE FACILITY

PREPARED FOR
PACGOLD LIMITED

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Table of Contents

1	Introduction	4
1.1	Project description	4
1.1.1	Tailings storage facility	5
1.2	Scope.....	6
1.3	Current landform design and vegetation management requirements	7
2	Methodology	8
2.1	Soil profile	8
2.2	Climate file	9
2.3	Slope profile	12
2.3.1	Final slope gradient	12
2.3.2	Current slope gradient	13
2.4	Vegetation management.....	15
2.5	Model validation	17
3	Results	18
3.1	Slope performance	18
3.2	Soil performance	19
3.3	Final land use performance	20
4	Discussion and conclusion	21
5	References	22

Appendices

A1	Supporting Information
A2	Analogue site photographic monitoring

List of Figures

Figure 1:	Regional location of the tailing storage facility.....	5
Figure 2:	Elevation model of existing tailings storage facility.	6
Figure 3:	CLIGEN-generated and SILO rainfall data comparison.....	12
Figure 4:	Cross section of infilled TSF embankment used in stability assessment (Blackrock 2022).	13
Figure 5:	Location and slope gradient of modelled slopes	14
Figure 6:	Cross-sections showing slope gradients	15
Figure 7:	Erosion rate vs vegetation cover under differing slope conditions	18
Figure 8:	Soil loss rates across vegetation cover under final landform condition	19

List of Tables

Table 1:	Summary of samples used for the soil data input in the WEPP analysis	8
Table 2:	Land conditions after achieving PMLU.....	16
Table 3:	Giant Speargrass traits	17
Table 4:	Topsoil profile characteristics	19
Table 5:	Erosion performance summary at 70% vegetation cover under current slope gradient	20
Table 6:	Erosion performance summary at 70% vegetation cover under representative final slope	20

Abbreviations

AARC	AARC Environmental Solutions Pty Ltd
CEC	Cation exchange capacity
DEM	Digital elevation model
DES	Department of Environment and Science
EC	Electrical conductivity
ESA	Erosion stability assessment
ML	Mining lease
NAF	Non-acid forming
PMLU	Post-mining land uses
PRCP	Progressive Rehabilitation and Closure Plan
The Project	Alice River Gold Project
TSF	tailings storage facility
WEPP	Water Erosion Prediction Project

1 Introduction

PacGold Limited has commissioned AARC Environmental Solutions Pty Ltd (AARC) to develop an Erosion Stability Assessment (ESA) for the Alice River tailings storage facility (TSF) located at the Alice River Gold Project (the Project).

This assessment has been prepared to satisfy the information requirements of the Guideline—Progressive Rehabilitation and Closure Plans (DES 2023) — specifically, the completion of erosion modelling to predict the long-term stability of the existing and final downstream slope of the TSF embankment.

Erosional stability for the Project has been assessed using the Water Erosion Prediction Project (WEPP) model. The WEPP model was used to predict long-term stability of the existing and proposed final landform designs of the TSF.

The WEPP model is a process-based, distributed parameter, continuous simulation erosion prediction model. It considers various factors including slope design, climate information, vegetation management structures and soil parameters (National Soil Erosion Research Laboratory 1995).

WEPP modelling was used to assess the erosional stability of various representative rehabilitated slopes, as identified in the proposed final landform.

1.1 Project description

The Alice River Gold Project is an historic open-cut gold mine located approximately 140 km west-northwest of Laura in the southern Cape York Peninsula area of north Queensland (Figure 1). The site is located within Lot 11SP266613, and is comprised of eight mining leases (MLs) covering approximately 60 ha, within which two small historical mines (Alice Queen and Peninsula King) are located.

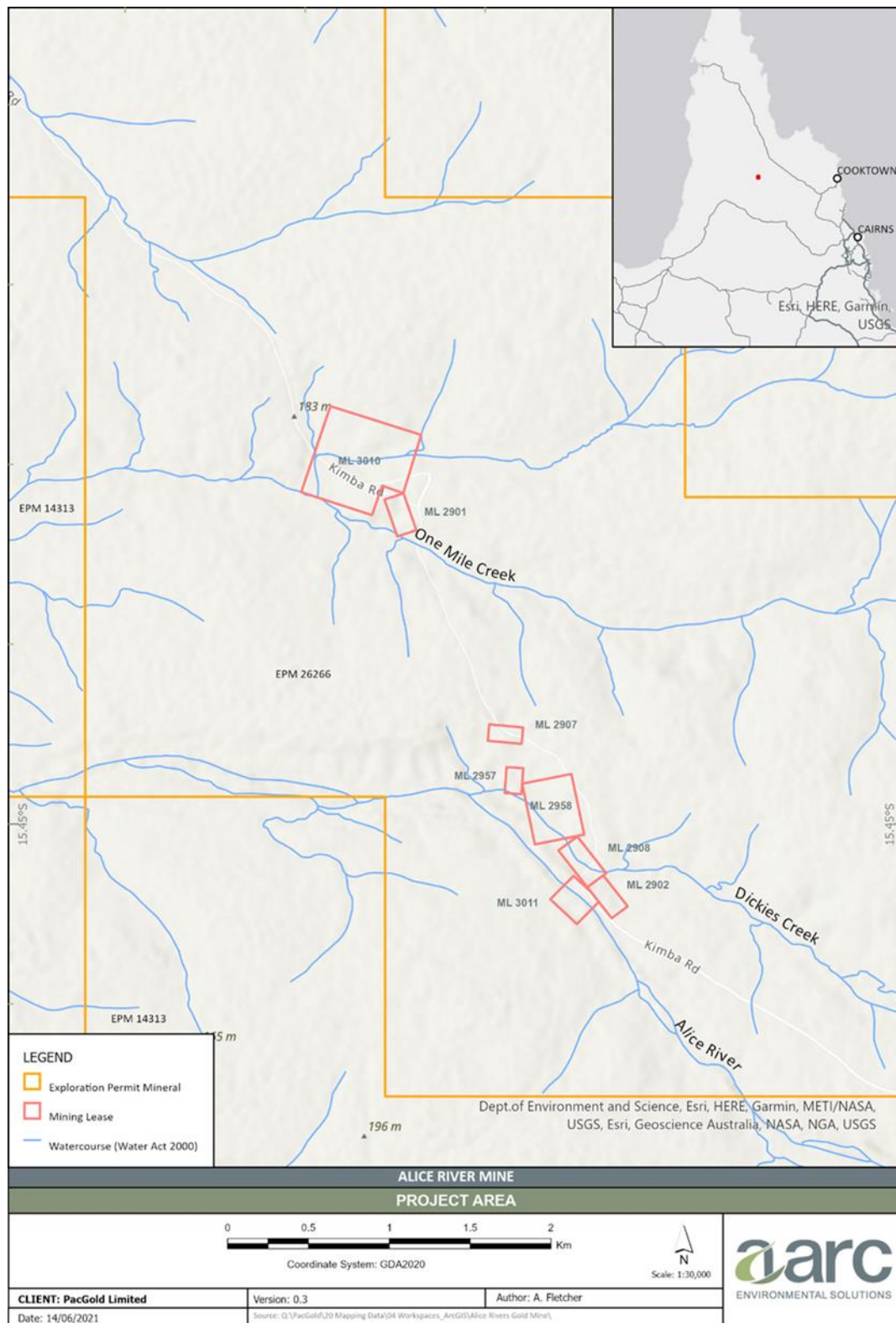


Figure 1: Regional location of the tailings storage facility

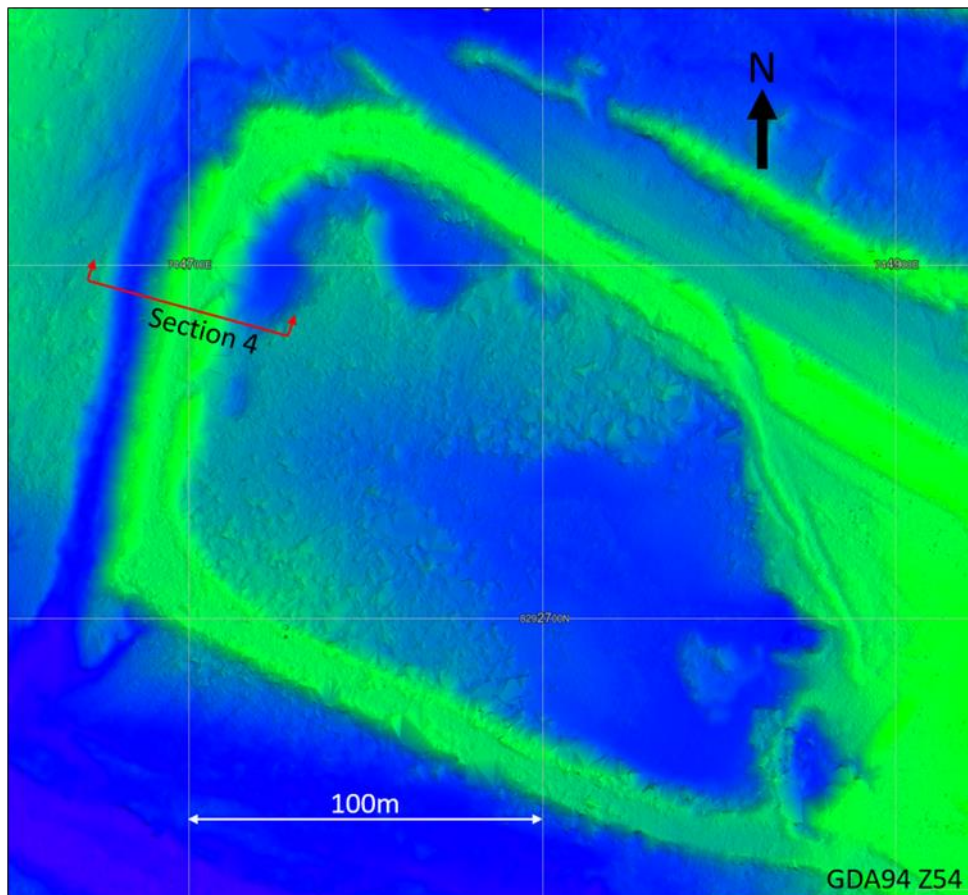
1.1.1 Tailings storage facility

The existing TSF is located approximately 500 m north-west of the Alice Queen Mine Pit. It covers an area of approximately 2.86 ha (200 m x 150 m) and is impounded by an engineered (or assumed to be) embankment between 4 m and 5 m high. The facility is partially filled with tailings to a depth of 3–4 m.

The tailings dam embankment walls have been naturally colonised by local grass, shrub and tree species (*Melaleuca spp.* and *Acacia spp.*) over the past 20 years. It is estimated that approximately 50% of the tailings surface is covered by vegetation.

A constructed drainage channel at the western toe of the tailings dam appears to be maintained and diverts water from behind the impoundment to the Alice River system. An elevation model of the existing TSF based on drone capture is shown in Note: image uses a blue (low): green (high) colour ramp

Figure 2, where green areas indicate a higher elevation than blue areas.



Note: image uses a blue (low): green (high) colour ramp

Figure 2: Elevation model of existing tailings storage facility.

1.2 Scope

The following scope of work has been completed for the TSF ESA:

- review of the proposed final landform design;
- review of rehabilitation monitoring data associated with existing rehabilitation areas;
- erosion modelling (WEPP analysis) for slopes in the final landform;
- recommendations of suitable landform design criteria and vegetation cover criteria for inclusion in the Progressive Rehabilitation and Closure Plan (PRCP); and
- recommendations for other management actions and measurable objectives to ensure the long-term stability of rehabilitated slopes.

This assessment incorporates modelling and analysis of theoretical surface erosion risk for structures. The assessment does not address the geotechnical stability of the constructed landforms or the associated risk of mass failure.

1.3 Current landform design and vegetation management requirements

Post-mining land use descriptions for land disturbed by the TSF are described in the proposed PRCP. Landform design criteria for the final landform are as follows:

- an area of approximately 140 m x 250 m;
- finished height: 5.3 m;
- 'infilled' slope stability scenario with a slope angle of 25°;
- self-draining low slope angled scalloped landform;
- water shedding design;
- depth of 200 mm of topsoil over the surface;
- will be covered by shallow rooted groundcover and grass species; and
- 70% or greater total ground cover, based on the analogue site that comprised 72% live cover and organic litter.

The following in situ tailings cover rehabilitation process was designed by RGS (2023). The process for the tailings dam and mine waste differs from the standard approach of placing soil and regolith units on top of tailings or waste rock. The in situ rehabilitation process is a viable approach because the tailings do not contain significant amounts of pyrite that could oxidise and produce additional acid.

The principle applied to the rehabilitation of the TSF at the Alice River Mine is to utilise neutralisation and in situ remediation to convert potentially acid forming (PAF) tailings into non-acid forming (NAF) tailings that can support vegetation. The following aspects are relevant:

- the tailings are low permeability, with low shrink-swell capacity and high potential to retain soil moisture to support vegetation;
- the high proportion of clay size fractions and low permeability of the tailings induces higher runoff relative to percolation;
- soil will be incorporated into the neutralised tailings and rock cover to produce a 'soil cover' system that can support vegetation;
- a low slope will be created on the reshaped surface profile that will direct surface runoff from the perimeter of the TSF to a NAF rock armoured release point, and then to the receiving environment;
- the surface of the TSF will include exposed rock infilled with pockets of neutralised tailings and topsoil which will retain moisture and nutrients and support vegetation; and
- a tailings surface that will resist erosion by surface runoff and wind will result.

2 Methodology

2.1 Soil profile

WEPP soil profiles were generated using a combination of topsoil and subsoil samples collected from two distinct sampling programs. The first program, conducted for the Annual Rehabilitation Monitoring Report (AARC 2021), involved extracting data from a topsoil sample taken at an analogue site that accurately represents the natural topography, vegetation type, and post-mine land use designated as 'low intensity grazing'. The second program focused on a geochemical assessment to support the Project's PRCP (RGS 2023) and involved six topsoil samples sourced from existing soil stockpiles. The sampling for the first program took place in May 2021, while the second program was conducted in December 2022.

Table 1 summarises the type of samples collected during the sampling program.

Table 1: Summary of soil data input in the WEPP analysis

Soil profile	Sample location	Number of samples	Depth (m)	Study
Topsoil	Analogue site (AS1)	1	-	Annual Rehabilitation Monitoring Report (2021)
Topsoil	Soil Stockpile	6	0.05–0.2	Soil capping assessment (2023)
Subsoil	TSF	1	0.00–0.5	
Subsoil	TSF	1	1.00–2.00	

Fourteen topsoil profiles were created containing geochemical and physical properties. In accordance with the RGS (2023) report, the recommended topsoil depth for rehabilitation is 0.2 m.

Appendix A1 details the physical properties for each topsoil and subsoil layered considered in the WEPP model.

In total, 72 combined soil profiles were created for the WEPP model by combining the topsoil and subsoil profiles. These combined profiles were then formatted for inclusion in the WEPP model. Each soil profile included the following data types:

- Sample name;
- organic matter (%);
- clay (%);
- silt (%);
- fine sand (%);
- medium sand (%);
- coarse sand (%);
- fine gravel (%);
- coarse gravel (%); and
- cation exchange capacity (meq/100g).

The initial saturation was left at a default value of 75%, and inter-rill erodibility, rill erodibility, critical shear and effective hydraulic conductivity were estimated from the model for each soil profile. The following functions were used to estimate inter-rill erodibility (K_i), rill erodibility (K_r), critical shear (τ_c) and effective hydraulic conductivity (K_b) (National Soil Erosion Research Laboratory 1995; Alberts *et al.* 1995).

For soils that contain 30% or more sand:

$$K_i = 2,728,000 + 192,100 \times VFS$$

$$K_r = 0.00197 + 0.00030 \times VFS + 0.03863 \times e^{-1.84 \times ORGMAT}$$

$$\tau_c = 2.67 + 0.065 \times CLAY - 0.058 \times VFS$$

For soils that contain less than 30% sand:

$$K_i = 6,054,000 - 55,130 \times CLAY$$

$$K_r = 0.0069 + 0.134 \times e^{-0.20 \times CLAY}$$

$$\tau_c = 3.5$$

Where, *VFS* is per cent very fine sand, *ORGMAT* is the organic material contained in the surface soil, and *CLAY* is per cent clay.

Where organic material is less than 0.35%, the *ORGMAT* value was set to 0.35%.

In estimating effective hydraulic conductivity (K_b), the value of 7.8 mm/h was used according to a validation test study of the WEPP model on a sandy soil in Queensland (Yu *et al.* 2020).

Inter-rill erodibility, rill erodibility, critical shear and effective hydraulic conductivity values for all topsoil samples considered can be found in Table A1. Given the number of samples, the nature of WEPP modelling and the practicality associated with doing so, topsoil samples have not been classified into soil classifications. This scenario contrasts with academic research, where a small number of samples are analysed in detail. Given the differences in granularity between datasets, it is difficult to compare calculated soil erodibility values to published literature reliably.

Considering the accuracy of the internally calculated baseline parameters, published literature based on the latest version of WEPP suggests that satisfactory predictions of runoff and soil loss can be made without additional laboratory testing (Wang *et al.* 2022). As such, it is reasonable to conclude that the baseline erodibility parameters are sufficient for predicting runoff and soil loss.

2.2 Climate file

For each day of the simulation, the WEPP model requires ten daily weather variables, namely precipitation depth and duration, peak storm intensity and time to peak, minimum and maximum temperatures, dew point temperature, solar radiation, wind speed and direction. For inclusion into the WEPP model for runoff and erosion prediction, these observation parameters were generated using CLIGEN.

CLIGEN is a stochastic weather generator that produces daily estimates of precipitation, temperature, dewpoint, wind, and solar radiation for a single geographic point, using monthly parameters (means, standard deviations, skewness, *etc.*) derived from historic measurements (Nicks *et al.* 1995). CLIGEN requires a.PAR file, which was constructed using the methods outlined in Yu (2005). All parameters required a total of 12 entries, with each entry often corresponding to average values in each month. Additionally, as the United States Department of Agriculture created the WEPP model, all parameters used in creating the climate file have been converted to customary United States units.

In developing the parameter file, daily weather data was sourced from SILO using the grid-point data method from 01 January 1972 to 28 July 2024. The data was taken from the location, with coordinates 143.30, -15.45; and contained the following parameters:

- daily rainfall (mm);
- maximum temperature (°C);

- minimum temperature (°C);
- radiation (MJ/m²); and
- relative humidity at maximum temperature (%).

The above information was used to establish the following CLIGEN parameters:

- mean rainfall amount on wet days (inches, 12 values, one for each month);
- standard deviation of rainfall amount on wet days (12 values, one for each month);
- skewness of daily rainfall amount on wet days (12 values, one for each month);
- probability of a wet day following a wet day (12 values, one for each month);
- probability of a wet day following a dry day (12 values, one for each month);
- the mean daily minimum temperature (°F, 12 values, one for each month);
- standard deviation of the minimum temperature (12 values, one for each month);
- the mean daily maximum temperature (°F, 12 values one for each month);
- standard deviation of the maximum temperature (12 values, one for each month);
- the mean solar radiation (Langley, 12 values, one for each month); and
- standard deviation of daily solar radiation (12 values, one for each month).

As there were no on-site rainfall intensity measurements for the Project, 1-minute pluviograph data was sourced from the Bureau of Meteorology. The pluviograph data from Laura Post Office weather station was used for its proximity to the site and currency of records, spanning 01 July 1972 to 28 July 2024. This information was used for the following CLIGEN parameters:

- mean maximum 30-minute rainfall depth (inches, 12 values, one for each month); and
- empirical distribution of the relative time to peak (12 values).

The initial parameters relating to daily rainfall, temperature and solar radiation were sourced directly from the SILO data.

The probability of a wet day following a wet day ($\Pr(W|W)$) and the probability of a wet day following a dry day ($\Pr(W|D)$) was calculated as follows (Yu 2005; Wang *et al.* 2018):

$$\Pr(W|W) = \frac{N_{ww}}{N_{dw} + N_{ww}}$$

$$\Pr(W|D) = \frac{N_{wd}}{N_{dw} + N_{dd}}$$

Where:

- a critical precipitation amount (cr) of 0.2 mm was set, such that a wet day is one where $r \geq cr$ where r is the amount of precipitation observed on that day;
- N_{dd} was the total number of dry days in a month following a dry day;
- N_{dw} was the total number of dry days in a month following a wet day;
- N_{wd} was the total number of wet days in a month following a dry day; and
- N_{ww} be the total number of wet days in a month following a wet day.

To estimate the mean maximum 30-minute rainfall depth, the number of 30-minute (Δt) wet intervals (M) within a day such that any rainfall events within a day form a single storm event was calculated. The storm duration in minutes (D) was then calculated using the formula derived by Yu (2005) and Wang *et al.* (2018):

$$D = M\Delta t$$

The mean maximum 30-minute rainfall depth (MX. 5P) was then calculated using the formula (Yu 2005; Wang *et al.* 2018):

$$\text{MX. 5P} = \frac{1}{k} \sum \max I_{30}$$

Where, be I_{30} is the maximum 30-minute interval within the storm duration and $\max I_{30}$ is the 30-minute interval of each month be for each year for k (months).

In determining the empirical distribution of relative time to peak, the peak intensity (i) of a storm event must first be calculated. The time to peak intensity of a storm (t_p) can be given by (Yu 2005; Wang *et al.* 2018):

$$t_p = \frac{i - 0.5}{M}$$

The empirical distribution of time to peak (*TimePk*) is calculated using the following formula (Yu 2005; Wang *et al.* 2018):

$$\text{TimePk}(i) = \frac{Ntp(i)}{Ntp(12)} \text{ for } i = 1, 2, \dots, 12$$

Where, taking the values calculated for t_p , let $Ntp(i)$ be the number of wet days with $tp \leq \frac{i}{12}$ for $i = 1, 2, \dots, 12$, as per a 12-break probability distribution.

Finally, dew point (T_{dp}) was estimated using the formula proposed by Lawrence (2005):

$$T_{dp} \approx T_{\circ F} - \frac{9}{25} (100 - RH)$$

Where, $T_{\circ F}$ is maximum temperature in degrees Fahrenheit, and RH is relative humidity at the maximum temperature.

Wind speed and direction is used by the WEPP model to calculate the evaporation potential with Penman equation and the snowdrift, a phenomenon which does not occur at the study site. For that reason, wind data was not required and evaporation was calculated using the Priestly-Taylor equation instead (WEPP 1995).

The parameters calculated above were then entered into a PAR file and processed in WEPP using the Climate Builder tool. CLIGEN v5.3 was then used to generate a 100-year data to be used in the final climate file.

A monthly rainfall distribution using CLIGEN-generated data is shown in Figure 3. A pattern similar to the SILO rainfall data obtained from the site was reproduced by CLINGEN. The weather generator effectively simulated 100 years of data, accurately reflecting the seasonal variations of the Project. This includes a wet season from November to March and a dry season from April to October.

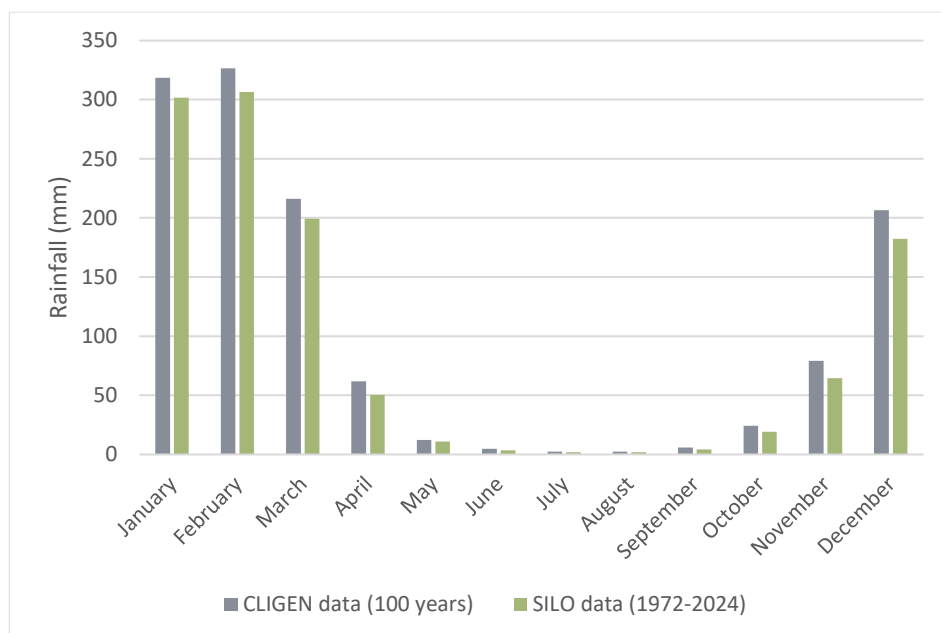


Figure 3: CLIGEN-generated and SILO rainfall data comparison

2.3 Slope profile

Hillslopes for WEPP analysis were generated based on the current and final landform design for the TSF. Final landform conditions were based on the stability assessment conducted for the TSF in the Geotechnical Assessment Report (Blackrock 2022) elaborated for the PacGold PRCP. This report establishes two long-term stability scenarios for the tailing's embankment. In the first 'as-built' scenario, the tailings dam are partially filled with water and in the second 'infilled' scenario the facility is used as waste material storage filled to the maximum height of the embankment.

2.3.1 Final slope gradient

The proposed final landform design for the WEPP erosion model analysis will be focused on the 'infilled' scenario where the TSF is long-term geotechnically stable. It should be noted that the height of the tailings dam, from toe to crest, is very low and is unlikely to present a significant risk from a geotechnical stability perspective.

The Geotechnical Assessment Report (Blackrock 2022) includes an assessment of the geotechnical stability of the tailings dam focusing on a representative section through the downstream embankment of the structure (Figure 4). As such, a representative final slope angle of 25° is employed for the WEPP erosion model.

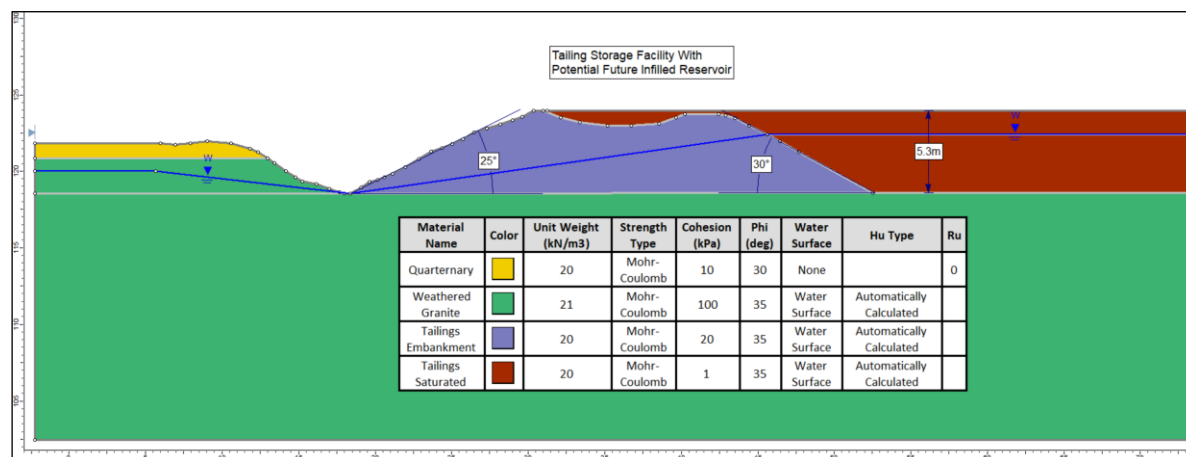


Figure 4: *Cross-section of infilled TSF embankment used in stability assessment (Blackrock 2022).*

2.3.2 Current slope gradient

For the current stability analysis, nine cross-sections were selected along the downstream faces of the TSF embankment, three at each side of the TSF (Figure 5). Slopes were derived using a Digital Elevation Model (DEM) at a 1 m resolution into a slope percentage for use in WEPP modelling within QGIS.

Each section was represented using a line file in QGIS which then was added points at 20% total length intervals, with endpoints included. In total, six points were produced per section, which were then spatially joined to the final landform DEM and the final percentage analysis in order to extract the input parameters for the WEPP modelling. Accordingly, each point stored the following information:

- ID;
- horizontal distance (m); and
- slope decline (%).

Figure 6 shows the slope gradient for each cross-section selected for the analysis under current slope conditions.



Figure 5: Location and slope gradient of modelled slopes

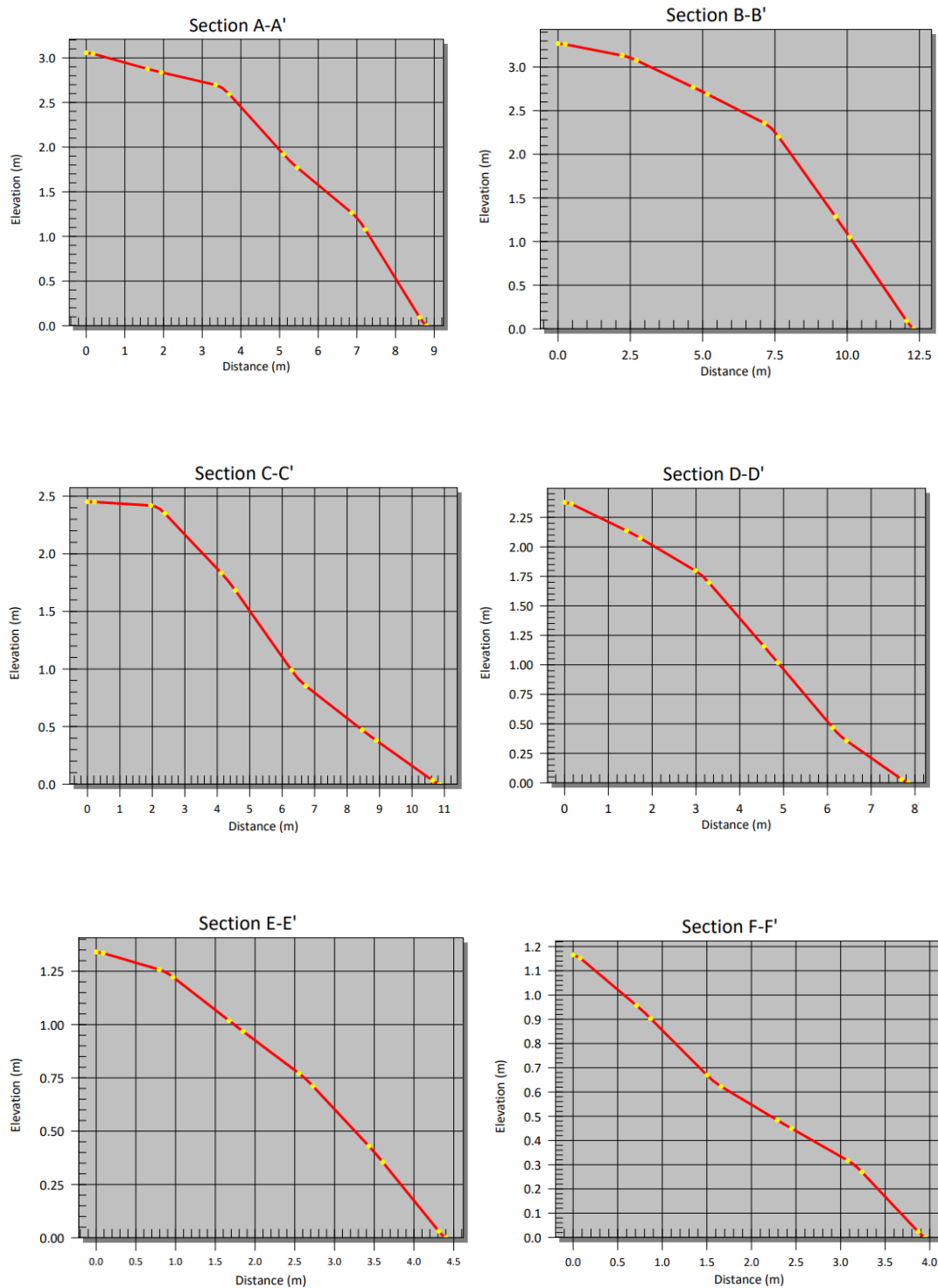


Figure 6: Cross-sections showing slope gradients

2.4 Vegetation management

Simulated vegetation cover was produced based on the proposed rehabilitation milestones and post-mining land uses (PMLUs) for the Alice River PRCP. Where initial vegetation parameter values were not stated in the PRCP, they were derived from the analogue sites conditions as per Schedule F of the current EA (EPML00870113).

Table 2 details the initial land condition parameters required by the WEPP model and the associated value corresponding to the final land conditions after the 'achievement of surface requirements' milestone for the low intensity grazing PMLU.

Rill and inter-rill conditions were set to a minimum value accepted by WEPP given the absence of erosion, rills or disturbance recorded at the two selected analogue sites as part of the PRCP.

Table 2: Land conditions after achieving PMLU

Parameter	Value	Unit
Initial Plant	Giant Speargrass	Unit
Bulk density after last tillage	1.1	(g/ cm ³)
Initial canopy cover	50-100	%
Days since last tillage	2000	days
Days since last harvest	2000	days
Initial frost depth	0	cm
Initial inter-rill cover (0-100%)	50	%
Initial residue cropping system	Perennial	-
Cumulative rainfall since last tillage	500	mm
Initial ridge height after last tillage	0.008	cm
Initial rill cover (0-100%)	50	%
Initial roughness after last tillage	0	cm
Rill spacing	3	cm
Rill width type	Temporary	-
Initial snow depth	0	cm
Initial depth of thaw	0	cm
Depth of secondary tillage layer	0.1	cm
Depth of primary tillage layer	0	cm
Initial rill width	0.2	cm
Initial total dead root mass	0.5	kg/m ²
Initial total submerged residue mass	0	kg/m ²

The area is deemed to be seeded with different types of native grasses according to the Alice River PRCP. In WEPP modelling only one type of plant can be selected. For that reason, Giant Speargrass (*Heteropogon triticeus*) was selected as the initial plant covering the surface given their abundance in the analogue sites. This plant species is a tropical, perennial tussock grass that during wet season grows over 2 m in height (Faster *et al.* 2021).

Table 3 summarises the characteristics of Giant Speargrass and its associated value.

Table 3: *Giant Speargrass traits*

Trait	Value
Growth form	Tussock
Life history	Perennial
Maximum vegetative height	2 m
Seed dry mass	11.4 mg
Mean leaf area	1,540 mm ²
Mean leaf length	500 mm
Mean leaf dry matter content	0.447 g/g

A total of 11 scenarios were nominated under different vegetation covers that ranged from 50% to 100%. In WEPP modelling, the vegetation cover parameter is nominated as 'canopy cover' and is defined as any live or dead standing vegetation elevated over 2.5 cm from the soil surface (Arnold *et al.*, 1995). The non-live vegetation includes the litter/organic materials, described as 'residue cover' which includes 'rill cover' and 'inter-rill cover' in the WEPP model. Bare soil is calculated as the total surface area minus ground surface cover (National Soil Erosion Research Laboratory 1995). For the present model, 'rill cover' and 'inter-rill cover' were set to 50% as this represents the average organic litter cover in the two analogue sites nominated in the PRCP.

The final PMLU proposed in the PRCP is low intensity grazing management. In WEPP, low intensity grazing is modelled as one mature cow of 450 kg weight consuming 8kg DM/day per 95 ha. These grazing pressures were constructed in line with the Queensland Government 'FORAGE Report Long Term Carrying Capacity' report for Lot 11SP266613 (A2). The low grazing pressure modelled is aligned with the long-term carrying capacity of Category D land condition pasture.

2.5 Model validation

While WEPP has been rigorously tested over 30 years and subject to numerous studies, to ensure complete accuracy, the simulated results were compared to measured erosion collected during the 2021 rehabilitation monitoring for the Project (AARC 2021). While there is limited information concerning the extent, size and volume of the erosion documented within the study area in the rehabilitation report, comparisons can be drawn based on the location of the transect, the slope of the landform, and the vegetation present located in the reference and rehabilitation sites within the mine site. The majority of erosion documented at the Project in 2021 was 'minor' for both analogue and rehabilitation sites with minor rills formed from waste material historically dug from borrow pits (Appendix A2).

The above results support the validity of the predicted results of the WEPP model, given that the model indicated tolerable erosion rates for all slopes where at least 70% cover was present on the slope. As the 50% vegetation cover predictions indicate, a reduction in cover can cause erosion to pass tolerable limits, especially in areas with long and steep slopes, which is supported by the above field information.

3 Results

Erosion stability was assessed across 1,386 WEPP simulations under current slope conditions and 154 under the representative final slope condition, testing a combination of parameters. Eleven vegetation cover conditions were considered for the analysis ranging between 50% and 100% vegetation cover for each slope condition.

3.1 Slope performance

As illustrated in Figure 7, while all the assessed slopes have a performance below the maximum tolerable erosion rate, not all of them perform the same under the target erosion rate.

There is a marked difference in soil loss among the various vegetation cover types. As vegetation cover increases from 50% to 70%, there is a significant decrease in annual soil loss. However, erosion rates only fall below the current target of 5 t/ha/year when vegetation cover exceeds 70%.

Among the current slope conditions, sections A-A' and B-B' located at the western side of the embankment are seen to have the highest erosion rates at 70% vegetation cover with values of 5.0 t/ha/year and 5.1 t/ha/year, respectively. In contrast, sections G-G' and H-H' located at the south face of the TSF have the lowest rates of erosion at the same vegetation conditions with values of 2.8 t/ha/year and 3.3 t/ha/year, respectively.

Representative final slope shows the highest erosion rate at 50% of vegetation cover when compared to current slope sections with a value of 8.4 t/ha/year. At 70% of vegetation cover its value decreases significantly but it is still just above the target erosion rate by 0.07 t/ha/year. However, as vegetation cover improves the erosion rates decreases below the target rate showing a slightly improvement as vegetation cover increases.

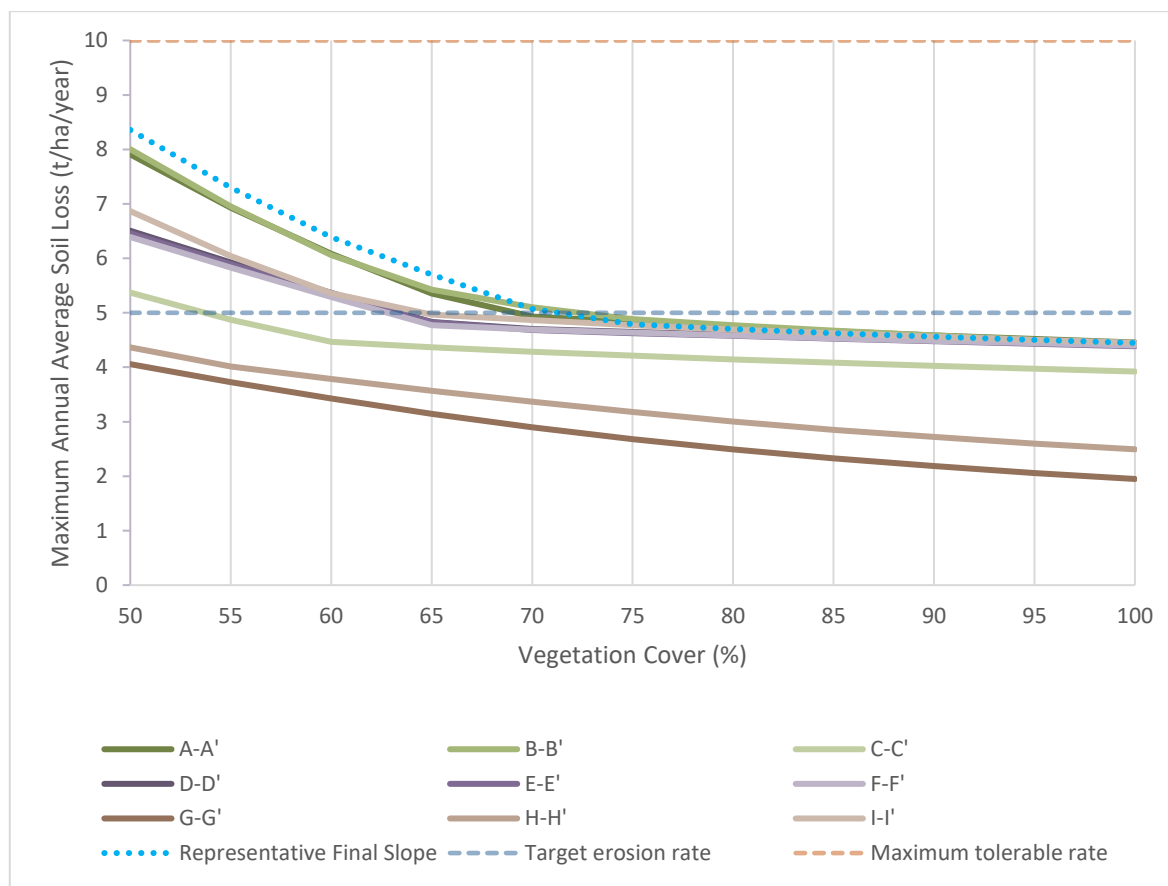


Figure 7: Erosion rate vs vegetation cover under differing slope conditions

3.2 Soil performance

Particle sizes of the topsoil layers were consistent, with variations limited to organic content and cation exchange parameters (CEC). These differences did not significantly influence the erosion rate under the final slope conditions. This is because the calculation of inter-rill erodibility, rill erodibility, critical shear and effective hydraulic conductivity heavily depends on the particle sizes and properties observed within each soil layer; with all of these parameters having a significant effect on the erosion performance of the landform (National Soil Erosion Research Laboratory 1995, Alberts *et al.* 1995).

Table 4 describes the particle size distribution for each topsoil layer and associated CEC and organic material contents.

Table 4: Topsoil profile characteristics

Topsoil class	Sand (%)	Clay (%)	Silt (%)	Organic matter (%)	CEC (meq/100g)
a	79	4	15	0.35	0.7
b	79	4	15	0.35	1
c	79	4	15	0.6	1
d	79	4	15	1.1	2
e	79	4	15	0.8	2.3
f	79	4	15	1.3	22.2
g	74	13	2	1.6	1.8

No significant variability was observed within the topsoil layers, resulting in little variation in erosion loss rates, as shown in Figure 8. As expected, all topsoil profiles show decreasing soil loss rates as vegetation cover increases under the representative final slope gradient. Considering 70% vegetation cover (Figure 8), the 'f' topsoil profile has the highest annual soil loss with 5.1 t/ha/year while the 'g' topsoil has the lowest loss rate with a value of 4.8 t/ha/year.

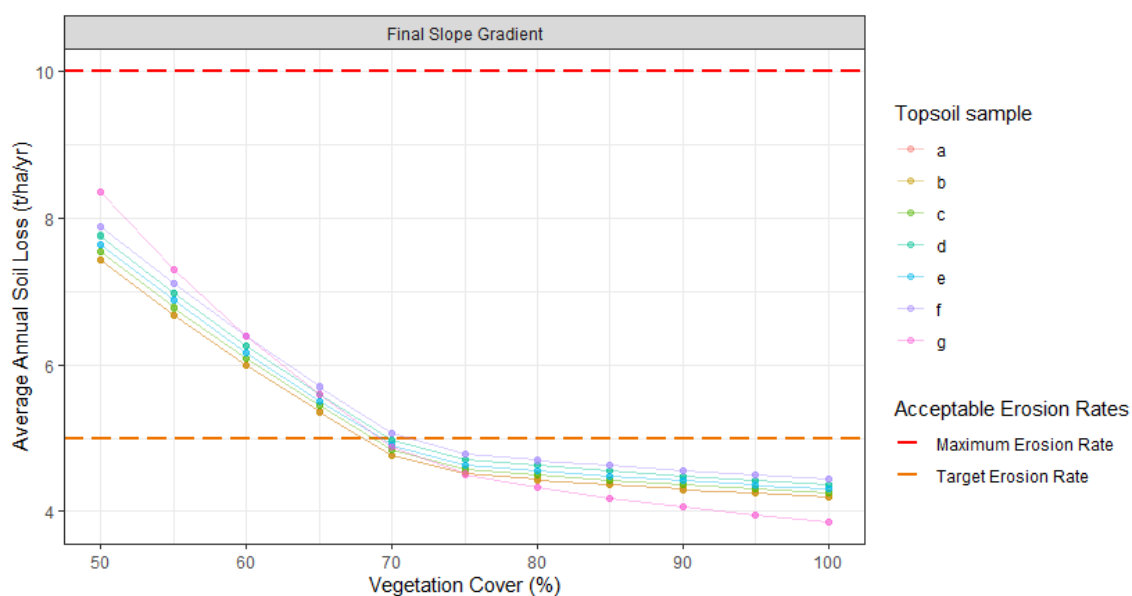


Figure 8: Soil loss rates across vegetation cover under final landform condition

3.3 Final land use performance

The final land use proposed in the PRCP nominates a vegetation cover of 70%. Table 5 summarises the general erosion performance of the TSF landform under the current slope gradient and at 70% vegetation cover. Under those conditions, the average annual soil loss across the TSF ranges between 1.9 t/ha/year and 5.1 t/ha/year, with a median value of 4.5 t/ha/year.

Table 5: *Erosion performance summary at 70% vegetation cover under current slope gradient*

Parameter	Minimum	Q1	Median	Q3	Maximum
Annual soil loss (t/ha)	1.9	4.1	4.5	4.7	5.1
Maximum on-slope soil loss (kg/m ²)	0.4	0.5	0.5	0.6	0.9
Maximum on-slope soil deposition (kg/m ²)	0.0	0.0	0.0	0.0	1.0
Average runoff (mm)	156.7	158.7	163.3	169.2	246.2

Table 6 summarises the erosion performance of the TSF landform under a 70% vegetation cover for the representative final slope. The total annual soil loss across the TSF at 70% cover ranges between 4.8 t/ha/year and 5.4 t/ha/year, with a median value of 4.9 t/ha/year.

Table 6: *Erosion performance summary at 70% vegetation cover under representative final slope*

Parameter	Minimum	Q1	Median	Q3	Maximum
Annual soil loss (t/ha)	4.8	4.8	4.9	5.0	5.1
Maximum on-slope soil loss (kg/m ²)	0.5	0.5	0.5	0.6	0.7
Maximum on-slope soil deposition (kg/m ²)	0.0	0.0	0.0	0.0	0.0
Average runoff (mm)	158.1	158.2	163.3	169.6	245.9

4 Discussion and conclusion

An erosion assessment using the WEPP model was run under a 100-year climate simulation for the current TSF landform condition and a final landform have a representative future slope gradient for the downstream face of the TSF embankment.

On-site parameters such as precipitation, slope gradient, vegetation cover, and soil properties, were employed as inputs for the model. Results have shown that the more influential drivers of erosion loss rates on the site are vegetation cover and slope gradient with the downstream batter located at the western side of the TSF having the highest erosion rate compared to the other faces of the TSF.

Infiltration and erodibility parameters are critical for accurately predicting runoff and soil loss (Yu *et al.* 2000). The soil samples from this site contained almost 80% sand, leading to a high hydraulic conductivity value being used for the model. This high hydraulic conductivity resulted in what was considered to be an excessively high infiltration proportion and correspondingly low soil loss rates when used in the WEPP model. To address this, a lower hydraulic conductivity parameter was adopted from a study conducted in Queensland which calibrated model parameters using measured runoff and soil loss data for a bare soil having similar sandy characteristics (Yu *et al.* 2000). Using this adjusted value, the model predicted an average maximum annual runoff of 246.2 mm under 70% vegetation cover.

Overall, total annual soil loss can change significantly under the different vegetation cover conditions. The variability is more pronounced across different slopes compared to the variations observed when comparing soil profiles, as illustrated in Figure 9. Such a result is to be expected, given the importance of vegetation cover in reducing erosion rates and stabilising slopes (Landloch 2013).

As derived from existing studies, an erosion rate of 5 t/ha/year at any point on the slope of the TSF has been adopted as the target acceptable erosion rate and the basis for assessment (Landloch 2013, Howard and Loch 2019). However, some studies suggest that a maximum tolerable erosion rate of 10 t/ha/year may be acceptable for mining rehabilitation (Lu 2001).

All simulations with the 70% vegetation cover have achieved the target erosion rate of ≤ 5 t/ha/year for both maximum on-slope and annual total soil loss, except for the representative final slope that exceeded the target by a marginal 0.01 t/ha/year—will within the model accuracy. No simulations exceeded the maximum tolerable erosion rate (10 t/ha/year). The median annual soil loss rate under current conditions at 70% vegetation cover is 4.5 t/ha/year, with a maximum on-slope soil loss of 0.9 t/ha/year.

For simulations with 70% vegetation cover under current slope conditions, 122 of the 126 simulations (97%) returned annual soil loss values within the 5 t/ha/year target tolerable rate, with four simulations (3%) returning annual soil loss values within the 10 t/ha/year maximum tolerable rate. When considering average maximum on-slope soil loss, all simulations returned values within the 5 t/ha/year target tolerable rate.

Overall, the information provided estimates that under current slope conditions and vegetation cover of 70%, the proposed final land use will meet the requirements outlined in the rehabilitation criteria. Given these findings, it is recommended that vegetation cover be maintained at greater than or equal to 70% under the representative future slope conditions to ensure that erosion rates remain below the target threshold. Where vegetation cover is less than 70%, there remains a chance of some level of erosional instability on the slope and excessive erosion leading to rehabilitation failure. The major factors affecting erosion of the landforms within the design considerations are the vegetation cover present, the slope length and the slope gradient.

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A1 Supporting information

Table A1: Topsoil physical properties and soil erodibility parameters.

Sample name	Silt (%)	Total sand (%)	Clay (%)	Organic matter (%)	Cation Exchange Capacity (meq/100g)	Fine gravel (%)	Inter-rill Erodibility (kg s/m ⁴)	Rill Erodibility (s/m)	Critical shear (n/m ²)	Effective Hydraulic Conductivity (mm/hr)
TS_1	15	79	4	0.35	0.7	2	7,146,300	0.005593794	7.8	37.10872902
TS_2	15	79	4	0.35	0.7	2	7,146,300	0.005593794	7.8	23.25444777
TS_3	15	79	4	0.35	1	2	7,146,300	0.005593794	7.8	23.25444777
TS_4	15	79	4	0.35	1	2	7,146,300	0.005593794	7.8	23.25444777
TS_5	15	79	4	0.6	1	2	7,146,300	0.004257642	7.8	23.25444777
TS_6	15	79	4	0.6	1	2	7,146,300	0.004257642	7.8	23.25444777
TS_7	15	79	4	1.1	2	2	7,146,300	0.002881669	7.8	23.25444777
TS_8	15	79	4	1.1	2	2	7,146,300	0.002881669	7.8	23.25444777
TS_9	15	79	4	0.8	2.3	2	7,146,300	0.003553316	7.8	23.25444777
TS_10	15	79	4	0.8	2.3	2	7,146,300	0.003553316	7.8	23.25444777
TS_11	15	79	4	1.3	22.2	2	7,146,300	0.002600982	7.8	23.25444777
TS_12	15	79	4	1.3	22.2	2	7,146,300	0.002600982	7.8	23.25444777
TS_13	2	74	13	1.6	1.8	2	7,146,300	0.002159557	7.8	23.25444777
TS_14	2	74	13	1.6	1.8	11	5,033,200	0.002159557	7.8	27.02149065

Table A2: Subsoil physical parameters.

Sample name	Subsoil layer 1 (500 mm)					Subsoil layer 2 (1,000 mm)				
	Silt (%)	Total sand (%)	Clay (%)	Organic matter (%)	CEC (meq/100g)	Silt (%)	Total sand (%)	Clay (%)	Organic matter (%)	CEC (meq/100g)
SS_1	42.4	49.5	8.1	0.35	1.8	55.7	16.5	26.8	0.35	-
SS_2	42.4	49.5	8.1	0.35	20.1	55.7	16.5	26.8	0.35	-

A2 Analogue site photographic monitoring

Analogue 1 (AS1)			
Date		Projection: WGS 84	S15.42727° E143.28488°
May 2021			
Analogue 2 (AS2)			
Date		Projection: WGS 84	S15.43290° E143.28699°
May 2021			

ALICE RIVER GOLD PROJECT

Golden-shouldered Parrot Exploration Management Plan

PREPARED FOR
Spitfire Materials Ltd

October 2018



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ALICE RIVER GOLD PROJECT
Golden-shouldered Parrot
Exploration Management Plan

INDEX

1.0	INTRODUCTION	1
1.1	SCOPE.....	1
1.2	PROJECT BACKGROUND.....	1
1.3	PROJECT LOCATION	1
2.0	ALWAL ECOLOGY	3
2.1	DESCRIPTION.....	3
2.2	DISTRIBUTION.....	3
2.3	HABITAT AND ECOLOGY.....	6
2.4	BIOLOGY AND REPRODUCTION	6
2.5	CONSERVATION STATUS.....	7
2.6	CURRENT THREATS.....	7
3.0	EXPLORATION MANAGEMENT PLAN	8
3.1	PROPOSED ACTIVITIES AND POTENTIAL IMPACTS	8
3.2	ASSESSMENT OF RISK.....	9
3.2.1	EPBC Act 1999 Significant Impact Criteria.....	9
4.0	SUGGESTED ACTIONS	17
4.1	CONTROL MEASURES	17
4.2	INCIDENTAL OBSERVATIONS	17
4.3	PROPOSED SURVEYS PRIOR TO EXPLORATION	17
5.0	REFERENCES	19

LIST OF FIGURES

Figure 1	Project Locality.....	2
Figure 2	Known and likely distribution of the Alwal.....	4
Figure 3	Records of Alwal, from the Morehead population near the EPMs.....	5

LIST OF TABLES

Table 1	Exploration Activities, Levels of Impacts During Breeding and Non-breeding Seasons	11
Table 2	Risk Assessment	12

LIST OF PHOTO PLATES

Photo Plate 1	Alwal (<i>Psephotus chrysopterygius</i>) (Source: Karl Seddon, 2016).....	3
Photo Plate 2	Alwal nesting in a conical termite mound (Source: Crowley et al. 2004).....	6

LIST OF APPENDICES

Appendix A	Alwal: Additional Ecology Information.....	A
Appendix B	Damage and Disturbances with the Potential to Produce Significant Impacts on the Alwal, and Actions Required for Avoiding, Mitigating and Restoring Adverse Impacts	B
Appendix C	Measure of Consequence, Measure of Likelihood and Risk Analysis Matrix.....	C
Appendix D	Significant Impact Criteria for Endangered species under the EPBC Act 1999	D
Appendix E	Alwal Record Tracking Form	E
Appendix F	Modelling of Alwal Nesting Habitat	F

LIST OF ABBREVIATIONS

AARC	AARC Environmental Solutions Pty Ltd
ASX	Australian Securities Exchange
BoT	Back on Track
cm	centimetre
CYPAL	Cape York Peninsula Aboriginal Land
DES	Department of Environment and Science
EPBC Act	Environment Protection and Biodiversity Conservation Act
EPM	Exploration Permit for Minerals
IUCN	International Union for Conservation of Nature
kg	kilogram
km ²	square kilometres
km	kilometres
m	metre
mm	millimetres
NA	Nesting Area
NCA	Nature Conservation Act
NS	Nest Sites
the Project	Alice River Gold Project
Spitfire	Spitfire Materials Ltd

1.0 INTRODUCTION

AARC Environmental Solutions Pty Ltd (AARC) was commissioned by Spitfire Materials Ltd (Spitfire) to prepare a Management Plan for the Golden-shouldered Parrot (*Psephotus chrysopterygius*) for the exploration phase at the Alice River Gold Project (the Project). The Golden-shouldered Parrot is called *Alwal* by the Olkola People. The name 'Alwal' will be used to refer to the Golden-shouldered Parrot throughout this report.

1.1 SCOPE

This document has been produced to provide:

- A description of Alwal habitat preferences and seasonal variations based on existing literature and database searches;
- Identify potential impacts associated with exploration activities;
- Provide management strategies and mitigation measures to avoid or minimise impact on local populations of the species; and
- Recommend maintaining a database of incidental observation to contribute to the knowledge of the local abundance and distribution of the Alwal.

1.2 PROJECT BACKGROUND

Spitfire is an emerging Australian resource company focused on the identification, exploration and development of mineral assets, including Gold and Manganese. An Australian Securities Exchange (ASX) listed company, Spitfire acquired the Alice River Gold Project in 2017 through the acquisition of Admiral Gold Limited, now a subsidiary of Spitfire.

Gold was first discovered at Alice River in 1903, and the area has undergone periodical prospecting and exploration ever since. The Project currently comprises six exploration permits for minerals (EPMs) amounting to approximately 445 square km, plus eight small mining leases (MLs) amounting to less than 1 square km. All of the significant gold mineralisation which has been identified historically is encompassed within the 8 small granted mining leases.

Spitfire Resources intends to undertake an exploration program on their Exploration Permit for Minerals (EPMs) spanning across six EPMs and will utilise this document for guidance to ensure no significant impacts are caused by exploration activities.

1.3 PROJECT LOCATION

The Project is located approximately 300 km northwest of Cairns in the southern Cape York Peninsula. The Alice River Gold Exploration Area is within the external boundaries of the Cape York United Number 1 Claim FC No QUD673/2014 and the Olkola People are the relevant native title holders for the area. The Alice River Gold Exploration Area lies within the bounds of Kimba station (Lot 47/Plan CP846855) and Alice River station (Lot 11/Plan SP266613). Figure 1 shows the location of the Alice River Gold Project.

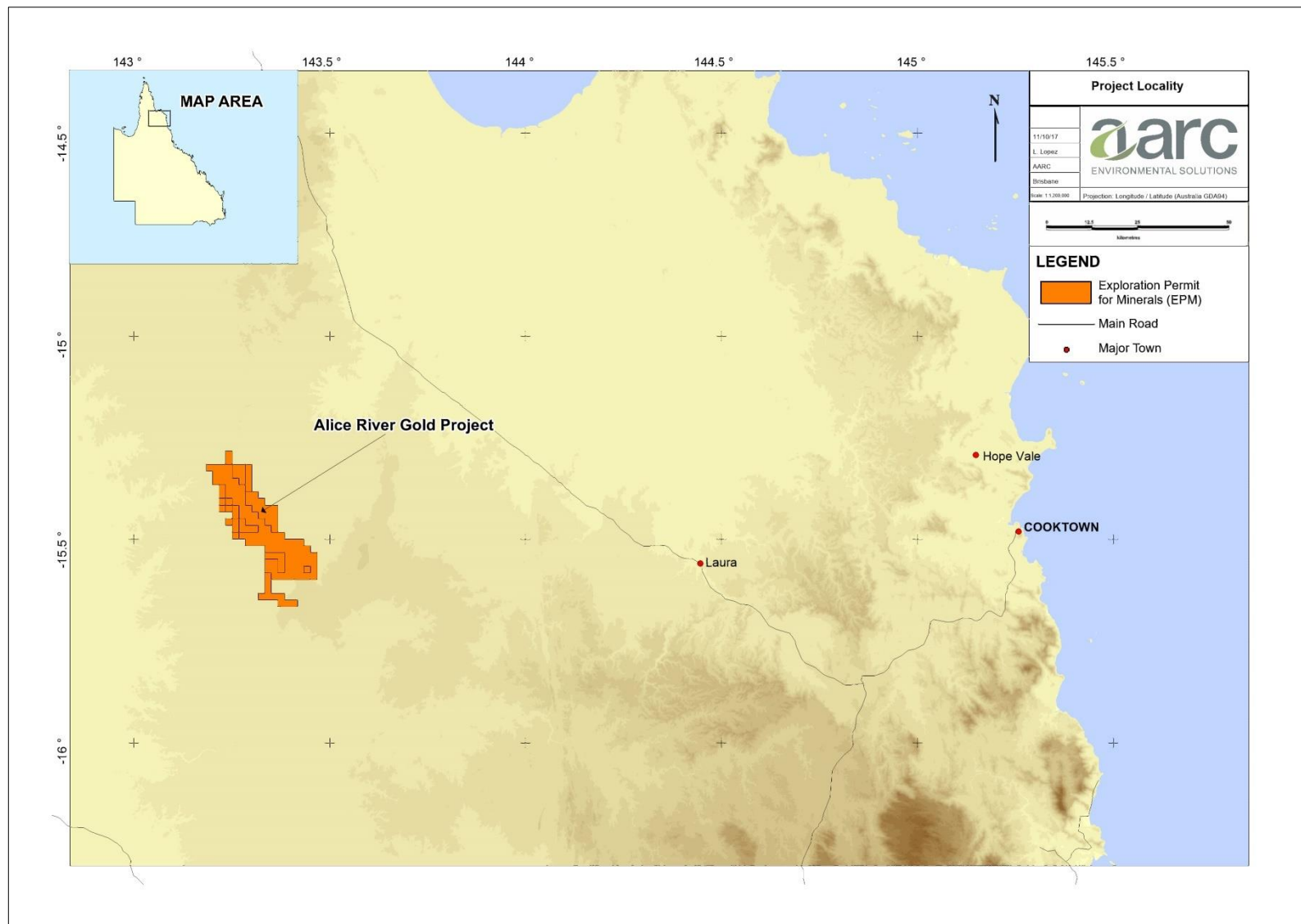


Figure 1 Project Locality

2.0 ALWAL ECOLOGY

2.1 DESCRIPTION

The Alwal is a small parrot, measuring 240-260 millimetres (mm) in length, including its long-tapered tail. The male is primarily turquoise with a salmon pink belly and bronze wings boasting a streak of bright yellow. Females and immature birds are mostly various shades of green with a turquoise rump (DES 2016). Photo Plate 1 portrays the typical female and male colouration of the Alwal.



Photo Plate 1 Alwal (*Psephotus chrysopterygius*) (Source: Karl Seddon, 2016)

2.2 DISTRIBUTION

The Alwal was reported to cover large areas of Cape York Peninsula, but is now thought to be restricted to two populations on the Peninsula, covering less than 2,000 km². The species only occurs in the southern and central Cape York Peninsula, where it has probably always been patchily distributed. The northern population is estimated at 1500 mature individuals based on 2009 surveys. The southern population is estimated at 1000 individuals based on surveys in 1999 and 2004 (DES 2016).

Figure 2 shows the location of the EPMS in relation to the known and likely distribution of Alwal (Commonwealth of Australia, 2014). Figure 3 below shows a close-up of the EPMS locations and Alwal's known and likely distribution, as well as the records of Alwal nests and sightings within the area (GBIF 2017).

Recent modelling of Alwal habitat has resulted in more accurate maps of the distribution of the northern sub-population of Alwal. Methodology used to model their habitat and distribution, and associated maps pending accreditation, are presented in Appendix F.

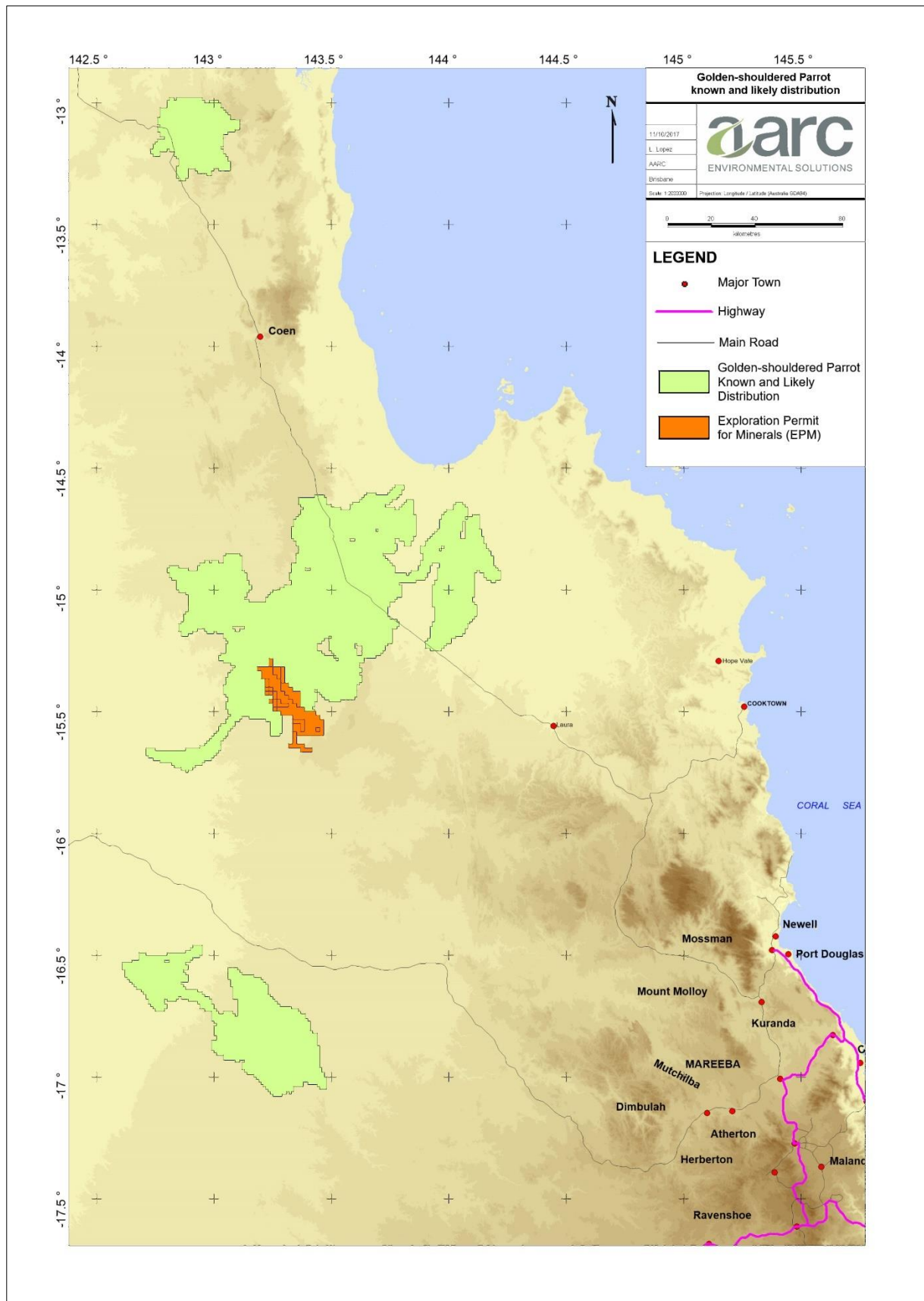


Figure 2 Known and Likely Distribution of the Alwal

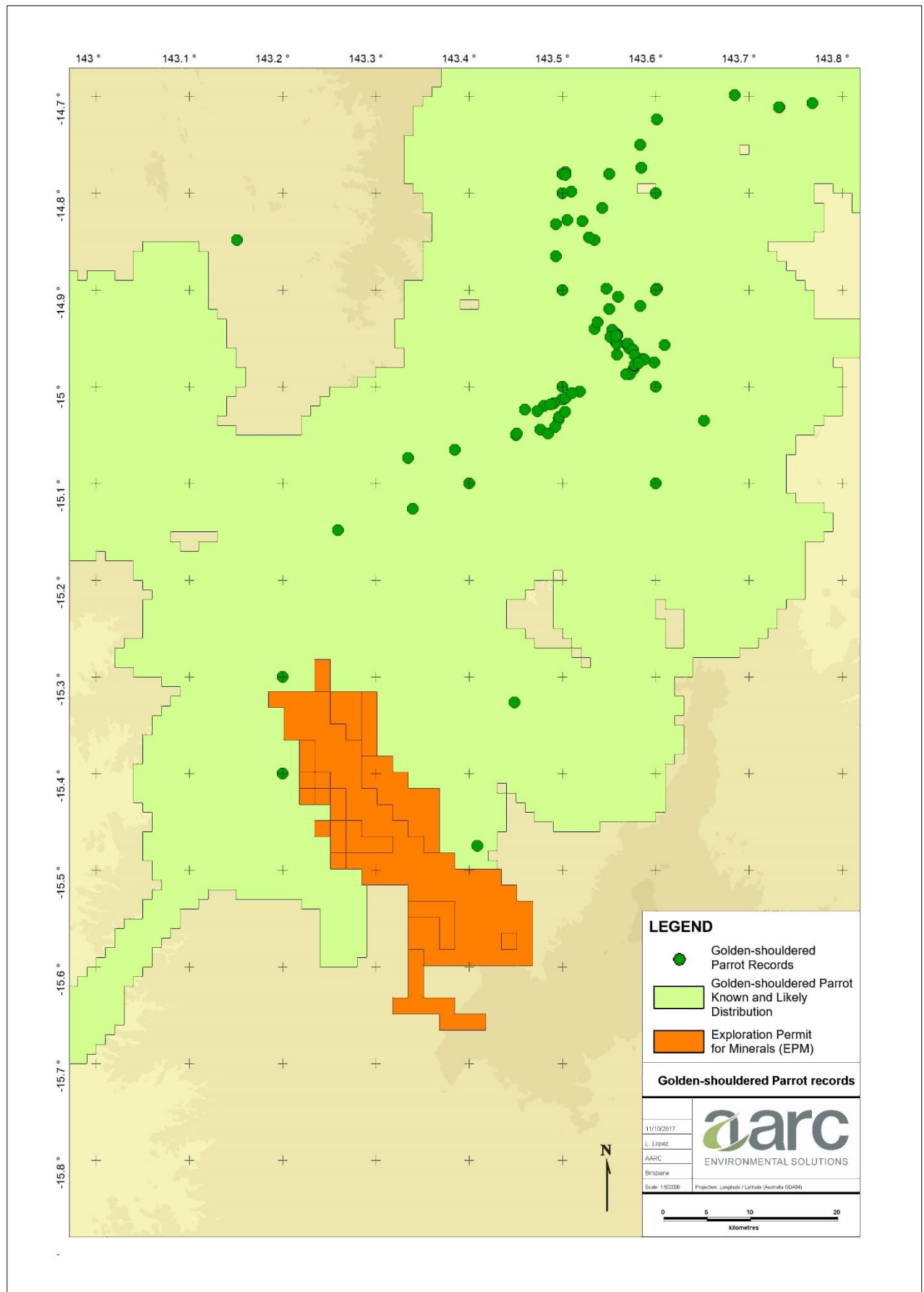


Figure 3 Alwal Records from the Morehead Population

2.3 HABITAT AND ECOLOGY

The Alwal nests in termite mounds in grassy areas within ti-tree or shiny-leafed box (*Eucalyptus chlorophylla*) savannas. There is a preference for birds to nest in conical-shaped termite mounds, also referred to as witches-hat mounds. After breeding, the bird disperses through open woodland, feeding on highly abundant seeds of Fire grass (*Schizachyrium* spp.). After the first wet-season rains, it forms flocks in association with breeding Black-faced Woodswallow (*Artamus cinereus*), so depredation by the Pied Butcherbird (*Cracticus nigrogularis*) is less likely (Crowley et al. 2004).

The species relies on grass seeds for food and open country where there is minimal cover for predators. Through the wet season the species switches foods continually, feeding through most of the daylight hours. The species is potentially limited by the availability of nest sites, as they rarely re-use the same mound once the termites have repaired the damage with tougher material, and new termite mounds are very slow to build up (Levy 2004). As mounds are usually only suitable for nesting when they are 30-50 years old, there are difficulties in some areas where most mounds of a suitable size have already been used (DES 2016).

Additional information on the ecology of the Alwal throughout the year is included in Appendix A.

2.4 BIOLOGY AND REPRODUCTION

Breeding occurs from March to June, after termites have stopped building (when the rain stops) and when plenty of green seed is available. Females lay on average five to six eggs at two-day intervals. Of the eggs, approximately 74% hatch in 20 days. Of the young hatched, approximately 65% are fully fledged in five weeks. The main reason for nest failure is predation, particularly between April and May. Re-nesting has only been observed following the failure or desertion of nests early in the breeding season (DES 2016).



Photo Plate 2 Alwal Nesting in a Conical Termite Mound (Source: Crowley et al. 2004)

2.5 CONSERVATION STATUS

The Alwal is listed as Endangered in Queensland under the *Nature Conservation Act* (NCA) 1992 and is ranked as a critical priority under the Department of Environment and Science's (DES) Back on Track (BoT) species prioritisation framework.

This species is listed as Endangered nationally, under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC), due to its restricted extent of occurrence and continued population decline as a consequence of habitat degradation causing a reduction in nest density.

The Alwal is listed as Endangered on the International Union for Conservation of Nature (IUCN) Red List as it has a very small, decreasing range, within which changes in the burning regime and the introduction of cattle to the region have resulted in a long-term population decline, which is continuing despite intensive conservation efforts.

2.6 CURRENT THREATS

The shortage of food that occurs annually in the wet season is often made worse by a lack of burning, and intense cattle and pig grazing. Altered fire patterns and grazing have also resulted in an increase in the density of woody shrubs which, it is thought, increases the vulnerability of the Alwal to predators, such as Pied Butcherbirds (*Cracticus nigrogularis*). Other threatening processes that may potentially impact the Alwal include trapping and habitat clearing.

Since European settlement, there has been a reduction in the number of intentionally lit fires and late dry season burning programs. Research suggests that this has resulted in a contraction of Alwal numbers and distribution due to alteration of habitat. Appropriate fires are required to keep the grasslands open and to promote wet season food availability. Animals such as small goannas (*Varanus* spp.) and Pied Butcherbirds predate on the eggs and nestlings of the Alwal. Once adults, the Alwal are susceptible to predation particularly in dense vegetation which provides cover for predators such as Butcherbirds. The Alwal are also particularly vulnerable to predation when feeding on the ground.

Feral Pigs (*Sus scrofa*) can cause major destruction to the land through their behaviour, which includes rooting for food, wallowing, trampling, tusking or rubbing trees, and by having a non-selective diet. These habits adversely affect birds such as the Alwal, that nest and dwell on the ground. Feral Pigs damage termite mounds, causing the loss of nesting sites and allowing the establishment of weeds that compete with these birds' preferred native food and habitat plants (DES 2016).

3.0 EXPLORATION MANAGEMENT PLAN

A comprehensive table describing how various activities may potentially have a significant impact on the Alwal, and the actions required for avoiding, mitigating and restoring adverse impacts is provided in Appendix B.

3.1 PROPOSED ACTIVITIES AND POTENTIAL IMPACTS

All activities described below will be assessed in relation to proximity to nest sites (NS) and nesting areas (NA), with consideration to the Alwal seasonality during each proposed activity.

Preliminary Activities

This includes geological mapping, traversing by foot, soil and rock sampling activities using hand-tools. All vehicle transport would use established tracks/roads.

These activities will have nil impact to the environment and Alwal habitat.

Activities Using Machinery

This includes soil augering and ground geophysical surveys, along arbitrary traverse lines. Access to the field areas will be via standard 4WD vehicles, 4WD buggies and quad bikes, traversing along arbitrary lines that run off the abundant established roads/tracks that are present in the exploration areas. Access along the traverse lines will utilise a GPS for navigation, using the best path, avoiding trees and termite mounds. No new tracks will be established as lines only need to be traversed once. Soil sampling will use an auger machine similar to a post-hole digger commonly used by landholders. The 20 centimetre (cm) diameter hole will be 1-2 metres (m) deep to sample the soil below surface. The hole will be filled in after a small 2-3 kilogram (kg) sample is taken and vegetation matter replaced on top of the small disturbed area of sampling. The traverse lines will weave through the best path, avoiding all termite mounds and larger trees.

This will have negligible impact to the environment and parrot habitat after implementing control strategies.

Drilling on Previously Disturbed Land

This involves using a drilling rig to drill a hole on a drill pad (approx. 20 x 30 m area), on land that has been previously disturbed (e.g. previous mining areas). Access to the drill pad will be via established tracks/roads. No additional disturbance of the land is involved. Earth moving equipment is only used to make the drill pad flat and safe of tripping hazards.

This has negligible impact on the environment and parrot habitat, as the land has already been previously highly disturbed and cleared. No additional disturbance is involved in this case. Some control strategies will also be implemented to ensure no impact on any parrot habitats nearby.

Drilling on New Exploration Areas

This involves making a new access track and/or a new drill pad (20 m x 30 m area) in a new area defined by the low-impact surveys such as geochemical / geophysical sampling. Established tracks/roads will be used where possible. The *Queensland Code of Environmental Compliance for Exploration and Mineral Development Projects version 1.1* will be adhered to. For new drill pads, the top soil is placed in a mound on one side and returned during rehabilitation stages after drilling.

Rehabilitation may include re-seeding of disturbed areas. The landholder retains the right to leave the area for natural regrowth or to rehabilitate utilising seeds of their choice.

Careful planning will be undertaken to reduce any impacts on the environment and Alwal habitats. These work areas will obtain Cultural Heritage Clearance and liaison with the landholder will occur. If required, an Alwal survey would be completed to reduce any impacts on potential Alwal habitats.

3.2 ASSESSMENT OF RISK

Table 1 shows the level of impacts on the Alwal that different activities have when they occur in breeding and non-breeding seasons, based on information contained in Appendix B.

A qualitative risk assessment (Table 2) was conducted to determine the degree of risk associated with various potential impacts from exploration activities to the Alwal and the effectiveness of proposed management and mitigation strategies. The aim of the assessment was to:

- Assess the likelihood and consequence, and assign an overall risk level to each identified potential impact;
- Document management and/or mitigation strategies that are proposed to address potential impacts; and
- Reduce the level of risk associated with regional assets to an acceptable level.

The likelihood and associated consequence value was determined for each potential impact associated with the exploration activities to qualify the level of risk. Tables showing the Measure of Consequence, Measure of Likelihood and Risk Analysis Matrix that have been used to produce the Risk Assessment below are included in Appendix C.

Prior to the application of control strategies, all potential impacts were assigned a low to medium risk rating. Following the application of control strategies, all risk ratings were reduced to a low rating. No high or medium risks remain for the Project's exploration activities following implementation of control strategies. Table 2 indicates the potential impacts assessed, control measures applied to reduce the initial level of risk associated with each potential impact and the residual risk rating following application of control measures.

3.2.1 EPBC Act 1999 Significant Impact Criteria

The *Significant Impact Guidelines 1.1: Matters of National Environmental Significance* (DoE 2013) define criteria for the assessment of Significant Impacts to Critically Endangered or Endangered species listed under the *EPBC Act 1999*. Significant Impact criteria on listed Endangered species under the *EPBC Act 1999* are included in this document in Appendix D.

The risk assessment in Table 2. was undertaken utilising the Significant Impact criteria from the *Significant Impact Guidelines 1.1: Matters of National Environmental Significance* (DoE2013) in conjunction with a Qualitative Threat Assessment Methodology (TSSC 2015), developed by the Threatened Species Scientific Committee, established under the *EPBC Act 1999*. Breeding season impacts apply whenever birds are undertaking breeding activities, but usually extends from March to June. Extent of Occupied Nesting Habitat is based on modelling using maximum potential extent, until nest surveys are completed to establish actual extent.

The outcome of the risk assessment is that there are no expected significant impacts to the Alwal as a result of exploration activities.

Table 1 Exploration Activities, Levels of Impacts During Breeding and Non-breeding Seasons

Activity	Relationship to Alwal Habitat Use	Season	
		Breeding	Non-breeding
Driving along made roads	All	Low	Low
Driving along established farm tracks	Within 10 m (i.e. within sight) of a current or recently used nest	Moderate (disrupt nesting behavior)	Low
	Other	Low	Low
Driving through the bush (single pass) using quad bikes and 4WD, without forming a permanent track	Within 10 m (i.e. within sight) of a current or recently used nest	Moderate (disrupt nesting behavior)	Low
	Other	Low	Low
Damage to mounds from vehicles or machinery (reducing available nest sites)	Occupied Nesting Habitat	High (desertion and habitat loss)	High (habitat loss)
Manual soil augering, ground geophysical surveys with minimal ground disturbance and minimal noise (If methods and equipment changes, a re-evaluation of the noise pollution risks is to be undertaken)	Within 20 m of a current or recently used nest	High (desertion)	Moderate (habitat degradation)
	Within 50 m (i.e. within sight) of a current or recently used nest	High (desertion)	Low
	Other	Low	Low
Operating loud machinery, including mechanised soil augers (i.e. producing noise levels at best sites that are above 80 dB)	Within 50 m of a current or recently used nest	High (desertion)	Low
	Other	Low	Low
Clearing for a 20 m x 30 m drill pad or 3 m wide access track, leaving grass roots in the ground to allow re-growth. Clearing will not impact mounds suitable for Alwal nesting	Within 50 m (i.e. within sight) of an Occupied Nest	High (desertion and temporary habitat loss)	Moderate (temporary habitat loss)
	Vegetation containing cockatoo grass which supports an ecologically dominant layer (of >25% groundcover) whilst in seed around Occupied Nesting Habitat	Moderate (habitat loss)	Moderate (habitat loss)
	Other	Low	Low
Fires lit in the early dry season	Within 100 m of an Occupied Nest	High (desertion and habitat degradation)	Moderate (habitat degradation)
	Nesting Habitat	Moderate (habitat degradation)	Moderate (habitat degradation)
	Other	Low	Low
Disposal of minor dredge or spoil, accidental spillage from vehicles, leakage from machinery etc, with successful clean up as per Environmental Obligations	Within a 100 m buffer around Occupied Nesting Habitat	High (potential poisoning)	High (potential poisoning)
	Other	Low	Low
Disposal of Major dredge or spoil, accidental spillage from vehicles, leakage from machinery etc., leading to major contamination of water supplies, including groundwater, streams and puddles.	Within a 10 km buffer around Occupied Nesting Habitat	Moderate (potential poisoning)	Moderate (potential poisoning)
	Other	Low	Low

Low = Green; Medium = Yellow; High = Red

Table 2 Risk Assessment

Source of Risk	Incident / Event	Potential Impact	No Control Strategies in Place			Control Strategies	Control Strategies in Place		
			C	L	Risk Rating		C	L	Risk Rating
Driving	Driving along established roads within the Southern Cape York Peninsula area of known Alwal habitat	Potential to spread weeds from other areas, which might affect the Alwal habitat	3	2	Low	- Thoroughly clean vehicle when traversing between different areas to help prevent weed seed transport into parrot habitats - Advise visitors to the area to clean vehicles	3	1	Low
	Driving along established farm tracks	Potential to cause some minor erosion with a potential impact on the number of mounds available for nesting	3	2	Moderate	- Stay on established tracks and do not deviate off the track - Maintain a safe working distance of 10 metres from any current or recently used nest - Zero disturbance to termite mounds (do not knock over/harm by person or vehicle)	3	1	Low
	Driving along established farm tracks in wet conditions	Potential to cause erosion with potential impact on the number of mounds available for nesting	3	2	Moderate	- Avoid driving along tracks near Alwal breeding habitat flats when they are wet and soft - Zero disturbance to termite mounds (do not knock over/harm by person or vehicle)	3	1	Low
	Putting in a new access track to new proposed drill pads (using earthmoving equipment)	Potential to cause erosion with an impact on the number of mounds available for nesting	3	3	High	- Carry out a Cultural Heritage Clearance Survey and liaise with the landholder - If required, carry out a parrot survey to reduce any impacts on potential parrot habitats - Determine where sensitive habitat areas exist - Visually inspect the area for conical termite mounds and determine if any birds are nesting during the March to June nesting season, prior to undertaking work - Maintain a safe working distance of 50 m of an Occupied Nest - Do not operate near any mound identified to have Alwal nesting - Zero disturbance to termite mounds (do not knock over/harm by person or vehicle)	3	1	Low

Source of Risk	Incident / Event	Potential Impact	No Control Strategies in Place			Control Strategies	Control Strategies in Place		
			C	L	Risk Rating		C	L	Risk Rating
		Disturbance to nesting or early wet season feeding refuges	3	3	Medium	As above	3	1	Low
Exploration activities	Manual Activities such as augering and ground geophysical surveys	Disturbance to early wet season feeding refuges for the Alwal	3	2	Low	- Utilise a GPS for navigation through the bush and avoid all trees and termite mounds - Maintain a safe working distance of 20 metres from identified current or recently used nests - Zero disturbance to termite mounds (do not knock over/harm by person or vehicle) - Do not park the vehicle in long grass to lessen the risk of starting unintentional fires in Alwal habitat - Avoid disturbance to gravel slopes and rocky hills, glimmer grass flats and open woodland vegetation as they are potential feeding sites during late dry season/early wet season, when seed is in short supply - Fill in small holes made by the auger straight after augering. - Clean up all rubbish from exploration sites and accommodation to prevent attracting feral pigs	3	1	Low
		Disturbance to nests and breeding cycle	3	3	Low	- March, April and May is the period when parrots are most sensitive to disturbance over the early breeding season. Work within eyesight (50 m) of Alwals attending to nests over the March to June period will be avoided. - Utilise a GPS for navigation through the bush and avoid all trees and termite mounds - Maintain a safe working distance of 20 metres from identified current or recently used nests - Zero disturbance to termite mounds (do not knock over/harm by person or vehicle) - Do not park the vehicle in long grass, to lessen the risk of starting unintentional fires in the parrot habitat - Do not utilise loud machinery or machinery which emits vibration sources above ambient levels near Alwal habitat during nesting season between March and June - Clean up all rubbish from exploration sites and accommodation to prevent attracting feral pigs	3	1	Low

Source of Risk	Incident / Event	Potential Impact	No Control Strategies in Place			Control Strategies	Control Strategies in Place		
			C	L	Risk Rating		C	L	Risk Rating
	Drilling on previously disturbed and cleared land	Disturbance to early wet season feeding refuges for the parrot	3	2	Low	- Avoid working in the peak wet season (January to March) where possible - If work can't be avoided in January to March, determine if any sensitive habitat areas exist nearby, by visually inspecting the area for conical termite mounds and birds prior to undertaking work - Maintain a safe working distance of 10 m from identified feeding grounds - Do not operate within 50 m of any mound identified to have Alwal nesting - Do not park the vehicle in long grass, to lessen the risk of starting unintentional fires in Alwal habitat - Avoid disturbance to gravel slopes and rocky hills, glimmer grass flats and open woodland vegetation as they are potential feeding sites during late dry season/early wet season (January) when seed is in short supply - Rehabilitate drill sites with native seeds as soon as possible (subject to landholder agreement) - Clean up all rubbish from exploration sites and accommodation to prevent attracting feral pigs	3	1	Low
		Disturbance to nests and breeding cycle	3	3	High	- March, April and May is the period when parrots are most sensitive to disturbance over the early breeding season. Work within eyesight (50 m) of Alwals attending to nests over the March to June period will be avoided. - Maintain a safe working distance from identified nesting grounds - Do not operate 50 m to any mound identified to have Alwal nestingZero disturbance to termite mounds (do not knock over/harm by person or vehicle) - Do not park the vehicle in long grass to lessen the risk of starting unintentional fires in the parrot habitat - Do not utilise loud machinery or machinery which emits vibration sources above ambient levels near Alwal habitat during nesting season between March and JuneClean up all rubbish from exploration sites and accommodation to prevent attracting feral pigs	3	1	Low

Source of Risk	Incident / Event	Potential Impact	No Control Strategies in Place			Control Strategies	Control Strategies in Place		
			C	L	Risk Rating		C	L	Risk Rating
	Clearing a new drill pad using earth moving equipment, and drilling a new drill hole	Disturbance to early wet season feeding refuges for the parrot	3	3	Medium	- Carry out a Cultural Heritage Clearance Survey and liaise with the landholder - If required, carry out an Alwal survey to reduce any impacts on potential Alwal habitat - Any work in the peak wet season (January to March) will be avoided where possible - If work can't be avoided in January to March, establish where sensitive habitat areas exist by visually inspecting the area for termite mounds and birds prior to undertaking work - Maintain a safe working distance from identified feeding grounds - Do not operate within 50 metres of any mound identified to have Alwal nesting - Zero disturbance to conical termite mounds (do not knock over/harm by person or vehicle) - Do not park the vehicle in long grass, to lessen the risk of starting unintentional fires in the Alwal habitat - Avoid disturbance to gravel slopes and rocky hills, glimmer grass flats and open woodland vegetation as they are potential feeding sites during late dry season/early wet season (usually January, but any time within eight weeks of the first heavy wet season rains) when seed is in short supply - Rehabilitate drill sites with native seeds as soon as possible (subject to landholder agreement) - Clean up all rubbish from exploration sites and accommodation to prevent attracting feral pigs	3	1	Low
		Disturbance to nests and breeding cycle	3	3	Medium	- March, April and May is the period when parrots are most sensitive to disturbance over the early breeding season. Work within eyesight (50 m) of Alwals attending to nests over the March to June period will be avoided. - Carry out a Cultural Heritage Clearance Survey and liaise with the landholder - If required, carry out a parrot survey to reduce any impacts on potential parrot habitats - Determine where sensitive habitat areas exist between March and June by visually inspecting the area for termite mounds and birds prior to undertaking work - Maintain a safe working distance from identified nesting grounds - Do not operate within 50 metres of any mound identified to have Alwal nesting - Zero disturbance to conical termite mounds (do not knock over/harm by person or vehicle) - Do not park the vehicle in long grass, to lessen the risk of starting unintentional fires in Alwal habitat - Do not utilise loud machinery or machinery which emits vibration sources above ambient levels in areas close to Alwal habitat during nesting season between March and June - Clean up all rubbish from exploration sites and accommodation to prevent attracting feral pigs	3	1	Low

Note: C – Consequence; L – Likelihood

4.0 SUGGESTED ACTIONS

4.1 CONTROL MEASURES

Spitfire Materials is committed to implementing the control measures outlined in Table 1 during its proposed exploration programs to reduce the impacts on the Alwal. For low-impact exploration activities, there will be no significant impacts on the Alwal. For any proposed higher-impact exploration activities (e.g. constructing a new track or drill pad), Spitfire will undertake Cultural Heritage and Alwal surveys (if required), to ensure that these activities have minimal impact on parrot habitats.

Spitfire will discuss all of the above with Olkola prior to an Alwal survey commencing. Landholders will be fully informed and biosecurity forms will be completed prior to entry.

4.2 INCIDENTAL OBSERVATIONS

Incidental observations of the Alwal and of their nests, identified during routine activities, will be recorded to contribute to an ongoing database. This database will be used to identify critical habitats that should not be disturbed by exploration activities during specified seasons. All records must be provided to Olkola Corporation, especially nest locations or groups of Alwal seen feeding.

Employees will be encouraged to report incidental sightings. A record tracking form is included below in Appendix E.

4.3 PROPOSED SURVEYS PRIOR TO EXPLORATION

Tinpitch's EPMs may cover a significant proportion of Alwal's northern population and contain large areas of potential nesting habitat (Appendix F). Only a small section of the EPMs have been surveyed for the parrot, therefore prior to exploration activities being undertaken, surveys within the proposed work areas are proposed to establish the extent to which this potential nesting habitat is occupied.

In order to better understand the regional distribution of Alwal within the exploration area, an assessment will be carried out within the Alice River Gold Exploration Area. This assessment will include quantification of:

- Extent and location of occupied breeding areas within the Alice River Gold Exploration Area based on nest surveys, which will assist in estimating the number of Alwal;
- Extent and location of wet season feeding habitat in areas in which mineral exploration will occur; and
- Extent and location of nesting habitat in areas in which mineral exploration will occur.

As described above, a two-week survey for Alwal nests and signs of breeding activity (scrapes in termite mounds) will be undertaken by experienced personnel from Olkola Aboriginal Land Managers (OALM) and their experienced ecologists (eg. Gay Crowley) in September – October 2018 using recognised survey techniques defined in the Department of Environment's *Survey Guidelines for Australia's Threatened Birds 2017* and the DES' *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland 2018*.

The two-week survey proposal and budget must be firstly approved by Tinpitch/Spitfire prior to commencing. All results must be provided to Tinpitch/Spitfire within four (4) weeks of completion of the survey. Future Alwal surveys may be conducted by other qualified and experienced ecologists.

All Alwal survey work in the field must abide by Queensland Government Biosecurity's regulations. Landowners on Kimba and Alice River stations must be notified a minimum of one week prior to working on these stations. In addition, a *Farm Safety Visitor Induction Form* must be completed on site, with landowners present to sign. This form is located as a hard copy at the landowner's residence. This includes vehicle, drone and helicopter surveys.

Landowners also reserve the right to accompany all field survey personnel on their property regarding the Alwal and cultural heritage surveys. All vehicles must be washed thoroughly to prevent the spread of weed seeds. The landholder reserves the right to reject vehicle access to those which do not comply with Biosecurity regulations.

All nests identified in this survey and other surveys undertaken by OALM and their experienced ecologists since 2014 will be classified as potential nest sites (NS) and the appropriate habitat within 3 km of these NS will be designated as potential Nesting Areas (NA). NS and NA will be used to make informed decisions about exploration activities and mitigation measures for the Alwal, in accordance with the risk assessment tool in Table 1 and Appendix B.

Low-impact exploration may occur within NAs in accordance with the risk assessment tool in Table 1 and Appendix B. If any high impact mineral exploration is planned within NAs, the relevant areas within the NAs will be resurveyed before these activities commence, following approval from Tinpitch. The activities will be undertaken with consideration to Table 1 and Appendix B.

5.0 REFERENCES

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Appendix A Alwal: Additional Ecology Information

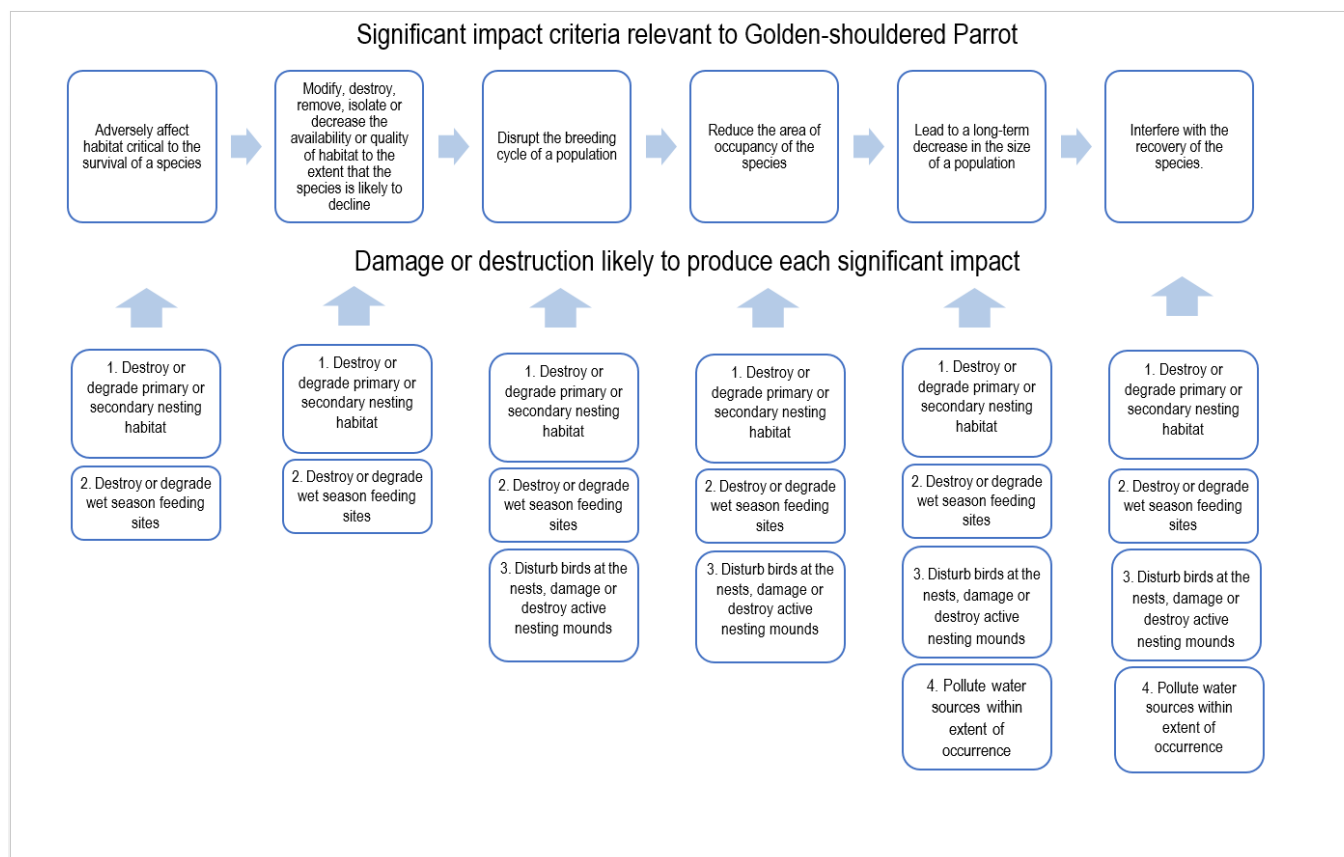
Month	Climate	Behaviour	Critical Food Sources	Frequent/Critical Habitat
January	Storm Season Early Wet Season	- Flocks associated with Black-faced woodswallows (& nests) - Mound scraping stops with onset of wet season - High juvenile mortality - Do not feed in rain / sit it out in trees (often for days at a time – mortality) - Pairing - A lot of time spend feeding (low resources and nutritional value)	- Dietary Bottleneck - burnt seed / ungerminated seed lying on rocks / broad-leaved ti-tree (growth buds & flowers) / Cooktown ironwood (new leaves) <i>Rottboellia cochinchinensis</i> (Itch Grass) <i>Hyptis suaveolens</i> (Hyptis) <i>Alloteropsis semialata</i> (Cockatoo Grass) <i>Planichloa nervilemma</i> (Glimmer grass), <i>Eriachne obtusa</i> (Early Wanderrie Grass), <i>Hybanthus enneaspermus</i> (Spade Flower), <i>Allopterigeron filifolius</i> (Parrot Daisy), <i>Aneilema siliculosum</i> (Aneilema), <i>Cartonema spicatum</i> (Cartonema), <i>Phyllanthus</i> spp. (Native Spurges), <i>Haemodorum brevicale</i> (Bloodroot), <i>Brunoniella acaulis</i> (Blue Trumpet) and <i>Heliotropium</i> spp. (Heliotrope)	- Gravel slopes & rocky hills (less inundation & germination) - Glimmer grass flats - Broad flats (Wanderrie & Sorghum Grasses) - Feeding habitat is frequently within open woodland, in association with Black-faced woodswallow nests
February	Wet Season	- High juvenile mortality - Mound scraping resumes in late February - A lot of time spent feeding (low resources and nutritional value)	<i>Alloteropsis semialata</i> (Cockatoo grass), <i>Planichloa nervilemma</i> (Glimmer grass), <i>Eriachne obtusa</i> (Early Wanderrie Grass), <i>Hybanthus enneaspermus</i> (Spade flower), <i>Allopterigeron filifolius</i> (parrot daisy), <i>Aneilema siliculosum</i> (Aneilema), <i>Cartonema spicatum</i> (Cartonema), <i>Phyllanthus</i> spp. (Native Spurges), <i>Haemodorum brevicale</i> (Bloodroot), <i>Brunoniella acaulis</i> (Blue Trumpet) and <i>Heliotropium</i> spp. (Heliotrope)Continually switch foods, feeding through most of the daylight hours	- Gravel slopes & rocky hills (less inundation & germination) - Glimmer grass flats - Sand ridges & low hills - Broad flats (Wanderrie & Sorghum Grasses) - Termite Mounds - Ideally, but not exclusively associated with Black-faced woodswallow nests - Ideally, but not exclusively with an open structure
March	Wet Season	- Nest excavation (mostly female) - Disturbance can cause nest abandonment	Continually switch foods, feeding through most of the daylight hours	- Termite Mounds - Broad flats (Wanderrie & Sorghum Grasses) - Narrow flats - Feeding habitat is frequently within open woodland, in association with Black-faced woodswallow nests
April	Late Wet Season Early Post-Wet	- Nesting / Nest excavation (mostly female) - Disturbance can cause nest abandonment	<i>Alloteropsis semialata</i> (Cockatoo Grass) <i>Sorghum plumosum</i> (Perennial Sorghum)	- Termite Mounds - Broad flats (Wanderrie & Sorghum Grasses) - Narrow flats

Month	Climate	Behaviour	Critical Food Sources	Frequent/Critical Habitat
			• Potentially <i>Chrysopogon fallax</i> (Golden-beard Grass, which is used by Hooded Parrots in the Northern Territory) • • Green legumes • <i>Schizachyrium</i> spp. (Fire Grass)	• Ideally, but not exclusively associated with Black-faced woodswallow nests
May	Post-Wet Season Early Dry Season	• Nesting / Nest excavation (mostly female) • Disturbance can cause nest abandonment	• <i>Schizachyrium</i> spp. (Fire Grass) • <i>Thaumastochloa</i> spp. (Snake Grass)	• Termite Mounds • Broad flats (Wanderrie & Sorghum Grasses) • Narrow flats • Open structure • Varied grasslands
June	Dry Season	• Nesting / Nest excavation (mostly female) • Disturbance can cause nest abandonment	• <i>Schizachyrium</i> spp. (Fire Grass) • <i>Thaumastochloa</i> spp. (Snake Grass)	• Termite Mounds • Broad flats (Wanderrie & Sorghum Grasses) • Narrow flats • Varied grasslands

Month	Climate	Behaviour	Critical Food Sources	Frequent/Critical Habitat
July	Dry Season (Early Fires)	• Nesting / Fledging • Family groups • Remain close to nest sites	• <i>Schizachyrium</i> spp. (Fire Grass) • <i>Thaumastochloa</i> spp. (Snake Grass)	• Open ground created by dry season fires • Varied grasslands
August	Dry Season (Early Fires)	• Fledging • Family groups • Remain close to nest sites • Pairing	• <i>Schizachyrium</i> spp. (Fire Grass) • <i>Thaumastochloa</i> spp. (Snake Grass)	• Open ground created by dry season fires • Varied grasslands
September	Late Dry Season (Fires)	• Family groups • Remain close to nest sites • Pairing • Flocks associated with Black-faced woodswallows	• <i>Schizachyrium</i> spp. (Fire Grass) • <i>Thaumastochloa</i> spp. (Snake Grass)	• Open ground created by dry season fires • Varied grasslands
October	Late Dry Season (Fires) Early Storm Season	• Paired adults leave groups • At first storms, begin displaying and making short scrapes in termite mounds • Flocks associated with Black-faced woodswallows (& nests)	• <i>Schizachyrium</i> spp. (Fire Grass) • <i>Thaumastochloa</i> spp. (Snake Grass) • <i>Planichloa nervilemma</i> (Glimmer Grass)	• Waterholes • Termite Mounds • Open ground created by dry season fires • Varied grasslands • Switch to Glimmer Grass flats after first heavy rain (return to fires grass during intermittent dry periods)
November	Late Dry Season (Fires) Early Storm Season	• At first storms, begin displaying and making short scrapes in termite mounds • Flocks associated with Black-faced woodswallows (& nests)	• <i>Schizachyrium</i> spp. (Fire Grass) • <i>Thaumastochloa</i> spp. (Snake Grass) • <i>Planichloa nervilemma</i> (Glimmer Grass)	• Waterholes • Termite Mounds • Open ground created by dry season fires • Varied grasslands • Switch to Glimmer Grass flats after first heavy rain (return to fires grass during intermittent dry periods)
December	Late Dry Season (Fires) Storm Season	• At first storms, begin displaying and making short scrapes in termite mounds • Flocks associated with Black-faced woodswallows (& nests)	• <i>Schizachyrium</i> spp. (Fire Grass) • <i>Thaumastochloa</i> spp. (Snake Grass) • <i>Planichloa nervilemma</i> (Glimmer Grass) • <i>Mnesithea formosa</i> (Sily-top Grass) • <i>Ischaemum decumbens</i> (Fisherman Grass) • <i>Fimbristylis</i> spp., <i>Scleria</i> spp. (Sedges)	• Waterholes • Termite Mounds • Open ground created by dry season fires • Varied grasslands • Switch to Glimmer Grass flats after first heavy rain (return to fires grass during intermittent dry periods)

Appendix B Potential Significant Impacts on the Alwal Impact
Mitigation

A conceptual framework for assessing impacts on the Alwal is shown below. This shows the types of disturbance that may potentially have significant impacts on the species; the category of potential impact and the cumulative effects of these impacts. Activities likely to produce such disturbances are described in the following table, along with advised actions for avoiding, mitigating and repairing adverse impacts. This information is incorporated into the subsequent management actions.



Nature of activities	Contributing activities	Avoidance actions	Mitigation actions	Restoration actions
Risk profile		Actions recommended to avoid adverse impacts:	Actions recommended to minimise adverse impacts:	Response to adverse impacts:
		Compliance with these actions presents minimal risk to Alwals	Compliance with these actions present moderate risk to Alwals	Necessity to implement these actions constitutes moderate to critical risk to the Alwal (depending on scale)
1. Destroy or degrade primary or secondary nesting habitat				
Clearing of nesting habitat (leading to loss of nesting habitat and associated feeding areas)	Clearing that removes potential nesting habitat (especially around conical termite mounds) and/or feeding habitat (especially Cockatoo Grass, Golden-Beard Grass and Perennial Sorghum) within 3 km of nest sites that have been occupied in the last decade (NS)	Avoid clearing potential nesting or feeding habitat within 3 km of NS. If nest surveys have not been completed, avoid clearing in modelled nesting habitat or vegetation containing conical termite mounds, Cockatoo grass, Golden-Beard Grass or Perennial Sorghum	None identified.	Rehabilitate Cockatoo Grass, Golden-beard Grass and/or Perennial Sorghum as appropriate as per Environmental Authorities EPSX04143716 and EPSX00301413. Replace termite mounds with mounds of the same species from outside currently occupied nesting habitat. Provide bird seed at supplementary feeding stations in proximity to Black-faced woodswallow nests
Erosion of nesting habitat (leading to loss of nesting habitat and associated feeding areas)	Erosion that removes potential nesting habitat (especially around conical termite mounds) and/or feeding habitat (especially Cockatoo Grass, Golden-Beard Grass and Perennial Sorghum) within 3 km of nest sites that have been occupied in the last decade (NS)	Avoid driving in wet conditions. Stay on established tracks.	Do not repeatedly drive the same off-track route. Confine any new tracks to settings and soils with a low erosion risk (especially avoiding coarse-grained granitic soils). Rehabilitate bare areas with locally sourced native grass seed as per Environmental Authorities EPSX04143716 and EPSX00301413	As per Environmental Authorities EPSX04143716 and EPSX00301413. Stabilise eroded areas using best practice methods (Shellberg and Brooks 2013)

Nature of activities	Contributing activities	Avoidance actions	Mitigation actions	Restoration actions
Vegetation thickening (leading to increased predation at nests and associated feeding areas, and deterioration and loss of termite mounds)	Fires lit in the early dry season (EDS) within 3 km of nest sites that have been occupied in the last decade	Do not light EDS fires within 3 km of NS. If nest surveys have not been completed, do not light EDS fires in modelled nesting habitat or vegetation containing conical termite mounds, <i>Melaleuca</i> spp. or <i>Asteromyrtus</i> spp.	Where EDS fires are essential for creating fire breaks, ensure different areas are burnt each year.	Reduce total grazing pressure in affected area and ensure the area is adequately secured with EDS fire-breaks to prevent fire escaping to non-target areas. Storm-burn after first heavy wet season rain. Where EDS fires are essential for creating fire breaks, ensure different areas are burnt each year.
		Do not overgraze within 3 km of NS in EDS. If nest surveys have not been completed, do not overgraze in the EDS in modelled nesting habitat or vegetation containing conical termite mounds, <i>Melaleuca</i> spp. or <i>Asteromyrtus</i> spp.	Maintain moderate grazing pressure and feral animal control	As above
	Vegetation clearance causing suckering of rootstock (particularly of <i>Melaleuca</i> spp. and <i>Asteromyrtus</i> spp.) in nesting habitat (especially around conical termite mounds) and/or feeding habitat (especially Cockatoo Grass, Golden-Beard Grass and Perennial Sorghum) within 3 km of nest sites that have been occupied in the last decade (NS)	Avoid clearing potential nesting or feeding habitat within 3 km of NS. If nest surveys have not been completed, avoid clearing modelled nesting habitat or vegetation containing conical termite mounds, Cockatoo grass, Golden-Beard Grass, Perennial Sorghum, <i>Melaleuca</i> spp. or <i>Asteromyrtus</i> spp.	None identified	Reduce total grazing pressure in affected area and ensure the area is adequately secured with EDS fire-breaks to prevent fire escaping to non-target areas. Storm-burn after first heavy wet season rain and before suckers grow to about 2 m in height. Where EDS fires are essential for creating fire breaks, ensure different areas are burnt each year.

Nature of activities	Contributing activities	Avoidance actions	Mitigation actions	Restoration actions
Grazing pressure that reduces abundance of Cockatoo Grass	Overgrazing of Cockatoo Grass in the wet season	Exclude cattle grazing in the wet season. Maintain feral animal control (pigs and horses)	Maintain moderate grazing pressure and feral animal control	Remove cattle and feral herbivores. Rehabilitate Cockatoo Grass as appropriate as per Environmental Authorities EPSX04143716 and EPSX00301413
Weed invasion that reduces availability of nesting habitat and associated feeding	Invasion of weed through transport of seeds and disturbance	None identified.	Maintain best practice hygiene of vehicles and machinery and washing down machinery on entry to each EPM, and on passing through any weed infestation within each EPM	Remove weeds and rehabilitate habitat as per Environmental Authorities EPSX04143716 and EPSX00301413
Loss or damage to termite mounds (reducing available nest sites)	Damage to mounds from vehicles or machinery	Do not operate machinery or drive vehicles within 200 m of conical termite mounds or any termite mound containing an Alwal nest	None identified	Stabilise any termite mounds that have been knocked over. If possible, replace broken parts. Replace damaged conical termite mounds with conical termite mounds from outside parrot's current distribution
	Damage to mounds from large herbivores	Maintain feral animal control	None identified	As above
	Vegetation thickening destroying termite mound habitat	See vegetation thickening	See vegetation thickening	See vegetation thickening
2. Destroy or degrade wet season feeding sites				

Nature of activities	Contributing activities	Avoidance actions	Mitigation actions	Restoration actions
Clearing of wet season feeding areas	Clearing that removes potential wet season feeding habitat (especially in vegetation containing Cockatoo Grass, Glimmer Grass, Early Wanderrie Grass, Spade flower, Parrot Daisy, Aneilema, Cartonema, Native Spurges, Bloodroot, Blue Trumpet or Heliotrope) within 5 km of nest sites that have been occupied in the last decade (NS)	Avoid clearing potential wet season feeding habitat within 5 km of NS. If nest surveys have not been completed, avoid undertaking activities which cause permanent destruction of vegetation containing Cockatoo Grass, Glimmer Grass, Early Wanderrie Grass, Spade flower, Parrot Daisy, Aneilema, Cartonema, Native Spurges, Bloodroot, Blue Trumpet or Heliotrope	None identified	Provide bird seed at supplementary feeding stations in proximity to Black-faced woodswallow nests. Rehabilitate cleared area with Cockatoo Grass, Glimmer Grass, Early Wanderrie Grass, Spade flower, Parrot Daisy, Aneilema, Cartonema, Native Spurges, Bloodroot, Blue Trumpet and Heliotrope as appropriate as per Environmental Authorities EPSX04143716 and EPSX00301413.
Grazing pressure that reduces abundance of Cockatoo Grass	Overgrazing of Cockatoo Grass in the wet season	Exclude cattle grazing in the wet season. Maintain feral animal control (pigs and horses)	Maintain moderate grazing pressure and feral animal control	Remove cattle and feral herbivores. Rehabilitate Cockatoo Grass as appropriate as per Environmental Authorities EPSX04143716 and EPSX00301413

Nature of activities	Contributing activities	Avoidance actions	Mitigation actions	Restoration actions	
Early dry season fires that suppress the abundance of wet season food plants	Fires lit in the early dry season (EDS) in potential wet season habitat (especially in vegetation containing Cockatoo Grass, Glimmer Grass, Early Wanderrie Grass, Spade flower, Parrot Daisy, Aneilema, Cartonema, Native Spurges, Bloodroot, Blue Trumpet or Heliotrope) within 5 km of nest sites that have been occupied in the last decade (NS)	Do not light EDS fires within 5 km of NS. If nest surveys have not been completed, do not light EDS fires in modelled nesting habitat or vegetation containing vegetation containing Cockatoo Grass, Glimmer Grass, Early Wanderrie Grass, Spade flower, Parrot Daisy, Aneilema, Cartonema, Native Spurges, Bloodroot, Blue Trumpet or Heliotrope	Where EDS fires are essential for creating fire breaks, ensure different areas are burnt each year	Reduce total grazing pressure in affected area and ensure the area is adequately secured with EDS fire-breaks to prevent fire escaping to non-target areas. Storm-burn after first heavy wet season rain, making sure that individual fires do not exceed 500 m ²	
Vegetation thickening (leading to increased predation at wet season feeding areas)	Fires lit in the early dry season (EDS) in potential wet season habitat (especially in vegetation containing Cockatoo Grass, Glimmer Grass, Early Wanderrie Grass, Spade flower, Parrot Daisy, Aneilema, Cartonema, Native Spurges, Bloodroot, Blue Trumpet or Heliotrope) within 5 km of nest sites that have been occupied in the last decade (NS)	Do not light EDS fires within 5 km of NS. If nest surveys have not been completed, do not light fires in the EDS in modelled nesting habitat or in vegetation containing <i>Melaleuca</i> spp. or <i>Asteromyrtus</i> spp.	As above	As above	

Nature of activities	Contributing activities	Avoidance actions	Mitigation actions	Restoration actions
	Overgrazing of potential wet season habitat (especially in vegetation containing Cockatoo Grass, Glimmer Grass, Early Wanderrie Grass, Spade flower, Parrot Daisy, Aneilema, Cartonema, Native Spurges, Bloodroot, Blue Trumpet or Heliotrope) within 5 km of nest sites that have been occupied in the last decade (NS), especially in the EDS before perennial grasses become dormant	Do not overgraze within 5 km of NS in EDS. If nest surveys have not been completed, do not overgraze in the EDS in modelled nesting habitat or vegetation containing <i>Melaleuca</i> spp. or <i>Asteromyrtus</i> spp.	As above	As above

Nature of activities	Contributing activities	Avoidance actions	Mitigation actions	Restoration actions
	Vegetation clearance causing suckering of rootstock (particularly of <i>Melaleuca</i> and <i>Asteromyrtus</i> spp.) in potential wet season habitat (especially in vegetation containing Cockatoo Grass, Glimmer Grass, Early Wanderie Grass, Spade flower, Parrot Daisy, Aneilema, Cartonema, Native Spurges, Bloodroot, Blue Trumpet or Heliotrope) within 5 km of nest sites that have been occupied in the last decade (NS)	Do not clear potential nesting or feeding habitat within 5 km of NS. If nest surveys have not been completed, do not clear modelled nesting habitat or vegetation containing <i>Melaleuca</i> spp. and <i>Asteromyrtus</i> spp.	None identified	Reduce grazing pressure in affected area and ensure the area is adequately secured with EDS fire-breaks to prevent fire escaping to non-target areas. Storm-burn after first heavy wet season rain and before suckers grow to about 2 m in height. Where EDS fires are essential for creating fire breaks, ensure different areas are burnt each year
3. Disturb birds at the nests, damage or destroy active nesting mounds				
Desertion of or damage to active nests	Desertion of or damage to nests caused by clearance of habitat containing one or more active nests	Do not clear habitat within 1 km of an active nest. If nest surveys have not been completed, do not clear in modelled nesting habitat or vegetation containing conical termite mounds. If active nests are found after clearance has commenced, cease clearance and leave area. Do not resume clearance within 1 km of identified/deserted nest	None identified	If active nests are damaged or deserted during vegetation clearance, cease clearance and leave area. Do not resume clearance within 1 km of identified/deserted nest

Nature of activities	Contributing activities	Avoidance actions	Mitigation actions	Restoration actions
	Desertion of or damage to nests caused by machinery operation close to one or more nests	Do not operate machinery within 200 m of a potentially active nest. If nest surveys have not been completed, minimise driving in modelled nesting habitat or vegetation containing conical termite mounds. If active nests are found, leave area. Do not return to or resume operation within 200 m of identified nest until nest has fledged or (if fledging has not been confirmed) the end of nesting season.	Monitor and manage noise, vibration and dust per Environmental Authorities EPSX04143716, EPSX00301413, <i>Environmental Protection Act</i> 1994 and <i>Environmental Protection (Noise) Policy</i> 2008. Use low-noise generating machinery. Undertake appropriate measures to ensure noise levels at nests do not increase above ambient levels (Brumm 2004), such as installing sound-abatement panels, adding baffling around the drill, installing high-efficiency mufflers.	If active nests are damaged or deserted during machinery operation, cease operating and leave area. Do not return to within 1 km of damaged or deserted nest until the end of nesting season.

Nature of activities	Contributing activities	Avoidance actions	Mitigation actions	Restoration actions
	Desertion of or damage to nests caused by fire	As above. Implement measures to ensure fires are not lit, including disposing of cigarette butts in appropriate receptacles, using appropriate and well-maintained spark-arresting mufflers on fuel-powered equipment, restricting heat-generating work (such as welding and soldering) to areas with low fire risk and to when a person is available to maintain vigilance during such work and for a period of at least 30 min after all such work has been completed. Carry appropriate fire-fighting equipment, including a fire extinguisher, water tank and fire hose	None identified	If a fire is started, extinguish it using the fire-fighting equipment. Move combustible and flammable material out of the area. Ensure fire is extinguished and leave area. Do not return to within 1 km of damaged or deserted nest until the end of nesting season

Nature of activities	Contributing activities	Avoidance actions	Mitigation actions	Restoration actions
	Desertion of or damage to nests caused by human interference	Do not walk or drive within 50 m of a potentially active nest. If active nests are found ,leave area, and do not return to within 100 m of identified nest until nest has fledged or (if fledging has not been confirmed), at the end of nesting season. If active nests are damaged or deserted as a result of human interference, leave area and do not return to within 1 km of deserted nest until the end of nesting season	None identified	None identified
	Desertion of or damage to active nests by large herbivores	Maintain feral animal control	None identified	None identified
4. Pollute water sources within extent of occurrence				
Pollutants contaminating water supplies including groundwater, streams and puddles	Disposal of dredge or spoil, accidental spillage from vehicles, leakage from machinery etc.	As per Environmental Authorities EPSX04143716 and EPSX00301413. Maintain best practice operational and maintenance practices to avoid pollution (Department of Industry, Innovation and Science, 2018)	Undertake best practice site cleaning practices (Department of Industry, Innovation and Science, 2018)	Ensure that spills of hazardous contaminants are cleaned up as quickly as practicable. Do not clean up by hosing, sweeping or otherwise releasing contaminants to any watercourse, waterway, groundwater, wetland or lake. Alert authorities of any contamination as required under the <i>Environment Protection Act 1994</i>

Appendix C Measure of Consequence, Measure of Likelihood
and Risk Analysis Matrix

Measure of Consequence

Consequence	Insignificant 1	Minor 2	Moderate 3	Major 4	Critical 5
Impact on population ³	Minimal impact on local population numbers; area affected negligible compared to total population; minimal or acceptable impact on population size	Minor impact on local population numbers. Population in other locations not impacted	Moderate impact on local population numbers. Some impacts on populations in other locations; moderate and/or short term effects	Major population reduction or loss of local population; recovery measure in years to decades; serious and significant impact on species	Population reduction which may result in species extinction; recovery period is greater than decades; very significant and serious impact on high value species
Fragmentation of habitat/loss of habitat connectivity/reduce the areas of occupancy ⁴	Minimal losses of local habitat only, recovery likely in a relatively short period of time; threats are covered by current management or legislation	Minor losses of local habitat requiring recovery over short term	Moderate loss of local habitat requiring recovery over a short to medium term and resulting in loss of connectivity between habitats at a local scale	Loss of local habitat with no potential for recovery, or partial loss of habitat across large areas and/or with limited potential for recovery in the medium to long term. Results in a net reduction in connectivity over a large area	Complete loss of local habitat with no potential for recovery and loss of habitat in other locations with limited potential for recovery in the long term resulting in a significant impact on habitat connectivity over a large area
Impact on the habitat critical to the survival of the species ⁵	Minimal modification, destruction, removal or decrease of local habitat only, recovery likely in a relatively short period of time; insignificant impact to habitat or threat activity only occurs in a very small areas of habitat; limited damage to minimal area of low significance; minor effects on physical environment	Minor modification, destruction, removal or decrease of local habitat requiring recovery over short term	Moderate modification, destruction, removal or decrease of local habitat requiring recovery over a short to medium term and resulting in loss of connectivity between habitats at a local scale	Modification, destruction, removal or loss of local habitat with no potential for recovery, or partial loss of habitat across large areas and/or with limited potential for recovery in the medium to long term. Results in a net reduction in connectivity over a large area; habitat is affected which may endanger the species and habitat long term survival – 70-90% habitat affected or removed; 30% fragile habitat affected or removed; 10-20% critical habitat affected or removed;	Significant impact resulting in the removal, destruction, fragmentation and degradation of habitat; the entire habitat is in danger of being affected or removed, that >90% habitat, >50% fragile habitat, and >30% critical habitat
Disruption to breeding cycle ⁶	Minimal impact on any aspect of the breeding cycle;	Minor disruption to the breeding cycle	Moderate disruption to breeding cycle resulting in modification of behaviour both within the direct impact zone and at nearby locations; long term recruitment and/or population dynamics are not adversely impacted	Direct impacts on breeding cycle resulting in a net decline in size of the population; the is limited information to judge the impact	Complete disruption of breeding cycles over several seasons with significant population decline and possible extinction
Impact of invasive species and/or disease ⁷	Minimal impact on local population numbers or habitat quality	Minor impact on local population numbers or habitat quality. Population in other locations not impacted	Moderate impact on local population numbers or habitat quality. Some impacts on populations in other locations	Major population reduction or loss of local population or loss of habitat quality	Population reduction which may result in species extinction loss of critical habitat extent or quality
Interaction with species migration	Minimal impact on species migratory patterns	Results in minor behavioural modification on a local scale or impacts to physical conditions of animal interfering with migration for the short term only. Unlikely to negatively impact on the overall success of migration	Results in modification of behaviour or animal conditions such that there is potential for medium term impacts, with some possibility of individuals failing to complete migration	Results in modification of behaviour or animal condition such that there is potential for medium to long term impacts, both locally and in nearby locations, with some individuals failing to complete migration	Significant impact resulting in either complete failure, or failure of majority of individuals, to complete migration in that cycle

Source: *Qualitative Threat Assessment Methodology*, Threatened Species Scientific Committee (2015) ³Refers to the proportional changes to the numbers of individuals; change in the size of the population; ⁴ Refers to the physical destruction of the species habitat and/or chemical or physical barriers; ⁵Refers to species habitat resource includes modify, destroy, isolate or decrease the availability or quality of habitat ; ⁶Breeding cycle including activities associated with breeding (mating, gestation, nesting). Assessment assumes that the species is present in the affected area during the breeding cycle; ⁷Refers to the invasive species that is harmful to the species becoming established in the species habitat and introduced disease that may cause the species to decline

Measure of Likelihood

Score	Likelihood	Descriptor
1	Rare	The outcome is not expected to occur; no record of occurring but not impossible; may occur in exceptional circumstances
2	Unlikely	The outcome will only occur in a few circumstances; uncommon but know to occur elsewhere
3	Possible	The outcome may occur; some evidence to support it will happen
4	Likely	The outcome will occur in most circumstances
5	Almost certain	The outcome is expected to occur

Source: *Qualitative Threat Assessment Methodology*, Threatened Species Scientific Committee (2015)

Risk Analysis Matrix

Likelihood	Consequence				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Critical 5
Almost Certain	Low	Medium	High	Severe	Severe
Likely	Low	Medium	Medium	High	Severe
Possible	Low	Low	Medium	High	Severe
Unlikely	Low	Low	Low	Medium	High
Rare	Low	Low	Low	Medium	High

Source: *Qualitative Threat Assessment Methodology*, Threatened Species Scientific Committee (2015)

Appendix D Significant Impact Criteria for Endangered species
under the EPBC Act 1999

Significant Impact criteria on listed Endangered species under the *EPBC Act 1999*

The *Significant Impact guidelines 1.1: Matters of National Environmental Significance* (DoE 2013) define significant impact criteria for the assessment of impacts to Critically Endangered or Endangered species listed under the *EPBC Act 1999*. The Guidelines state that an action is likely to have a significant impact on a Critically Endangered or Endangered species if there is a real chance or possibility that it will:

- *Lead to a long-term decrease in the size of a population;*
- *Reduce the area of occupancy of the species;*
- *Fragment an existing population into two or more populations;*
- *Adversely affect habitat critical to the survival of a species;*
- *Disrupt the breeding cycle of a population;*
- *Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;*
- *Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat;*
- *Introduce disease that may cause the species to decline; or*
- *Interfere with the recovery of the species.*

Appendix E Alwal Record Tracking Form

Date	Observation (Circle: Parrot/Nest)	Colour	Number of parrots	Location (GPS coordinates – GDA94 54K)	Habitat (specify if the parrot was on the nest)
	P / N				
	P / N				
	P / N				
	P / N				
	P / N				
	P / N				
	P / N				
	P / N				
	P / N				

Appendix F Modelling of Alwal Nesting Habitat

Appendix F

Modelling of Alwal (Golden-shouldered Parrot) nesting habitat in the northern sub-population and importance of Alice River Gold exploration areas

Gabriel Crowley¹

August 2018

Firescape Science Pty Ltd



OLKOLA
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Executive Summary

The Golden-shouldered Parrot (*Psephotus chrysopterygius*) is a unique and colourful bird that nests in termite mounds and is found only on Cape York Peninsula. The species is known as *Alwal* to the Olkola people, to whom it is an important totem, and this name is used throughout this report. Alwal is also important to other Indigenous people on Cape York Peninsula, as well as to other land managers. Birdwatchers from around the globe visit Cape York Peninsula in the hope of glimpsing this beautiful parrot. Alwal has been listed as Endangered in Queensland and Australia since at least the early 1990s, and much research and management to support the species' recovery has been undertaken over the last four decades.

This report provides an assessment of the importance of the Alice River Gold Exploration Area to the Alwal's nesting habitat in the northern sub-population. It will inform further management and research efforts relating to the persistence and recovery of the species as a whole.

Modelling of Alwal habitat for the northern sub-population was based on nest survey data collected by Artemis station, Olkola Aboriginal Land Managers and Bush Heritage Australia, and included 1,194 verified nest locations. The following assumptions (supported by field observations where appropriate) were made when calculating the estimates:

- Nest survey data provide a good indication of Alwal's population size and extent
- Adult parrots remain within 3 km of the nest while breeding, and all parrots remain within 20 km of nesting habitat in the non-breeding season
- Survey effort was adequate to identify desertion of nesting territories only in the northern part of the northern sub-population. The size and extent of the remainder of the northern sub-population were therefore based on results of surveys undertaken since 1992. Therefore, 'occupied' nests in well-surveyed areas included those identified between 2010 and 2018, and moderately-surveyed areas included nests identified from 1992 onwards.

Maxent modelling was used to rate the suitability of nesting habitat for all areas within 50 km of nest sites located in the northern population since 1990. Habitat suitability ratings (p-scores) were generated by intersecting known nests in relation to geology, vegetation, terrain roughness and drainage pattern data layers. Maxent-generated p-scores of verified nest sites recorded since the 1970s, were divided into three groups: (i) nests within the top 60 percentile of p-scores were used to define primary habitat; (ii) nests with the next highest 20 percentile were used to define secondary habitat; and (iii) nests ranked in the lowest 20 percentile of p-scores were considered to occur in marginal habitat. This p-score classification was then applied across the study area to identify primary, secondary and marginal nesting habitat.

Three classes of nesting habitat extent were identified: (1) Minimum extent of nesting habitat was identified based on the assumption that all occupied nesting territories are occupied, and so included a 3 km-buffer around all 'occupied' nests; (2) minimum potential estimates assumed suitable habitat within a concave hull drawn around buffered 'occupied' nests would also be occupied; (3) maximum potential nesting habitat was identified by extending the minimum potential nesting habitat to include adjacent areas with high densities of modelled potential nesting habitat, in areas that have not yet been surveyed. Further surveys are required to determine the extent to which modelled potential nesting habitat is occupied by Alwal.

At the time of assessment, the Alice River Gold Exploration Permit for Minerals (EPM) area included six EPMs awarded to Tinpitch Pty Ltd: EPM 16301, 15359, 15360, 14313, 15409, and 26266. The relative importance of these areas was determined by intersecting them with each modelled estimate of primary and secondary nesting habitat. The results are summarised below.

Summary table of the importance of Alice River Gold Exploration Area to the northern Alwal population
Source: Olkola Aboriginal Corporation

	Primary nesting habitat		Secondary nesting habitat		Adult population	
	(km ²)	(%)	(km ²)	(%)	(no. birds)	(%)
Known nest sites	33.9	6.9	22.4	7.5	48	7.1
Known and minimum potential nesting habitat	55.1	8.2	38.3	9.2	79	8.5
Known and maximum potential nesting habitat	118.7	13.3	79.3	14.8	168	13.7

Using Maxent modelling to estimate potential habitat suitability in areas that have not been surveyed for Alwal nests, Tinpitch EPMs may contain up to 119 km² of primary Alwal nesting habitat, and 79 km² of secondary nesting habitat (Figure 9, Figure 10, and Table 4, Table 5). The lower estimate includes all habitat within the known extent of nesting habitat, as defined by drawing a concave hull around known nesting territories. The northern limits of this population are well established, whereas the southern limits (which includes most of Tinpitch's EPMs) are unclear, so the maximum estimates include unsurveyed areas to the south of the known extent of nesting habitat.

Using nest densities from reference areas¹, Tinpitch's EPMs may support between 23 and 80 Alwal nesting territories and between 48 and 168 adult birds. This represents between 7.1% and 13.7% of the northern population of GSP (Table 3, Table 5).

Surveys are required to establish these limits and clarify the relative importance of the EPMs to the northern population of Alwal. However, even the lowest estimate constitutes a significant percentage of the Alwal's northern population, so that any adverse impact on these birds may negatively affect the species' recovery if no management or mitigation strategies are implemented by mineral explorers, graziers and other land users.

The Alwal's range may be contracting, with the desertion of about 500 ha of primary nesting habitat on Artemis and Dixie stations since 2010, although further field studies on distribution need to be completed. To date, once Alwal have been lost from an area, there has been no evidence of any recolonisation by the species.

In the the Alwal's northern sub-population, surveys to determine extent of nesting activity (and therefore population size) are still required in large parts of the parrot's Area of Occupancy (AOO). These areas (mainly in the southern parts of Killarney and on Alice River station, and south of Alwal National Park) are the highest priority for surveys.

Modelling also identified substantial areas of potential nesting habitat to the south and southwest of the mapped AOO. These are on Alice River Station, on and east of Killarney, and in the northwestern section of Kimba. These areas should be surveyed before any developments that might cause significant impacts to the species are undertaken.

Tinpitch's EPMs are in the section of the Alwal's distribution that is furthest from the population's retreating edge, so is likely to be part of the species' most secure habitat. Hence its relative importance is likely to increase with time. Any loss of nesting habitat as a result of clearing may be irreversible, and therefore may potentially represent a significant impact on the species by disrupting breeding cycles of the overall population or lead to a long-term decline in the population size (DoE 2013).

¹ In well-surveyed reference areas on Artemis station in the 1990s, primary habitat (defined as habitat containing 60% of mapped Alwal nests) had a nest density of 0.38 nests/km²/year, and secondary habitat (20% of nests) had a density of 0.24 nests/km²/year. A further 20% of nests were found in other habitat.

Table of Contents

Executive Summary..... iii

 List of Tablesvii

 List of Figuresvii

 Acknowledgements and disclaimer.....vii

Disclaimerviii

Introduction 9

 Overview of methods 9

 Assumptions 9

 Data management and statistical analysis.....10

 Nesting habitat suitability modelling10

 Nesting habitat extent.....21

References30

List of Tables

Table 1. Locations of golden-shouldered parrot nests in relation to mapped Regional Ecosystem units in the northern sub-population	15
Table 2. Relative contributions of the environmental variables to the Maxent model for the northern study area	20

List of Figures

Figure 1. Survey effort across known extent of Alwal's nesting distribution.....	10
Figure 2. Study areas for nesting habitat modelling for the northern sub-population.....	11
Figure 3. Distribution of Alwal nests in relation to environmental parameters for the northern and sub-populations	14
Figure 4. Data layers used in modelling nesting habitat for the northern sub-population: (a) rock type, (b) regional ecosystems, (c) distance from water, (d) drainage density and (e) terrain roughness.....	16
Figure 5. Data layers used in modelling nesting habitat for the southern sub-population: (a) rock type, (b) regional ecosystems, (c) distance from water, (d) drainage density and (e) terrain roughness.....	17
Figure 6. Contribution of environmental variables to the Maxent model of nesting habitat suitability in the northern study area.....	19
Figure 7. (a) Sensitivity curve and (b) omission curve for Maxent model of nesting habitat suitability in the northern study area.....	20
Figure 8. Habitat model output for the northern study area, recoded to show suitability of nesting habitat, classified as primary, secondary and marginal habitat. Source: Olkola Aboriginal Corporation.....	22

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Disclaimer

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Introduction

The Golden-shouldered Parrot *Psephotus chrysopterygius* is an important totem for the Olkola people, who refer to the bird as *Alwal*, and this name is used throughout this report. Alwal once occurred through much of the savanna lands of Cape York Peninsula, but is now restricted to two populations (Garnett & Crowley 1999a). The largest population is almost completely restricted to Olkola lands. These lands are now being managed primarily for the Alwal's conservation. This report identifies potential nesting habitat for the Alwal's northern sub-population and assesses its importance to the Alice River Gold Exploration Area in order to inform management for the species' recovery.

Overview of methods

Alwals nest in termite mounds on open grassy drainage depressions, with the adult birds feeding within a 3 km radius of the nests and young remaining with their parents within about 2 km of the nest for the first six weeks after fledging (Garnett & Crowley 2002). Nesting pairs are territorial, and those that survive between breeding seasons return to the same nesting territory each year. Therefore the extent of nesting territory reflects the species' population size. Since the 1990s, presence and density of nests has been used to locate breeding birds and estimate population size (Garnett 1995; Garnett & Crowley 1995a, c, b, 1998, 1999b; Crowley *et al.* 2004). Active or recent nests (which are built in conspicuous terrestrial antbeds (Weaver 1982)) provide a reliable indication of the species' presence in an area. This analysis therefore used nest surveys from the last four decades as a basis for assessing the Alwal' population parameters

Assumptions

Calculation of the population parameters were based on the spatial extent of nesting areas deemed to be 'occupied' in the current decade. However, survey effort in the current decade was sufficient to confirm the species' absence from current records alone, only in well-surveyed areas (surveyed at least three times in the current decade) in the northern part of the northern population (Figure 1). Elsewhere, absence of records could not be assumed to indicate absence of nests, so all nesting areas located since the 1990s were considered to be still occupied. Hence, 'occupied' nests in well-surveyed areas included only the nests found in the current decade, and – in moderately-surveyed areas – included all nests recorded since 1992. For the purpose of this assessment, unsurveyed areas were assumed to contain no active nesting habitat.

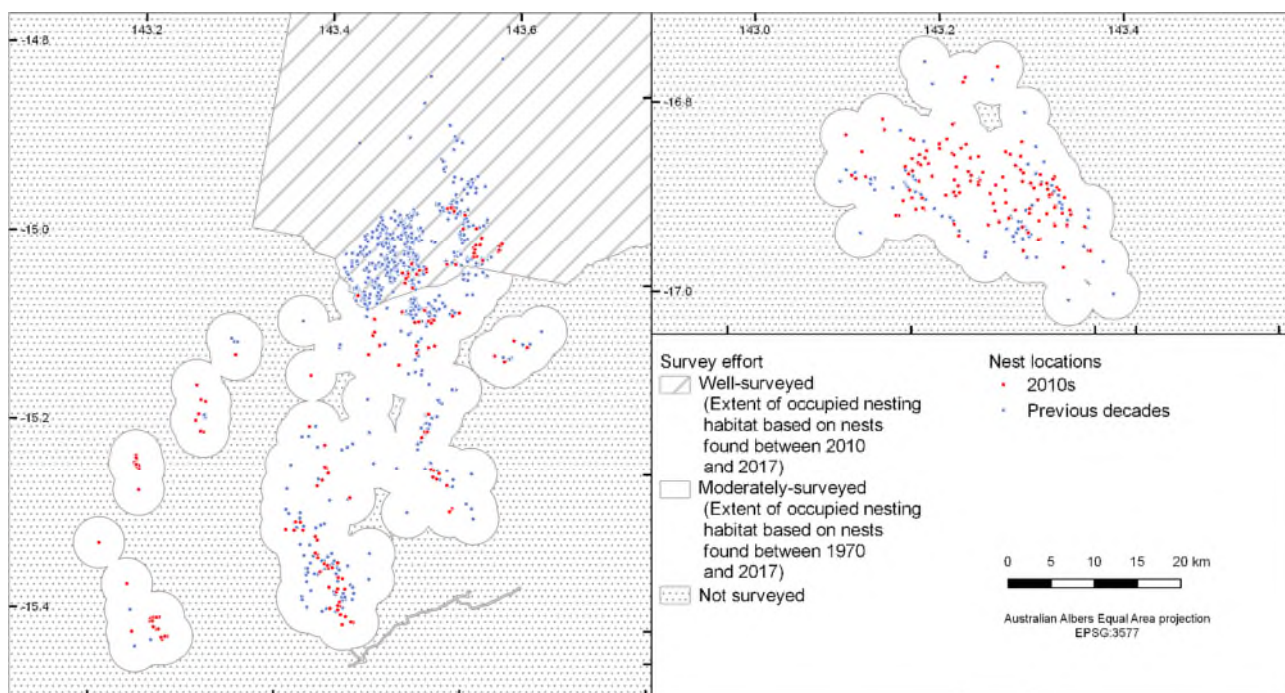


Figure 1. Survey effort across known extent of Alwal's nesting distribution

Another assumption that needs to be made to calculate population parameters is that the full extent of nesting is known. However, it was not possible to know whether or not nests were present in unsurveyed areas (Figure 1). Therefore this report provides a lower estimate that is based on only recorded nests, and an upper estimate that includes all potential nesting habitat within the species' known nesting extent, regardless of whether or not nests have been recorded there.

Data management and statistical analysis

Nest location data were compiled in Microsoft Excel, exported to text files and imported into Quantum GIS. All mapping and analysis was undertaken in QGIS (64 bit), versions 2.18 and 3.0 (Queensland Herbarium 2016; Quantum GIS Software 2017). All area calculations were undertaken in Australian Albers Equal Area projection (EPSG:3577). Details specific to the calculation of individual population measures are included in the relevant section of this report.

Nesting habitat suitability modelling

Methods

When the full extent of nesting territories within an area is not known, it can be estimated using modelling based on the environmental characteristics at known nests. Maxent is the most commonly used model for this purpose (Phillips *et al.* 2006), as it can predict species' occurrence based on confirmed presence

records alone, and it has been found to be the most accurate of easily-accessible models (Hernandez *et al.* 2006). This assessment therefore uses Maxent modelling to estimate the extent of nesting habitat within the Area of Occupancy (AOO) of each sub-population.

Extents

Modelling of nesting habitat was based on verified nest records that had reliable precision and accuracy (i.e. recorded using a GPS or plotted to within 100 m on a topographic map) spanning the period from 1992 to 2017. This included 1,187 verified nest locations for the northern sub-population and 259 nest locations for the southern sub-population. A rectangular study area was created for each sub-population in QGIS covering an area that included all nest locations buffered by 50 km (Figure 2). Nest locations from 1997 in the northern sample area were not accurate enough to be included in the identification of habitat characteristics. However, the study area still provided a 40 km buffer around these nests, and they were included in later analysis.

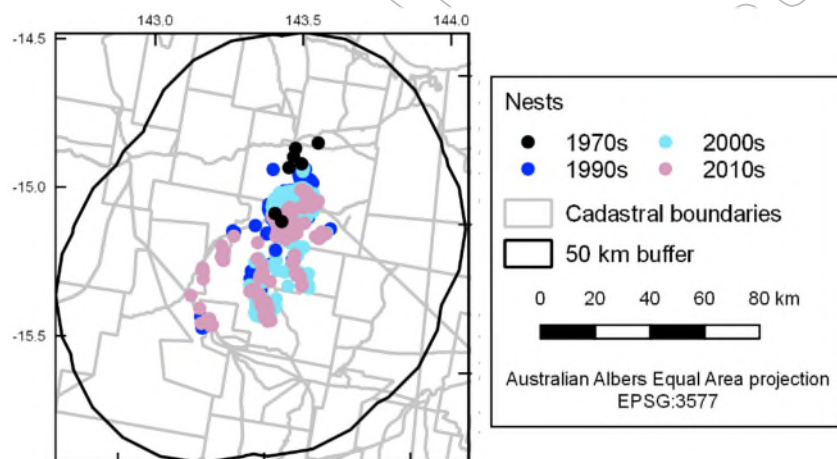


Figure 2. Study areas for nesting habitat modelling for the northern sub-population

Selection of model parameters

Most Maxent modelling is based on – or includes – climatic variables (components of temperature and rainfall regimes) (Warren & Seifert 2011), and such parameters have been used to roughly predict the extent of the Alwal's distribution before its decline (Glasco *et al.* 1995; Environmental Resources Information Network 2013). However, given the low level of climatic variability through the species' range and the Alwal's dependence on drainage and vegetation features that are more related to topography than to climate, bioclimatic modelling is unlikely to be able to predict either the parrot's current AOO or its habitat use within this AOO. Bioclimatic modelling therefore has limited use for estimating population size.

Risk of exposure to cold during the nesting season (Apr-May) may determine the species' southern limit as brooding of young stops a few days after hatching (Garnett & Crowley 1995c). Pattern of rainfall – being strongly seasonal, but fairly reliable – is more important than are annual rainfall totals, which have a broad range. Moreover, pattern of rain at the start of the season (Nov-Jan) is most favourable to the species when it starts with scattered storms that do not germinate all the seed in one event (Crowley & Garnett 1999) and so initiates production of new grass seeds at different times in different places, providing food for the Alwal over an extended period (Crowley & Garnett 2001; Crowley *et al.* 2004). Such a patchy start to a reliable wet season characterises the tropical savanna climatic zone (Dick 1975; Garnett & Williamson 2010).

The Alwal's environmental requirements are narrowest through the breeding season, when the adults build nests in antbeds (mounds of the termites *Amitermes scopulus* or *Amitermes laurensis*) that occur on open grassy drainage depressions that flood during the wet season (Weaver 1982). The adults must find enough food close-by to raise their chicks, and confine their feeding to within a 3 km radius of the nests (Garnett & Crowley 2002). Long periods of flooding across extensive areas, which can submerge food supplies, drown perennial grasses and destroy termite colonies (Dangerfield *et al.* 1998; Capon & Brock 2006; James *et al.* 2007), are likely to be disadvantageous to the Alwal. Hence the species' core habitat is restricted to parts of Cape York Peninsula that have highly reliable seasonal rainfall and where flooding is restricted to narrow drainage lines, with access to well-drained country within a 3 km radius. Open vegetation along these drainage lines is also important for minimising exposure to predation by Butcherbirds (Crowley *et al.* 2004). Hence, factors controlling nesting habitat suitability within the favourable climatic envelope are likely to include vegetation (which is, in turn, influenced by geology, soils and drainage), and drainage patterns (which are, in turn, affected by terrain roughness, watercourse position and drainage density). To further characterise the habitat Alwal use for nesting, 1,187 verified nest locations for the northern sub-population and 259 nest locations for the southern sub-population collected between 1992 and 2017 were intersected with data layers for each of the above variables (except soil) in QGIS (Quantum GIS Software 2017). These

layers were produced at a 25 m pixel resolution from the most complete data layers available for the study areas at the time of analysis, as follows:

- A geology layer was produced by extracting lithological units that intersected with at least one nest from North Queensland Geology mapping (Bain & Haipola 1996).
- A terrain roughness layer was produced by applying the GDAL routine of Zevenbergen & Thorne (1987) to the 1 arc second cells (30m) Shuttle Radar Topography Mission digital elevation model of Gallant *et al.* (2000).
- A stream density layer was produced by intersecting watercourse mapping (Department of Natural Resources 2015a, b) with a 1 km grid covering each study area.
- A distance from watercourse layer was produced by buffering watercourse mapping (Department of Natural Resources 2015a, b) by 50, 100, 150 and 200 m buffers.
- A Regional Ecosystem (RE) (vegetation) layer produced by extracting RE sub-units that intersected with at least 5% of nests from Queensland Regional Ecosystem mapping (Queensland Herbarium 2016).

Soil was not included in this assessment, as detailed soil mapping was not available for the entire extent of either population.

Most nests in the northern sub-population occurred on granitoid rocks, where there was a terrain roughness score between one and 4 m change in elevation/m² and a stream density of between 2,000 and 6,000 km/km², and within 150 m of a mapped drainage line (Figure 3). The majority of nest locations were mapped as occurring in broad-leaved tea-tree, thryptomene or box woodlands and low open woodlands on low-lying plains and drainage depressions (~37%), or eucalypt woodlands on granites (~34%) or sandplains (~16%) (Table 1). These findings are used for modelling nesting habitat later in this report (see [Nesting habitat suitability modelling](#)).

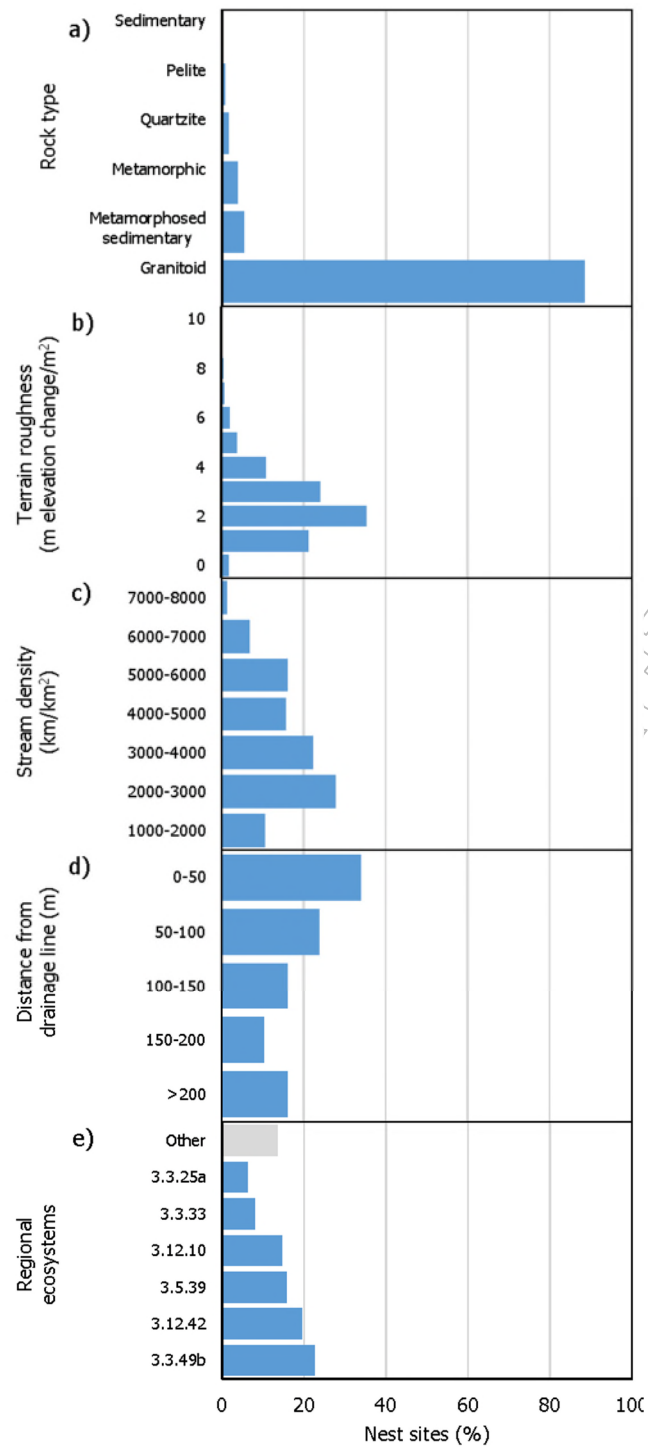


Figure 3. Distribution of Alwal nests in relation to environmental parameters for the northern and sub-populations
See text for data sources. See Table 1 for explanation of Regional Ecosystem codes.

Table 1. Locations of Alwal nests in relation to mapped Regional Ecosystem units in the northern sub-population

See text for source of data.

Regional Ecosystem	Description	Nests	
		(no.)	(%)
Northern sub-population			
3.3.49b	Broad-leaved tea-tree (<i>Melaleuca viridiflora</i>) low open woodland on low-lying plains	267	22.5
3.12.42	Darwin stringybark (<i>Eucalyptus tetradonta</i>) woodland on low to undulating granite hills	231	19.5
3.5.39	Darwin stringybark / Clarkson’s bloodwood (<i>Corymbia clarksoniana</i>) woodland on sand plains	185	15.6
3.12.10	Cullen’s ironbark (<i>E. cullenii</i>)/ Clarkson’s bloodwood woodland or shiny-leaved box (<i>E. chlorophylla</i>) woodland on granitic ranges	173	14.6
3.3.33	Thryptomene (<i>Thryptomene oligandra</i>) and broad-leaved tea-tree woodland on sides of depressions	95	8.0
3.3.25a	Molloy box (<i>Eucalyptus leptophleba</i>) woodland on floodplains	75	6.3
Other	-	160	13.5
Total		1,187	100

Therefore, this report models habitat suitability using knowledge of the species' distinct nesting habitat requirements, in relation to drainage and vegetation features that are available as detailed map layers across both populations, as described in [Error! Reference source not found.](#) These layers were converted to rasters with a 25 m pixel resolution in QGIS (Figure 4 & Figure 5) before converting to ASCII files for importing into Maxent. To recap, the following layers were produced separately for each sub-population:

- Rock type units (Bain & Haipola 1996), including all rock types that intersected with at least one nest.
- Regional Ecosystem (RE) sub-units (Queensland Herbarium 2016), including all RE sub-units that intersected with at least 5% of nests.
- Distance from mapped watercourses (Department of Natural Resources 2015a, b) in 50 m intervals up to 200 m.
- A 1 km grid of stream density produced by intersecting mapped watercourses (Department of Natural Resources 2015a, b).
- Terrain roughness (Zevenbergen & Thorne 1987; Gallant *et al.* 2000).

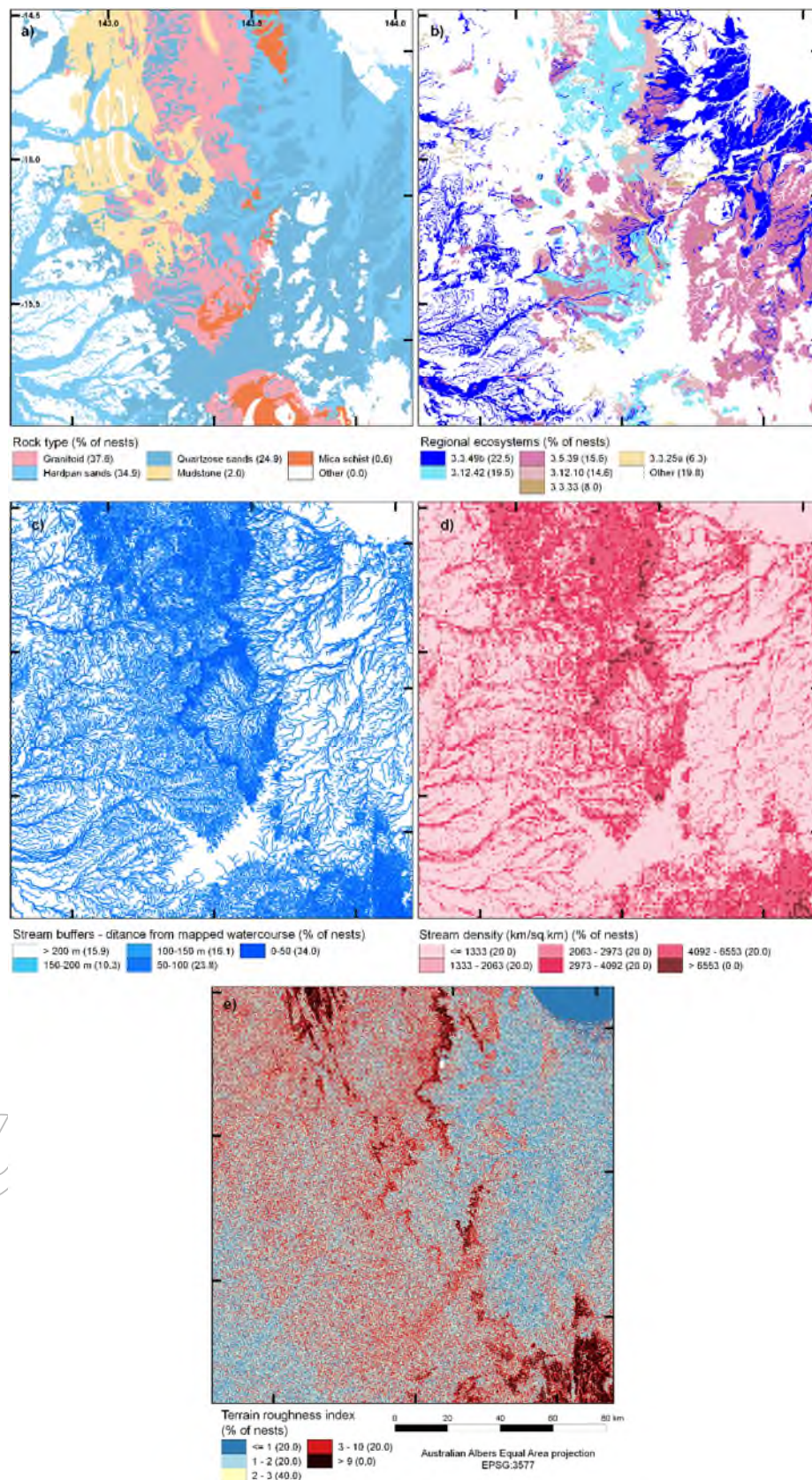


Figure 4. Data layers used in modelling nesting habitat for the northern sub-population: (a) rock type, (b) regional ecosystems, (c) distance from water, (d) drainage density and (e) terrain roughness

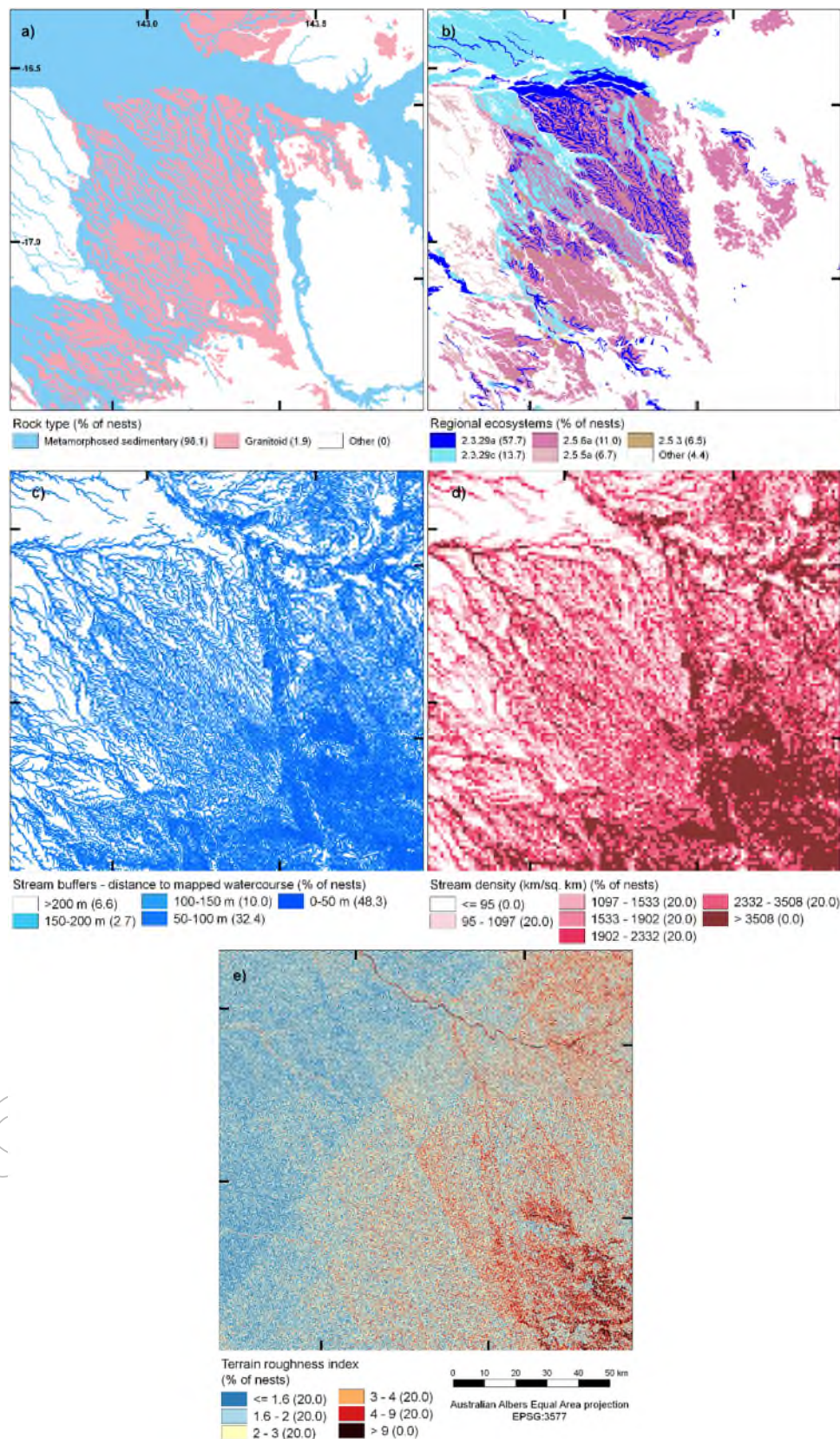


Figure 5. Data layers used in modelling nesting habitat for the southern sub-population: (a) rock type, (b) regional ecosystems, (c) distance from water, (d) drainage density and (e) terrain roughness

Modelling

Separate habitat suitability models were run for each sub-population using the nest locations as samples and the Regional Ecosystem, rock type, stream buffers, stream density and terrain roughness as environmental layers, using 10-fold cross-validation in Maxent version 3.4.1. Models were assessed by the Area Under the receiver operating characteristic Curve (AUC) statistic, which varies between 0 and 1. Models with an AUC of 0.5 are considered to have no predictive power. Predictive power increased as AUC increases above 0.5: an AUC of between 0.7 and 0.9 is considered to indicate moderate predictive capacity and an AUC greater than 0.9, excellent predictive capacity (Pearce & Ferrier 2000). Variables were added to the model if they had positive predictive power when they were the only variable in the model. They were retained in the model only if their positive contribution to AUC was maintained when all other variables were added. The final models selected for each study area contained a combination of variables, each of which made a positive contribution (gain) to AUC, both alone and in combination with other variables. Value of each variable was assessed by its percent contribution made as the model was being trained and by the permutation importance, which indicates how strongly the final model depends on each variable (Phillips 2006). Omission rates produced by the model were used to assess how likely the model was to identify habitat in areas with unfavourable conditions (Phillips *et al.* 2006).

The Maxent model produces output in the form of a raster grid, with each 25 m pixel being allocated a p-score indicating a relative probability that this cell contain habitat that is suitable for nesting. These scores are not true probabilities because the model is based on presence data, not on presence and absence data (Phillips *et al.* 2017). The p-scores for the actual nest locations used to create each model were ranked to produce three classes indicating nesting habitat quality based on percentiles: (i) primary habitat contained nests ranked in the top 60% of p-scores; (ii) secondary habitat contained nests with a p-score ranked in the next highest 20 percentile; and (iii) marginal habitat contained nests ranked in the lowest 20% of p-scores. The p-scores bounding each habitat class were then used to recode the raster output to produce an indicative nesting habitat suitability map.

Results

Northern population

In the northern study area, all five variables made useful contributions to predicting habitat suitability, having both predictive power of their own and information that was not provided by other variables (Figure 6). Hence, all five variables were retained in the model. The model was found to be stable, providing similar estimates of variable importance in both the original model based on a training set of data, and the validation based on a test set of data, as in the model as a whole. Regional Ecosystems had the best predictive capacity when used in isolation, as well as the most information that was not provided by the other variables. While terrain roughness provided the least contribution to the model, it was retained in the model because model predictive capacity was reduced when it was excluded. The final model depended most heavily on geology, stream density and REs (Table 2). The model's AUC value of 0.824 ± 0.016 (Figure 7a) indicated that the model had a moderate predictive capacity. An omission rate close to the predicted values indicated that the model predicted few nests in areas with unfavourable conditions (Figure 7b). p-scores for nest locations ranged between 0.0407 and 0.99541. Sixty percent of nest locations had p-scores greater than 0.64099 and 20% had p-scores less than 0.44451, so these values were used to recode the model output into primary nesting habitat (p-score > 0.64099), secondary habitat (0.44451-0.64099) and marginal habitat (<0.44451) (**Error! Reference source not found.**).

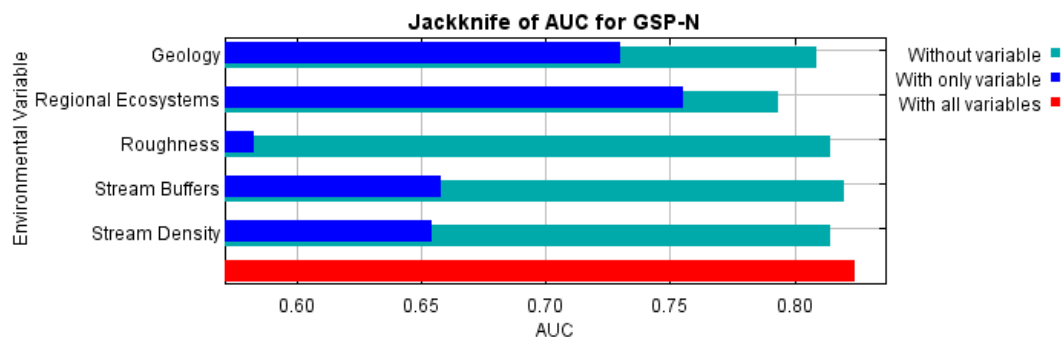
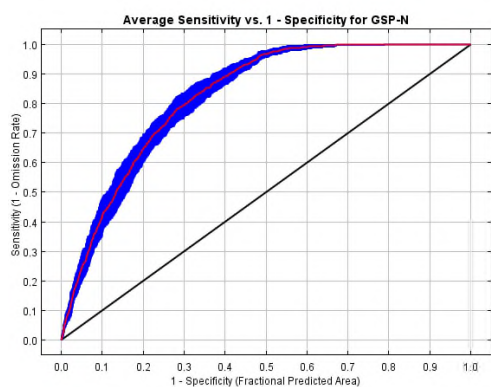


Figure 6. Contribution of environmental variables to the Maxent model of nesting habitat suitability in the northern study area

Table 2. Relative contributions of the environmental variables to the Maxent model for the northern study area

Variable	Percent contribution	Permutation importance
Regional ecosystems	53.2	24.9
Stream density	16.3	26.5
Geology	13.3	33.9
Stream buffers	11.7	5.6
Roughness	5.4	9

a)



b)

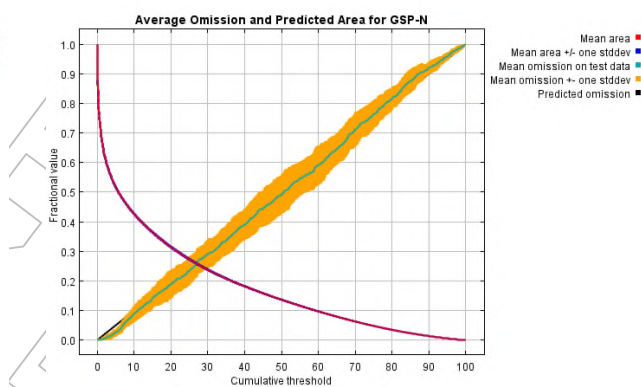


Figure 7. (a) Sensitivity curve and (b) omission curve for Maxent model of nesting habitat suitability in the northern study area

Nesting habitat extent

The Alice River Gold Exploration Area is important to Alwal's northern population, and therefore to the persistence and recovery of the species as a whole. Alwal's northern population is known to extend from Artemis station in the north-east to Alice River station (Imooya) in the south-west.

The Alice River Gold Project is located approximately 300 km northwest of Cairns in the southern Cape York Peninsula. The Alice River Gold Exploration Area is within the external boundaries of the Cape York United Number 1 Claim FC No QUD673/2014 and the Olkola People are the relevant native title holders for the area. The Alice River Gold Exploration Area lies within the bounds of Kimba and Alice River stations.

At the time of assessment, the Alice River Gold Exploration Permit for Minerals (EPM) area included six EPMs awarded to Tinpitch Pty Ltd: EPM 16301, 15359, 15360, 14313, 15409, and 26266. The relative importance of these areas was determined by intersecting them with each modelled estimate of primary and secondary nesting habitat.

Methods

Nesting habitat extent was estimated by clipping primary and secondary nesting habitat layers to the polygons used to calculate minimum and maximum AOO (before their conversion to grid squares) in QGIS and intersecting each result with the extent of Tinpitch EPMs. Grass routine 'r.report' was then used to calculate the area of each nesting habitat class.

Results

The extent of occupied Alwal nesting habitat, based on known nest locations with a 3 km buffer, is shown in Figure 8.

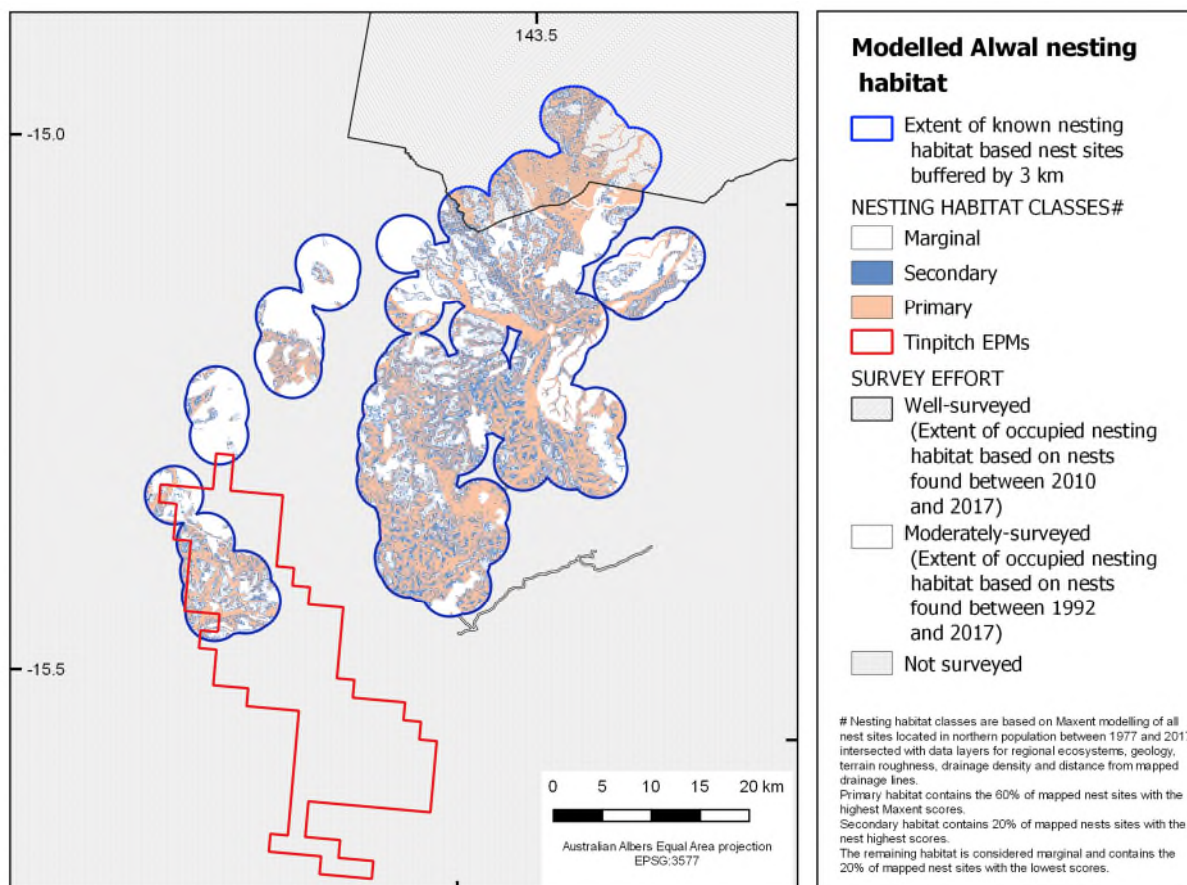


Figure 8. Habitat model output for the northern study area, recoded to show suitability of nesting habitat, classified as primary, secondary and marginal habitat. Source: Olkola Aboriginal Corporation

Based on the location of nest sites from surveys and modelling of nesting habitat suitability, it is estimated that Tinpitch EPMS contain 34 km² of primary Alwal nesting habitat and 22 km² of known secondary nesting habitat (Table 3).

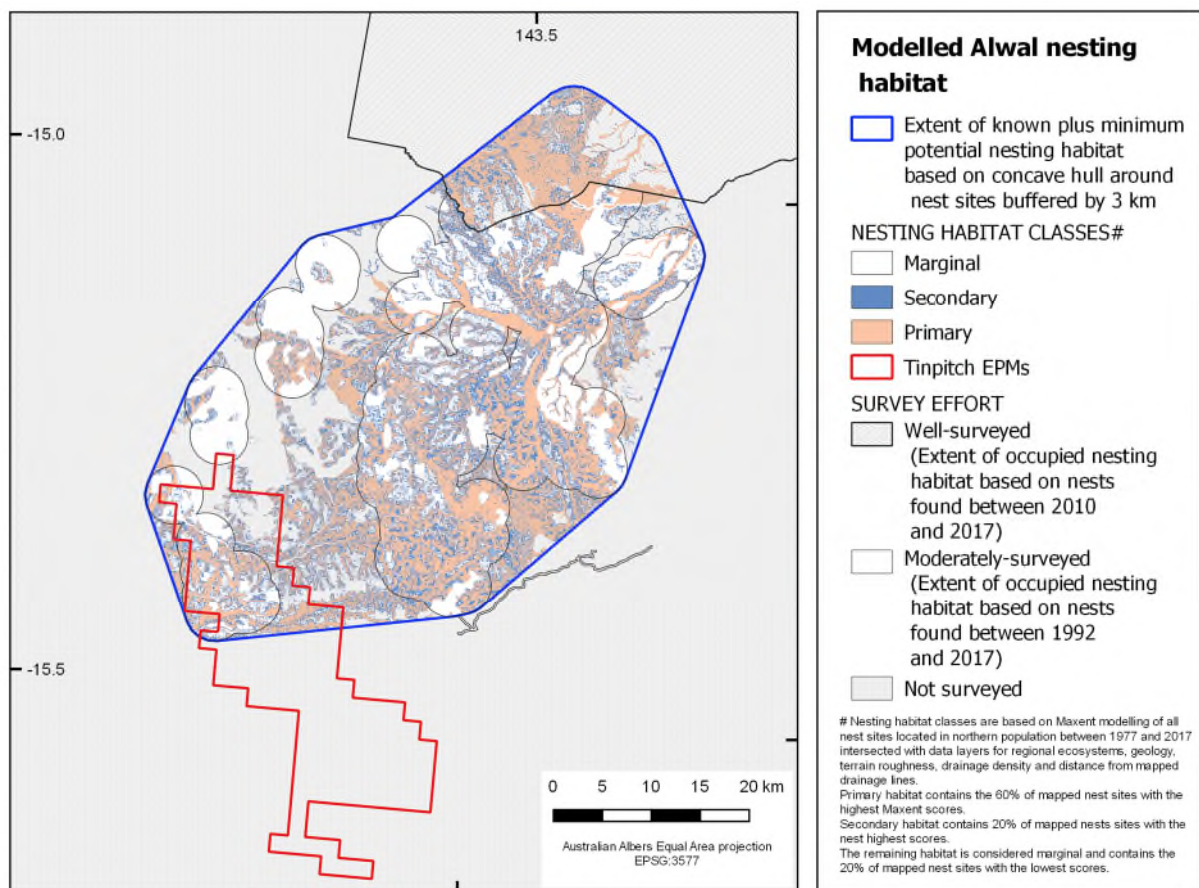
Table 3. Northern Alwal population, based on nesting habitat within Tinpitch EPMS. Source: Olkola Aboriginal Corporation

	Measure	Unit	Alice River Gold Exploration Area	Rest of population	Total	Importance of Alice River Gold Exploration Area
Total area	Area	(km ²)	101	1339	1439	
Primary habitat	Area	(km ²)	34	459	492	6.9
Secondary habitat	Area	(km ²)	22	277	299	7.5
Other habitat	Area	(km ²)	44	603	647	
Primary habitat	Nest territory density	(territories/km ²)	0.38	0.38	0.38	
Secondary habitat	Nest territory density	(territories/km ²)	0.24	0.24	0.24	
Other habitat	Nest territory density		n/a	n/a	n/a	
Primary habitat	Nesting territories	(no.)	13	174	187	6.9

Secondary habitat	Nesting territories	(no.)	5	66	72	7.5
Other territories	Nesting territories	(no.)	5	60	65	7.1
Total territories	Nesting territories	(no.)	23	301	324	7.1
Population density	Adult birds	(no./territory)	2.1	2.1	2.1	
Population	Adult birds	(no.)	48	632	680	7.1

Using Maxent modelling to determine the potential habitat suitability in areas that have not been surveyed for Alwal nests, it was estimated that Tinpitch EPMs may contain up to 119 km² of primary nesting habitat, and 79 km² of secondary nesting habitat (Figure 9, Figure 10, Table 4, Table 5).

The lower or minimum estimate includes all habitat within the known extent of nesting habitat, as defined by drawing a concave hull around known nesting territories (Figure 9). The northern limits of this population are well established, whereas the southern limits (which includes most of Tinpitch's EPMs) are unclear, so the maximum estimates include unsurveyed areas to the south of the known extent of nesting habitat (Figure 10).



Figure

9. Known and minimum potential extent of occupied Alwal nesting habitat, based on known nest locations and modelling. Includes areas found within the known range, as defined by a concave hull drawn around all known nesting territories. Source: Olkola Aboriginal Corporation

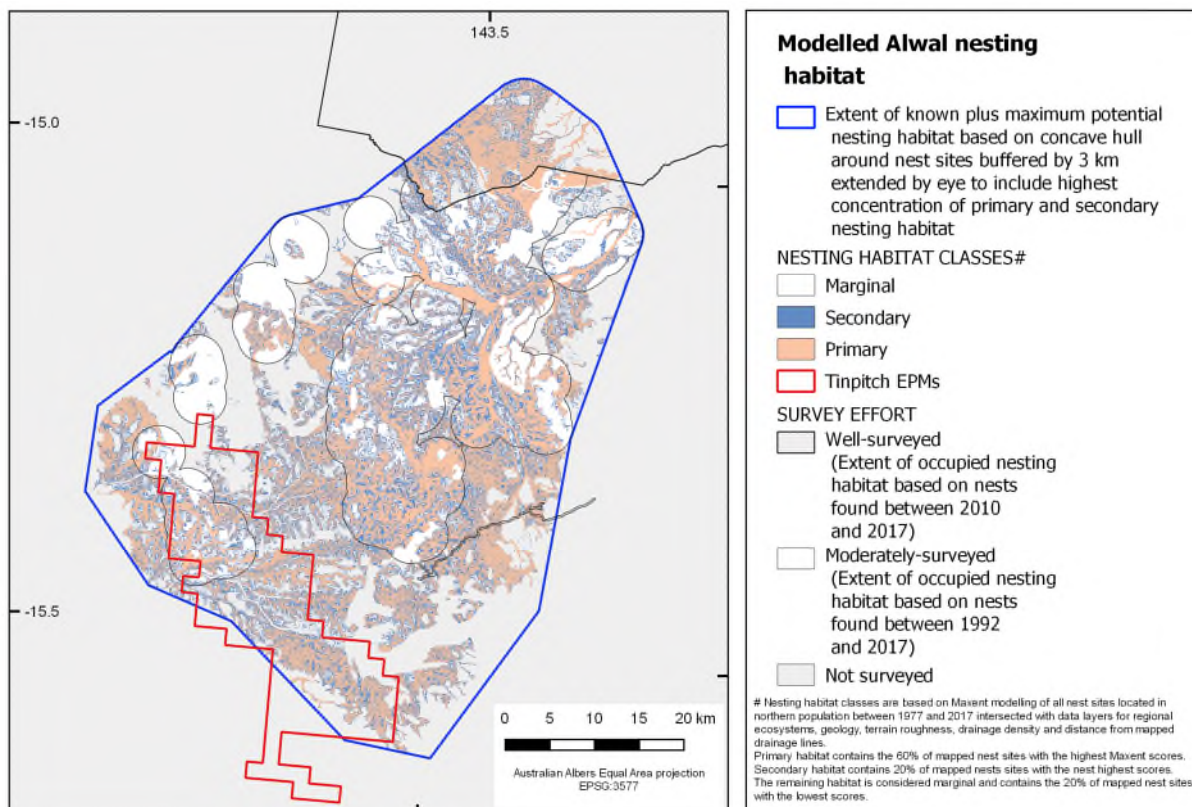


Figure 10. Known and maximum potential extent of occupied Alwal nesting habitat, based on known nest locations and modelling. Includes areas found within the known range, as defined by a concave hull drawn around all known nesting territories, and extended by eye to include areas of highest concentration of primary and secondary nesting habitat. Source: Olkola Aboriginal Corporation

Using nest densities from reference areas², Tinpitch’s EPMs may support between 23 and 80 Golden-shouldered Parrot nesting territories and between 48 and 168 adult birds. This represents between 7.1% and 13.7% of Alwal’s northern population (Table 4, Table 5, Table 6).

² In well-surveyed reference areas on Artemis station in the 1990s, primary habitat (defined as habitat containing 60% of mapped Alwal nests) had a nest density of 0.38 nests/km²/year, and secondary habitat (20% of nests) had a density of 0.24 nests/km²/year. A further 20% of nests were found in other habitat.

Table 4. Calculation of importance of Alice River Gold Exploration Area to the northern Alwal population, based on known and minimum potential nesting habitat. Source: Olkola Aboriginal Corporation

Habitat type	Measure	Unit	Alice River Gold Exploration Area	Rest of population	Total	Importance of Alice River Gold Exploration Area
Total area	Area	(km ²)	179	1897	2076	
Primary habitat	Area	(km ²)	55	616	671	8.2
Secondary habitat	Area	(km ²)	38	379	417	9.2
Other habitat	Area	(km ²)	86	143	228	
Primary habitat	Nest territory density	(territories/km ²)	0.38	0.38	0.38	
Secondary habitat	Nest territory density	(territories/km ²)	0.24	0.24	0.24	
Other habitat	Nest territory density		n/a	n/a	n/a	
Primary habitat	Nesting territories	(no.)	21	234	255	8.2
Secondary habitat	Nesting territories	(no.)	9	91	100	9.2
Other territories	Nesting territories	(no.)	8	81	89	8.5
Total territories	Nesting territories	(no.)	38	406	444	8.5
Population density	Adult birds	(no./territory)	2.1	2.1	2.1	
Population	Adult birds	(no.)	79	853	932	8.5

Table 5. Calculation of importance of Alice River Gold Exploration Area to the northern Alwal population, based on known and maximum potential nesting habitat. Source: Olkola Aboriginal Corporation

	Measure	Unit	Alice River Gold Exploration Area	Rest of population	Total	Importance of Alice River Gold Exploration Area
Total area	Area	(km ²)	371	2458	2829	
Primary habitat	Area	(km ²)	119	773	892	13.3
Secondary habitat	Area	(km ²)	79	458	537	14.8
Other habitat	Area	(km ²)	173	1227	1400	
Primary habitat	Nest territory density	(territories/km ²)	0.38	0.38	0.38	
Secondary habitat	Nest territory density	(territories/km ²)	0.24	0.24	0.24	
Other habitat	Nest territory density		n/a	n/a	n/a	
Primary habitat	Nesting territories	(no.)	45	294	339	13.3
Secondary habitat	Nesting territories	(no.)	19	110	129	14.8
Other territories	Nesting territories	(no.)	16	101	117	13.7
Total territories	Nesting territories	(no.)	80	505	585	13.7
Population density	Adult birds	(no./territory)	2.1	2.1	2.1	
Population	Adult birds	(no.)	168	1060	1228	13.7

Table 6. Summary table of importance of Alice River Gold Exploration Area to the northern Alwal population based on each projection. Source: Olkola Aboriginal Corporation

	Primary nesting habitat		Secondary nesting habitat		Adult population	
	(km ²)	(%)	(km ²)	(%)	(no. birds)	(%)
Known nest sites	33.9	6.9	22.4	7.5	48	7.1
Known and minimum potential nesting habitat	55.1	8.2	38.3	9.2	79	8.5
Known and maximum potential nesting habitat	118.7	13.3	79.3	14.8	168	13.7

Conclusion

Surveys are required to clarify the relative importance of the EPMs to the Alwal northern population. However, even the lowest estimate constitutes a significant percentage of this Alwal population, so that any adverse impact on these birds may negatively affect the species' recovery if no management or mitigation strategies are implemented by mineral explorers, graziers and other land users.

The Alwal's range may be contracting, with the desertion of about 500 ha of primary nesting habitat on Artemis and Dixie stations since 2010, although further field studies on distribution need to be completed. To date, once Alwal have been lost from an area, there has been no evidence of any recolonisation by the species.

Tinpitch's EPMs are in the section of the Alwal's distribution that is furthest from the population's retreating edge, so is likely to be part of the species' most secure habitat. Hence its relative importance is likely to increase with time. Any loss of nesting habitat as a result of clearing may be irreversible, and therefore may potentially represent a significant impact on the species by disrupting breeding cycles of the overall population or lead to a long-term decline in the population size (DoE 2013).

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Priority areas for future nest surveys

In the Alwal's northern sub-population, surveys to determine extent of nesting activity (and therefore population size) are still required in large parts of the Alwal's Area of Occupancy (AOO) (Figure 11). These areas (mainly in the southern parts of Killarney and on Alice River station, and south of Alwal National Park) are the highest priority for surveys. Modelling also identified substantial areas of potential nesting habitat to the south and southwest of the mapped AOO. These are on Alice River Station, on and east of Killarney, and in the northwestern section of Kimba. These areas should be surveyed before any developments that might cause significant impacts to the species are undertaken.

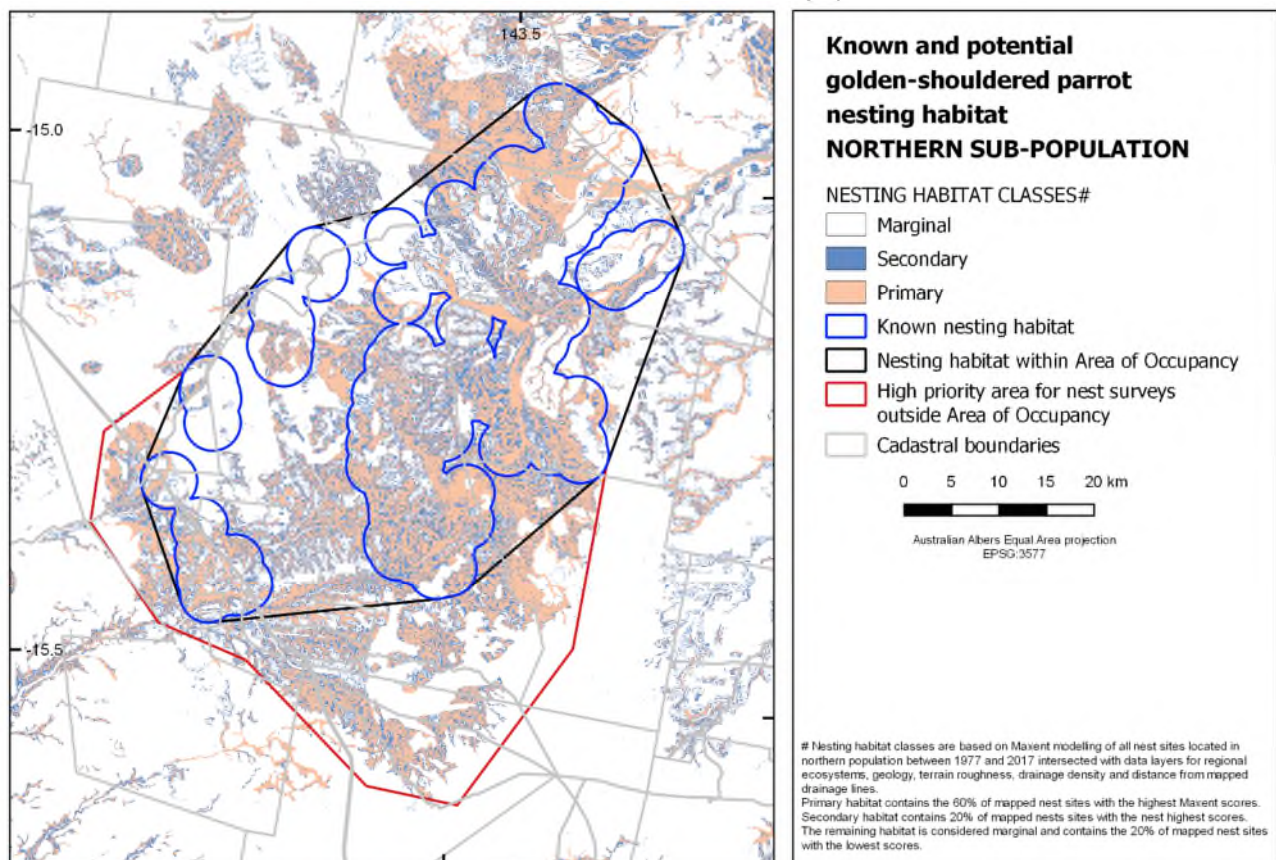


Figure 11. Priority areas for Alwal (Golden-shouldered Parrot) surveys in the northern population.

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ALICE RIVER REHABILITATION REPORT

PREPARED FOR
PacGold Limited

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Table of Contents

1	Introduction	1
1.1	Scope.....	1
1.2	Site location and description	1
2	Objectives, indicators and success criteria	3
2.1	Rehabilitation legislation in Queensland	3
2.2	Site specific EA conditions	3
2.3	Site Specific Rehabilitation Objectives.....	4
2.4	Indicators and success criteria	5
2.5	Rainfall and seasonal influences.....	9
3	Rehabilitation Monitoring Locations.....	10
4	Methodology	12
4.1	Permanent vegetation monitoring transects	12
4.2	Erosion monitoring.....	14
4.1	Photographic monitoring	15
4.2	Soil Investigation	15
5	Results and interpretation	18
5.1	Vegetation monitoring	18
5.1.1	Ground cover monitoring.....	18
5.1.2	Species richness.....	20
5.1.3	Woody stem density	21
5.1.4	Canopy cover.....	22
5.1.5	Restricted invasive plant species.....	23
5.2	Erosion monitoring.....	23
5.1	Topsoil characteristics	23
5.1.1	Physical Parameters	26
5.1.2	General Soil Characteristics.....	26
5.1.3	Exchangeable Cations.....	26
5.1.4	Exchangeable Phosphorous, and Nitrogen	27
6	Conclusions and recommendations	28
6.1.1	Ground cover.....	28
6.1.2	Species richness.....	29
6.1.3	Woody stem density	29
6.1.4	Canopy cover.....	29
6.1.5	Restricted invasive species.....	29

6.1.6	Erosion monitoring.....	29
6.1.7	Topsoil characterisation	29
6.1.8	PMLU acceptance criteria	30
6.1.9	Future monitoring	30
7	References	31

List of Figures

Figure 1:	Project locality	2
Figure 2:	Interpolated rainfall data for Alice River.....	9
Figure 3:	Alice River rehabilitation sites.....	11
Figure 5:	Ground cover percentage sampling.....	13
Figure 6:	Guide to monitoring canopy cover (after Eyre et al. 2017)	14
Figure 7:	Alice River soil sampling sites.....	17
Figure 9:	Live ground cover percentage across all monitoring sites for 2021	19
Figure 10:	Species richness across all monitoring sites in 2021	20
Figure 11:	Woody stem density across all monitoring site	21
Figure 12:	Canopy cover across all monitoring sites	22

List of Tables

Table 1:	Schedule F - Table 1 (Final Land Use and Rehabilitation Approval Schedule (recreated from the Project's EA)	4
Table 2:	Schedule F - Table 3 (Landform design) (recreated from the Project's EA)	4
Table 3:	Rehabilitation objectives and acceptance criteria	6
Table 4:	Rehabilitation monitoring sites.....	10
Table 5:	Erosion Characteristics.....	15
Table 6:	Soil sampling sites	16
Table 7:	Mean ground cover across all monitoring sites for 2021.....	19
Table 8:	Species richness across all monitoring sites in 2021	20
Table 9:	Woody stem density across all monitoring sites for 2021	21
Table 10:	Canopy cover across all monitoring sites for 2021	22
Table 11:	Weed species across all monitoring sites in 2021.....	23
Table 12:	Erosion characteristics	23
Table 13:	Topsoil analysis	24
Table 14:	PMLU acceptance criteria status.....	30

List of Abbreviations

%	-	per cent
<	-	less than
>	-	greater than
AARC	-	AARC Environmental Solutions Pty Ltd
ANZECC	-	Australian and New Zealand Environment and Conservation Council
cm	-	centimetre(s)
DES	-	Department of Environment and Science
EA	-	Environmental Authority
EHP	-	Department of Environment and Heritage Protection
EP Act	-	Environmental Protection Act 1994 (Qld)
GDA	-	Geocentric Datum of Australia
GPS	-	Global Positioning System
H	-	Height
ha	-	hectare(s)
km	-	kilometre(s)
m	-	metre(s)
ML	-	Mining Lease
ND	-	No data
PacGold	-	PacGold Ltd
Qld	-	Queensland
RDR	-	Rehabilitation Design Report
The Project	-	Alive River Gold Mine
TinPitch -	-	TinPitch Pty Ltd
V	-	Vertical
WRD	-	Waste Rock Dump

1 Introduction

AARC Environmental Solutions Pty Ltd (AARC) has been commissioned by PacGold Limited (PacGold) in May 2021 to prepare a Rehabilitation Progress Report for the Alice River Mine (the Project) for annual rehabilitation monitoring that took place from the 24 – 27 May 2021.

1.1 Scope

AARC undertook monitoring at the Project to assess progress against rehabilitation objectives applicable to the exploration, Run of Mine Pads, and Borrow Pit rehabilitation areas, as rehabilitation works have only been undertaken on the exploration area to date. Previously established analogue monitoring sites were also included for comparison.

The monitoring program targets areas of progressive rehabilitation at the Alice River Mine. This Progress Report provides a summary of rehabilitation performance at the rehabilitation areas against the objectives and criteria set out in the Project's Environmental Authority (EA) (EPML00870113).

This report summarises results from the first annual rehabilitation monitoring event and compares parameters to the Project's rehabilitation acceptance criteria in order to demonstrate that rehabilitation has been successful. To be considered successful, acceptance criteria must be met for a period of three consecutive years.

1.2 Site location and description

The Project is located approximately 310 kilometres (km) north-west of Cairns on the southern Cape York Peninsula. The Project occupies eight MLs, with the largest (ML 3010) containing the Project's historic gold processing plant, tailings dam and waste rock dumps (WRD). The adjoining ML 2901 contains the historical Queen Pit. Since operations ceased in 2000, the Mine has remained in care and maintenance with no mining or processing activities being taken.

PacGold also holds a number of Exploration Permits for Minerals (EPMs) that surround the 8 MLs. Figure 1 outlines the location of the Project within a regional context.

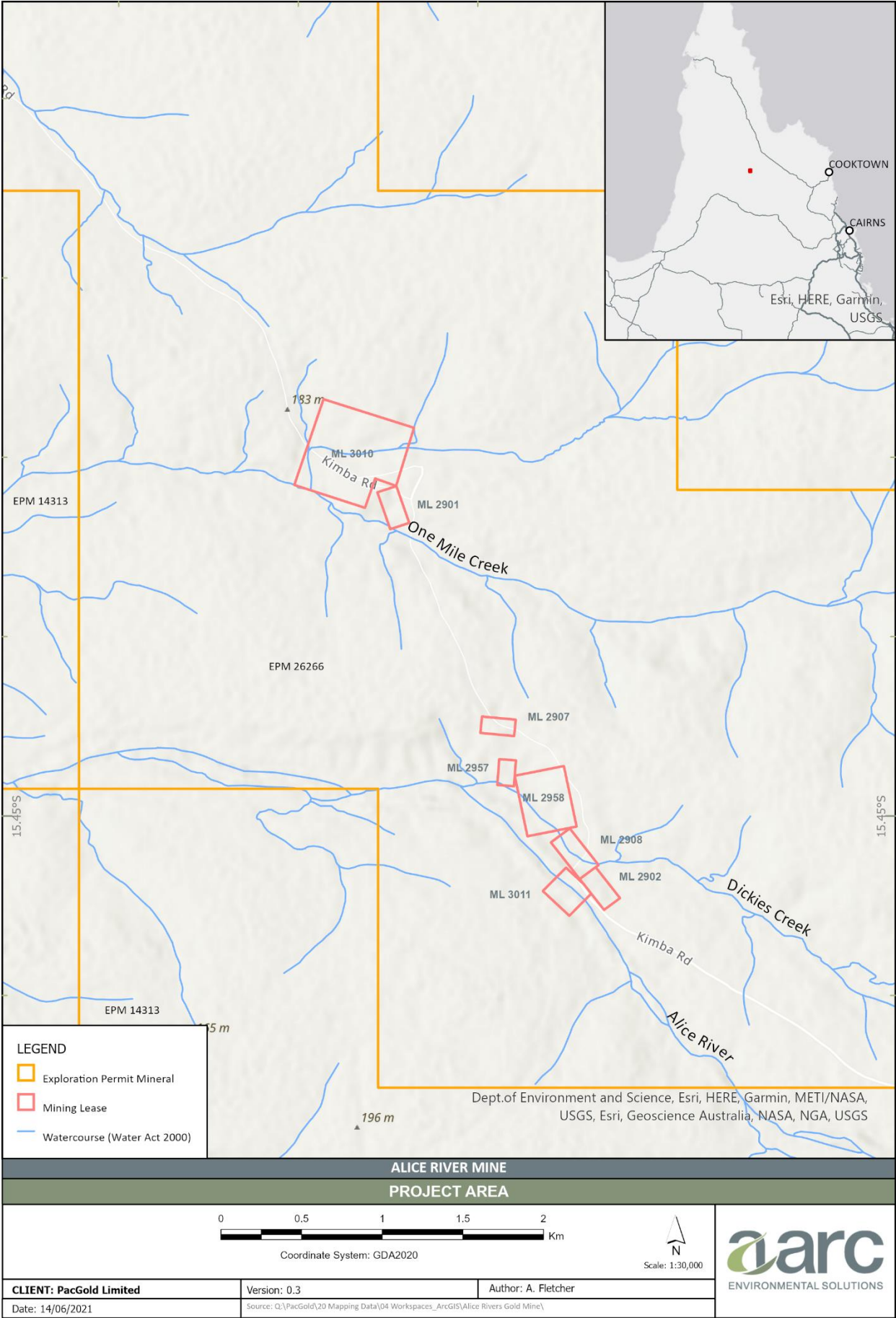


Figure 1: Project locality

2 Objectives, indicators and success criteria

2.1 Rehabilitation legislation in Queensland

In Queensland, rehabilitation is required under the *Environmental Protection Act 1994* (Qld) (EP Act), with site specific requirements often flowing through to project EA conditions (Section 2.2)

In addition to the EA requirements for the Project, the recent introduction of the *Mineral and Energy Resources (Financial Provisioning) Act 2019* (MERFP Act) has introduced a number of amendments to the EP Act, that create a significant change to the way mine site rehabilitation is regulated in Queensland. These changes dictate the establishment of clear post-mining land uses, rehabilitation objectives, completion criteria, and milestones for progressive rehabilitation.

Rehabilitation objectives provide a clear description of proposed rehabilitation outcomes within the individual rehabilitation areas on the mine site. The objectives within each distinct rehabilitation area are assigned rehabilitation indicators and success criteria. Indicators are the parameters by which rehabilitation success is measured. Success criteria form the minimum requirements that must be met to demonstrate that the objective has been achieved. Rehabilitation Success Criteria for the Project are defined in the Rehabilitation Design Report (AARC, 2019) submitted to the Department in 2019.

Section 318Z of the EP Act provides for the certification of particular areas within a resource project tenure that have been rehabilitated in accordance with the requirements of the EP Act. This is referred to as 'progressive certification' and is only applicable to the area being certified.

An application for progressive certification must be in the approved form and supported by a Progressive Certification Report and a compliance statement (section 318ZD of the EP Act). The Progressive Certification Report must meet the requirements of section 318ZF of the EP Act. The application must be supported by evidence of rehabilitation success when assessed against completion criteria. Monitoring data presented in this report is intended to contribute to a future certification application.

2.2 Site specific EA conditions

The conditions relating to the rehabilitation of the Project site are outlined in Schedule F of the current EA (EPML00870113) and are detailed below.

Schedule F – Land Management

Rehabilitation Landform Criteria

(F1-1) All areas significantly disturbed by mining activities must be rehabilitated to the final land description as defined in Schedule F - Table 1 (Final Land Use and Rehabilitation Approval Schedule) and compared to an analogue site in an adjacent undisturbed area with similar grazing management practices. Grazing Pasture Outcome

(F2-1) Areas which are to be rehabilitated / progressively rehabilitated to grazing pasture must comply with the following outcomes;

- d) Generate a self sustaining vegetation with projective cover, species composition and species distribution comparable to analogue sites at two locations (E 744882, N 8292570 adjacent to processing area and E 745297, N 8292349 adjacent to airstrip) identified as AS1 and AS2 on Schedule I – Figure 1 – Authorised Activities and locations; and*
- e) All areas disturbed by mining activities must be rehabilitated to the landform design criteria defined in Schedule F – Table 3 (Landform design) (replicated in Table 2);*
- f) Landforms are stable with rates of erosion comparable to analogue sites; and*

- g) A measure of productivity (e.g. sustainable dry matter production, stock live weight gain) are comparable to analogue sites at two locations (E 744882, N 8292570 adjacent to processing area and E 745297, N 8292349 adjacent to airstrip) identified as AS1 and AS2 on Schedule I – Figure 1 – Authorised activities and locations.

(F2-2) Complete an investigation into rehabilitation of disturbed areas and submit a report to the administering authority proposing acceptance criteria to meet the outcomes in (F2-1) and landform design criteria in Schedule F – Table 3 (Landform design) by 26 July 2018.

Table 1: Schedule F - Table 1 (Final Land Use and Rehabilitation Approval Schedule (recreated from the Project's EA)

Disturbance Type	Disturbance Area ha	Pre-mine Land Description	Post-mine Land Description	Pre-mine Land Capability	Post-mine Land Capability	Analogue Site Identification
Mine Pit	2.0	Low intensity grazing	Stock water point	VII	VII	AS1 and AS2
Mullock Dumps	0.5	Low intensity grazing	Low intensity grazing	VII	VII	AS1 and AS2
Burrow Pits/Costeans	0.6	Low intensity grazing	Low intensity grazing	VII	VII	AS1 and AS2
Tailings Dam	3.0	Low intensity grazing	Low intensity grazing	VII	VII	AS1 and AS2
Run-of-Mine Pad	1.1	Low intensity grazing	Low intensity grazing	VII	VII	AS1 and AS2
Plant Area	2.0	Low intensity grazing	Low intensity grazing	VII	VII	AS1 and AS2
Roads and Tracks	2.0	Low intensity grazing	Low intensity grazing	VII	VII	AS1 and AS2
Exploration Areas	13.33	Low intensity grazing	Low intensity grazing	VII	VII	AS1 and AS2
Exploration	3.0	In accordance with condition A9-1				

Key: ha hectare(s)

Table 2: Schedule F - Table 3 (Landform design) (recreated from the Project's EA)

Identification	Slope range (%)	Projective surface area (ha)
Waste rock dump/s	1 (V) : 3 (H)	1

Key: V vertical
H height

2.3 Site Specific Rehabilitation Objectives

Rehabilitation objectives and completion criteria were developed based on the Project's pre-mining land use of low intensity cattle grazing. Rehabilitation aims to return land impacted by the Project to an equivalent final land use, as outlined in the Project's EA.

The major final land use goal is to enable low intensity cattle grazing, which was the predominant previous site use, as well as the current use of the adjoining land. This post mining land use is understood to meet relevant stakeholder and landowner expectations. Areas suitable for grazing will include improved pasture species already established on site

2.4 Indicators and success criteria

Rehabilitation indicators provide measures of progress towards rehabilitation objectives. Completion criteria are the standards which provide a clear definition of successful rehabilitation and take the form of a set of measurable benchmarks against which the rehabilitation indicators can be compared, to determine whether objectives are being met. Rehabilitation is deemed successful when completion criteria for each rehabilitation goal and objective are consistently met. Proposed completion criteria for the RDR (Rehabilitation Design Report) are outlined for each disturbance type in Table 3 (with the areas containing rehabilitation sites in grey).

In order to demonstrate that rehabilitation has been successful, monitoring of indicators is repeated annually, with data compared over time. It is envisaged that acceptance criteria will need be met for a minimum period of three consecutive years, prior to certification occurring.

Trend analysis will be used to assess if rehabilitation results are moving towards success criteria. If data is trending away from success criteria, an investigation will be undertaken to assess if there is an underlying issue and what additional maintenance is required. Monitoring may also suggest the implementation of other measures of success.

Table 3: Rehabilitation objectives and acceptance criteria

Domain	Post-Mine Land Use	Rehabilitation Objective	Acceptance Criteria
Mine Pit Alice Queen Open Pit	Stock Watering Point	Safe and stable for humans and animals now and in the foreseeable future. Suitable for stock consumption. Non-polluting.	Certification in rehabilitation report that ground is structurally sound and safe to people and animals. Water quality complies with stock watering limits (ANZECC 2000 Guidelines). Water quality in the receiving environment is consistent with upstream levels. Land capability assessment identifies a minimum of Class VII as per post mine land capability.
Mullock Dumps Waste Rock Dump	Low intensity grazing	Safe and stable for humans and animals now and in the foreseeable future. Suitable for low intensity cattle grazing. Non-polluting.	Evidence in rehabilitation report that ground is structurally safe and sound. Final Landform meets slope criteria (1 (V) : 3 (H)) as per EA condition (Schedule F - Table 3). Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). Water quality in the receiving environment is consistent with upstream levels. Rate of erosion is consistently similar to analogue sites (AS1, AS2). Pasture productivity is consistently similar to analogue sites (AS1, AS2). Land capability assessment identifies a minimum of Class VII as per post mine land capability.
Burrow Pits/Costeans Big Blow Borrow Pit, Peninsula King Borrow Pit	Low intensity grazing	Safe and stable for humans and animals now and in the foreseeable future. Suitable for low intensity cattle grazing. Non-polluting.	Evidence in rehabilitation report that ground is structurally safe and sound. Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). Water quality in the receiving environment is consistent with upstream levels. Rate of erosion is consistently similar to analogue sites (AS1, AS2). Pasture productivity is consistently similar to analogue sites (AS1, AS2). Land capability assessment identifies a minimum of Class VII as per post mine land capability.

Domain	Post-Mine Land Use	Rehabilitation Objective	Acceptance Criteria
Tailings Dam	Low intensity grazing	Safe and stable for humans and animals now and in the foreseeable future. Suitable for low intensity cattle grazing. Non-polluting.	Evidence in rehabilitation report that ground is structurally safe and sound. Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). Water quality in the receiving environment is consistent with upstream levels. Rate of erosion is consistently similar to analogue sites (AS1, AS2). Pasture productivity is consistently similar to analogue sites (AS1, AS2). Land capability assessment identifies a minimum of Class VII as per post mine land capability.
Run-of-Mine Pad Ore Stockpile, Scrap yards	Low intensity grazing	Safe and stable for humans and animals now and in the foreseeable future. Suitable for low intensity cattle grazing. Non-polluting	Evidence in rehabilitation report that ground is structurally safe and sound. Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). Water quality in the receiving environment is consistent with upstream levels. Rate of erosion is consistently similar to analogue sites (AS1, AS2). Pasture productivity is consistently similar to analogue sites (AS1, AS2). Land capability assessment identifies a minimum of Class VII as per post mine land capability.
Processing Plant Ball mills, Gold room, metal screening, tanks.	Low intensity grazing	Safe and stable for humans and animals now and in the foreseeable future. Suitable for low intensity cattle grazing. Non-polluting	Evidence in rehabilitation report that ground is structurally safe and sound. Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). Water quality in the receiving environment is consistent with upstream levels. Rate of erosion is consistently similar to analogue sites (AS1, AS2). Pasture productivity is consistently similar to analogue sites (AS1, AS2). Land capability assessment identifies a minimum of Class VII as per post mine land capability.

Domain	Post-Mine Land Use	Rehabilitation Objective	Acceptance Criteria
Roads and Tracks	Low intensity grazing	Safe and stable for humans and animals now and in the foreseeable future. Suitable for low intensity cattle grazing.	Evidence in rehabilitation report that ground is structurally safe and sound. Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). Rate of erosion is consistently similar to analogue sites (AS1, AS2). Pasture productivity is consistently similar to analogue sites (AS1, AS2). Land capability assessment identifies a minimum of Class VII as per post mine land capability.
Exploration Areas Drill pads / holes	Low intensity grazing	Safe and stable for humans and animals now and in the foreseeable future. Suitable for low intensity cattle grazing. Non-polluting	Evidence in rehabilitation report that ground is structurally safe and sound. Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). Water quality in the receiving environment is consistent with upstream levels. Rate of erosion is consistently similar to analogue sites (AS1, AS2). Pasture productivity is consistently similar to analogue sites (AS1, AS2). Land capability assessment identifies a minimum of Class VII as per post mine land capability.
Exploration	Low intensity grazing	Safe and stable for humans and animals now and in the foreseeable future. Suitable for low intensity cattle grazing. Non-polluting	Evidence in rehabilitation report that ground is structurally safe and sound. Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). Water quality in the receiving environment is consistent with upstream levels. Rate of erosion is consistently similar to analogue sites (AS1, AS2). Pasture productivity is consistently similar to analogue sites (AS1, AS2). Land capability assessment identifies a minimum of Class VII as per post mine land capability.

2.5 Rainfall and seasonal influences

The Project is located within the Cape York region which has a tropical climate with high to very high temperatures throughout the year (Department of Environment and Science (DES), 2019). The rainfall is highly seasonal, with most rain falling during the wet season (October-March) either as heavy thunderstorms, monsoonal lows or tropical cyclones (DES, 2019).

Rainfall data from the Bureau of Meteorology (BOM) Kimba Weather Station (028027) (located approximately 29 km west of the Project site) recorded no rainfall since June 2019. As this is unlikely, the more likely scenario is that the rainfall data has yet to be processed by BOM Melbourne Head Office, who have a data backlog due to COVID-19 restrictions last year.

As an alternative, the Queensland Government's climate database SILO (Scientific Information for Land Owners), provides datasets which use observational data as well as mathematical interpolation techniques to infill gaps in time series. Figure 2 shows the datasets from the SILO grid points -15.45, 143.30 (Queensland Government, 2021). The interpolated rainfall data indicates a wet season with greater monthly rainfall than average leading up to the May 2021 survey.

Seasonal variation should be considered when comparing rehabilitation monitoring data over time. Previous studies completed by Xu Z and Zhou G (2011) and Yan *et al.* (2015) have shown a correlation between aboveground biomass, species richness and precipitation. This correlation results from available soil moisture and higher water availability, which generally leads to increases in plant biomass and species composition (Xu Zhou 2011 & Yan *et al.* 2015).

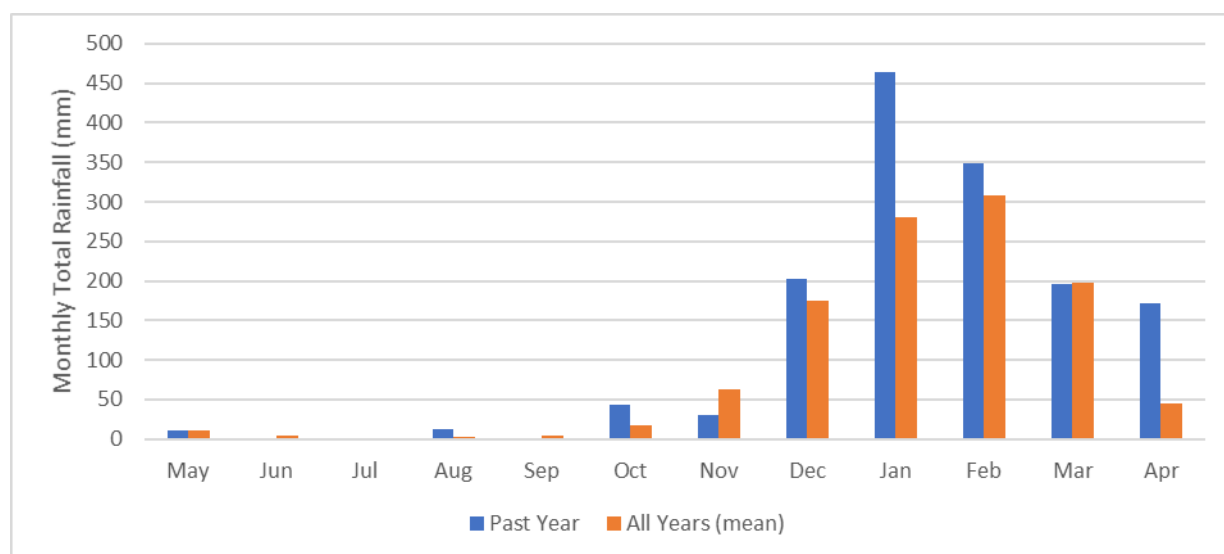


Figure 2: Interpolated rainfall data for Alice River

3 Rehabilitation Monitoring Locations

In order to determine the success of rehabilitation areas, monitoring sites have been established at various locations representative of the different rehabilitation areas throughout the Project site.

Permanent analogue sites are to be established at locations that were not impacted by past mining activities. Analogue sites are intended to provide a benchmark (a final land use of open pasture) for measuring rehabilitation performance. Upon site inspection in May 2019; the analogue site AS1 as per the Projects EA was found to occur within a previously disturbed area, as such it has been relocated to an unimpacted site.

The two analogue sites were selected as they are representative of the natural topography, vegetation type and the post-mine land use of 'open pasture'.

At the current stage of mine life, rehabilitation has only been undertaken in the exploration, cleared areas around the Alice Queen Pit areas.

Locations of monitoring sites are detailed in Table 4 and shown in Figure 3.

Table 4: Rehabilitation monitoring sites

Site Name	GDA 94		Location	Site Type	Disturbance Type / Domain
	Latitude	Longitude			
AS1	-15.4272	143.2849	North of ML 3010	Analogue	Low Intensity Grazing
AS2	-15.4328	143.287	East of ML 3010	Analogue	Low Intensity Grazing
EX1	-15.4298	143.2836	ML 3010	Rehabilitation	Exploration Areas
EX2	-15.4286	143.2845	ML 3010	Rehabilitation	Exploration Areas
Pit	-15.4330	143.285	ML 2901	Rehabilitation	Adjacent to Alive River Mine Pit
RM1	-15.4313	143.2841	ML 3010	Rehabilitation	Scrap yard
BP1	-15.4533	143.2962	ML 2902	Rehabilitation	Adjacent to Big Blow Borrow Pit
BP2	-15.4516	143.2952	ML 2908	Rehabilitation	Adjacent to Peninsula King Borrow Pit

Note: AS1 has been relocated to the coordinates outlined above.
GDA Geocentric Datum of Australia 94

Slope is only to be monitored at sites located at the Waste Rock Dumps.

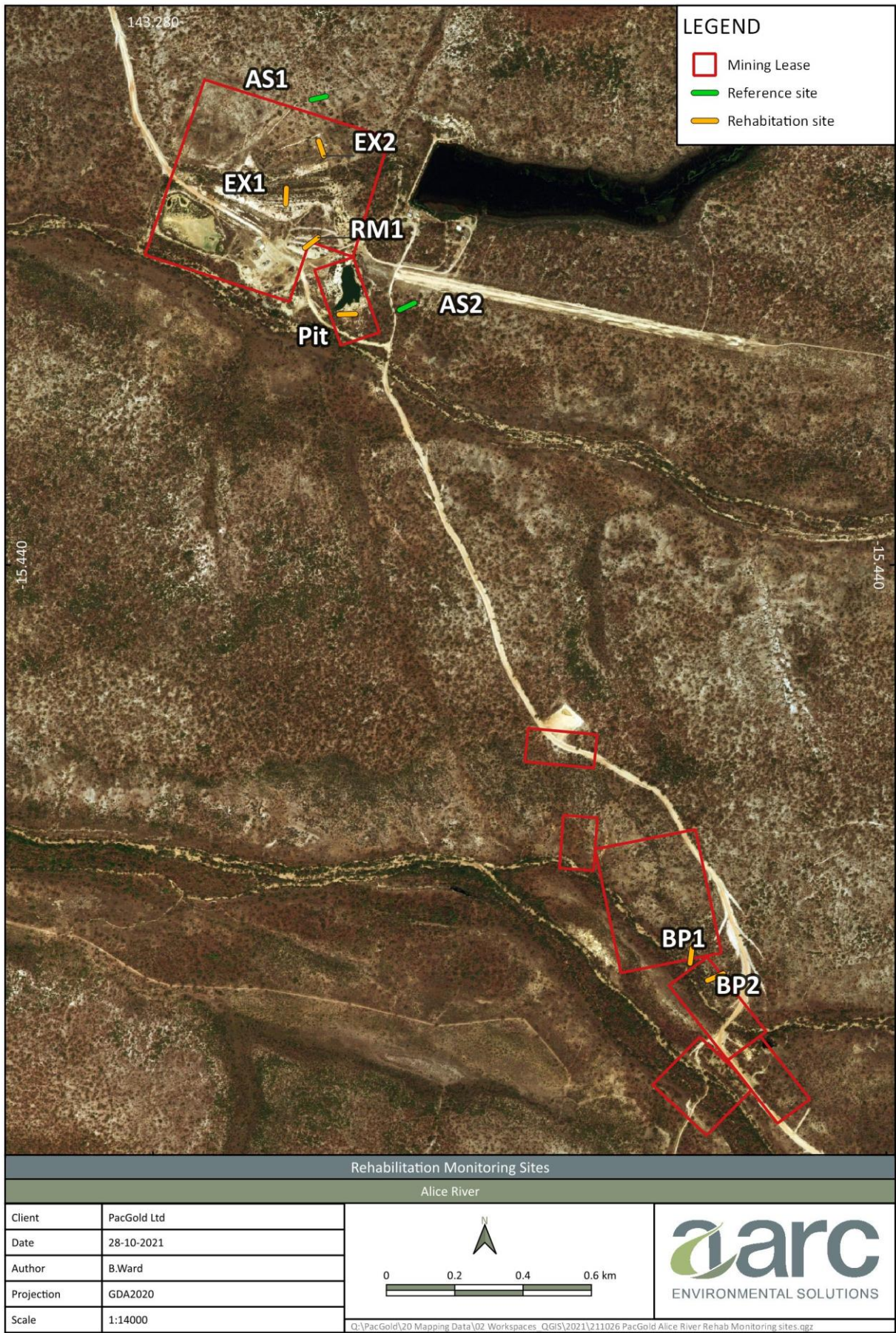


Figure 3: Alice River rehabilitation sites

4 Methodology

The rehabilitation monitoring program was designed to collect sufficient spatial and temporal data to establish statistically valid justifiable conclusions of rehabilitation success. It is recommended that this monitoring program is repeated annually for a minimum of three consecutive years to demonstrate rehabilitation success.

The first rehabilitation monitoring event was undertaken from the 24 – 27 May 2021.

The following methods are employed at each monitoring site:

- permanent vegetation monitoring transect
- erosion monitoring;
- photographic monitoring; and
- topsoil characterisation.

Additionally, observations recorded while walking between the permanent transects were incorporated in the results.

4.1 Permanent vegetation monitoring transects

Permanent vegetation monitoring transects were established across each site (refer Table 4). Monitoring across permanent vegetation transects involves the collection of quantitative data on ground cover composition, species richness, woody stem density, and canopy cover. At each monitoring site a 50 metre (m) tape was run out to establish a transect and observations/measurements were taken every five metres on either side of the transect, thereby representing a plot size of 50 m x 10 m.

Across each transect groundcover, species richness, woody stem and canopy cover were monitored. The survey methodologies outlined below have been adapted from the Queensland Herbarium survey technique (*Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland* (Version 5.0)) (Neldner et al. 2019) and the *Method for the Establishment and Survey of Reference Sites for BioCondition* (Eyre et al. 2017).

4.1.1.1 Ground cover monitoring

This method involved the collection of quantitative data on average ground cover (%) where the percentage of all types of ground cover within ten 1 m x 1 m quadrats was determined. The quadrat was placed every 5 m on alternating sides along the 50 m transect, commencing at 0 m on the left and the final quadrat at 45 m (see Figure 4). In each quadrat the total percentage of ground cover of each plant species in the quadrat was recorded, as well as percentage cover of bare soil, rock, and organic litter. Species were classified into six groups for reporting purposes.

- native pasture grasses;
- exotic pasture grasses;
- non-pasture grasses;
- forb and other non-grass species;
- shrubs;
- restricted invasive plants as listed in the *Biosecurity Act 2014 (QLD)*)

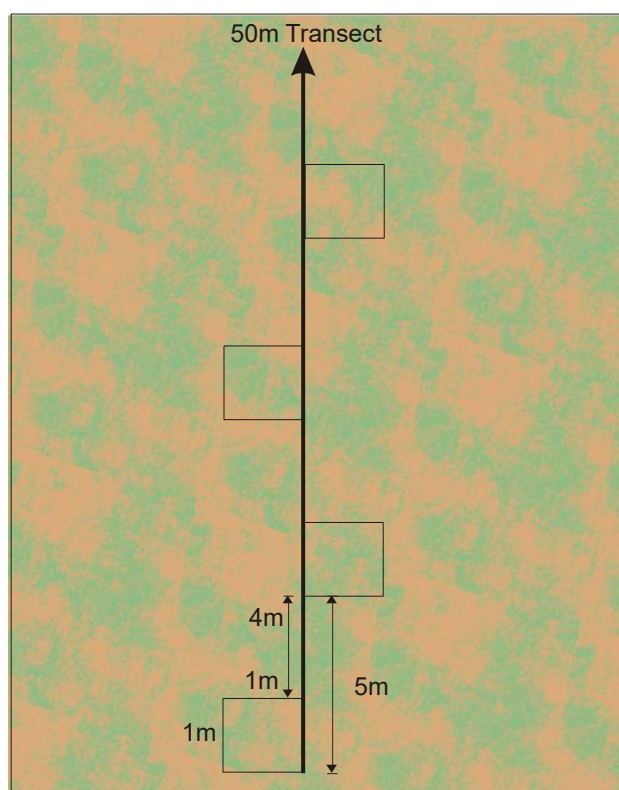


Figure 4: Ground cover percentage sampling

4.1.1.2 Species richness

Species richness was assessed using the method outlined in Eyre et al. (2017) where all vascular plants occurring within a 10 m x 50 m plot area were recorded. The surveyor walked along each side of the 50 m transect centreline and recorded all trees, shrubs, forbs/other species and grasses occurring within 5 m of either side of the centreline. This has been adjusted to a 10 m x 50 m plot area in conjunction with standards adopted by the Queensland Herbarium (Neldner et al. 2019).

Species that could not be identified within the field were collected for later identification or sent to the Queensland Herbarium for identification.

4.1.1.3 Woody stem density

Woody stem density was calculated using methodology adapted from *the Method for the Establishment and Survey of Reference Sites for BioCondition* (Eyre et al. 2017). All woody stems for each tree and shrub species was counted within the 10 m x 50 m plot area (i.e. 5 m either side of each 50 m transect). From this data, both total woody stem density, as well as the density of each individual tree or shrub species was calculated. The density of species and growth forms on the monitoring sites is then calculated using the following equation:

$$\text{Density per hectare (ha)} = \text{Number of stems recorded within the transect} \times 20.$$

4.1.1.4 Canopy Cover

Tree canopy cover can be used to characterise stand productivity and the distribution and abundance of biomass (Eyre et al. 2017). It refers to the estimation of the percentage canopy cover of the living, native tree layer along a 50 m transect, using the line intercept method (Greig-Smith et al. 1964). For this attribute, the vertical projection of tree canopy cover of the species making up the tree canopy cover was assessed. The vertical projection of the tree canopy over the 50 m transect was recorded as illustrated in Figure 5. The total length of the projected canopy of each layer is then divided by the total length of the tape to give an estimate of percentage canopy cover on the site.

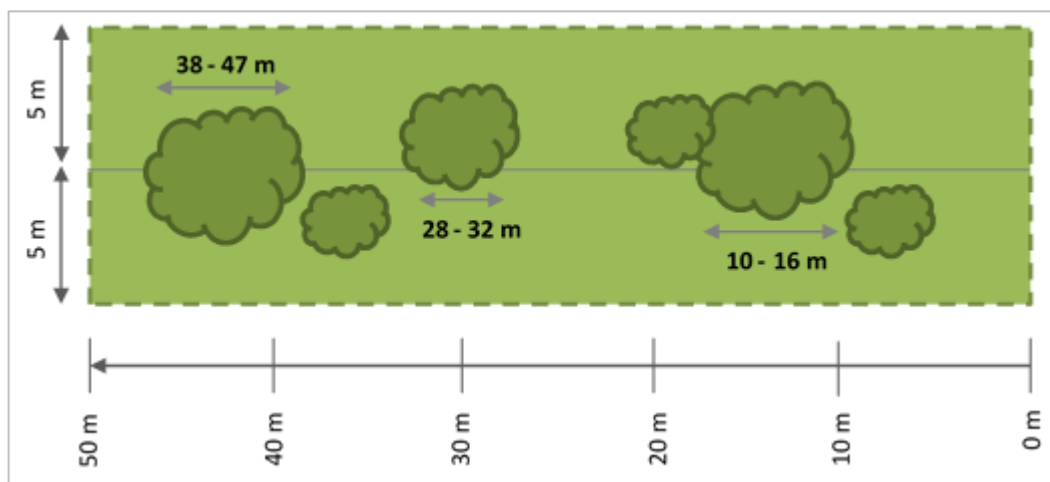


Figure 5: Guide to monitoring canopy cover (after Eyre et al. 2017)

4.2 Erosion monitoring

Erosion at the survey sites was monitored through visual examination. Assessment was undertaken by traversing the 50 m transect on foot and recording the number and average depth of any erosion features or rill lines. Table 5 was used to record and classify these observations. The overall classification of the erosion on each transect is determined by the higher classification attributed to either the number of rills/gullies or the average depth. For example, a transect may present only one or two rills but if these are recorded as being 25 cm deep, the transect will be classified as presenting a Moderate erosion classification.

In addition, the location of any severe erosion outside the transect (i.e. tunnels, mass wasting, large gullies) was recorded and marked with a handheld Global Positioning System (GPS), and the following information recorded:

- GPS reading of location;
- General description of type of erosion (gully, rill line, circular failure, tunnelling etc.) and possible causes;
- Depth of erosion;
- Width of erosion;
- Length of erosion;
- Where eroded material is being deposited; and,
- Whether the erosion line is being stabilised by vegetation.

Table 5: Erosion Characteristics

Erosion characteristics	Minor	Moderate	Severe	Extreme
No. of rills ¹ /gullies	< 15	15–30	31–50	> 50
Average depth (cm)	< 10	10–30	30–60	> 60

¹Source: Australian Soil and Land Survey Field Handbook (National Committee on Soil and Terrain 2009).

4.1 Photographic monitoring

Photographic monitoring at monitoring sites shows a visual comparison over time of the vegetation, ground cover, erosion and general appearance of each monitoring site.

A digital camera was used to take the photos. Photos are retained to provide a permanent record for each monitoring site. The process consisted of taking one photograph from the start of the transect facing towards the end of the transect, and another from the end of the transect facing towards the beginning.

A photo monitoring database can be found in Appendix A2. As this is the first annual monitoring round only images 2021 have been included in Appendix A2. This photo monitoring database will be updated annually after each monitoring round.

4.2 Soil Investigation

A soil investigation was completed across rehabilitation landforms within the Project area. The objectives of this investigation was to:

- Collect sufficient data to infer past rehabilitation methods to inform erosion prediction (WEEP modelling) for PRCP development in 2022; and
- Evaluate soil quality between analogue and sampling sites.

Soil samples were collected at different locations listed in Table 6 and shown in Figure 6 and **Error! Reference source not found..** Samples were sent to a National Association of Testing Authorities (NATA) certified laboratory for both physical and chemical parameters in order to assess whether the topsoil characteristics were consistent with those required to establish and sustain the identified vegetation species diversity on rehabilitated landforms at the Project.

Table 6: Soil sampling sites

Site Name (AR = Alice River)	Coordinates (WGS 84)		Photographed	Sampled
AR1	S15.42804°	E143.28302°	Yes	Yes
AR2	S15.42916°	E143.28296°	Yes	
AR3	S15.42858°	E143.28454°	Yes	Yes
AR4	S15.42964°	E143.28199°	Yes	Yes
AR5	S15.42982°	E143.28364°	Yes	Yes
AR6	S15.43041°	E143.28515°	Yes	Yes
AR7	S15.43043°	E143.28346°	Yes	
AR8	S15.43123°	E143.28405°	Yes	Yes
AR9	S15.43067°	E143.28436°	Yes	
AR10	S15.45326°	E143.29618°	Yes	Yes
AR11	S15.45160°	E143.29519°	Yes	Yes
AR12	S15.42916°	E143.28296°	Yes	Yes
Analogue 1	S15.42727°	E143.28488°	Yes	
Analogue 2	S15.43290°	E143.28699°	Yes	Yes

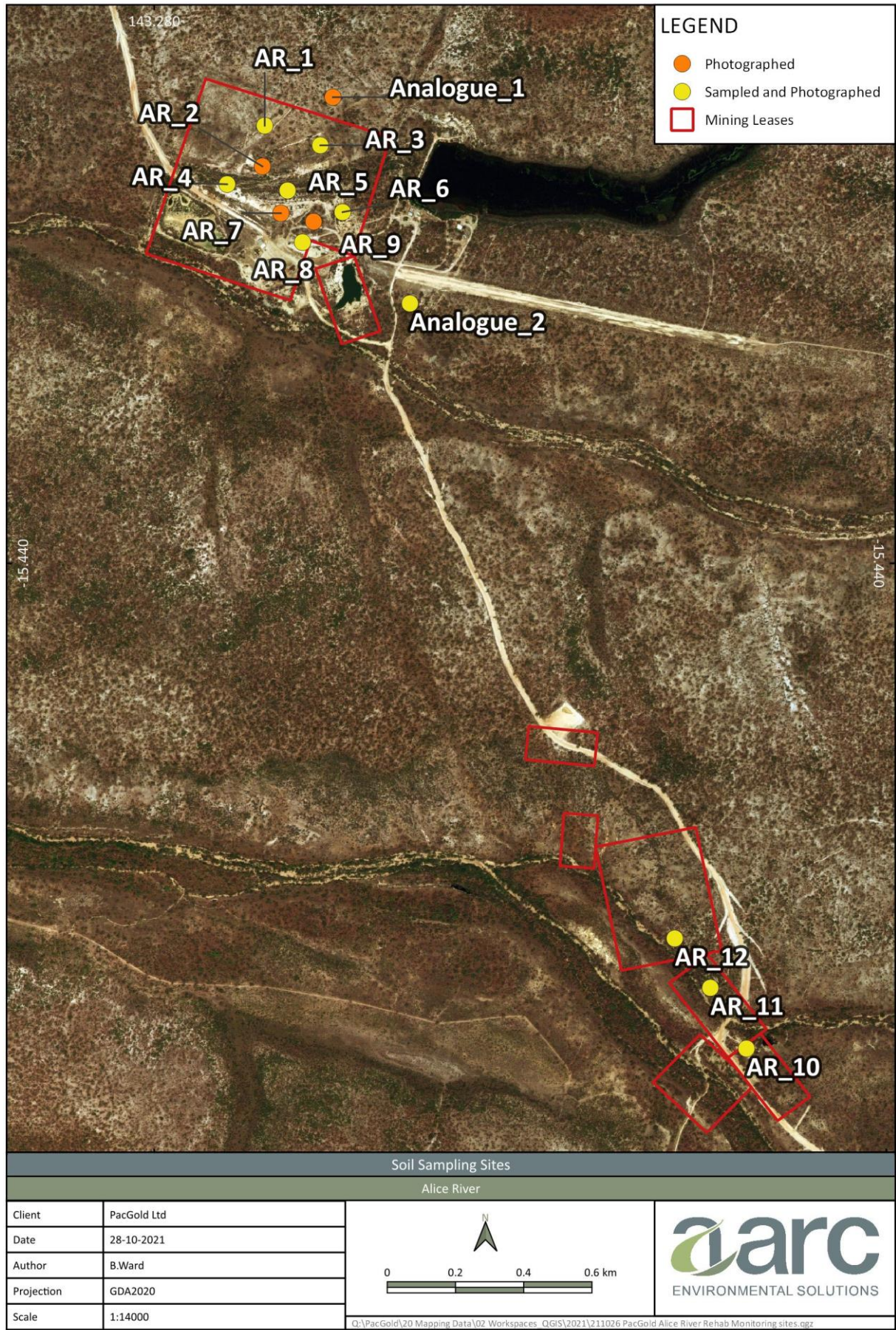


Figure 6: Alice River soil sampling sites

5 Results and interpretation

5.1 Vegetation monitoring

5.1.1 Ground cover monitoring

The complete results of ground cover monitoring for May 2021 are presented in Appendix A1. Table 7 and Figure 7 present mean ground cover for both the reference and rehabilitation sites for the same period.

Total live cover registered on individual sites in the 2021 survey ranged from 25% to 55% across all monitoring sites, with an average ground cover of 33% for analogue sites and 34% for rehabilitation sites. The rehabilitation site RM1 had the highest mean total live cover (55%) of all sites while site AS1 had the highest mean total cover for the analogue sites (37%). The lowest mean total live cover was recorded at rehabilitation site BP1 (25%). There was no significant difference between the live cover at the analogue and rehabilitation sites ($p = 0.91$).

The mean grass cover in 2021 across the analogues was slightly lower than at the rehabilitation sites (analogue 21% and rehabilitation 29%). Grass cover was highest at rehabilitation site RM1 (54%). Native grass cover was highest at rehabilitation site BP2 and exotic grass cover highest at RM1. Species composition was similar between the analogue and rehabilitation sites, with native pasture species cover dominating all sites. There was no significant difference between the grass cover at the analogue sites to the rehabilitation sites ($p = 0.23$).

Mean forb cover was greater at the analogue sites (7%) compared to the rehabilitation sites (2%). The highest forb cover in 2021 was observed across the analogue site AS1 (9%) whereas the highest across the rehabilitation sites was at site EX2 (3%). The lowest forb cover was seen at rehabilitation site 'Pit' with 0%.

Mean shrub cover was slightly higher at analogue sites (5%) than rehabilitation sites (3%) in 2021. The highest shrub cover was observed across the analogue site AS1 (9%) whereas the highest across the rehabilitation sites was at site EX2 (8%). The lowest shrub cover was recorded at analogue site AS2 with 1%.

Mean bare ground was the same at analogue and rehabilitation sites in 2021 (29%). The highest bare ground cover was seen at rehabilitation site 'Pit' with 61%. Mean rock cover was 0% at analogue sites and 8% at rehabilitation sites. Site EX2 had the highest rock cover with 19%.

Litter cover ranged from 2%-45% across all sites. Mean litter cover was higher at analogue sites (37%) than rehabilitation sites (26%) in 2021. The highest litter was recorded at rehabilitation site BP1 (45%) whereas the highest at the analogue sites was at site AS2 (44%). The lowest litter cover was recorded at rehabilitation site RM1 with 2%.

Mean weed cover at the rehabilitation sites was twice that of the analogue sites (rehabilitation 4%, analogue 2%). The highest weed cover was observed at rehabilitation site EX1 (7%), whereas analogue site AS1 was the lowest as well as the only site with 0% weed cover. Weed species recorded include Knobweed (*Hyptis capitata*), Guava (*Psidium guajava*), Stinking Passionfruit (*Passiflora foetida*) and are discussed further in Section 5.1.4.

Monitoring has identified that no active rehabilitation activities have occurred at RM1. Notable remnant mining equipment and waste materials were present around this transect. Although native species have encroached this historical mining disturbance area, it is recommended that this area is declassified as rehabilitation until all historical mining equipment is removed, as this activity will result in the disturbance of the established regrowth vegetation.

Table 7: Mean ground cover across all monitoring sites for 2021

Ground Cover	Analogue			Rehabilitation						
	AS1	AS2	Mean	BP1	BP2	EX1	EX2	RM1	Pit	Mean
Bare ground	34.1	22.9	28.5	13.5	10.4	22.8	34.5	29.8	60.9	28.7
Organic litter	29	44.2	36.6	44.9	44.3	41.5	14.6	2	6.5	25.6
Rock	0	0	0	10.7	4	1	19	9.5	5.8	8.3
Native pasture grass	17.5	21.9	19.7	20.5	36	21.5	10.7	29.5	13.5	22.0
Exotic pasture grass	1.5	1.5	1.5	0.5	0	3.7	4.8	24.4	10.6	7.3
Forbs and other non-grass species	8.9	4.3	6.6	2.2	1.6	1.5	3.4	0.5	0	1.5
Shrubs and trees	9	1	5	2.2	1.5	1.5	8	0.5	2.5	2.7
Weeds	0	4.2	2.1	5.5	2.2	6.5	5	3.8	0.2	3.9
Total Live Cover (ex. Weeds)	36.9	28.7	32.8	25.4	39.1	28.2	26.9	54.9	26.6	33.5

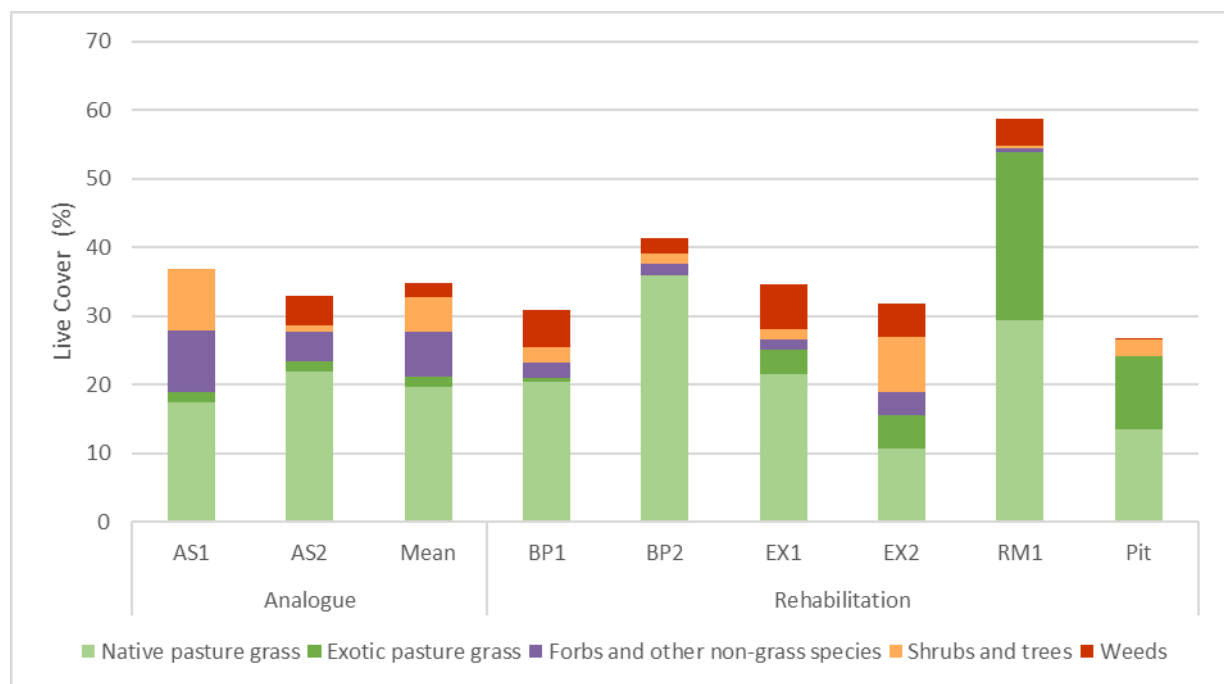


Figure 7: Live ground cover percentage across all monitoring sites for 2021

5.1.2 Species richness

The species richness of analogue and rehabilitation sites is shown in Table 8 and Figure 8 below.

The total species richness across analogue and rehabilitation sites was between 15 to 29 species. The mean species richness for both analogue and rehabilitation sites was 21.5 species. The highest species richness score of all monitoring sites was recorded at rehabilitation site BP2 (29). The highest at the analogue sites was recorded at site AS1 (23). The lowest species richness score was observed at rehabilitation site RM1 with 15 species. There was no significant difference in species richness between the analogue and rehabilitation sites ($p = 1$).

The mean species richness of native and exotic species was higher at the rehabilitation sites (native 7.3, exotic 2.7), than the analogue sites (native 4.5, exotic 1). The difference between the analogue and rehabilitation sites is significant (native $p = 0.02$, exotic $p = 0.03$). This difference between the sites can be attributed to the analogue sites' history of vegetation clearing and cattle grazing.

Table 8: Species richness across all monitoring sites in 2021

Species Richness	Analogue			Rehabilitation						
	AS1	AS2	Mean	BP1	BP2	EX1	EX2	RM1	Pit	Mean
Native pasture grass	4	5	4.5	6	8	10	7	5	8	7.3
Exotic pasture grass	1	1	1	1	1	4	3	4	3	2.7
Forbs and other non-grass species	7	6	6.5	3	8	4	6	3	1	4.2
Shrubs and trees	11	8	9.5	9	12	8	6	3	6	7.3
Weeds	0	1	0.5	2	2	3	2	3	1	2.2
Total Species Richness (ex. Weeds)	23	20	21.5	19	29	26	22	15	18	21.5



Figure 8: Species richness across all monitoring sites in 2021

5.1.3 Woody stem density

The woody stem density of analogue and rehabilitation sites is shown in Table 9 and Figure 9 below.

Stem density varied widely from 300 (RM1) to 1900 (BP1) stems/ha at individual monitoring sites. The mean woody stem density was higher at the rehabilitation sites than analogue sites (rehabilitation 880, analogue 700). There was no significant difference in woody stem density between the analogue and the rehabilitation sites ($p = 0.6$).

Table 9: Woody stem density across all monitoring sites for 2021

Woody Stem Density	Analogue			Rehabilitation						
	AS1	AS2	Mean	BP1	BP2	EX1	EX2	RM1	Pit	Mean
Total Woody Stem Density/ha	540	860	700	1900	1600	300	780	300	400	880.0

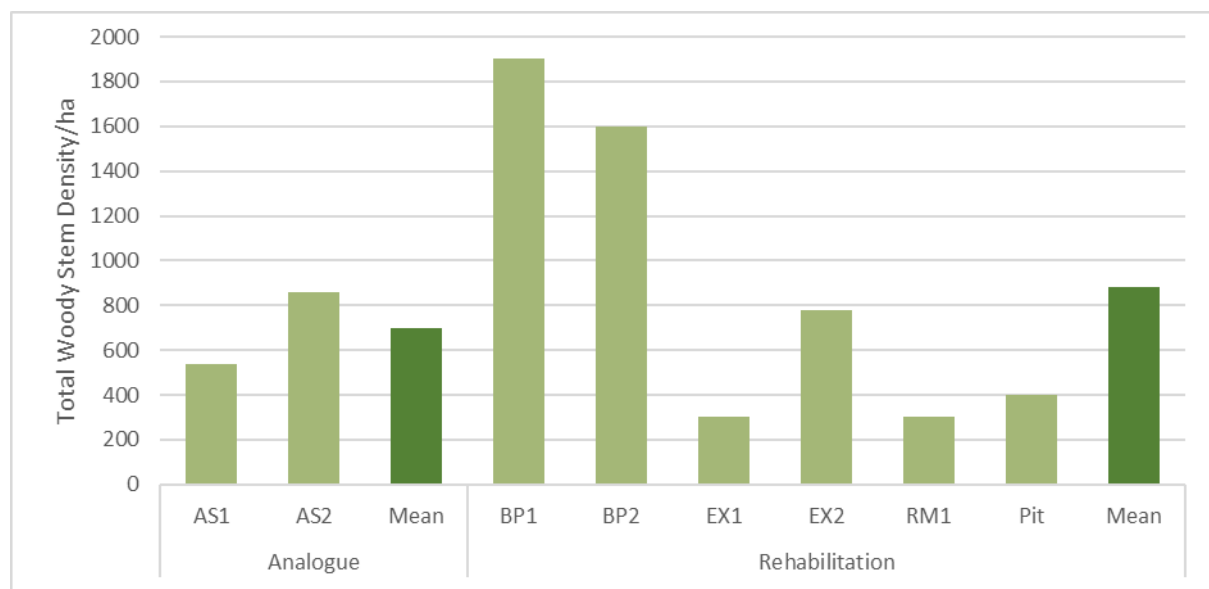


Figure 9: Woody stem density across all monitoring site

5.1.4 Canopy cover

The tree canopy cover across the monitoring sites ranged from 0% (EX1, EX2, RM1, and Pit) to 80% (BP2). The analogue sites had higher mean tree canopy cover (58%) compared to the rehabilitation sites (24%). Shrub canopy cover ranged from 0% (RM1 and Pit) to 12% (AS1). The mean shrub canopy cover was slightly higher at analogue sites (7%) than rehabilitation sites (4.7%). There was no significant difference in tree or shrub canopy cover between the analogue and the rehabilitation sites (tree canopy $p = 0.11$, shrub canopy $p = 0.73$).

Table 10: Canopy cover across all monitoring sites for 2021

Canopy cover (%)	Analogue			Rehabilitation						
	AS1	AS2	Mean	BP1	BP2	EX1	EX2	RM1	Pit	Mean
Tree	50	58	54	64	80	0	0	0	0	24.0
Shrub	12	2	7	6	6	8	8	0	0	4.7

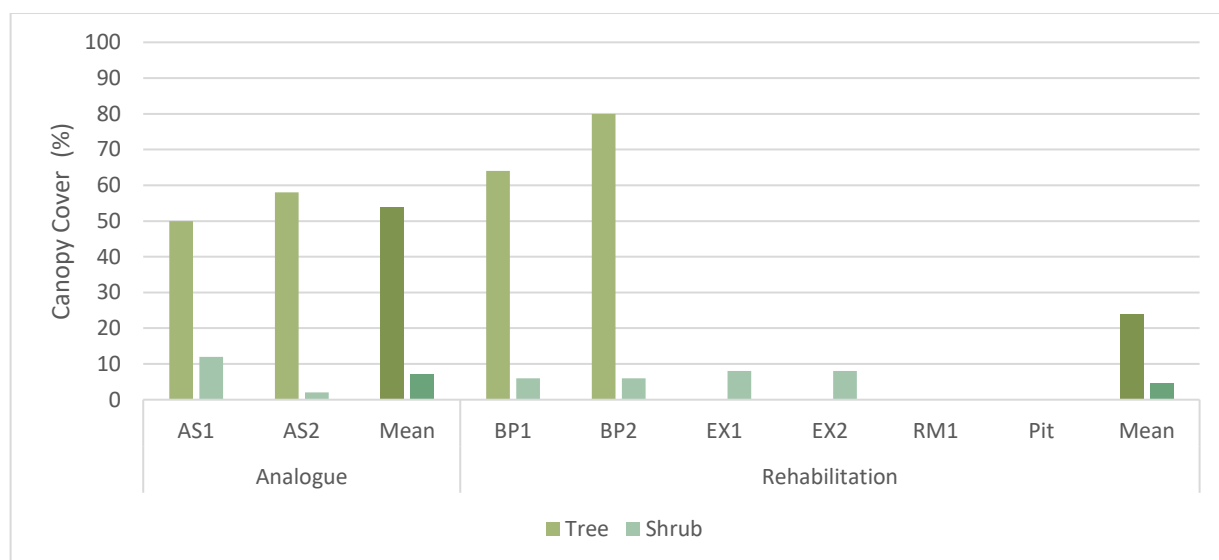


Figure 10: Canopy cover across all monitoring sites

5.1.5 Restricted invasive plant species

Weed species identified during the 2021 monitoring event are detailed in Table 11. No restricted weed species were found at any of the monitoring sites.

Table 11: Weed species across all monitoring sites in 2021

Species Name	Common Name	Status under Biosecurity Act	2021
<i>Hyptis capitata</i>	Knobweed	Invasive	AS2, BP1, BP2, EX1, EX2, RM1, and Pit
<i>Psidium guajava</i>	Guava	Invasive	BP1 and BP2
<i>Silybum marianum</i>	Milk Thistle/Sowthistle	Not listed	EX1

5.2 Erosion monitoring

The analogue sites AS1 and AS2, and rehabilitation sites RM1 and Pit, showed minor levels of erosion (number of rills < 15, average depth < 10 cm). The areas surrounding BP1, BP2, EX1, and EX2 had either topsoil stockpiles or contour banks present within the transect. Erosion characteristics recorded in-situ are presented in Table 12.

Table 12: Erosion characteristics

Erosion Characteristics	Analogue		Rehabilitation					
	AS1	AS2	BP1	BP2	EX1	EX2	RM1	Pit
Number of rills/gullies	Minor	Minor	Area still contains slopes consistent with exploration activities or water management works.				Minor	Minor
Average depth (cm)	Minor	Minor					Minor	Minor

Although there was minor erosion due to historical topsoil stockpiles or contour banks noted at EX1 and EX2, the sites presented as stable. These contours/topsoil stockpiles are not reflective of the surrounding environment and increase the risk of erosion within these rehabilitated areas. Therefore, it is recommended that these topsoil stockpiles or contour banks are removed from the rehabilitated landform.

Minor rills at sites BP1 and BP2 have formed from waste material historically dug from the borrow pits. Monitoring indicates that the rehabilitation is stabilised, however it is recommended the rills are removed as a part of ongoing maintenance activities.

5.1 Topsoil characteristics

A comparative topsoil study was completed at Alice River to evaluate soil quality between reference and impact sites. Topsoil sampling is not considered to be an annual requirement of the rehabilitation monitoring program but was undertaken to assess whether the topsoil characteristics were consistent with those required to establish and sustain the identified vegetation species diversity on rehabilitated landforms at the Project.

The results are displayed in Table 13. Items shaded in orange are considered outside the bounds generally suitable for plant life as defined in various 'best practice' soil sampling resources (Hazelton & Murphy, 2016, Rayment GE & Lyons D 2011, Rayment & Bruce 1984, and Botta 2016).

Table 13: Topsoil analysis

Analyte	Unit	Range	Sites									
			Analogue_2	AR_1	AR_3	AR_4	AR_5	AR_6	AR_8	AR_10	AR_11	AR_12
Physical Parameters												
Moisture Content	%	-	0.4	0.2	15.1	0.6	5.2	0.8	0.2	1	0.9	1.1
Organic Matter	%	1.7-3.0	1.6	0.6	0.7	<0.5	1.4	0.8	<0.5	3.9	2.9	6.3
Soil Particle Density (Clay/Silt/Sand)	g/cm3	-	2.63	2.66	2.75	2.63	2.59	2.6	2.66	2.57	2.56	2.41
Physical Parameters (Particle size)												
Clay (<2 μm)	%	-	13	11	16	7	15	18	7	17	17	18
Coarse Sand (0.2-2.0 mm)	%	-	62	58	31	42	58	54	60	32	33	48
Fine Sand (0.02-0.2 mm)	%	-	12	5	4	3	6	6	3	21	4	11
Gravel (>2mm)	%	-	11	26	45	45	17	19	30	24	39	17
Silt (2-20 μm)	%	-	2	<1	4	3	4	3	<1	6	7	6
General Soil Characteristics												
pH Value	pH Unit	5.5-7.5	5.4	5.3	5.3	5.5	4.9	5.1	5.2	5.7	5.2	5.2
Electrical Conductivity @ 25°C	μS/cm	<450 ²	11	4	7	46	14	6	5	29	10	7
Chloride	mg/kg	<600 ³	<10	<10	<10	60	<10	<10	<10	20	<10	<10
Exchangeable Cations												
Exchangeable Calcium	meq/100g	2-30 ¹	1.3	0.4	0.9	0.2	0.6	0.8	0.4	1.9	1.5	1.6
Exchangeable Magnesium	meq/100g	1-15 ¹	0.4	0.1	0.8	1.1	0.3	0.4	0.2	1	0.8	0.9
Exchangeable Potassium	meq/100g	0.2-2.0	<0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	0.3	0.1	0.2

Analyte	Unit	Range	Sites									
			Analogue_2	AR_1	AR_3	AR_4	AR_5	AR_6	AR_8	AR_10	AR_11	AR_12
Exchangeable Sodium	meq/100g	<0.1	<0.1	<0.1	<0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	meq/100g	6-25 ¹	1.8	0.6	2.4	2.1	1.5	2.3	0.7	3.3	3.1	3.8
Exchangeable Sodium Percent (ESP)	%	<6 ²	<0.1	<0.1	2.9	24.6	1.1	<0.1	<0.1	2.5	0.4	0.7
Calcium/Magnesium Ratio		>1 ¹	3.2	4.0	1.1	0.2	2.0	2.0	2.0	1.9	1.9	1.8
Exchangeable N₂, P												
Nitrite + Nitrate as N (Sol.)	mg/kg	>8	<0.1	0.4	0.2	1.6	4.5	0.2	1.3	0.6	0.7	<0.1
Bicarbonate Ext. P (Colwell)	mg/kg	>10 ¹	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Bicarbonate Ext. K (Colwell)	mg/kg	60-100 ⁴	<100	<100	241	107	<100	101	<100	294	175	321

Note: Items shaded in orange are outside of the bounds generally suitable for plant life.

Sources for guideline values:

- 1 – Hazelton & Murphy, 2016;
- 2 – Rayment GE & Lyons D 2011, (EC limit dependant on soil texture);
- 3 – Rayment & Bruce 1984;
- 4 – Botta 2016;

5.1.1 Physical Parameters

Physical soil parameters are those items which are not based on chemical data and commonly include parameters such as soil moisture, organic matter, particle density and particle size.

When comparing sampling sites to analogue sites, very little variability was observed in soil particle density which reflects the relative composition of clays, silts and sands present. Soil moisture percentage was 0.4% at the analogue site while at the sampling sites the soil moisture ranged from 0.2% and 15.1%.

Organic matter across sites ranged from high (6.3%, site AR12), to extremely low (< 0.7, site AR1 and site AR8). Samples with values 3.00% to 5.15% are considered to have good structural condition and high structural stability. Most samples contained low (1.0-1.7) to very low (0.7-1.0) levels of organic matter which means the soil has poor structural condition and low structural stability.

Samples from all sites have a high concentration of coarse sand and gravel which may indicate a reduced water holding capacity. Although this is not uniformly seen in the soil moisture results for site AR3 with 15.1% soil moisture and a particle composition of 45% gravel, 31% coarse sand, 16% clay, and 3% for fine sand and silt each.

A mix of particle sizes is preferred to avoid the development of preferential flow paths. Additionally, a combination of clay and sand in the soil will allow water to permeate, allowing it to become available for plant use, however high sand content can reduce soil water-holding capacity. Soils with a very high sand content may be prone to slumping if they do not have enough plant cover. High clay content in soil helps to increase water holding capacity as water molecules can be held between clay particles. Soil binding capacity also increases with clay content if the soil is not dispersive. The development of organic matter in soils is also important, particularly for rehabilitated areas and can be accelerated by controlled grazing of rehabilitated sites.

5.1.2 General Soil Characteristics

General soil characteristics include pH, electrical conductivity (EC) and chloride content. These characteristics assist in defining the soil's ability to support plant life. pH values should generally measure between 5.5 and 7.5, as the availability of nutrients decreases outside of these limits. The analogue site registered a pH of 5.4, all sites at sampling sites registered pH between 5.2 and 5.7. Apart from sites AR4 and AR10, all sites are contained acidified soils which are typical for soils in the region.

EC and chloride results help interpret the salinity of the soil. High soil salinity can have a detrimental impact on plant health if it is too high both from the toxicity effect of certain salt ions as well as reducing the ability of a plant to absorb water from soil. No sites demonstrated elevated EC or chloride results.

5.1.3 Exchangeable Cations

The concentrations and ratios of exchangeable cations can impact the nutrient capacity and dispersive nature of a soil body. Of particular importance to dispersion is the percentage of exchangeable sodium (ESP), and ratio of calcium to magnesium (Ca:Mg ratio). Ultimately, however, the cation exchange capacity (CEC) of the soil determines how much impact these factors will have, as they operate based on a soil's clay content and ability to hold ions. Soils with a low cation exchange capacity has less resistance to changes in soil chemistry caused by land use.

Analogue and sampling sites at Alice River indicate soil dispersion is likely. All sites were below the recommended CEC range of values. However, only site AR4 had Exchangeable Sodium Percent (ESP) (24.6%), and the Calcium to Magnesium Ratio (Ca:Mg) (0.2) values outside the recommended values (ESP < 6, Ca:Mg > 1). The ESP and Ca:Mg ratios of all other sites were within the recommended range.

5.1.4 Exchangeable Phosphorous, and Nitrogen

Exchangeable nitrogen and phosphorous are considered two of the most important macro-nutrients used by plants and are key to increasing the carrying capacity of the soil.

Nitrate (the plant available nitrogen) concentrations were extremely low across all sites (< 0.1 mg/kg to 1.6 mg/kg). For the analogue site, nitrate levels are below the desirable levels (>8 mg/kg) and therefore nitrogen deficiency may be limiting plant growth. Eight out of twenty-one rehabilitation sites exhibited Nitrate levels below 8 mg/kg, with the remaining sampling sites presenting nitrate concentrations conducive to healthy plant growth.

From the results of this testing, it is apparent that nitrogen is a likely limiting factor in the natural environment of the mine site. Consequently, where similar results are observed at sampling sites, this should not be considered abnormal.

‘Colwell P’ is a measure of immediately available phosphorus plus the phosphorus that is absorbed to the soil and released over the next few years. Phosphorus concentrations were extremely low across all sites (< 5 mg/kg). and did not meet the recommended levels for plant growth (> 10).

Estimating critical values for phosphorus requires local knowledge of soil and climatic conditions. Therefore, local advisers should be consulted to obtain recommendations on the addition of phosphorus fertilisers (Hazelton & Murphy 2016).

‘Colwell K’ is a measure of immediately available potassium plus the potassium that is absorbed to the soil and released over the next few years. Potassium concentrations exceeded the recommended range (60-100 mg/kg) at sites AR3 (241 mg/kg), AR4 (107 mg/kg), AR6 (101 mg/kg), AR10 (294 mg/kg), AR11 (175 mg/kg), and AR12 (321 mg/kg).

6 Conclusions and recommendations

This Progressive Rehabilitation Monitoring Report aimed to assess the success of existing rehabilitation of the Alice River exploration areas, mine pits, and ROM pad. Specifically, this report examines trends observed over the current monitoring event and across years, in relation to the rehabilitation goals of self-sustaining land use and stable condition. Objectives relating to revegetation success and erosion have been assessed as per the Rehabilitation Design Report (AARC 2019).

Of the completion criteria identified in Section 2.2, EA condition (F2-1a) is considered relevant to the vegetation monitoring:

(F2-1) Areas which are to be rehabilitated / progressively rehabilitated to grazing pasture must comply with the following outcomes;

- a) Generate a self sustaining vegetation with projective cover, species composition and species distribution comparable to analogue sites at two locations (E 744882, N 8292570 adjacent to processing area and E 745297, N 8292349 adjacent to airstrip) identified as AS1 and AS2 on Schedule I – Figure 1 – Authorised Activities and locations*

This encompasses the ground cover assessment (section 6.1.1), the species richness and composition assessment (section 6.1.2), woody stem density assessment (section 6.1.3), canopy cover assessment (section 6.1.4), noxious weed species identification (section 6.1.5)

The EA condition (F2-1c) is considered relevant to the ground cover assessment (section 6.1.1) and the assessment of erosion characteristics (section 6.1.6):

- c) Landforms are stable with rates of erosion comparable to analogue sites;*

For the given site, analogue data is integral to the applied completion criteria, giving a reference point for rehabilitation goals. The findings of the rehabilitation assessment for the progression towards achieving the stated rehabilitation completion criteria are described below along with recommendations for ongoing management and enhancement of the rehabilitation areas.

The post-mining land use (PMLU) for all rehabilitation sites is low intensity grazing as outlined in Table 3. A Table 14: PMLU acceptance criteria status summary of the monitoring results against the acceptance criteria required for the PMLU is outlined in Table 14.

6.1.1 Ground cover

Monitoring results and statistical testing of mean live ground cover percentage revealed no significant differences exist between the analogue and rehabilitation sites. The ground cover percentage at the rehabilitation sites is currently comparable to the analogue sites. To meet the EA condition (F2-1a), the vegetation must also be self-sustaining. A self-sustaining ground cover composition is reliant on adequate foliage cover and organic litter cover. Litter cover is likely to improve with time as woody stem species become established and biomass accumulates. Over time, monitoring efforts will ascertain whether the vegetation at the rehabilitation sites is self-sustaining and meeting the EA condition (F2-1a). The presence of live ground cover is important to achieving EA condition (F2-1c) as vegetation stabilises soils and reduces erosion risk when there is more than 30% live cover (Qld Government, 2020).

It is recommended that RM1 is declassified as rehabilitation due to the retained mining waste materials in the area. It should not be considered eligible for rehabilitation monitoring until the mining waste material has been removal, and vegetation has had time to recover from the disturbance created by the waste removal.

6.1.2 Species richness

The key findings of the species richness analysis were that there was no significant difference between the analogue and rehabilitation sites regarding total species richness. There was a significant difference in the presence of native and exotic pasture grasses. However, as the difference was due to the rehabilitation sites exceeding the analogue sites in grass species richness, it indicates the rehabilitation sites are on course to achieving the post mining land use (low intensity grazing). Future monitoring efforts will determine if the species richness and composition is self-sustaining as per EA condition (F2-1a).

6.1.3 Woody stem density

Statistical analysis of the mean stem density between the analogue and rehabilitation sites revealed no significant difference ($p = 0.6$). A self-sustaining ground cover composition is reliant on adequate foliage cover and organic litter cover. As previously demonstrated, the rehabilitation sites are achieving live foliage cover levels consistent with analogue site conditions. Vegetation is more likely achieve 'self-sustaining' criterion if litter cover is present which requires the establishment of woody stem species and the accumulation of biomass.

6.1.4 Canopy cover

At the time of the monitoring, May 2021, the mean tree and shrub canopy cover across the rehabilitation sites was comparable to the analogue sites. Given that no significant differences in mean canopy cover have been identified between the analogue and rehabilitation sites, the sites are on course to meeting EA condition (F2-1a).

Ongoing weed management and supplementary planting of long-lived canopy species may be required to enhance canopy cover in some areas.

6.1.5 Restricted invasive species

Weed diversity and density across the rehabilitation areas was slightly higher than the analogue sites. However, none of the weeds identified were noxious or considered a biosecurity concern.

Future monitoring efforts in combination with consistent weed management controls, will prevent the noxious weeds becoming established in the rehabilitation areas and inhibiting sites achieving EA condition (F2-1a).

6.1.6 Erosion monitoring

The completion criteria considered relevant to the assessment of erosion is as follows:

- d) Landforms are stable with rates of erosion comparable to analogue sites;*

As mentioned in section 5.2, whilst rehabilitation sites BP1, BP2, EX1, and EX2 are stable, further work is required before the sites are considered are comparable to analogue sites. Rehabilitation sites surveyed (RM1 and Pit), only minor erosion was recorded. This is comparable to the minor erosion seen at the analogue sites. All landforms must be assessed and deemed stable and comparable to the analogue sites before EA condition (F2-1c) is achieved.

6.1.7 Topsoil characterisation

When comparing impact sites to analogue sites, very little variability was observed in the physical and chemical parameters. The soils are naturally acidic, prone to dispersion, and lacking in exchangeable phosphorous and nitrogen. Local advisers should be consulted to obtain recommendations on the addition of phosphorus fertilisers. Future topsoil sampling is not recommended unless areas have not been able to establish self-sustaining vegetation.

6.1.8 PMLU acceptance criteria

The PMLU for all rehabilitation sites is low intensity grazing. A Table 14: PMLU acceptance criteria status summary of the monitoring results against the acceptance criteria required for low intensity grazing is outlined in Table 14.

Table 14: PMLU acceptance criteria status

Acceptance Criteria	BP1	BP2	EX1	EX2	RM1	Pit
Evidence in rehabilitation report that ground is structurally safe and sound.	✓	✓	✓	✓	✓	✓
Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2).	✓	✓	✓	✓	Work required	✓
Water quality in the receiving environment is consistent with upstream levels.	Not assessed in this report					
Rate of erosion is consistently similar to analogue sites (AS1, AS2).	Work required	Work required	Work required	Work required	✓	✓
Pasture productivity is consistently similar to analogue sites (AS1, AS2).	Not assessed in this report					
Land capability assessment identifies a minimum of Class VII as per post mine land capability.	Not assessed in this report					

✓ = on track

Water quality was not assessed in this report but is detailed in separate report. Neither pasture productivity nor land capability assessments were conducted as part of the monitoring methodology.

6.1.9 Future monitoring

It is recommended that rehabilitation monitoring continue to be conducted annually in late May. In addition to the vegetation and erosion monitoring, it is recommended that pasture productivity also be measured. This can be done numerous ways with varying levels of sophistication. The RDR recommends the use of a pasture meter, however that equipment may not be readily available to surveyors. Alternatively, once a scale has been measured and implemented, sites could be readily matched to the photo standards publish by Future Beef and the corresponding estimate of kg/ha.

Additionally, it is recommended that the Project EA completion criteria and the acceptance criteria are updated from using the land capability classifications to using the land suitability classifications. Land suitability assessments are more current and used more broadly in land use classifications. Both are labour intensive assessments and would require more detailed monitoring outside the scope of the standard annual rehabilitation monitoring. It is recommended a land assessment is conducted five years after rehabilitation works have been completed and/or at such time when the area is nearing rehabilitation certification.

7 References

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A1 2021 Rehabilitation monitoring database

Transect Name	Canopy Cover				Layer Heights (m)								Erosion						Photo Start			095221	
AS1	Tree Total (m)	25	Shrub Total (m)	6	E	T1	T2	T3	S1	S2	G	No. of rills/gullies < 15	Minor	Average Depth	< 10	Minor		Photo End	100050				
RE Code:	Tree Total (%)	50	Shrub Total (%)	12	16	12	8	4	0.5		0.4	Remainder											
3.12.10													100	100	100	100	100	100	100				
Notes	land is shallow coarse sand of quartz sand. Open woodland, bare ground was used to include the sandy quartz as opposed to clear rocks.											Quadrat Totals	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean
												Bare Ground	83	40	25	15	10	53	35	10	40	30	34.1
												Organic Litter	10	35	40	40	10	15	20	60	30	30	29
												Rock											0
Sample Identification				Species Dominance																			
Number of Plants	Field Name	Species Name	Common Name	Growth Type	E	T1	T2	T3	S1	S2	G	Stem Count	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	
1		Melaleuca viridiflora	Broad Leaved Paperbark	Native Tree			Dom	Dom				17				10			10			20	4
2		Corymbia clarksoniana	Clarkson's Bloodwood	Native Tree	Dom							2											0
3		Eremophila mitchellii	False Sandalwood	Native Tree				Pre															0
4		Heteropogon triticeus	Giant Speargrass	Native Grass							Cdom												0
5		Commelina agrostophylla	Wandering Jew	Native Forb/Herbaceous							Occ		2					5					0.7
6		Alternanthera denticulata	Lesser Joyweed	Native Forb/Herbaceous							Occ												0
7		Sida subspicata	Spiked Sida	Native Forb/Herbaceous					Pre									2					0.2
8		Erythrophleum chlorostach	Cooktown Ironwood	Native Tree			Ass					5											0
9		Grevillea pteridifolia	Golden Parrot Tree	Native Shrub			Occ					1											0
10		Alphitonia pomaderroides	Soapbush	Native Shrub				Pre															0
11		Spermacoce sp		Native Forb/Herbaceous							Pre		5			5		20		10	30		7
12		Acacia holosericea	Silver Wattle	Native Shrub				Pre				2			15								1.5
13		Schizachyrium fragile	Firegrass	Native Grass							Cdom				10	15		5	35	20			8.5
14		Corymbia dallachiana	Dallachy's Gum	Native Tree		Pre																	0
15		Wahlenbergia gracilis	Native Bluebell	Native Forb/Herbaceous																			0
16		Polycarpaea spirostylis	Copper Bush	Native Forb/Herbaceous										5		5							1
17		Goodenia armitiana	Fine Goodenia	Native Forb/Herbaceous																			0
18		Hibiscus meraukensis	Bush Hibiscus	Native Shrub																			0
19		Grewia retisifolia	Dysentery Bush	Native Shrub																			0
20		Enneapogon polyphyllus	Leafy Nineawn	Native Grass												80							8
21		Mallotus polyadenos	Red Kamala	Native Shrub										15								20	3.5
22		Chamaecrista rotundifolia	Wynn Cassia	Pasture Grass										5		10							1.5
23		Eulalia aurea	Silky Browntop	Native Grass											10								1

Transect Name	Canopy Cover				Layer Heights (m)								Erosion						Photo Start		092344		
AS2	Tree Total (m)	29	Shrub Total (m)	1	E	T1	T2	T3	S1	S2	G	No. of rills/gullies < 15	Minor	Average Depth	< 10	Minor		Photo End	094109				
RE Code:	Tree Total (%)	58	Shrub Total (%)	2	18	16	10		1.5		0.3	Remainder											
3.12.42													100	100	100	100	100	100	100	100	100		
Notes	e quartz sand as soil. start on right hand side. evidence of historic fire, and ash buildup. adjacent to airstrip. Not landzo											Quadrat Totals	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean
												Bare Ground		34	40	5	20	20	40	30	30	10	22.9
												Organic Litter	74	34	39	60	70	58	27	10	20	50	44.2
												Rock											0
Sample Identification				Species Dominance								Stem Count											
Number of Plants	Field Name	Species Name	Common Name	Growth Type	E	T1	T2	T3	S1	S2	G		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	
1		Corymbia clarksoniana	Clarkson's Blood	Native Tree								1								10		1	
2		Eucalyptus cullenii	Cullen's Ironbark	Native Tree																		0	
3		Panicum decompositum	Native Millet	Native Grass									4	30	15			10	5		10	7.4	
4		Setaria surgens	Pigeon Grass	Native Grass																		0	
5		Erythrophleum chlorostach	Cooktown Ironw	Native Tree								5										0	
6		Eucalyptus tetradonta	Darwin's Stringy	Native Tree								35										0	
7		Xanthorrhoea johnsonii	Northern Forest	Native Tree																		0	
8		Heteropogon triticeus	Giant Speargrass	Native Grass																	20	10	3
9		Chamaecrista rotundifolia	Wynn Cassia	Pasture Grass																15		1.5	
10		Cymbopogon refractus	Barbed-wire Gra	Native Grass																		0	
11		Hyptis capitata	Knobweed	Weed									20	2	1	10	2		7			4.2	
12		Schizachyrium fragile	Firegrass	Native Grass												10	5	10	20	30	20	20	11.5
13		Sida corrugata	Corrugated Sida	Native Forb/Herbaceous											5		3					0.8	
14		Corymbia dallachiana	Dallachy's Gum	Native Tree								1										0	
15		Goodenia armitiana	Fine Goodenia	Native Forb/Herbaceous														2				0.2	
16		Phyllanthus maderspatensis	Spurge	Native Forb/Herbaceous																		0	
17		Brachychiton vitifolius		Native Forb/Herbaceous																		0	
18		Spermacoce sp		Native Forb/Herbaceous											15				1	5		10	3.1
19		Alphitonia excelsa	Soap Bush	Native Shrub																		0	
20		Acacia sp		Native Shrub								1										0	
21		Glycine tomentella	Wooly Glycine	Native Forb/Herbaceous										2								0.2	

Transect Name	Canopy Cover				Layer Heights (m)								Erosion						Photo Start		075602		
BP1	Tree Total (m)	32	Shrub Total (m)	3	E	T1	T2	T3	S1	S2	G	No. of rills/gullis < 15	Minor	Average Depth	< 10	Minor		Photo End	080505				
RE Code:	Tree Total (%)	64	Shrub Total (%)	6		16	8	4	2	1	0.3	Remainder											
													100	100	100	100	100	100	100	100	100	100	
Notes												Quadrat Totals	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean
												Bare Ground	10		65	45			15				13.5
												Organic Litter	50	40	10	50	51	86	72	25	15	50	44.9
												Rock	30	10	10	5	2			15	15	20	10.7
Sample Identification				Species Dominance																			
Number of Plants	Field Name	Species Name	Common Name	Growth Type	E	T1	T2	T3	S1	S2	G	Stem Count	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	
1		Hyptis capitata	Knobweed	Weed																10	10	5	2.5
2		Acacia sp		Native Shrub								28		10									1
3		Melaleuca nervosa	Fibrebark	Native Tree								29			5		2						0.7
21		Cyanthillium cinereum	Little Ironweed	Native Forb/Herbaceous															2	5			0.7
5		Schizachyrium fragile	Firegrass	Native Grass										40	10				5	15	30	5	10.5
6		Erythrophleum chlorostach	Cooktown Ironw	Native Tree								2											0
7		Corymbia clrksoniana	Clarkson's Blood	Native Tree								19							5				0.5
8		Eriachne obtusa	Northern Wande	Native Grass																			0
9		Breynia oblongifolia	Coffee Bush	Native Shrub								14											0
10		Heteropogon triticeus	Giant Speargrass	Native Grass													15	10		30	30	15	10
11		Eragrostis lacunaria		Native Grass																			0
12		Trema tomentosa	Poison Peach	Native Shrub																			0
13		Stylosanthes hamata	Caribbean Stylo	Pasture Grass																		5	0.5
14		Panicum decompositum	Native Millet	Native Grass																			0
15		Mallotus polyadenos	Red Kamala	Native Shrub																			0
16		Cheilanthes tenuifolia	Rock Fern	Native Forb/Herbaceous									10					2					1.2
17		Sporobolus diandrus	Tussoky sporob	Native Grass																			0
18		Tephrosia leptoclada	Slender Tephros	Native Forb/Herbaceous														2	1				0.3
19		Corymbia dallachiana	Dallachy's Gum	Native Tree								3											0
20		Psidium guajava	Guava	Weed								3					30						3
21		Petalostigma pubescens	Quinine Bush	Native Shrub																			0

Transect Name	Canopy Cover				Layer Heights (m)							Erosion						Photo Start		083107			
BP2	Tree Total (m)	40	Shrub Total (m)	3	E	T1	T2	T3	S1	S2	G	No. of rills/gullis < 15	Minor	Average Depth	< 10	Minor		Photo End		084309			
RE Code:	Tree Total (%)	80	Shrub Total (%)	6		12	6		1		1	Remainder											
													100	100	100	100	100	100	100	100	100	100	
Notes												Quadrat Totals	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean
												Bare Ground	0	0	0	65	5		5	15	10	4	10.4
												Organic Litter	70	5	18	5	74	75	55	51	50	40	44.3
												Rock	10	0	0	10	10	0	0	10	0	0	4
Sample Identification					Species Dominance																		
Number of Plants	Field Name	Species Name	Common Name	Growth Type	E	T1	T2	T3	S1	S2	G	Stem Count	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	
1		Brunonia australia	Blue Pincushion	Native Forb/Herbaceous																		1	0.1
2		Panicum decompositum		Native Grass															15		15	20	5
3		Eriachne obtusa	Northern Wand	Native Grass																			0
4		Erythrophleum chlorostach	Cooktown Ironw	Native Tree								4											0
5		Jacksonia thesioides		Native Shrub								2											0
6		Alternanthera denticulata	Lesser Joyweed	Native Forb/Herbaceous																			0
7		Acacia sp		Native Shrub								37						5					0.5
8		Lamprolobium fruticosum		Native Forb/Herbaceous																			0
9		Eriachne armitii	Long-awn Wand	Native Grass															15			30	4.5
10		Bossiaea armitii		Native Forb/Herbaceous								15							10				1
11		Chamaecrista rotundifolia	Wynn Cassia	Pasture Grass																			0
12		Spermacoce sp		Native Forb/Herbaceous													1			2			0.3
13		Petalostigma pubescens	Quinine Bush	Native Shrub																			0
14		Macroptilium atropurpureu	Siratro	Native Forb/Herbaceous																			0
15		Alphitonia excelsa	Soap Bush	Native Shrub								2											0
16		Heteropogon triticeus	Giant Speargrass	Native Grass													5	5		15			2.5
17		Psidium guajava	Guava	Weed								10											0
18		Evolvulus alsinoides	Tropical Speedw	Native Forb/Herbaceous																			0
19		Planchonia careya	Cocky Apple	Native Shrub								1											0
20		Aristida latifolia	Feathertop Wire	Native Grass														15					1.5
21		Sporobolus diandrus	Tussoky sporoba	Native Grass									15										1.5
22		Sida corrugata	Corrugated Sida	Native Forb/Herbaceous											2								0.2
23		Erythroxylum australe	Cocaine Bush	Native Shrub								9											0
24		Melaleuca viridiflora	Broad Leaved Pa	Native Tree								2											0
25		Breynia oblongifolia	Coffee Bush	Native Shrub								1											0
26		Melaleuca nervosa	Fibrebark	Native Tree								4											0
27		Hyptis capitata	Knobweed	Weed												10				2	5	5	2.2
28		Mallotus polyadenos	Red Kamala	Native Shrub								8											0
29		Corymbia dallachiana	Dallachy's Gum	Native Tree								10	5				5			5	10		1
30		Schizachyrium fragile	Firegrass	Native Grass											95	80	10						20
31		Eulalia aurea	Silky Browntop	Native Grass																	10		1

Transect Name	Canopy Cover				Layer Heights (m)								Erosion						Photo Start		103956			
EX1	Tree Total (m)		Shrub Total (m)	4	E	T1	T2	T3	S1	S2	G	No. of rills/gullies < 15		Minor	Average Depth	< 10	Minor	Photo End		104755				
RE Code:	Tree Total (%)		Shrub Total (%)	8	10	8	4		1.2	0.5	0.2	Remainder												
													100	100	100	100	100	100	100	100	100	100		
Notes												Quadrat Totals	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean	
												Bare Ground	30	30	15			40	53				60	22.8
												Organic Litter	30	10	70	60	25	10	15	90	100	5	41.5	
												Rock	10										1	
Sample Identification				Species Dominance																				
Number of Plants	Field Name	Species Name	Common Name	Growth Type	E	T1	T2	T3	S1	S2	G	Stem Count	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10		
1		Aristida latifolia	Feathertop Wire	Native Grass																			0	
2		Alphitonia pomaderroides	Soapbush	Native Shrub								1											0	
3		Melinis repens	Red Natal	Pasture Grass														10	2				1.2	
4		Hyptis capitata	Knobweed	Weed														15	5			35	5.5	
5		Chrysopogon fallax	Golden Beardgrass	Native Grass																			0	
6		Passiflora foetida	Stinking Passion	Weed																			0	
7		Acacia holosericea	Silver Wattle	Native Shrub								8							10				1	
8		Sida subspicata	Spiked Sida	Native Forb/Herbaceous																			0	
9		Melaleuca viridiflora	Broad Leaved Paperbush	Native Tree								3											0	
10		Eriachne armitii	Long-awn Wandoo	Native Grass																			0	
11		Commelina agrostophylla	Wandering Jew	Native Forb/Herbaceous									5										0.5	
12		Silybum marianum	Milk Thistle	Weed															10				1	
13		Perotis rara	Comet Grass	Pasture Grass																			0	
14		Erythrophleum chlorostachy	Cooktown Ironwood	Native Tree								1											0	
15		Sporobolus australasicus	Australian Dropseed	Native Grass																			0	
16		Acacia sp		Native Shrub								2											0	
17		Fimbristylis tetragona	Four-ridged Fringe	Native Sedge																			0	
18		Stylosanthes hamata	Caribbean Stylo	Pasture Grass											5								0.5	
19		Eulalia aurea	Silky Browntop	Native Grass																			0	
20		Sida corrugata	Corrugated Sida	Native Forb/Herbaceous										10									1	
21		Carissa ovata	Currant Bush	Native Shrub																			0	
22	Matchbox Wood			Native Shrub																			0	
23		Panicum trichoides		Native Grass									20	40			60	5					12.5	
24		Trema tomentosa	Poison Peach	Native Shrub									5										0.5	
25		Heteropogon triticeus	Giant Speargrass	Native Grass										10									1	
26		Cynodon dactylon	Green Couch	Native Grass											10	30	5	5					5	
27		Chamaecrista rotundifolia	Wynn Cassia	Pasture Grass												10	10						2	
29		Schizachyrium fragile	Firegrass	Native Grass													15						1.5	
30		Eriachne obtusa	Northern Wandoo	Native Grass															5	10			1.5	

Transect Name	Canopy Cover				Layer Heights (m)							Erosion						Photo Start		091122			
EX2	Tree Total (m)	0	Shrub Total (m)	0	E	T1	T2	T3	S1	S2	G	No. of rills/gullies < 15	Minor	Average Depth	< 10	Minor							
RE Code:	Tree Total (%)		Shrub Total (%)	0		5	1.5		1		0.5	Remainder											
Notes													100	100	100	100	100	100	100	100	100	100	
												Quadrat Totals	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean
												Bare Ground	25	25	38	39	40	88	10	45	30	5	34.5
												Organic Litter	40	10	14	20	2	5	5	15	10	25	14.6
												Rock				10	20	5	85	30	40		19
Sample Identification					Species Dominance							Stem Count											
Number of Plants	Field Name	Species Name	Common Name	Growth Type	E	T1	T2	T3	S1	S2	G		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	
1		Melaleuca nervosa	Fibrebark	Native Tree								34		50	17					10		7.7	
2		Erythrophleum chlorostach	Cooktown Ironw	Native Tree								1			3							0.3	
3		Acacia sp		Native Shrub								3										0	
4		Pittosporum spinescens	Wallaby Apple	Native Shrub								1										0	
5		Alternanthera denticulata	Lesser Joyweed	Native Forb/Herbaceous																		0	
6		Fimbristylis tetragona	Four-ridged Frin	Native Sedge																		0	
7		Fimbristylis dichotoma	Common Finger	Native Sedge																		0	
9		Spermacoce sp		Native Forb/Herbaceous									10	5	6	8	5					3.4	
10		Schizachyrium fragile	Firegrass	Native Grass										10	25	5		2		10		5.2	
11		Heteropogon triticeus	Giant Speargrass	Native Grass																		0	
12		Setaria surgens	Pigeon Grass	Native Grass																		0	
13		Heteropogon contortus	Blackheaded Spe	Native Grass																		0	
14		Chamaecrista rotundifolia	Wynn Cassia	Pasture Grass									10			15					10	3.5	
15		Sida corrugata	Corrugated Sida	Native Forb/Herbaceous																		0	
16		Corymbia dallachiana	Dallachy's Gum	Native Tree																		0	
17		Acacia holosericea	Silver Wattle	Native Shrub																		0	
18		Stylosanthes scabra	Shrubby Stylo	Pasture Grass													3					0.3	
19		Phyllanthus maderspatensis	Spurge	Native Forb/Herbaceous																		0	
20		Sporobolus diandrus	Tussocky sporobol	Native Grass													30			10		4	
21		Passiflora foetidia	Stinking Passion	Weed																		0	
22		Perotis rara	Comet Grass	Pasture Grass									10									1	
23		Chrysopogon fallax	Golden Beardgrass	Native Grass									5									0.5	
24		Hyptis capitata	Knobweed	Weed																	50	5	
25		Cynodon dactylon	Green Couch	Native Grass																	10	1	

Transect Name	Canopy Cover				Layer Heights (m)								Erosion						Photo Start		100158			
RM1	Tree Total (m)	0	Shrub Total (m)	0	E	T1	T2	T3	S1	S2	G	No. of rills/gullies < 15	Minor	Average Depth	< 10	Minor		Photo End		102037				
RE Code:	Tree Total (%)		Shrub Total (%)	0	10	5				2	0.5	Remainder												
														100	100	100	100	100	100	100	100	100	100	
Notes													Quadrat Totals	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean
													Bare Ground	30	10	25		60	9	50	89	10	15	29.8
													Organic Litter	20										2
													Rock	10	85									9.5
Sample Identification					Species Dominance																			
Number of Plants	Field Name	Species Name	Common Name	Growth Type	E	T1	T2	T3	S1	S2	G	Stem Count	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10		
1		Aristida latifolia	Feathertop Wire	Native Grass							Dom												0	
2		Melaleuca viridiflora	Broad Leaved Pa	Native Tree																			0	
3		Schizachyrium fragile	Firegrass	Native Grass									40			30	60	20	60		5		10	22.5
4		Chrysopogon fallax	Golden Beardgra	Native Grass												10	20			20	5	10		6.5
5		Stylosanthes scabra	Shrubby Stylo	Pasture Grass											5	30				30				6.5
6		Chamaecrista rotundifolia	Wynn Cassia	Pasture Grass												5	2		1		1	80	70	15.9
7		Stylosanthes viscosa	Sticky Stylo	Pasture Grass																				0
8		Hyptis capitata	Knobweed	Weed												8	20	5					5	3.8
9		Stylosanthes hamata	Caribbean Stylo	Pasture Grass												10		10						2
10		Sida corrugata	Corrugated Sida	Native Forb/Herbaceous														5						0.5
11		Erythrophleum chlorostach	Cooktown Ironw	Native Tree														5						0.5
12		Sporobolus diandrus	Tussocky sporob	Native Grass														5						0.5
13		Evolvulus alsinoides	Tropical Speedw	Native Forb/Herbaceous															5					0
14		Aristida calycina	Dark Wiregrass	Native Grass																				0
15		Cyanthillium cinereum	Little Ironweed	Native Forb/Herbaceous																				0
16		Eucalyptus tetradonta	Darwin's Stringy	Native Tree								15												0

Transect Name	Canopy Cover				Layer Heights (m)								Erosion							Photo Start	080013		
Pit	Tree Total (m)	0	Shrub Total (m)	2	E	T1	T2	T3	S1	S2	G	No. of rills/gullies	< 15	Minor	Average Depth	< 10	Minor		Photo End	081804			
RE Code:	Tree Total (%)		Shrub Total (%)	4		10			2	1	0.4	Remainder											
													100	100	100	100	100	100	100	100	100	100	
Notes												Quadrat Totals	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean
												Bare Ground	10	85	92	85	78	85	80	34	55	5	60.9
												Organic Litter	40									25	6.5
												Rock	10	15	3		2	5	15	5		3	5.8
Sample Identification					Species Dominance							Stem Count											
Number of Plants	Field Name	Species Name	Common Name	Growth Type	E	T1	T2	T3	S1	S2	G		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	
1		Melaleuca viridiflora	Broad Leaved Pa	Native Tree								11	5										0.5
2		Alphitonia pomaderroides	Soapbush	Native Tree																			0
3		Schizachyrium fragile	Firegrass	Native Grass									5		5	11		5		40	35	7	10.8
4		Heteropogon triticeus	Giant Speargrass	Native Grass																			0
5		Chrysopogon fallax	Golden Beardgra	Native Grass												4							0.4
6		Cyanthillium cinereum	Little Ironweed	Native Forb/Herbaceous																			0
7		Hyptis capitata	Knobweed	Weed																		2	0.2
8		Acacia holosericea	Silver Wattle	Native Shrub								7								20			2
9		Stylosanthes hamata	Caribbean Stylo	Pasture Grass									25				15			1	5	55	10.1
10		Stylosanthes viscosa	Sticky Stylo	Pasture Grass																			0
11		Chamaecrista rotundifolia	Wynn Cassia	Pasture Grass									5										0.5
12		Corymbia dallachiana	Dallachy's Gum	Native Tree																			0
13		Eucalyptus tetradonta	Darwin's Stringy	Native Tree								1											0
14		Alloteropsis semialata	Cockatoo Grass	Native Grass																			0
15		Eriachne obtusa	Northern Wande	Native Grass															5		5		1
16		Enneapogon polyphyllus	Leafy Nineawn	Native Grass														5					0.5
17		Ectrosia leporina	Hares Foot Grass	Native Grass													5						0.5
18		Sporobolus diandrus	Tussoky sporob	Native Grass																		3	0.3
19		Erythrophleum chlorostach	Cooktown Ironw	Native Tree								1											0

A2 Photographic monitoring

Transect AS1		
Date	Start of Transect (0 m) S15.42722° E143.28472°	End of Transect (50 m) S15.42731° E143.28432°
May 2021		
Transect AS2		
Date	Start of Transect (0 m) S15.43285° E143.28713°	End of Transect (50 m) S15.43305° E143.28672°
May 2021		
Transect BP1		
Date	Start of Transect (0 m) S15.45045° E143.29470°	End of Transect (50 m) S15.45087° E143.29465°

May 2021		
Transect BP2		
Date	Start of Transect (0 m) S15.45133° E143.29512°	End of Transect (50 m) S15.45115° E143.29556°
May 2021		
Transect EX1		
Date	Start of Transect (0 m) S15.42972° E143.28364°	End of Transect (50 m) S15.43016° E143.28362°
May 2021		

Transect EX2		
Date	Start of Transect (0 m) S15.42844° E143.28452°	End of Transect (50 m) S15.42884° E143.28466°
May 2021		
Transect RM1		
Date	Start of Transect (0 m) S15.43135° E143.28414°	End of Transect (50 m) S15.43120° E143.28434°
May 2021		
Transect Pit		
Date	Start of Transect (0 m) S15.43315° E143.28553°	End of Transect (50 m) S15.43317° E143.28507°

May 2021



A3 Soils photographic monitoring

Site AR1			
Date		Projection: WGS 84	S15.42804° E143.28302°
May 2021			
Site AR2			
Date		Projection: WGS 84	S15.42916° E143.28296°
May 2021			

Site AR3			
Date		Projection: WGS 84	S15.42858° E143.28454°
May 2021			
Site AR4			
Date		Projection: WGS 84	S15.42964° E143.28199°
May 2021			

Site AR5			
Date		Projection: WGS 84	S15.42982° E143.28364°
May 2021			
Site AR6			
Date		Projection: WGS 84	S15.43041° E143.28515°
May 2021			

Site AR7			
Date		Projection: WGS 84	S15.43043° E143.28346°
May 2021			
Site AR8			
Date		Projection: WGS 84	S15.43123° E143.28405°
May 2021			

Site AR9			
Date		Projection: WGS 84	S15.43067° E143.28436°
May 2021			
Site AR10			
Date		Projection: WGS 84	S15.45326° E143.29618°
May 2021			

Site AR11			
Date		Projection: WGS 84	S15.45160° E143.29519°
May 2021			
Site AR12			
Date		Projection: WGS 84	S15.42916° E143.28296°
May 2021			

Analogue 1			
Date		Projection: WGS 84	S15.42727° E143.28488°
May 2021			
Analogue 2			
Date		Projection: WGS 84	S15.43290° E143.28699°
May 2021			

A4 Soils laboratory results

Lab Report No	Lims Code	Unit	LOR	EB2115818	EB2115818	EB2115818	EB2115818	EB2115818	EB2115818	EB2115818	EB2115818	EB2115818	EB2115818
Lab Sample No				001	002	003	004	005	006	007	008	009	010
Client Sample No				Analogue_2	AR_1	AR_3	AR_4	AR_5	AR_6	AR_8	AR_10	AR_11	AR_12
Station													
Sample Date				04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021
Top Depth													
Bottom Depth													
pH Value	EA002	pH Unit	0.1	5.4 pH Unit	5.3 pH Unit	5.3 pH Unit	5.5 pH Unit	4.9 pH Unit	5.1 pH Unit	5.2 pH Unit	5.7 pH Unit	5.2 pH Unit	5.2 pH Unit
Electrical Conductivity @ 25°C	EA010	µS/cm	1	11 µS/cm	4 µS/cm	7 µS/cm	46 µS/cm	14 µS/cm	6 µS/cm	5 µS/cm	29 µS/cm	10 µS/cm	7 µS/cm
Moisture Content	EA055	%	0.1	0.4 %	0.2 %	15.1 %	0.6 %	5.2 %	0.8 %	0.2 %	1.0 %	0.9 %	1.1 %
Color (Munsell)	EA058			Light Gray (N 7	Light Gray (N 7	Very Pale Brow	Very Pale Brow	Gray (10YR 5/1	Gray (5YR 6/1	Light Gray (10Y	Light Brownish	Light Brownish	Gray (10YR 6/1
Emerson Class Number	EA058			8	8	8	8	8	8	8	8	8	8
Texture	EA058			Course Sand	Course Sand	Course Sand	Course Sand	Course Sand	Course Sand	Course Sand	Course Sand	Course Sand	Course Sand
Clay (<2 µm)	EA150H	%	1	13 %	11 %	16 %	7 %	15 %	18 %	7 %	17 %	17 %	18 %
Coarse Sand (0.2-2.0 mm)	EA150H	%	1	62 %	58 %	31 %	42 %	58 %	54 %	60 %	32 %	33 %	48 %
Fine Sand (0.02-0.2 mm)	EA150H	%	1	12 %	5 %	4 %	3 %	6 %	6 %	3 %	21 %	4 %	11 %
Gravel (>2mm)	EA150H	%	1	11 %	26 %	45 %	45 %	17 %	19 %	30 %	24 %	39 %	17 %
Silt (2-20 µm)	EA150H	%	1	2 %	<1 %	4 %	3 %	4 %	3 %	<1 %	6 %	7 %	6 %
Soil Particle Density (Clay/Silt/Sand)	EA152	g/cm3	0.01	2.63 g/cm3	2.66 g/cm3	2.75 g/cm3	2.63 g/cm3	2.59 g/cm3	2.60 g/cm3	2.66 g/cm3	2.57 g/cm3	2.56 g/cm3	2.41 g/cm3
Exchange Acidity	ED005	meq/100g	0.1	<0.1 meq/100g	<0.1 meq/100g	1.5 meq/100g	0.3 meq/100g	0.4 meq/100g	0.9 meq/100g	<0.1 meq/100g	<0.1 meq/100g	0.6 meq/100g	1.0 meq/100g
Exchangeable Aluminium	ED005	meq/100g	0.1	<0.1 meq/100g	<0.1 meq/100g	1.2 meq/100g	0.2 meq/100g	0.2 meq/100g	0.6 meq/100g	<0.1 meq/100g	<0.1 meq/100g	0.4 meq/100g	0.7 meq/100g
Calcium/Magnesium Ratio	ED007		0.1	3.2	4.0	1.1	0.2	2.0	2.0	2.0	1.9	1.9	1.8
Cation Exchange Capacity	ED007	meq/100g	0.1	1.8 meq/100g	0.6 meq/100g	2.4 meq/100g	2.1 meq/100g	1.5 meq/100g	2.3 meq/100g	0.7 meq/100g	3.3 meq/100g	3.1 meq/100g	3.8 meq/100g
Exchangeable Calcium	ED007	meq/100g	0.1	1.3 meq/100g	0.4 meq/100g	0.9 meq/100g	0.2 meq/100g	0.6 meq/100g	0.8 meq/100g	0.4 meq/100g	1.9 meq/100g	1.5 meq/100g	1.6 meq/100g
Exchangeable Magnesium	ED007	meq/100g	0.1	0.4 meq/100g	0.1 meq/100g	0.8 meq/100g	1.1 meq/100g	0.3 meq/100g	0.4 meq/100g	0.2 meq/100g	1.0 meq/100g	0.8 meq/100g	0.9 meq/100g
Exchangeable Potassium	ED007	meq/100g	0.1	<0.1 meq/100g	<0.1 meq/100g	0.1 meq/100g	<0.1 meq/100g	0.1 meq/100g	<0.1 meq/100g	<0.1 meq/100g	0.3 meq/100g	0.1 meq/100g	0.2 meq/100g
Exchangeable Sodium	ED007	meq/100g	0.1	<0.1 meq/100g	<0.1 meq/100g	<0.1 meq/100g	0.4 meq/100g	<0.1 meq/100g	<0.1 meq/100g	<0.1 meq/100g	<0.1 meq/100g	<0.1 meq/100g	<0.1 meq/100g
Exchangeable Sodium Percent	ED007	%	0.1	<0.1 %	<0.1 %	2.9 %	24.6 %	1.1 %	<0.1 %	<0.1 %	2.5 %	0.4 %	0.7 %
Magnesium/Potassium Ratio	ED007		0.1			7.3		2.6			3.7	5.3	5.2
Bicarbonate Extractable K (Colwell)	ED021	mg/kg	10	<100 mg/kg	<100 mg/kg	241 mg/kg	107 mg/kg	<100 mg/kg	101 mg/kg	<100 mg/kg	294 mg/kg	175 mg/kg	321 mg/kg
Sulfate as SO4 2-	ED040T	mg/kg	100	<100 mg/kg	<100 mg/kg	<100 mg/kg	<100 mg/kg	<100 mg/kg	<100 mg/kg	<100 mg/kg	180 mg/kg	<100 mg/kg	<100 mg/kg
Chloride	ED045G	mg/kg	10	<10 mg/kg	<10 mg/kg	<10 mg/kg	60 mg/kg	<10 mg/kg	<10 mg/kg	<10 mg/kg	20 mg/kg	<10 mg/kg	<10 mg/kg
Copper	ED092	mg/kg	1.00	<1.00 mg/kg	<1.00 mg/kg	<1.00 mg/kg	<1.00 mg/kg	<1.00 mg/kg	<1.00 mg/kg	<1.00 mg/kg	<1.00 mg/kg	<1.00 mg/kg	<1.00 mg/kg
Iron	ED092	mg/kg	1.00	9.53 mg/kg	4.01 mg/kg	11.0 mg/kg	3.10 mg/kg	34.6 mg/kg	8.06 mg/kg	8.35 mg/kg	20.2 mg/kg	11.2 mg/kg	24.0 mg/kg
Manganese	ED092	mg/kg	1.00	13.4 mg/kg	2.24 mg/kg	4.11 mg/kg	<1.00 mg/kg	5.28 mg/kg	6.71 mg/kg	3.64 mg/kg	17.4 mg/kg	5.43 mg/kg	4.79 mg/kg
Zinc	ED092	mg/kg	1.00	<1.00 mg/kg	<1.00 mg/kg	<1.00 mg/kg	<1.00 mg/kg	1.34 mg/kg	<1.00 mg/kg	1.91 mg/kg	1.56 mg/kg	<1.00 mg/kg	<1.00 mg/kg
Nitrite + Nitrate as N (Sol.)	EK059G	mg/kg	0.1	<0.1 mg/kg	0.4 mg/kg	0.2 mg/kg	1.6 mg/kg	4.5 mg/kg	0.2 mg/kg	1.3 mg/kg	0.6 mg/kg	0.7 mg/kg	<0.1 mg/kg
Bicarbonate Ext. P (Colwell)	EK080	mg/kg	5	<5 mg/kg	<5 mg/kg	<5 mg/kg	<5 mg/kg	<5 mg/kg	<5 mg/kg	<5 mg/kg	<5 mg/kg	<5 mg/kg	<5 mg/kg
Organic Matter	EP004	%	0.5	1.6 %	0.6 %	0.7 %	<0.5 %	1.4 %	0.8 %	<0.5 %	3.9 %	2.9 %	6.3 %



Golden-shouldered Parrot Nesting Habitat Assessment

PREPARED FOR
PacGold Limited

6 July 2021

Document Control

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Report Title:	Golden-shouldered Parrot Nesting Habitat Assessment
Client:	PacGold Limited
Project Manager:	Emily Brown

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Table of Contents

1	Introduction	4
1.1	Background	4
1.2	Site Location and Description	4
1.3	Purpose and Scope	4
2	Methodology	9
3	Results	10
3.1	Habitat Assessment.....	10
3.1.1	Nesting Habitat.....	10
3.1.2	Foraging Habitat	10
3.2	Observed Golden-shouldered Parrot.....	10
4	References	12

List of Figures

Figure 1	Project location	5
Figure 2	Study area	6
Figure 3	Suitably sized conical termite mound for nesting Golden-shouldered Parrots	7
Figure 4	Historic Golden-shouldered Parrot nest	8
Figure 5	Golden-shouldered Parrot nesting habitat and observed occurrences	11

List of Tables

Table 1:	Potential fauna breeding places	10
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Abbreviations List

AARC	AARC Environmental Solutions Pty Ltd
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EPM	Exploration Mineral Permit
GPS	Global Positioning System
km	Kilometre(s)
m	Meter(s)
ML	Mining Lease
NC Act	<i>Nature Conservation Act 1992</i>
PacGold	PacGold Limited
RE	Regional Ecosystem
The Project	Alice River Mine

1 Introduction

1.1 Background

AARC Environmental Solutions Pty Ltd (AARC) was commissioned by PacGold Limited (PacGold) to undertake an assessment of potential Golden-shouldered Parrot (*Psephotus chrysopterygius*) nesting habitat, within areas identified for exploration activities associated with the Alice River Mine (The Project). The survey was undertaken in accordance with the existing 'Alice River Gold Project Golden-shouldered Parrot Exploration Management Plan' (AARC 2018) prepared for Spitfire Materials Ltd.

1.2 Site Location and Description

The Project is located on Queensland's Cape York Peninsula, approximately 470 kilometres (km) north-west of Cairns and 120 km west of Laura (Figure 1). The Project occupies eight Mining Leases (MLs) including: ML 2901, ML 2902, ML 2907, ML 2908, ML 2957, ML 2958, ML 3010 and ML 3011. The largest ML (ML 3010) contains the Project's historic gold processing plant, tailings dam and waste rock dumps. The study area is also located within the Exploration Mineral Permit (EPM) 26266 and EPM 14313.

The study area is comprised of a series of 18 linear exploration transects, equating to approximately 27 km. These transects run east to west and range from approximately 830 meters (m) to 2 km long. A 20 metre buffer was applied to each exploration transect (Figure 2). For continuity, the entirety of the transects were surveyed. However, it is noted that these transects overlap areas not authorised for exploration activities under the Project's Environmental Authorities. Prior to exploration works being undertaken, AARC recommends that a detailed review of the Project's approved exploration boundaries be undertaken.

1.3 Purpose and Scope

All exploration works within the PacGold ML's and EPM's must be undertaken in accordance with the 'Alice River Gold Project Golden-shouldered Parrot Exploration Management Plan' (AARC 2018) (the Plan). The Plan details the management strategies and mitigation measures required for avoiding, mitigating, and restoring adverse impacts resulting from exploration activities on the Golden-shouldered Parrot. In accordance with this Plan, this survey aimed to identify all current, historical, and potential future nesting areas for the Golden-shouldered Parrot within the proposed Study Area (Figure 2).

The survey was designed to identify areas containing:

- conical termite mounds of suitable size and shape for the species to utilise in the current breeding season;
- active nests for the Golden-shouldered Parrot;
- signs of historic nests, or signs of Golden-shouldered Parrot activity; and
- areas of conical termite mounds with the potential to form future breeding habitat.

The Golden-shouldered Parrot is listed as endangered in Queensland, under the *Nature Conservation Act 1992* (NC Act) and federally under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Golden-shouldered Parrot breeding primarily occurs from March to June, after termites have stopped building (at the conclusion of the wet season) while green grass seed is still available.

The Golden-shouldered Parrot nests in conical-shaped termite mounds, also referred to as witches-hat mounds. Previous studies have shown that the species is limited by the availability of suitable nest sites, as the Golden-shouldered Parrot is known to rarely re-use the same mound, and the 30 – 50 year construction time for a mound to be suitably sized as a nesting habitat (Cape York NRM n.d., Levy 2004). A suitably sized conical termite mound for nesting Golden-shouldered Parrots is shown in Figure 3. A historic Golden-shouldered Parrot nest is shown in Figure 4. Based on the known ecology of this species the survey for the Golden-shouldered Parrot nesting habitat was undertaken towards the end of the breeding season.

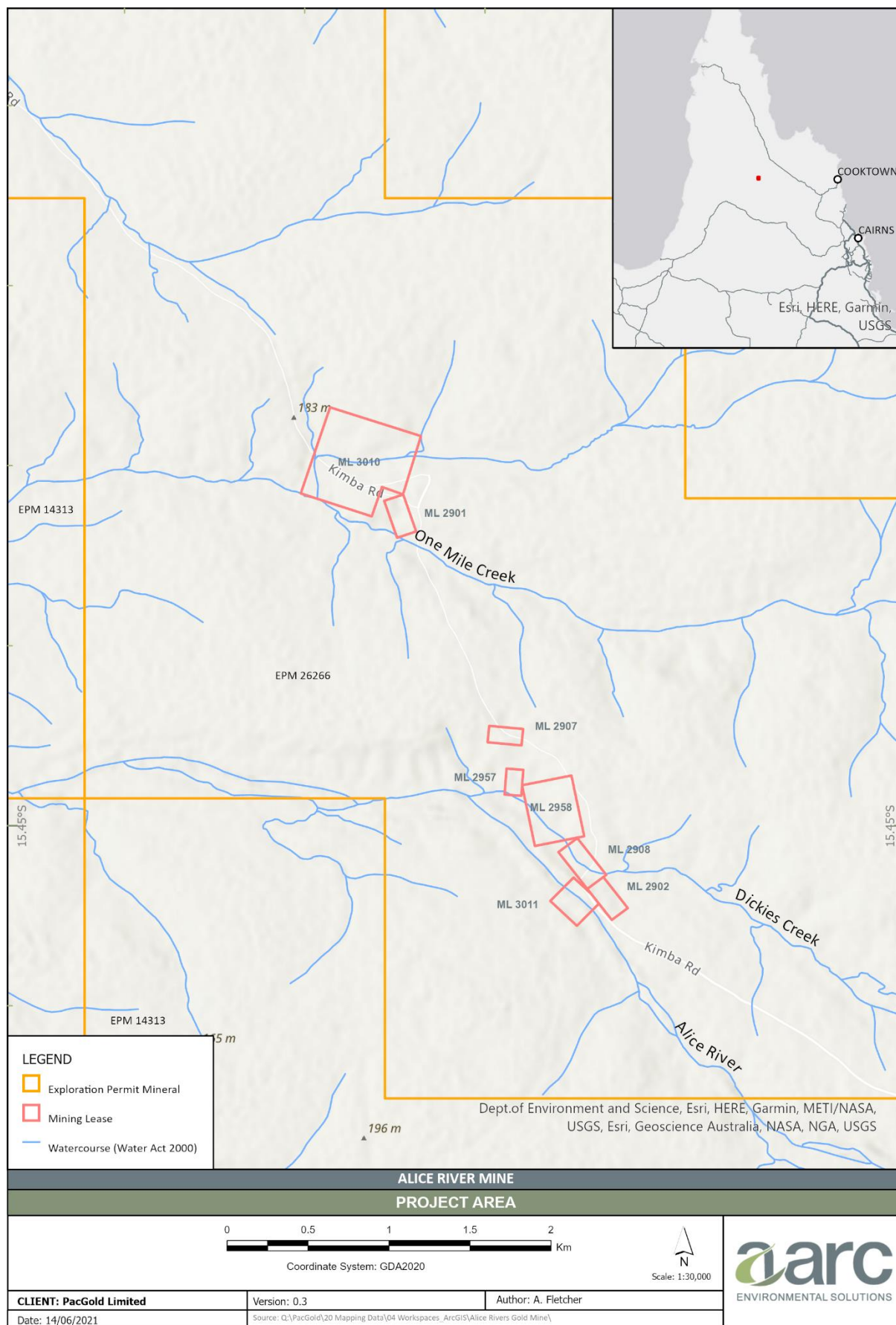


Figure 1 Project location

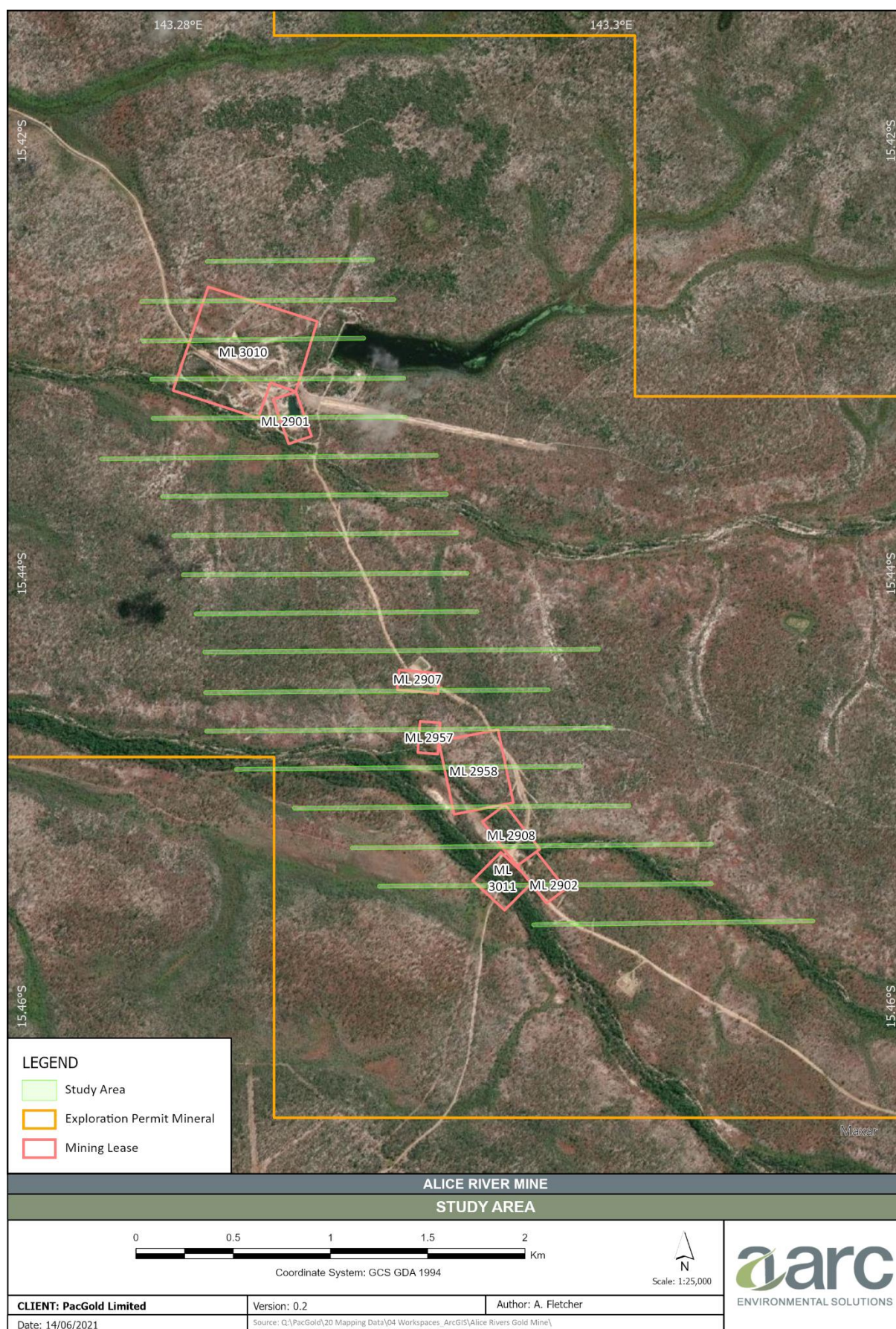


Figure 2 Study area



Figure 3 *Suitably sized conical termite mound for nesting Golden-shouldered Parrots*



Figure 4 *Historic Golden-shouldered Parrot nest*

2 Methodology

The Golden-shouldered Parrot nesting habitat assessment was undertaken within the proposed exploration transects. This assessment was undertaken in accordance with the following management plans and survey guidelines:

- *'Alice River Gold Project Golden-shouldered Parrot Exploration Management Plan'* (AARC 2018);
- *'Survey guidelines for Australia's threatened birds'* (DEWHA 2010); and
- *'Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (V3.0)'* (Eyre et al. 2018).

The study area was traversed on foot and by vehicle, to conduct survey activities. Incidental fauna observations were recorded whilst moving around the study area. Habitat features such as the size and density of conical termite mounds were recorded in the field. Habitat features and boundaries were recorded in the field using a Global Positioning System (GPS). While surveying for habitat features, evidence of indirect presence of fauna through the detection of tracks, scats, and traces (e.g., scratching's on conical termite mounds) were also recorded.

3 Results

3.1 Habitat Assessment

3.1.1 Nesting Habitat

The Golden-shouldered Parrot nesting habitat assessment was undertaken from Saturday 29 May 2021 until Monday 31 May 2021. Of the areas identified for exploration activities none were identified to contain active or historic Golden-shouldered Parrot nests. Nesting habitat within the study area was mapped based on the below table (Table 1). During the field surveys it was noted that areas identified as containing a high density of suitably sized conical termite mounds coincided with areas of loam sandy soils, these areas were mapped as Regional Ecosystem (RE) 3.3.49/3.3.16.

Table 1: Potential fauna breeding places

Nesting habitat type	Description
Unsuitable	Areas found void of conical termite mounds, not suitable for nesting Golden-shouldered Parrots.
Potential Future	Areas were found to contain small conical termite mounds; these termite mounds were too small to be considered suitable habitat for the Golden-shouldered Parrot. These areas often contained mounds that had been knocked over as the result of flood waters during the wet season. These areas have the potential to form future nesting sites for the Golden-shouldered Parrot, however given the long timeframe for conical termite mounds to reach a suitable size (30-50 years), these areas are not considered suitable nesting habitat for the purposes of this survey.
Low Density Suitable	Areas were found to contain occasional conical termite mounds that meet the size and shape suitable for nesting Golden-shouldered Parrots.
High Density Suitable	These areas were found to contain a high density of large conical termite mounds suitable for nesting Golden-shouldered Parrots.

3.1.2 Foraging Habitat

An overall assessment of foraging habitat for the Golden-shouldered Parrot was undertaken concurrently with the nesting habitat assessment. Foraging habitat for the Golden-shouldered Parrot is considered to include open savanna woodlands dominated by *Melaleuca* or *Eucalyptus* species, with an understorey dominated by *Schizachyrium*, *Thaumastachloa*, *Sorghum plumosum* or *Eriachne burkit*. Site assessments determined the majority of areas within the proposed exploration transects to be potential foraging habitat for this species. The only areas excluded from meeting suitable foraging habitat were areas that have been significantly disturbed, this included access roads and tracks, the aeroplane runway, and existing historic mining disturbance. As such exploration activities will need to consider the potential impacts to foraging habitats for this species when planning works.

3.2 Observed Golden-shouldered Parrot

During the survey, Golden-shouldered Parrots were observed within proximity of the study area. There were three separate incidental observations of Golden-shouldered Parrots; two occurrences are considered to be the same individuals due to the close proximity and timeframes of the occurrences. The location of each occurrence is shown on Figure 5.

During the survey, two Golden-shouldered Parrots were observed feeding on Caribbean Stylo (*Stylosanthes hamata*) along the banks of the Alice River. This observation was video recorded as the species has not been previously identified as consuming Stylo species. Caribbean Stylo is an introduced herbaceous

species, primarily utilised by farmers as a stock fodder species. Caribbean Stylo has been sown by landowners across the Alice River Mine exploration and mining tenements.

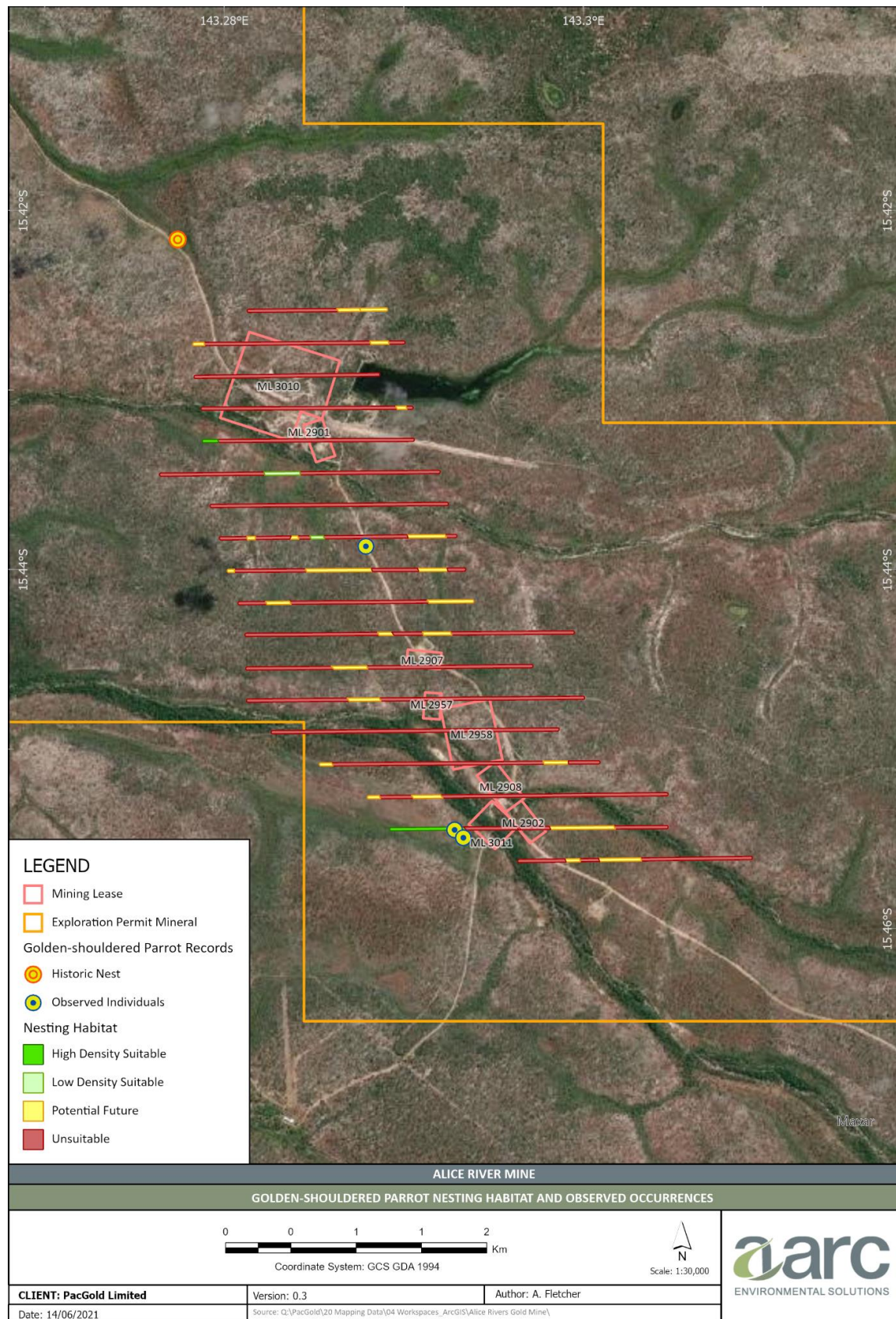


Figure 5 Golden-shouldered Parrot nesting habitat and observed occurrences

4 References

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Alice River Gold Project

Progressive Rehabilitation & Closure Planning Geotechnical Assessment Report

July 2022

BMS-P22022C-AAR-ALR-R-1-V1.0



ABN 91 383 829 253

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DOCUMENT CONTROL SHEET

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Mine	Alice River Project
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Reviewed By	Ty Grantham (Principal Consultant)
Approved By	Ty Grantham (Principal Consultant)

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EXECUTIVE SUMMARY

A geotechnical assessment was carried out to inform the development of a Progressive Rehabilitation and Closure Plan (PRCP) in accordance with the Department of Environment and Sciences' Guideline – Progressive Rehabilitation and Closure Plans (2019) and Environmental Authority (EA) for the Project. The Project includes the Alice Queen Pit (AQ Pit), tailings storage facility (TSF) and waste rock dump (WRD).

The purpose of the assessment was to identify areas of concern related to long-term geotechnical stability of the final landform, and to provide recommendations for the long-term stability of slopes (i.e., in perpetuity) to meet the final landform design objectives.

The AQ Pit void is approximately 130 m long x 50 m wide and approximately 40 mbgl, from the model data supplied. The site lies across the natural landform on a gentle slope dipping toward the south-southwest (SSW). The mine area consists of the AQ residual void, a small, low height WRD, TSF and a ROM lay down.

The TSF is located approximately 500 m northwest of the AQ Pit. It covers an area approximately 250 m x 140 m and is impounded by an engineered (or assumed to be) embankment between 4 and 5 m high.

The WRD located is approximately 300 m due west of the AQ Pit void, consists of a single lift (approximately 3 m high) and approximately 42 m long by 26 m wide footprint.

In the Quaternary and weathered granite horizons, batter angles in the AQ Pit void range between 30° and 60° and extend to a remnant catch bench located at approximately 115 m RL. The remainder of the void is below the current water level and the pit walls are presumed to comprise slightly weathered and fresh granite.

Geotechnical stability in rock slopes is generally controlled by geological structure, as rock material is generally too strong to permit shear failure. However, rock mass strength is scale-dependent, and if the block size produced by the discontinuities is small enough compared to the slope height, steep slip pathways could be generated in high faces by linking through the discontinuities without shearing the rock itself (Simmons, 1995). This is unlikely for the current Project design for the following reasons:

- Given the thin covering of Quaternary and friability of the weathered granite across the site, which are generally up to approximately < 15 m, combined thickness, these units are unlikely to cause geotechnical instability over the long-term; and
- Rock mass strength failures are unlikely to occur at slope heights below 300 m under normal conditions (Simmons, 1995).

In the absence of TSF construction records, weathered granitic rock spoil is generally sandy and some clay component. Ageing TSF embankments dump surfaces are likely to be susceptible to erosion from surface run-off with a possibility of loss of fines. This would apply mainly to the downstream face of the TSF embankment. In this case, generated fine materials reporting to drainage system which would flow into the Alice River, which is unlikely to have a significant effect on geotechnical stability (Ward, 2016). It should be noted that the height of the TSF, from toe to crest, is very low and is unlikely to present a significant risk from a geotechnical stability perspective.

Based on the results of the slope stability analyses, all slope stability scenarios analyses exceeded the minimum required FoS value for long-term geotechnical stability of 1.5. Therefore, the pit void and TSF slopes are unlikely to pose a significant long-term slope stability risk, based on the defined scenarios and assumptions.

Whilst the results of the limit equilibrium analyses justify suitably stable structures within the current landform, the results assume the applied material properties and lithological boundaries modelled for the pit and the TSF are representative of actual site conditions. Further assessment of rock mass structure and pit slope defects should be carried out post dewatering and prior to end of mining.

Prominent erosional features are evident from aerial photos and from the terrain models provided. As part of closure planning, these surface areas should be re-graded to encourage the flow of surface water away from the crest area. Where earthen bunds are placed, there will be a need to minimise the catchment area between the pit crest and bund to prevent water ponding on the surface.

It can be concluded from the geotechnical assessment and analyses that:

- The final landform exceeds the minimum FoS of 1.5 for long-term stability, based on the assumptions, and is therefore acceptable from a geotechnical perspective;
- The final pit slopes were assessed to be geotechnically stable against large-scale failure, based on the assumptions, and scenarios examined. Localised instability can occur where geological structures daylight on the pit face and form geometries that are kinematically unstable. This has not been evaluated as part of this assessment; however, these failures may occur as the highwall erodes; and
- The downstream slope of the TSF embankment was assessed to be geotechnically stable, based on the assumptions, and scenarios examined.

The following recommendations are proposed:

- Carry out further assessment at closure to confirm assumptions and use as-built data for compiling slope stability analyses sections in the southern cutback area;
- Regrading of the upper weathered granite will need to be considered to establish sufficient drainage around the crest area in order to prevent deep gully erosion;
- Bunds should be designed to accommodate the discharge of surface water during rainfall events to prevent overtopping. In this case, cut-throughs leading to rubble-lined discharge spillways should be installed at regular intervals along the bund; and
- Pit wall mapping should be carried out upon recommencement of operations to provide a dataset for the assessment of adverse geological structures in the pit. This would enable kinematic analysis to be carried out to assess the likelihood of adverse structural failure mechanisms forming on pit slopes.

TABLE OF CONTENTS

DOCUMENT CONTROL SHEET	i
Document Details.....	i
Document History	i
EXECUTIVE SUMMARY.....	i
TABLE OF CONTENTS.....	iii
LIST OF FIGURES	iv
LIST OF TABLES	iv
ACRONYMS & ABBREVIATIONS	v
DISCLAIMER.....	vi
1 INTRODUCTION.....	1
2 SCOPE OF WORK.....	1
3 SITE DESCRIPTION.....	1
3.1 AQ Pit Void.....	2
3.2 Tailings Storage Facility.....	3
3.3 Waste Rock Dump (WRD).....	4
4 GEOLOGY AND HYDROGEOLOGY.....	4
4.1 Geology and Geotechnical Structures	4
4.2 Hydrogeology	6
5.1 Available Data for Assessment	6
6 OPERATIONAL SLOPE DESIGN	7
7 LONG TERM STABILITY – FINAL LANDFORM.....	7
7.1 Progressive Rehabilitation and Closure Plan (PRCP) Compliance – Geotechnical Stability	7
7.2 Geotechnical Stability – Pit Walls.....	8
7.3 Geotechnical Stability - Tailings Storage Facility.....	8
7.4 Environmental Stability – Weathering and Erosion.....	8
8 SLOPE STABILITY ASSESSMENT	9
8.1 Material Properties	9
8.2 Methodology and Assumptions.....	9
8.2.1 Limit Equilibrium Methodology	9
8.3 Analysis Scenarios.....	9
8.3.1 Pit Slopes – AQ Pit.....	10

8.3.2 Tailings Storage Facility	14
8.4 Analysis Results and Discussion	16
9 SURFACE WATER MANAGEMENT	18
11 CONCLUSIONS AND RECOMMENDATIONS.....	18
11.1 Conclusions	18
11.2 Recommendations	18
12 REFERENCES.....	19
APPENDIX A: LIMIT EQUILIBRIUM MODEL OUTPUTS	1

LIST OF FIGURES

Figure 3-1: Drone captured aerial imagery overlain by 1:100k geology and location of mine site features.	2
Figure 3-2: As constructed pit shell	3
Figure 3-3: DTM of TSF and Drainage Channels	4
Figure 4-1: Weathered Imooya Granite	5
Figure 4-2: Unweathered Imooya Granite	6
Figure 8-1: As-Built AQ Pit Void Shell.....	11
Figure 8-2: Design AQ Pit Void Shell	12
Figure 8-3: Section 1 - As Built AQ Pit - South Wall (Looking West).....	13
Figure 8-4: Section 2 – Designed (Cutback) AQ Pit -South Wall (Looking West).....	13
Figure 8-5: Section 3 - West to East Section (Looking North).....	14
Figure 8-6: Tailings Storage Facility Embankment and Footprint.	15
Figure 8-7: Section 4 - As-Built TSF Embankment (Looking Northeast) – Scenario 1.....	15
Figure 8-8: Section 4 - TSF Embankment, Filled To Capacity (Looking Northeast) – Scenario 2	16

LIST OF TABLES

Table 7-1: Proposed Closure Specifications (Ward, 2016).....	7
Table 8-1: Assumed Rock Mass Unit Properties	9
Table 8-2: Limit Equilibrium Analyses Results	17

ACRONYMS & ABBREVIATIONS

Term	Description
AHD	Australian Height Datum
BHWE	Base of Weathering
BMS	Blackrock Mining Solutions
DTM	Digital Terrain Model
FoS	GLE, Morgenstern-Price Factor of Safety
GSQ	Geological Survey of Queensland
WRD	Waste Rock Dump
TFS	Tailings Storage Facility
mbgl	Metres Below Ground Level
RL	Reduced Level
ROM	Run of Mine
SWL	Standing Water Level
TSF	Tailings Storage Facility

DISCLAIMER

Subject to the professional standard of care expected of a professional service provider, Blackrock Mining Solutions has formulated recommendations for review and approval by AARC Pty Ltd (AARC) and PacGold Ltd (PacGold). The recommendations formulated by Blackrock have been made based on the information provided by and assumptions described. Blackrock assumes no responsibility for undisclosed variations in the ground conditions beyond those assumed.

The assumptions used by Blackrock Mining Solutions Pty Ltd (Blackrock) to formulate recommendations are subject to approval by PacGold and AARC, and it is assumed that PacGold and AARC accept full responsibility if these assumptions prove different to what is found at the site due to undisclosed variations in ground conditions beyond those assumed. The study therefore assumes that all relevant data currently in the possession of PacGold and AARC has been made available to Blackrock.

We expect that should project personnel disagree with any of these assumptions, or become aware of any additional relevant information, PacGold and AARC will promptly notify Blackrock, to enable the conclusions to be revised accordingly.

1 INTRODUCTION

At the request of AARC Environmental Solutions Pty Ltd (AARC), a geotechnical assessment was carried out by Blackrock Mining Solutions (Blackrock) for the Alice River Gold Project (the Project) to inform the development of a Progressive Rehabilitation and Closure Plan (PRCP) in accordance with the Department of Environment and Sciences' Guideline – Progressive Rehabilitation and Closure Plans (2019) and Environmental Authority (EA) for the Project. The Project includes the Alice Queen Pit (AQ Pit), tailings storage facility (TSF) and waste rock dump (WRD).

The assessment was carried out to determine the geotechnical stability of the final landform which includes a final void at the completion of mining the AQ Pit, and filling of the TSF to capacity with materials from the WRD.

The purpose of the assessment was to identify areas of concern related to long-term geotechnical stability of the final landform, and to provide recommendations for the long-term stability of slopes (i.e., in perpetuity) to meet the final landform design objectives.

This report presents the results of a preliminary geotechnical assessment for the Project final landform, i.e., pit residual void, and TSF.

A detailed assessment of the Project final landform and residual voids should be completed by a suitably qualified person prior to closure to assess the condition of slopes (i.e., pit slopes and TSF) and to provide further recommendations on remedial measures, if required, to achieve a long-term, geotechnically stable and non-eroding final landform for the Project.

2 SCOPE OF WORK

The following scope of work was completed to achieve project outcomes:

- Review of existing geological and groundwater datasets for the Project area, reports, and regional geology;
- Development of two-dimensional slope stability models through the open pit void and TSF and application of appropriate shear strength parameters and groundwater assumptions;
- Slope stability modelling of final landforms to examine failure modes, to identify areas of potential geotechnical risk, and to develop appropriate slope design criteria for long-term geotechnical stability, based on the assumed/derived parameters; and
- Provision of recommendations for long-term, geotechnically stable and non-eroding final landforms as required by the Project EIS Terms of Reference and the *Guideline - Progressive Rehabilitation and Closure Plans (PRC Plans)*.

3 SITE DESCRIPTION

The Alice River Gold Project located approximately 200 km west of Cooktown in Far North Queensland (approximate co-ordinates GDA94 Z54 745,000 mE and 8,292,600 mN) and comprises a disturbed mine work area approximately 750 m long by 230 m wide. The site lies across the natural landform on a gentle slope dipping toward the south-southwest (SSW). The mine area consists of the AQ residual void, a small, low height WRD, TSF and a ROM lay down, as shown in Figure 3-1.

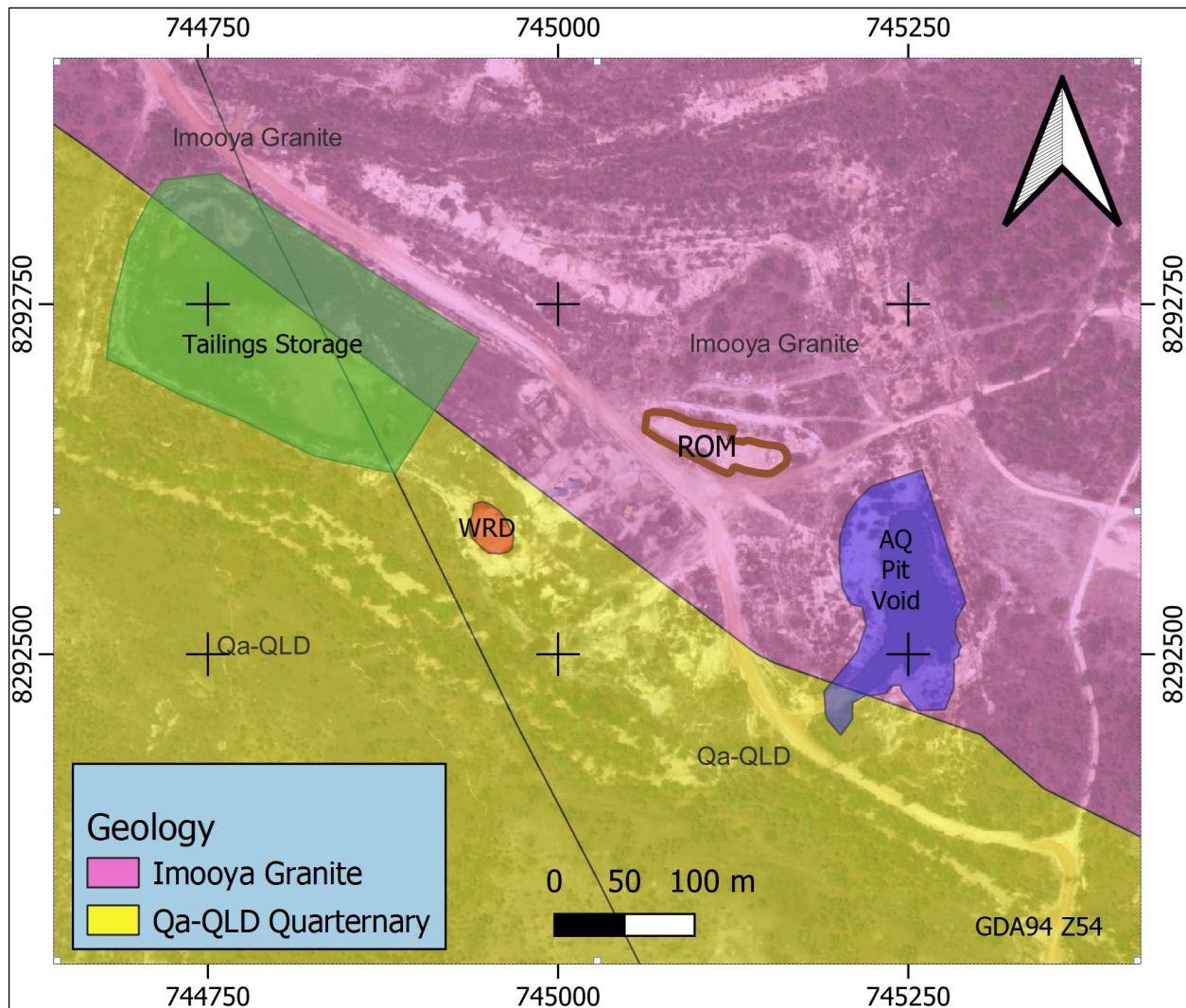


Figure 3-1: Drone captured aerial imagery overlain by 1:100k geology and location of mine site features.

3.1 AQ Pit Void

The AQ Pit void is approximately 130 m long x 50 m wide and approximately 40 mbgl, from the model data supplied.

In the Quaternary and weathered granite horizons, batter angles range between 30° and 60°, and extend to a remnant catch bench located at approximately 115 m RL. Between the remnant catch berm and the modelled pit floor (a further approximately 20 vertical metres), the remainder of the void is below the current water level and the pit walls are presumed to comprise slightly weathered and fresh granite.

The Alice River is located along the southern limit of the mine area, and at the southern end of the AQ Pit void. The river flows in a west-northwest direction passing adjacent to and within 100 m of the AQ Pit ramp entrance. The Alice River channel elevation and AQ open cut access ramp elevation have only several meters difference, suggesting inundation of the pit by seasonal river flooding is likely.

As discussed with the Client, it was indicated from a recent pit survey that the current standing water level (SWL) was approximately 117 m RL. It is understood that the pit void would be

drained to access the southern wall cutback. A series of cutbacks in the southern pit are planned to access ore in this zone.

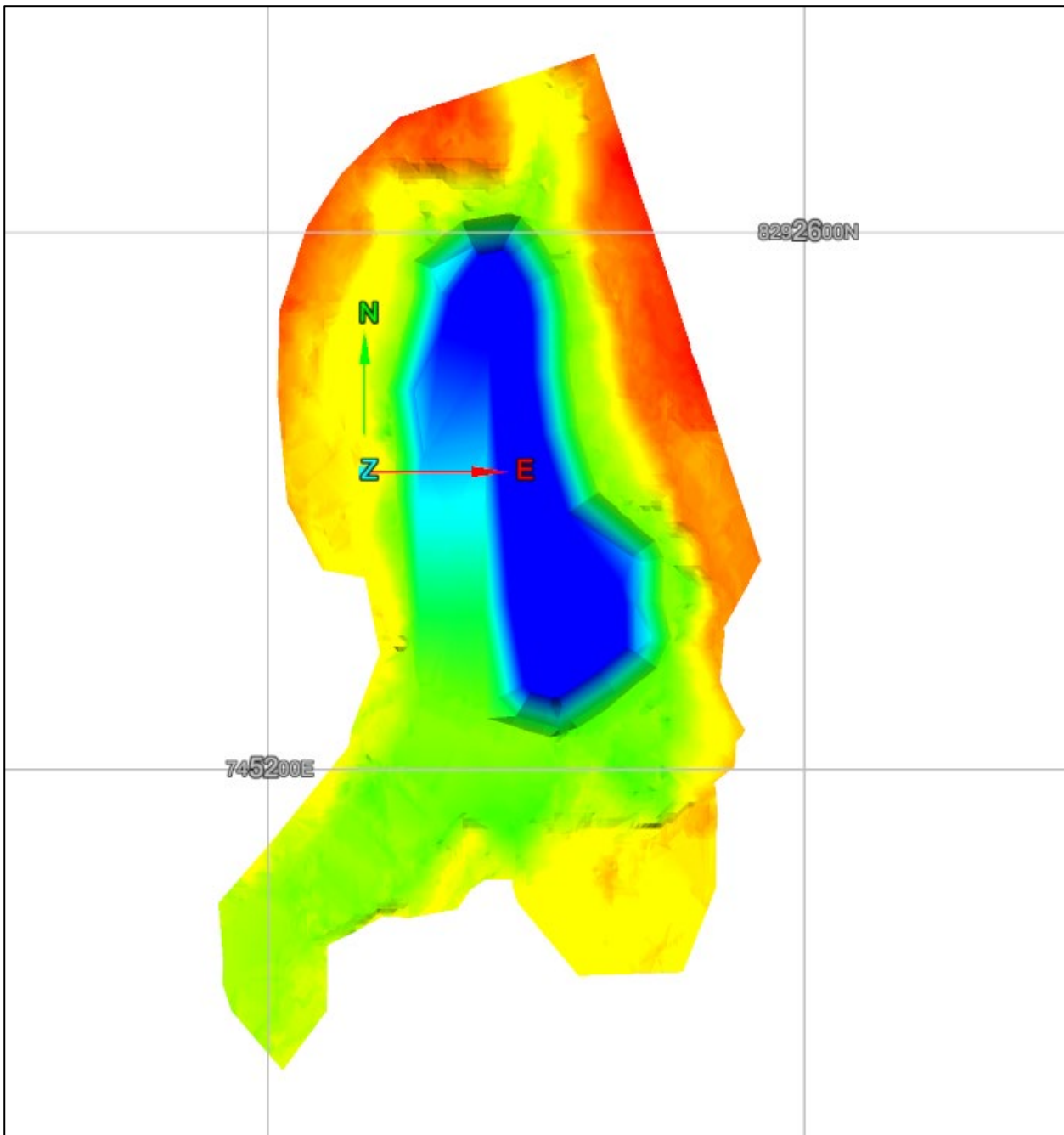


Figure 3-2: As constructed pit shell

3.2 Tailings Storage Facility

The TSF is located approximately 500 m northwest of the AQ Pit. It covers an area approximately 250 m x 140 m and is impounded by an engineered (or assumed to be) embankment between 4 and 5 m high.

The facility is partially filled 3 to 4 m deep with tailings. A constructed drainage channel at the western toe of the TSF appears to be maintained which would divert water from behind the impoundment to the Alice River system. Drone captured elevation model showing the tailings storage facility and the western drainage channel is presented in Figure 3-3.

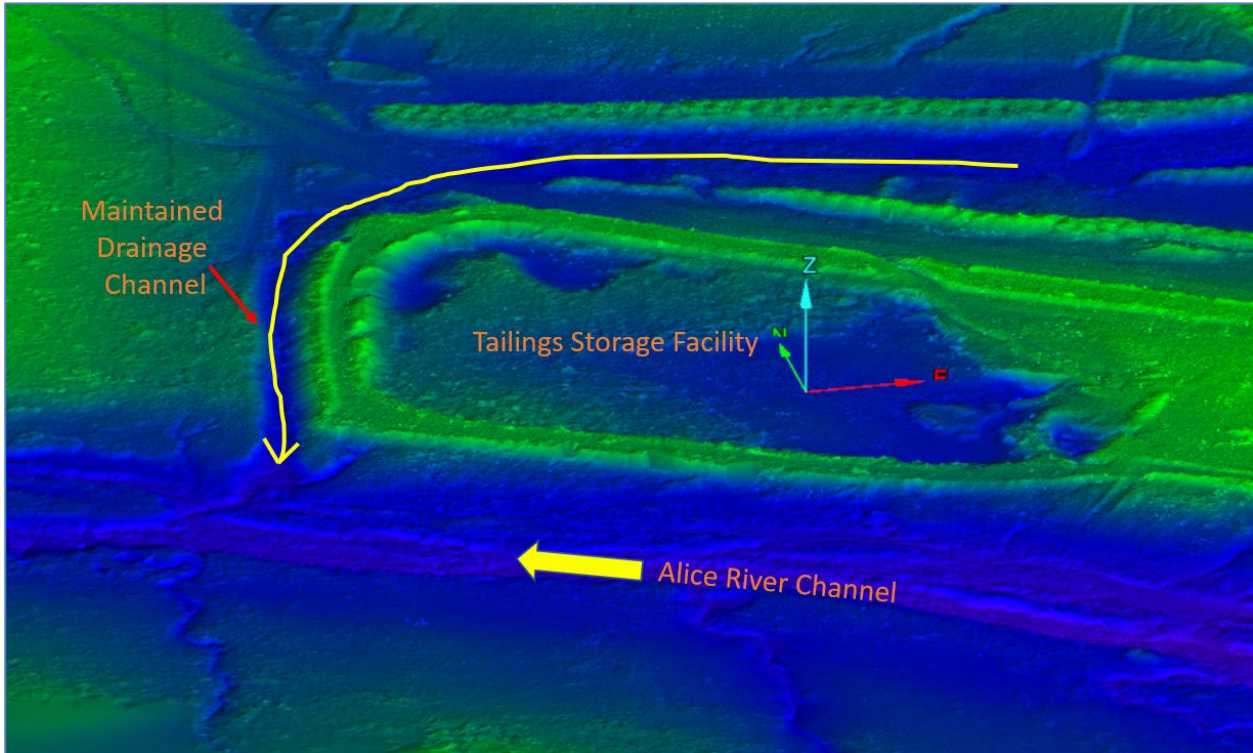


Figure 3-3: DTM of TSF and Drainage Channels

3.3 Waste Rock Dump (WRD)

The WRD located is approximately 300 m due west of the AQ Pit void, consists of a single lift (approximately 3 m high) and approximately 42 m long by 26 m wide footprint.

Blackrock were advised by AARC the WRD materials will be relocated to partially infill the TSF. As the waste material appears stable in the current landform and will be relocated to the TSF, long term stability modelling has not been carried out.

4 GEOLOGY AND HYDROGEOLOGY

4.1 Geology and Geotechnical Structures

The open file 1:100k geological map identified the site being underlain by the Imooya Granite with a thin partial covering of Quaternary sediments adjacent to the Alice River system.

The site geology is summarised as follows:

- Quaternary sediments comprising clay, silt and gravel compositions, typical of flood-plain alluvium;

- Early Devonian aged Imooya Granite which is typically a pale grey to white muscovite-biotite to biotite-muscovite granite and leucogranite. Forms colluvial deposits at lower elevations; and
- Ore zone which comprises silica rich shears.

From the core photos provided, the weathered Imooya Granite horizon is typically degraded comprising altered and decomposed feldspars (sericite clay) and coarse-grained quartz crystals, as shown in Figure 4-1. Below the base of weathered (BHWE), the unweathered Imooya Granite is likely to be high to very high strength with high rock quality designation (RQD), with widely spaced jointing, as shown in Figure 4-2.

The depth of weathering for the Imooya Granite was estimated from the supplied AQ Pit void surface and confirmed during discussions with the client representative. The break in slope between shallow (30 to 50°) batter angle in the upper portion of the void and the steeper (70°) batter angle for the lower portion of the void to floor, assumed as the BHWE. This equates to a 10 m to 12 m depth of weathering and a reduced level weathered to fresh boundary at approximately 115m RL (in the AQ Pit void vicinity).

The ore zone is generally a narrow shear/fault zone trending north - south. The expression of this geological structure is identified as a topographically lower channel feature that appears to act as a preferred surface water pathway.

Quaternary sediments within the location of the AQ Pit void and rock waste dump are believed to be thin 1 m - 1.5 m thick at most sequences and limited to the fringes of the Alice River channel.

Geomorphological interpretation of the drone acquired point cloud and resulting elevation model suggested an erosional feature (possibly fault induced) extended to the north of the AQ Pit void. This was later verified as the mineralised altered zone within the Imooya Granite which forms the ore body.

Rock mass characterisation or rock mass discontinuity information was not available that could assist in the slope stability assessments made in this report. Therefore, any impacts on slope stability from kinematic mechanisms/adverse structural geometries on the pit slopes cannot be confirmed at this stage.

Interpretation of geomorphology from the drone captured point cloud, did not indicate any additional significant rock mass discontinuities for the site.



Figure 4-1: Weathered Imooya Granite

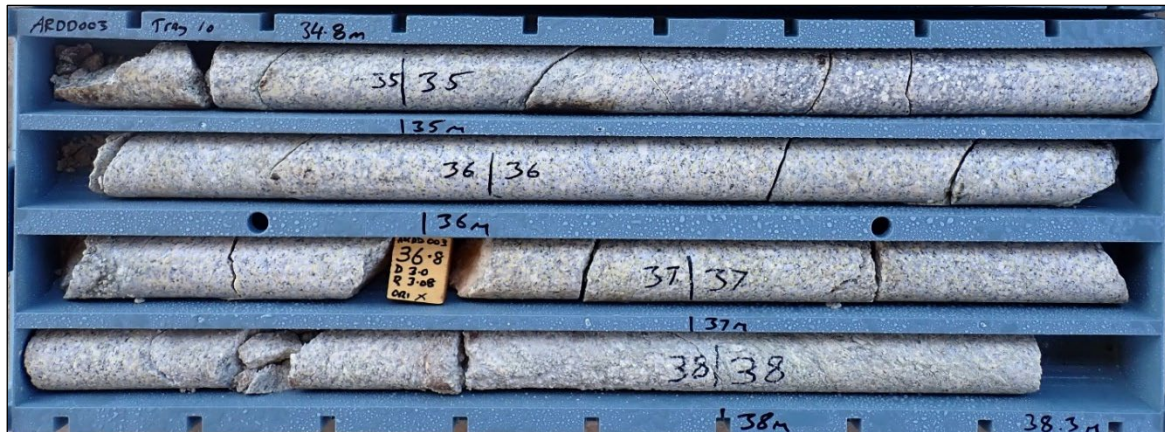


Figure 4-2: Unweathered Imooya Granite

4.2 Hydrogeology

Limited information was available about site hydrogeology. Discussions with the consultant hydrogeologist indicated the likely source of groundwater pit inflow would be from structural features, such as the ore zone. However, the hydrogeologist noted that any inflow of groundwater to the pit would be minimal.

5 DATA PROVISIONS

5.1 Available Data for Assessment

Data provided by AARC/ PacGold included:

- AQ Pit as constructed surface. It should be noted that the pit slope profile below the groundwater surface has been assumed;
- The designed AQ Pit void surface;
- WRD design surface;
- ROM pad footprint;
- Drone acquired point cloud of the mine site features and surrounding landform; and
- Verbal consultation with the client to confirm rock types, depth of weathering and influence of rock mass structures to finalise modelling scenarios.

Externally acquired data from publicly available sources:

- An open file GSQ portal data search returned only a 1:100k geological map. There was no open file drill hole or hydrological data that could be obtained for the site; and
- A Google Earth site review, including the apparent level of water in the AQ pit void and tailings storage facility were used as a guide to estimate long-term standing water levels in the AQ Pit void and TSF.

6 OPERATIONAL SLOPE DESIGN

The general slope design criteria for pit slopes in weathered and unweathered materials are summarised below:

- Berms are designed to specific RL depending on material types of weathering horizon. In this case, a nominal 5 m berm would suffice to accommodate materials from the weathered horizon;
- Batter angle in the weathered horizon typically generally up to 50°;
- Rock batters in fresh granite would generally be 70° (maximum); and
- Bench heights in fresh granite rock up to 40m (maximum) and in weathered granite up to 20 m (maximum).

7 LONG TERM STABILITY – FINAL LANDFORM

7.1 Progressive Rehabilitation and Closure Plan (PRCP) Compliance – Geotechnical Stability

The PRCP Guideline generally specifies that the residual void and surrounding landforms must be geotechnically and geochemically stable and, consider the effects of long-term erosion and weathering of the slopes (Department of Environment and Science [DES], 2019).

The existing Environmental Authority for the Project, which is considered a Land Outcome Document (LOD), specifies the residual void design criteria in relation to geotechnical stability which must be met (Schedule F – Table 2). Notably, for the Alice Queen Pit, both the void wall – competent and void wall - incompetent rock slope angles are set as the angle of mining.

Although the requirements for final slopes are not specific in terms of geotechnical design parameters, highwall slope designs typical of those used in open cut mining are normally suitable for closure purposes, with remedial modifications sometimes required, particularly in the Cenozoic and weathered horizons, to achieve stable slopes. Remedial modifications often involve re-grading the slope to a shallower angle and the installation of surface drains to reduce erosion.

A summary of PRCP requirements for geotechnical stability is presented in Table 7-1.

Table 7-1: Proposed Closure Specifications (Ward, 2016)

Disturbance Type	Proposed Design Criteria
Unweathered Pit Slopes (Competent Rock)	$\leq 70^\circ$ slopes
Weathered Pit Slopes (Incompetent Rock)	$\leq 50^\circ$ slopes
External Dump (Grassland suitable for grazing)	< 20% (11.5°) outer slopes
External Dump	

Disturbance Type	Proposed Design Criteria
(Not suitable for grazing)	

7.2 Geotechnical Stability – Pit Walls

Geotechnical stability in rock slopes is generally controlled by geological structure, as rock material is generally too strong to permit shear failure. However, rock mass strength is scale-dependent, and if the block size produced by the discontinuities is small enough compared to the slope height, steep slip pathways could be generated in high faces by linking through the discontinuities without shearing the rock itself (Simmons, 1995). This is unlikely for the current Project design for the following reasons:

- Given the thin covering of Quaternary and friability of the weathered granite across the site, which are generally up to approximately < 15 m, combined thickness, these units are unlikely to cause geotechnical instability over the long-term; and
- Rock mass strength failures are unlikely to occur at slope heights below 300 m under normal conditions (Simmons, 1995). Given the maximum height of <30 m for the Project, the residual void slopes are likely to be inherently stable from mass failures in the absence of adverse geological structures (i.e., faults or shears) that could interact with the pit slopes. A review of core photos supplied by PacGold, indicated that the fresh Imooya Granite was competent and high strength with a widely spaced joint pattern.

7.3 Geotechnical Stability - Tailings Storage Facility

In the absence of TSF construction records, weathered granitic rock spoil is generally sandy and some clay component. Ageing TSF embankments dump surfaces are likely to be susceptible to erosion from surface run-off with a possibility of loss of fines. This would apply mainly to the downstream face of the TSF embankment. In this case, generated fine materials reporting to drainage system which would flow into the Alice River, which is unlikely to have a significant effect on geotechnical stability (Ward, 2016).

It should be noted that the height of the TSF, from toe to crest, is very low and is unlikely to present a significant risk from a geotechnical stability perspective.

7.4 Environmental Stability – Weathering and Erosion

Quaternary and weathered granitic materials will continue to degrade over time via dispersive mechanisms if exposed for extended periods of time, and eventually form flatter slope angles. This process typically results in the weathered granite being highly friable and susceptible to erosion due to the alteration of feldspars in the ground matrix. Surface water drainage is likely to be a key contributor for erosion, particularly in the upper weathered portion of the granite unit.

A common erosional feature of granite terrains is that there is a component of differential weathering, whereby the outside of the rock mass peels off, referred to as ‘onion skin weathering’. Eventually this type of rock would weather to a fine to coarse grained sand fraction, and a dispersive fines fraction. This is evident from the available site photos, which shows the topography around the pit limits to be highly variable and severely eroded.

It is generally difficult to ascribe a timeframe for weathering, however, similar studies carried out at sites within the Bowen Basin of Queensland show a possible estimated degradation rate of approximately 40 to 50 millimetres per year (mm/year) on the exposed pit walls, which is equivalent to approximately 1 m every 20 years (Ward, 2016). Overall, these weathering and erosional processes should not prejudice the geotechnical stability of the entire slope.

8 SLOPE STABILITY ASSESSMENT

8.1 Material Properties

The following rock mass strength parameters were assigned estimates applied to the modelled lithological and engineered material types for the site. These parameters form the basis for the limit equilibrium analyses conducted herein.

Table 8-1: Assumed Rock Mass Unit Properties

Material Name	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (deg)
Quaternary Sediments	20	Mohr-Coulomb	10	30
Weathered Granite	22	Mohr-Coulomb	100	35
Fresh Granite	26	Mohr-Coulomb	500	42
Tailings Embankment	20	Mohr-Coulomb	20	35
Tailings (Dry)	18	Mohr-Coulomb	15	23
Tailings (Saturated)	20	Mohr-Coulomb	20	20

8.2 Methodology and Assumptions

Analyses were made for representative cross-sections of pit slopes from the residual void and from the planned cutback in the south of the pit, as shown in Figure 3-1 (Section 3). Analyses were carried out using industry-standard 2D limit equilibrium methods in Slide2 (V9.023) developed by Rocscience.

The generally accepted Factor of Safety (FoS) criterion for geotechnical stability of long-term slopes or residual voids is ≥ 1.5 . The FoS is generally a measure of driving forces versus resisting forces in a system, where a FoS of 1 equates to a 50% probability that failure will occur. FoS values >1 generally indicate that a system is likely to be geotechnically stable.

8.2.1 Limit Equilibrium Methodology

The drone captured elevation data and provided AQ Pit shells were used to model the surface slope angles in two dimensions across the AQ Pit void and TSF. The four sections chosen were considered representative of the mine site structures being analysed.

The sections were imported into Slide2 v9.023, a Rocscience proprietary software, where material properties, lithological and hydrological boundaries were applied. These were then tested using circular and non-circular failure analyses using the General Limit of Equilibrium (GLE) method.

8.3 Analysis Scenarios

Several analysis scenarios were examined to assess slope stability and potential failure mechanisms for the AQ Pit and TSF.

8.3.1 Pit Slopes – AQ Pit

The following representative sections were generated through the AQ Pit void, as shown in Figure 8-2 and Figure 8-3:

- Section 1 - As built AQ Pit void southern wall profile adjacent to the ramp, as shown in Figure 8-3;
- Section 2 - Design AQ Pit void wall profile for cutback, as shown in Figure 8-4.
- Section 3 - West to east section through the AQ Pit void immediately north of the access ramp, as shown in Figure 8-5.

Pit slope stability analyses were carried out for the following scenarios:

- Failure scenarios:
 - Weathered horizon failure; and
 - Global slope failure (crest to toe).
- Groundwater scenarios:
 - No groundwater – representing pit drainage for cutback access and end-of-mining condition; and
 - Mean groundwater level – approximately 117 m RL (i.e. post-closure condition).

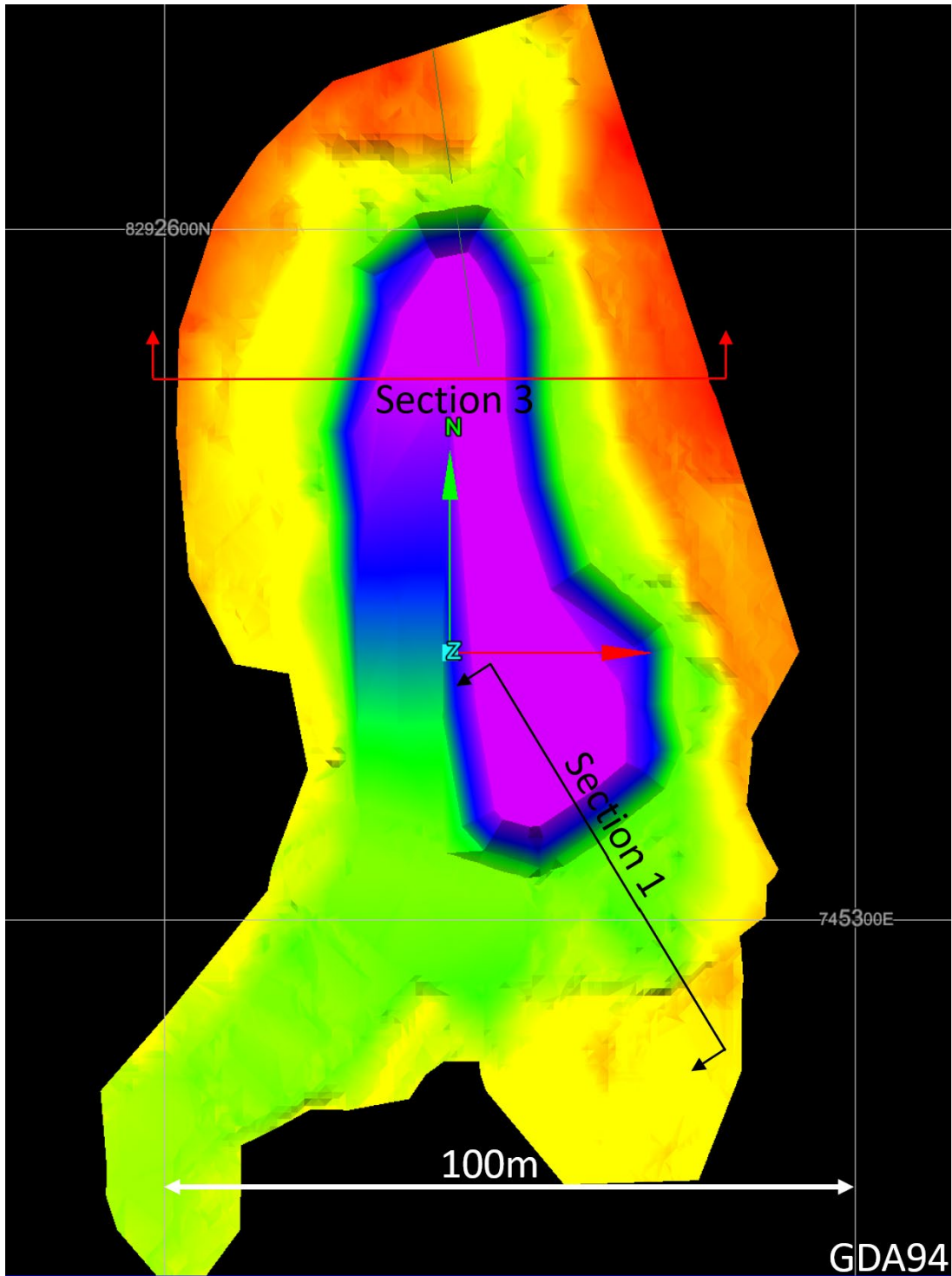


Figure 8-1: As-Built AQ Pit Void Shell

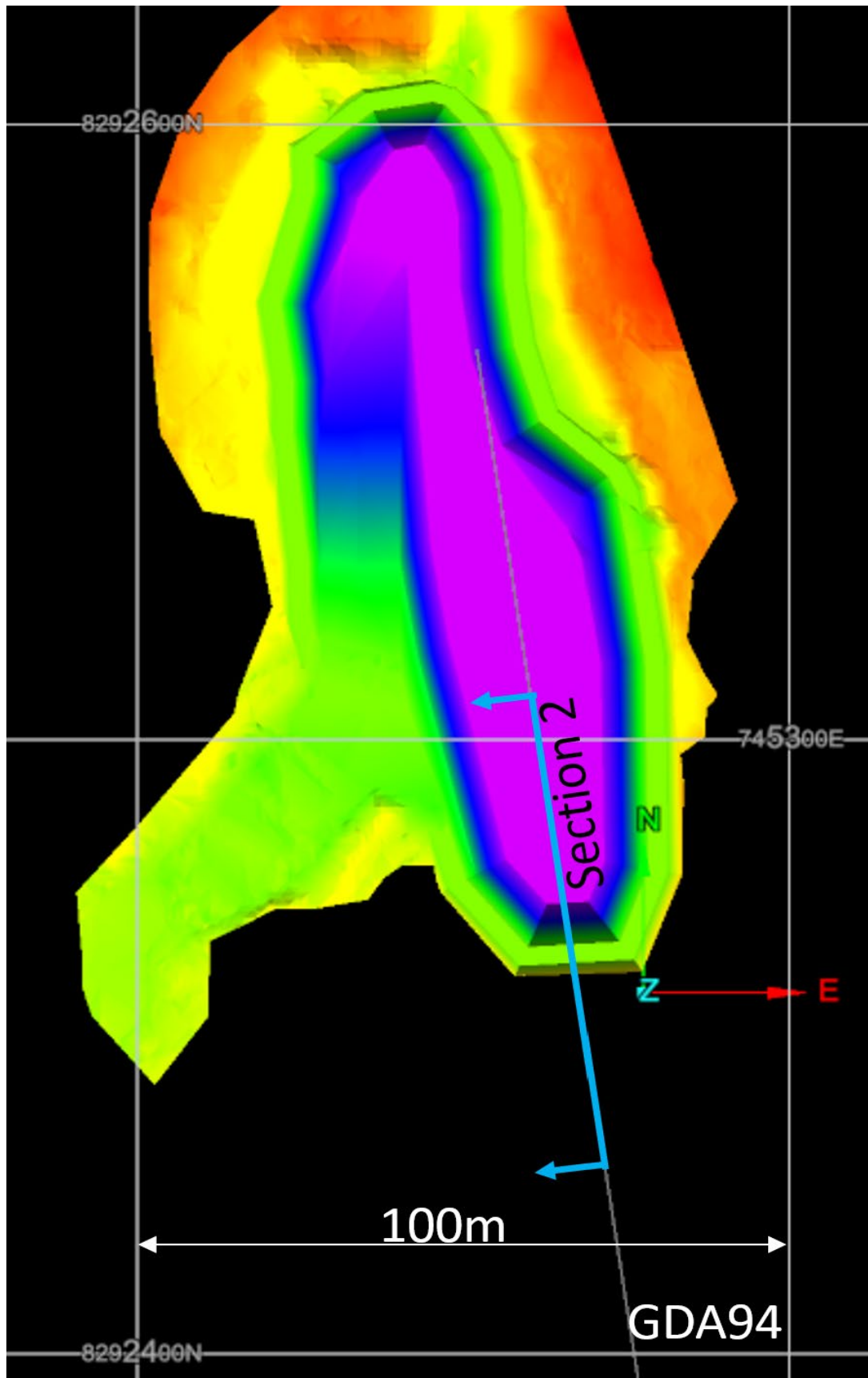


Figure 8-2: Design AQ Pit Void Shell

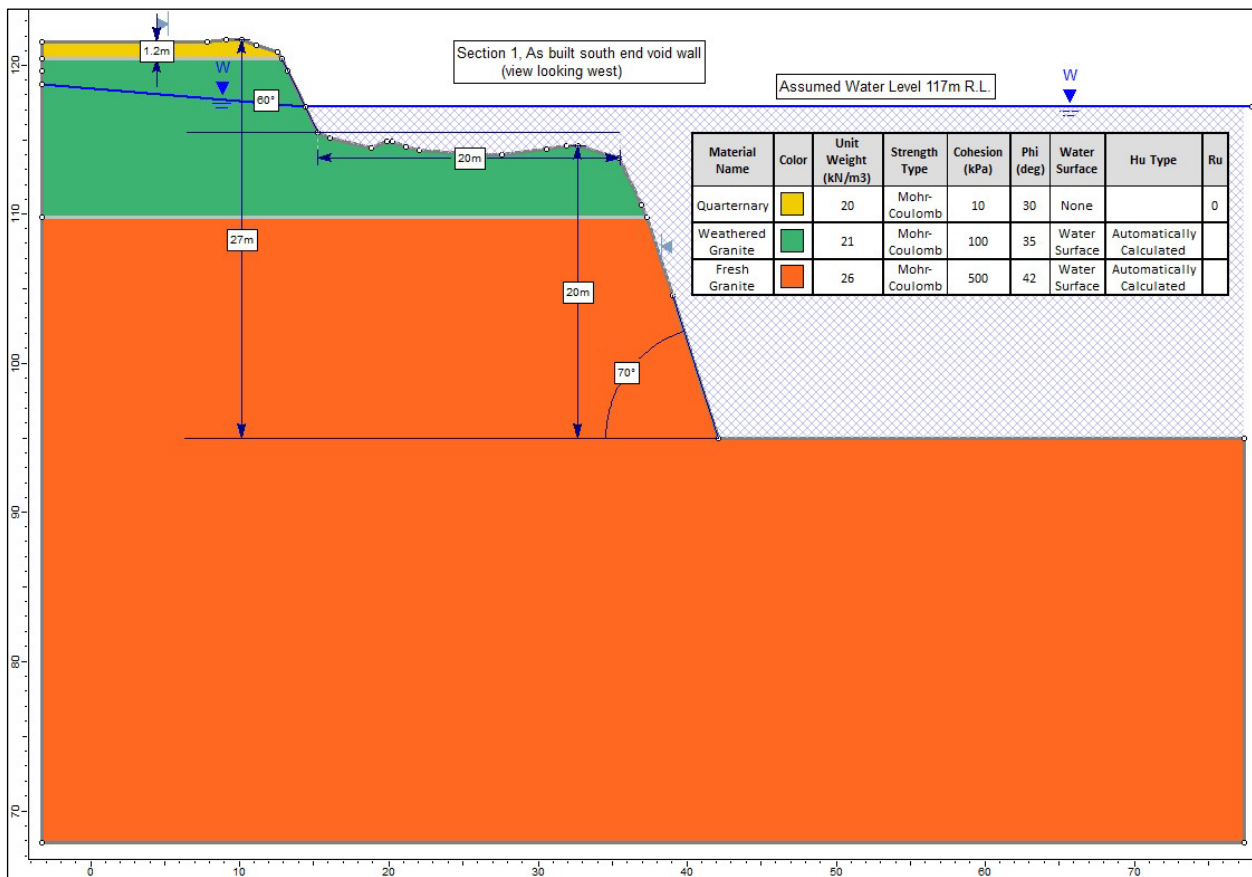


Figure 8-3: Section 1 - As Built AQ Pit - South Wall (Looking West).

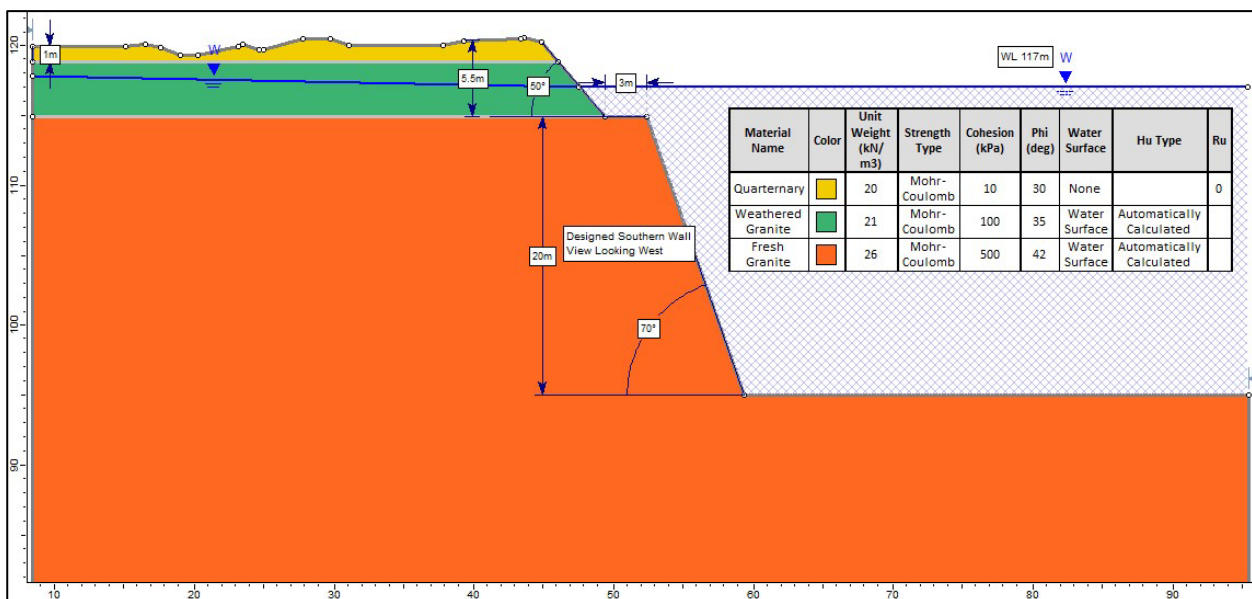


Figure 8-4: Section 2 – Designed (Cutback) AQ Pit -South Wall (Looking West).

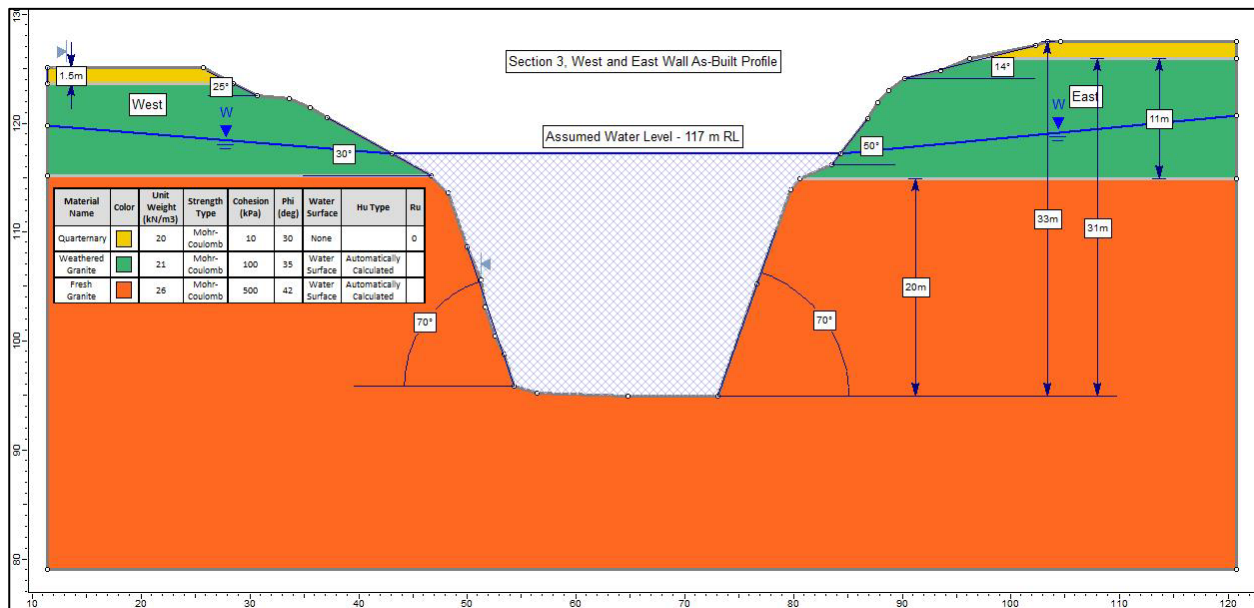


Figure 8-5: Section 3 - West to East Section (Looking North)

8.3.2 Tailings Storage Facility

Representative sections were developed as follows:

- TSF downstream (west wall) embankment, as shown in Figure 8-6.

The tailings storage facility was the last of the four cross sections to be modelled.

Slope stability analyses were carried out for the following scenarios:

1. The 'as-built' scenario where the tailings dam is currently partially filled and a worse case water level applied, as shown in Figure 8-7.
2. The second 'Infilled' scenario to exemplify the potential further use of the facility as additional waste material storage filled to the maximum height of the embankment, as shown in Figure 8-8.

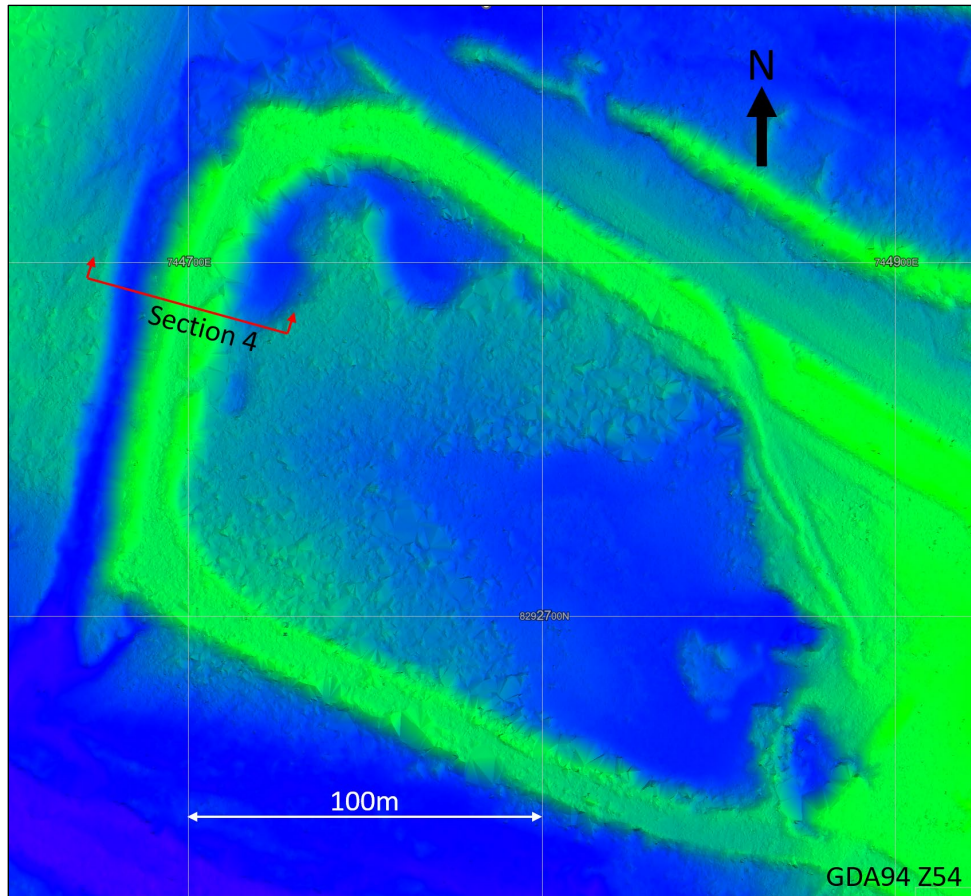


Figure 8-6: Tailings Storage Facility Embankment and Footprint.

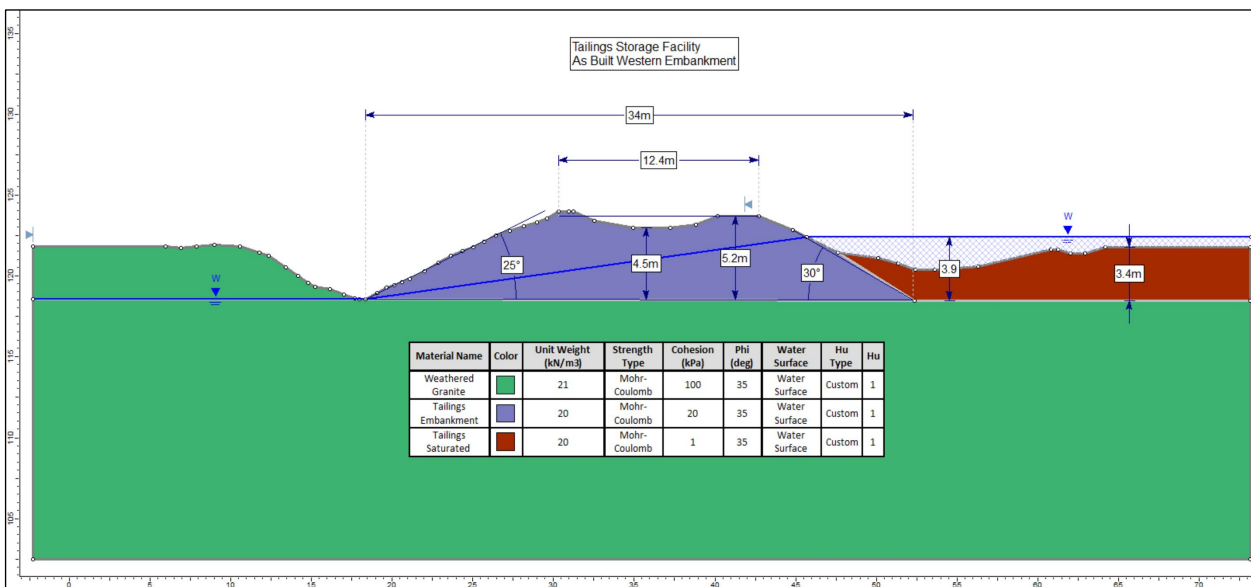


Figure 8-7: Section 4 - As-Built TSF Embankment (Looking Northeast) – Scenario 1

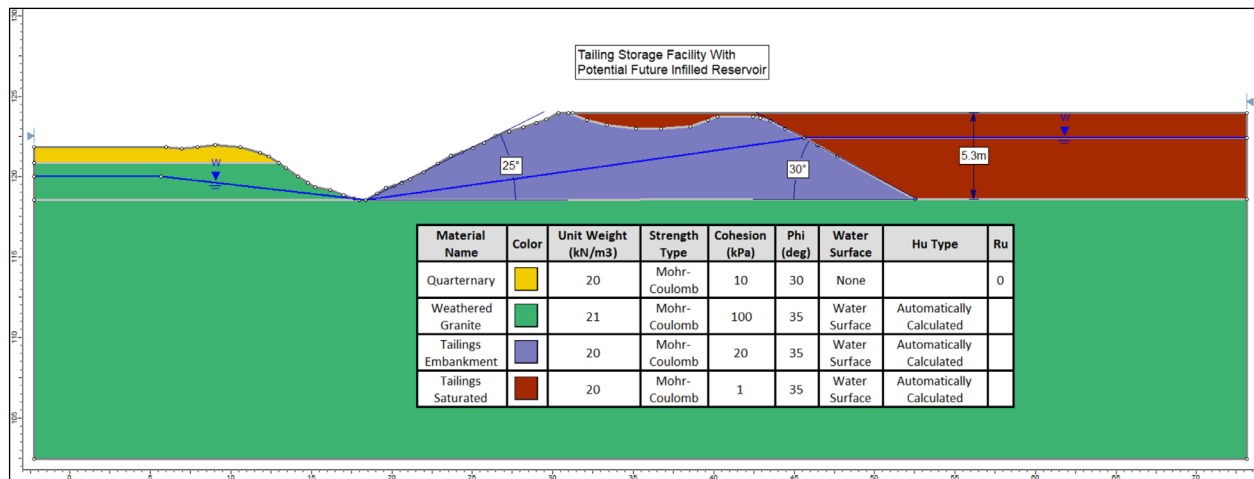


Figure 8-8: Section 4 - TSF Embankment, Filled To Capacity (Looking Northeast) – Scenario 2

8.4 Analysis Results and Discussion

All slope stability scenarios analyses exceeded the minimum required FoS value for long-term geotechnical stability of 1.5. Therefore, the pit void and TSF slopes are unlikely to pose a significant long-term slope stability risk, based on the defined scenarios and assumptions.

Whilst the results of the limit equilibrium analyses justify suitably stable structures within the current landform, the results assume the applied material properties and lithological boundaries modelled for the pit and the TSF are representative of actual site conditions.

Rock mass defect information for the pit slopes was not available at the time of modelling, the influence of which could change the outcome of the analyses. Based on a review of available core photos, rock mass structural conditions suggest that kinematic failure mechanisms would be possible; however, any failures of this type would report directly to the void and are unlikely to present a significant geotechnical risk post closure.

Further assessment of rock mass structure and pit slope defects should be carried out post dewatering and prior to end of mining.

The results of the slope stability analyses are summarised in Table 8-2.

Individual slope stability analyses outputs are presented in Appendix A.

Table 8-2: Limit Equilibrium Analyses Results

Section Number	Scenario	Failure Surface	FoS GLE/M-P
1	Section 1 – inundated to 117 m RL, as built, southern AQ Pit void wall, 70° slope in fresh granite, 50° slope in weathered granite and colluvials.	Circular	4.9
		Non-Circular	7.6
	Section 1 - dewatered, as built, southern AQ Pit void wall, 70° slope in fresh granite, 50° slope in weathered granite and colluvials.	Circular	4.7
		Non-Circular	5.0
2	Section 2 - inundated, designed southern AQ Pit void wall, 70° slope in fresh granite, 50° slope in weathered granite and colluvials	Circular	3.9
		Non-Circular	7.7
	Section 2 - dewatered, designed southern AQ Pit void wall, 70° slope in fresh granite, 50° slope in weathered granite and colluvials	Circular	3.0
		Non-Circular	4.3
3	Section 3 - inundated, western wall of AQ Pit void, 70° slope in fresh granite, 25° to 30° slope in weathered granite and colluvials	Circular	4.2
	Section 3 - inundated, eastern wall of AQ Pit void, 70° slope in fresh granite, 50° slope in weathered granite and 14° in upper colluvials	Circular	3.8
	Section 3 – dewatered condition, western wall of AQ Pit Void, 70° slope in fresh granite, 25° to 30° slope in weathered granite and colluvials	Non-Circular	4.1
	Section 3 - dewatered condition, eastern wall of AQ Pit void, 70° slope in fresh granite, 50° slope in weathered granite and 14° in upper colluvials	Non-Circular	3.5
4	Section 4 - TSF, partially filled – Scenario 1	Circular	3.6
	Section 4 - TSF, proposed Infilled – Scenario 2	Circular	3.6

9 SURFACE WATER MANAGEMENT

Run-off over the pit crest should have no impact on the stability of the rock benches, and there were no areas of potential mass instability identified from the assessment, based on the available data; however, concentrated run-off will continue to erode and gully the upper weathered granite horizon. This is unlikely to result in global failure of pit slope.

Prominent erosional features are evident from aerial photos and from the terrain models provided. As part of closure planning, these surface areas should be re-graded to encourage the flow of surface water away from the crest area. Where earthen bunds are placed, there will be a need to minimise the catchment area between the pit crest and bund to prevent water ponding on the surface.

10 CREST BUNDING

In general, it is not practicable to treat all slopes to eliminate geotechnical stability hazards. The usual approach is to mitigate the likelihood of such hazards that present a significant risk, and then restrict access to the void. This is achieved by bunding-off the access ramps and placing exclusion bunds along perimeter of the pit void.

The perimeter exclusion bund should be located at an adequate distance from the pit crest to avoid damage from erosion or time dependent degradation. Whilst there are no official guidelines in Queensland pertaining to the appropriate location of exclusion bunds, generic guidelines were developed by Ward (2016), based on unpublished, comprehensive studies of open-cut voids in the Bowen Basin.

Bunding, for the purpose of restricting access, should have a minimum height of 2 m and should be constructed of non-dispersive material, or alternatively by placing hard barriers which would prevent access without constricting run-off, if water is being directed into the void.

11 CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

It can be concluded from the geotechnical assessment and analyses that:

- The final landform exceeds the minimum FoS of 1.5 for long-term stability, based on the assumptions, and is therefore acceptable from a geotechnical perspective;
- The final pit slopes were assessed to be geotechnically stable against large-scale failure, based on the assumptions, and scenarios examined. Localised instability can occur where geological structures daylight on the pit face and form geometries that are kinematically unstable. This has not been evaluated as part of this assessment; however, these failures may occur as the highwall erodes; and
- The downstream slope of the TSF embankment was assessed to be geotechnically stable, based on the assumptions, and scenarios examined.

11.2 Recommendations

Based on the outcomes of the analyses and assessment presented herein, the following recommendations are proposed:

- Carry out further assessment at closure to confirm assumptions and use as-built data for compiling slope stability analyses sections in the southern cutback area;

- Regrading of the upper weathered granite will need to be considered to establish sufficient drainage around the crest area in order to prevent deep gully erosion;
- Bunds should be designed to accommodate the discharge of surface water during rainfall events to prevent overtopping. In this case, cut-throughs leading to rubble-lined discharge spillways should be installed at regular intervals along the bund; and
- Pit wall mapping should be carried out upon recommencement of operations to provide a dataset for the assessment of adverse geological structures in the pit. This would enable kinematic analysis to be carried out to assess the likelihood of adverse structural failure mechanisms forming on pit slopes.

12 REFERENCES

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Ward, B (2016). “Burton Widening Residual Void Slope Stability Study”. Geotechnical Consulting Services. Report 169.

APPENDIX A: LIMIT EQUILIBRIUM MODEL OUTPUTS

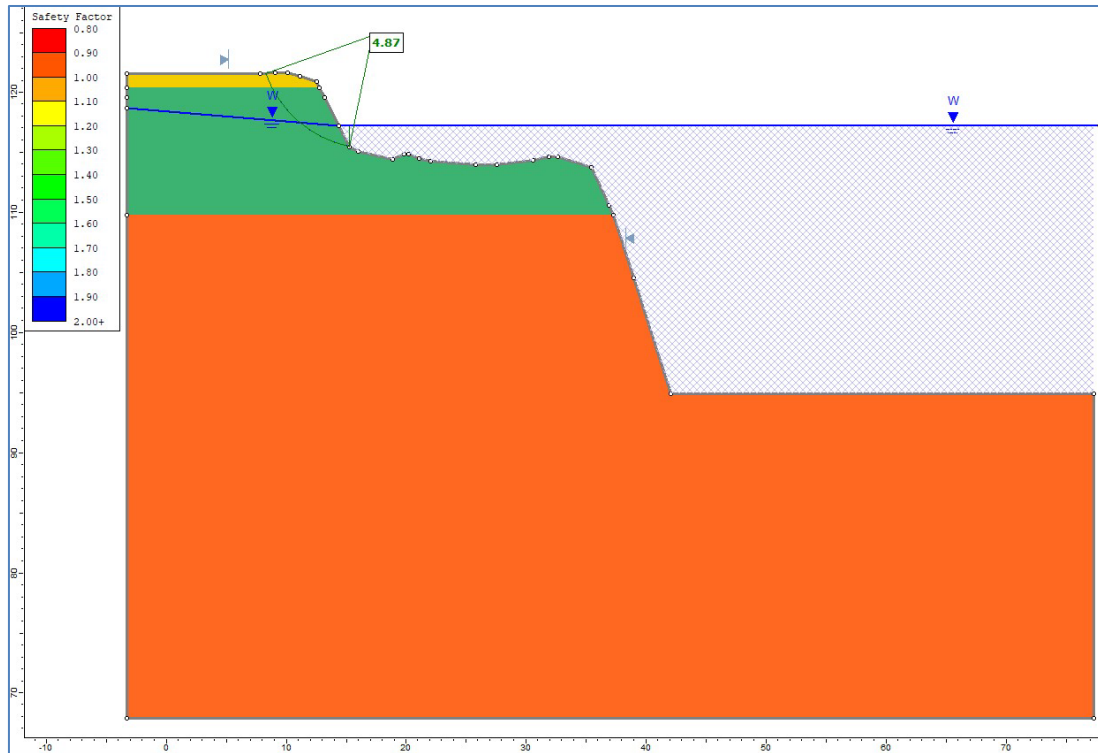


Figure A-1: Section 1 - AQ Void - As Built (Inundated) - Circular Failure (Auto Refine) – FoS 4.87

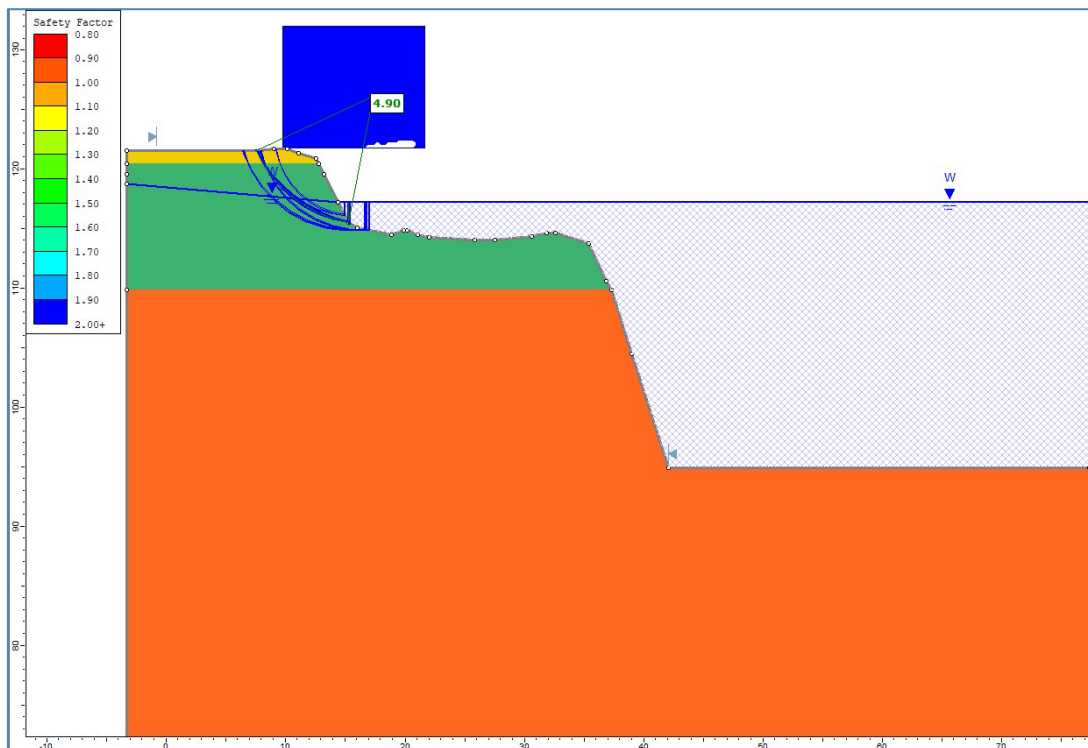


Figure A-2: Section 1 - AQ Void - As Built (Inundated) - Circular Failure (Grid Search) FoS 4.90

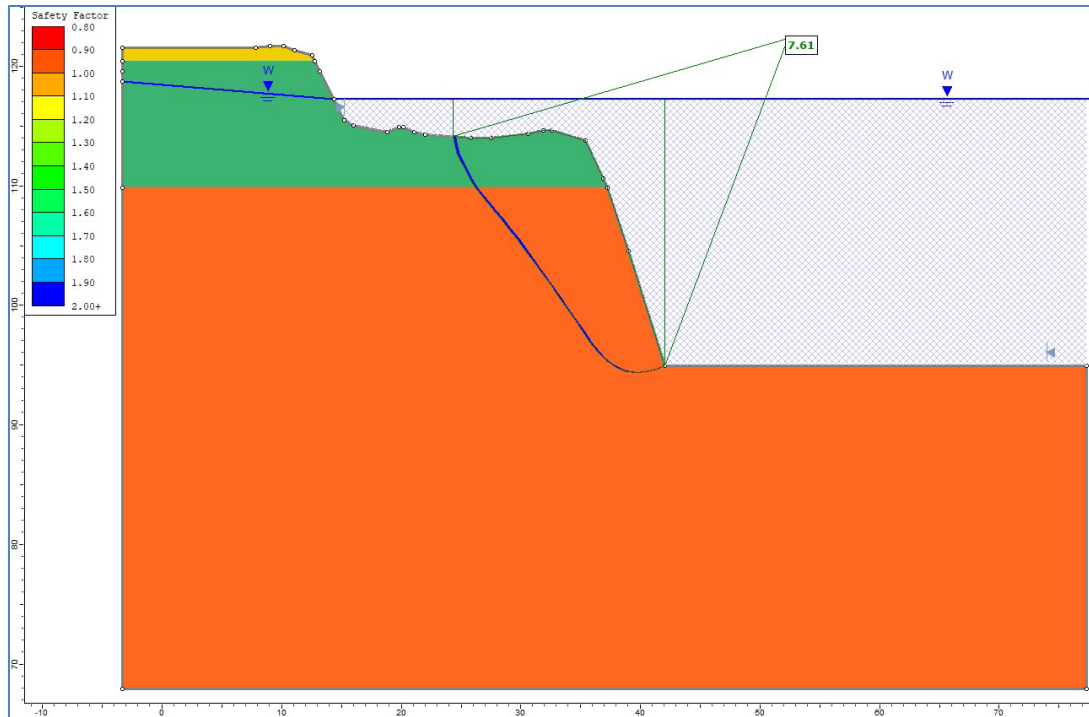


Figure A-3: Section 1 - AQ Void - As Built (Inundated) – Non-Circular Failure (Auto Refine) - FoS 7.61

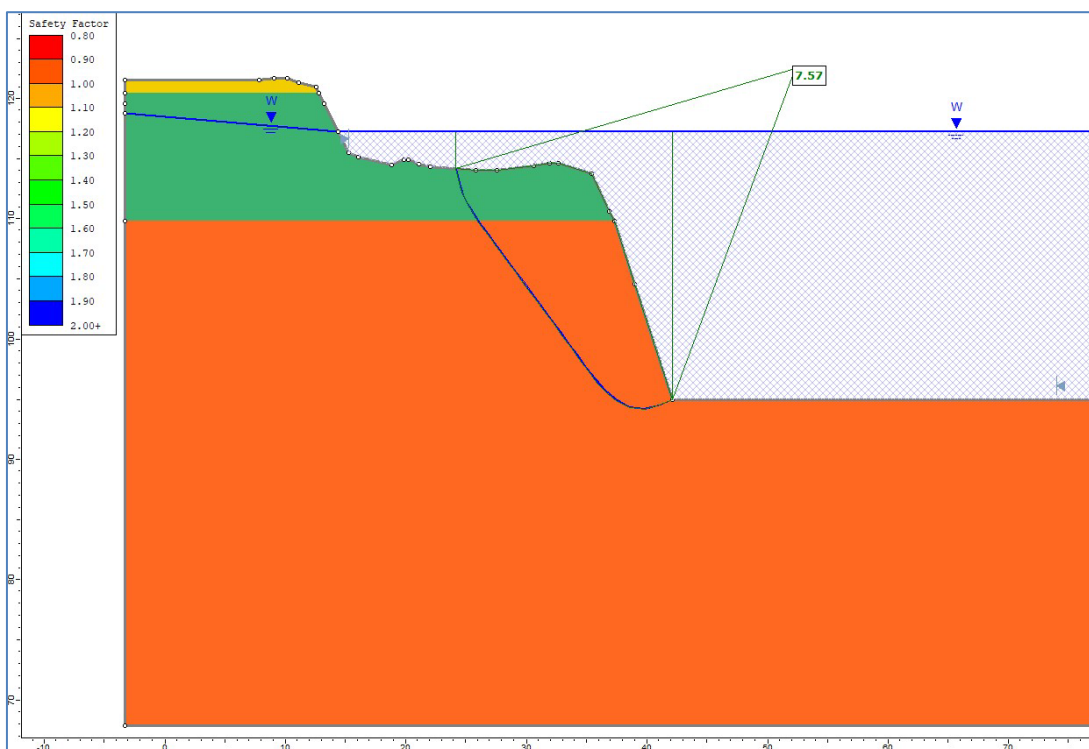


Figure A-4: Section 1 - AQ Void - As Built (Inundated) – Non-Circular Failure (Cuckoo Search) - FoS 7.57

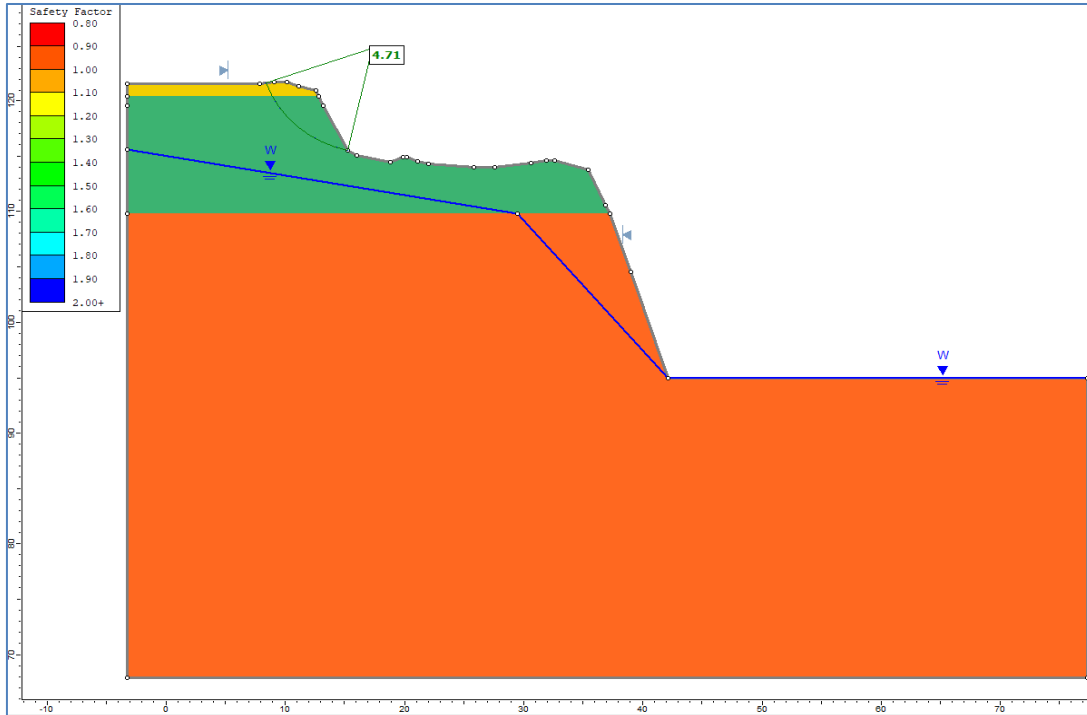


Figure A-5: Section 1 - AQ Void - As Built (Dewatered) - Circular Failure (Auto Refine) - FoS 4.71

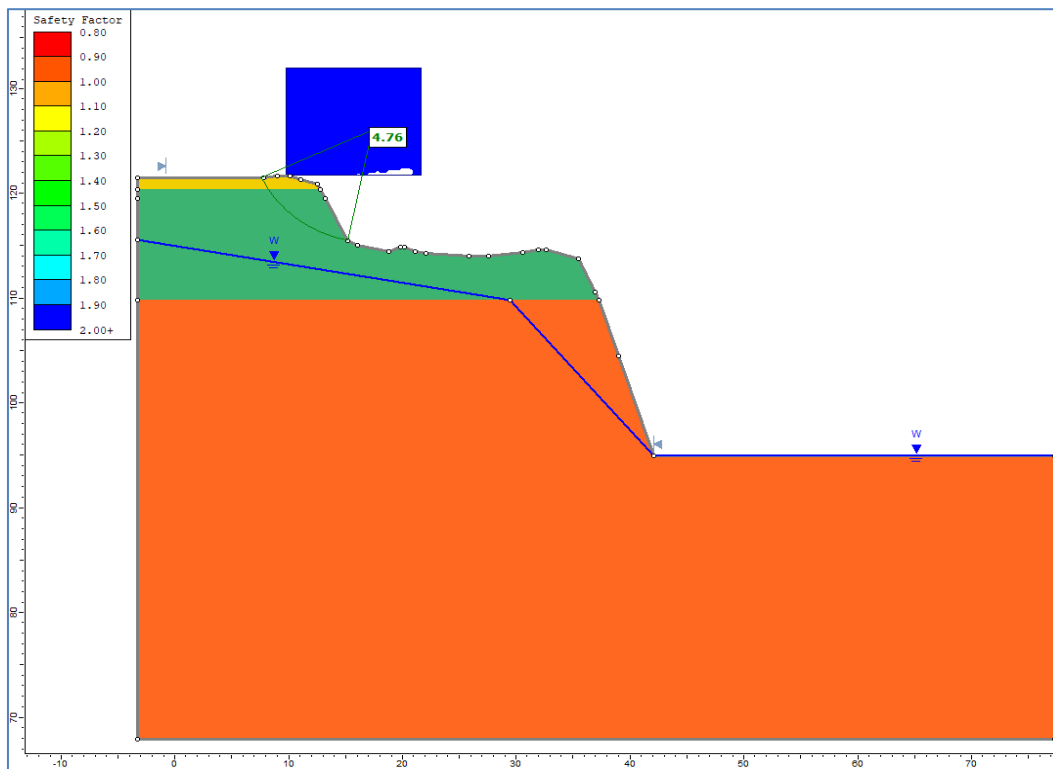


Figure A-6: Section 1 - AQ Void - As Built (Dewatered) - Circular Failure (Grid Search) - FoS 4.76

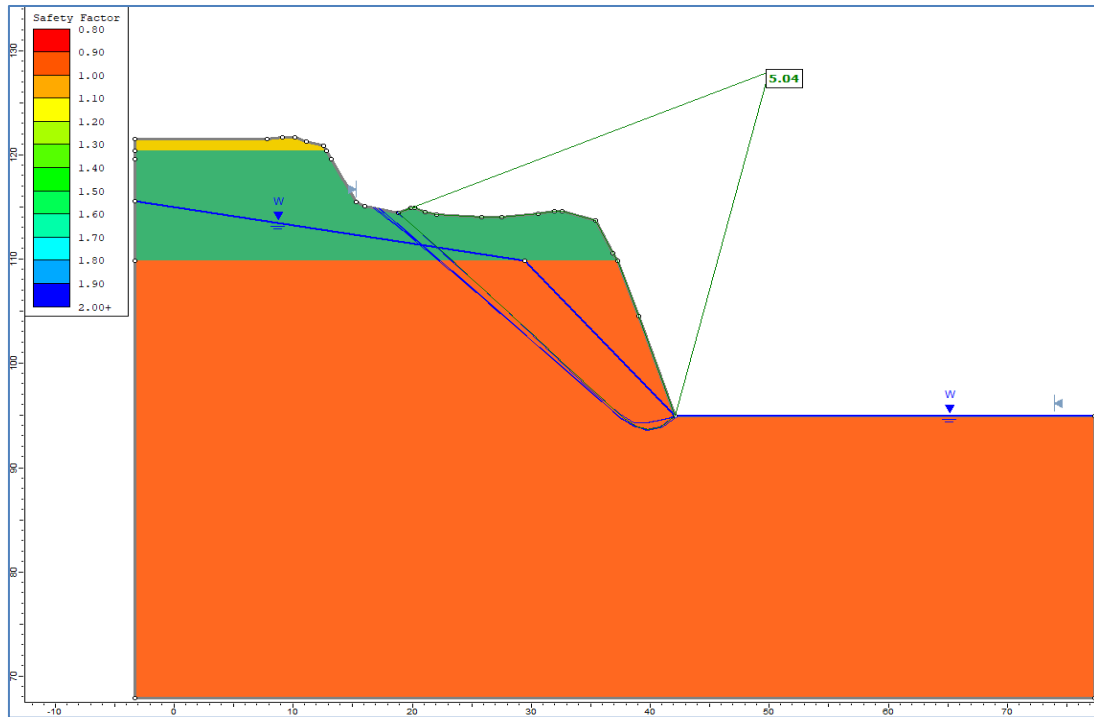


Figure A-7: Section 1 - AQ Void - As Built (Dewatered) – Non-Circular Failure (Auto Refine) - FoS 5.04

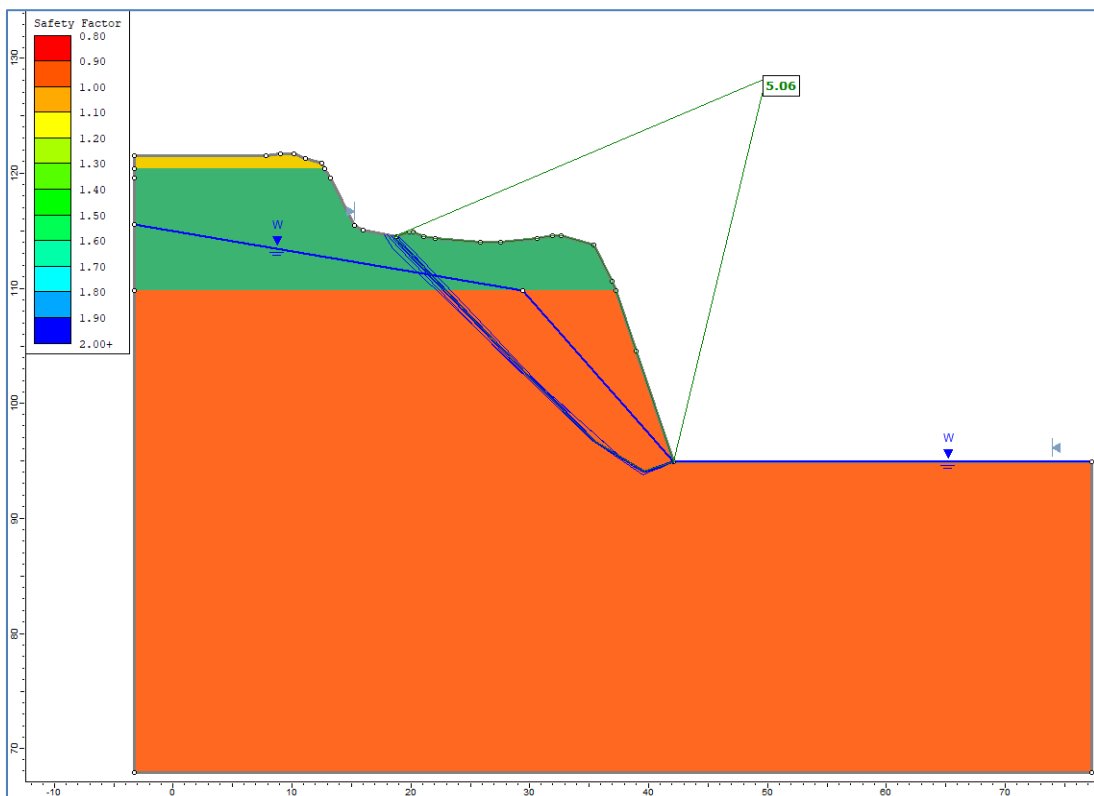


Figure A-8: Section 1 - AQ Void - As Built (Dewatered) – Non-Circular Failure (Cuckoo Search) - FoS 5.06

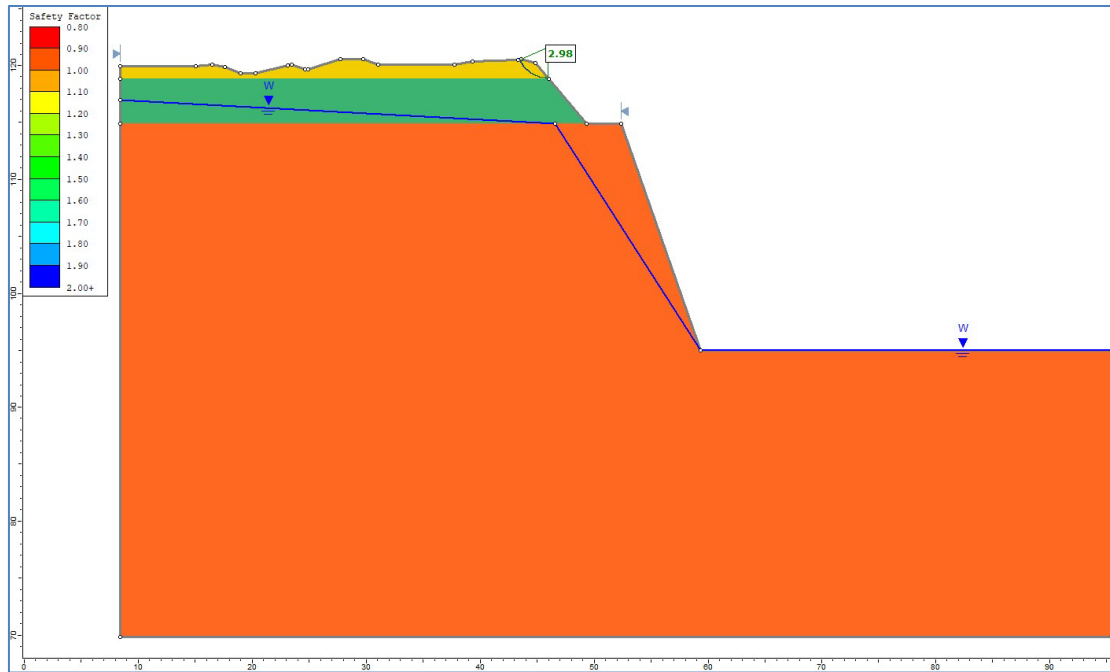


Figure A-9: Section 2 -AQ Void - Pushback (Dewatered) - Circular Failure (Auto Refine) - FoS 2.98

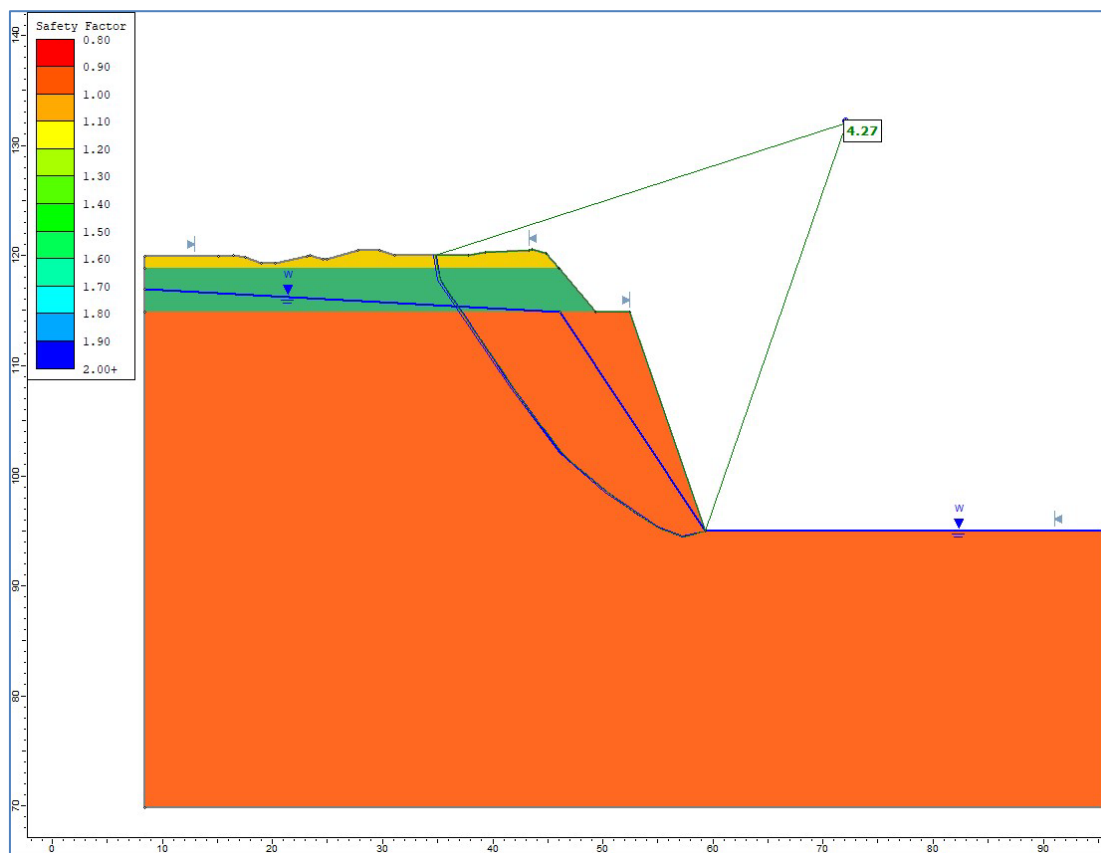


Figure A-10: Section 2 -AQ Void - Pushback (Dewatered) - Non-Circular Failure (Auto Refine) - FoS 4.27

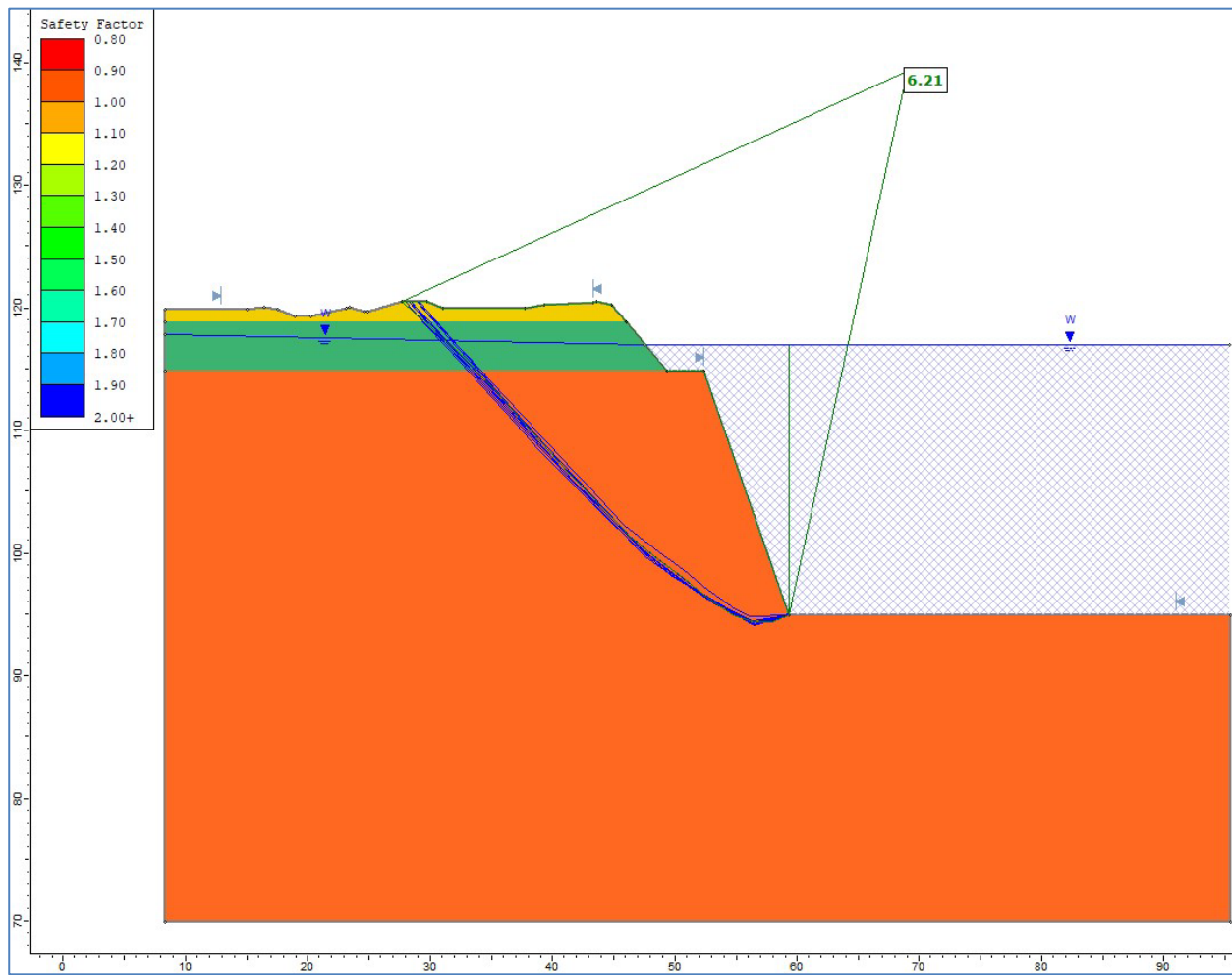


Figure A-11: Section 2 -AQ Void - Pushback (Dewatered) – Non-Circular Failure (Cuckoo Search) - FoS 6.21

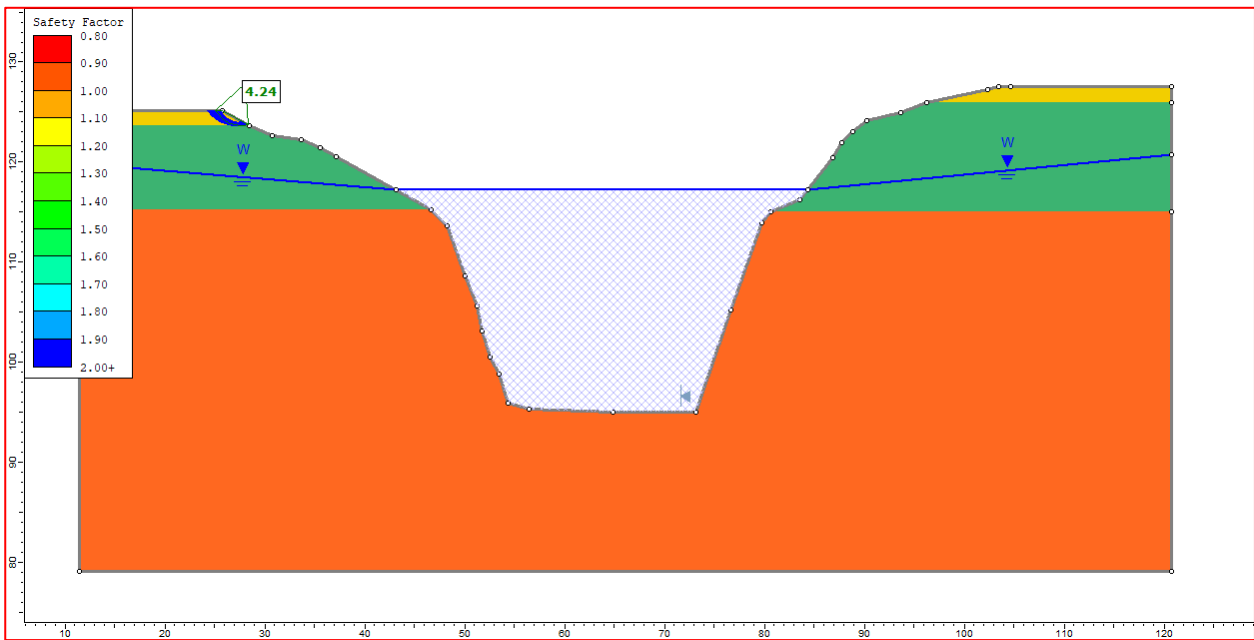


Figure A-12: Section 3 (West Wall) - AQ Void - As Built (Inundated) – Circular Failure (Auto Refine) - FoS 4.24

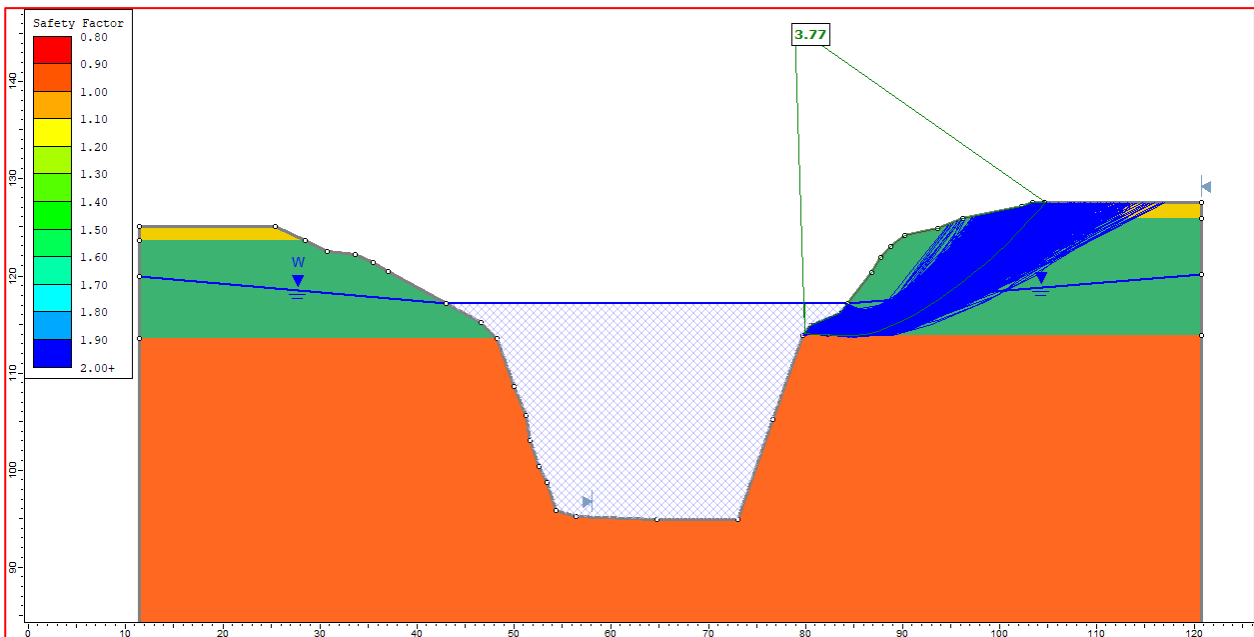


Figure A-13: Section 3 (East Wall) - AQ Void - As Built (Inundated) – Non-Circular Failure (Cuckoo Search) - FoS 3.77

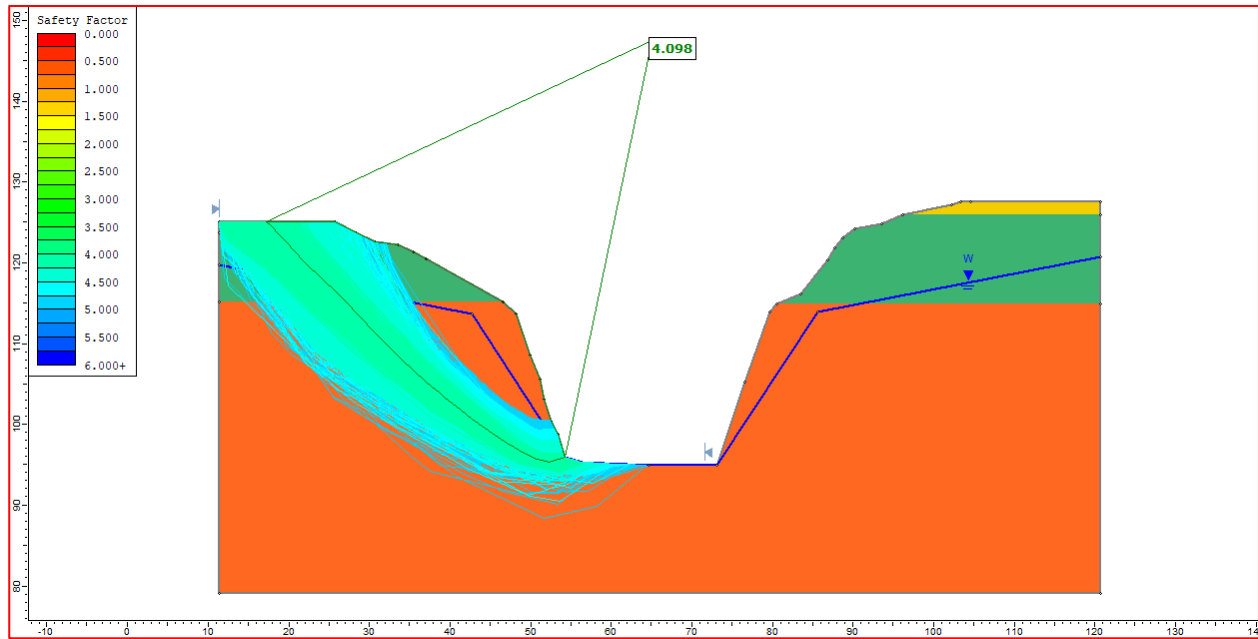


Figure A-14: Section 3 (West Wall) - AQ Void - As Built (Dewatered) – Non-Circular Failure (Cuckoo Search) - FoS 4.1

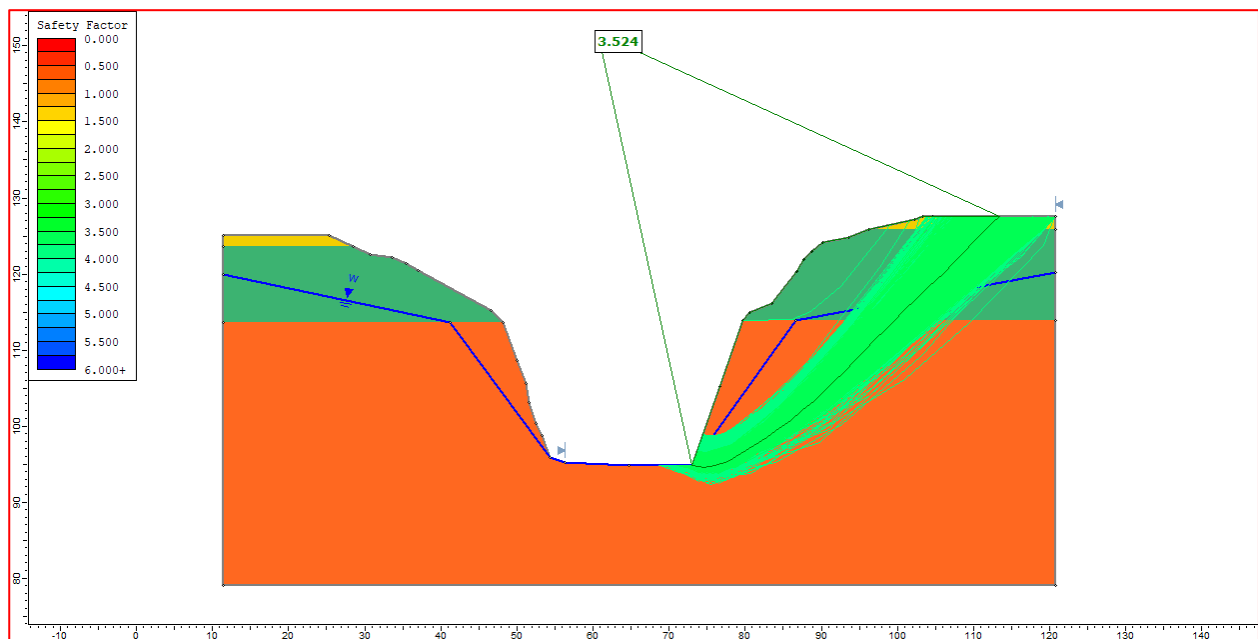


Figure A-15: Section 3 (East Wall) - AQ Void - As Built (Dewatered) – Non-Circular Failure (Cuckoo Search) - FoS 3.5

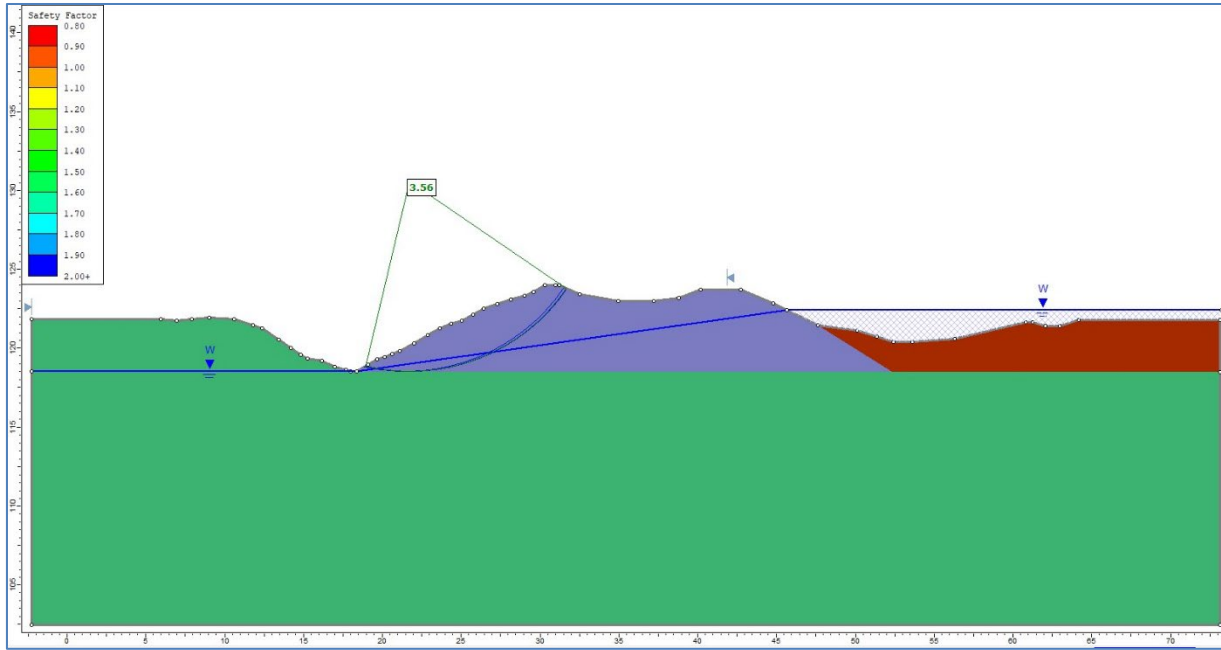


Figure A-16: As Built Tailings Storage Facility, Circular Failure (Auto Refine) - FoS 3.56

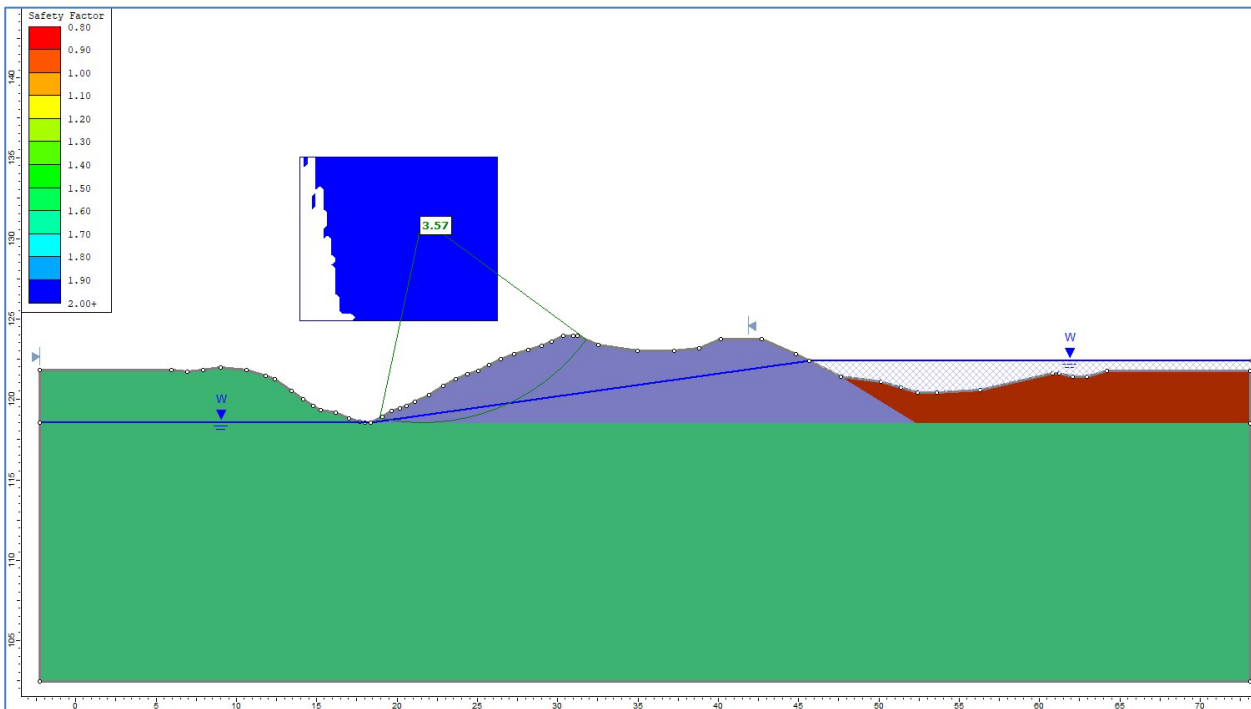


Figure A-17: As Built Tailings Storage Facility, Circular Failure (Grid Search) - FoS 3.56.

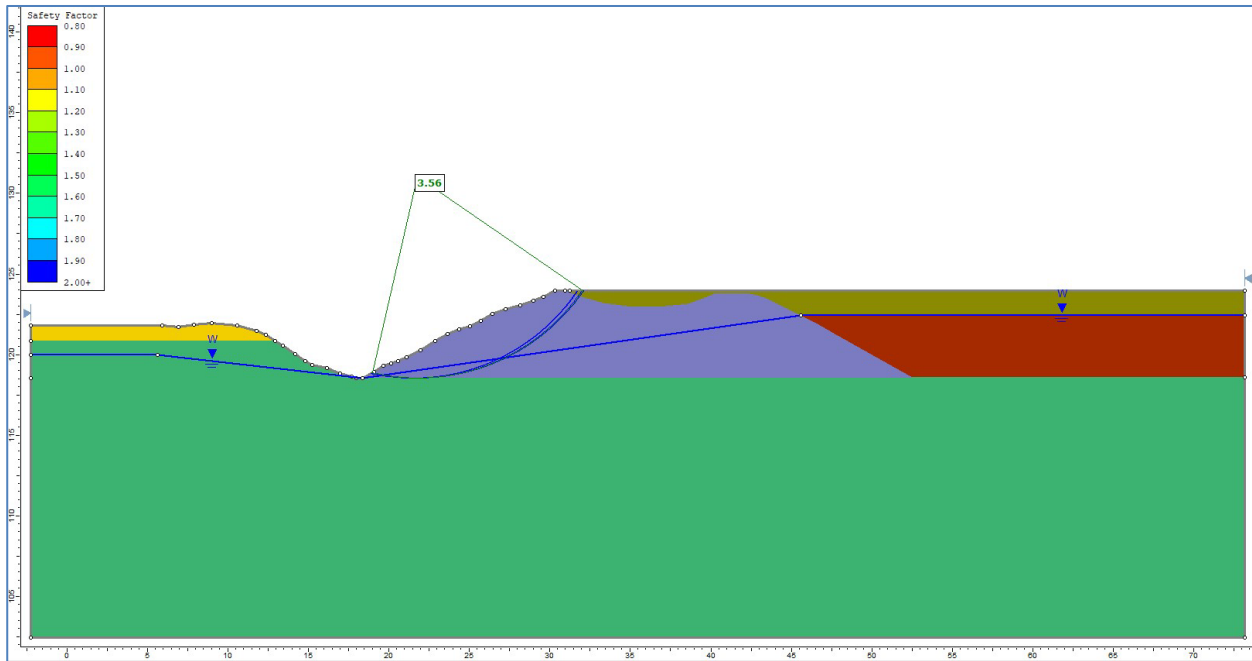


Figure A-18: Proposed Infilled Tailings Storage Facility - Circular Failure (Auto Refine) - FoS 3.56

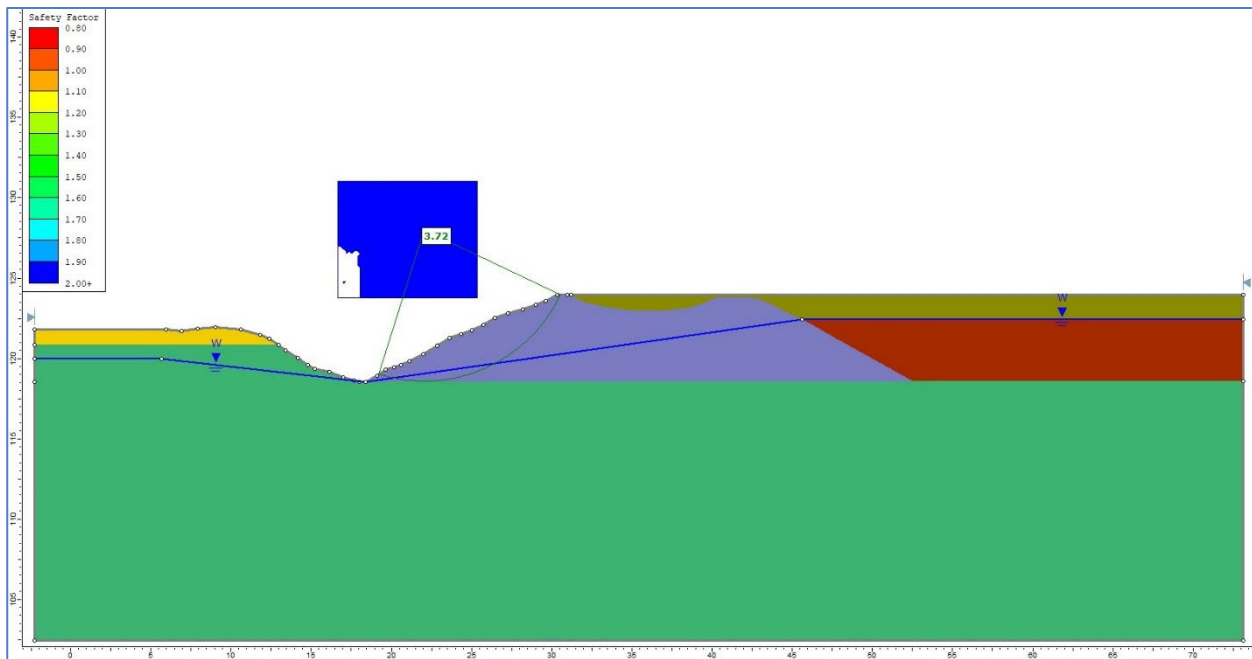


Figure A-19: Proposed Infilled Tailings Storage Facility - Circular Failure (Grid Search) - FoS 3.72.

Alice River Gold Mine

Progressive Rehabilitation and Closure Plan Surface Water Assessment Report

24/02/2025

BBNW00406_0002-REP-001-3

Job no. and Project Name: M7355_002-REP-001-0 ARGM PRCP Surface Water Assessment
Doc Path File: \\online.com\files\BNEManagement\BNE_Projects\BNE00406 PacGold Pty Ltd\BBNE00406_0002 ARGM SW Update\07
Deliv\2. Report\BBNE00406-REP-001-2A-ARGM PRCP Surface Water Assessment.docx

Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	1/08/2022	Client Issue	Nutan Gothwal	Aaron Baldwin	Nutan Gothwal	Aaron Baldwin
1	04/08/2023	Client Issue	Nutan Gothwal	Andrew Vitale	Nutan Gothwal	Andrew Vitale
2	11/02/2025	Draft Issue	Nutan Gothwal	Aaron Baldwin	Nutan Gothwal	Aaron Baldwin
3	24/02/2025	Client Issue	Nutan Gothwal	Aaron Baldwin	Nutan Gothwal	Aaron Baldwin

Signatures

DISCLAIMER

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Contents

1	INTRODUCTION	1
1.1	BACKGROUND	1
1.2	OBJECTIVES	1
2	PROPOSED FINAL LANDFORM	3
2.1	FINAL LANDFORM AND VOIDS	3
2.1.1	Existing Void and Water Quality	3
2.1.2	Queen Pit Flooding Interaction	3
3	RECEIVING ENVIRONMENT	8
3.1	RECEIVING WATERWAYS	8
3.1.1	One Mile Creek	8
3.1.2	Dickies Creek	8
3.1.3	Alice River	8
3.2	REGIONAL ECOSYSTEMS	10
3.3	DOWNSTREAM POPULATION AND SURFACE WATER USERS	12
4	ENVIRONMENTAL VALUES AND WATER QUALITY OBJECTIVES	13
4.1	ENVIRONMENTAL VALUES	13
4.1.1	Relevant Legislation	13
4.1.2	Proposed Environmental Values	14
4.2	PIT LAKE WATER QUALITY OBJECTIVES	15
4.2.1	Water Quality Objectives	15
5	CONTAMINANT SOURCES AND POTENTIAL IMPACTS	17
5.1	CONTAMINANT SOURCES POST CLOSURE	17
5.2	POTENTIAL IMPACTS	17
6	POST MINING FLOOD ASSESSMENT	18
6.1	HYDROLOGIC MODELLING	18
6.1.1	Overview	18
6.1.2	Model Development	18
6.1.3	Design Hydrology Results	20
6.1.4	Model Validation	21

6.2	HYDRAULIC ASSESSMENT	21
6.2.1	Overview	21
6.2.2	Model Data	22
6.2.3	Model Simulation	22
6.3	FINAL LANDFORM FLOOD ASSESSMENT RESULTS	22
6.4	PRE-MINING FLOODPLAIN EXTENT	23
7	POST MINING WATER MANAGEMENT	24
7.1	SURFACE DRAINAGE	24
7.2	WATERCOURSE DIVERSIONS	24
7.3	FINAL VOIDS	24
7.4	ONGOING DEWATERING OR WATER MANAGEMENT REQUIREMENTS	24
8	FINAL VOID HYDROLOGY ASSESSMENT	25
8.1	OVERVIEW	25
8.2	FINAL LANDFORM	25
8.3	CLIMATE DATA	25
8.4	CATCHMENT RUNOFF	26
8.5	GROUNDWATER INTERACTIONS	28
8.6	ONE MILE CREEK FLOODING INTERACTION	28
8.7	MODEL VALIDATION	28
9	FINAL VOID HYDROLOGY RESULTS	30
9.1	MODEL FORECAST	30
9.2	WATER QUALITY ASSESSMENT	32
9.2.1	Stratification	32
9.3	CONCLUSIONS	32
10	QUALIFICATIONS	34
11	REFERENCES	35

Appendices

Appendix A: Water Quality Comparison

Appendix B: Hydrology Model Validation

Appendix C: Post Closure Flood Mapping

List of Tables

Table 2.1: Summary of ARGM Final Void	3
Table 2.2: Summary of Historical Queen Pit Water Quality Data	3
Table 4.1: Default Water Quality Objectives	16
Table 5.1: Contaminant Source Summary	17
Table 6.1: Design Hydrology Results	20
Table 6.2: Design Hydrology Validation	21
Table 8.1: Climate Input Data Sources	26
Table 8.2: Alice Gold Mine Average Climate Data	26
Table 8.3: AWBM Parameters	27
Table 9.1: Final Void Lake Results Summary	30

List of Figures

Figure 1.1: ARGM Northern Mining Leases Post Mining Landuse	2
Figure 1.2: ARGM Southern Mining Lease Landuse Rehabilitation Plan	2
Figure 2.1: ARGM Monitoring Locations	5
Figure 2.2: ARGM Final Void and Drainage	6
Figure 2.3: Queen Pit –Pit Lake (July 2022)	7
Figure 2.4: Queen Pit – Spill Location into Pit (Ramp) (July 2022)	7
Figure 3.1: Receiving Waterways	9
Figure 3.2: Matters of State Environmental Significance Regional Ecosystems	11
Figure 6.1: One Mile Creek and Alice River Hydrology Model Catchments	19
Figure 8.1: Final Void Storage Characteristics	25
Figure 8.2: AWBM Schematic	27
Figure 8.3: Model Validation – Queen Pit Lake Level	29
Figure 9.1: Final Void Water Level Time Series Results - Base Case	30
Figure 9.2: Final Void Water Level Time Series Results - Sensitivity Case	31

1 INTRODUCTION

1.1 BACKGROUND

Alice River Gold Mine (ARGM) is an open-cut operation located in the Gulf drainage area in north Queensland. Mining activities at Alice River Gold Mine are currently approved under Environmental Authority (EA) EPML00870113. ARGM are preparing a Progressive Rehabilitation and Closure Plan (PRCP) which includes a design of the proposed rehabilitated final landform for the site. This report assesses the mine closure water management and final void hydrology and the post mining landuse flooding assessment to support the submission of the PRCP. ARGM is proposed to be rehabilitated to provide a dominant grazing post mining land use (PMLU) with the remaining final void to be used for stock water). Figure 1.1: and Figure 1.2: shows the proposed ARGM post mining landuse rehabilitation outcomes for the northern (ML2901 and ML3010) and southern mining leases (ML2907, ML2957, ML2958, ML 2908, ML3011 and ML2902).

The planned residual void post closure is in the northern mining area on ML2901. The residual void will be the existing Queen Pit with a slightly larger footprint than the existing pit with a total storage capacity of 83ML. The remaining landforms in the northern mining areas are proposed to be rehabilitated and free draining.

The southern mining area is proposed to be rehabilitated and free draining with light vehicle access tracks remaining for the local landholder. The southern mining area rehabilitation has a small footprint and will not have a residual void or storage.

1.2 OBJECTIVES

The key objectives of the ARGM closure water management and flooding assessment report are:

- Review final void configuration and determine final drainage catchments.
- Identify changes to storage volumes and water quality over time as well as predicted equilibrium status.
- Recommend final landform drainage diversions to manage void catchments.
- Assess long-term groundwater interactions and potential for seepage to and from alluvial aquifers.
- Assess the flooding interactions with the final voids post closure.
- Assess the post mining flood behaviour and stability of the proposed final landform.

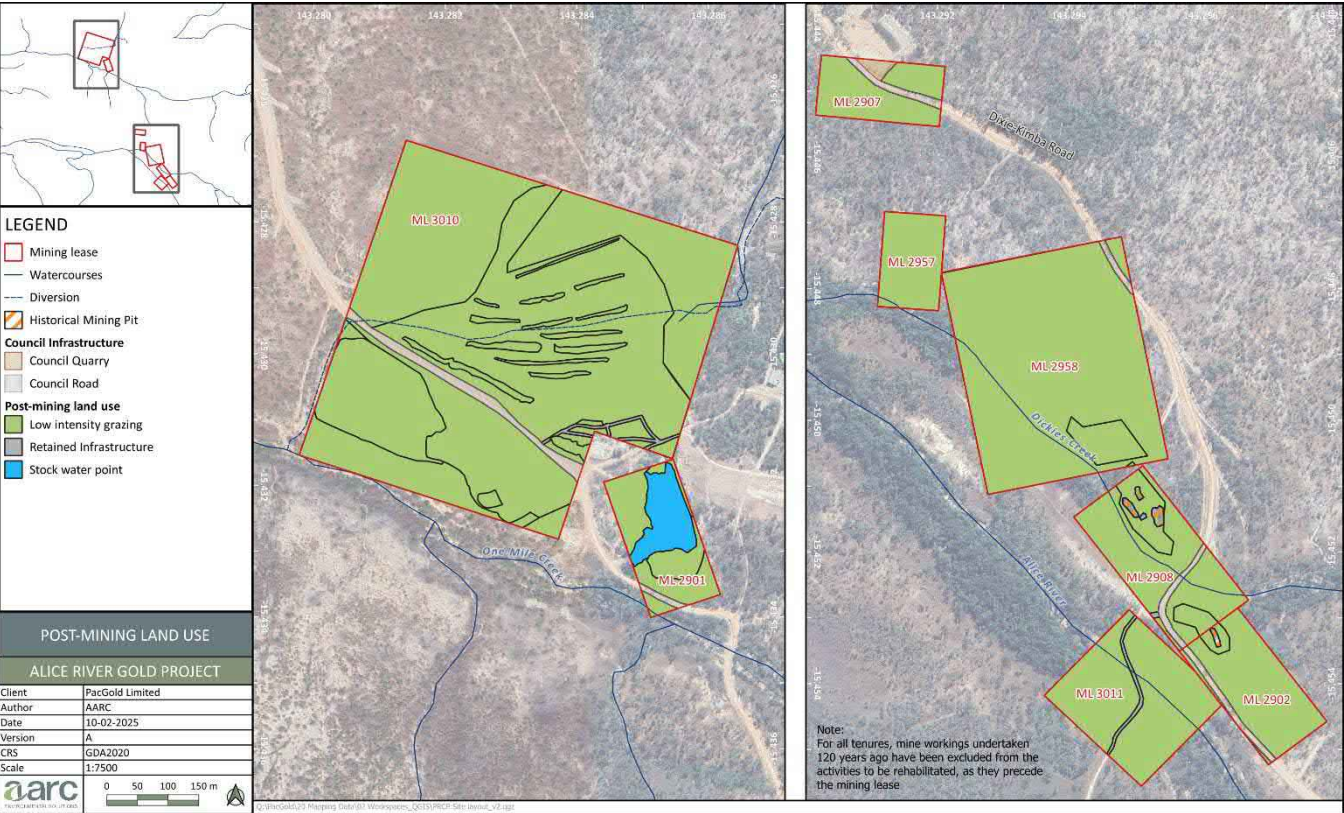


Figure 1.1: ARGM Northern Mining Leases Post Mining Landuse

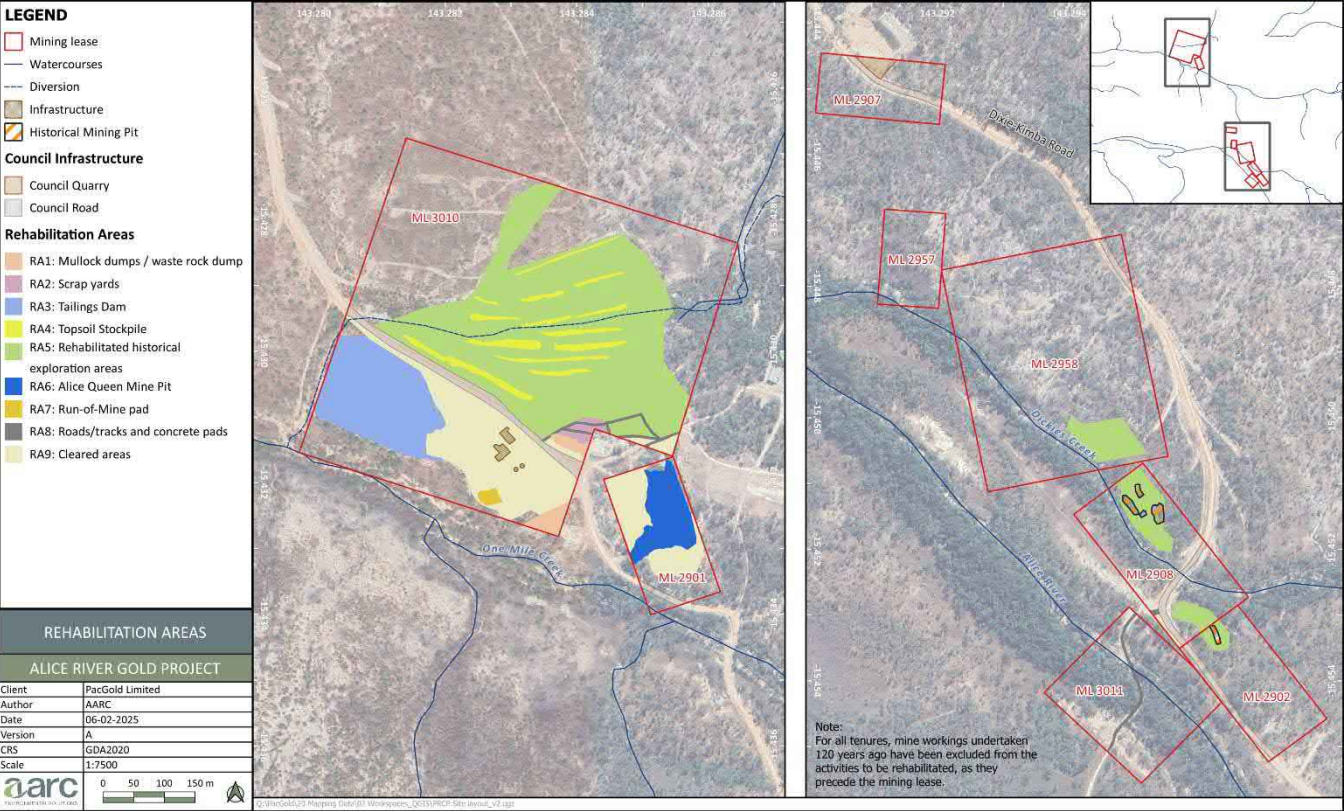


Figure 1.2: ARGM Southern Mining Lease Landuse Rehabilitation Plan

2 PROPOSED FINAL LANDFORM

2.1 FINAL LANDFORM AND VOIDS

ARGM post mining landform will have 1 final void in the northern mining lease (ML2901) and no final voids in the southern leases. Figure 2.2 shows the proposed ARGM final void (Queen Pit) as well as the reporting catchment area and drainage pathways. The ARGM final void will have a Post Mining Landuse (PMLU) of grazing and be utilised by the local landholder. Queen Pit is currently used for grazing by the final landform and maintains a good water quality Table 2.1 outlines key details of the ARGM final void.

Table 2.1: Summary of ARGM Final Void

Void ID	Description	Catchment Area (ha)	Floor Level (m AHD)	Spill Level (m AHD)	Capacity (ML)
Queen Pit	A small open cut pit void with a minor external drainage catchment.	3.7	95	117.4	83 ML

2.1.1 Existing Void and Water Quality

The Queen Pit operated between 1992 to 1995 and has been closed since the end of 1995 forming a pit lake. The Queen Pit is currently full of water and expected to be at equilibrium and is used for grazing by the local landholder. The pit surrounds are vegetated and stable. The pit lake receives inflows from its local catchment, groundwater, and flood ingress inflows from One Mile Creek, therefore the water quality is representative of rainfall and surface water overflow.

The historical water quality data for Queen Pit from 22/10/2001 to 04/05/2023 is summarised in Table 2.2 and Appendix A. Photos of the current pit lake are shown in Figure 2.4 and Figure 2.4.

Table 2.2: Summary of Historical Queen Pit Water Quality Data

Parameter	Units	20 th Percentile	Median	80 th Percentile	Most Recent
pH	pH Units	6.6	6.8	7.3	8.3
Dissolved Oxygen	%	8.5	86.2	111.7	111.7
Turbidity	NTU	2.6	5.0	7.6	1.4
Electrical Conductivity (EC)	µS/cm	34.4	47.0	56.2	47.8
Sulphate	mg/L	2.0	3.0	13.7	<1
Antimony (total)	mg/L	0.004	0.005	0.006	0.003
Total Arsenic (total)	mg/L	0.136	0.185	0.248	0.149
Copper (total)	mg/L	-	<0.001	-	<0.001
Lead (total)	mg/L	-	<0.001	-	<0.001
Zinc (total)	mg/L	0.0062	0.0080	0.0128	<0.005
Cyanide (total)	mg/L	-	<0.004	-	<0.004

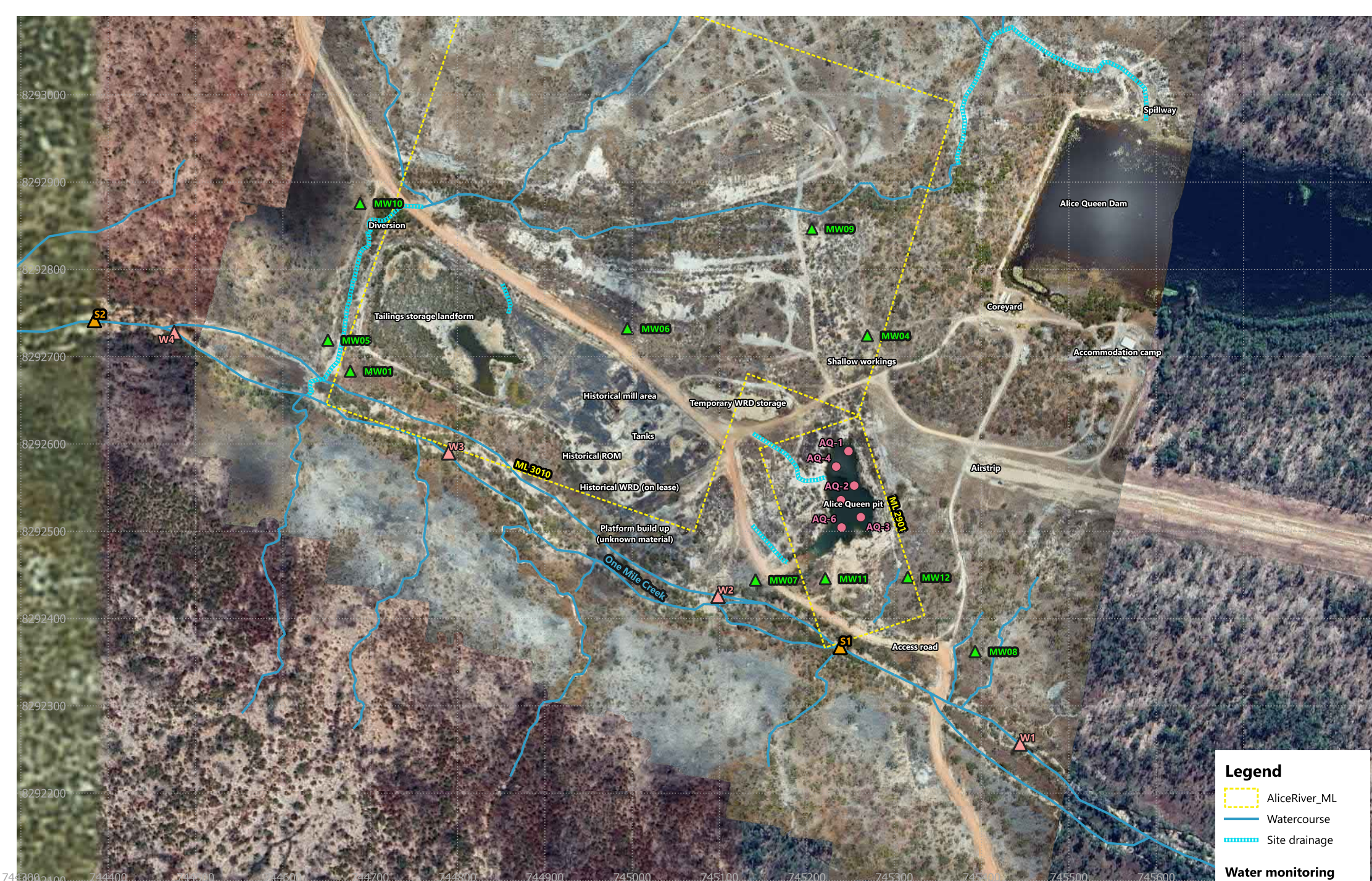
2.1.2 Queen Pit Flooding Interaction

Queen Pit currently has a spill level of 117.4m AHD which is approximately 4m above the One Mile Creek invert immediately adjacent the pit void. The local landholder has described, One Mile Creek inundates the current pit lake during flood flows which agrees with the post mining flooding assessment undertaken in this report (refer Section 5). The current pit lake water quality is representative of rainfall and surface water overflow (refer Table 2.2) and the pit inflow location is in a safe stable condition with the current flood ingresses (refer Figure 2.4). It is proposed to maintain the existing flooding interaction with One Mile Creek and

catchment configuration for the Queen Pit rehabilitated final landform to ensure the final void maintains a good water quality for the PMLU. This is justified by the existing water quality sampling data and current condition and stability of the pit ramp and walls.

The Appendix A includes graphs delineating the water quality comparison between the pit lake, W1 (upstream receiving environment monitoring location) and W2 and W4 (downstream receiving environment monitoring location). The W1 monitoring point is located at least 300m upstream of the pit inflow location. W2, W3, and W4 are approximately 70 m, 400 m, and 800 m downstream of the Queen Pit respectively. Refer to Figure 2.1.

The assessment of the pit lake water quality and W1 monitoring point in comparison with the water quality objectives defined in Table 4.1 is summarised in Section 4.2 and Section 9.2.



Legend

- AliceRiver_ML
- Watercourse
- Site drainage

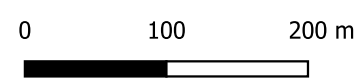
Water monitoring

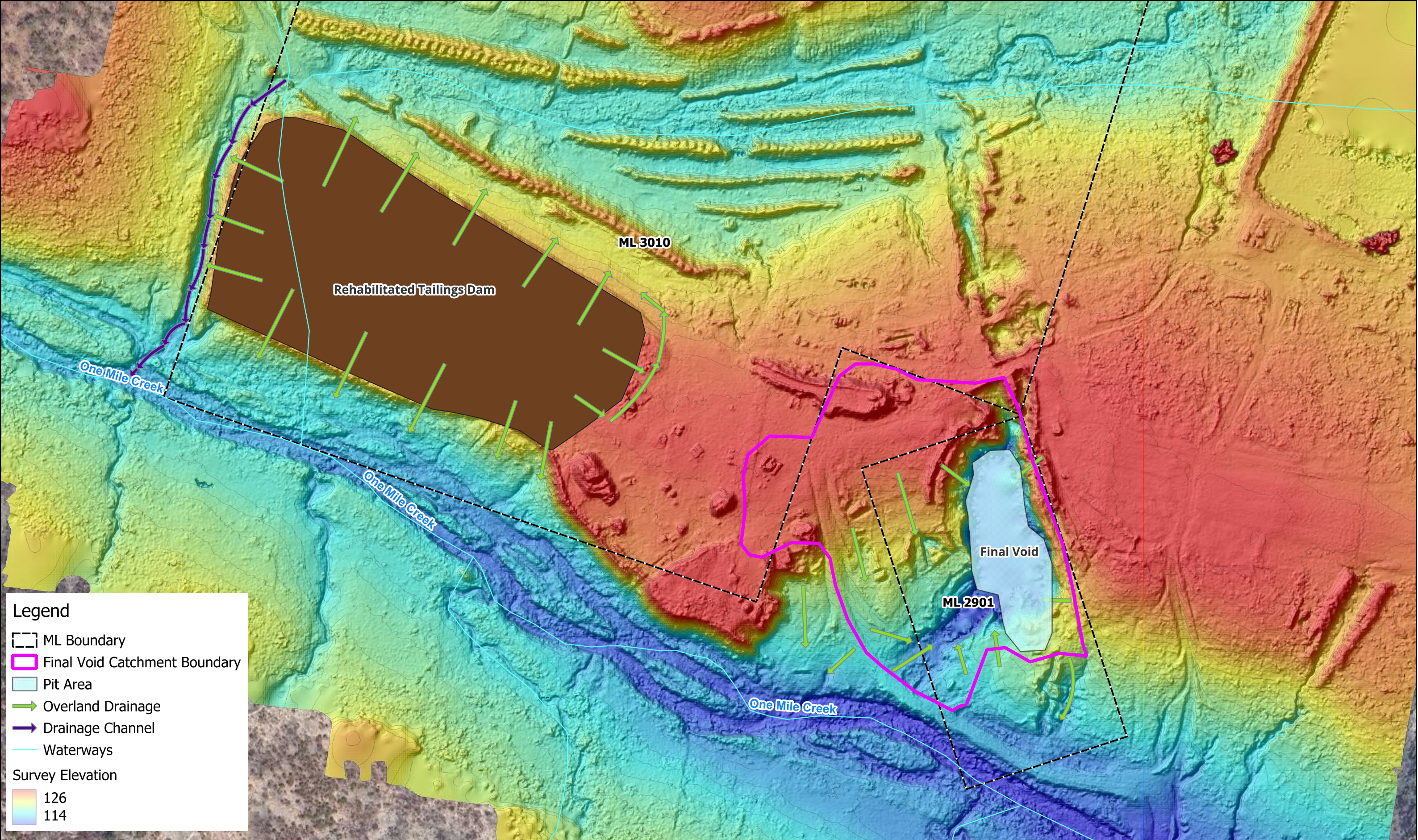
- Groundwater wells
- Stream sediment
- REMP
- AQ pit sampling



PACGOLD

Alice River Monitoring network





Legend

ML Boundary

Final Void Catchment Boundary

Pit Area

Overland Drainage

Drainage Channel

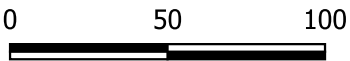
Waterways

Survey Elevation

126

114

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Scale in metres (1:2400 @ A3)
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 54

		PACGOLD		
DATE	07/02/2025	Alice River Gold Mine PRCP Flood Assesment One Mile Creek and Alice River Hydrology Model Catchments		
DRAWN	SS			
JOB NO.	BBNE00406_0002			
		A3	Figure 2.2	A



Figure 2.3: Queen Pit –Pit Lake (July 2022)



Figure 2.4: Queen Pit – Spill Location into Pit (Ramp) (July 2022)

3 RECEIVING ENVIRONMENT

3.1 RECEIVING WATERWAYS

3.1.1 One Mile Creek

One Mile Creek is located along the southern boundaries of ML3010 and ML2901, flowing in a westerly direction before discharging into the Alice River 5.5km from ML2901. Runoff from the Alice River final landform will flow into One Mile Creek. Overflow from the farm reservoir located east of ML3010 has potential to discharge into One Mile Creek's upstream tributaries.

One Mile Creek is an ephemeral waterway and stock may have access to this waterway downstream of the mines leases (MLs).

3.1.2 Dickies Creek

Dickies Creek is fed by a network of tributaries to the east of the mine and flows in a north-westerly direction through ML2908, ML2958 and the southeast corner of ML2957 before discharging into the Alice River 200m west from ML2957. Runoff from the southern Alice River MLs will flow into Dickies Creek, however no active mining is to occur on these MLs.

Dickies Creek is an ephemeral waterway and stock may have access to this waterway downstream of the MLs.

3.1.3 Alice River

Alice river flows in a north-westerly direction through ML3011 and to the west of the other MLs. It is the receiving waterway for Dickies Creek and One Mile Creek, and as such all runoff discharged from the ARGM will end up in the Alice River.

Alice river transitions from an ephemeral to intermittent waterway as it approaches the confluence of the Mitchell River. Various persistent rock pools, water holes and lakes form along the Alice River, however there are no surface water licenses applicable to this system.

Considering the predominant land use in the vicinity of ARGM is grazing, stock may have access to this waterway downstream of the ARGM. Furthermore, water releases from ARGM have the potential to impact local and downstream EVs applicable to the Mitchell River Basin catchment.

Figure 3.1 provides an overview of the receiving waterways in the vicinity of ARGM.

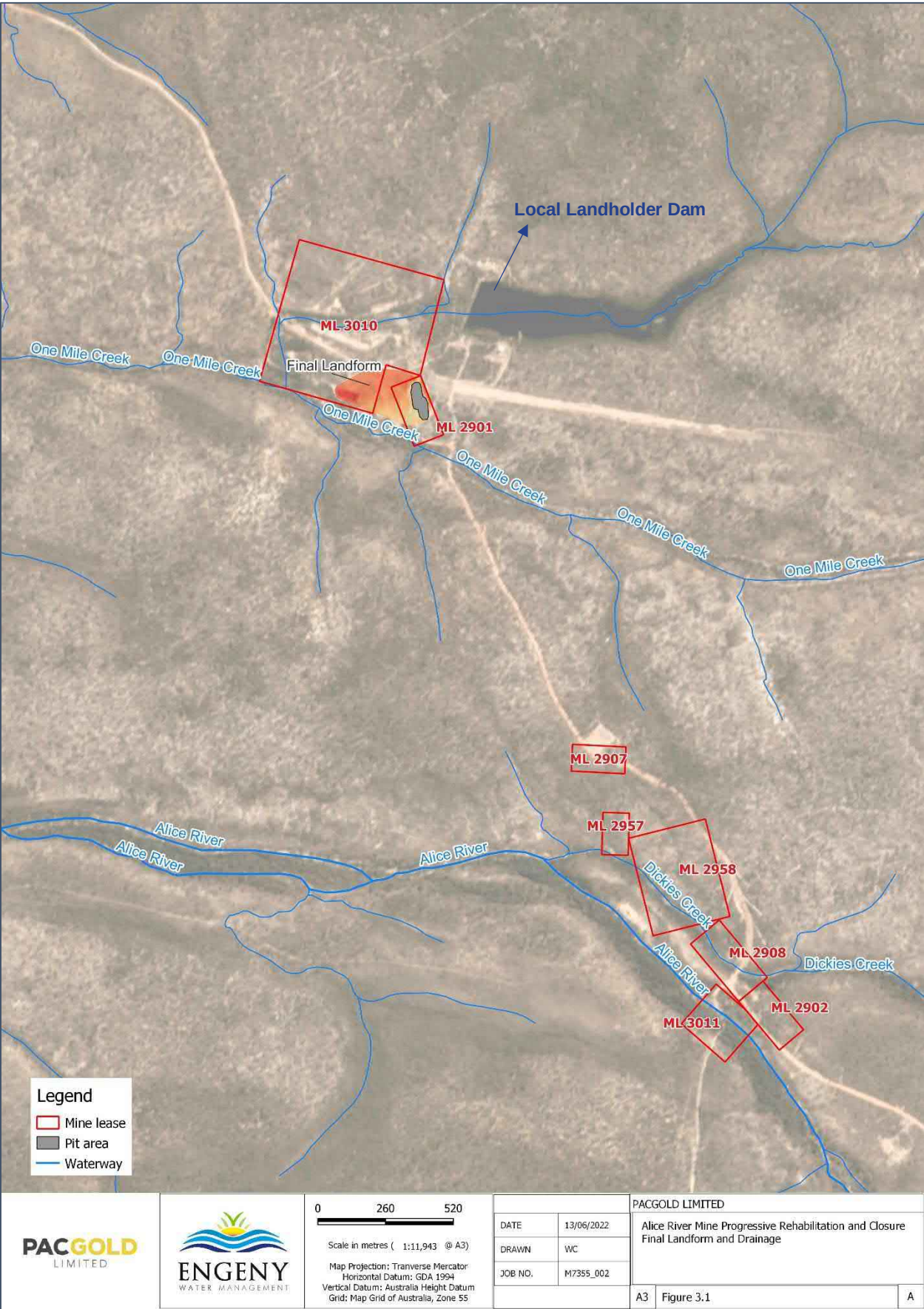


Figure 3.1: Receiving Waterways

3.2 REGIONAL ECOSYSTEMS

The Queensland Department of Environment, Tourism, Science and Innovation (DETSI) has developed a regional ecosystems database which classifies the status of remnant vegetation throughout Queensland as Endangered, Of Concern, or Not of Concern as well as providing additional supporting information on the vegetation characteristics.

Figure 3.2 illustrates the regional ecosystems located in the vicinity of the Alice River ML areas.

There is one regional ecosystem that is considered “Of Concern” located within the vicinity of the Alice River MLs. The “Of Concern” area is located across ML2907 and extends west downstream of the central mining area between One Mile Creek and Alice River. Endangered, Of Concern remnant vegetation is not mapped on One Mile Creek of Alice River immediately downstream of the mining leases.

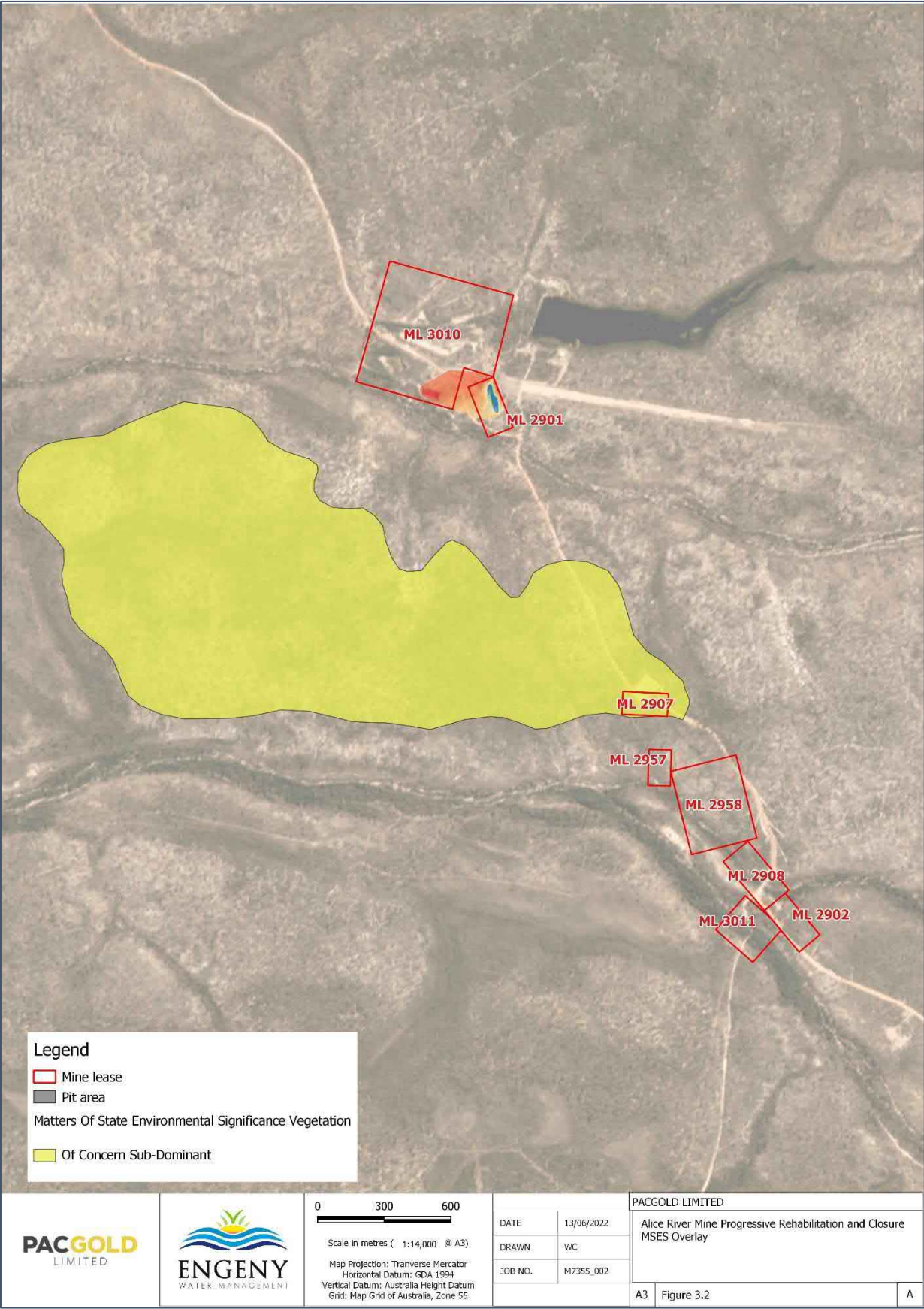


Figure 3.2: Matters of State Environmental Significance Regional Ecosystems

3.3 DOWNSTREAM POPULATION AND SURFACE WATER USERS

There are no known habitable dwellings or surface water users located along One Mile Creek, Dickies Creek, or Alice River downstream of the mine site.

4 ENVIRONMENTAL VALUES AND WATER QUALITY OBJECTIVES

4.1 ENVIRONMENTAL VALUES

4.1.1 Relevant Legislation

Environmental Protection Act 1994 (EP Act)

Section 9 of the EP Act defines environmental value as:

- a) A quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or
- b) Another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.

Environmental Protection Regulation (EP Regulation) 2008

The EP Regulation further defines environmental values for wetlands however there are no mapped referable wetlands within a 50 km radius of the ARGM site and therefore is not relevant for ARGM.

Fisheries Act 1994

The purpose of the Fisheries Act is to provide for the use, conservation and enhancement of the community's fisheries resources and fish habitats in a way that seeks to apply and balance the principles of ecologically sustainable development and promote ecologically sustainable development.

The Fisheries Act is of most relevance to the ARGM and the surface water environment when considering fish passage and maintenance of migration paths and water quality that supports aquatic life.

Environmental Protection (Water and Wetland Biodiversity) Policy (EPP (Water and Wetland Biodiversity)) 2019

The purpose of the EPP (Water and Wetland Biodiversity) is to identify environmental values as defined in Section 9 of the EP Act (and associated water quality objectives) for Queensland waters.

There are currently no published environmental values under the EPP (Water and Wetland Biodiversity) for the area of the Mitchell Catchment where ARGM resides (QLD Government, 2020). In this instance the EPP (Water and Wetland Biodiversity) indicates that the environmental values are to be determined through an assessment of the value, condition, suitability and uses of the relevant waters. Factors to be assessed in waters surrounding and within the ARGM include:

- Biological integrity of aquatic ecosystems for a defined category of waters:
 - High ecological value.
 - Slightly disturbed waters.
 - Moderately disturbed waters.
 - Highly disturbed waters.
- Production of aquatic foods for human consumption.
- Aquaculture.
- Agricultural purposes.
- Recreation or aesthetic purposes (including primary, secondary and visual use).
- Drinking water.
- Industrial purposes.
- Cultural and spiritual value.

4.1.2 Proposed Environmental Values

As there are no published environmental values for the ARGM catchment under the EPP (Water and Wetland Biodiversity), the following sections justify and outline the perceived environmental values for the ARGM surface waters based on all available information and legislative requirements.

Aquatic Ecosystems

Aquatic ecosystem health is an environmental value for the ARGM, however there are no published ecosystem condition categories of the waterways surrounding the ARGM under the EPP (Water and Wetland Biodiversity) or other Queensland guidelines such as the Queensland Water Quality Guidelines 2009 (QWQG). The ecosystem condition categories are used to define the value of the aquatic ecosystem and consequent objectives for its protection.

The EPP (Water and Wetland Biodiversity) defines the categories as follows:

- High ecological value waters: waters in which the biological integrity of the water is effectively unmodified or highly valued.
- Slightly disturbed waters: waters that have the biological integrity of high ecological value waters with slightly modified physical or chemical indicators but effectively unmodified biological indicators.
- Moderately disturbed waters: waters in which the biological integrity of the water is adversely affected by human activity to a relatively small but measurable degree.
- Highly disturbed waters: waters that are significantly degraded by human activity and have lower ecological value than high ecological value waters or slightly or moderately disturbed waters.

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC Guidelines (both the 2000 and 2018 revisions)) and the QWQG provide further guidance for classification of aquatic ecosystem condition where:

- High value ecosystems are effectively unmodified or other highly valued systems, typically (but not always) occurring in national parks, conservation reserves or in remote and/or inaccessible locations (ANZECC, 2000).
- Slightly to moderately disturbed ecosystems for freshwater systems would have slightly to moderately cleared catchments and/or reasonably intact riparian vegetation. This could include rural streams receiving runoff from land disturbed to carrying degrees by grazing or pastoralism (ANZECC, 2000).
- Highly disturbed ecosystems are measurably degraded systems for e.g. shipping ports, urban streams or rural streams receiving runoff from intensive horticulture (ANZECC, 2000).

Based on the above definitions and guidance the waterways surrounding the ARGM are likely to be classed as 'slightly to moderately disturbed' as the ARGM is located in an area used for native grazing purposes and is therefore modified (not high value waters) but likely not to the extent to be classified as highly disturbed.

Aquaculture and Human Consumption

There are no known users of local surface water sources for aquaculture or the production of aquatic foods for human consumption. There are also no known local users of surface water sources for human consumption.

Based on the above, aquaculture and human consumption are not considered to be a likely environmental value for the ARGM project.

Agriculture

The main land use for the ARGM receiving environment is grazing native vegetation therefore the source and quality of water for watering stock is likely to be a relevant local environmental value.

Under the Water Plan (Gulf) 2007, the taking of surface water for stock and domestic purposes is permitted (under licence) for the Mitchell Catchment. A review of current water licences was conducted in the vicinity and downstream of the ARGM MLs. It was determined that there are no current surface water licences downstream from ARGM. Water licences currently in use downstream from ARGM pertain to ground water stock watering use.

There are no known or mapped areas of cropping or irrigation within or surrounding the ARGM MLs.

Based on the above, agriculture in the form of native grazing vegetation can be considered a relevant environmental value for the ARGM project.

Recreational Uses

Flow within the waterways surrounding the ARGM are intermittent however segregated waterholes, rock pools and lakes may persist and be utilised for recreational purposes such as swimming (primary recreational use) and fishing (secondary recreational use).

For this reason, primary and secondary recreational uses are considered relevant environmental values for the ARGM project.

Drinking Water

There are no dams or weirs located downstream of the ARGM related to bulk water supply, nor were any locations downstream of the ARGM identified as potentially suitable for consideration of future dams.

Based on the above, drinking water is not considered to be a likely environmental value for the ARGM project.

Industrial Use

There are no known users of local surface water supply for industrial purposes therefore industrial use is not considered to be a likely environmental value for the ARGM project.

Visual Recreation and Cultural and Spiritual Values

As there are some sections of the surrounding waterways that are likely to have recreational uses, it is also possible that the waterways provide an aesthetic quality or visual recreational use. Similarly, it is also possible that the waterways provide cultural and spiritual value.

For this reason, visual recreational use and cultural and spiritual value are considered to be a relevant environmental value that the ARGM must consider.

4.2 PIT LAKE WATER QUALITY OBJECTIVES

Water Quality Objectives (WQO) for protection of the identified category of waters (including specific thresholds for water quality parameters) are usually scheduled under the EPP (Water and Wetland Biodiversity) for the relevant catchment. WQO for the Gulf Catchment are yet to be derived and scheduled under the EPP (Water and Wetland Biodiversity). In the absence of scheduled WQO, the EPP (Water and Wetland Biodiversity) requires WQO to be a set of water quality guidelines for all indicators that will protect all environmental values for the water.

The ANZECC (ANZECC & ARMCANZ, 2000) and QWQG (DEHP, 2009) provide broad-scale thresholds for water quality parameters for varying levels of ecosystem protection. However, both guidelines strongly encourage the collection of local data, where available, to develop guidelines relevant to the area in question (DEHP, 2009) and provide guidance on minimum monitoring program requirements to obtain suitable water quality datasets that capture both spatial and temporal variation.

The ANZECC Guidelines were updated in late 2018 for the purposes of updating the water quality management framework and revising some of the default guideline values based on more recent, and longer, water quality datasets. At the time this report was being prepared the 2018 ANZECC Guidelines are on an online platform and in the early stage of implementation with many supporting guidelines yet to be released. The ANZECC Guideline 2000 categorises the water types for several broad regions based on physio-chemical parameters. The ARGM project is classified as lowland freshwater based on the project situated at less than 150m AHD and the transition between highland and lowland being 150 m AHD.

4.2.1 Water Quality Objectives

In the absence of published WQO for the Gulf catchment and insufficient existing monitoring data at the time of developing this report, interim WQO for the ARGM project have been adopted from guideline values from ANZECC 2000 for protection of the EVs described in Section 4.1. The default guideline WQO developed for the ARGM project are presented in Table 4.1. The proposed ANZECC thresholds for lowland freshwater, slightly moderately disturbed waters have been adopted. The 95% level

of protection was adopted for the freshwater ecosystem WQO values due to the waters being classified as slightly moderately disturbed, as recommended by the ANZECC 2000 Guideline.

As part of the PRCP, site specific WOQs will be developed for closure for various water types based on site specific water quality monitoring.

Table 4.1: Default Water Quality Objectives

Monitoring Category	Indicator	Units	Water Quality Guideline Value			Adopted Guideline Value Threshold
			95% Protection - Aquatic Ecosystems & Lowland Rivers - Tropical Australia	Livestock ³	Recreational Use ⁵	
Surface Water - Physio-chemical	pH	n/a	6-8 ¹	-	5-9	6-8
	Salinity (EC)	µS/cm	250 ²	5,970 (beef cattle) 3,732 (dairy cattle)	-	250
	Sulphate	mg/L	-	1000	400	400
	Dissolved Oxygen (DO)	% saturation	120 ¹	-	-	120
	Turbidity	NTU	15 ²	-	-	15
Surface Water - Toxicants	Cyanide Total	mg/L	0.007 ⁴	-	0.1	0.007
	Arsenic (As III)	mg/L	0.024 ⁴	-	-	0.024
	Arsenic (As V)	mg/L	0.013 ⁴	-	-	0.013
	Arsenic Total	mg/L	0.05 ³	0.5	0.05	0.05
	Copper	mg/L	0.0014 ⁴	1 (cattle)	1	0.0014
	Lead	mg/L	0.0034 ⁴	0.1	0.05	0.0034
	Zinc	mg/L	0.008 ⁴	20	5	0.008

¹Table 3.3.4 - ANZECC, 2000

²Table 3.3.5 - ANZECC, 2000

³ANZECC, 2000 – Section 4.3

⁴ANZG 2018 Online Portal – Aquatic Ecosystems

⁵Table 5.2.3 - ANZECC, 2000

⁶ '-' = no value was present in the ANZECC guideline

5 CONTAMINANT SOURCES AND POTENTIAL IMPACTS

5.1 CONTAMINANT SOURCES POST CLOSURE

The final landform areas not draining to the final void will be rehabilitated with established vegetation to prevent the generation of contaminants (except for retained infrastructure areas including access roads for the local landholder). The final void and the rehabilitated tailings storage facility are the main potential source of contaminants post closure.

Post closure the final void pit lake will receive inflows from its local catchment and seepage and flood ingress inflows from One Mile Creek which provide flushing of the pit lake and maintain a freshwater quality. The water quality of the pit lake is not expected to deteriorate unless the water inflows from seepage and flood ingress are removed which may result in evapo-concentration of the pit lake increasing contaminant concentrations.

The tailings dam is proposed to be backfilled and reprofiled to create a water shedding structure, then revegetated with shallow-rooted species. The backfilling and reprofiling is proposed to prevent rainfall infiltration (causing seepage) and landform erosion.

A summary of the contaminant sources, flow paths and destinations for the ARGM final landform post closure are summarised in Table 5.1. Salinity is the key contaminant of concern for the ARGM final voids.

Table 5.1: Contaminant Source Summary

Source	Potential Transport Mechanism	Receiving System	Key Contaminant
Final Void	Seepage into groundwater system.	Groundwater system.	Low pH, heavy metals, and soluble salts
	Overtopping due to local hydrological inflows and outflows.	Receiving waters.	Low pH, heavy metals, and soluble salts
	Overtopping due to flood ingress resulting in the void filling.	Receiving waters.	Low pH, heavy metals, and soluble salts
Rehabilitated tailings storage facility	Seepage from rainfall infiltration.	Receiving waters.	Low pH, heavy metals, and soluble salts
	Rainfall runoff causing erosion of the landform exposing tailings material.	Receiving waters.	Low pH, heavy metals, and soluble salts
Rehabilitated Mine landforms (draining to waterways)	Rainfall runoff causing erosion.	Receiving waters.	Sediment

5.2 POTENTIAL IMPACTS

The potential impacts of the mine on surface and groundwater water environmental values are identified based on the known contaminants, their sources, and the performance of the site water management system. These potential impacts are expected to include:

- Release of contaminants through overflows from the final voids (from local runoff or flood inflows) with the potential for accumulation within the receiving waters during dry periods. Potential impacts to stock, riparian, and aquatic ecosystems.
- Release of contaminants to from the rehabilitated tailings storage facility to One Mile Creek through either seepage or erosion failure of the landform with the potential for accumulation within the receiving waters during dry periods. Potential impacts to stock, riparian, and aquatic ecosystems.
- Erosion or instability of the rehabilitated final landform resulting in generation and release of sediments to receiving waters potentially impacting downstream riparian vegetation and waterway condition.
- Potential impacts of the ARGM final landform on groundwater environmental values have been identified in the PRCP groundwater assessment report.

6 POST MINING FLOOD ASSESSMENT

6.1 HYDROLOGIC MODELLING

6.1.1 Overview

A hydrologic model (XP-RAFTS) of the One Mile Creek and Alice River systems was developed, validated, and used to produce design event hydrographs to undertake the post mining flooding assessment of ARGM. Design flood hydrology for ARGM was completed for events ranging from the 50% Annual Exceedance Probability (AEP) flood event up to the 0.1% AEP flood event using methodologies from Australian Rainfall and Runoff 2019 (Ball J, 2019).

The One Mile Creek and Alice River system is mostly ungagged and calibration or validation (with an at site Flood Frequency Analysis) of the model was not possible. Therefore, the model was validated for design flows up to the 1% AEP against regional peak flow estimation techniques including the Regional Flood Frequency Estimation method recommended by ARR19 (Ball J, 2019).

6.1.2 Model Development

Catchment Representation

The XP-RAFTS model catchment delineation and structure was generated using the CatchmentSIM software. The sub-catchment and channel parameters were determined based on the 28 m cell size Shuttle Radar Topographic Mission (SRTM) Digital Elevation Model (DEM) of the Alice River catchment surface. Catchment areas were then refined around the ARGM site using site survey captured in December 2020.

The catchment was subdivided into 36 sub-catchments as follows:

- 13 sub-catchments for the One Mile Creek catchment to the northern mining leases (total area 217 km²).
- 22 sub-catchments for the Alice River catchment to the southern mining leases (total area 466 km²).
- 1 sub-catchments for the Alice River catchment downstream of the confluence with One Mile Creek (total area 685 km²).

The Model was developed using the following routing approach:

- Sub-catchment routing (parameters confirmed through model validation):
 - Manning's roughness – 0.04
 - Catchment Slope – Calculated as average slope using CatchmentSIM for each sub-catchment.
 - Impervious fraction – 0% (natural landuse catchment).
- Stream routing:
 - Defined using the stream length between catchment outlets.
 - Adopted an average stream velocity of 1m/s to produce a time lag between sub-catchments.

The model routing coefficient was adjusted to 0.7 (Bx) to improve the model comparison to the validation (6.1.4). The sub-catchment layout for the ARGM hydrology model is shown in Figure 6.1.

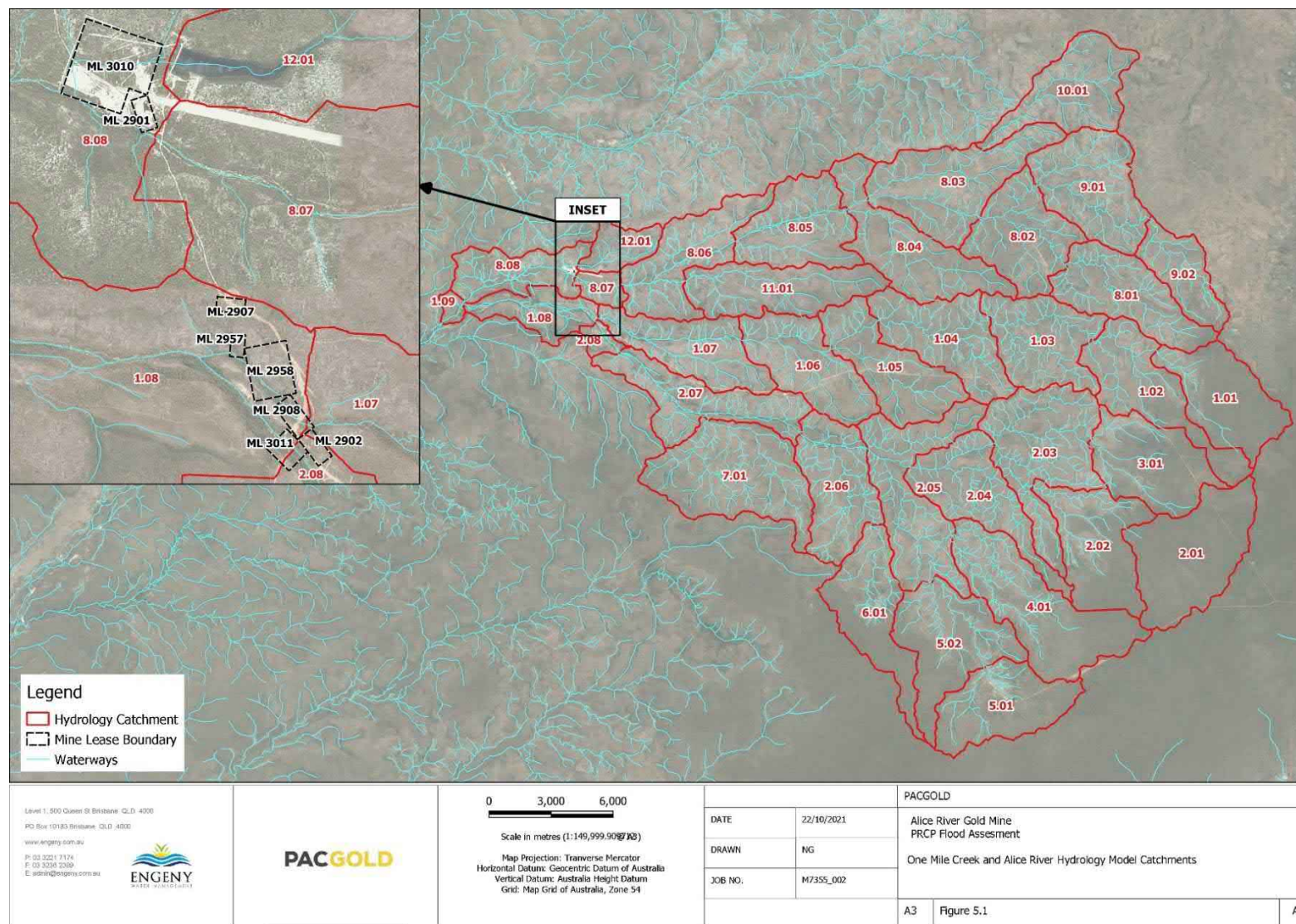


Figure 6.1: One Mile Creek and Alice River Hydrology Model Catchments

Design Rainfall

Design rainfall data for the ARGM hydrology was derived for rainfall events between the 50% and 0.1% AEP event. Rainfall totals in the AEP range 50% to 0.1% were generated for model catchment centroid using the BoM IFD tool (www.bom.gov.au/water/designRainfalls/revise-ifd/).

Aerial Reduction Factors (ARFs) have been used to convert point rainfall estimates to areal rainfall estimates. ARFs have been calculated using the methodology for catchments between 10 km² and 30,000 km² for the “Northern Coastal” QLD Zone (Ball J, 2019). ARF's are calculated based on the total catchment area (lower rainfall for larger catchments) and therefore were calculated separately for the One Mile Creek and Alice River systems.

An ensemble of 10 temporal patterns was simulated for each design storm AEP and storm duration as recommended by ARR 19 (Ball J, 2019). Temporal patterns for the 50% AEP to 0.1% AEP design storms were adopted from the ensemble temporal patterns for “Monsoonal North” sourced from ARR Data Hub (<http://data.arr-software.org/>) were applied. The Aerial temporal patterns were applied in the model as recommended for catchments greater than 100 km² (Ball J, 2019). The ensemble with the peak flow result, closest to the average of all the ensemble peak flow results was adopted as the design flow estimate.

Design Rainfall Losses

Design storm loss was sourced from the ARR Data Hub (<http://data.arr-software.org/>). The median pre-burst rainfall depths sourced from the ARR Data Hub (<http://data.arr-software.org/>) were modelled prior to the burst design rainfall with the storm loss applied to produce the design storm burst loss. The adopted design rainfall losses were then validated to regional point flow estimation techniques.

6.1.3 Design Hydrology Results

Design event simulations were undertaken using the XP-RAFTS model for AEPs ranging from 50% to the 0.1% AEP event, and for a large range of design storm durations. The modelled storms were analysed to determine the critical storm duration which produced the highest average peak flow for the catchment. The reported peak flow and ensemble number in the table represents result for the next highest peak flow from the average of all ensembles for the critical duration.

The design hydrology results for One Mile Creek and Alice River downstream of the confluence with One Mile Creek are provided in Table 6.1.

Table 6.1: Design Hydrology Results

AEP	One Mile Creek (216km ²)		Alice River Downstream of Confluence with One Mile Creek (685 km ²)	
	Peak Flow (m ³ /s)	Critical Duration (hrs)	Peak Flow (m ³ /s)	Critical Duration (hrs)
50%	138	12	501	12
20%	258	12	925	12
10%	350	12	1244	12
5%	439	18	1545	18
2%	572	18	1957	18
1%	677	18	2301	18
0.1%	1187	18	4119	18

6.1.4 Model Validation

The One Mile Creek and Alice River systems are ungauged making calibration or validation against an at site Flood Frequency Analysis (FFA). Therefore, the model has been validated using regional peak flow estimate techniques. Modelled peak flows for design events ranging from the 50% AEP to the 1% AEP were validated using the following methods:

- Regional Flood Frequency Estimation Model (RFFE).
- Quantile Regression Technique (QRT).

The RFFE is a recommended peak flow validation method from the ARR19 guideline (Ball J, 2019). The RFFE provides peak flow estimations based on the catchment area and a catchment shaping factor, determined using the catchment centroid and outlet coordinates. The RFFE peak flow estimates were calculated using the AR&R RFFE Model online tool (<http://rffe.arr-software.org/>).

Validation was also undertaken using the Department of Main Roads Quantile Regression Technique (QRT) (Palmen et al, 2011) which is a method for peak flow estimation for rural catchments up to 1,000 km² in area. Like the RFFE, the QRT provides a peak flow estimate using a design rainfall intensity for the catchment locality and the total catchment area.

The peak flow validation is summarised in Table 6.2 and details of the model validation calculations are provided in Appendix B. The peak flows calculated using the XP-RAFTS hydrology model for each of the waterways generally lay in the middle of the estimates from the two validation methods except for the rarer AEPs for One Mile Creek (2% AEP and 1% AEP). This is expected due to One Mile Creek having a skewed catchment shape which sits outside the bounds of the RFFE and QRT peak flow estimation techniques (Refer Appendix B). Considering the Alice River validation matches well for all AEP's, the runoff hydrographs calculated from the hydrology model were considered suitable for post mining landform flooding assessment.

Table 6.2: Design Hydrology Validation

AEP	One Mile Creek (216km ²)			Alice River Downstream of Confluence with One Mile Creek (685 km ²)		
	XP-RAFTS (m ³ /s)	RFFE (m ³ /s)	QRT (m ³ /s)	XP-RAFTS (m ³ /s)	RFFE (m ³ /s)	QRT (m ³ /s)
50%	138	184	88	501	481	211
20%	258	329	237	925	859	534
10%	350	443	358	1244	1160	783
5%	439	565	522	1545	1470	1131
2%	572	739	748	1957	1930	1590
1%	677	883	934	2301	2300	1958

6.2 HYDRAULIC ASSESSMENT

6.2.1 Overview

This study has used the two-dimensional modelling software TUFLOW to quantify the flood behavior and characteristics around the proposed final void. Two-dimensional models are best suited to scenarios where flow direction and water surface are not uniform across a section (i.e., floodplain and overbank areas). The development and analysis of the flood model are described in the sections below.

6.2.2 Model Data

Model Topography and Extent

Limited survey data is available for the ARGM and therefore the hydraulic model extent was restricted to the immediate areas of the northern mining leases using the following survey (order of priority):

- The post mining landform design including the final void and TSF backfill.
- Detailed LiDAR topographic survey of the ARGM site and the One Mile Creek channel immediately adjacent the site.
- Shuttle Radar Topographic Mission (SRTM) Digital Elevation Model (DEM) adjusted -2m vertically to tie in with the site survey to capture the southern floodplain extent and downstream channel.

The model bathymetry was represented using a 4m cell size which provided definition for a minimum 3 cell width for the base width of One Mile Creek and over 20 cell width for the active channel. The model extent is shown on the flood mapping in Appendix C.

Boundary Conditions

Boundary conditions are required in the model to define hydrology inflows, flow leaving the model domain and interfaces between the one dimensional and two-dimensional model domains. The following boundary conditions were used in the models:

- Upstream: The upstream boundary condition used 'SA' boundaries, allocating flow to the defined model grid cells based on the design hydrograph from the hydrologic model (flow per unit of time) input. Total inflow hydrographs were applied for One Mile Creek and the farmers' dam located to the north of the final void.
- Downstream: The outflow boundary condition for the model was represented as a normal depth with a hydraulic grade based on the One Mile Creek grade at the downstream location of the model.

Hydraulic Roughness

The Manning's roughness coefficients used in the model are based on visual observation of aerial photography of the site and photos of One Mile Creek channel and floodplain areas. Roughness values have been adopted as per the following:

- One Mile Creek Channel – 0.045.
- Vegetated floodplain areas – 0.07.
- Rehabilitated mine landform areas – 0.05.

Initial Water Level

An initial water level was applied in the ARGM final void of 115.5m AHD, corresponding to the predicted equilibrium level of the void (refer Section 9 for final void hydrology assessment).

6.2.3 Model Simulation

The TUFLOW flood model for the northern mining area and final void was assessed for all flood events ranging from the 50% AEP up to the 0.1% AEP. The maximum flood height, depth and velocity results from the model simulation were output to assess the flood behavior with ARGM the final landform and interactions with the final void. Flood mapping results are provided in Appendix C.

6.3 FINAL LANDFORM FLOOD ASSESSMENT RESULTS

The following comments and conclusions are made from the post mining landform flood assessment:

- The final void is inundated in flood events more frequent than the 50% AEP.
- Peak flood velocities at the flood inflow location to the final void (pit ramp) remain below 2.2 m/s in the 0.1% AEP flood event, indicating minimal risk of erosion or failure.
- The equilibrium lake level of Queen Pit is approximately 116.2 m AHD and is expected to receive up to 60 ML of water when inundated by One Mile Creek. This is less than 1% of the critical 50% AEP 12-hour design event hydrograph volume (>7GL) indicating volumes harvested by the final void are negligible and are not expected to impact downstream water resources.

- The rehabilitated tailings storage facility and other remaining landforms are not inundated in the flood events up to the 0.1% AEP.
- Peak flood velocities against the rehabilitated tailings storage velocity remain below 1.3 m/s in the 0.1% AEP flood event indicating a low risk of erosion.
- Modelled peak flood velocities across other rehabilitation areas remain low (<1.0m/s) and are expected to have a low risk of erosion.

6.4 PRE-MINING FLOODPLAIN EXTENT

Due to the long mining history of the ARGGM, a pre-mining survey is unavailable for the site to accurately assess the pre-mining flood extent in accordance with the Information Sheet: Voids in floodplains' (ESR/2019/4966, Version 1.00). The proposed final void is, however, located within the One Mile Creek flood plain extent and is inundated in flood events more frequently than the 50% AEP. The flooding inundation of the final void provides flushing of the pit lake, improving water quality which supports the PMLU of stock water. The flood model results also show peak velocities of water entering the pit lake are low and show a low risk of erosion. This is supported by the good condition of the current Queen Pit ramp and reservoir area shown in Figure 2.3 and Figure 2.4.

7 POST MINING WATER MANAGEMENT

7.1 SURFACE DRAINAGE

The surface drainage for the post mining landform has been designed to reduce the catchment area reporting to the final voids and make the remaining landforms free draining. The ARGM final landform surface drainage is shown in Figure 2.2. The surface drainage has been designed so that:

- The Tailings Dam and disturbed areas will be backfilled and rehabilitated.
- The Alice Queen Open Pit will drain internally to a pit lake with no significant external catchment.
- Rehabilitated surfaces will sheet flow to either existing drainage gullies or constructed drains.
- Catchment runoff will be directed from site so that stability of the existing waterways and drainage gullies are not impacted.
- Where drains are required, they will be constructed at a suitable longitudinal grade and correctional area to convey the upstream catchment without causing erosion or instability.
- Where locations of high velocity are expected (step sections of drain or tie in locations with existing drainage features) rock protection will be provided to prevent erosion.

7.2 WATERCOURSE DIVERSIONS

There are no permanent watercourse diversions associated with ARGM.

7.3 FINAL VOIDS

The Queen Pit will remain as the only residual void as part of the ARGM closure landform as presented in Section 2.1. The final void will have a void lake which will receive rainfall runoff, groundwater inflows and flood inflows from One Mile Creek (Engeny, 2021) and have loss from lake evaporation. The final void will be used for stock water post closure as per its current use. The hydrological assessment of the final voids is presented in Section 8 of this report.

7.4 ONGOING DEWATERING OR WATER MANAGEMENT REQUIREMENTS

Based on the final void hydrological assessment presented in Section 8, there are no ongoing dewatering or water management requirements to manage dam water levels or water quality to reduce residual impacts to the receiving environment.

8 FINAL VOID HYDROLOGY ASSESSMENT

8.1 OVERVIEW

The post-closure hydrological balance of the proposed ARGM final void (Queen Pit) was simulated using GoldSim software. GoldSim is a general-purpose software package capable of analysing complex time dependant systems. All inputs and assumptions are outlined in the following sections.

The water balance model of the final void utilises a daily time step, and simulates rainfall, runoff, evaporation, groundwater ingress, One Mile Creek flood ingress, overflows (where applicable) and the long-term void lake level changes as a result of these flows. The purpose of the WBM is to identify the ARGM final void (Queen Pit) equilibrium lake levels post closure and the interaction with One Mile Creek post closure (refer to Project Layout in Figure 2.2).

8.2 FINAL LANDFORM

The final landform design presented in Section 2.1 was used for the hydrological assessment. This includes the design storage curve, residual catchment area, spill level and floor level. The storage characteristics of the ARGM final void are shown in Figure 8.1.

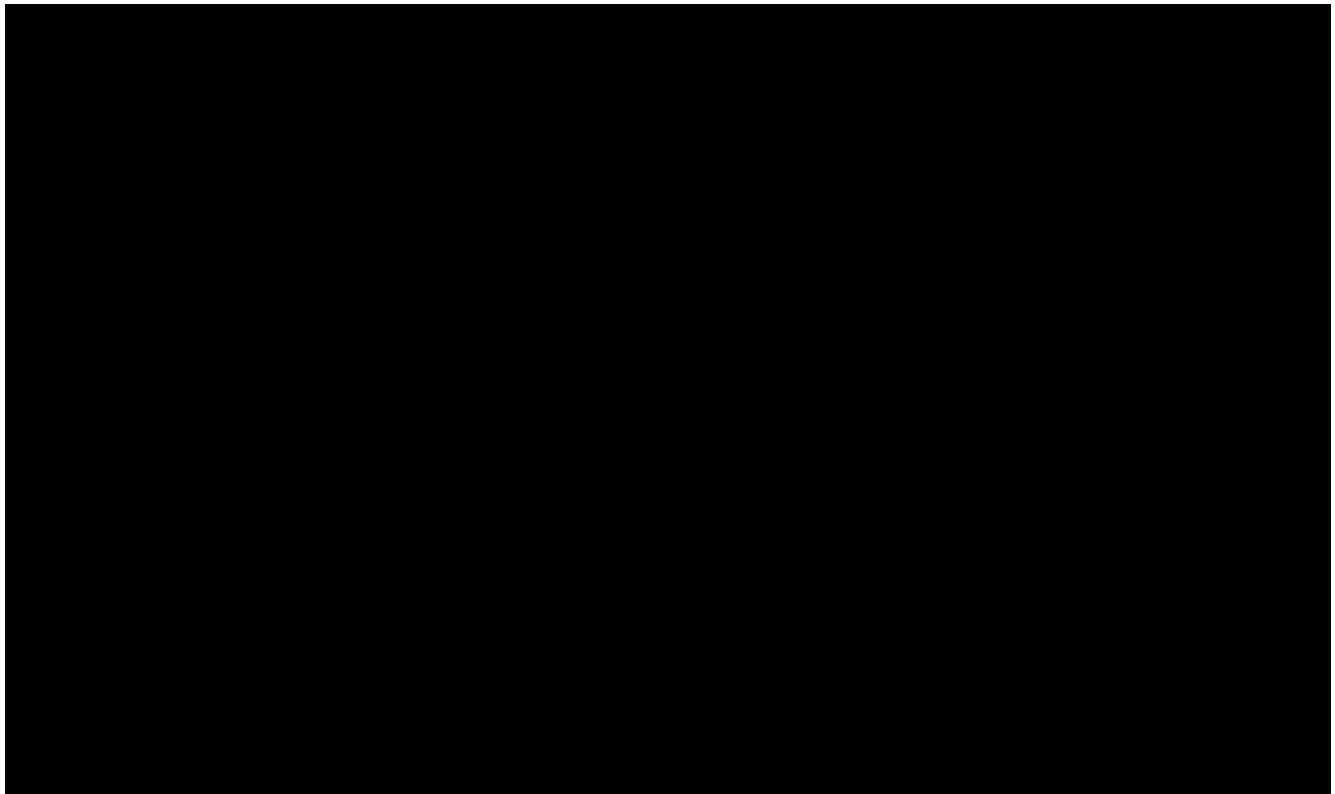


Figure 8.1: Final Void Storage Characteristics

8.3 CLIMATE DATA

Climate data for the water balance model was derived from the SILO rainfall database at the Alice River Gold Mine locality. The SILO climate data record calculates the last 135 years of climatic data at site based on available historical rainfall gauging data near the study location. The nearest gauges to the site are Pinnacle (28025) and King Junction (28005), 41.8 km and 56.3 km from the mine site respectively. A site rainfall gauging station has been installed in late 2023, however, due to limited period of rainfall data, the SILO data set was used to allow a continuous daily simulation of the water balance model. Details of referenced

SILO climate data are provided in Table 8.1 and monthly average rainfall, lake evaporation and evapotranspiration from the adopted climate data set for Alice River Gold Mine are summarised in Table 8.1.

Table 8.1: Climate Input Data Sources

Climate Data	Value	Data Source
Rainfall	Daily Rainfall Rate (mm/day)	SILO Data Drill (Jan 1889 – December 2024)
Evaporation	Evaporation Rate (mm/day)	SILO Data Drill (Jan 1889 – December 2024) – Morton's estimate for evaporation over shallow lakes
Evapotranspiration	Evapotranspiration Rate (mm/day)	SILO Data Drill (Jan 1889 – December 2024) – FAO56 Synthetic Evapotranspiration Series

Table 8.2: Alice Gold Mine Average Climate Data

Month	Mean Rainfall (mm)	Mean Maximum Temperature (°C)	Mean Minimum Temperature (°C)	Mean Morton's Lake Evap. (mm)	Mean Evapotranspiration (mm)
Jan	267	33.3	23.4	190	154
Feb	295	32.6	23.4	165	130
Mar	191	32.4	22.6	177	141
Apr	48	32.1	20.4	160	135
May	9	31.0	17.9	139	124
June	6	29.9	15.4	119	112
July	3	29.8	14.4	128	122
Aug	3	31.2	15.0	152	143
Sept	4	33.5	17.1	179	166
Oct	15	35.3	19.8	212	194
Nov	60	36.0	22.0	214	190
Dec	181	35.1	23.2	209	178
Annual	1082			2044	1789

8.4 CATCHMENT RUNOFF

Catchment runoff has been simulated using the Australian Water Balance Model (AWBM). A schematic representation of the AWBM model is provided in Figure 8.1. The model represents the catchment using two surface stores to simulate partial areas of runoff. The water balance of each surface store is calculated independently of the others. The model calculates the water balance of each partial area at daily time steps. At each time step, rainfall is added to each of the three surface stores and evapotranspiration is subtracted from each store. If the value of water in the store exceeds the capacity of the store, the excess water becomes runoff.

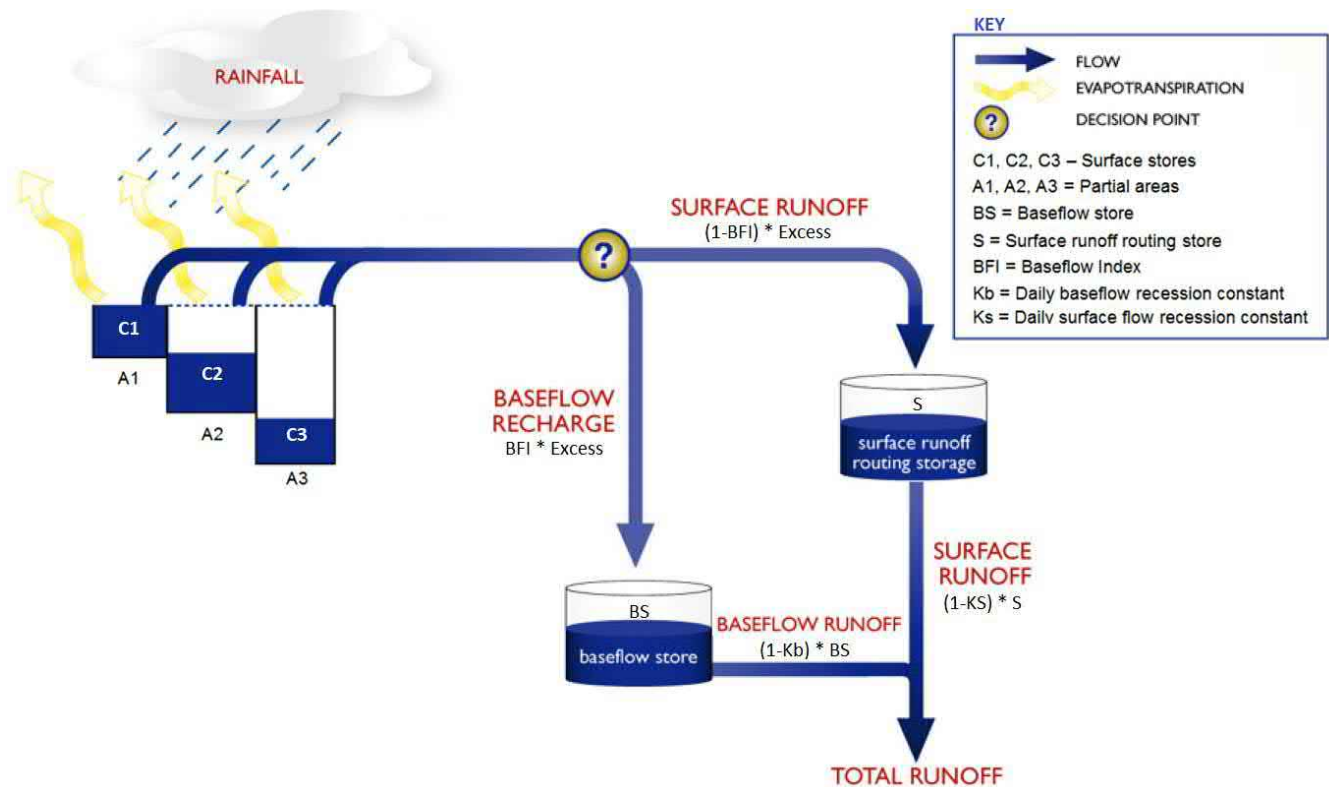


Figure 8.2: AWBM Schematic

The AWBM requires calibration to develop site specific runoff parameters that can accurately predict runoff volumes and response. Limited data is available for the ARGM site to calibrate the models and therefore AWBM parameters were sourced from an existing validated WBM for a nearby site with similar landuse and expected rainfall and runoff properties. The adopted AWBM parameters have however been validated using anecdotal information of the current pit lake equilibrium level (Refer Section 9.2). The ARGM Final void has a total catchment area of 3.7 ha, including 0.79 ha and 2.9 ha of 'Hardstand / Pits' and 'Natural/ Rehabilitation' land uses respectively.

The adopted AWBM parameters are summarised in Table 8.3 and the catchment area reporting to the final void is shown in Figure 2.2.

Table 8.3: AWBM Parameters

Parameter	Natural/ Rehabilitation	Hardstand / Pits	Tailings
C1 (mm)	23.0	5.0	1.0
C2 (mm)	125.0	10.0	5.5
C3 (mm)	180.0	120.0	0.0
A1	0.134	0.134	0.100
A2	0.433	0.433	0.900
A3	0.433	0.433	0.000
BFI	0.1	0.0	0.0
Kb	1.0	1.0	1.0
Ks	0.2	0.0	0.0

8.5 GROUNDWATER INTERACTIONS

The recent conceptual groundwater model and water quality analysis conducted by SeeBuiltEarth (2025) suggests Queen Pit likely receives low-permeability groundwater and is unlikely to have seepage outflows. The groundwater assessment however could not determine likely inflow rates due to limited groundwater level monitoring data (SeeBuiltEarth,2025). The groundwater levels will be refined as the groundwater monitoring continues.

Potential groundwater inflow rates were therefore assessed through validation of the water balance model to three pit lake level records between October 2021 to December 2024. A range of potential groundwater inflow rates were assessed in the validation (refer to Section 8.7), which determined an inflow rate of 0.01 L/s (with no outflows) produced the best comparison of modelled and recorded lake levels. The validated groundwater inflow rate aligns with the conceptual groundwater model (SeeBuiltEarth,2025). The future Queen Pit arrangement is very similar to the current pit and therefore the validated groundwater inflow rate of 0.01L/s was adopted for the final void hydrology assessment.

8.6 ONE MILE CREEK FLOODING INTERACTION

The pit lake is expected to be inundated by flow in One Mile Creek in a 50% AEP flood event (refer Section 6.3). The flooding interaction with One Mile Creek results in freshwater inflows and flushing of the pit lake which will improve long term water quality.

For the purpose of final void modelling, flood water inflows from One Mile Creek has been modelled to occur based on the 50% AEP daily rainfall depth (similar to the critical storm duration for the One Mile Creek catchment). Flood inflow volumes were determined from the flood model peak level results in Section 6.3. To assess the potential variability of the frequency of flood inflows occurring, a sensitivity analysis was conducted by reducing the frequency of inflows to 10% AEP. The model sensitivity to the frequency of flood inflows occurring is assessed in Section 9.

8.7 MODEL VALIDATION

The Water Balance Model validation for the Queen Pit was conducted from 01/10/2021 to 31/12/2024, considering variable groundwater inflows rates from 0.01 L/s to 0.25 L/s.

Historical pit lake level data, provided by SeeBuiltEarth (2025) through analysis of pit water levels to DTM from pit lake photographs over time, was used to estimate groundwater inflows to the Queen Pit:

- 03/10/2021: 115.8 m AHD
- 05/07/2022: 116.5 m AHD
- 23/11/2024: 115.5 m AHD

A comparison of modelled void lake levels at varying groundwater inflow rates against historical lake level data indicates that a groundwater inflow rate of 0.01 L/s closely aligns with recorded Queen Pit levels. This inflow rate is considered suitable for final void modelling. This aligns with the conceptual groundwater model, which suggests low-permeability groundwater inflows into the pit with no groundwater outflows.

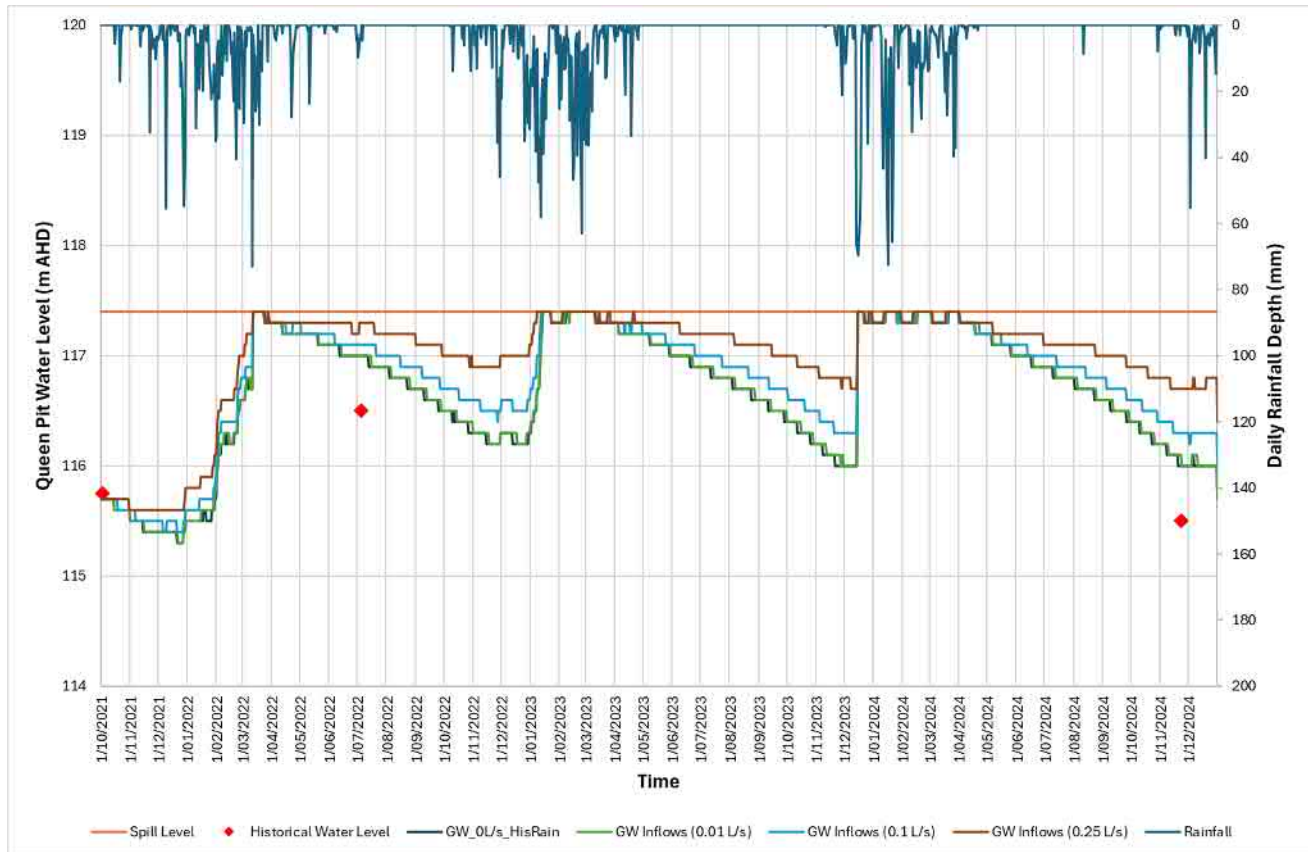


Figure 8.3: Model Validation – Queen Pit Lake Level

9 FINAL VOID HYDROLOGY RESULTS

9.1 MODEL FORECAST

The GoldSim model was simulated by repeating the 135 years of available SILO climate data for 1000 years post closure to assess void lake behaviour. The following two scenarios were simulated for the final void assessment:

- **Base Case:** One Mile Creek flood inflows occur based on a 50% AEP daily rainfall event, which is consistent with the flooding assessment outcomes detailed in Section 6.3.
- **Sensitivity Case:** Reduced annual frequency of flood inflows from One Mile Creek to less than 10%, to assess variability in void lake behaviour from less frequent creek flooding inflows.

Table 9.1: summarises the final void water balance results and the void lake equilibrium condition for the two scenarios. The final void lake levels for Base Case and Sensitivity Case are presented in Figure 9.1 and Figure 9.2 respectively.

Table 9.1: Final Void Lake Results Summary

Final Void	Bottom of Pit (m AHD)	Void Spill Elevation (m AHD)	Void Equilibrium Water Level (m AHD)	Void Equilibrium Lake Area (ha)	Equilibrium Volume (ML, % of total volume)	Estimated One Mile Creek Inflow Frequency (% of years)	Estimated Spill Frequency (% of years) (Including flood ingress)
Base Case	95	117.4	116.2	0.74	78 (94% full)	50%	71% of years
Sensitivity Case			115.8	0.73	76 (92% full)	Approx. 7%	53% of years

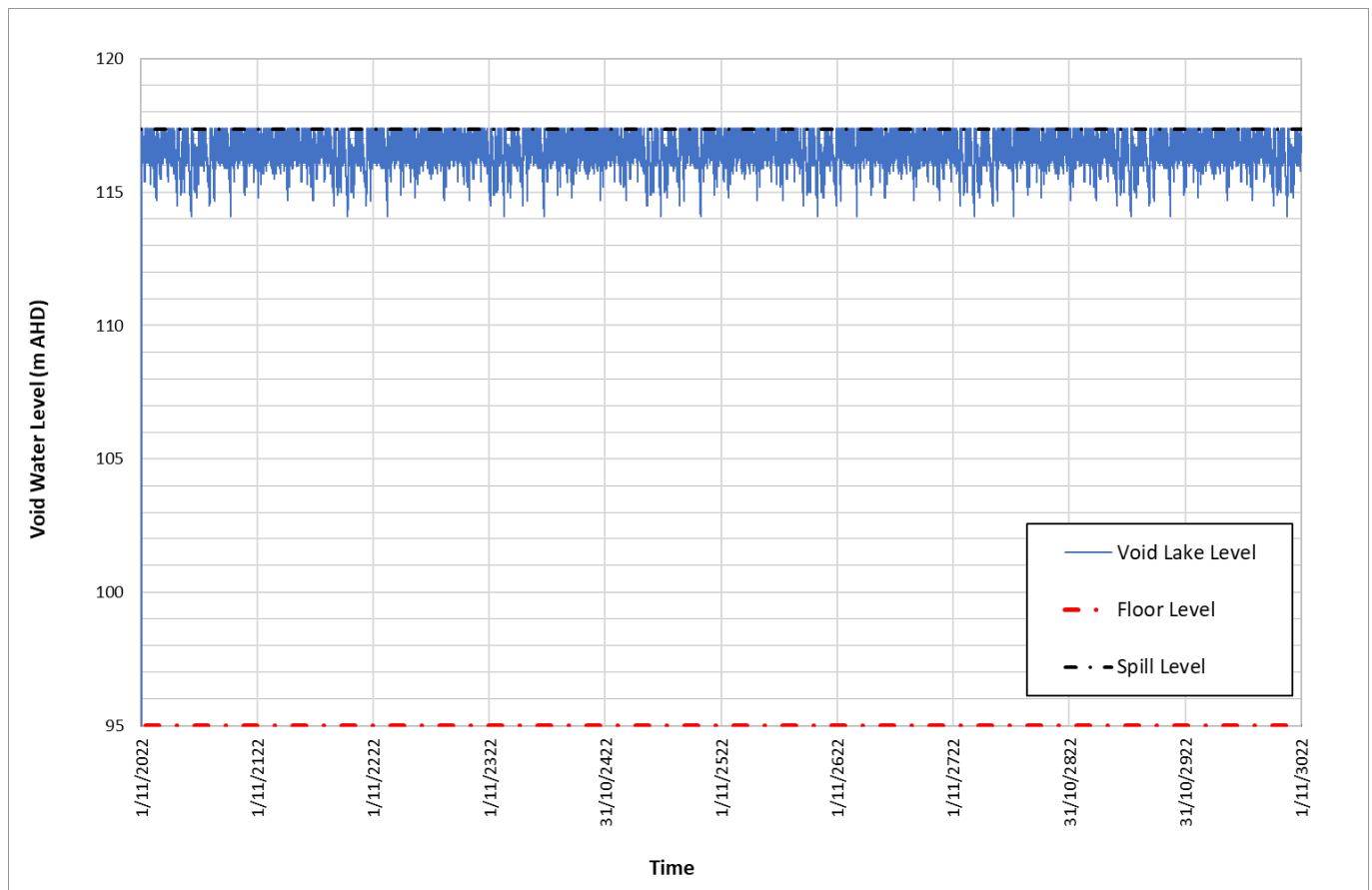


Figure 9.1: Final Void Water Level Time Series Results - Base Case

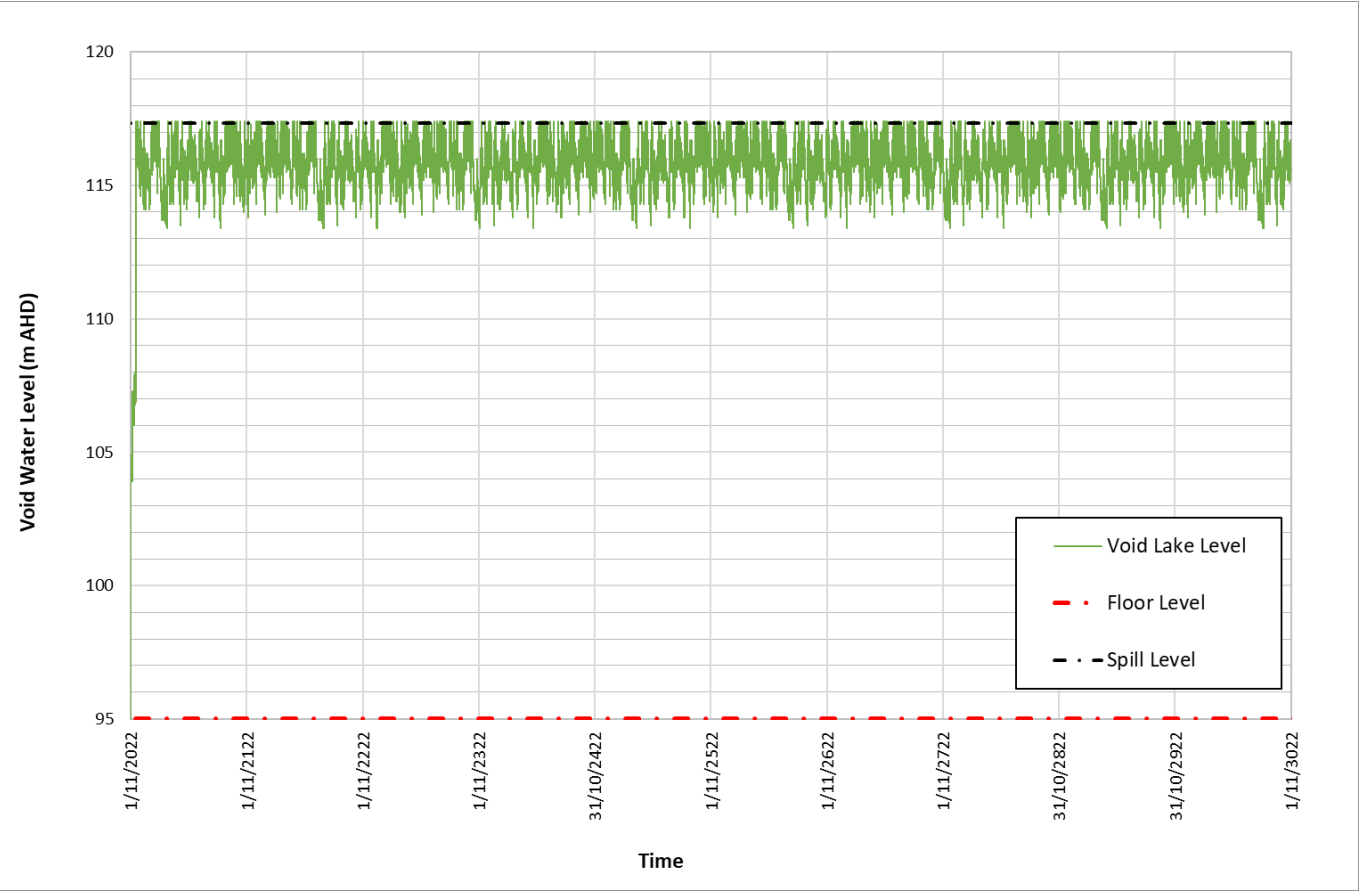


Figure 9.2: Final Void Water Level Time Series Results - Sensitivity Case

9.2 WATER QUALITY ASSESSMENT

The Queen Pit is a non-operational pit that has served as a pit lake for about 24 years since mining ceased in 2001. Over this period, the historical pit lake levels and water quality have been consistently observed, making them reliable indicators of future pit lake behaviour. The pit lake receives inflows from its local catchment and also benefits from seepage inflows and flood ingress inflows from One Mile Creek, which contribute to maintaining good water quality within the pit.

In Appendix A, a summary of the historical water quality monitoring data for the Queen Pit is presented. A comparison the Queen Pit water quality against the upstream and downstream monitoring point waterway quality as well as the water quality objectives.

The water quality parameters adopted for comparison are pH, Dissolved Oxygen, Turbidity, Electrical Conductivity, Sulphate, Arsenic (III), Arsenic (V), Total Arsenic, Antimony, Copper, Lead, Zinc and Total Cyanide. The comparison indicates.

- There is a close alignment in water quality between the W1 monitoring point (300 m upstream of the pit on One Mile Creek) and the Queen Pit in nearly all parameters with the exception of Total Arsenic:
 - Although, the recorded monitoring data for Total Arsenic in Queen Pit from 2014 to current suggest elevated concentrations in comparison to background monitoring point, W1(refer to Figure 2.1), the Total Arsenic values downstream recorded at W2 (70 m downstream of Pit) and W4 (approximately 800 m downstream of the Pit) show generally low concentrations with clear evidence of dilution along the stream.
 - The Total Arsenic concentration at W4 monitoring point (refer to Figure 2.1) is below the trigger level of the WQO and consequently no environmental harm is likely to be caused by the overflows from the pit lake.
- The data suggests no deterioration of water quality since 2013, supporting regular ingress from the One Mile Creek.
- The pit lake water quality is within the trigger levels for the PMLU of stock water and is generally within the WQO limits.

9.2.1 Stratification

The groundwater assessment reviewed water quality data for the pit lake which was sampled various depths to determine groundwater interactions and stratification in the water column (SeaBuiltEarth, 2025). The water quality sampling at various depths indicated weak temperature and dissolved oxygen (DO) stratification. Stratification was not observed with salinity remaining at low concentrations. This is likely due to a low salinity in water inflows from surrounding catchment. A relatively low void lake volume and the estimated frequency of flooding interactions (50% AEP). Frequent freshwater inflows from One Mile Creek are expected to keep salinity levels low, ranging between 35 and 60 $\mu\text{S}/\text{cm}$ (refer to Table 2.2).

9.3 CONCLUSIONS

The Long-term water balance model assessment of the ARGGM final void indicates the following:

Base Case:

- Modelled equilibrium pit lake level is approximately 116.6 m AHD. This aligns with a historical site surveyed water level between 115.8 m AHD and 116.5 m AHD (refer to Section 8.7).
- The water balance model shows the pit lake overflowing in approximately 71% of the years where approximately 50% of the overflow events coincide with modelled flood ingress from One Mile Creek and 21% of years are expected to overflow independent of modelled interaction of the One Mile Creek.
- The water balance model predicts a final void filling period of 1 year under median climate conditions (<1 to 3 years for 10th and 90th percentile climate periods).
- The existing pit lake water quality data shows a freshwater quality with similar contaminant concentrations as the receiving waterways.

Based on the monitoring data and water balance model assessment, seepage, rainfall, and flood inflows are expected to sustain the pit lake, preventing it from drying up while maintaining water quality representative of rainfall and surface water overflow. This supports the PMLU of stock water.

Sensitivity Case:

- The sensitivity analysis of reduced frequency of One Mile Creek flood inflows shows an approximate modelled equilibrium level of 116.4 m AHD.
- The water balance model shows the pit lake overflowing in approximately 53% of the years where approximately 7% of the overflow events coincide with modelled flood ingress from One Mile Creek and 45% of years are expected to overflow independent of modelled interaction of the One Mile Creek.
- The water balance model predicts a final void filling period of 5 year under median climate conditions (1 to 9 years for 10th and 90th percentile climate periods).

10 QUALIFICATIONS

- a) In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.
- b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.
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 - ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.
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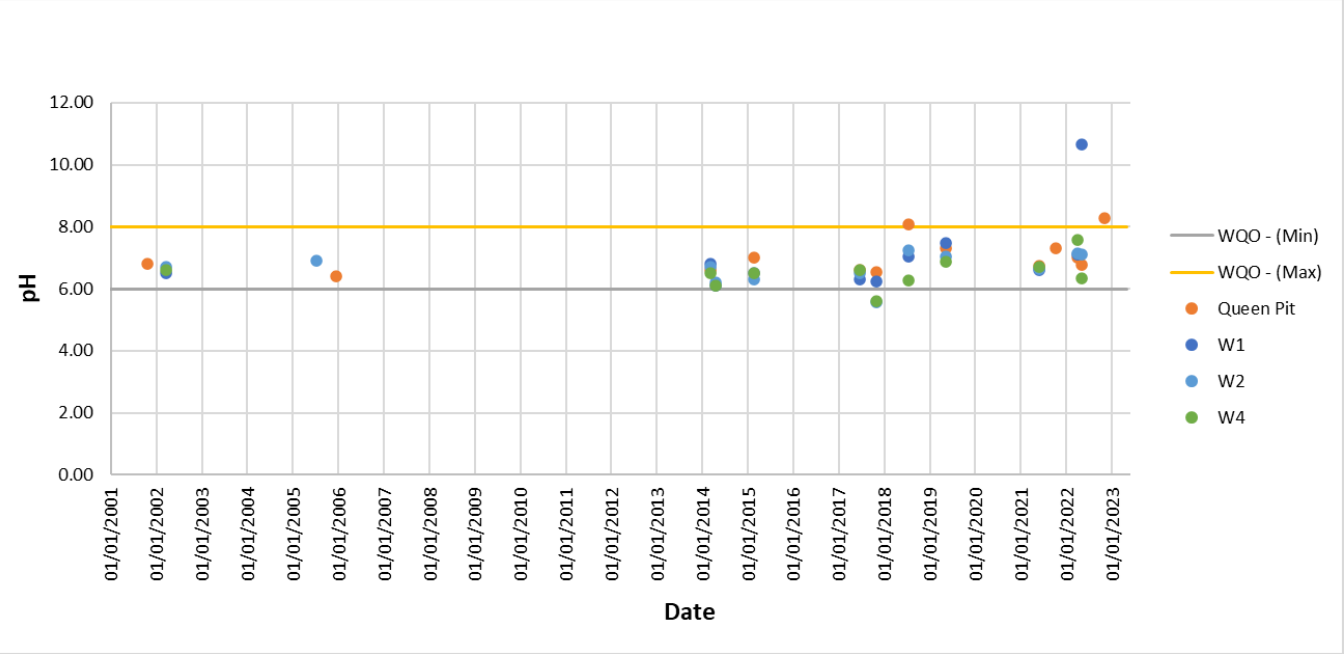
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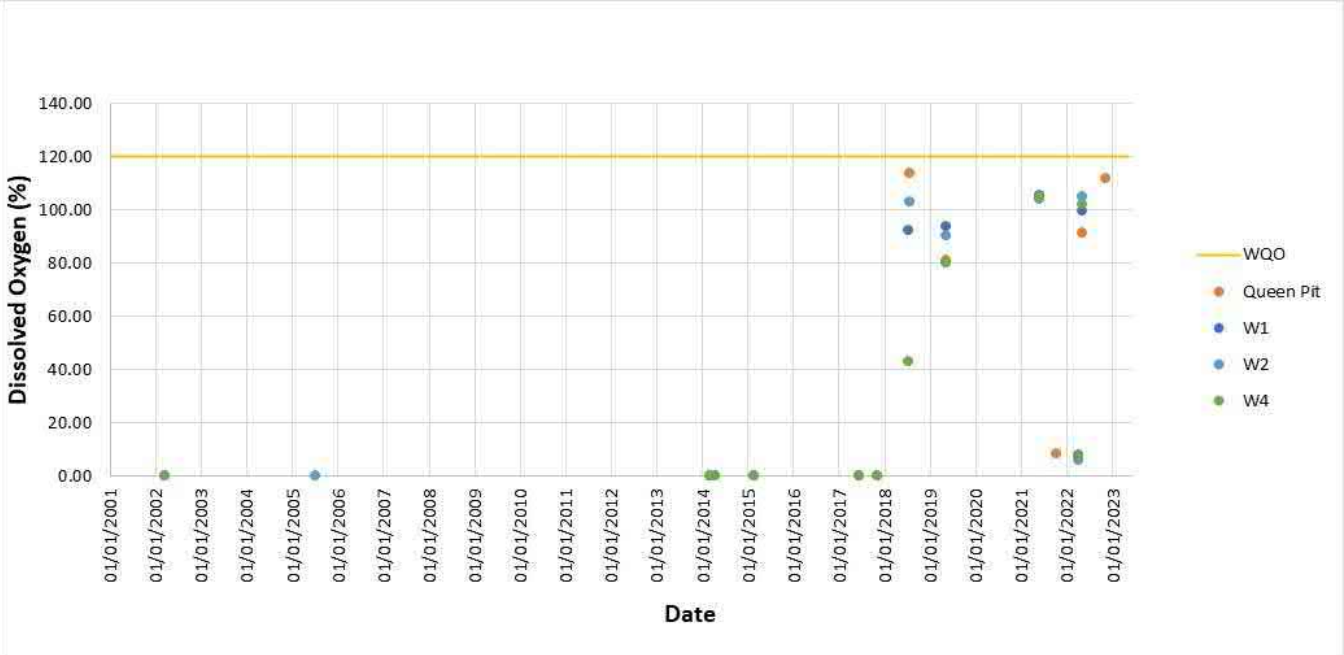
Appendix A:

Water Quality Comparison

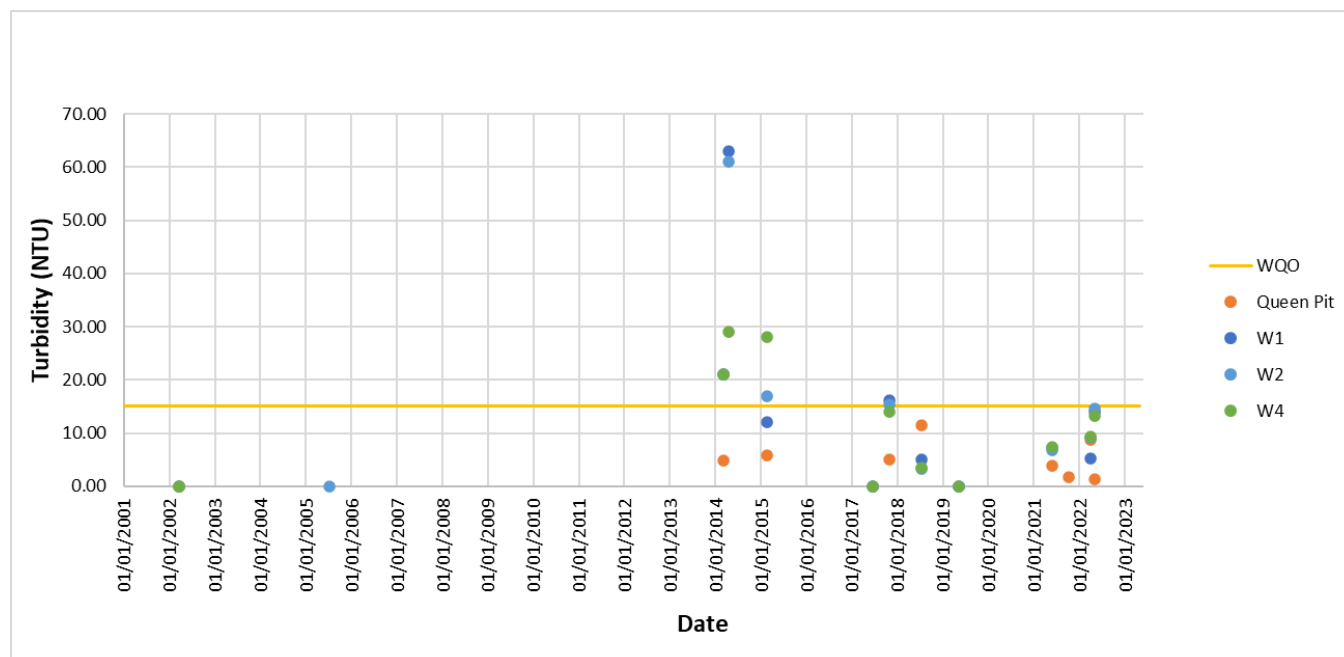
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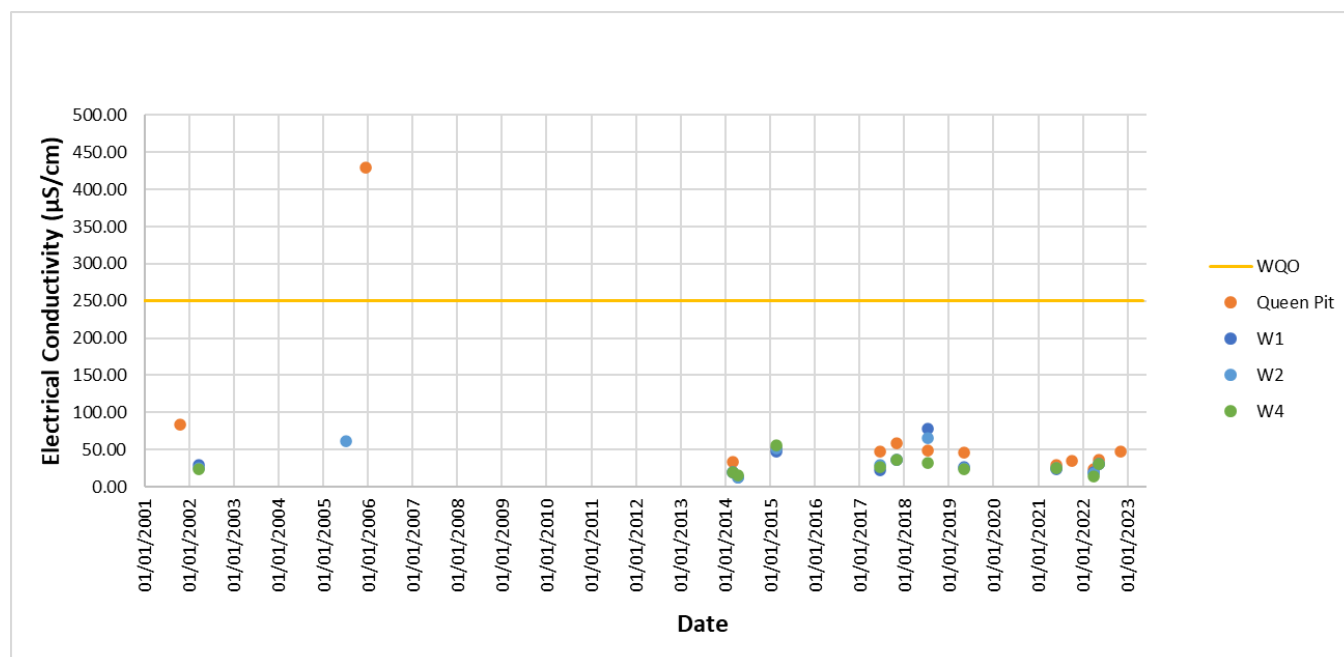
Dissolved Oxygen



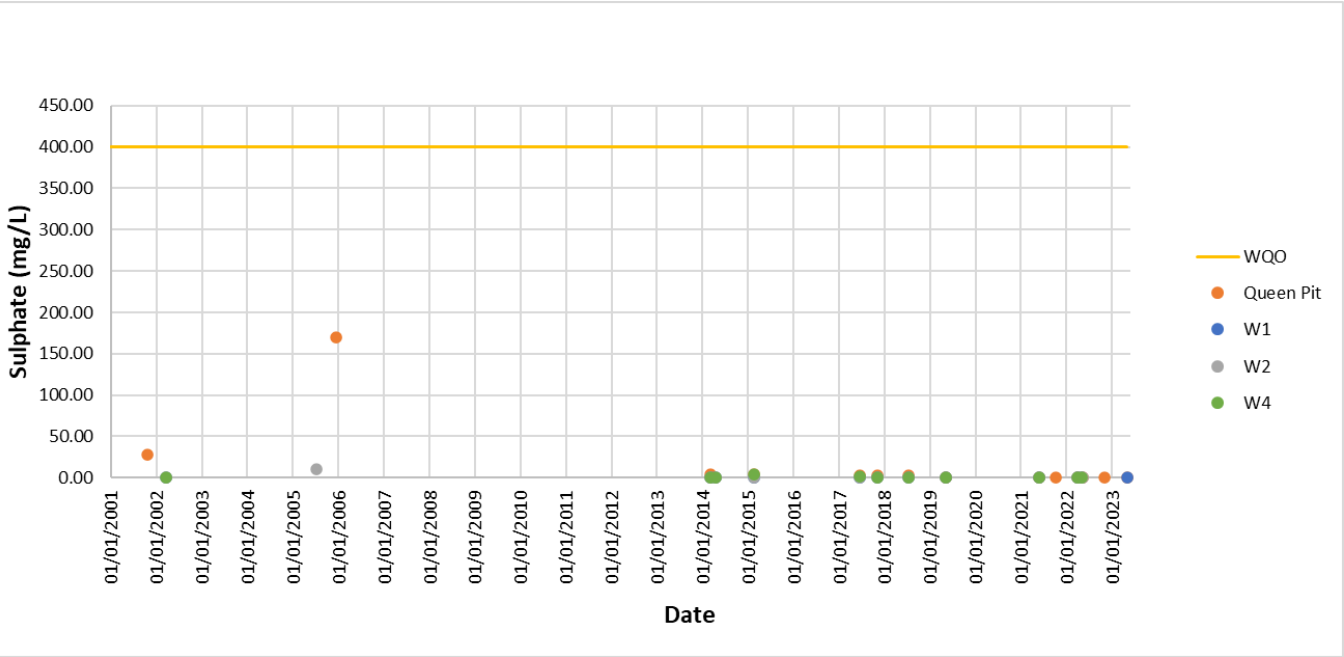
Turbidity



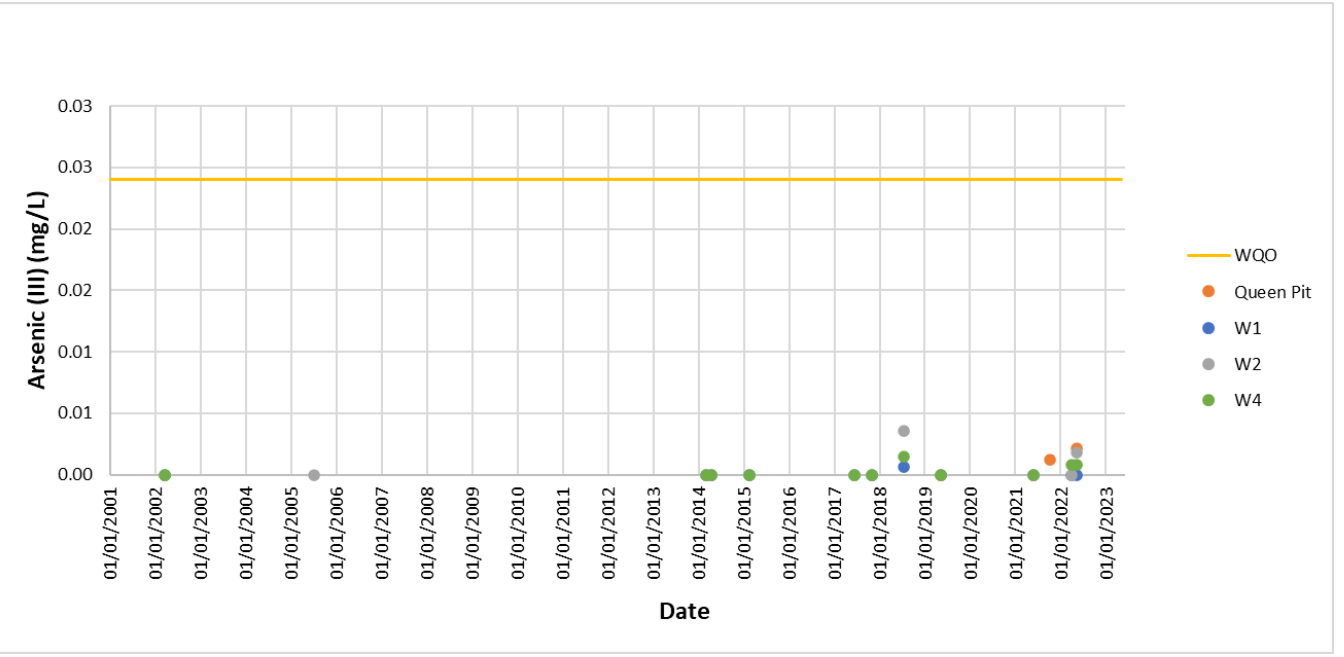
Electrical Conductivity



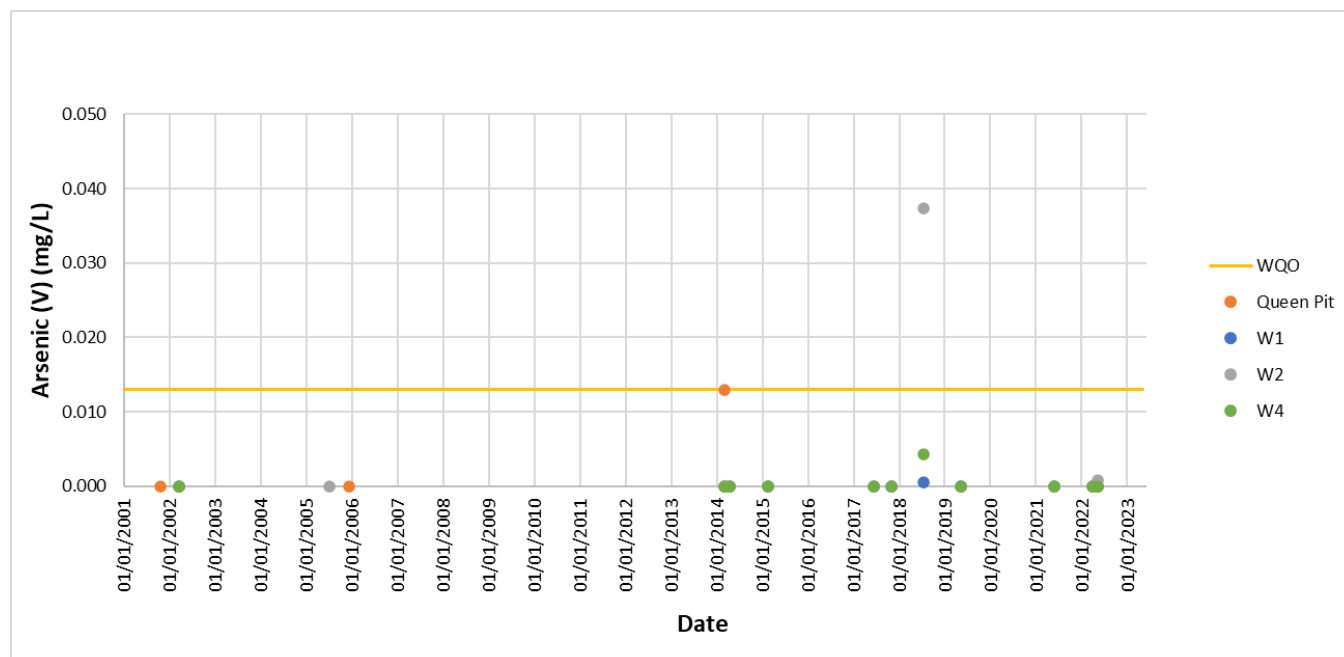
Sulphate



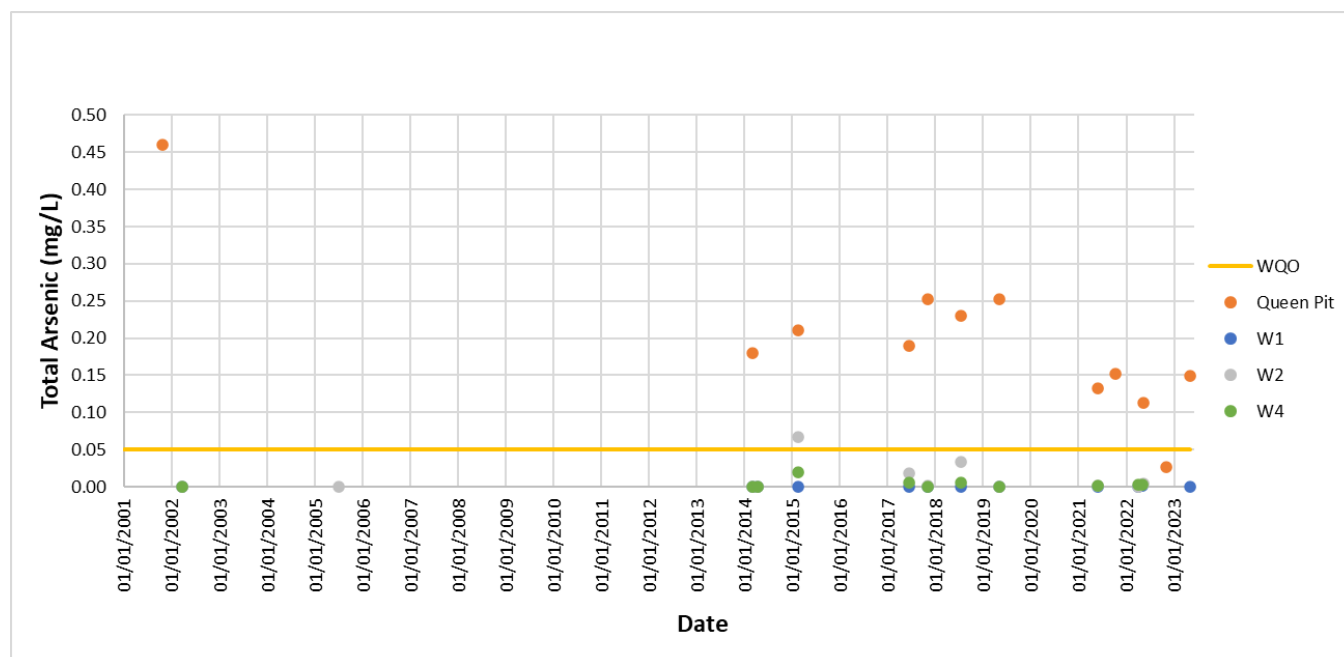
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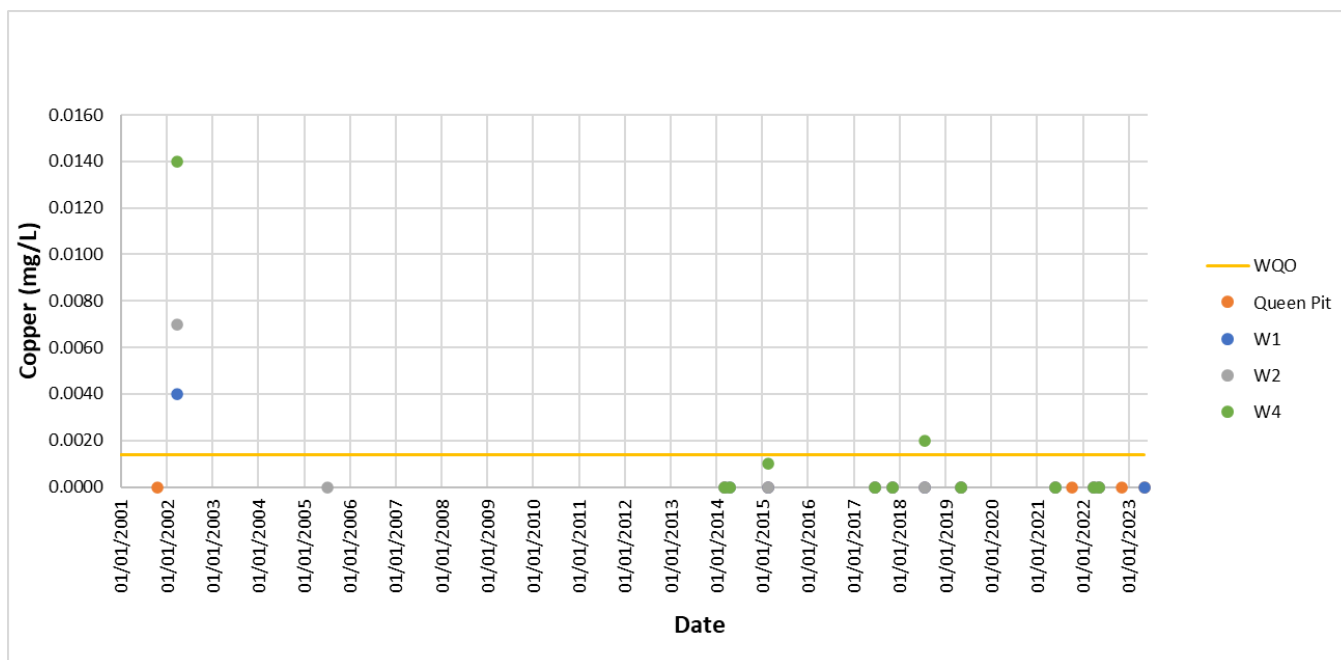
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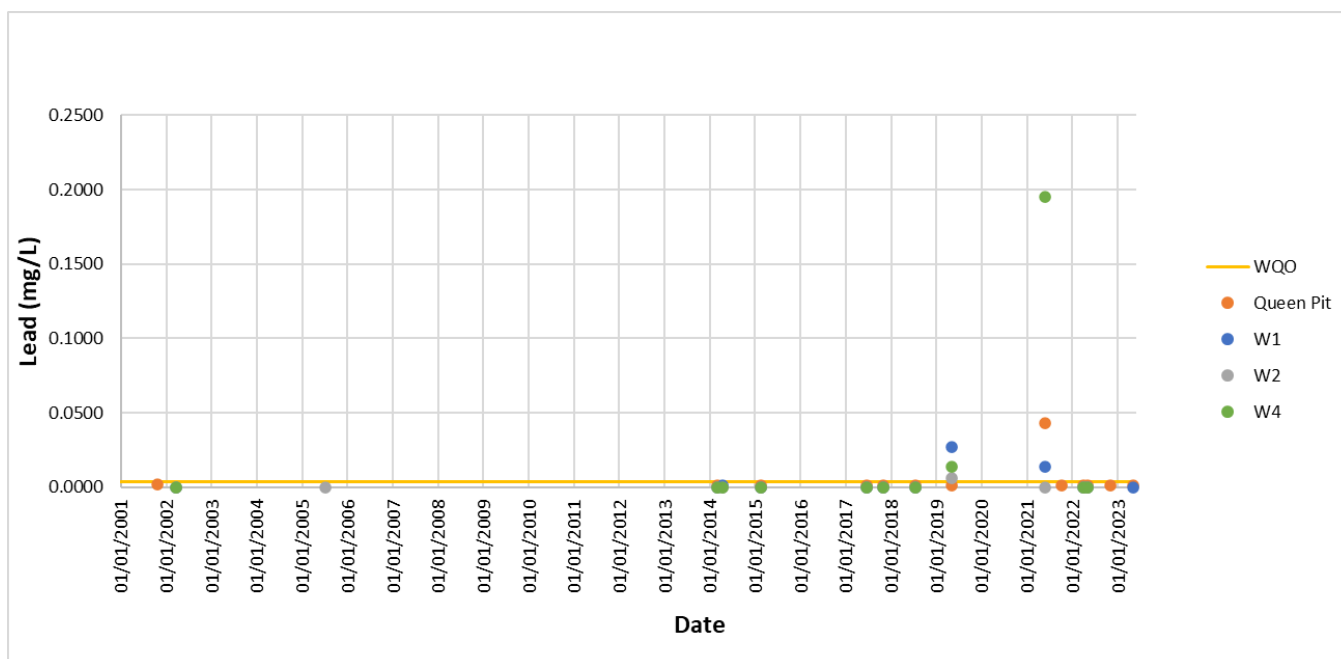
Total Arsenic



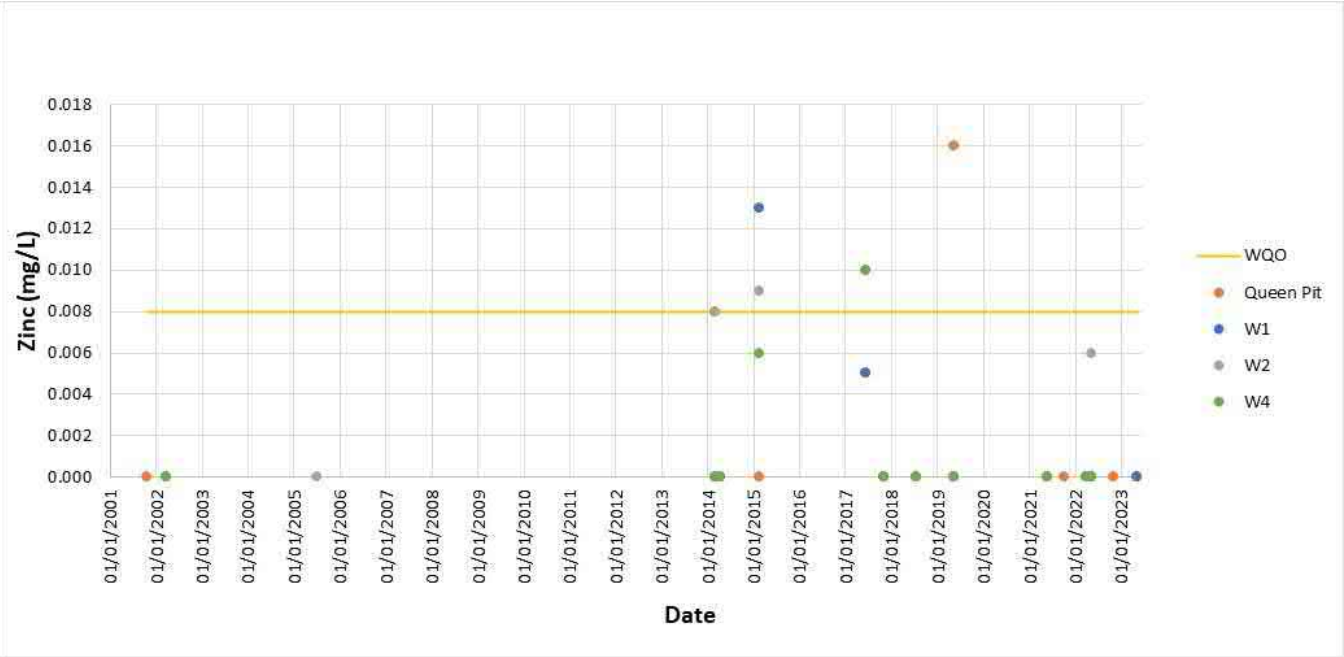
Copper



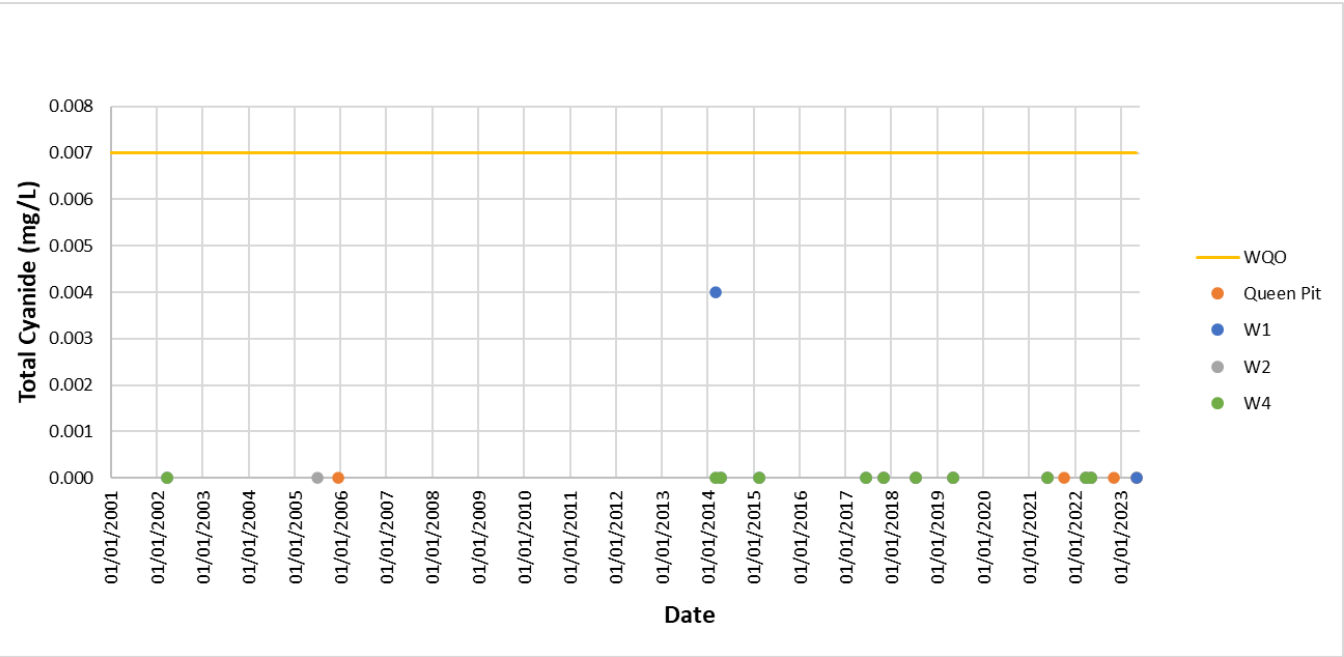
Lead



Zinc



Total Cyanide



Appendix B:

Hydrology Model Validation

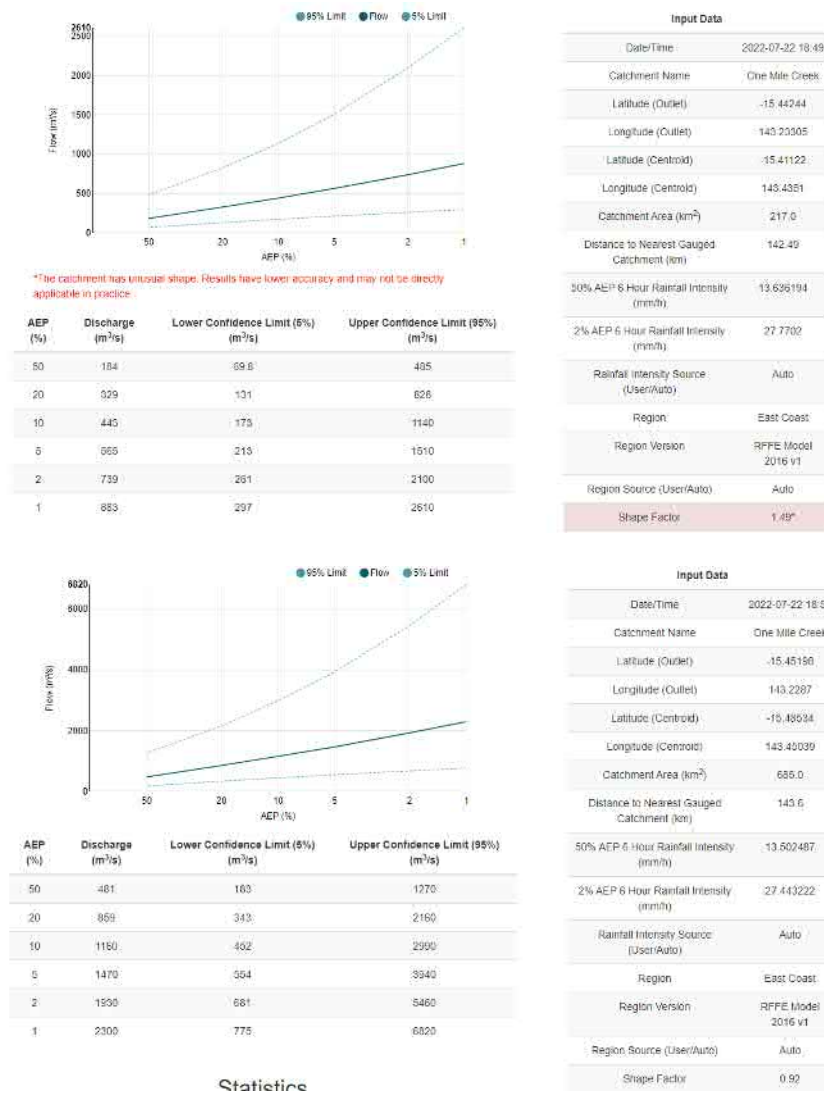
ARGM Hydrology Model Validation

Model: XP RAFTS developed via CatchmentSim
Status: Uncalibrated using ARR19 standard inputs
Validation Methods: QRT, RFFE

Date: 22/07/2022
By: NG
Reviewed: AB

Catchment ID	Model	Peak Flow (m3/s)					
		36.3% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP
One Mile Creek (217 sq.km)	XP-RAFTS	138	258	350	439	572	677
	RFFE	184	329	443	565	739	883
	QRT	88	237	358	522	748	934
Alice River (Downstream Confluence) (685 sq.km)	XP-RAFTS	501	925	1244	1545	1957	2301
	RFFE	481	859	1160	1470	1930	2300
	QRT	211	534	783	1131	1590	1958

RFFE Calculations



QRT Calculations

Catchment ID	Catchment Area (sq.km)	72hr 50yr ARI Intensity	Peak Flow (m3/s)					
			36.3% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP
One Mile Creek	217	4.88	88	237	358	522	748	934
Alice River (Downstream Confluence)	684	4.88	211	534	783	1131	1590	1958

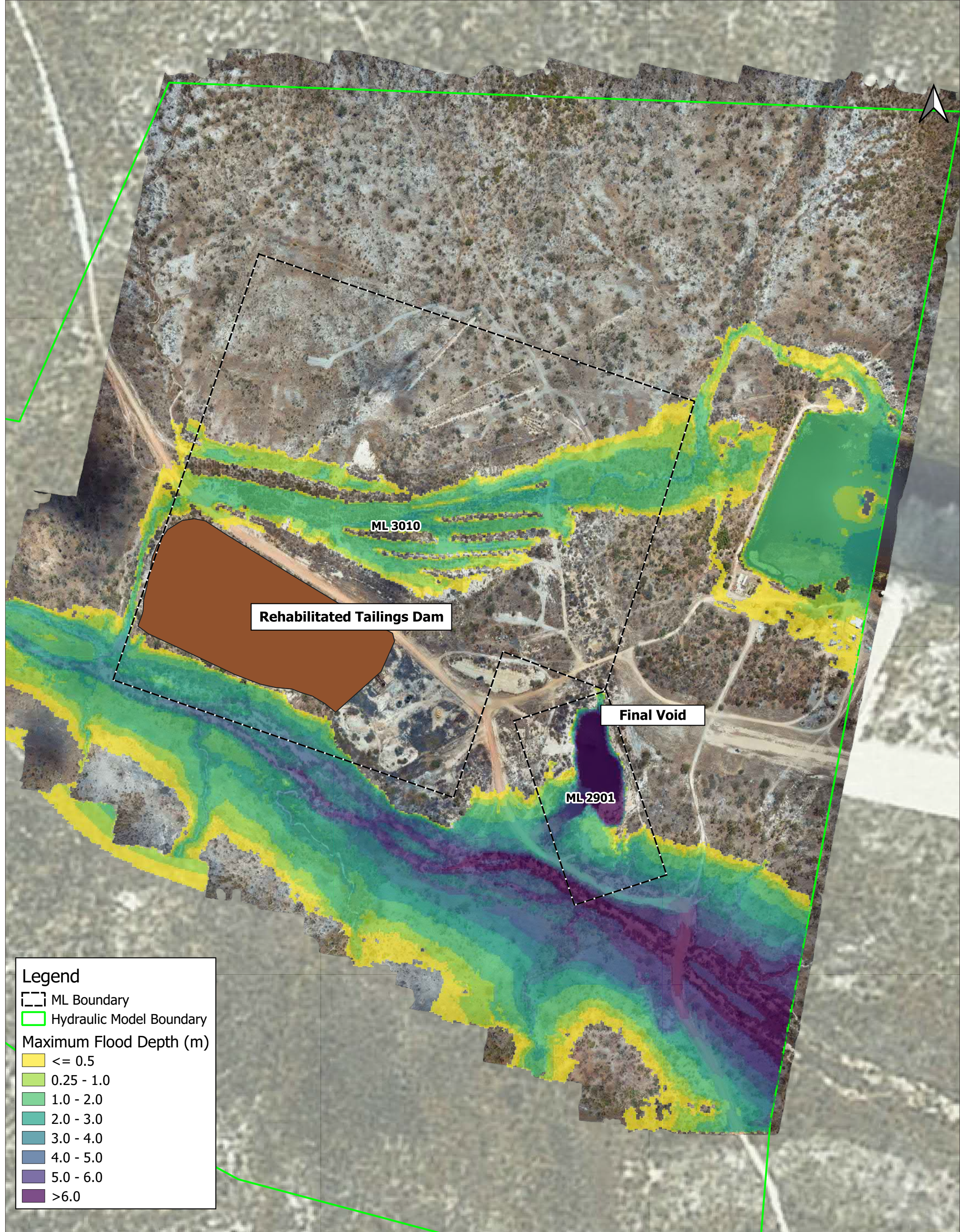
QRT Notes:

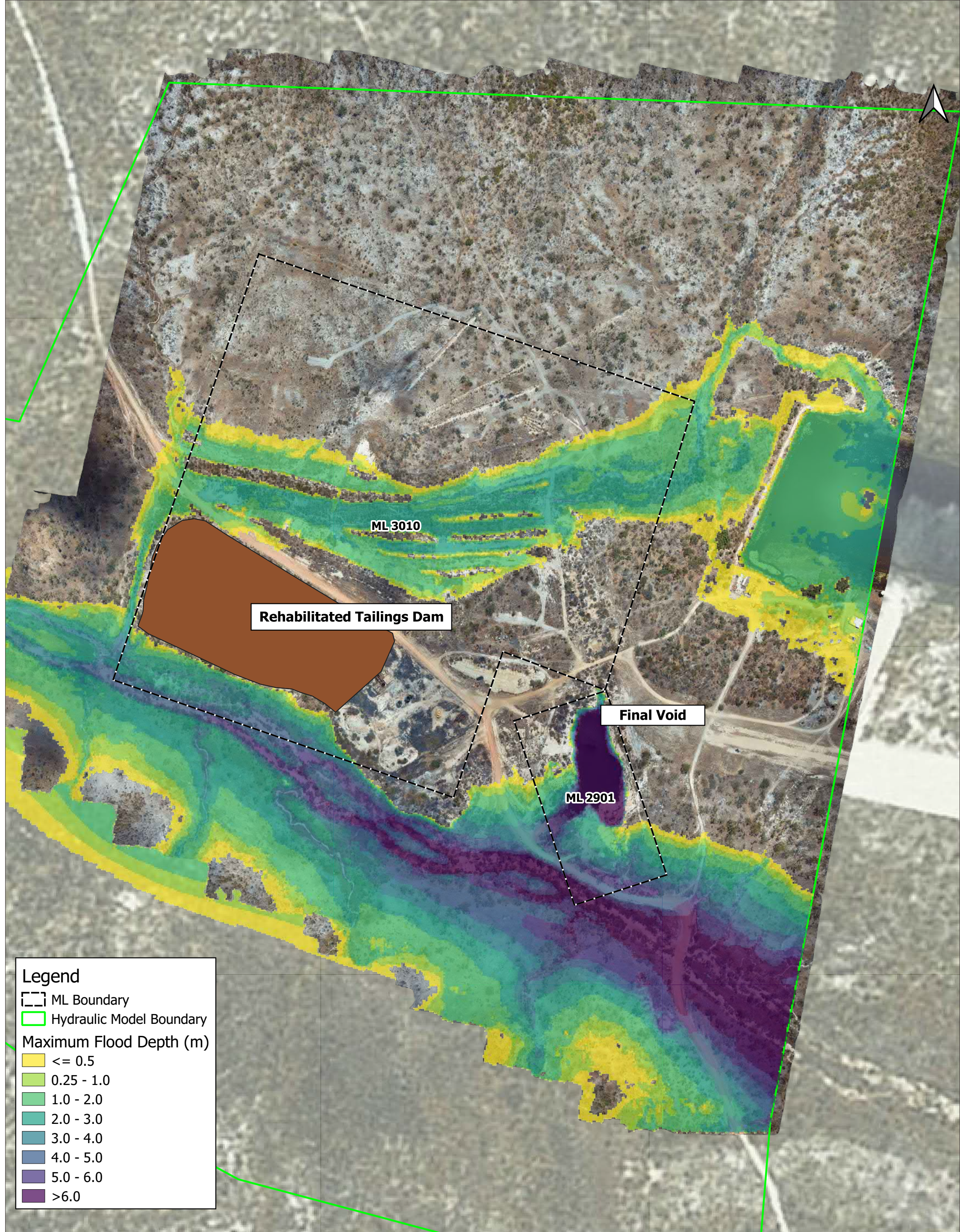
Method: *Quantile Regression Technique (QRT)*
Department of Transport and Roads (Palmen, L.B and Weeks, W.D)

Suitable for catchments: *Located in Queensland*
Area < 1000 km²
Urban land use = insignificant
Flow regulation = insignificant

Appendix C:

Post Closure Flood Mapping





Legend

ML Boundary

Hydraulic Model Boundary

Maximum Flood Depth (m)

<= 0.5

0.25 - 1.0

1.0 - 2.0

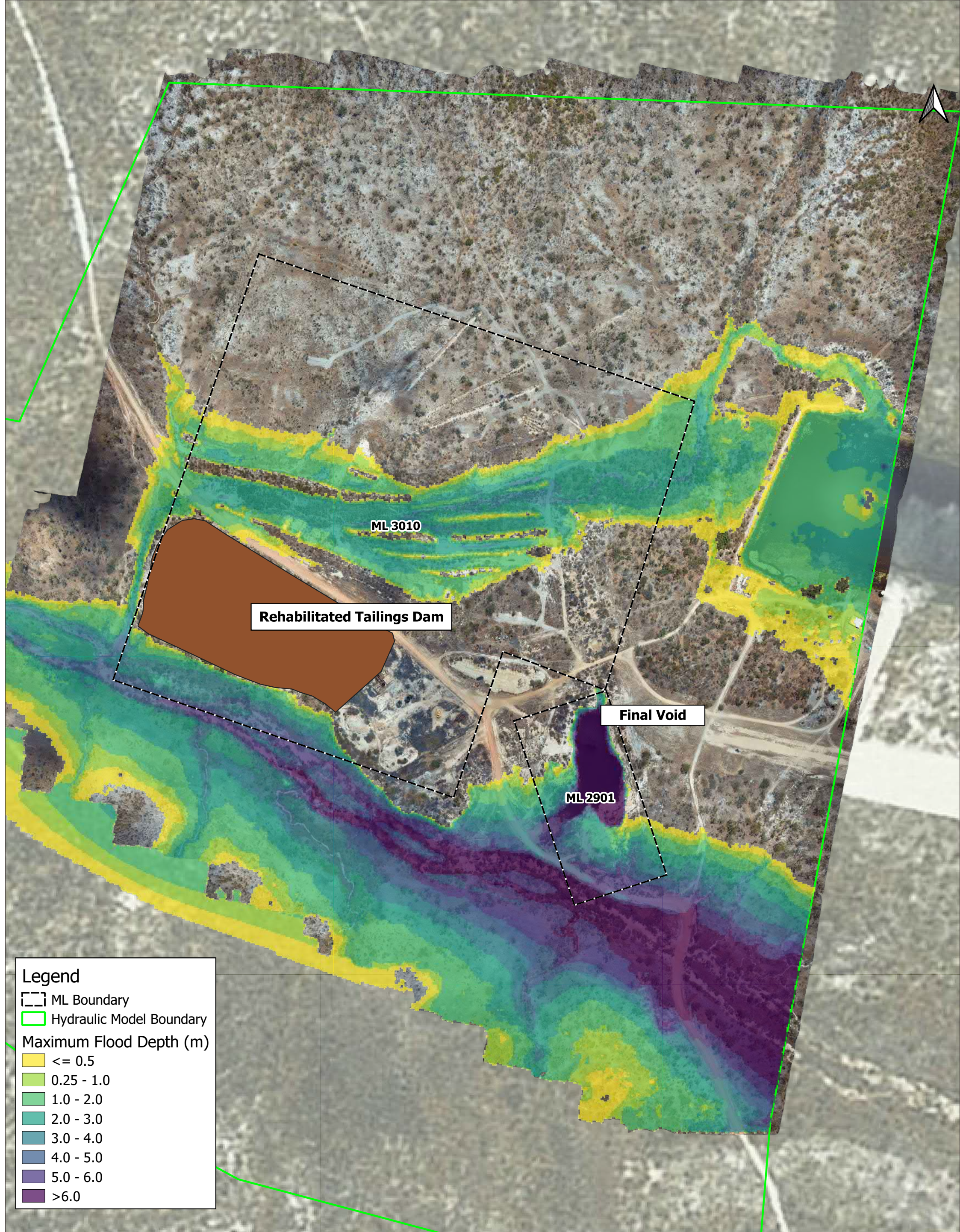
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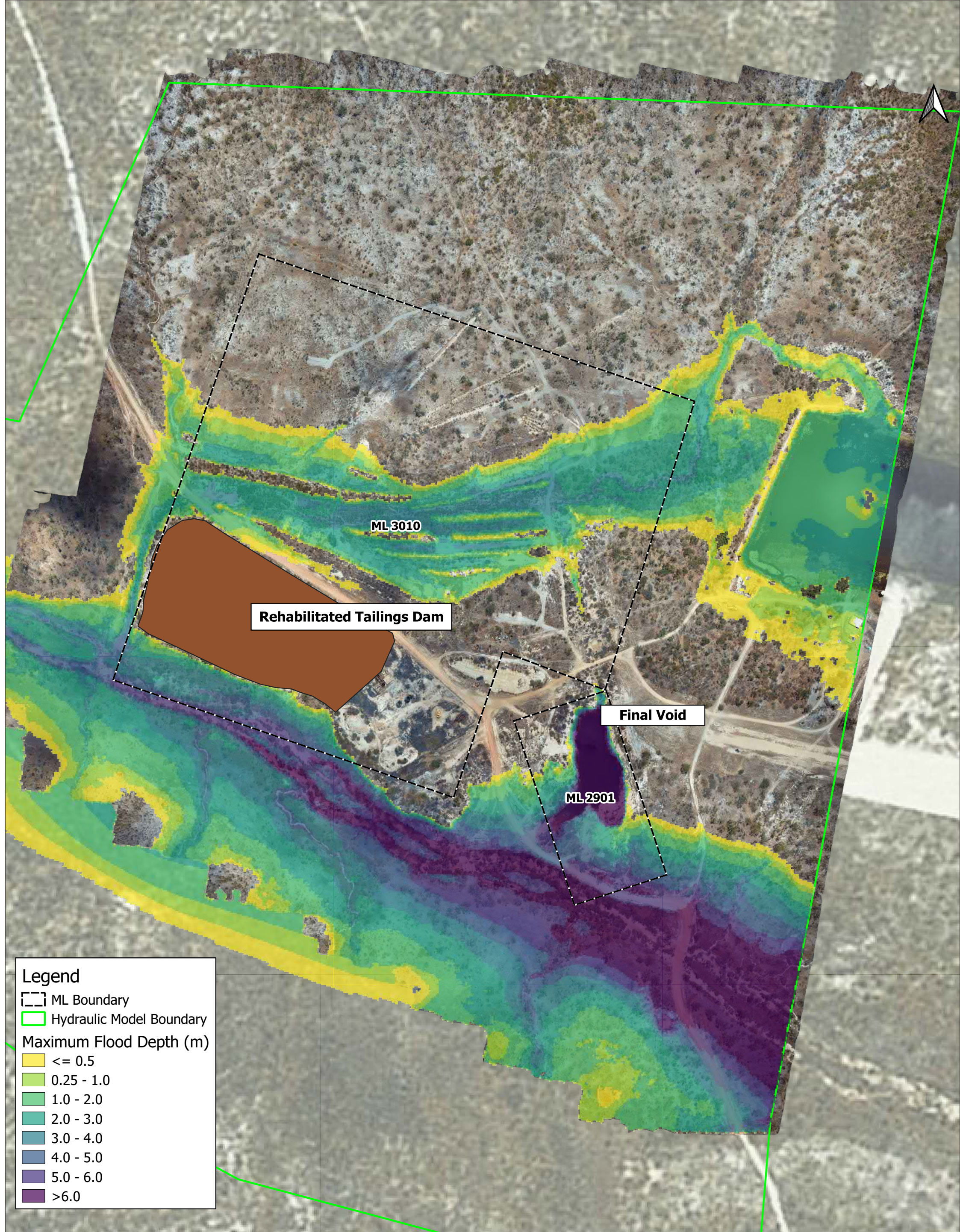
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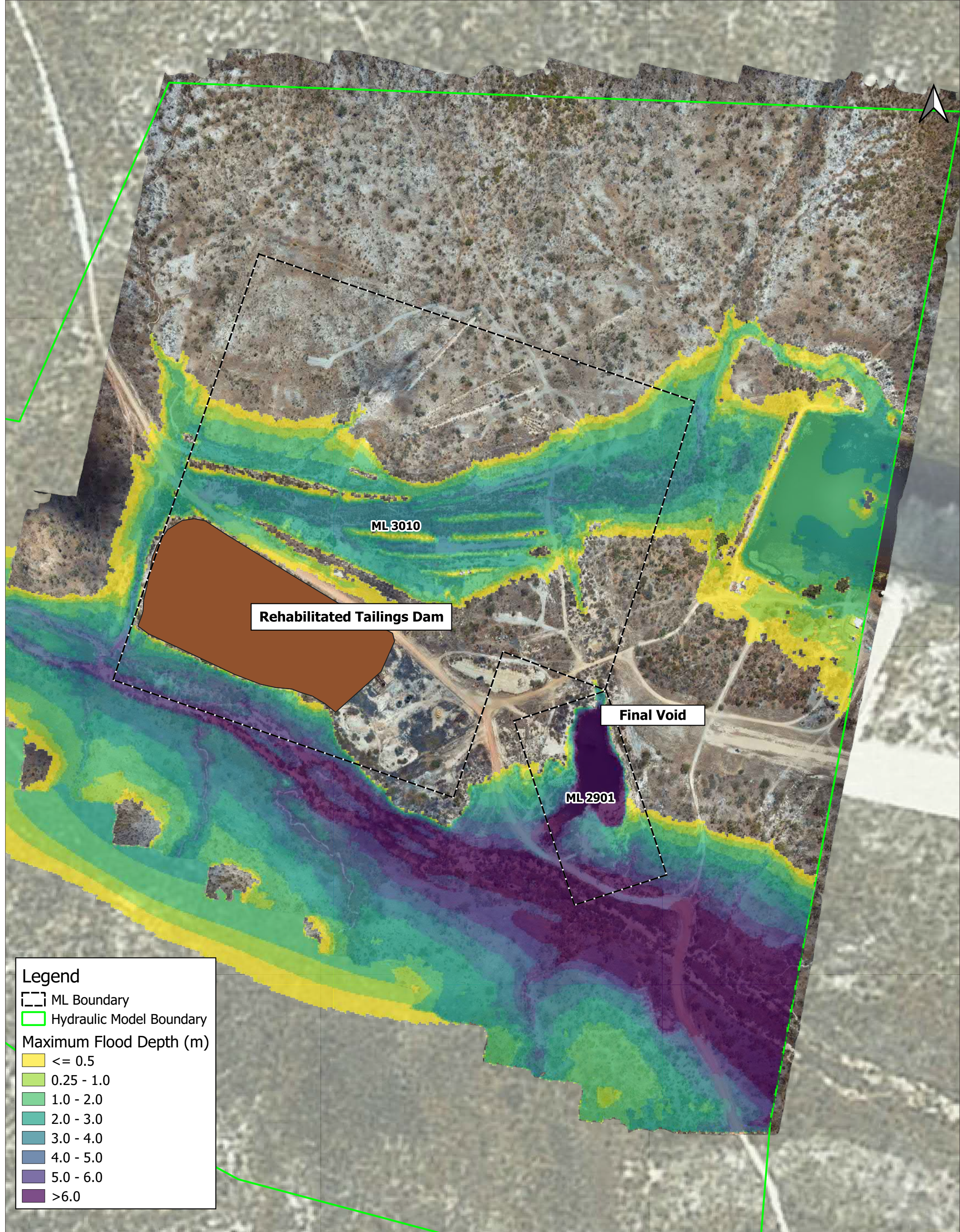
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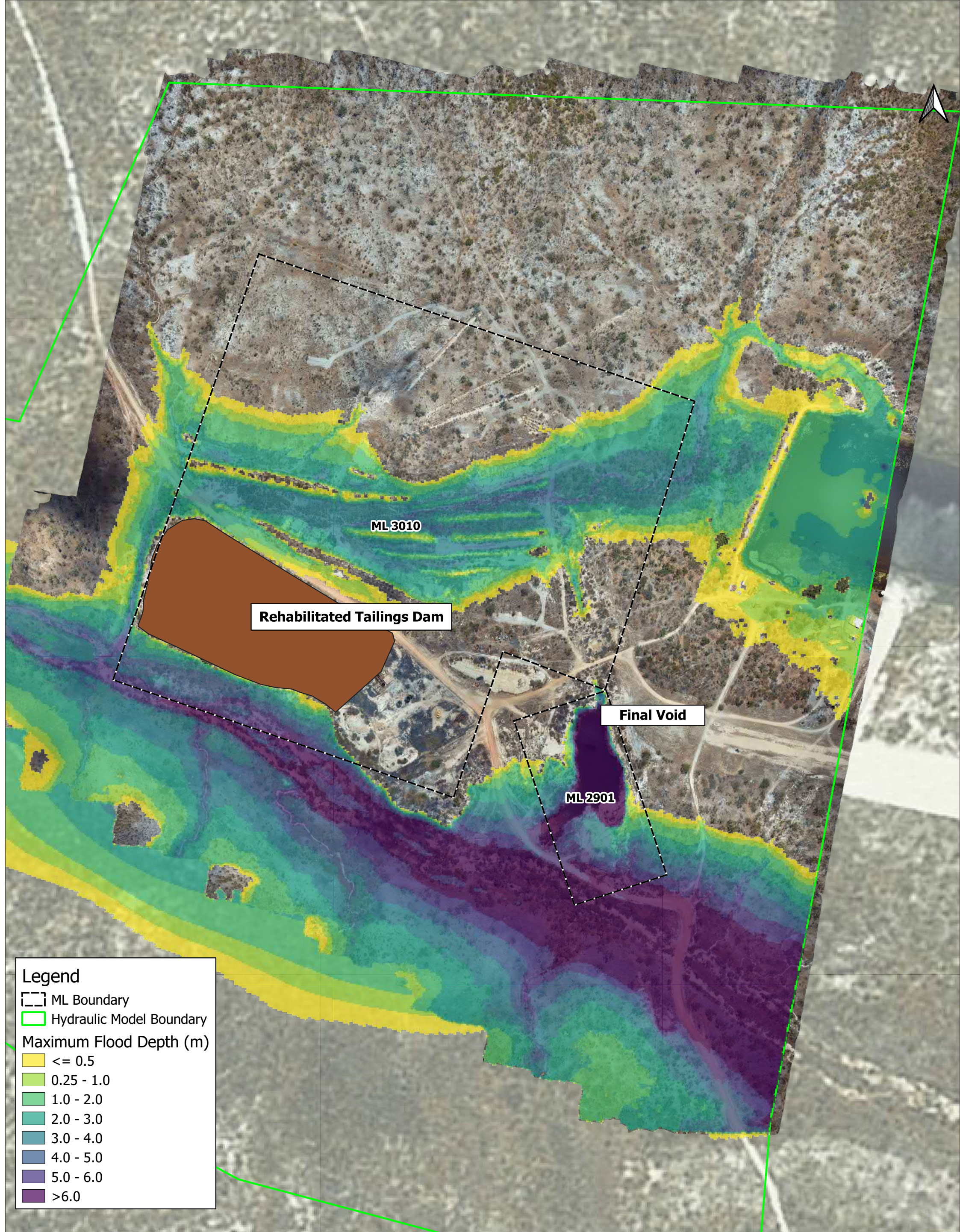
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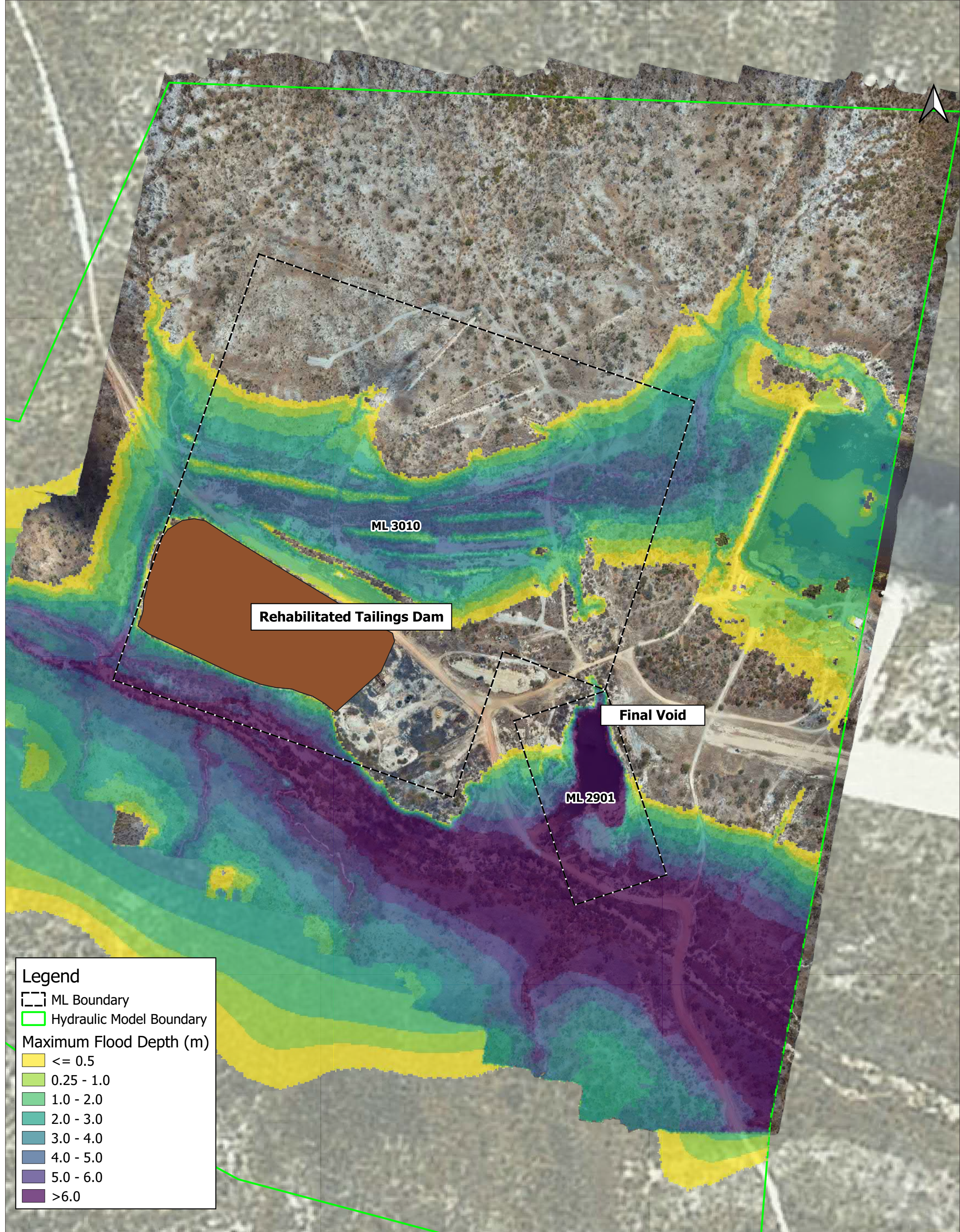
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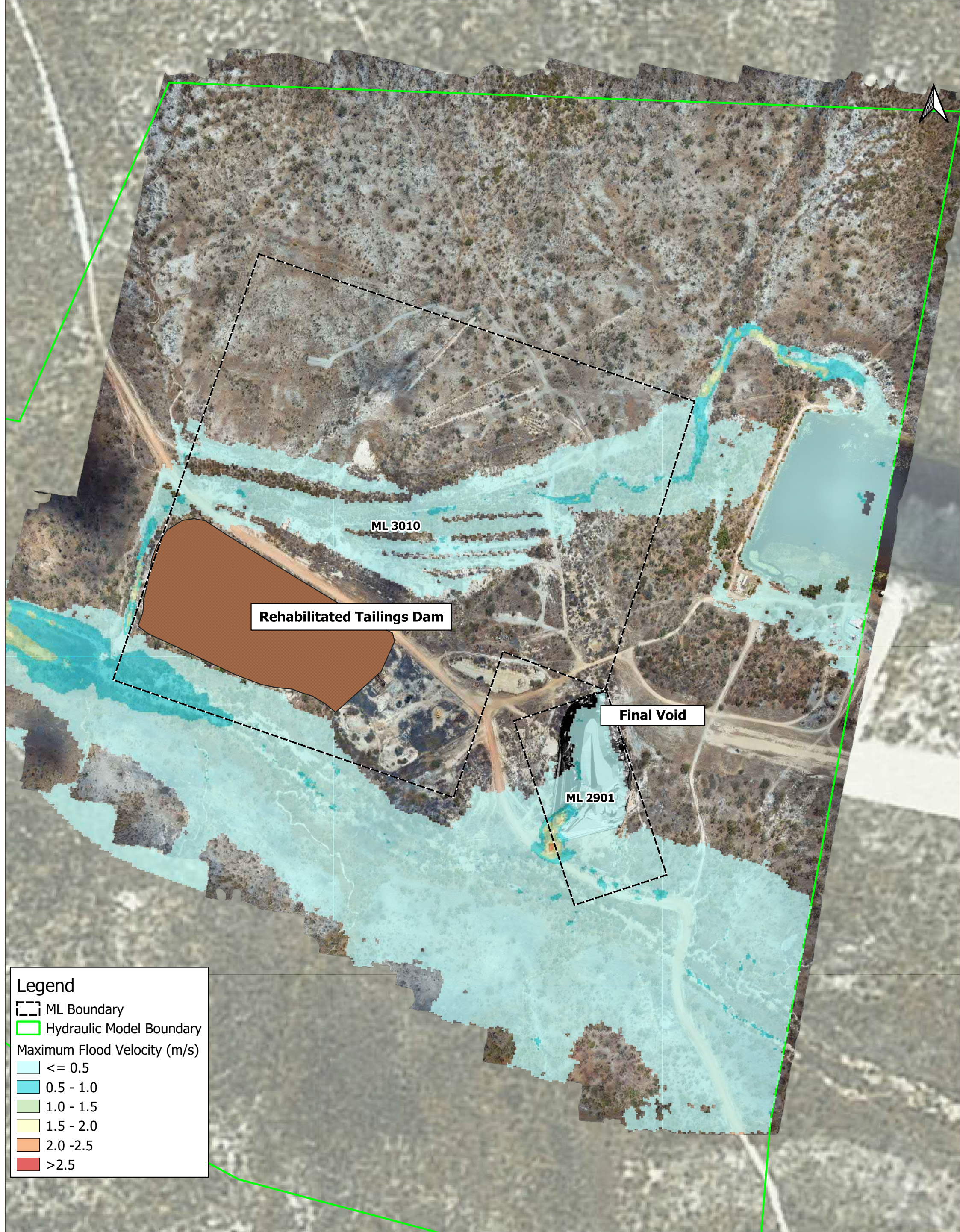
Legend

ML Boundary

Hydraulic Model Boundary

Maximum Flood Depth (m)

	<= 0.5
	0.25 - 1.0
	1.0 - 2.0
	2.0 - 3.0
	3.0 - 4.0
	4.0 - 5.0
	5.0 - 6.0
	>6.0



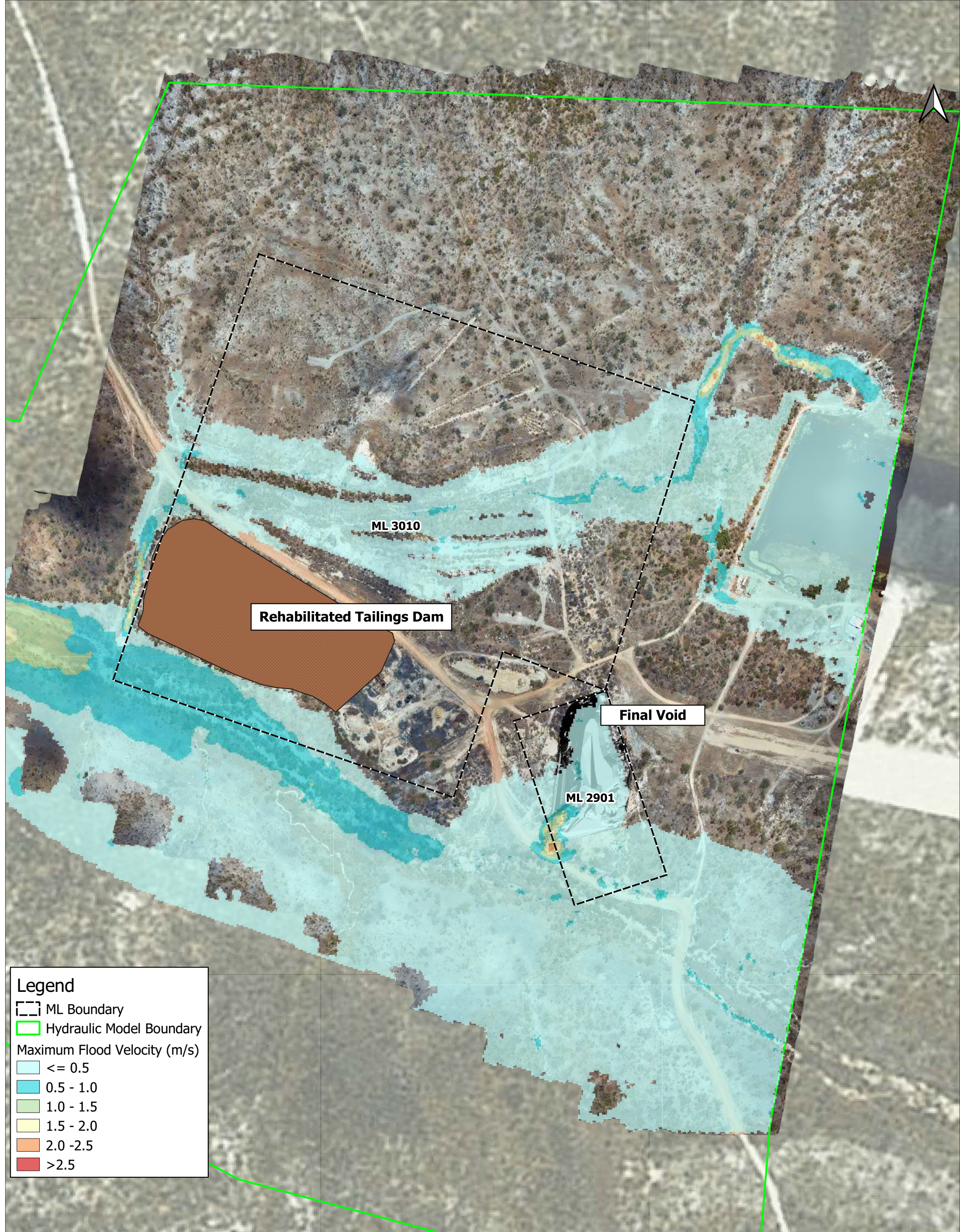
Legend

ML Boundary

Hydraulic Model Boundary

Maximum Flood Velocity (m/s)

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	2.0 - 2.5
	>2.5



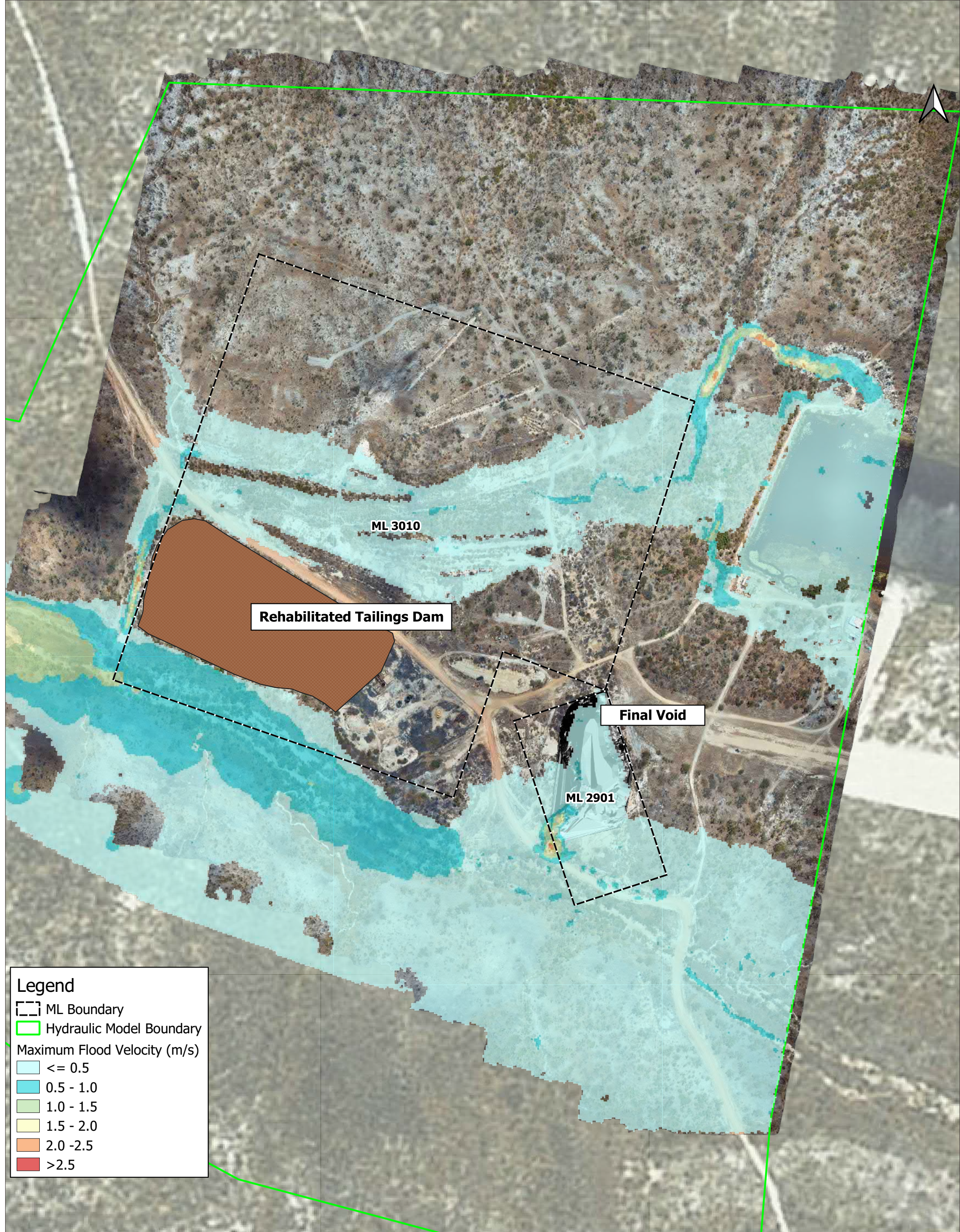
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ML Boundary

Hydraulic Model Boundary

Maximum Flood Velocity (m/s)

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	1.0 - 1.5
	1.5 - 2.0
	2.0 - 2.5
	>2.5



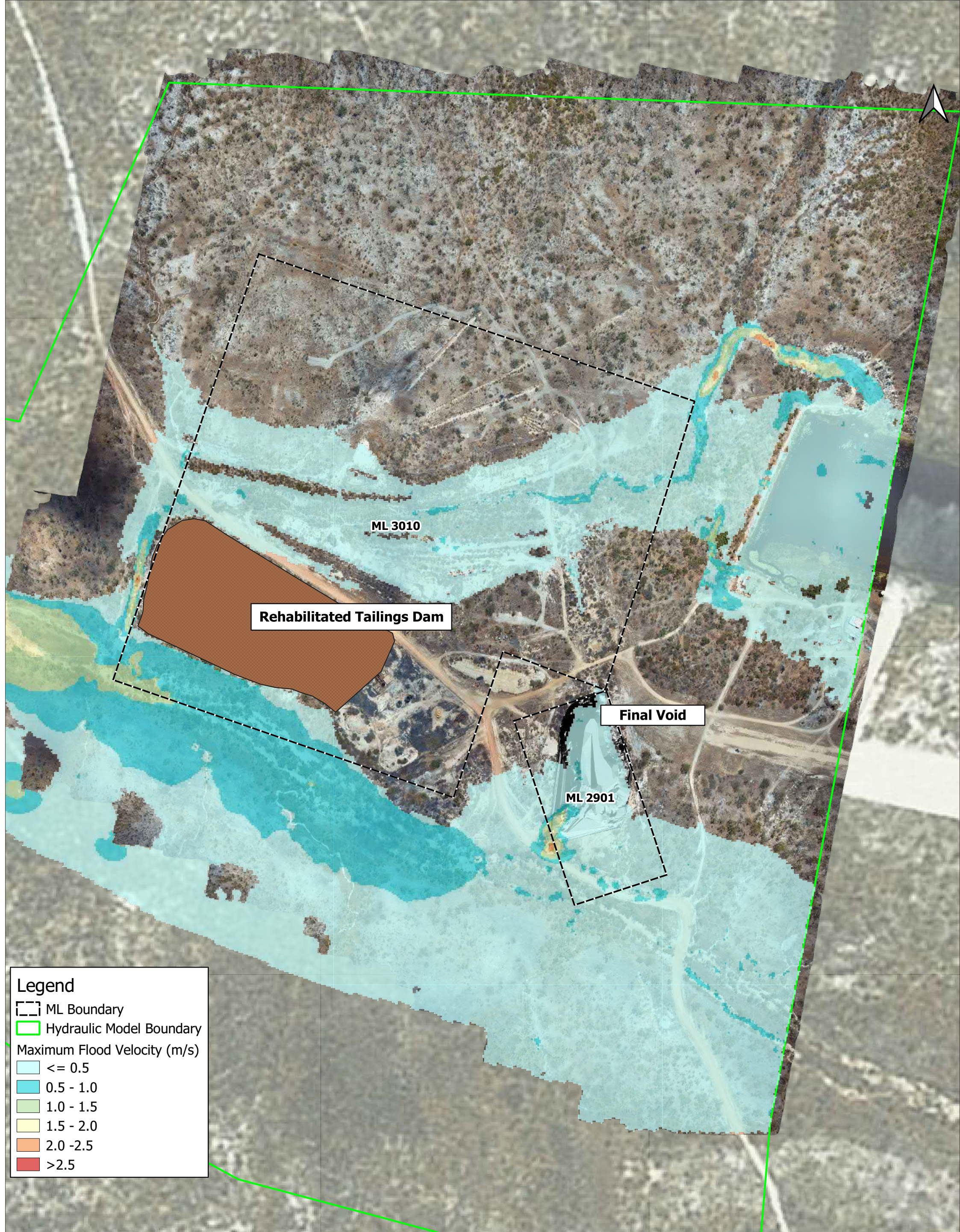
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ML Boundary

Hydraulic Model Boundary

Maximum Flood Velocity (m/s)

	<= 0.5
	0.5 - 1.0
	1.0 - 1.5
	1.5 - 2.0
	2.0 - 2.5
	>2.5



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0 100 200 m

Scale in metres (1:4,000 @ A3)

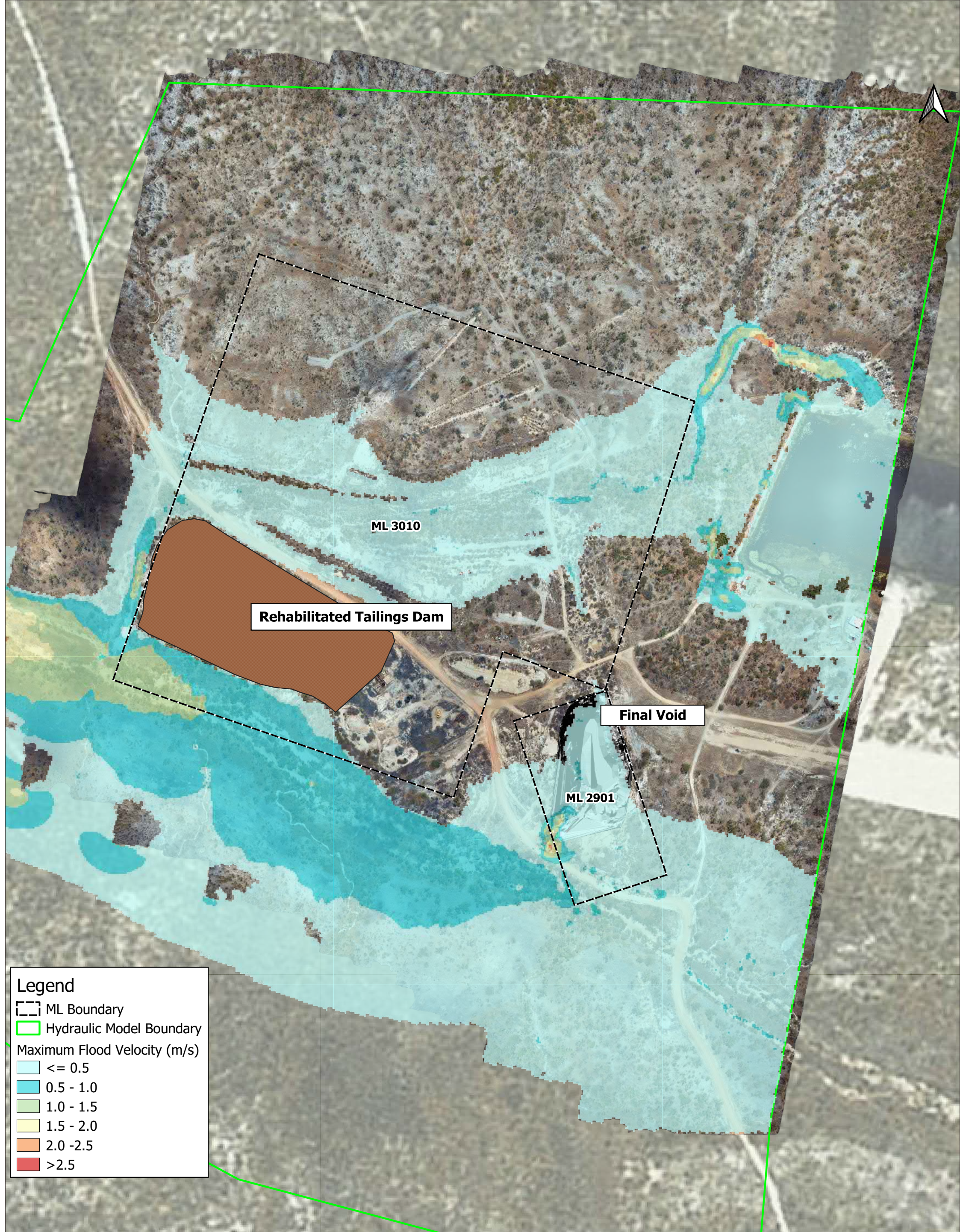
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Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 54

PACGOLD

Alice River Gold Mine
PRCP Flood Assessment
5% AEP - Flood Velocity

Figure B4

Job Number: M7355_002
Revision: 1
Drawn: SS
Checked: NG
Date: 19 /5 /2023



Legend

ML Boundary

Hydraulic Model Boundary

Maximum Flood Velocity (m/s)

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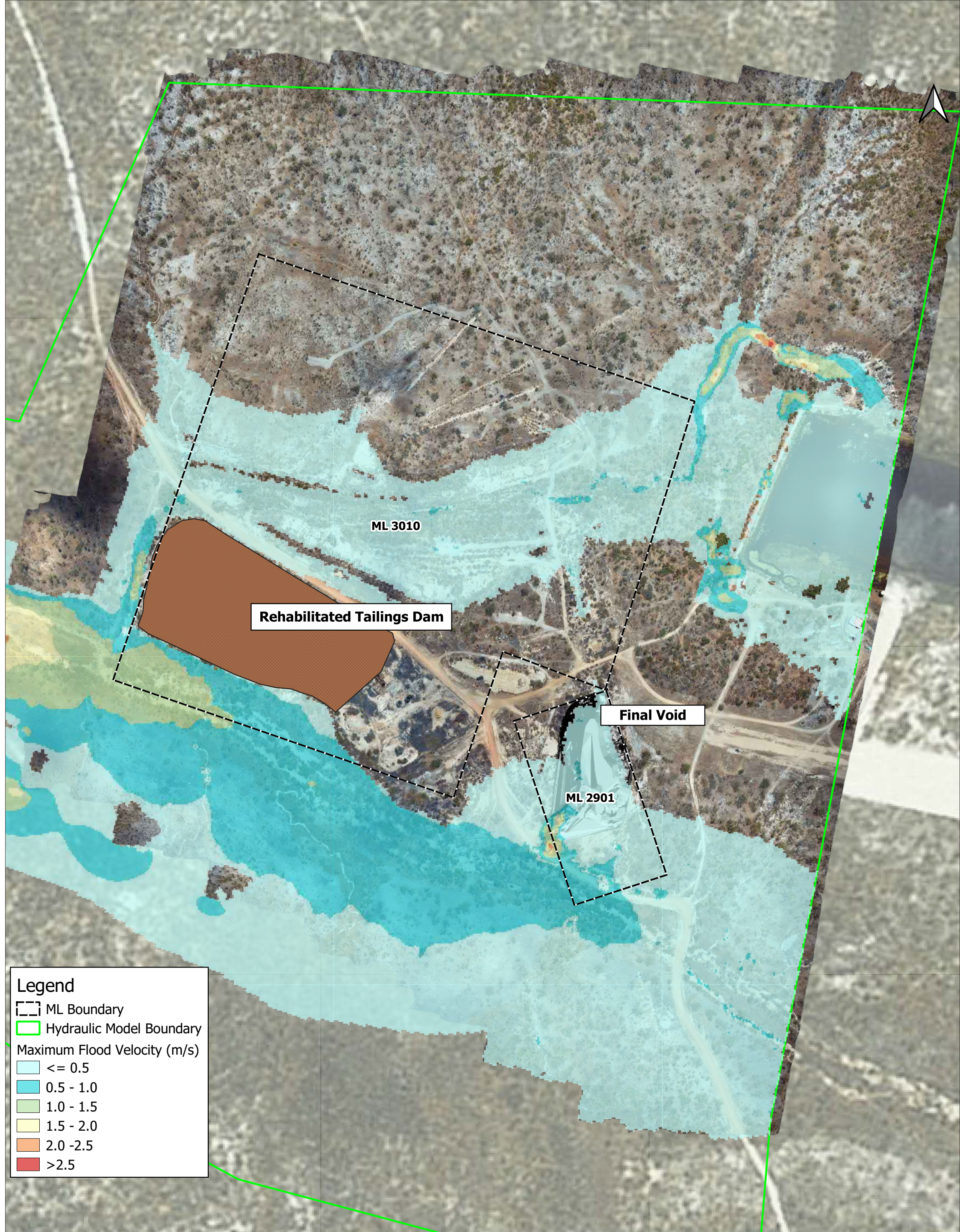
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Legend

ML Boundary

Hydraulic Model Boundary

Maximum Flood Velocity (m/s)

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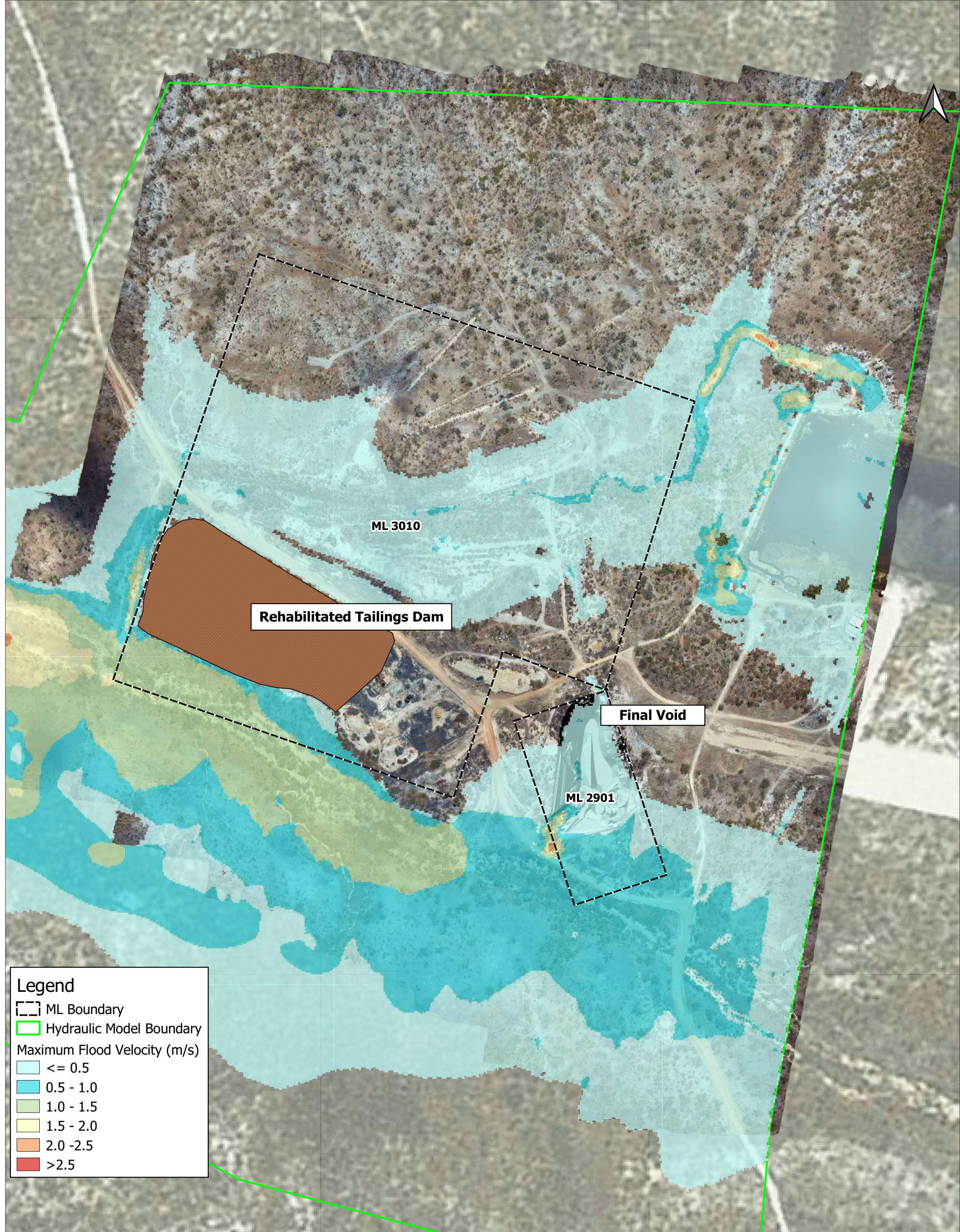
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1.5 - 2.0

2.0 -2.5

>2.5



Legend

ML Boundary

Hydraulic Model Boundary

Maximum Flood Velocity (m/s)

	<= 0.5
	0.5 - 1.0
	1.0 - 1.5
	1.5 - 2.0
	2.0 - 2.5
	>2.5



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DRAFT TECHNICAL REPORT

Soil capping and mine waste assessment and tailings dam rehabilitation

Alice River Gold Mine.

Prepared for: AARC Environmental Solutions Pty Ltd, on behalf of Pacgold Limited



DRAFT TECHNICAL REPORT

Soil capping and mine waste assessment and tailings dam rehabilitation

Alice River Gold Mine

Prepared for: AARC Environmental Solutions Pty Ltd, on behalf of Pacgold Limited

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Project Number	2022095

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Table of Contents

1	Introduction	1
1.1	Purpose.....	1
1.2	Scope	1
1.3	Objectives	1
1.4	Quality, standards, regulation, legislation, and guidelines.....	2
2	Geology	3
2.1	Mineralisation	3
3	Sampling program.....	4
4	Analytical program.....	5
5	Interpretation of geochemical results.....	7
5.1	Static analytical methods for assessing AMD.....	7
5.2	Reference to guidelines	7
5.3	Maximum potential acidity	7
5.3.1	Actual acidity	7
5.3.2	Potential acidity	8
5.3.3	Reactive acid neutralising capacity.....	9
5.3.4	Net acid producing potential (NAPP) and neutralisation potential ratio (NPR).....	10
5.3.5	Net acid generation (NAG).....	Error! Bookmark not defined.
5.4	Metalliferous drainage potential	10
5.4.1	Speciation	10
5.4.2	Fractionation	10
6	Results	11
6.1	Net acid producing potential.....	11
6.1.1	Total sulfur (TS)	12
6.1.2	Chromium reducible sulfide sulfur (CRS).....	12
6.1.3	Maximum potential acidity (MPA)	12
6.1.4	Acid neutralising capacity (ANC)	13
6.1.5	Mineralogy.....	13
6.1.6	Net acid producing potential (NAPP)	13
6.1.7	Neutralisation potential ratio (NPR)	13
6.1.8	Net acid producing potential classification	15
6.2	Saline drainage potential.....	15
6.2.1	Electrical conductivity _{1:5} (EC _{1:5})	15
6.3	Metalliferous drainage potential	16
6.3.1	Whole rock metal(loid)s.....	16
6.3.2	Water soluble metal(loid)s	17
6.4	Soil fertility results	18
6.5	Physical analysis results	20
6.5.1	Particle size distribution (PSD) and hydrometer	20
6.5.2	Shrink-swell.....	20
6.5.3	Permeability	21
6.5.4	Pin-hole dispersion.....	21

6.5.5	Soil water characteristic curves (SWCC's)	21
6.5.6	Salinity, sodicity, and stability	22
7	Proposed rehabilitation and closure plan	26
7.1	Mine waste and tailings dam rehabilitation overview	26
7.2	Available material balance and geochemical classification	26
7.3	Neutralisation of the actual acidity in the tailings and mine waste	26
7.4	Proposed movement and management of mine waste, tailings, and soil	27
7.5	Basis of the tailings cover design	27
7.5.1	Cover materials	27
7.5.2	Cover design objectives	28
7.5.3	Cover design performance monitoring	28
8	Conclusions	29
9	Recommendation	29
10	References	30
11	Attachments	
11.1	Attachment A: Acid and metalliferous drainage	
11.2	Attachment B: Soil quality, geochemical and physical results	
11.2.1	Attachment B1 Acid base account results - tailings	
11.2.2	Attachment B2 Acid base account results – mine waste	
11.2.3	Attachment B3 Acid base account results – soil	
11.2.4	Attachment B4 Multi element results from tailings	
11.2.5	Attachment B5: Multi-element results for water extracts from soil, mine waste, and tailings	
11.2.6	Attachment B6: Soil fertility results	
11.3	ALS Certificates of Analysis	
11.4	Trilab physical reports	
11.5	Levay & Co semi quantitative-XRD (semi-QXRD) report	
11.6	Soil Water Group Soil Water Characteristic Curves (SWCC) Report	

List of Figures

Figure 3-1: Sample locations	4
Figure 6-1: MPA _{TS} , ANC _T and NPR values for the soil, waste rock and tailings samples	14
Figure 6-2: NPR for tailings using CRS	14
Figure 6-3: Box and whisker plot for elements ≥ 3 (GAI) from tailings.....	17
Figure 6-4: Box and whisker plot for water soluble metal(loid)s.....	18
Figure 6-5: Soil quality parameters for soil, waste rock and tailings	18
Figure 6-6: PSD and hydrometer.....	20
Figure 6-7: SWCC	22
Figure 6-8: Rengasamy soil classification	23

List of Tables

Table 3-1: Summary of samples.....	4
Table 3-2: Composite samples.....	4
Table 4-1: Analysis program.....	6
Table 5-1: pH concentrations and terms used to describe pH	8
Table 5-2: Relative Mineral Reactivity	10
Table 5-3: Geochemical Abundance Index (GAI) values and Enrichment Factor.....	11
Table 6-1: Summary ABA results	11
Table 6-2: pH concentrations and terms used to describe pH	Error! Bookmark not defined.
Table 6-3: QXRD mineral percentage	13
Table 6-4: Geochemical classification	15
Table 6-5: Saline drainage classification	15
Table 6-6: Soil fertility results	19
Table 6-7: Dry grading results for USCS classification	20
Table 6-8: Shrink-swell and permeability.....	21
Table 6-9: Exchangeable sodium percentage classification	22
Table 6-10: Rengasamy aggregate class description	23
Table 6-11: Emerson class results	24
Table 6-12: Emerson class descriptions.....	24
Table 6-13: Settling columns	25

Glossary of terms and acronyms

Acidity	A measure of hydrogen ion (H ⁺) concentration; generally expressed as pH.
ABA	Acid Base Account. Evaluation of the balance between acid generation and acid neutralisation processes. Determines the maximum potential acidity (MPA) and the inherent acid neutralising capacity (ANC), as defined below.
ALS	Australian Laboratory Services.
AMD	Acid and metalliferous drainage from mine waste materials characterised by low pH, elevated metal concentrations, high sulfate concentrations and high salinity.
ANC	Acid Neutralising Capacity expressed as kg H ₂ SO ₄ per tonne of sample. A measure of a sample's maximum potential ability to neutralise acid.
ANC:MPA	The ratio of the acid neutralising capacity to the maximum potential acidity of a sample. Used to assess the risk of a sample generating acid conditions.
EC	Electrical Conductivity, expressed as μS/cm.
FIMS	Flow Injection Mercury System.
GAI	Geochemical Abundance Index.
ICP-MS	Inductively Coupled Plasma Mass Spectrometry.
ICP-AES	Inductively Coupled Plasma Atomic Emission Spectrometry.
INAP	International Network on Acid Prevention.
KLC	Kinetic Leach Column. Leaching setup that generates time-dependent data on the kinetics and rate of acid generation and acid neutralising reactions under laboratory controlled (or onsite conditions).
LOR	Limit of Reporting. Laboratory detection limit for the reporting of results for a particular geochemical test.
MPA	Maximum Potential Acidity. Calculated by multiplying the total sulfur or sulfide-sulfur (CRS) content of a sample by 30.6 (stoichiometric factor) and expressed as kg H ₂ SO ₄ per tonne.
NAF	Non-Acid Forming. Geochemical classification criterion for a sample that will not generate acid conditions.
NAPP	Net Acid Producing Potential, expressed as kg H ₂ SO ₄ per tonne. Calculated by subtracting the ANC from the MPA.
NMD	Neutral mine drainage typically caused by exposure of sulfide minerals in mine waste materials to oxygen and water and then neutralisation by gangue minerals. Typically characterised by neutral pH and elevated concentrations of salts, sulfate, and metals.
PAF	Potentially Acid Forming. Geochemical classification criterion for a sample that has the potential to generate acid conditions.
PC Titrator	Potentiometric Compact Titrator. PC Titrators are specially designed for routine applications and simple operation, allowing basic titration analysis from a single device.
pH	A measure of hydrogen ion (H ⁺) concentration.
PRC Plan	Progressive Rehabilitation and Closure Plan
PSD	Particle size distribution.
S	Sulfur.

SD	Saline Drainage. Water that is elevated in dissolved salts (e.g., Na^+ , K^+ , Ca^{2+} , Mg^{2+} , Cl^- , and SO_4^{2-}), but may have acidic, neutral, or alkaline pH.
Sodic	Sodic soil and rock materials are characterized by a disproportionately high concentration of sodium (Na) in their cation exchange complex and are innately unstable, exhibiting poor physical and chemical properties, which impede water infiltration, water availability, and ultimately plant growth.
SO_4^{2-}	Sulfate.
Static test	Procedure for characterising the geochemical nature of a sample at a single point in time. Static tests may include measurements of mineral and chemical composition of a sample and the Acid Base Account.
TS	Total sulfur content of a sample generally measured using a 'LECO' analyser expressed as total sulfur%.
TSF	Tailings Storage Facility.

1 Introduction

RGS Environmental Consultants Pty Ltd (RGS) is contracted by AARC Environmental Solutions Pty Ltd (AARC), on behalf of Pacgold Limited (Pacgold), to undertake a geochemical assessment of soil, mine waste, and tailings for the Alice River Gold Mine (ARGM) to provide conceptual cover designs for the Project tailings dam, and to provide advice associated with geotechnical stability and likely methodology and timing for covering the tailings dam. The ARGM is an existing gold mine being explored by Pacgold Limited. ARGM is in central Cape York approximately 300 km north-west of Cairns. The ARGM comprises 30km of prospective gold targets within 377km² of granted exploration permits and eight granted mining leases. Gold mining in the area has occurred intermittently since 1903. The area being explored by Pacgold is hosted within the Alice-Palmer Structural Zone, comprising 30km of prospective gold targets within a high-grade epithermal gold system. Pacgold have focused an exploration drilling program on the Central, Southern, and Northern target, covering 7 km of the gold bearing shear zone. The Central and Southern Targets are located on one continuous regional-scale structural zone, with greater than 3.8km of strike defined for the gold system. The extent of this gold system has not been previously recognised or drilled due to the wide-spread shallow sediment cover. The ARGM comprises a shallow historical open pit (AQ open pit, up to 40 m bgl), a run-of-mine (ROM) pad, mullock dumps, costeans and a small tailings storage facility (TSF).

1.1 Purpose

The purpose of the work is to undertake a geochemical assessment of soil, mine waste, and tailings and provide details for a conceptual capping design for the tailings dam. The assessment will be used to support the PRC Plan for the Project.

1.2 Scope

The scope of work will be completed over three stages.

Stage 1

- Undertake a review of available data relevant to the geochemical assessment and conceptual tailings capping design.
- Undertake a gap analysis of data to understand the information needed to best meet the proposed objectives.
- Develop a geochemical and physical sampling and analytical program (GaPSaAP) to guide the collection and analysis of suitable representative samples from the Project to address any knowledge gaps identified.

Stage 2

- Implement the GaPSaAP in conjunction with AARC.
- Create this Technical Report describing the findings of the geochemical assessment.
- Include details for a conceptual cover design for the tailings dam.
- Provide advice associated with the stability, and likely methodology and timing for the covering of tailings.

1.3 Objectives

The objectives include the following.

- Develop and implement the GaPSaAP.
- Quantify the soil quality, geochemical and physical properties of soil, mine waste, and tailings.
- Sample and analyse mine material to verify the potential for acid to alkaline drainage, saline drainage and metalliferous drainage (collectively referred to as AMD) (COA, 2016a). More information on AMD in mine materials is in **11.1**.
- Provide this Technical Report documenting the findings of the GaPSaAP.

- Provide a Technical Memo with details of conceptual cover designs at surface level for the tailings dam.

1.4 Quality, standards, regulation, legislation, and guidelines

Data interpretation and reporting for this report is consistent with the following applicable legislation, regulation, guidelines, and standards in Queensland.

- The *Mineral Resources and Energy (Financial Provisioning) Act 2018* amended the *Environmental Protection Act 1994* and the Environmental Protection (Rehabilitation Reform) Amendment Regulation 2019 implements key elements of the Mined Land Rehabilitation Policy.
- DES (2021) Progressive Rehabilitation and Closure Plan (PRC plan) progressive rehabilitation and closure plan guideline ESR/2019/4964 • Version 2.00 • Last reviewed: 17 MAR 2021.
- DES (2020) Department of Environment and Science. Residual Risk Assessment Guideline - Interim ESR/2020/5433 • Version 1.00 • Effective: 2 OCTOBER 2020.
- DSITI (2017). Using monitoring data to assess groundwater quality and potential environmental impacts. Version 1. Department of Science, Information Technology and Innovation (DSITI), Queensland Government, Brisbane.
- DES (2014) Department of Environment and Science. Rehabilitation requirements: as appropriate for mining resource activities: ESR/2016/1875 • Version 2.01 • Effective 23 May 2014.

Other Commonwealth and international requirements may include the following.

- AMIRA (2002). ARD Test Handbook: Project 387A Prediction and Kinetic Control of Acid Mine Drainage, Australian Minerals Industry Research Association, Ian Wark Research Institute and Environmental Geochemistry International Pty Ltd, May.
- Australian and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality (2018).
- Commonwealth of Australia Leading Practice Sustainable Development Program (LPSPD) for the Mining Industry: Prevention of Acid and Metalliferous Drainage (2016a).
- Commonwealth of Australia Leading Practice Sustainable Development Program (LPSPD) for the Mining Industry: Rehabilitation (COA, 2016b).
- Commonwealth of Australia Leading Practice Sustainable Development Program (LPSPD) for the Mining Industry: Mine Closure (COA, 2016c).
- Environmental Protection Act (1994).
- INAP Global Acid Rock Drainage Guide (2021).

2 Geology

The deposit lies within the southern Savannah Province. The Savannah Province is a north–south trending belt of metasediments, with lesser amounts of metadolerite and amphibolite, that forms the western part of the Coen Inlier in Cape York Peninsula. The deposit includes rocks of the Proterozoic Holroyd Metamorphics, which form a belt of sedimentary and igneous rocks (greenschist to amphibolite facies). These older rocks include the Sugar Bag Creek Quartzite and Carew Greenstone units. The Proterozoic rock units have been intruded by Late Silurian to Early Devonian Granitoids of the Pama Igneous Province.

There are multiple Pama granite bodies in this region that are also included as part of the Kintore Granite Supersuite, a pale grey biotite-muscovite granite and granodiorite containing some aplites and pegmatites. Subdivisions of the Kintore Supersuite include the Wulpan Granite, Imooya Granite, Culpin Granite, Dixie Granite, and several unnamed Siluro-Devonian granites.

These Proterozoic and Palaeozoic sequences are cut by a series of faults, with strong north-west to north-north-west trends, including the Alice River Shear Zone. These faults contain gold mineralization in several places, along a 50 km strike length of the Alice River Shear Zone. The gold mineralisation is generally hosted in quartz veins, and minor quartz breccias within dilational fault jogs. Gold often occurs as both fine free-gold in quartz or interstitial within sulphides such as pyrite, arsenopyrite, and stibnite. Green-white quartz-sericite-epidote alteration zones extends around some of the mineralised veins, in particular around Alice Queen Gold mine which is located along strike to the SE (Tinpich Pty Ltd, 2018).

The depth of weathering observed at the Project area is approximately 10 to 20 m below ground level.

2.1 Mineralisation

The Alice River deposit is a low-sulfidation intrusion related epithermal deposit, characterised by a series of east-west trending quartz veins hosted within a sequence of metamorphosed sedimentary rocks. Mineralisation is primarily hosted in quartz veins and minor quartz breccias and includes gold, arsenopyrite, and stibnite.

Generally, alteration of the host rocks is confined to areas immediately adjacent to the mineralised quartz veins, although, in some areas the green-white quartz-sericite-epidote alteration zones may extend up to 70 m from the mineralised veins.

Gold mineralisation primarily occurs along regional-scale, north-west striking shear zones. These shear zones are generally hosted within a pale grey to white, mica-biotite leucogranite; the Imooya Granite (previously described as adamellite), part of the Silurian to Devonian aged Kintore Supersuite. In the north of the ARGM project area the shear zones also intersect Mesoproterozoic aged schists and gneisses of the Sugarbag Creek Quartzite.

3 Sampling program

The sampling program was developed by RGS and undertaken by AARC personnel. Sixty-six samples were collected and sent to Indicium Laboratory in Brisbane for sample preparation. Bulk soil samples were collected from the existing soil stockpiles. Mine waste samples were collected from the existing waste rock dump (WRD) and run of mine (ROM) pad. Tailings were collected using an excavator and in increments from surface to 0.5 mbgl, 0.5 – 1.0 mbgl, and 1.0 – 2.0 mbgl. Sampling locations are in **Figure 3-1**.

Three of the mine waste samples were held for internal interpretation, therefore, 63 samples were used for the analytical program. A breakdown of samples used for analysis is in **Table 3-1**.

Table 3-1: Summary of samples

Sample location	Material	Number of samples
Soil stockpiles	Soil	6
ROM	Mine waste	5
WRD	Mine waste	16
TSF	Tailings	36
Total		63

To obtain 'bulk' sample masses required to facilitate the physical analyses and for mineralogical analysis, samples were composited by material type and/or depth (**Table 3-2**).

Table 3-2: Composite samples

Material	Depth	Number of samples
Soil	0.05 – 0.20	1
Mine waste	0.00 – 0.10	1
Tailings	0.00 – 0.05	1
Tailings	1.00 – 2.00	1
Total		4



Figure 3-1: Sample locations

4 Analytical program

Geochemical analysis was completed by the NATA accredited laboratories ALS Environmental and ALS Minerals, Brisbane. Physical analyses were completed at Trilab, Brisbane and RGS in-house laboratory, Brisbane; soil mineralogy semi-quantitative x-ray diffraction (semi-QXRD) results were produced by Levay & Co. Environmental Services, South Australia; soil water characteristic curve (SWCC) results were produced by Soil Water Group, Perth.

Static geochemical analyses were completed to quantify the bulk chemical attributes of mine materials for parameters such as acidity ($\text{pH}_{1:5}$), salinity ($\text{EC}_{1:5}$), total sulfur (TS), sulfide sulfur (CRS), total acid neutralising capacity (ANC_T), whole rock and water-soluble element concentrations, and mineralogy. The analyses help to evaluate the potential for AMD.

Physical analyses determine geotechnical properties and are also important for interpreting and quantifying geochemical properties, e.g., the particle size distribution (PSD) of mine material has a direct effect on the geochemical properties and reactivity of the material due to differences in sulfide grain size and associated surface area, and pore space and associated availability of water and oxygen to move through.

Physical analyses completed included PSD with hydrometer, Emerson Class, shrink swell, pinhole dispersion, permeability and maximum dry density, and settling columns.

The suite of static geochemical and physical analyses for mine materials are in **Table 4-1**. Certificates of analysis are in **Sections 11.3, 11.4, 11.5, and 11.6**.

Table 4-1: Analysis program

Geochemical Analyses				
Acid Base Account (ABA)	ALS Code	Method Code	Fraction size used for analysis	Number of analyses
pH plus EC _{1:5}	IN-4S	APHA 4500 H+ - B and APHA 2510 B	< 75 µm	66
NAPP (includes ANC, Total S)	ASS-1	III. Coastech Research (Canada)	< 75 µm	66
Chromium reducible sulfur (CRS)	EA026	Ahern et al (2004)	< 75 µm	6
Multi-Element and mineralogy analyses	ALS Code	Method Code	Fraction size used for analysis	Number of analyses
Major, minor, and trace elemental analysis (Total) 49 elements: Ag, Al, As, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, V, W, Y, Zn, Zr	ME-MS41 - 2 acid aqua regia digest	-	< 2.36 mm	6
QXRD and clay speciation	-	Based on method	< 2.36 mm	4
Soil fertility analyses	ALS Code	Method Code	Fraction size used for analysis	Number of analyses
AG-3: AG2 + Chloride (1:5), pH (CaCl ₂) Colwell P and K, DTPA extractable Fe, Cu, Zn and Mn, Organic Matter and Organic Carbon by Walkley Black	AG1 (EK055, EK057G, EK058G, EK059G, EK061G)	APHA 4500-NH ₃ B, APHA 4500 NO ₃ - B, APHA 4500 NO ₃ - - I/NO ₂ - -B, Thermo Scientific Method D08727 and NEMI: 9171, APHA 4500 Norg – D	< 2.36 mm	24
Shake flask extraction leach method (1:3 and 16-hour leach for water soluble elements)	ALS Code	Method Code	Fraction size used for analysis	Number of analyses
pH plus EC (1:3)	EA005P and EA010P	APHA 4500 H+ - B and APHA 2510 B	< 2.36 mm	12
Alkalinity: including Bicarbonate, Carbonate, Hydroxide & Total as CaCO ₃	ED037	APHA 2320 B	< 2.36 mm	12
Acidity as CaCO ₃	ED038	APHA 2310 B	< 2.36 mm	12
Major cations (Ca, Mg, Na and K) [ICP-AES/MS (1:3 w:v water extracts)] and major anions (Cl, F, and SO ₄) [ICP-AES/MS and PC Titrator (1:3 w:v water extracts)]	NT-1 & NT-2	APHA 3120B, APHA 3125B	< 2.36 mm	12
Soluble metal(oids) for 52 elements: (Ag, Al, As, B, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Ge, Hf, Ho, Hg, In, La, Li, Lu, Mn, Mo, Nb, Ni, P, Pr, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, V, W, Y, Zn, Zr) [ICP-AES/MS (1:3 w:v water extracts)]	EG020F (ME-02)	USEPA 6020 ICP/MS	< 2.36 mm	12
Dissolved Mercury	EG035F	APHA 3112 Hg-B CV/FIMS	< 2.36 mm	12
Physical analyses	Method Code		Fraction size used for analysis	Number of analyses (composite samples)
Grading – with hydrometer	AS1141.12		As received	4
Emerson Class No.	AS 1289 3.8.1		As received	4
Shrink Swell Index	-		As received	4
Pinhole Dispersion	-		< 2.36 mm	4
Maximum Dry Density	-		As received	4
Permeability	-		As received	4
Soil water characteristic curves	-		< 2.36 mm	4

5 Interpretation of geochemical results

Results are summarised in the following sections. Results tables are in **Section 11.2** and Laboratory certificates of analysis are in **Sections 11.3, 11.4, 11.5, and 11.6**.

5.1 Static analytical methods for assessing AMD

To characterise the acid producing potential of a sample, a range of analyses are generally undertaken. Analyses include determination of total sulfur (TS), sulfide sulfur measured using the chromium reducible sulfur method (CRS), sulfate (that can be measured in a range of fractions and species using various methods), the hydrogen ion concentration (pH), electrical conductivity (EC), total acid neutralising capacity (ANC_T), available ANC_{AV} using the acid buffering characteristic curve (ABCC) method, mineralogy, and the single peroxide addition net acid generation (NAG) method (MEND, 2010). However, it is often cost prohibitive and unnecessary to undertake all these analyses on every sample.

RGS undertakes $pH_{1:5}$, $EC_{1:5}$, TS and ANC_T on all samples to screen them and undertake supplementary analyses on specific samples to understand anomalies or to verify assumptions. This approach results in a balance between sample coverage and cost and is an effective strategy for geochemical assessment.

5.2 Reference to guidelines

There are a number of guidelines that are used in the international mining sector to characterise and classify beneficial and deleterious mine materials.

- INAP GARD Guide (Live document, 2021)
- AMIRA (2002)
- Australian Government Leading Practice Handbook on Acid and Metalliferous Drainage (COA, 2016a)
- MEND NEDM – Price 2010
- ADTI
- MDAG
- EnviroMine (Downing et al, 2014)

The principles of these guidelines are consistent, but there are variations in terms, units, and criteria. Subjective analysis and interpretation by suitability qualified scientists and engineers is required within each jurisdiction.

5.3 Maximum potential acidity

Maximum potential acidity (MPA) includes total actual acidity (TAA) + potential acidity (PA).

5.3.1 Total actual acidity

Total actual acidity includes **soluble acidity** and **retained acidity**.

- Soluble acidity is defined as acidity measured using a 1:5 (soil:water) extract
- Retained acidity is defined as the acidity that is not recorded in such an extraction however, there is no clear-cut distinction between soluble acidity and retained acidity because part of the retained forms of acidity can be released during successive extractions with water.

Soluble acidity can be subdivided into **active soluble acidity** and **buffered acidity**.

- Active soluble acidity accounts for the activity of hydrogen ions (H^+) (pH)
- Buffered soluble acidity accounts for other soluble acidic cations (mainly Fe^{2+} , $AlSO_4^+$ and Al^{3+}) that can produce hydrogen ions when they hydrolyse.

Retained acidity can be sub-divided into **(a) exchangeable acidity, (b) acidity carried by protonated variably charged particles, such as clays, and (c) acidity carried by basic sulfate minerals.**

These retained forms of acidity are temporarily immobilised by soils and are subject to re-mobilisation if geochemical conditions change, e.g., during liming, or re-flooding with brackish tidal water.

Exchangeable acidity is acidity that is retained through cation exchange reactions. An example of exchangeable acidity is found in the sulfate mineral Jarosite; One mole of jarosite carries three moles of acidity that can be released by hydrolysis: $\text{KFe}_3(\text{OH})_6(\text{SO}_4)_2 + 3\text{OH}^- \rightarrow 3\text{Fe}(\text{OH})_3 + 2\text{SO}_4^{2-} + \text{K}^+$

Acidity that is buffered through protonation of variably charged particles can be released through their de-protonation, e.g.: $[\text{Al}(\text{OH})]\text{SO}_4 + 2\text{OH}^- \rightarrow \text{Al}(\text{OH})_3 + \text{SO}_4^{2-}$

Terms used to define pH can include the following.

Table 5-1: pH concentrations and terms used to describe pH

pH	Term
< 2	Very strongly acid
2 to 3	Strongly acid
3 to 4	Moderately acid
4 to 5.5	Mildly acid
5.5 to 7.5	Circum-neutral
7.5 to 8.5	Mildly alkaline
8.5 to 9.5	Moderately alkaline
9.5 to 10.5	Strongly alkaline
> 10.5	Caustic

5.3.2 Potential acidity

Total sulfur (**TS**) is measured by combustion of the sample in a furnace at 1,350°C in the presence of strong oxidants/catalysts. This method measures the total concentration of sulfur, including elemental sulfur, sulfur present in sulfide and sulfate minerals as well as organic sulfur. The most environmentally conservative approach to calculate maximum potential acidity (MPA) is to assume that all sulfur in a sample is potentially reactive sulfide and therefore capable of generating acid. By convention in acid base accounting studies, it is assumed that the sulfide sulfur is present as pyrite (FeS_2). Therefore, the stoichiometry of pyrite oxidation is used to calculate a theoretical maximum amount of sulfuric acid that could be generated which is expressed in kg H_2SO_4 / tonne. However, this ignores the fact that not all sulfur will contribute to the generation of acidity (e.g. sulfate sulfur in gypsum and barite). As a result, the total sulfur concentration may overestimate the acid generation potential of a sample.

Sulfur can be present within acid producing primary minerals such as pyrite and marcasite (FeS_2), chalcopyrite (CuFeS_2) and bornite (Cu_5FeS_4) and non-acid producing primary minerals such as galena (PbS) and sphalerite (ZnS). Sulfur can also be present as a large number of non-acid producing secondary minerals such as alunite ($\text{KAl}_3(\text{SO}_4)_2(\text{OH})_6$), gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) through to minerals such as jarosite ($\text{KFe}^{3+}_3(\text{OH})_6(\text{SO}_4)_2$) that can store and release acid and trace, minor and major elements.

To differentiate between total sulfur and sulfide sulfur the **CRS** method was used to measure the sulfide sulfur. The CRS method provides a direct measure of reduced inorganic sulfur over the wide range of values encountered in acid sulfate soils and mineral waste in geological materials. The selectivity of the CRS test in samples containing residual organic sulfur makes it an ideal choice analytically to measure sulfide within primary sulfide minerals. While this method excludes sulfur present as sulfate, or organic sulfur it does not differentiate between acid producing (e.g. pyrite) and non-acid producing (e.g. sphalerite) minerals.

Acid generation is caused by the exposure of sulfide minerals, most commonly pyrite (FeS_2), to atmospheric oxygen and water. Sulfur assay results are used to calculate the maximum acid that could be generated by the sample by either directly determining the pyritic sulfur content or assuming that all sulfur not present as sulfate occurs as pyrite. Pyrite reacts under oxidising conditions to generate acid according to the following overall reaction: $4\text{FeS}_2 + 15\text{O}_2 + 14\text{H}_2\text{O} \rightarrow 4\text{Fe}(\text{OH})_3 + 8\text{SO}_4^{2-} + 16\text{H}^+$. According to this reaction, the MPA of a sample containing 1% sulfur as **pyrite** would be 30.6 kg H_2SO_4 /t.

5.3.2.1 Sulfide mineral morphology and reactivity

The assumptions used to calculate MPA are generally:

- All sulfide are pyrite
- All sulfide will react to produce acid
- The rate of oxidation and reaction is always the same.

5.3.2.2 Total acid neutralising capacity (ANC_T)

The primary minerals in geological materials that are readily able to neutralise acidity are calcium and magnesium carbonates, although RGS has verified that some manganese carbonate minerals such as kutnohorite and rhodochrosite can also provide ANC. Secondary neutralising minerals accounted for in the measurement of ANC include basic silicates such as calcic feldspars, olivine, amphiboles, and biotite. However, due to their slower dissolution rates, their contribution to the overall ANC is generally considered to be small under ambient conditions. Felsic silicates such as sodic and potassic feldspars, muscovite, most clay minerals, and quartz do not contribute significantly to the ANC. In addition, carbonate minerals that contain iron and/or manganese do not report to the ANC measurement.

The total ANC (ANC_T) can be measured using a number of analytical methods (Downing, 2014).

- BC Research Inc. Initial Test Procedure
- BC Research Inc. Confirmation Test Procedure
- Coastech Research Modified Biological Oxidation Test Procedure
- Lapakko Neutralization Potential Test Procedure
- Modified Acid Base Accounting Procedure for Neutralizing Potential (Lawrence)
- Net Carbonate Value (NCV) for Acid Base Accounting (Bucknam)
- Peroxide Siderite Correction for Sobek Method (Skousen et al.)
- Sobek Neutralization Potential Method (Procedure)
- Static Net Acid Generation (NAG) Procedure

Each of these methods may yield different results. Care must be taken in the interpretation of ANC_T data.

RGS provide our samples to ALS Environmental (ALS). The ALS method refers to the AMIRA Guideline (2002) that uses a HCl digest at 80 to 90°C and a back titration with NaOH. The AMIRA method references: Sobek, A.A., Schuller, W.A., Freeman, J.R., and Smith, R.M., 1978. Field and Laboratory Methods Applicable to Overburdens and Minesoils. p.p. 47-50. U.S. Environmental Protection Agency, Cincinnati, Ohio, 45268. EPA-600/2-78-054. ANC_T is affected substantially by particle size distribution (PSD). The finer the PSD of a sample the more reactive the sample will be due to the higher surface area. the static ANC_T method measures the total ANC, but under environmental conditions the ANC (in a boulder of limestone for example) is weathered slowly over decades, centuries, or millennia.

5.3.3 Reactive acid neutralising capacity

The reactive (available) ANC is determined using the acid buffering characteristic curve (ABCC) (AMIRA, 2002) method that was derived from the British Columbia Research Incorporated Initial Neutralisation Potential method (Duncan and Bruynesteyn, 1979). The measurements of reactive (available) acid neutralising capacity involves slow titration of a sample with the addition of hydrochloric or sulfuric acid over set time intervals while continuously measuring the pH. The method is used to estimate the ANC of the material and the buffering capacity available at a pre-determined pH value. When acid is added to finely ground particles or aggregates the material will react with the acid neutralising components and reduce the pH of the solution. The amount of acid required to reach each pH interval is dependent on the amount of neutralisation present. 'Buffering' occurs where a significant amount of acid is added before the pH drops, thereby producing a 'step-like' curve in a plot of pH versus volume of acid added.

The relative reactivity of acid consuming minerals at pH 5 is provided in **Table 5-2**.

Table 5-2: Relative mineral reactivity

Mineral Group	Typical Minerals	Relative Reactivity at pH 5
Dissolving	Calcite, aragonite, dolomite, magnesite, brucite	1.0
Fast weathering	Anorthite, nepheline, olivine, jadeite, leucite, spodumene, diopside, wollastonite	0.6
Intermediate weathering	Epidote, zoisite, enstatite, hypersthene, augite, hedenbergite, hornblende, glaucophane, tremolite, actinolite, anthophyllite, serpentine, chrysotile, talc, chlorite, biotite	0.4
Slow weathering	Albite, oligoclase, labradorite, montmorillonite, vermiculite, gibbsite, kaolinite	0.02
Very slow weathering	K-feldspars, muscovite	0.01
Inert	Quartz, rutile, zircon	0.004

(Source <http://technology.infomine.com/enviromine/ard/acid-base%20accounting/ABAdiscussion.htm>)

5.3.4 Net acid producing potential (NAPP) and neutralisation potential ratio (NPR)

Geochemical classification is achieved using the net acid producing potential (NAPP) of a sample, which is calculated from acid base accounting (ABA) procedures (COA, 2016). The NAPP value is derived as the difference between the MPA and ANC of a sample. The neutralising potential ratio (NPR) is also used as a means of assessing the risk of acid generation from mine waste materials. The purpose of the NPR is to provide an indication of the relative margin of safety within a material. As a general rule, an NPR of 2 can signify that a material will remain circum-neutral in pH and an NPR of 3 or more can signify that a material will retain mildly alkaline drainage (AMIRA, 2002; INAP, 2021).

5.4 Metalliferous drainage potential

The potential of a geological material to leach trace, minor or major elements (salts, metal(oids)) is a function of the fractionation and speciation of the elements and the way the mine waste materials will be managed.

5.4.1 Speciation

Speciation refers to specific metal species such as, organometallic compounds, metals bonded to different anions (e.g., chlorides, sulfates, sulfides, carbonates, oxides, etc.) or metals with different redox states that determine elemental toxicity such as Cr^{3+} (limited toxicity) and Cr^{6+} (highly toxic) (Templeton et al., 2000; Quevauviller, 2002).

5.4.2 Fractionation

Fractionation refers to and describes the physical or chemical properties or methods that are used to remove metals from a soil (Templeton et al., 2000). In this thesis the term operationally defined fraction (ODF) refers to the metals removed from a soil using a specific selective extractant. For instance, the use of water or 0.01M CaCl_2 is often used to describe the “bioavailable” soil fraction. In effect these should be described as the water-soluble ODF or the 0.01M CaCl_2 ODF and can only be referred to as a “bioavailable” fraction when a specific biotic endpoint (e.g., the earthworm species *Eisenia. Fetida*) has total body tissue metal concentrations that correlate with either of the aforementioned extractants.

5.4.2.1 2 acid aqua regia fraction (commonly and incorrectly referred to as total element concentration)

The static methods used in this assessment will measure the “total” and “water soluble” fractions of these elements. The geochemical abundance index (GAI) quantifies a “total” assay result for a particular element in terms of the average crustal abundance for that element. The index, based on a log (2) scale, is expressed in seven integer increments (0 to 6), which correspond to enrichment factors from 0 to over 96 times average crustal abundance, as shown in **Table 5-3**.

Table 5-3: Geochemical Abundance Index (GAI) values and Enrichment Factor

GAI	Enrichment factor	GAI	Enrichment factor
0	Less than 3-fold enrichment	4	24 – 48 fold enrichment
1	3 – 6 fold enrichment	5	48 – 96 fold enrichment
2	6 – 12 fold enrichment	6	Greater than 96 fold enrichment
3	12 – 24 fold enrichment		

As a general rule, a GAI greater than or equal to three indicates element enrichment to a level that may warrant further investigation (INAP, 20021). This is the case with some environmentally important 'trace' elements, such as As, Cd, Cu and Zn, rather than with major rock-forming elements, such as Ca, Mg, K and Na. Elements identified as enriched may not necessarily be a concern for revegetation, drainage water quality or public health, but their significance should still be evaluated. Similarly, because an element is not enriched does not mean it will never be a concern, because under some conditions (e.g., low pH) the solubility of common environmentally important elements such as Al, Cu, Cd, Fe and Zn increases significantly.

5.4.2.2 Water soluble fraction

A 1:5 (solid:solute) or more concentrated deionised water leach test at 1:3 or 1:2 ratio can be used to measure the pH, EC, and the concentration of major ions and trace metals/metalloids in water extracts. It should be recognised that direct comparison of geochemical data from water extracts with guideline values can be misleading. RGS prefer to evaluate the solubility of metals/metalloids and major ions in leachate from mining wastes and rejects using kinetic leach column testing that generally provides an indication of the rate of weathering and associated concentration/release rate of elements in the leachate over time under controlled laboratory conditions.

6 Results

6.1 Net acid producing potential

The net acid producing potential was calculated using the acid base account (ABA) results for the 63 soil, mine waste, and tailings samples (**Table 6-1**).

Table 6-1: Summary ABA results

	Soil			Mine waste			Tailings		
	Min.	Med.	Max.	Min.	Med.	Max.	Min.	Med.	Max.
pH (1:5)	4.8	5.1	6.0	3.4	4.6	7.6	3.0	6.1	9.3
EC (1:5) (µS/cm)	12	31	50	11	22	209	4	445	2,820
TS (%)	< LoR	< LoR	0.02	< LoR	0.05	0.11	< LoR	0.08	0.58
CRS (%)	-	-	-	-	-	-	0.012	0.036	0.255
ANC kg H ₂ SO ₄ /t	2.8	3.5	14.3	1.0	3.3	12.9	2.0	4.8	13.9
MPA _{TS} kg H ₂ SO ₄ /t	0.2	0.2	0.6	0.2	1.5	3.4	0.2	2.5	17.8
NAPP _{TS} kg H ₂ SO ₄ /t	-13.7	-3.3	-2.6	-9.5	-1.6	0.5	-9.7	-2.7	15.5
MPA _{CRS} kg H ₂ SO ₄ /t	-	-	-	-	-	-	0.4	1.1	7.8
NAPP _{CRS} kg H ₂ SO ₄ /t	-	-	-	-	-	-	-6.7	-3.9	2.2

Notes:

1. Min. = minimum, med. = median, max. = maximum

2. CRS = Chromium Reducible Sulfur, ANC = Acid Neutralising Capacity, MPA = Maximum Potential Acidity, NAPP = Net Acid Producing Potential, LoR = limit of reporting.

6.1.1 Total sulfur (TS)

TS is below the laboratory limit of reporting (LoR) to 0.02 %TS in soil, below the LoR to 0.11 %TS with a median of 0.05 %TS in mine waste, and below the LoR to 0.58 %TS with a median of 0.08 %TS in tailings (**Table 6-1**).

6.1.2 Chromium reducible sulfide sulfur (CRS)

CRS in tailings samples analysed is 0.012 to 0.255 %CRS with a median of 0.036 %CRS. The proportion of CRS in TS is 11 to 76 % with a median of 56 %.

6.1.3 Maximum potential acidity (MPA)

The maximum potential acidity (MPA) is the sum of the total actual acidity (TAA) and potential acidity (PA).

6.1.3.1 Total actual acidity

Total actual acidity can be divided into soluble acidity (pH) and retained acidity.

- Soluble acidity is defined as acidity measured using a 1:5 (soil:water) extract (pH)
- Retained acidity is defined as the acidity that is not recorded in such an extraction however, there is no clear-cut distinction between soluble acidity and retained acidity because part of the retained forms of acidity can be released during successive extractions with water.

Soluble acidity can be subdivided into active soluble acidity and buffered acidity.

- Active soluble acidity accounts for the activity of hydrogen ions (H^+) (pH)
- Buffered soluble acidity accounts for other soluble acidic cations (mainly Fe^{2+} , $AlSO_4^+$ and Al^{3+}) that can produce hydrogen ions when they hydrolyse.

Terms used to define pH can include the following (**Table 6-2**).

Table 6-2: pH concentrations and terms used to describe pH

pH	Term
< 2	Very strongly acid
2 to 3	Strongly acid
3 to 4	Moderately acid
4 to 5.5	Mildly acid
5.5 to 7.5	Circum-neutral
7.5 to 8.5	Mildly alkaline
8.5 to 9.5	Moderately alkaline
9.5 to 10.5	Strongly alkaline
> 10.5	Caustic

The soluble acidity measured using pH_{1:5} in soil is mildly acid to circum-neutral (**Table 6-2**). Mine waste is moderately acid to mildly alkaline. Tailings are moderately acid to moderately alkaline; there is no significant correlation across the tailings samples between pH and depth, however, the four samples with the highest pH values (> 9.0) are from 1.0 – 2.0 mbgl. This could be attributed to variations in the ore during processing.

The exchangeable and retained acidity were not measured in this assessment.

6.1.3.2 Potential acidity

The potential acidity (PA) is the acidity that would be produced if all of the sulfide minerals in a sample were to oxidise and produce acid: it is assumed that the sulfide mineral is pyrite.

The PA can be calculated from total sulfur (TS) or from sulfide sulfur measured using the chromium reducible sulfur method (CRS).

The PA calculated from TS (PA_{TS}) is 0.2 to 0.6 H_2SO_4/t with a median of 0.2 H_2SO_4/t in soil, 0.2 to 3.4 H_2SO_4/t with a median of 1.5 H_2SO_4/t in mine waste, and 0.2 to 17.8 H_2SO_4/t with a median of 2.5 H_2SO_4/t in tailings. When derived from CRS the PA is 0.4 to 7.8 H_2SO_4/t with a median of 1.1 H_2SO_4/t in tailings.

For this assessment $PA = \text{Maximum potential acidity}$.

6.1.4 Acid neutralising capacity (ANC)

The ANC is 2.8 to 14.3 H_2SO_4/t with a median of 3.5 H_2SO_4/t in soil, 1.0 to 12.9 H_2SO_4/t with a median of 3.3 H_2SO_4/t in mine waste, and 2.0 to 13.9 H_2SO_4/t with a median of 4.8 H_2SO_4/t in tailings. The measured ANC values are all very low (negligible) and provide very little buffering capacity.

6.1.5 Mineralogy

Four composite samples were analysed for (semi)-Quantitative X-Ray Diffraction (QXRD) and clay speciation. Mineralisation in all samples includes clay (Illite) and silicate (Quartz, Orthoclase), as the dominant phases. Significant amounts of Albite and Kaolinite were also detected (Table 6-3).

Table 6-3: QXRD mineral percentage

Sample ID	2022095_C001	2022095_C002	2022095_C003	2022095_C004
Sample description	Soil	Mine waste	Tailings	Tailings
Phase	Weight %			
Albite	6.7	7.3	2.4	3.9
Ankerite	0.1	0.4	-	-
Calcite	-	0.5	-	0.1
Goethite	0.7	1.7	1.3	1.4
Illite	14.9	28.5	19.6	30.2
Kaolinite	3.6	3.9	4.1	6
Maghemite	-	0.1	-	-
Orthoclase	8.1	15	9.9	11.3
Montmorillonite	4.5	2.8	0.6	0.5
Pyrite	0.4	0.3	0.2	0.4
Quartz	59.8	37.9	61.8	45.8
Rutile	1.2	1.6	0.1	0.4

6.1.6 Net acid producing potential (NAPP)

The calculated NAPP values derived from TS ($NAPP_{TS}$) are -13.7 to -2.6 H_2SO_4/t with a negative median of -3.3 H_2SO_4/t in soil, -9.5 to 0.5 H_2SO_4/t with a negative median of -1.6 H_2SO_4/t in mine waste, and -9.7 to 15.5 with a negative median of -2.7 H_2SO_4/t in tailings.

The calculated NAPP values derived from CRS ($NAPP_{CRS}$), is -6.7 to 2.2 H_2SO_4/t with a negative median of -3.9 H_2SO_4/t in tailings.

6.1.7 Neutralisation potential ratio (NPR)

The NPR is the ratio between ANC and MPA. The NPR for when derived from TS is 18.3 to 26.1 in soil, 0.9 to 23.5 in mine waste, and 0.1 to 23.5 in tailings. When derived from CRS, the NPR is 0.7 to 12.5 in tailings.

Figure 6-1 and **Figure 6-2** show the ANC versus MPA (TS/CRS) for the samples. NPR lines have been plotted on the graph to illustrate the factor of safety associated with the samples in terms of potential for generation of AMD. Generally, samples with an NPR of greater than 2 and/or sulfur value less than or equal to 0.2 %TS/CRS are considered to represent material with negligible/low risk of acid generation and high factor of safety in terms of potential for AMD (COA, 2016a; INAP, 2021).

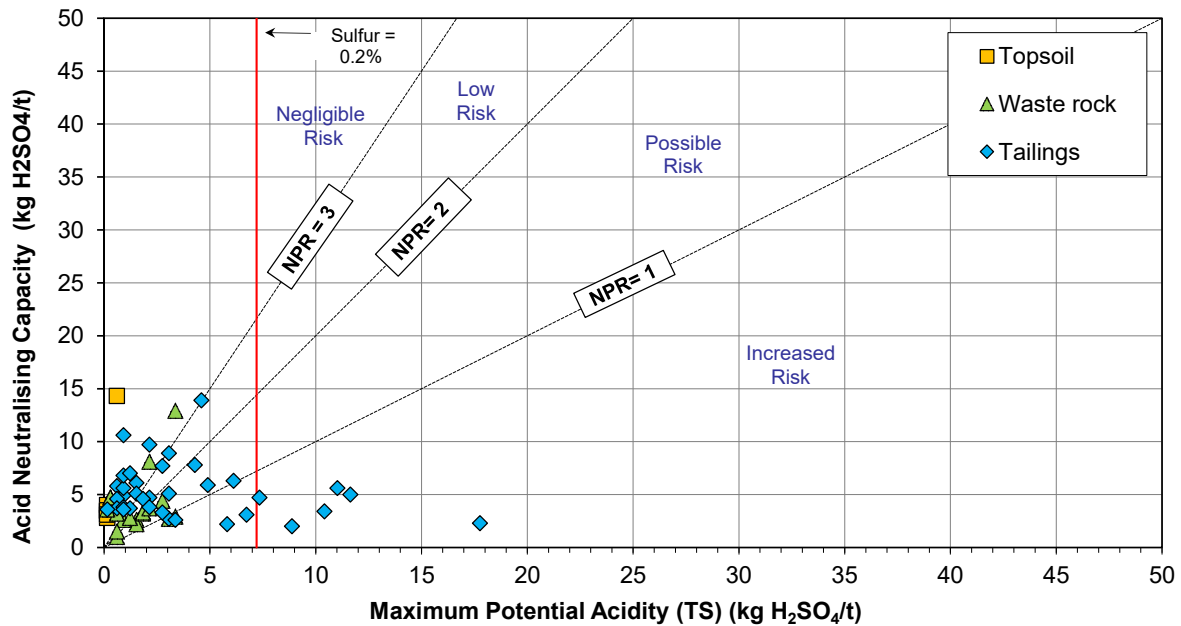


Figure 6-1: MPA_{TS}, ANC_T and NPR values for the soil, mine waste, and tailings samples

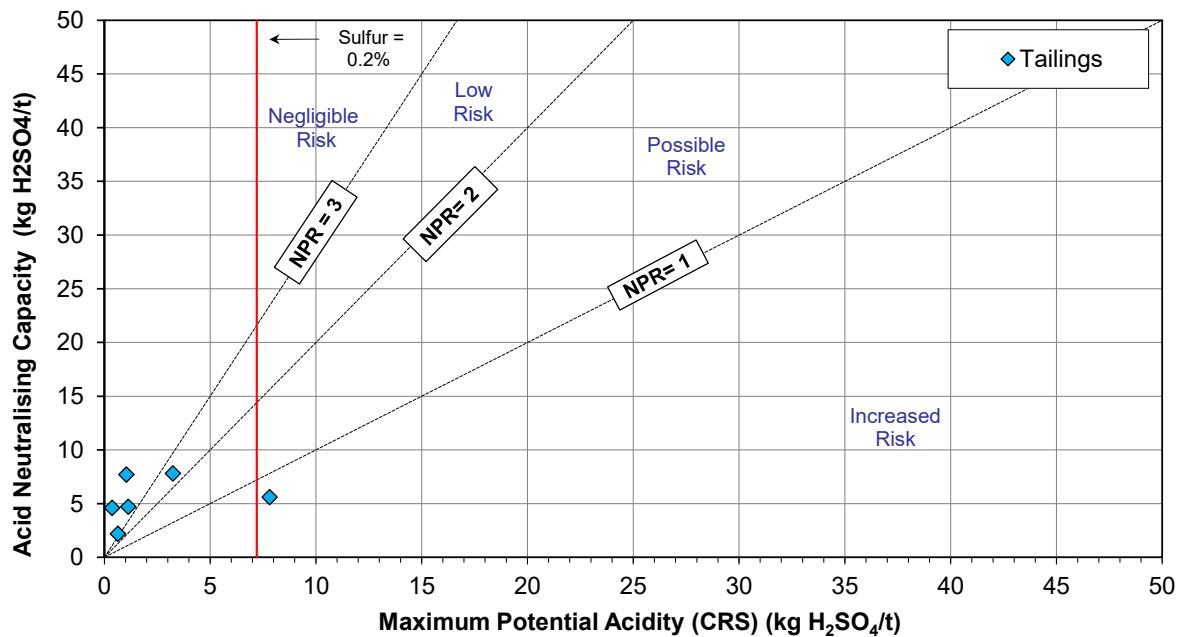


Figure 6-2: NPR for tailings using CRS

Soil and mine waste meet the above criterion and therefore have a high factor of safety and a low to negligible risk for acid generation. Ten tailings samples have an NPR of < 1; six of those samples have a TS value > 0.2 %TS and are therefore considered to have an increased risk for acid generation.

When using CRS, one of the six tailings samples analysed were considered to have an increased risk for acid generation.

6.1.8 Net acid producing potential (NAPP) classification

The criteria used by RGS to classify acid drainage potential use six NAPP classes and pH. For mine waste and tailings if the pH is < 4.5 then the samples are considered to be Acid Forming regardless of the NAPP. For soil, the samples are considered to be Acid Forming only if the soil pH is < 3.5. Soils with a pH of 4.5 to 5.5 may have minor soil quality issues related to Al and Mn ecotoxicity, and are not considered acid forming. The number of soil, mine waste, and tailings samples in each class is in **Table 6-4**. The geochemical classification represented by samples received verifies that soil is NAF to NAF_{LC}, mine waste is NAF_{LC} to PAF_{LC}, and tailings are predominantly NAF_{LC} to PAF_{LC}, with one sample classified as PAF.

Full acid base account results are in **Section 11.2.1 to 11.2.3**.

Table 6-4: Geochemical classification

Geochemical classification	NAPP _{TS}	Soil (n = 6)	Mine waste (n = 21)	Tailings (n = 36)
	(kg H ₂ SO ₄ /t)			
Acid consuming	< -100			
NAF	> -100 to < -10	1		
NAF (Low Capacity)	> -10 to < 0	5	10	19
Potentially Acid Forming (PAF) (Low Capacity)	> 0 to < 10			3
PAF	> 10 to < 50			
Acid forming (AF)	> 50		11	14

6.2 Saline drainage potential

Saline drainage potential is associated with the relative contributions of soluble sodium-based minerals such as sodium chloride and/or sodium bi-carbonate, the oxidation of sulfide minerals (e.g., pyrite) releasing sulfate and sulfate-based mineral dissolution from minerals such as gypsum, barite, or alunite and presence of soluble calcium and or magnesium.

6.2.1 Electrical conductivity_{1:5} (EC_{1:5})

The EC_{1:5} measures the concentration of dissolved major ions in water. The EC_{1:5} in soil is 12 to 50 µS/cm, mine waste 11 to 209 µS/cm, and tailings 4 to 2,820 µS/cm (median 445 µS/cm) (**Table 6-1**).

Soil has a very low hazard ranking for saline drainage potential, mine waste has a very low to low hazard ranking, and the majority of tailings have low to moderate hazard ranking (**Table 6-5**). The tailings sample with an increased hazard ranking is the sample geochemically classified as PAF.

Table 6-5: Saline drainage classification

Electrical conductivity (µS/cm)	Saline drainage hazard ranking	Soil (n = 6)	Mine waste (n = 21)	Tailings (n = 36)
> 2500	Increasing hazard	-	-	1
> 500 to < 2500	Moderate hazard	-	-	17
> 100 to < 500	Low hazard	-	5	16
< 100	Very low hazard	6	16	2

6.2.1.1 Sulfate drainage potential

Sulfate drainage potential refers to the potential of mine materials to generate acid drainage as a result of the oxidation of sulfide minerals. The concentration of soluble sulfate (SO₄²⁻) can be an indicator of sulfate drainage potential. Of the 12 samples (soil, mine waste, and tailings) analysed for water-soluble multi-element analysis (1:3 solid:water), EC is dominated by SO₄²⁻ (R² = 0.9459) compared to other dissolved ions in the samples. All samples were classed as low risk (< 1,000 mg/L) for sulfate drainage potential.

The low sulfate values suggest that the ions have weathered out of the samples; as surface material is exposed to oxygen and water allowing oxidation of sulfide minerals and release of sulfate.

6.3 Metalliferous drainage potential

6.3.1 Whole rock metal(loid)s

Whole rock multi-element analysis quantified the concentrations of 49 elements on six tailings samples. To provide context in line with mining industry guidelines, the multi-element results were compared to the typical background concentrations (median crustal abundance) of the metal(oids) in unmineralised soils (Bowen, 1979; COA, 2016a; and INAP, 2021).

The extent of enrichment is reported as the Geochemical Abundance Index (GAI), which relates the concentration in a sample with the median crustal abundance on a $\log_{10}$ scale. The GAI is expressed in integer increments, where a GAI value of 0 indicates that the element is present at a concentration less than, or similar to, the median crustal abundance; and a GAI value of 6 indicates approximately a 100-fold enrichment above median crustal abundance.

Elements identified as enriched using the GAI may not necessarily be a concern for revegetation and water quality and the following points should be noted:

- The median crustal abundance varies between literature sources, therefore effecting the calculated GAI values.
- If a sample is enriched relative to the median crustal abundance, there is no direct correlation that the sample will also leach metal(oids) at elevated concentrations. The mobility of metal(oids) is dependent on mineralogy, adsorption/desorption, and the environment in which it occurs.

Similarly, because an element is not enriched does not mean it will never be a concern, because under some conditions (e.g., low pH) the solubility of common environmentally important elements such as Al, Cu, Cd, Fe, and Zn can increase significantly.

Figure 6-3 shows elements that are enriched ($\text{GAI} \geq 3$) when compared to unmineralised soils in the tailings.

The enrichment of arsenic, antimony, gold, silver, and tellurium are expected since these elements are associated with gold mineralisation and are often found in the same ore deposits as gold.

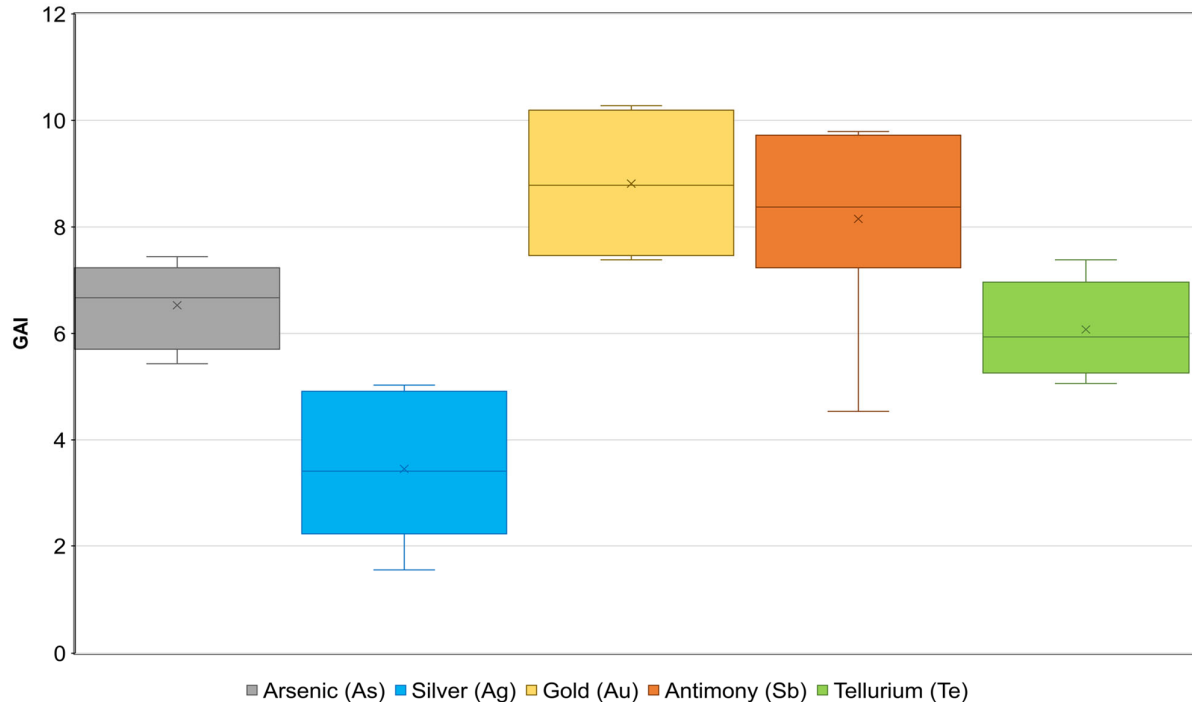


Figure 6-3: Box and whisker plot for elements ≥ 3 (GAI) from tailings

The potential mobility of elements in water extracts is discussed in **Section 6.3.2**; water soluble analysis verified that arsenic is water soluble in tailings.

6.3.2 Water soluble metal(loid)s

Water soluble multi-element analysis (1:3 solid:water) quantified the concentrations of 49 metal(loid)s on water extracts from the soil, mine waste, and tailings samples to provide an indication of the environmental mobility and degree of risk associated with major, minor, and trace elements from material represented by the samples. Tabulated results for water soluble metal(loid)s are in **Section 11.2**. **Figure 6-4** shows relevant elements with values above the laboratory limit of reporting (LoR). Antimony and arsenic are enriched in the water extracts from tailings and pose the highest risk of metalliferous drainage potential **Figure 6-4**.

6.3.2.1 Soil

The shake flask extraction (SFE) 16-hr, 1:3 water soluble metal(loid)s in soil are low with most of the results below the relevant LoR. The concentration of the elements above detection represent optimal conditions for rehabilitated land i.e., water soluble arsenic in the soil was 0.007 to 0.036 mg/L which is in the same range as freshwater aquatic ecosystem guideline values.

6.3.2.2 Mine waste

The SFE 16-hr, 1:3 water soluble metal(loid)s in the mine waste are above the soil concentrations, but in the low to moderate range with most of the results below the relevant LoR. The mine waste samples are about one order of magnitude higher than the soil.

6.3.2.3 Tailings

The SFE 16-hr, 1:3 water soluble metal(loid)s in the tailings are enriched and one to two orders of magnitude higher than the mine waste and soil. The arsenic and antimony concentrations are particularly elevated and are attributed to the long term oxidation and weathering of the primary sulfide minerals that has released these elements into more mobile fractions (**Figure 6-4**).

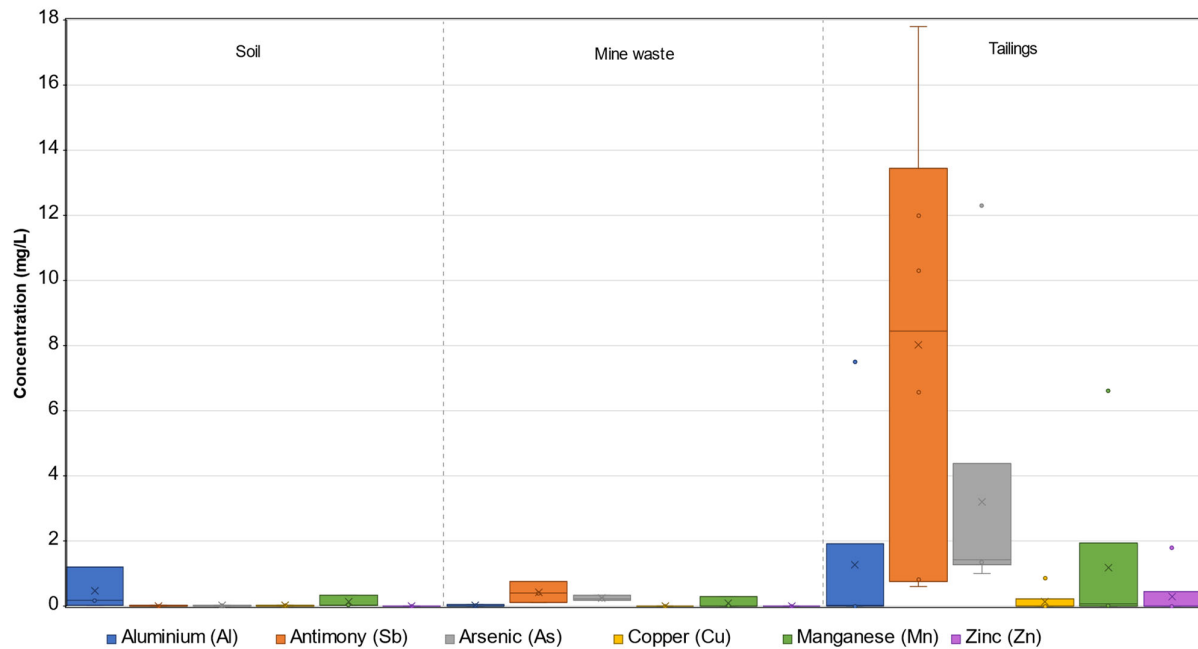


Figure 6-4: Box and whisker plot for water soluble metal(loid)s

6.4 Soil fertility results

The soil fertility results are provided for soil, mine waste and tailings (**Table 6-6**). Key soil quality findings are that the ESP and EC is low in all samples, total nitrogen is rate limiting for growth and there is no deficiency of Cowell fractionated phosphorous (**Figure 6-5**).

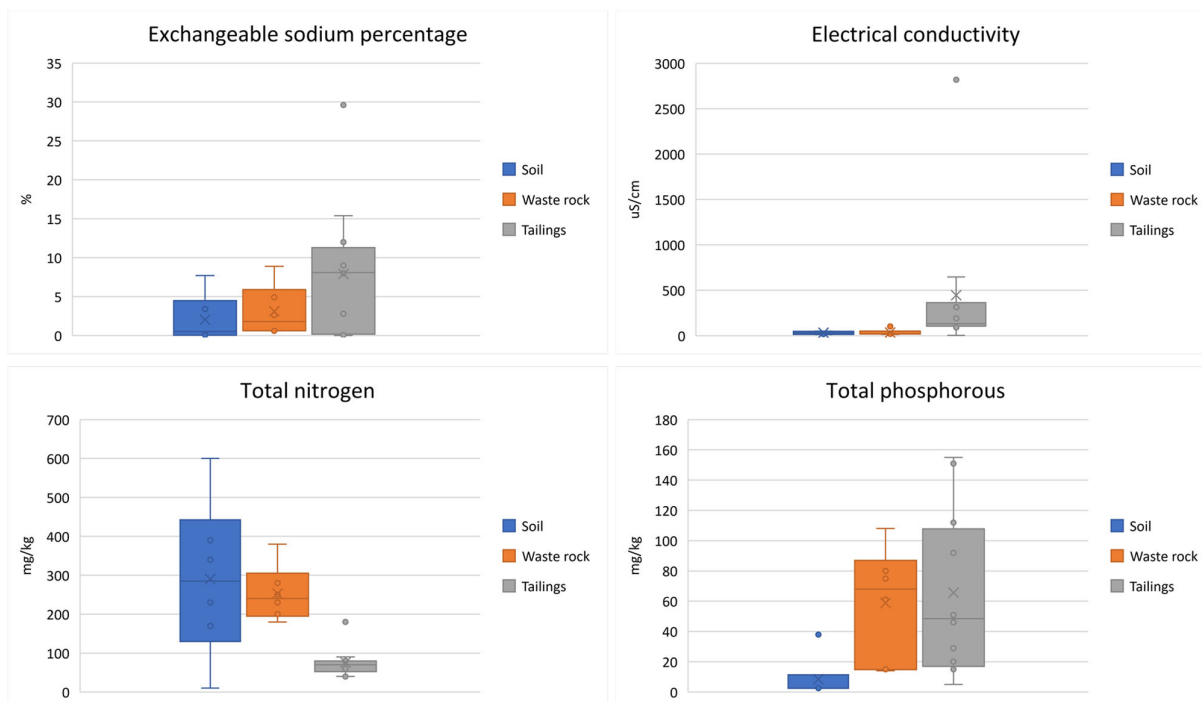


Figure 6-5: Soil quality parameters for soil, mine waste (aka waste rock, and tailings)

Table 6-6: Soil fertility results

RGS Sample Number →		2022095_0001	2022095_0002	2022095_0003	2022095_0004	2022095_0005	2022095_0006	2022095_0002	2022095_0003	2022095_0013	2022095_0015	2022095_0020	2022095_0022
Sampling Date →		13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022
ALS Laboratory ID →		EB2237627001	EB2237627002	EB2237627003	EB2237627004	EB2237627005	EB2237627006	EB2237627008	EB2237627009	EB2237627017	EB2237627019	EB2237627023	EB2237627025
Parameters	Limit of Reporting	TS_1 Topsoil	TS_2 Topsoil	TS_3 Topsoil	TS_4 Topsoil	TS_5 Topsoil	TS_6 Topsoil	WRD_2 Mine waste	WRD_3 Mine waste	WRD_13 Mine waste	WRD-S_15 Mine waste	ROM_2 Mine waste	ROM_4 Mine waste
Exchangable Cations		All units meq/100g (except Exchangable Sodium Percentage (%))											
Exchangeable Calcium	0.2	0.2	<0.1	0.4	1.1	0.3	10.1	0.4	1.7	3.6	4.8	0.3	0.2
Exchangeable Magnesium	0.2	<0.1	<0.1	0.2	0.5	0.5	11.6	0.6	0.9	1.6	0.6	<0.1	<0.1
Exchangeable Potassium	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	0.4	0.1	0.2	0.2	0.2	<0.1	0.1
Exchangeable Sodium	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.5	<0.1	<0.1
Cation Exchange Capacity	0.2	0.7	1	1	2	2.3	22.2	6.9	5	6.6	6.5	3.8	5.8
Exchangeable Sodium Percent	0.2	3.4	<0.1	<0.1	0.5	7.7	0.5	1	0.6	0.6	8.9	2.6	4.9
Calcium/Magnesium Ratio	0.2	----	----	2	2.2	0.6	0.9	0.7	1.9	2.2	8	----	----
Magnesium/Potassium Ratio	0.2	----	----	----	----	----	27.8	4.5	5.7	9.3	3.4	----	<0.1
Analyte/Metals													
pH (1:5) (pH)	0.1	5.0	4.8	5.2	5.1	4.9	6.0	4.5	4.9	5.4	5.7	4.2	4.4
EC (1:5) (µS/cm)	1	17	12	27	50	34	48	21	20	14	103	33	22
Moisture Content (%)	1	<1.0	<1.0	<1.0	<1.0	<1.0	4.8	1.3	1.3	1.2	<1.0	1.3	<1.0
Bicarbonate Extractable K (Colwell) (mg/kg)	100	<100	<100	<100	<100	<100	686	258	245	257	242	255	279
Chloride (mg/kg)	10	<10	<10	<10	<10	20	<10	<10	<10	<10	40	<10	<10
Copper (mg/kg)	1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1
Iron (Fe) (mg/kg)	1	10	9	7	17	26	40	77	47	22	86	102	93
Manganese (mg/kg)	1	2	<1	4	9	4	14	2	17	16	16	<1	<1
Zinc (mg/kg)	1	<1	<1	<1	<1	<1	<1	1	3	3	<1	<1	1
Ammonia as N (mg/kg)	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Nitrite as N (Sol.) (mg/kg)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
Nitrate as N (Sol.) (mg/kg)	0.1	5.8	2.6	10	19	5.1	15.4	1.1	1.6	1.3	<0.1	0.4	0.3
Nitrite + Nitrate as N (Sol.) (mg/kg)	0.1	5.8	2.6	10	19	5.1	15.4	1.1	1.7	1.3	<0.1	0.4	0.3
Total Kjeldahl Nitrogen as N (mg/kg)	20	<20	170	220	370	340	580	200	380	180	280	250	230
Total Nitrogen as N (mg/kg)	20	<20	170	230	390	340	600	200	380	180	280	250	230
Total Phosphorus as P (mg/kg)	2	<2	49	73	86	92	1740	437	441	208	483	438	562
Bicarbonate Ext. P (Colwell) (mg/kg)	5	<5	<5	<5	<5	<5	38	75	15	14	61	80	108
Organic Matter (%)	0.5	<0.5	<0.5	0.6	1.1	0.8	1.3	<0.5	0.7	0.6	1.2	<0.5	<0.5
Total Organic Carbon (%)	0.5	<0.5	<0.5	<0.5	0.6	<0.5	0.8	<0.5	<0.5	<0.5	0.7	<0.5	<0.5

RGS Sample Number →		2022095_3001	2022095_3004	2022095_3007	2022095_3010	2022095_3013	2022095_3016	2022095_3019	2022095_3022	2022095_3025	2022095_3028	2022095_3031	2022095_3034
Sampling Date →		13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022
ALS Laboratory ID →		EB2237627028	EB2237627031	EB2237627034	EB2237627037	EB2237627040	EB2237627043	EB2237627046	EB2237627049	EB2237627052	EB2237627055	EB2237627058	EB2237627061
Parameters	Limit of Reporting	TSF_1a Tailings	TSF_2a Tailings	TSF_3a Tailings	TSF_4a Tailings	TSF_5a Tailings	TSF_6a Tailings	TSF_7a Tailings	TSF_8a Tailings	TSF_9a Tailings	TSF_10a Tailings	TSF_11a Tailings	TSF_12a Tailings
Exchangable Cations		All units meq/100g (except Exchangable Sodium Percentage (%))											
Exchangeable Calcium	0.2	2.6	3.2	2.2	0.5	1.5	1.8	2.8	3.2	1.3	16.5	0.7	1.5
Exchangeable Magnesium	0.2	<0.2	0.2	0.2	<0.1	0.2	0.3	<0.2	<0.2	0.2	0.2	<0.1	<0.1
Exchangeable Potassium	0.2	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	0.2	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	0.2	0.4	0.4	0.2	<0.1	0.3	0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	0.2	3.3	4	2.9	3.3	2.6	3	4.2	3.4	2.6	20.1	2.2	1.8
Exchangeable Sodium Percent	0.2	12	9.2	8	8.2	15.4	9	29.6	<0.2	2.8	0.5	<0.1	<0.1
Calcium/Magnesium Ratio	0.2	----	16	11	----	7.5	6	----	----	6.5	82.5	----	----
Magnesium/Potassium Ratio	0.2	<0.2	----	----	----	----	----	----	<0.2	----	----	----	----
Analyte/Metals													
pH (1:5) (pH)	0.1	8.2	6.8	5.9	3.8	4.3	4.6	8.3	8.0	4.0	3.4	3.4	5.7
EC (1:5) (µS/cm)	1	150	191	91	115	133	106	646	314	119	2820	363	4
Moisture Content (%)	1	2.6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.2	1	<1.0	<1.0
Bicarbonate Extractable K (Colwell) (mg/kg)	100	148	123	106	137	<100	104	141	163	209	183	227	226
Chloride (mg/kg)	10	<10	<10	<10	<10	<10	<10	<10	20	<10	30	<10	<10
Copper (mg/kg)	1	<1	<1	<1	5	1	3	<1	<1	<1	4	1	<1
Iron (Fe) (mg/kg)	1	10	19	36	408	307	367	21	13	99	220	168	11
Manganese (mg/kg)	1	2	2	1	5	8	28	2	<1	5	32	3	2
Zinc (mg/kg)	1	<1	<1	<1	2	<1	2	<1	<1	<1	9	1	<1
Ammonia as N (mg/kg)	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Nitrite as N (Sol.) (mg/kg)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate as N (Sol.) (mg/kg)	0.1	0.1	0.2	<0.1	<0.1	<0.1	<0.1	0.2	0.1	<0.1	<0.1	<0.1	0.1
Nitrite + Nitrate as N (Sol.) (mg/kg)	0.1	0.1	0.2	<0.1	<0.1	<0.1	<0.1	0.2	0.1	<0.1	<0.1	<0.1	0.1
Total Kjeldahl Nitrogen as N (mg/kg)	20	70	70	40	60	40	70	80	80	80	180	90	50
Total Nitrogen as N (mg/kg)	20	70	70	40	60	40	70	80	80	80	180	90	50
Total Phosphorus as P (mg/kg)	2	282	194	199	327	274	362	355	170	299	427	429	90
Bicarbonate Ext. P (Colwell) (mg/kg)	5	20	15	46	151	51	95	29	16	92	112	155	5
Organic Matter (%)	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Organic Carbon (%)	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Notes: < indicates less than the laboratory limit of reporting.

6.5 Physical analysis results

6.5.1 Particle size distribution (PSD) and hydrometer

The dry grading PSD results were done on samples collected from the field. Oversize material (> 75 mm diameter) was excluded from the field samples.

The dry grading results obtained from the combined dry grading and hydrometer analyses (**Figure 6-6**) using the USCS method verify that:

- Soil is classified as a sandy silt
- Mine waste is classified as a gravelly sand
- Tailings is classified as sandy silt (surface tailings) silty clay (deeper tailings)

Table 6-7: Dry grading results for USCS classification

		Soil	Mine waste	Tailings 0 to 0.5 m	Tailings 1.0 to 2.0 m
Fines (clay)	< 0.002mm	4.0	3.0	8.1	26.8
Fines (silt)	> 0.002 mm < 0.075mm	15.0	8.0	42.4	55.7
Fine sand	> 0.075 mm < 0.425mm	23.0	11.0	48.5	10.3
Medium sand	> 0.425 mm < 2.36 mm	45.0	19.0	1.0	3.1
Coarse sand	> 2.36 mm < 4.75 mm	11.0	16.0		3.1
Fine gravel	> 4.75 mm < 19 mm	2.0	27.0		1.0
Coarse gravel	> 19 mm < 75 mm		16.0		
Cobbles	> 75 mm				

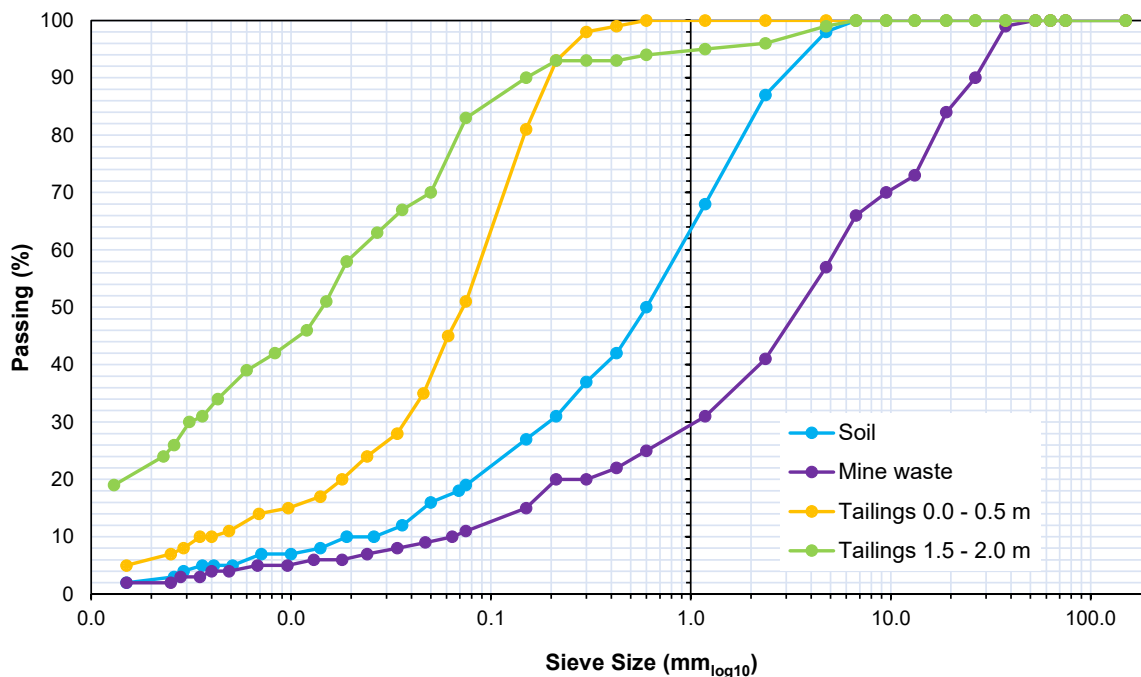


Figure 6-6: PSD and hydrometer

6.5.2 Shrink-swell

The composite samples have a shrink-swell index (SSI) of 0.1 to 0.3 % (**Table 6-8**) and are considered to have low potential for shrinkage and swelling and will have minimal changes in volume when exposed to wetting and drying cycles.

6.5.3 Permeability

The permeability results verify that the samples have low permeability (**Table 6-8**). Materials with low permeability have a high resistance to water flow, reducing seepage potential and improving safety of structures and containment systems, such as tailings dams. Tailings and soil are less permeable than mine waste.

Table 6-8: Shrink-swell and permeability

Sample ID	Material	Depth	Swell (%)	Shrinkage (%)	Shrink swell index (SSI) (%)	Permeability K_{20} (m/sec)
2022095_C001	Topsoil	0.0 – 0.0	-0.1	0.6	0.3	2.7×10^{-08}
2022095_C002	Mine waste	0.0 – 0.0	-0.2	0.2	0.1	2.0×10^{-06}
2022095_C003	Tailings	0.0 – 0.5	-0.1	0.2	0.1	4.7×10^{-07}
2022095_C004	Tailings	1.5 – 2.0	0.0	0.6	0.3	9.3×10^{-09}

6.5.4 Pin-hole dispersion

Pinhole dispersion analysis classified the soil and tailings composites as highly dispersive. The mine waste composite was classified as completely erosion resistant. Pinhole dispersion tests are performed on < 2.36 mm fraction sized samples, and so do not include larger fraction size particles that may behave differently in terms of erosion resistance and dispersion characteristics.

6.5.5 Soil water characteristic curves (SWCC's)

SWCC's measure the limits of water storage capacity of materials. There is an upper limit (field capacity) and lower limit (permanent wilting point). The point between the limits is the plant available water. Maintaining an appropriate soil moisture content is important for plant growth and the specific needs and conditions of the area.

After rainfall events, infiltration occurs due to gravity, which is referred to as drainage. Soil moisture decreases through this process; the rate that the moisture of the materials decreases is dependent on soil texture class. Typically, soils with a higher clay content retain water for longer. The graphed SWCC for soil, mine waste, and tailings in **Figure 6-7** can be used to understand the water storage capacity and drainage characteristics of the materials, which can be useful in determining their suitability for use or in developing management strategies to optimise their performance.

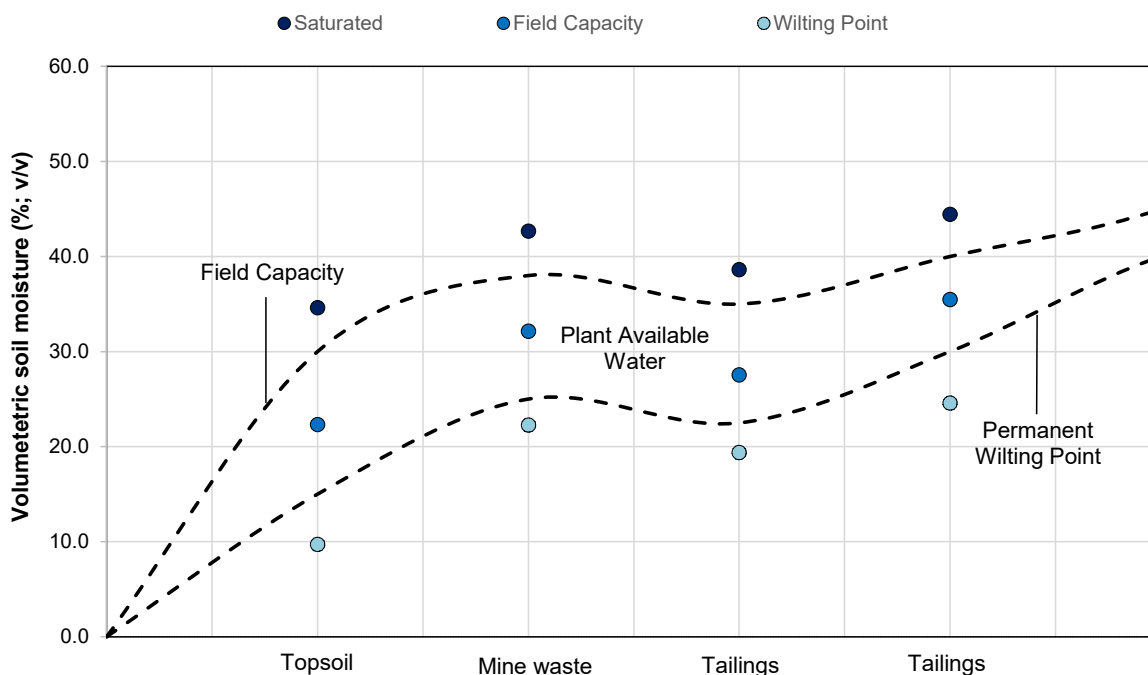


Figure 6-7: SWCC

6.5.6 Salinity, sodicity, and stability

Chemical (EC and ESP) and physical (Emerson aggregate stability and column settlement) data and the application of the data using subjective (e.g., Emerson aggregate stability) and quantitative analysis (e.g. EC and ESP) is required to evaluate erosive potential. The chemical and physical results can provide conflicting results.

6.5.6.1 Electrical conductivity

EC is used as a measure of salinity in solids and water. Soil and mine waste have very low to low EC when classed using the saline drainage classification (**Section 6.2.1**), the majority of tailings samples have low to moderate EC.

6.5.6.2 Exchangeable sodium percentage

ESP is a measure of sodium ions in the sample relative to other cations, higher values of ESP can lead to soil sodicity, reduced soil permeability, and structural stability. Using the Australian Soil and Land Survey Field Handbook (McDonald et al, 1998), the majority of samples are classified as having low to moderate ESP (**Table 6-9**), with two of the tailings samples classed as having high ESP values.

Table 6-9: Exchangeable sodium percentage classification

ESP (%)	ESP classification	Soil (n = 6)	Mine waste (n = 6)	Tailings (n = 12)
> 15	High	-	-	2
> 6 to < 15	Moderate	1	1	5
< 6	Low	5	5	5

6.5.6.3 Rengasamy plot

EC and ESP results are plotted using the Rengasamy et al (1984) soil classification to quantify the potential for dispersion or flocculation and salinity of soil, mine waste, and tailings (**Figure 6-8, Table 6-10**). EC and

All soil samples are class 2A and have dispersive characteristics. Five of the six mine waste samples are class 2A, and one mine waste sample is class 1 and is classified as dispersive. The majority of tailings samples (n = 10) are classes as dispersive class 1 and 2. Two tailings samples are class 3 and are classified as non-dispersive.

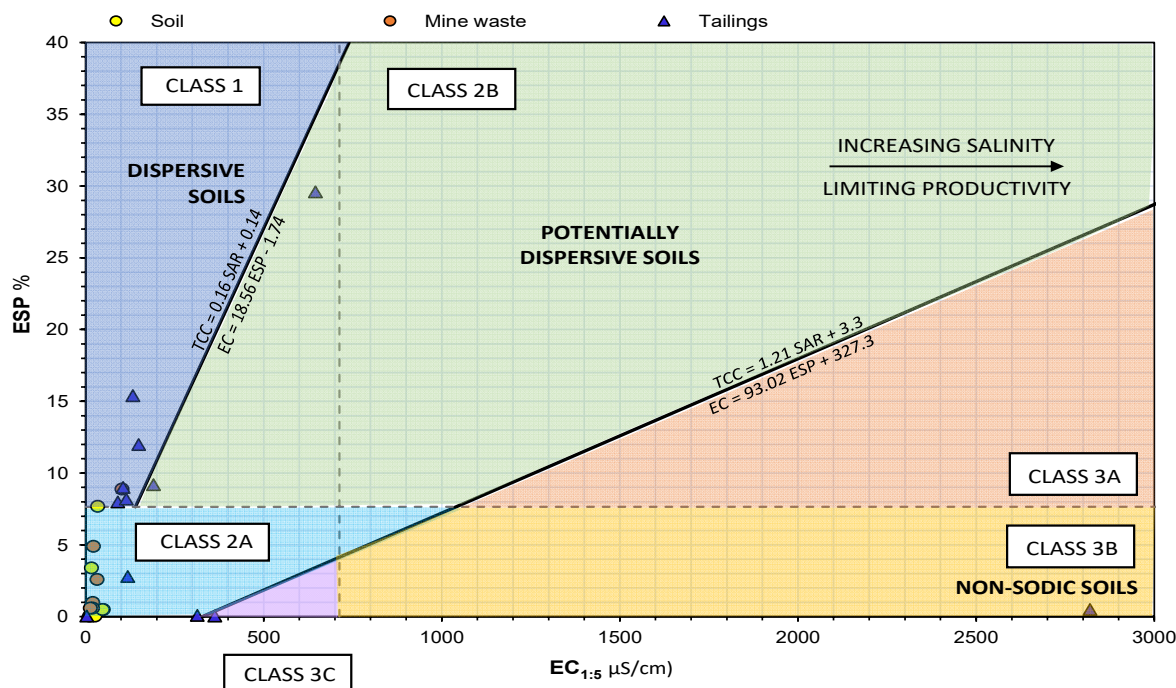


Table 6-10: Rengasamy aggregate class description

Class	Rengasamy aggregate class description
1	Soils which disperse spontaneously
2	Soils which disperse after mechanical shaking are potentially dispersive
2A	Soils from the A-horizon of red-brown earths with a sodium absorption ratio (SAR) of less than 3 and which mechanically disperse, require an electrolyte concentration of $(1.21\text{SAR} + 3.3) \text{ m.e. l}^{-1}$ for structural stability. Class 2a soils will have few structural problems if managed using minimum tillage techniques or if maintained under continuous pasture growth.
2B	Surface (A-horizon) soils with a SAR above 3 require an electrolyte level similar to class 2a soils in order to maintain flocculation. Unlike class 2a soils, these soils become spontaneously dispersive (class 1) when leached without the addition of calcium compounds, and if there is no generation of electrolytes in the soils due to mineral weathering (Shainberg et al. 1981).
3	When soils have more than the minimum required electrolyte levels (as defined by equations 3 to 6), they remain flocculated when subjected to rainfall, irrigation or mechanical stress.
3A	If the SAR of a soil is above 3 and its total cation concentration (TCC) exceeds the flocculation value, then it is saline and sodic. Leaching with good quality water may change a saline-sodic soil to class 2b (e.g. Quirk 1971), or on extreme leaching to class 1. The soil may consequently disperse and cause severe crusting
3B	These soils have no physical problems, and their leaching requirements depend on the salt tolerance of the crops to be grown.
3C	When the SAR is less than 3 and the TCC is ideally similar to the flocculation level, there are no dispersion or salinity problems.

6.5.6.4 Emerson class

Soil descriptions of composite samples analysed for the Emerson Aggregate Test (EAT) are in **Table 6-11**. Soil has an Emerson class number of 3 and is described to have some dispersion characteristics at Field Capacity water content (**Table 6-12**). Tailings has an Emerson class number of 2 and is described to have slaking and some dispersive characteristics. Mine waste also has an Emerson class number of 2; pinhole dispersion analysis classed mine waste as completely erosion resistant, indicating the material has characteristics contributing to its stability such as low clay content, as found in the PSD results.

Table 6-11: Emerson class results

Sample ID	2022095_C001	2022095_C002	2022095_C003	2022095_C004
Material	Soil	Mine waste	Tailings	Tailings
Depth (m)	0.0 – 0.0	0.0 – 0.0	0.0 – 0.5	1.5 – 2.0
Description	Clayey SAND – brown	Silty Sandy GRAVEL with cobbles – pale brown	Silty SAND – pale brown/yellow	Sandy SILT – pale brown/white
Emerson class number	3	2	2	2

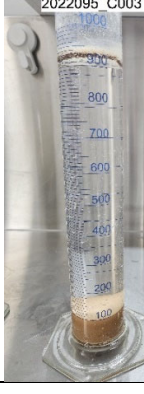
Table 6-12: Emerson class descriptions

Class	Emerson aggregate class description
1	Slaking, complete dispersion
2	Slaking, some dispersion
3	Dispersion after remould at water content equivalent to Field Capacity
4	Carbonate or gypsum present
5	Dispersion (DP $\geq$ 6) after 1:5 soil-to-water suspension
6	Complete flocculation (DP $<$ 6) after 1:5 soil-to-water suspension
7	No dispersion (slaking or swelling)
8	No dispersion (no slaking or swelling)

6.5.6.5 Settling columns

Settling column tests were performed at the RGS laboratory to understand how particles in the material settle out of suspension from water. Large and heavy sand particles will settle quicker than small and light clay particles. Column settlement for soil, mine waste, and tailings shown in **Table 6-13** is consistent with the Emerson results (**Section 6.5.6.3**).

Table 6-13: Settling columns

Time	Soil Mine waste		Tailings	
0 hour				
1 hour				
48 hours				

7 Proposed rehabilitation and closure plan

The Alice River Mine site is small with very low volumes of mine waste, low grade ore, and tailings that require management. The depth of the tailings dam is less than 2.5 m and the geochemical properties of the mine waste are all considered to be low risk.

7.1 Mine waste and tailings dam rehabilitation overview

Standard approaches to rehabilitate PAF tailings in a tailings dam are to construct soil cover systems that aim to minimise the movement of air and water into and through the tailings to minimise sulfide oxidation and the development of acid conditions. These are typically built in layers that range from a simple soil cover placed over mine waste through to multi-layered covers that can include graded rock capillary breaks, and or geo-synthetic materials.

The principle applied to the rehabilitation of the tailings at the Alice River Mine is to utilise neutralisation and in-situ remediation to convert acid forming (AF) tailings into non-acid forming (NAF) tailings that can support vegetation. In-situ remediation trials undertaken at Mount Carrington in NSW (Maddocks, 2009) were viewed by the International Network for Acid Prevention (INAP) board members in 2022 and were described as leading industry practice. This approach is viable because the tailings have low actual acidity (requiring small amounts of neutralising material) and low residual total sulfur content (minimum, average and maximum values of 0.005, 0.126 and 0.58 TS%) sulfide content (0.012, 0.078 and 0.255 CRS%) and the tailings profile is very shallow (<2.5 m deep).

7.2 Available material balance and geochemical classification

There is approximately ~ 5,700 m³ of soil available for tailings dam rehabilitation that would enable 0.2 m of topsoil to be added to the tailings cover.

The mullock dump is estimated to contain ~1,650 m³ of material. The AF material has low MPA and low ANC and the material is therefore not projected to produce substantially more actual acidity.

The low grade ore stockpile(s) contains ~3,000 m³ of material and is approximately 50% NAF_{LC} and 50% AF material. The AF material has low MPA and low ANC and the material is therefore not projected to produce substantially more actual acidity.

The tailings dam (TD) has a small earthen embankment of about 2.5 m height, is 2.87 Ha in area, and is estimated to contain ~8,750 m³ of tailings solids and a storage capacity of 31,800 m³. The tailings are classified as NAF_{LC} (~ 75%) and PAF_{LC} (~ 25%): some of the deeper tailings is more likely to be PAF. The TS was measured at BDL to 0.58% with an average of 0.12% and sulfide sulfur was measured sulfide concentration was present at 0.012 to 0.255%. The low sulfide sulfur concentrations verify that the potential for acid drainage from the tailings is unlikely. However, the soluble concentrations of antimony and arsenic do verify that these elements could be leached from the tailings.

7.3 Neutralisation of the actual acidity in the tailings and mine waste

The mine waste and tailings contain Acid Forming (AF) material. The material becomes AF because the sulfide minerals oxidise and produce acid, the acid consumes the neutralising minerals in the mine waste and tailings matrix and when the acid neutralising minerals have been consumed the materials then become acidic: the higher the sulfide content in the material the higher the actual acidity concentration will become.

The AF tailings and mine waste do not have significant actual acidity (based on the measured pH); the actual acidity concentration can be verified by getting the actual acidity measured (refer to **Section 6.1.3.1**). The measured actual acidity concentration is then used to calculate the neutralisation requirement.

To remediate the AF tailings and mine waste, RGS recommend adding a controlled amount of calcium hydroxide and calcium carbonate to neutralise the actual acidity and provide additional buffering so that any potential acid produced from the residual sulfide mineral material does not become acidic in the future. The specific application rate will be defined in proposed KLC analysed in Q3 2023.

With a neutralised bed of tailings and mine waste on the top of the tailings dam it is then possible to place a shallow soil and rock cover over the tailings dam to develop a safe, non-polluting, stable landform.

7.4 Proposed movement and management of mine waste, tailings, and soil

The AF mine waste is proposed to be picked up and moved to the TSF using 20 tonne (40m³) dump trucks.

The (small) amount of proposed neutralant (combined Ca(OH)₂ and CaCO₃) required to neutralise the actual acidity would be added to each truck load of mine waste as it moves onto the tailings dam. This could be achieved by getting a backhoe to move the required mass of neutralant from a stockpile into each truck. The precise combination of Ca(OH)₂ and CaCO₃ and the mass required to be added to the tailings will be verified with proposed batch analysis and KLC methods. The long-term viability of the proposed remediation method to neutralise acid and immobilise arsenic (for example) will be verified with KLC analysis.

If the tailings is trafficable (using these trucks) the mine waste and added neutralant would be end tipped in piles over the tailings surface.

A small bulldozer would then spread the mine waste and added neutralant over the surface of the tailings dam. During this process the mine waste would be mixed into the top 0.5 m of the tailings beach. Any large shrubs or trees that would not be broken up and mulched into the surface layer would be pushed to the side of the tailings dam.

Because the soil and mine waste contains sufficient nitrogen, and the tailings contains sufficient phosphorous there should not be a requirement for the addition of fertiliser into the final tailings beach.

The available soil stockpiles would then be hauled on the tailings beach, pushed across the surface, and then ripped (shallow ripper to 0.5m along contour into the final profile. If there is insufficient soil within existing stockpiles, topsoil/subsoil from the pedolith could be recovered from the crest of the open pit.

The landform would be graded to drain from the perimeter embankments to the proposed surface runoff release point. At this location the surface runoff release point would be rock armoured to provide a stable, non-erosive point to dissipate surface flow into the receiving environment.

The surface of the tailings dam can then be fertilised (if required) and seeded to attain the desired land use.

Stock and local fauna should be excluded from the tailings dam if this is feasible as the cover system on the tailings dam should be preserved to the extent possible.

7.5 Basis of the tailings cover design

The in-situ rehabilitation process for the tailings dam and mine waste differs from the standard approach of placing soil and regolith units on top of tailings or waste rock. This is a viable approach because the tailings do not contain significant amounts of pyrite that could oxidise and produce additional acid. This type of approach is referenced in the Office of the Queensland Mine Rehabilitation Commissioner: Research Brief – research scoping and stakeholder feedback: February 2022.

The proposed in-situ cover for the TSF will utilise the following materials.

7.5.1 Cover materials

- **Soil**
 - Site soils have low potential for dispersion and are suitable for incorporation into the tailings to create a soil cover system.
- **Surface mine waste**
 - AF mine waste that contains (or contained) low sulfide mineral concentrations that oxidised and produced acid through to NAF_{LC} mine waste that retains circum-neutral to mildly alkaline pH, low residual ANC_T and unoxidized sulfide minerals, that have the potential to become acid in the future.
- **Tailings**
 - The tailings dam and depth of the tailings is likely to be < 2.5 m
 - The tailings geochemical properties range from NAF_{LC} to AF with low residual sulfide content and PAF_{LC}. Although the actual acidity in the solid tailings mass was not measured the pH range infer that the actual acidity concentration is low range.
 - The tailings are low permeability, with low shrink-swell capacity and high potential to retain soil moisture to support vegetation

- The high proportion of clay size fractions and low permeability of the tailings induces higher runoff relative to percolation and these factors are responsible for the retention of water soluble arsenic and antimony and other metal(lids) in the solid fraction of the tailings matrix.
- Water soluble arsenic and antimony is present in the tailings because of the fine grained nature of the tailings, high clay content and low permeability of water through the tailings. The chemical and physical characteristics of the tailings make it unlikely that these elements are being leached from the tailings dam.
- The actual acidity can be neutralised with $\text{Ca}(\text{OH})_2$ and CaCO_3 to increase the pH of the tailings to 8 to 9 and ensure that any oxidation and acid production in the underlying tailings can be neutralised to maintain neutral to mildly alkaline pH.

7.5.2 Cover design objectives

Neutralise the acid forming (AF) low sulfide bearing tailings with $\text{Ca}(\text{OH})_2$ and CaCO_3 so the soluble and exchangeable Al and Mn that induce root toxicity and necrosis tailings can be precipitated in the tailings cover thereby supporting revegetation.

Co-mingle the AF to NAF_{LC} mine waste into the top 0.5 m of the tailings, to minimise the potential for the mine waste to oxidise and produce additional acidity.

Incorporate soil into the neutralised tailings and rock cover to produce a “soil cover” system that can support vegetation.

Create a low slope on the reshaped surface profile that will direct surface runoff from the perimeter of the tailings dam to a NAF rock armoured release point into the receiving environment.

The surface on the tailings dam that will include exposed rock in-filled with pockets of neutralised tailings and topsoil that will retain moisture and nutrients and support vegetation.

Provide a tailings surface that will resist erosion by surface runoff and wind.

7.5.3 Cover design performance monitoring

The proposed approach for in-situ remediation can be verified with bench scale kinetic leach column analysis, by combining acid tailings with $\text{Ca}(\text{OH})_2$ and CaCO_3 with mine waste and tailings and then leaching the “cover system” with water to verify how it will perform.

The laboratory assessment could be supplemented with field measurements such as k_{sat} using double ring infiltrometer and Guelph Permeameter analysis. For detailed design (± 10 cm) LIDAR data is required for the site to verify the tailings dam surface, the tailings dam void and mine waste material balance to be reclaimed and placed into the TSF. The LIDAR surface would also be used for detailed design drawings. The measured parameters from the field, LIDAR data, and soil quality, geochemical and physical analyses in this report can be used to develop a detailed design and SEEPW numerical cover modelling to forecast future performance (if this is deemed necessary by DES).

7.5.4 Groundwater

Groundwater monitoring is being undertaken at the site to verify groundwater elevations and groundwater quality to determine groundwater conditions. There are currently two groundwater bores, MW03 (upgradient, near Alice Queen pit lake) and MW02 (downgradient from TSF), but several additional bores are being drilled, including upgradient and downgradient of the TSF. Both bores intercepted water < 6m bgl: this must be attributed to the alluvial nature of the strata the bores were developed in and the proximity to the creek. A water sample was also collected from the pit lake. Of the 0.45 μm filtered metal(lids) analysed arsenic and manganese are the primary elements of concern. The pH of the groundwater bores was circum-neutral pH 6.6. and 6.9.

Water quality analyses were done on the 4th and 5th November 2022. The pit lake had an extremely low TDS of 25 mg/L and sulfate < 1 mg/L but arsenic was present at 0.175 mg/L. MW03 near the Alice River pit lake had an elevated TDS of 3,570 mg/L, sulfate < 5 mg/L and arsenic < 0.005 mg/L. This suggests (i) no connectivity between the pit lake and groundwater in MW03 or (ii) the groundwater bore is upgradient of the pit lake, (iii) salinity in the MW03 is dominated by sodium chloride / sodium bi-carbonate as opposed to sulfate,

indicating there is very little sulfate dissolution or sulfide oxidation in the system. MW02 that is down-gradient of the tailings dam has moderate TDS of 720 mg/L and arsenic at 0.839 mg/L. It is possible that the elevated arsenic concentration in the bore downgradient of the tailings dam is coming from the tailings. However the limited dataset for the two bores does not make this initial assumption valid and more bores and additional rounds of groundwater analyses are required to evaluate this.

8 Conclusions

RGS has completed a geochemical and physical assessment of 63 mine material samples (soil (n = 6), mine waste (n = 21), and tailings (n = 36)) from the Alice River Gold Project for AARC Environmental Solutions Pty Ltd. The assessment findings are as follows.

- Soil is mildly acid to circum-neutral. Mine waste is moderately acid to mildly alkaline. Tailings are moderately acid to moderately alkaline (**Section 6.1.3.1**).
- Total sulfur in soil is below the laboratory limit of reporting (LoR) to 0.02 %TS, in mine waste is below the LoR to 0.11 %TS, and in tailings is below the LoR to 0.58 %TS (**Section 6.1.1**). CRS in tailings samples analysed is 0.012 to 0.255 %CRS (**Section 6.1.2**).
- The variation in pH, TS, and CRS within the tailings profile may be attributed to variations in the ore during processing and weathering of the material.
- (semi)-Quantitative X-Ray Diffraction analysis found that mine materials are predominantly comprised of illite, orthoclase, and quartz. Pyrite is present in all samples with weight percentages from 0.2 to 0.4 % (**Section 6.1.5**).
- The neutralisation potential ratio (NPR) (TS) is 18.3 to 26.1 in soil, 0.9 to 23.5 in mine waste, and 0.1 to 23.5 in tailings (**Section 6.1.7**). The majority of samples have a low (negligible) potential to become acid forming, except six tailings samples which are considered to have an increased risk of acid generation.
- Geochemical assessment and classification of the mine waste using the net acid producing potential (NAPP) verifies that all soil samples are Non-Acid Forming (NAF) to NAF (Low Capacity), mine waste samples are NAF (Low Capacity) to Potentially Acid Forming (PAF) (Low Capacity), and tailings are NAF (Low Capacity) to PAF (Low Capacity) with one tailings sample classified as PAF (**Section 6.1.8**).
- Saline drainage hazard ranking assessment and classification verifies that soil has a very low hazard ranking, mine waste has a very low to low hazard ranking, and tailings have a very low to increased hazard ranking, with one (PAF) sample in the increased hazard ranking (**Section 6.2.1**).
- When compared to the median crustal abundance of metal(loids) in unmineralised soils, tailings were enriched ($GAI \geq 3$) in As, Ag, Au, Cd, Cu, Te, Zn, and S (**Section 6.3.1**). Enriched metal(loids) in the tailings are associated with the geology/mineralisation of the deposit.
- Water soluble metal(loids) were low or below the laboratory limit of reporting in soil and mine waste and have a low risk of metalliferous drainage in current conditions. Arsenic and antimony are elevated in the water extracts of tailings (**Section 6.3.2**).

9 Recommendation

Undertaking batch analysis on a combined mixture of NAF and AF tailings, mine waste rock types, soil to verify the mass of $\text{Ca}(\text{OH})_2$ and CaCO_3 that is required to achieve the design objectives of maintaining neutral to mildly alkaline pH and immobilisation of metal(loids) such as arsenic.

This work would occur over a period of 6 to 12 months and be completed before the cover system is constructed at the site.

Kinetic leach column (KLC) analysis is proposed to be done on the combined tailings, mine waste, soil cover material to verify the validity of the proposed cover design.

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11 Attachments

11.1 Attachment A: Acid and metalliferous drainage

The use of consistent terminology is required so the potential for misunderstanding is reduced throughout the project.

Mined materials may include the following.

- Mining waste – mining waste can include overburden, tailings, rejects, low grade ore, process residue.
- Rehabilitation materials – material to be utilised for cover systems and water management drains that could include oxide (e.g. soil, or fully weathered non-consolidated units such as clay that can be free dug without blasting), transition (include oxide and fresh material) or fresh (competent un-weathered rock) geological units.
- Cover materials – material selectively placed within the upper profile of the rehabilitated landform in a cover system. Cover systems are constructed from rehabilitation materials. Cover systems should be designed and constructed to meet specific objectives and design criteria. Chemical and physical characterisation of rehabilitation materials is required to ensure that the cover system will meet the objectives and design criteria.

In Australia, the term Acid and Metalliferous Drainage (AMD) is defined as incorporating acidic metalliferous drainage, neutral metalliferous drainage, and saline drainage (COA, 2016).

Standard industry terms used to classify the net acid producing potential (NAPP) of mined materials include the following.

- AF (Acid Forming) – highly reactive material that can produce acid rapidly (days to weeks).
- PAF (Potentially Acid Forming) - has the potential to produce acid.
- PAF- LC (Potentially Acid Forming - Low Capacity) - has the potential to produce minor amounts of acid.
- NAF (Non-Acid Forming) - will not produce acid but may leach salts and some metals due to the presence of low sulfide bearing material.
- AC (Acid Consuming) – has some acid neutralising capacity (ANC) that will contribute to ongoing acid neutralisation e.g. calcite in Basalt.

General industry terms that can be used to describe water quality at mines include the following.

- Acid Mine Drainage.
- Acid Rock Drainage.
- Acid and Metalliferous Drainage.
- Neutral Mine Drainage.
- Saline Drainage.
- Mine Impacted Water.

Water on mines includes surface water and groundwater. Groundwater can be considered as water that is present in non-mined ground that has the potential to enter pits (operational pits, backfilled pits or decommissioned pits). After groundwater enters a pit, it will become mine impacted water. Mine impacted water could leave a pit and enter the groundwater system in the receiving environment or become surface water that may then be pumped from the pit. Surface water is present in dams, creeks, and process plants. Seepage from landforms can drain to groundwater or it may appear as resurgent seepage to surface water.

The term mine impacted water is used as a general term to describe water which contacts disturbed ground and that may include water in:

- Seepage from waste rock dumps or low-grade ore stockpiles (in-pit or ex-pit);
- Operating pits;
- Decommissioned pits; and

- Back-filled pits.

Mine impacted water can be classified as having:

- Acid, neutral or alkaline pH;
- Variable concentrations of major ions (salts e.g. calcium, magnesium, potassium, sodium, chloride, sulfate, boron or fluoride); and
- Variable concentrations of metals (e.g. Al, Fe, Mn and Zn) or metalloids (e.g. Mo, Se and V) with the concentrations often linked to pH.

Potential sources of acid in mine impacted water at mine sites can include the following.

- Oxidation of sulfide minerals such as pyrite that produce sulfuric acid (INAP, 2009).
- Rainfall and leaching of cations such as calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^+) and sodium (Na^+) that reduce soil pH by atmospheric carbonic, nitric or sulfuric acid.
- Organic matter decay.

Potential sources of salts in mine impacted water at mine sites that can include the following.

- Oxidation of sulfide minerals, the production of sulfuric acid and subsequent neutralisation reactions that mobilise major ions such as sulfate (SO_4^{2-}) and calcium.
- Chemical weathering of adjacent soil and rock by sulfuric acid that releases major ions such as sodium, potassium, magnesium and chloride.
- The mobilisation of sodium chloride (NaCl) or sodium bi-carbonate (NaHCO_3) that are present within geological units and groundwater and then released in fluxes as mined materials are extracted (blasted), processed (crushed) and placed into mine landforms.

Potential sources of metals (e.g. Al, Fe, Mn, and Zn) and metalloids (oxyanions such as Mo, Se and V) in water at mine sites can include elements present:

- As ancillary minerals within primary sulfide minerals like pyrite or marcasite;
- In the solid phase of geological units in a range of minerals; and
- In pore water.

Pathways by which AMD is mobilised

AMD is mobilised by water and is transported from the source materials along aqueous physical pathways into the receiving environment. The salts, metals and metalloids in aqueous phases can be taken up by aqueous flora and fauna via aqueous biophysical pathways.

Salts, metals, and metalloids present as exchangeable or less soluble fractions (e.g., carbonate or oxide fractions) can also be relocated via physical pathways in the aqueous environment as suspended sediment or bedload sediment.

Salts, metals, and metalloids present in soluble or exchangeable fractions within mined material or process waste can also be taken up by plants via terrestrial biophysical pathways.

Wind borne erosion is another pathway whereby salts, metals and metalloids can be moved from the source to the receiving environment.

11.2 Attachment B: Soil quality, geochemical and physical results

11.2.1 Attachment B1 Acid base account results - tailings

ALS Lab ID	Client Sample ID	Sample Lithology	H ⁺ (M)	pH (1:5)	EC (1:5) (µS/cm)	Total S (%)	Scr (%)	Scr Proportion (%)	ANC	MPA	NAPP	ANC (Scr)	MPA(Scr) (kg H ₂ SO ₄ /t)	NAPP (Scr)	ANC: MPA Ratio	NAPP _{rs} Classification	Geochemical Classification
EB2237627056	TSF_10b	Tailings	0.001	3.00	854	0.1			2.7	3.1	0.4	2.7			0.9	PAF (LC)	AF
EB2237627051	TSF_8c	Tailings	0.000630957	3.20	1,380	0.29			2	8.9	6.9	2.0			0.2	PAF (LC)	AF
EB2237627059	TSF_11b	Tailings	0.000630957	3.20	726	0.11			2.6	3.4	0.8	2.6			0.8	PAF (LC)	AF
EB2237627050	TSF_8b	Tailings	0.000398107	3.40	1,480	0.22			3.1	6.7	3.6	3.1			0.5	PAF (LC)	AF
EB2237627055	TSF_10a	Tailings	0.000398107	3.40	2,820	0.58			2.3	17.8	15.5	2.3			0.1	PAF	AF
EB2237627058	TSF_11a	Tailings	0.000398107	3.40	363	0.09			3.3	2.8	-0.5	3.3			1.2	NAF (LC)	AF
EB2237627047	TSF_7b	Tailings	0.000316228	3.50	1,290	0.19	0.021	11%	2.2	5.8	3.6	2.2	0.6	-1.6	0.4	NAF (LC)	AF
EB2237627063	TSF_12c	Tailings	0.000251189	3.60	444	0.07			3.8	2.1	-1.7	3.8			1.8	NAF (LC)	AF
EB2237627037	TSF_4a	Tailings	0.000158489	3.80	115	0.02			3.7	0.6	-3.1	3.7			6.0	NAF (LC)	AF
EB2237627052	TSF_9a	Tailings	0.0001	4.00	119	0.03			3.6	0.9	-2.7	3.6			3.9	NAF (LC)	AF
EB2237627062	TSF_12b	Tailings	0.0001	4.00	374	0.06			4.6	1.8	-2.8	4.6			2.5	NAF (LC)	AF
EB2237627057	TSF_10c	Tailings	7.94328E-05	4.10	1,110	0.34			3.4	10.4	7.0	3.4			0.3	PAF (LC)	AF
EB2237627029	TSF_1b	Tailings	5.01187E-05	4.30	806	0.1			5.1	3.1	-2.0	5.1			1.7	NAF (LC)	AF
EB2237627040	TSF_5a	Tailings	5.01187E-05	4.30	133	0.03			3.8	0.9	-2.9	3.8			4.1	NAF (LC)	AF
EB2237627043	TSF_6a	Tailings	2.51189E-05	4.60	106	0.04			3.7	1.2	-2.5	3.7			3.0	NAF (LC)	NAF (LC)
EB2237627061	TSF_12a	Tailings	1.99526E-06	5.70	4	0.005			3.6	0.2	-3.4	3.6			23.5	NAF (LC)	NAF (LC)
EB2237627045	TSF_6c	Tailings	1.58489E-06	5.80	530	0.16			5.9	4.9	-1.0	5.9			1.2	NAF (LC)	NAF (LC)
EB2237627034	TSF_3a	Tailings	1.25893E-06	5.90	91	0.02	0.012	60%	4.6	0.6	-4.0	4.6	0.4	-4.2	7.5	NAF (LC)	NAF (LC)
EB2237627032	TSF_2b	Tailings	6.30957E-07	6.20	446	0.05			5.1	1.5	-3.6	5.1			3.3	NAF (LC)	NAF (LC)
EB2237627053	TSF_9b	Tailings	5.01187E-07	6.30	345	0.03			6.8	0.9	-5.9	6.8			7.4	NAF (LC)	NAF (LC)
EB2237627038	TSF_4b	Tailings	2.51189E-07	6.60	1,360	0.38			5	11.6	6.6	5.0			0.4	PAF (LC)	PAF (LC)
EB2237627031	TSF_2a	Tailings	1.58489E-07	6.80	191	0.03			4.9	0.9	-4.0	4.9			5.3	NAF (LC)	NAF (LC)
EB2237627030	TSF_1c	Tailings	0.0000001	7.00	532	0.05			6.1	1.5	-4.6	6.1			4.0	NAF (LC)	NAF (LC)
EB2237627054	TSF_9c	Tailings	0.0000001	7.00	310	0.04			7	1.2	-5.8	7.0			5.7	NAF (LC)	NAF (LC)
EB2237627048	TSF_7c	Tailings	6.30957E-08	7.20	658	0.36	0.255	71%	5.6	11.0	5.4	5.6	7.8	2.2	0.5	PAF (LC)	PAF (LC)
EB2237627049	TSF_8a	Tailings	0.00000001	8.00	314	0.03			5.6	0.9	-4.7	5.6			6.1	NAF (LC)	NAF (LC)
EB2237627060	TSF_11c	Tailings	7.94328E-09	8.10	622	0.24			4.7	7.4	2.7	4.7			0.6	PAF (LC)	PAF (LC)
EB2237627028	TSF_1a	Tailings	6.30957E-09	8.20	150	0.02			5.8	0.6	-5.2	5.8			9.5	NAF (LC)	NAF (LC)
EB2237627044	TSF_6b	Tailings	6.30957E-09	8.20	1,260	0.15			13.9	4.6	-9.3	13.9			3.0	NAF (LC)	NAF (LC)
EB2237627035	TSF_3b	Tailings	5.01187E-09	8.30	803	0.09	0.034	38%	7.7	2.8	-4.9	7.7	1.0	-6.7	2.8	NAF (LC)	NAF (LC)
EB2237627041	TSF_5b	Tailings	5.01187E-09	8.30	1,070	0.2			6.3	6.1	-0.2	6.3			1.0	NAF (LC)	NAF (LC)
EB2237627046	TSF_7a	Tailings	5.01187E-09	8.30	646	0.07	0.037	53%	4.7	2.1	-2.6	4.7	1.1	-3.6	2.2	NAF (LC)	NAF (LC)
EB2237627033	TSF_2c	Tailings	7.94328E-10	9.10	379	0.03			10.6	0.9	-9.7	10.6			11.5	NAF (LC)	NAF (LC)
EB2237627036	TSF_3c	Tailings	6.30957E-10	9.20	357	0.14	0.106	76%	7.8	4.3	-3.5	7.8	3.2	-4.6	1.8	NAF (LC)	NAF (LC)
EB2237627039	TSF_4c	Tailings	6.30957E-10	9.20	430	0.07			9.7	2.1	-7.6	9.7			4.5	NAF (LC)	NAF (LC)
EB2237627042	TSF_5c	Tailings	5.01187E-10	9.30	368	0.1			8.9	3.1	-5.8	8.9			2.9	NAF (LC)	NAF (LC)

11.2.2 Attachment B2 Acid base account results – mine waste

ALS Lab ID	Client Sample ID	Sample Lithology	H ⁺ (M)	pH (1:5)	EC (1:5) (μS/cm)	Total S (%)	ANC	MPA (kg H ₂ SO ₄ /t)	NAPP	ANC: MPA Ratio	NAPP _{TS} Classification	Geochemical Classification
EB2237627014	WRD_8	Mine waste	0.000398107	3.40	209	0.10	2.7	3.1	0.4	0.9	PAF (LC)	AF
EB2237627010	WRD_4	Mine waste	0.000251189	3.60	128	0.11	2.9	3.4	0.5	0.9	PAF (LC)	AF
EB2237627013	WRD_7	Mine waste	0.000199526	3.70	100	0.09	4.4	2.8	-1.6	1.6	NAF (LC)	AF
EB2237627015	WRD_11	Mine waste	0.000158489	3.80	90	0.05	2.2	1.5	-0.7	1.4	NAF (LC)	AF
EB2237627023	ROM_2	Mine waste	6.30957E-05	4.20	33	0.06	3.3	1.8	-1.5	1.8	NAF (LC)	AF
EB2237627026	ROM_5	Mine waste	5.01187E-05	4.30	14	0.06	3.3	1.8	-1.5	1.8	NAF (LC)	AF
EB2237627007	WRD_1	Mine waste	3.98107E-05	4.40	52	0.05	2.6	1.5	-1.1	1.7	NAF (LC)	AF
EB2237627025	ROM_4	Mine waste	3.98107E-05	4.40	22	0.06	3.2	1.8	-1.4	1.7	NAF (LC)	AF
EB2237627008	WRD_2	Mine waste	3.16228E-05	4.50	21	0.03	2.6	0.9	-1.7	2.8	NAF (LC)	AF
EB2237627022	ROM_1	Mine waste	3.16228E-05	4.50	21	0.04	2.8	1.2	-1.6	2.3	NAF (LC)	AF
EB2237627027	ROM_6	Mine waste	2.51189E-05	4.60	16	0.07	3.7	2.1	-1.6	1.7	NAF (LC)	NAF (LC)
EB2237627009	WRD_3	Mine waste	1.25893E-05	4.90	20	0.02	4.7	0.6	-4.1	7.7	NAF (LC)	NAF (LC)
EB2237627011	WRD_5	Mine waste	0.00001	5.00	15	0.02	1.0	0.6	-0.4	1.6	NAF (LC)	NAF (LC)
EB2237627012	WRD_6	Mine waste	0.00001	5.00	19	0.01	3.6	0.3	-3.3	11.8	NAF (LC)	NAF (LC)
EB2237627016	WRD_12	Mine waste	0.00001	5.00	18	0.02	3.2	0.6	-2.6	5.2	NAF (LC)	NAF (LC)
EB2237627018	WRD_14	Mine waste	6.30957E-06	5.20	11	0.005	3.6	0.2	-3.4	23.5	NAF (LC)	NAF (LC)
EB2237627017	WRD_13	Mine waste	3.98107E-06	5.40	14	0.01	4.7	0.3	-4.4	15.3	NAF (LC)	NAF (LC)
EB2237627021	WRD-S_18	Mine waste	2.51189E-06	5.60	29	0.02	1.5	0.6	-0.9	2.4	NAF (LC)	NAF (LC)
EB2237627019	WRD-S_15	Mine waste	1.99526E-06	5.70	103	0.07	8.1	2.1	-6.0	3.8	NAF (LC)	NAF (LC)
EB2237627020	WRD-S_16	Mine waste	5.01187E-07	6.30	25	0.01	4.7	0.3	-4.4	15.3	NAF (LC)	NAF (LC)
EB2237627024	ROM_3	Mine waste	2.51189E-08	7.60	194	0.11	12.9	3.4	-9.5	3.8	NAF (LC)	NAF (LC)



11.2.3 Attachment B3 Acid base account results – soil

ALS Lab ID	Client Sample ID	Sample Lithology	H ⁺	pH (1:5)	EC (1:5)	Total S	ANC	MPA	NAPP	ANC: MPA Ratio	NAPPTs Classification
			(M)		(µS/cm)		(kg H ₂ SO ₄ /t)				
EB2237627002	TS_2	Topsoil	1.58489E-05	4.80	12	0.005	2.8	0.2	-2.6	18.3	NAF (LC)
EB2237627005	TS_5	Topsoil	1.25893E-05	4.90	34	0.005	3.1	0.2	-2.9	20.2	NAF (LC)
EB2237627001	TS_1	Topsoil	0.00001	5.00	17	0.005	4.0	0.2	-3.8	26.1	NAF (LC)
EB2237627004	TS_4	Topsoil	7.94328E-06	5.10	50	0.005	3.5	0.2	-3.3	22.9	NAF (LC)
EB2237627003	TS_3	Topsoil	6.30957E-06	5.20	27	0.005	3.4	0.2	-3.2	22.2	NAF (LC)
EB2237627006	TS_6	Topsoil	0.000001	6.00	48	0.02	14.3	0.6	-13.7	23.3	NAF



11.2.4 Attachment B4 Multi element results from tailings

Parameters	RGS Sample Number →	2022095_3007	2022095_3008	2022095_3009	2022095_3019	2022095_3020	2022095_3021
	Sampling Date →	20/12/2022	20/12/2022	20/12/2022	20/12/2022	20/12/2022	20/12/2022
	ALS Laboratory ID →	EB2237627034	EB2237627035	EB2237627036	EB2237627046	EB2237627047	EB2237627048
	Drill Hole ID and Depth (m) →	TSF_3a 0.0 - 0.5	TSF_3b 0.5 - 1.0	TSF_3c 1.0 - 2.0	TSF_7a 0.0 - 0.5	TSF_7b 0.5 - 1.0	TSF_7c 1.0 - 2.0
Limit of Reporting							
Major Cations	All units mg/kg						
Calcium (Ca)	50	600	2900	2600	1300	1500	1800
Magnesium (Mg)	50	100	300	500	100	200	200
Potassium (K)	50	1000	1200	1800	1200	1900	1800
Sodium (Na)	50	<50	600	700	400	400	200
Aluminium (Al)	50	2400	3400	5000	2900	3700	3200
Iron (Fe)	50	3200	8000	11600	5000	10500	8000
Minor and Trace Elements	All units mg/kg						
Silver (Ag)	0.01	0.41	0.22	1.14	0.56	2.20	2.45
Arsenic (As)	0.1	388	500	943	889	1290	1565
Gold (Au)	0.02	0.27	0.25	0.97	0.45	1.72	1.86
Boron (B)	10	<10	<10	<10	<10	<10	<10
Barium (Ba)	10	40	180	250	60	110	100
Beryllium (Be)	0.05	0.20	0.61	0.98	0.29	0.60	0.63
Bismuth (Bi)	0.01	0.06	0.20	0.33	0.10	0.22	0.16
Cadmium (Cd)	0.01	0.01	0.02	0.04	0.01	0.04	0.04
Cerium (Ce)	0.02	10.75	18.50	27.20	12.15	14.35	12.20
Cobalt (Co)	0.1	0.10	0.40	0.90	0.30	0.60	0.70
Chromium (Cr)	1.0	4	17	21	8	18	15
Caesium (Cs)	0.05	1.1	2.2	3.2	1.5	2.4	2.3
Copper (Cu)	0.2	3.8	3.3	13.6	3.0	13.6	12.8
Gallium (Ga)	0.05	0.94	1.38	1.74	1.15	1.32	1.08
Geranium (Ge)	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Hafnium (Hf)	0.02	0.03	0.06	0.08	0.06	0.06	0.08
Mercury (Hg)	0.01	0.03	0.09	0.11	0.28	0.08	0.09
Indium (In)	0.005	<0.005	<0.005	0.012	<0.005	0.005	0.005
Lanthanum (La)	0.2	5.0	8.5	11.5	5.7	6.6	5.7
Lithium (Li)	0.1	0.6	1.0	1.7	0.8	1.0	1.0
Manganese (Mn)	5.0	15	48	69	29	39	53
Molybdenum (Mo)	0.05	0.12	0.16	0.32	0.25	0.55	0.42
Niobium (Nb)	0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05
Nickel (Ni)	0.2	0.2	0.8	1.2	0.7	1.2	0.9
Phosphorus (P)	10	60	130	190	70	110	100
Lead (Pb)	0.2	8.1	40.6	53.5	15.8	30.7	23.5
Rubidium (Rb)	0.1	6.7	9.3	13.1	8.0	10.9	11.2
Rhenium (Re)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sulfur (S)	100	200	900	1400	700	1900	3400
Antimony (Sb)	0.05	34.8	420.0	496.0	499.0	1245.0	1330.0
Scandium (Sc)	0.1	0.2	0.5	1.0	0.4	0.4	0.3
Selenium (Se)	0.2	0.4	0.8	0.5	0.3	0.8	1.1
Tin (Sn)	0.2	<0.2	0.2	0.2	<0.2	0.2	<0.2
Strontium (Sr)	0.2	5.7	44.6	58.8	15.3	26.6	24.5
Tantalum (Ta)	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium (Te)	0.01	0.05	0.07	0.25	0.06	0.17	0.12
Thorium (Th)	0.2	2.2	3.8	5.0	2.5	3.1	2.8
Titanium (Ti)	50	<50	<50	<50	<50	<50	<50
Thallium (Tl)	0.02	0.07	0.13	0.23	0.13	0.18	0.28
Uranium (U)	0.05	0.49	1.18	1.59	0.70	1.42	1.24
Vanadium (V)	1.0	1.0	2.0	4.0	2.0	5.0	1.0
Tungsten (W)	0.05	0.22	0.77	0.60	0.32	0.49	0.28
Yttrium (Y)	0.05	1.30	4.13	6.90	2.14	3.32	2.82
Zinc (Zn)	2.0	5	14	26	8	15	26
Zirconium (Zr)	0.5	1.0	2.0	2.8	1.5	1.9	1.7

Notes: < indicates less than the laboratory limit of reporting.

11.2.5 Attachment B5: Multi-element results for water soluble SFE extracts from soil, mine waste, and tailings

Parameters	RGS Sample Number →	2022095_0001	2022095_0004	2022095_0006	2022095_2002	2022095_2015	2022095_2020	2022095_3007	2022095_3008	2022095_3009	2022095_3019	2022095_3020	2022095_3021
	Sampling Date →	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022
	ALS Laboratory ID →	EB2237627001	EB2237627004	EB2237627006	EB2237627008	EB2237627019	EB2237627023	EB2237627034	EB2237627035	EB2237627036	EB2237627046	EB2237627047	EB2237627048
	Drill Hole ID and Depth (m) →	TS_1	TS_4	TS_6	WRD_2	WRD-S_15	ROM_2	TSF_3a	TSF_3b	TSF_3c	TSF_7a	TSF_7b	TSF_7c
Limit of Reporting	0.05 - 0.20	0.05 - 0.20	0.05 - 0.20	0.05 - 0.20	0.0 - 1.0	0.05	0.07	0.00 - 0.50	0.50 - 1.00	1.00 - 2.00	0.00 - 0.50	0.50 - 1.00	1.00 - 2.00
pH	0.01 pH unit	5.0	5.1	6.0	4.5	5.7	4.2	5.9	8.3	9.2	8.3	3.5	7.2
Electrical Conductivity	1 µS/cm	17	50	48	21	103	33	91	803	357	646	1290	658
Carbonate Alkalinity (mg CaCO ₃ /L)	1 mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity (mg CaCO ₃ /L)	1 mg/L	4	2	6	<1	21	<1	2	46	90	36	<1	97
Hydroxide Alkalinity (mg CaCO ₃ /L)	1 mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Alkalinity (mg CaCO ₃ /L)	1 mg/L	4	2	6	<1	21	<1	2	46	90	36	<1	97
Acidity (mg CaCO ₃ /L)	1 mg/L	6	8	6	3	7	8	8	9	2	7	103	8
Major Ions	All units mg/L												
Calcium (Ca)	1.0	<1	4	4	<1	9	<1	17	130	2	68	327	153
Magnesium (Mg)	1.0	<1	3	4	<1	1	<1	1	4	<1	3	15	7
Potassium (K)	1.0	2	4	3	6	8	10	3	12	4	4	12	12
Sodium (Na)	1.0	4	2	5	2	29	2	14	184	109	131	100	50
Chloride (Cl)	1.0	1	1	4	2	11	2	2	11	13	3	4	6
Fluoride (F)	0.1	<0.1	<0.1	0.1	<0.1	0.2	<0.1	0.2	0.7	1.2	0.8	0.4	0.5
Sulfate (SO ₄ ²⁻)	1.0	<1	5	7	7	47	14	69	654	102	408	1070	422
Trace Metals/Metalloids	All units mg/L												
Aluminium (Al)	0.01	0.18	1.21	0.03	<0.01	0.06	0.02	0.03	0.02	0.07	<0.01	7.51	<0.01
Antimony (Sb)	0.001	0.004	0.004	0.029	0.128	0.754	0.403	0.819	10.300	17.800	6.580	0.606	12.000
Arsenic (As)	0.001	0.007	0.019	0.036	0.222	0.351	0.189	0.999	1.390	12.300	1.460	1.360	1.760
Beryllium (Be)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.020	<0.001
Barium (Ba)	0.001	0.005	0.060	0.135	0.006	0.014	0.026	0.021	0.051	0.011	0.021	0.020	0.029
Bismuth (Bi)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (B)	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium (Cd)	0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0038	<0.001
Cerium (Ce)	0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	<0.001
Caesium (Cs)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (Cr)	0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.022	<0.001
Cobalt (Co)	0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.002	0.067	0.001
Copper (Cu)	0.001	<0.001	0.001	0.005	<0.001	0.008	0.001	0.003	0.002	0.013	0.002	0.858	0.002
Dysprosium (Dy)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.007	<0.001
Erbium (Er)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.001
Europium (Eu)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Gadolinium (Gd)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.007	<0.001
Gallium (Ga)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium (Hf)	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Holmium (Ho)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Indium (In)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron (Fe)	0.05	<0.05	0.37	<0.05	<0.05	0.07	<0.05	<0.05	<0.05	0.27	0.07	1.17	<0.05
Lanthanum (La)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	<0.001
Lead (Pb)	0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.001
Lithium (Li)	0.001	<0.001	0.002	0.005	0.003	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	0.028	0.007
Lutetium (Lu)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese (Mn)	0.001	0.034	0.344	0.040	0.003	0.295	0.014	0.086	0.055	0.006	0.014	6.610	0.399
Molybdenum (Mo)	0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	0.011	0.020	0.006	<0.001	0.011
Neodymium (Nd)	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.016	<0.001
Nickel (Ni)	0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.071	0.002
Praseodymium (Pr)	0.001	<0.001	<0.001	0.0005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.001
Rubidium (Rb)	0.001	0.006	0.010	0.0005	0.004	0.004	0.008	0.002	0.013	0.003	0.002	0.025	0.013
Samarium (Sm)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	<0.001
Selenium (Se)	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Silver (Ag)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	0.001	0.006	0.060	0.064	0.001	0.026	0.007	0.020	0.264	0.006	0.094	0.245	0.264
Tellurium (Te)	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Terbium (Tb)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Thallium (Tl)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium (Th)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thulium (Tm)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin (Sn)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium (Ti)	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium (U)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.009	0.011	0.001	0.005	0.006
Vanadium (V)	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ytterbium (Yb)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001
Yttrium (Y)	0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.050	<0.001
Zinc (Zn)	0.005	<0.005	0.009	0.014	<0.005	<0.005	0.017	0.006	<0.005	<0.005	<0.005	1.800	<0.005
Zirconium (Zr)	0.005	<0.005	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

Notes: < indicates concentration less than the detection limit.



11.2.6 Attachment B6: Soil fertility results

RGS Sample Number →		2022095_0001	2022095_0002	2022095_0003	2022095_0004	2022095_0005	2022095_0006	2022095_2002	2022095_2003	2022095_2013	2022095_2015	2022095_2020	2022095_2022
Sampling Date →		13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022
ALS Laboratory ID →		EB2237627001	EB2237627002	EB2237627003	EB2237627004	EB2237627005	EB2237627006	EB2237627008	EB2237627009	EB2237627017	EB2237627019	EB2237627023	EB2237627025
Parameters	Limit of Reporting	TS_1 Topsoil	TS_2 Topsoil	TS_3 Topsoil	TS_4 Topsoil	TS_5 Topsoil	TS_6 Topsoil	WRD_2 Mine waste	WRD_3 Mine waste	WRD_13 Mine waste	WRD-S_15 Mine waste	ROM_2 Mine waste	ROM_4 Mine waste
Exchangable Cations		All units meq/100g (except Exchangable Sodium Percentage (%))											
Exchangeable Calcium	0.2	0.2	<0.1	0.4	1.1	0.3	10.1	0.4	1.7	3.6	4.8	0.3	0.2
Exchangeable Magnesium	0.2	<0.1	<0.1	0.2	0.5	0.5	11.6	0.6	0.9	1.6	0.6	<0.1	<0.1
Exchangeable Potassium	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	0.4	0.1	0.2	0.2	0.2	<0.1	0.1
Exchangeable Sodium	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.5	<0.1	<0.1
Cation Exchange Capacity	0.2	0.7	1	1	2	2.3	22.2	6.9	5	6.6	6.5	3.8	5.8
Exchangeable Sodium Percent	0.2	3.4	<0.1	<0.1	0.5	7.7	0.5	1	0.6	0.6	8.9	2.6	4.9
Calcium/Magnesium Ratio	0.2	----	----	2	2.2	0.6	0.9	0.7	1.9	2.2	8	----	----
Magnesium/Potassium Ratio	0.2	----	----	----	----	----	27.8	4.5	5.7	9.3	3.4	----	<0.1
Analyte/Metals													
pH (1:5) (pH)	0.1	5.0	4.8	5.2	5.1	4.9	6.0	4.5	4.9	5.4	5.7	4.2	4.4
EC (1:5) (µS/cm)	1	17	12	27	50	34	48	21	20	14	103	33	22
Moisture Content (%)	1	<1.0	<1.0	<1.0	<1.0	<1.0	4.8	1.3	1.3	1.2	<1.0	1.3	<1.0
Bicarbonate Extractable K (Colwell) (mg/kg)	100	<100	<100	<100	<100	<100	686	258	245	257	242	255	279
Chloride (mg/kg)	10	<10	<10	<10	<10	20	<10	<10	<10	<10	40	<10	<10
Copper (mg/kg)	1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1
Iron (Fe) (mg/kg)	1	10	9	7	17	26	40	77	47	22	86	102	93
Manganese (mg/kg)	1	2	<1	4	9	4	14	2	17	16	16	<1	<1
Zinc (mg/kg)	1	<1	<1	<1	<1	<1	<1	1	3	3	<1	<1	1
Ammonia as N (mg/kg)	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Nitrite as N (Sol.) (mg/kg)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
Nitrate as N (Sol.) (mg/kg)	0.1	5.8	2.6	10	19	5.1	15.4	1.1	1.6	1.3	<0.1	0.4	0.3
Nitrite + Nitrate as N (Sol.) (mg/kg)	0.1	5.8	2.6	10	19	5.1	15.4	1.1	1.7	1.3	<0.1	0.4	0.3
Total Kjeldahl Nitrogen as N (mg/kg)	20	<20	170	220	370	340	580	200	380	180	280	250	230
Total Nitrogen as N (mg/kg)	20	<20	170	230	390	340	600	200	380	180	280	250	230
Total Phosphorus as P (mg/kg)	2	<2	49	73	86	92	1740	437	441	208	483	438	562
Bicarbonate Ext. P (Colwell) (mg/kg)	5	<5	<5	<5	<5	<5	38	75	15	14	61	80	108
Organic Matter (%)	0.5	<0.5	<0.5	0.6	1.1	0.8	1.3	<0.5	0.7	0.6	1.2	<0.5	<0.5
Total Organic Carbon (%)	0.5	<0.5	<0.5	<0.5	0.6	<0.5	0.8	<0.5	<0.5	<0.5	0.7	<0.5	<0.5

RGS Sample Number →		2022095_3001	2022095_3004	2022095_3007	2022095_3010	2022095_3013	2022095_3016	2022095_3019	2022095_3022	2022095_3025	2022095_3028	2022095_3031	2022095_3034
Sampling Date →		13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022	13/12/2022
ALS Laboratory ID →		EB2237627028	EB2237627031	EB2237627034	EB2237627037	EB2237627040	EB2237627043	EB2237627046	EB2237627049	EB2237627052	EB2237627055	EB2237627058	EB2237627061
Parameters	Limit of Reporting	TSF_1a Tailings	TSF_2a Tailings	TSF_3a Tailings	TSF_4a Tailings	TSF_5a Tailings	TSF_6a Tailings	TSF_7a Tailings	TSF_8a Tailings	TSF_9a Tailings	TSF_10a Tailings	TSF_11a Tailings	TSF_12a Tailings
Exchangable Cations		All units meq/100g (except Exchangable Sodium Percentage (%))											
Exchangeable Calcium	0.2	2.6	3.2	2.2	0.5	1.5	1.8	2.8	3.2	1.3	16.5	0.7	1.5
Exchangeable Magnesium	0.2	<0.2	0.2	0.2	<0.1	0.2	0.3	<0.2	<0.2	0.2	0.2	<0.1	<0.1
Exchangeable Potassium	0.2	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	0.2	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	0.2	0.4	0.4	0.2	<0.1	0.3	0.2	1.2	<0.2	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	0.2	3.3	4	2.9	3.3	2.6	3	4.2	3.4	2.6	20.1	2.2	1.8
Exchangeable Sodium Percent	0.2	12	9.2	8	8.2	15.4	9	29.6	<0.2	2.8	0.5	<0.1	<0.1
Calcium/Magnesium Ratio	0.2	----	16	11	----	7.5	6	----	----	6.5	82.5	----	----
Magnesium/Potassium Ratio	0.2	<0.2	----	----	----	----	----	----	<0.2	----	----	----	----
Analyte/Metals													
pH (1:5) (pH)	0.1	8.2	6.8	5.9	3.8	4.3	4.6	8.3	8.0	4.0	3.4	3.4	5.7
EC (1:5) (µS/cm)	1	150	191	91	115	133	106	646	314	119	2820	363	4
Moisture Content (%)	1	2.6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.2	1	<1.0	<1.0
Bicarbonate Extractable K (Colwell) (mg/kg)	100	148	123	106	137	<100	104	141	163	209	183	227	226
Chloride (mg/kg)	10	<10	<10	<10	<10	<10	<10	<10	20	<10	30	<10	<10
Copper (mg/kg)	1	<1	<1	<1	5	1	3	<1	<1	<1	4	1	<1
Iron (Fe) (mg/kg)	1	10	19	36	408	307	367	21	13	99	220	168	11
Manganese (mg/kg)	1	2	2	1	5	8	28	2	<1	5	32	3	2
Zinc (mg/kg)	1	<1	<1	<1	2	<1	2	<1	<1	<1	9	1	<1
Ammonia as N (mg/kg)	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Nitrite as N (Sol.) (mg/kg)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate as N (Sol.) (mg/kg)	0.1	0.1	0.2	<0.1	<0.1	<0.1	<0.1	0.2	0.1	<0.1	<0.1	<0.1	0.1
Nitrite + Nitrate as N (Sol.) (mg/kg)	0.1	0.1	0.2	<0.1	<0.1	<0.1	<0.1	0.2	0.1	<0.1	<0.1	<0.1	0.1
Total Kjeldahl Nitrogen as N (mg/kg)	20	70	70	40	60	40	70	80	80	80	180	90	50
Total Nitrogen as N (mg/kg)	20	70	70	40	60	40	70	80	80	80	180	90	50
Total Phosphorus as P (mg/kg)	2	282	194	199	327	274	362	355	170	299	427	429	90
Bicarbonate Ext. P (Colwell) (mg/kg)	5	20	15	46	151	51	95	29	16	92	112	155	5
Organic Matter (%)	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Organic Carbon (%)	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Notes: < indicates less than the laboratory limit of reporting.

11.3 ALS Certificates of Analysis

CERTIFICATE OF ANALYSIS

Work Order : **EB2237627**
Client : **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**
Contact : ALEXANDRA KISS
Address : 3/30 LENSWORTH STREET
 COOPERS PLAINS 4108
Telephone : 07 3344 1222
Project : 2022095 Alice River
Order number : ----
C-O-C number : ----
Sampler : ALEXANDRA KISS
Site : ----
Quote number : EN/222
No. of samples received : 64
No. of samples analysed : 64

Page : 1 of 37
Laboratory : Environmental Division Brisbane
Contact : Customer Services EB
Address : 2 Byth Street Stafford QLD Australia 4053

Telephone : +61-7-3243 7222
Date Samples Received : 14-Dec-2022 10:13
Date Analysis Commenced : 16-Dec-2022
Issue Date : 06-Jan-2023 15:07



Accreditation No. 825
 Accredited for compliance with
 ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ALS is not NATA accredited for the analysis of Exchangeable Aluminium and Exchange Acidity in soils when performed under ALS Method ED005.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- ALS is not NATA accredited for the performance of EN35: Miscellaneous Leaching procedure.
- ED007-Exchangeable Cations on Alkaline Soils: Unable to calculate Calcium/Magnesium Ratio for some samples as required Calcium & Magnesium results are less than the limit of reporting.
- ED007-Exchangeable Cations on Alkaline Soils: Unable to calculate Magnesium/Potassium Ratio for some samples as required Exchangeable Magnesium and/or Potassium results are less than the limit of reporting.
- ED007 (Exchangeable Cations): Unable to calculate Magnesium/Potassium Ratio result as required Exchangeable Potassium results are less than the limit of reporting.
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Calcium/Magnesium Ratio results for some samples as required Calcium & Magnesium results are less than the limit of reporting.
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Magnesium/Potassium Ratio results for some samples as required Exchangeable Potassium results are less than the limit of reporting.
- ED008 (Exchangeable Cations with pre-treatment): Unable to calculate Calcium/Magnesium Ratio results for some samples as required Calcium & Magnesium results are less than the limit of reporting.
- ED008 (Exchangeable Cations with pre-treatment): Unable to calculate Magnesium/Potassium Ratio results for some samples as required Exchangeable Potassium results are less than the limit of reporting.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity ($H^+ + Al^{3+}$).



Analytical Results

Sub-Matrix: LEACHATE
 (Matrix: WATER)

Sample ID

				2022095__0001 TS_1 Topsoil	2022095__0004 TS_4 Topsoil	2022095__0006 TS_6 Topsoil	2022095__2002 WRD_2 Mine waste	2022095__2015 WRD-S_15 Mine waste
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-001	EB2237627-004	EB2237627-006	EB2237627-008	EB2237627-019
				Result	Result	Result	Result	Result
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	4	2	6	<1	21
Total Alkalinity as CaCO3	----	1	mg/L	4	2	6	<1	21
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	6	8	6	3	7
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	5	7	7	47
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	1	1	4	2	11
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	<1	4	4	<1	9
Magnesium	7439-95-4	1	mg/L	<1	3	4	<1	1
Sodium	7440-23-5	1	mg/L	4	2	5	2	29
Potassium	7440-09-7	1	mg/L	2	4	3	6	8
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.18	1.21	0.03	<0.01	0.06
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	0.007	0.019	0.036	0.222	0.351
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	0.006	0.060	0.064	0.001	0.026
Barium	7440-39-3	0.001	mg/L	0.005	0.060	0.135	0.006	0.014
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L	<0.01	0.01	<0.01	<0.01	<0.01
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005

Sub-Matrix: LEACHATE
(Matrix: WATER)

2022095__0001 TS_1 Topsoil	2022095__0004 TS_4 Topsoil	2022095__0006 TS_6 Topsoil	2022095__2002 WRD_2 Mine waste	2022095__2015 WRD-S_15 Mine waste
13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
EB2237627-001	EB2237627-004	EB2237627-006	EB2237627-008	EB2237627-019
Result	Result	Result	Result	Result

Cobalt	7440-48-4	0.001	mg/L	<0.001	0.001	0.001	<0.001	<0.001
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.002
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	0.001	0.005	<0.001	0.008
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L	0.006	0.010	<0.001	0.004	0.004
Lithium	7439-93-2	0.001	mg/L	<0.001	0.002	0.005	0.003	<0.001
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium	7440-45-1	0.001	mg/L	<0.001	0.002	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.034	0.344	0.040	0.003	0.295
Neodymium	7440-00-8	0.001	mg/L	<0.001	0.001	<0.001	<0.001	<0.001
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.003
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.002	<0.001	<0.001
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	0.002	<0.001	<0.001	<0.001
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L	0.004	0.004	0.029	0.128	0.754
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	0.001	<0.001	0.001
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zirconium	7440-67-7	0.005	mg/L	<0.005	0.006	<0.005	<0.005	<0.005
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	0.009	0.014	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	0.37	<0.05	<0.05	0.07

EG035F: Dissolved Mercury by FIMS



Analytical Results

Sub-Matrix: **LEACHATE**
 (Matrix: **WATER**)

Sample ID

				2022095__0001 TS_1 Topsoil	2022095__0004 TS_4 Topsoil	2022095__0006 TS_6 Topsoil	2022095__2002 WRD_2 Mine waste	2022095__2015 WRD-S_15 Mine waste
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-001	EB2237627-004	EB2237627-006	EB2237627-008	EB2237627-019
				Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS - Continued								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	<0.1	0.1	<0.1	0.2



Analytical Results

Sub-Matrix: LEACHATE
 (Matrix: WATER)

Sample ID

				2022095__2020 ROM_2 Mine waste	2022095__3007 TSF_3a Tailings	2022095__3008 TSF_3b Tailings	2022095__3009 TSF_3c Tailings	2022095__3019 TSF_7a Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-023	EB2237627-034	EB2237627-035	EB2237627-036	EB2237627-046
				Result	Result	Result	Result	Result
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	2	46	90	36
Total Alkalinity as CaCO3	----	1	mg/L	<1	2	46	90	36
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	8	8	9	2	7
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	14	69	654	102	408
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	2	2	11	13	3
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	<1	17	130	2	68
Magnesium	7439-95-4	1	mg/L	<1	1	4	<1	3
Sodium	7440-23-5	1	mg/L	2	14	184	109	131
Potassium	7440-09-7	1	mg/L	10	3	12	4	4
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.02	0.03	0.02	0.07	<0.01
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	0.189	0.999	1.39	12.3	1.46
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	0.007	0.020	0.264	0.006	0.094
Barium	7440-39-3	0.001	mg/L	0.026	0.021	0.051	0.011	0.021
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	0.003	0.002

Sub-Matrix: **LEACHATE**
(Matrix: **WATER**)

2022095__2020
ROM 2 Mine waste

2022095__3007
TSF 3a Tailings

2022095__3008
TSF 3b Tailings

2022095__3009
TSF 3c Tailings

2022095__3019
TSF 7a Tailings

Sampling date / time

13-Dec-2022 00:00

13-Dec-2022 00:00

13-Dec-2022 00:00

13-Dec-2022 00:00

13-Dec-2022 00:00

Compound

CAS Number

LOR

Unit

EB2237627-023

EB2237627-034

EB2237627-035

EB2237627-036

EB2237627-046

Result

Result

Result

Result

Result

Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	0.009	0.011	0.001
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.001	0.003	0.002	0.013	0.002
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L	0.008	0.002	0.013	0.003	0.002
Lithium	7439-93-2	0.001	mg/L	0.004	<0.001	<0.001	<0.001	<0.001
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.014	0.086	0.055	0.006	0.014
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.011	0.020	0.006
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.001	<0.001	<0.001
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L	0.403	0.819	10.3	17.8	6.58
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	0.02	<0.01
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	0.017	0.006	<0.005	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	0.27	0.07

Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
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EK040P: Fluoride by PC Titrator



Analytical Results

Sub-Matrix: **LEACHATE**
 (Matrix: **WATER**)

Sample ID

				2022095__2020 ROM_2 Mine waste	2022095__3007 TSF_3a Tailings	2022095__3008 TSF_3b Tailings	2022095__3009 TSF_3c Tailings	2022095__3019 TSF_7a Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-023	EB2237627-034	EB2237627-035	EB2237627-036	EB2237627-046
				Result	Result	Result	Result	Result
EK040P: Fluoride by PC Titrator - Continued								
Fluoride	16984-48-8	0.1	mg/L	<0.1	0.2	0.7	1.2	0.8



Analytical Results

Sub-Matrix: LEACHATE
 (Matrix: WATER)

Sample ID

				2022095_3020 TSF_7b Tailings	2022095_3021 TSF_7c Tailings	----	----	----
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2237627-047	EB2237627-048	-----	-----	-----
Result				Result	Result	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	97	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	<1	97	----	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	103	8	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	1070	422	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	4	6	----	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	327	153	----	----	----
Magnesium	7439-95-4	1	mg/L	15	7	----	----	----
Sodium	7440-23-5	1	mg/L	100	50	----	----	----
Potassium	7440-09-7	1	mg/L	12	12	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	7.51	<0.01	----	----	----
Dysprosium	7429-91-6	0.001	mg/L	0.007	<0.001	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	----	----	----
Arsenic	7440-38-2	0.001	mg/L	1.36	1.76	----	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	----	----	----
Erbium	7440-52-0	0.001	mg/L	0.004	<0.001	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	----	----	----
Europium	7440-53-1	0.001	mg/L	0.002	<0.001	----	----	----
Strontium	7440-24-6	0.001	mg/L	0.245	0.264	----	----	----
Barium	7440-39-3	0.001	mg/L	0.020	0.029	----	----	----
Gadolinium	7440-54-2	0.001	mg/L	0.007	<0.001	----	----	----
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	----	----	----
Beryllium	7440-41-7	0.001	mg/L	0.020	<0.001	----	----	----
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	0.0038	<0.0001	----	----	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	----	----	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	----	----	----
Cobalt	7440-48-4	0.001	mg/L	0.067	0.001	----	----	----



Analytical Results

Sub-Matrix: LEACHATE
 (Matrix: WATER)

Sample ID

				2022095_3020 TSF_7b Tailings	2022095_3021 TSF_7c Tailings	----	----	----
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2237627-047	EB2237627-048	-----	-----	-----
Result				Result	Result	----	----	----

EG020F: Dissolved Metals by ICP-MS - Continued

Holmium	7440-60-0	0.001	mg/L	0.001	<0.001	----	----	----
Uranium	7440-61-1	0.001	mg/L	0.005	0.006	----	----	----
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	----	----	----
Chromium	7440-47-3	0.001	mg/L	0.022	<0.001	----	----	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	0.858	0.002	----	----	----
Lanthanum	7439-91-0	0.001	mg/L	0.008	<0.001	----	----	----
Rubidium	7440-17-7	0.001	mg/L	0.025	0.013	----	----	----
Lithium	7439-93-2	0.001	mg/L	0.028	0.007	----	----	----
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	----	----	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	----	----	----
Cerium	7440-45-1	0.001	mg/L	0.028	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L	6.61	0.399	----	----	----
Neodymium	7440-00-8	0.001	mg/L	0.016	<0.001	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.011	----	----	----
Praseodymium	7440-10-0	0.001	mg/L	0.004	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L	0.071	0.002	----	----	----
Samarium	7440-19-9	0.001	mg/L	0.005	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L	0.004	<0.001	----	----	----
Terbium	7440-27-9	0.001	mg/L	0.001	<0.001	----	----	----
Antimony	7440-36-0	0.001	mg/L	0.606	12.0	----	----	----
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	----	----	----
Ytterbium	7440-64-4	0.001	mg/L	0.003	<0.001	----	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	----	----	----
Yttrium	7440-65-5	0.001	mg/L	0.050	<0.001	----	----	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	----	----	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	----	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L	1.80	<0.005	----	----	----
Iron	7439-89-6	0.05	mg/L	1.17	<0.05	----	----	----

EG035F: Dissolved Mercury by FIMS

Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
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EK040P: Fluoride by PC Titrator



Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Sample ID	2022095_3020 TSF_7b Tailings	2022095_3021 TSF_7c Tailings	----	----	----
Sampling date / time					13-Dec-2022 00:00	13-Dec-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2237627-047	EB2237627-048	-----	-----	-----
					Result	Result	----	----	----
EK040P: Fluoride by PC Titrator - Continued									
Fluoride	16984-48-8	0.1	mg/L		0.4	0.5	----	----	----



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095__0001 TS_1 Topsoil	2022095__0002 TS_2 Topsoil	2022095__0003 TS_3 Topsoil	2022095__0004 TS_4 Topsoil	2022095__0005 TS_5 Topsoil
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-001	EB2237627-002	EB2237627-003	EB2237627-004	EB2237627-005
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl ₂)	----	0.1	pH Unit	4.1	4.1	4.3	4.3	3.9
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	5.0	4.8	5.2	5.1	4.9
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H ₂ SO ₄ /t	-4.0	-2.8	-3.4	-3.5	-3.1
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	17	12	27	50	34
EA013: Acid Neutralising Capacity								
ANC as H ₂ SO ₄	----	0.5	kg H ₂ SO ₄ equiv./t	4.0	2.8	3.4	3.5	3.1
ANC as CaCO ₃	----	0.1	% CaCO ₃	0.4	0.3	0.4	0.4	0.3
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	<1.0	<1.0	<1.0	<1.0	<1.0
ED005: Exchange Acidity								
∅ Exchange Acidity	----	0.1	meq/100g	0.3	0.9	0.3	0.3	1.3
∅ Exchangeable Aluminium	----	0.1	meq/100g	0.4	0.7	0.3	0.3	0.9
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.2	<0.1	0.4	1.1	0.3
Exchangeable Magnesium	----	0.1	meq/100g	<0.1	<0.1	0.2	0.5	0.5
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	0.7	1.0	1.0	2.0	2.3
Exchangeable Sodium Percent	----	0.1	%	3.4	<0.1	<0.1	0.5	7.7
Calcium/Magnesium Ratio	----	0.1	-	----	----	2.0	2.2	0.6
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	<100	<100	<100	<100	<100
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	<0.01	<0.01	<0.01
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	<10	20
ED092: DTPA Extractable Metals								
∅ Copper	7440-50-8	1	mg/kg	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095__0001 TS_1 Topsoil	2022095__0002 TS_2 Topsoil	2022095__0003 TS_3 Topsoil	2022095__0004 TS_4 Topsoil	2022095__0005 TS_5 Topsoil
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-001	EB2237627-002	EB2237627-003	EB2237627-004	EB2237627-005
				Result	Result	Result	Result	Result
ED092: DTPA Extractable Metals - Continued								
Ø Iron	7439-89-6	1	mg/kg	10	9	7	17	26
Ø Manganese	7439-96-5	1	mg/kg	2	<1	4	9	4
Ø Zinc	7440-66-6	1	mg/kg	<1	<1	<1	<1	<1
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	5.8	2.6	10.0	19.0	5.1
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	5.8	2.6	10.0	19.0	5.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	<20	170	220	370	340
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	<20	170	230	390	340
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	<2	49	73	86	92
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	<5	<5	<5
EP004: Organic Matter								
Organic Matter	----	0.5	%	<0.5	<0.5	0.6	1.1	0.8
Total Organic Carbon	----	0.5	%	<0.5	<0.5	<0.5	0.6	<0.5

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	2022095__0006 TS_6 Topsoil	2022095__2001 WRD_1 Mine waste	2022095__2002 WRD_2 Mine waste	2022095__2003 WRD_3 Mine waste	2022095__2004 WRD_4 Mine waste
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	
Compound	CAS Number	LOR	Unit	EB2237627-006	EB2237627-007	EB2237627-008	EB2237627-009	EB2237627-010	
				Result	Result	Result	Result	Result	
EA001: pH in soil using 0.01M CaCl extract									
pH (CaCl2)	----	0.1	pH Unit	5.2	----	3.6	3.8	----	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	6.0	4.4	4.5	4.9	3.6	
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t	-13.7	-1.1	-1.7	-4.1	<0.5	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	48	52	21	20	128	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	14.3	2.6	2.6	4.7	2.9	
ANC as CaCO3	----	0.1	% CaCO3	1.4	0.3	0.3	0.5	0.3	
Fizz Rating	----	0	Fizz Unit	1	0	0	0	0	
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%	4.8	----	1.3	1.3	----	
ED005: Exchange Acidity									
∅ Exchange Acidity	----	0.1	meq/100g	0.2	----	5.7	3.3	----	
∅ Exchangeable Aluminium	----	0.1	meq/100g	0.2	----	4.4	2.8	----	
ED007: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g	10.1	----	0.4	1.7	----	
Exchangeable Magnesium	----	0.1	meq/100g	11.6	----	0.6	0.9	----	
Exchangeable Potassium	----	0.1	meq/100g	0.4	----	0.1	0.2	----	
Exchangeable Sodium	----	0.1	meq/100g	0.1	----	<0.1	<0.1	----	
Cation Exchange Capacity	----	0.1	meq/100g	22.2	----	6.9	5.0	----	
Exchangeable Sodium Percent	----	0.1	%	0.5	----	1.0	0.6	----	
Calcium/Magnesium Ratio	----	0.1	-	0.9	----	0.7	1.9	----	
Magnesium/Potassium Ratio	----	0.1	-	27.8	----	4.5	5.7	----	
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	686	----	258	245	----	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.05	0.03	0.02	0.11	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg	<10	----	<10	<10	----	
ED092: DTPA Extractable Metals									



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095__0006 TS_6 Topsoil	2022095__2001 WRD_1 Mine waste	2022095__2002 WRD_2 Mine waste	2022095__2003 WRD_3 Mine waste	2022095__2004 WRD_4 Mine waste
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-006	EB2237627-007	EB2237627-008	EB2237627-009	EB2237627-010
				Result	Result	Result	Result	Result
ED092: DTPA Extractable Metals - Continued								
Ø Copper	7440-50-8	1	mg/kg	<1	----	1	<1	----
Ø Iron	7439-89-6	1	mg/kg	40	----	77	47	----
Ø Manganese	7439-96-5	1	mg/kg	14	----	2	17	----
Ø Zinc	7440-66-6	1	mg/kg	<1	----	1	3	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	----	<20	<20	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	----	<0.1	0.1	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	15.4	----	1.1	1.6	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	15.4	----	1.1	1.7	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	580	----	200	380	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	600	----	200	380	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	1740	----	437	441	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	38	----	75	15	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	1.3	----	<0.5	0.7	----
Total Organic Carbon	----	0.5	%	0.8	----	<0.5	<0.5	----



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095__2005 WRD_5 Mine waste	2022095__2006 WRD_6 Mine waste	2022095__2007 WRD_7 Mine waste	2022095__2008 WRD_8 Mine waste	2022095__2011 WRD_11 Mine waste
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-011	EB2237627-012	EB2237627-013	EB2237627-014	EB2237627-015
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	5.0	5.0	3.7	3.4	3.8
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-0.4	-3.3	-1.6	<0.5	-0.7
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	15	19	100	209	90
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1.0	3.6	4.4	2.7	2.2
ANC as CaCO3	----	0.1	% CaCO3	0.1	0.4	0.4	0.3	0.2
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.01	0.09	0.10	0.05



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095_2012 WRD_12 Mine waste	2022095_2013 WRD_13 Mine waste	2022095_2014 WRD_14 Mine waste	2022095_2015 WRD-S_15 Mine waste	2022095_2016 WRD-S_16 Mine waste
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-016	EB2237627-017	EB2237627-018	EB2237627-019	EB2237627-020
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	----	4.2	----	4.9	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	5.0	5.4	5.2	5.7	6.3
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-2.6	-4.4	-3.6	-6.0	-4.4
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	18	14	11	103	25
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	3.2	4.7	3.6	8.1	4.7
ANC as CaCO3	----	0.1	% CaCO3	0.3	0.5	0.4	0.8	0.5
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	----	1.2	----	<1.0	----
ED005: Exchange Acidity								
∅ Exchange Acidity	----	0.1	meq/100g	----	1.2	----	0.5	----
∅ Exchangeable Aluminium	----	0.1	meq/100g	----	1.0	----	0.4	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	3.6	----	4.8	----
Exchangeable Magnesium	----	0.1	meq/100g	----	1.6	----	0.6	----
Exchangeable Potassium	----	0.1	meq/100g	----	0.2	----	0.2	----
Exchangeable Sodium	----	0.1	meq/100g	----	<0.1	----	0.5	----
Cation Exchange Capacity	----	0.1	meq/100g	----	6.6	----	6.5	----
Exchangeable Sodium Percent	----	0.1	%	----	0.6	----	8.9	----
Calcium/Magnesium Ratio	----	0.1	-	----	2.2	----	8.0	----
Magnesium/Potassium Ratio	----	0.1	-	----	9.3	----	3.4	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	----	257	----	242	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.01	<0.01	0.07	0.01
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	----	<10	----	40	----



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095_2012 WRD_12 Mine waste	2022095_2013 WRD_13 Mine waste	2022095_2014 WRD_14 Mine waste	2022095_2015 WRD-S_15 Mine waste	2022095_2016 WRD-S_16 Mine waste
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-016	EB2237627-017	EB2237627-018	EB2237627-019	EB2237627-020
				Result	Result	Result	Result	Result
ED092: DTPA Extractable Metals								
Ø Copper	7440-50-8	1	mg/kg	----	<1	----	<1	----
Ø Iron	7439-89-6	1	mg/kg	----	22	----	86	----
Ø Manganese	7439-96-5	1	mg/kg	----	16	----	16	----
Ø Zinc	7440-66-6	1	mg/kg	----	3	----	<1	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	----	<20	----	<20	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	----	<0.1	----	<0.1	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	----	1.3	----	<0.1	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	1.3	----	<0.1	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	180	----	280	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	180	----	280	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	208	----	483	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	----	14	----	61	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	0.6	----	1.2	----
Total Organic Carbon	----	0.5	%	----	<0.5	----	0.7	----

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	2022095_2018 WRD-S_18 Mine waste	2022095_2019 ROM_1 Mine waste	2022095_2020 ROM_2 Mine waste	2022095_2021 ROM_3 Mine waste	2022095_2022 ROM_4 Mine waste
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	
Compound	CAS Number	LOR	Unit	EB2237627-021	EB2237627-022	EB2237627-023	EB2237627-024	EB2237627-025	
				Result	Result	Result	Result	Result	
EA001: pH in soil using 0.01M CaCl extract									
pH (CaCl2)	----	0.1	pH Unit	----	----	3.5	----	3.4	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	5.6	4.5	4.2	7.6	4.4	
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t	-0.9	-1.6	-1.5	-9.5	-1.4	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	29	21	33	194	22	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1.5	2.8	3.3	12.9	3.2	
ANC as CaCO3	----	0.1	% CaCO3	0.2	0.3	0.3	1.3	0.3	
Fizz Rating	----	0	Fizz Unit	0	0	0	1	0	
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%	----	----	1.3	----	<1.0	
ED005: Exchange Acidity									
∅ Exchange Acidity	----	0.1	meq/100g	----	----	3.4	----	5.4	
∅ Exchangeable Aluminium	----	0.1	meq/100g	----	----	2.8	----	4.4	
ED007: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g	----	----	0.3	----	0.2	
Exchangeable Magnesium	----	0.1	meq/100g	----	----	<0.1	----	<0.1	
Exchangeable Potassium	----	0.1	meq/100g	----	----	<0.1	----	0.1	
Exchangeable Sodium	----	0.1	meq/100g	----	----	<0.1	----	<0.1	
Cation Exchange Capacity	----	0.1	meq/100g	----	----	3.8	----	5.8	
Exchangeable Sodium Percent	----	0.1	%	----	----	2.6	----	4.9	
Magnesium/Potassium Ratio	----	0.1	-	----	----	----	----	<0.1	
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	----	----	255	----	279	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.04	0.06	0.11	0.06	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg	----	----	<10	----	<10	
ED092: DTPA Extractable Metals									



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095__2018 WRD-S_18 Mine waste	2022095__2019 ROM_1 Mine waste	2022095__2020 ROM_2 Mine waste	2022095__2021 ROM_3 Mine waste	2022095__2022 ROM_4 Mine waste
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-021	EB2237627-022	EB2237627-023	EB2237627-024	EB2237627-025
				Result	Result	Result	Result	Result
ED092: DTPA Extractable Metals - Continued								
Ø Copper	7440-50-8	1	mg/kg	----	----	<1	----	<1
Ø Iron	7439-89-6	1	mg/kg	----	----	102	----	93
Ø Manganese	7439-96-5	1	mg/kg	----	----	<1	----	<1
Ø Zinc	7440-66-6	1	mg/kg	----	----	<1	----	1
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	----	----	<20	----	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	----	----	<0.1	----	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	----	----	0.4	----	0.3
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	0.4	----	0.3
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	250	----	230
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	----	250	----	230
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	----	438	----	562
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	----	----	80	----	108
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	----	<0.5	----	<0.5
Total Organic Carbon	----	0.5	%	----	----	<0.5	----	<0.5



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095__2023 ROM_5 Mine waste	2022095__2024 ROM_6 Mine waste	2022095__3001 TSF_1a Tailings	2022095__3002 TSF_1b Tailings	2022095__3003 TSF_1c Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-026	EB2237627-027	EB2237627-028	EB2237627-029	EB2237627-030
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	----	----	7.1	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	4.3	4.6	8.2	4.3	7.0
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-1.5	-1.6	-5.2	-2.0	-4.6
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	14	16	150	806	532
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	3.3	3.7	5.8	5.1	6.1
ANC as CaCO3	----	0.1	% CaCO3	0.3	0.4	0.6	0.5	0.6
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	----	----	2.6	----	----
ED006: Exchangeable Cations on Alkaline Soils								
∅ Exchangeable Calcium	----	0.2	meq/100g	----	----	2.6	----	----
∅ Exchangeable Magnesium	----	0.2	meq/100g	----	----	<0.2	----	----
∅ Exchangeable Potassium	----	0.2	meq/100g	----	----	0.2	----	----
∅ Exchangeable Sodium	----	0.2	meq/100g	----	----	0.4	----	----
∅ Cation Exchange Capacity	----	0.2	meq/100g	----	----	3.3	----	----
∅ Exchangeable Sodium Percent	----	0.2	%	----	----	12.0	----	----
∅ Magnesium/Potassium Ratio	----	0.2	-	----	----	<0.2	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	----	----	148	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.06	0.07	0.02	0.10	0.05
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	----	----	<10	----	----
ED092: DTPA Extractable Metals								
∅ Copper	7440-50-8	1	mg/kg	----	----	<1	----	----
∅ Iron	7439-89-6	1	mg/kg	----	----	10	----	----
∅ Manganese	7439-96-5	1	mg/kg	----	----	2	----	----
∅ Zinc	7440-66-6	1	mg/kg	----	----	<1	----	----



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095__2023 ROM_5 Mine waste	2022095__2024 ROM_6 Mine waste	2022095__3001 TSF_1a Tailings	2022095__3002 TSF_1b Tailings	2022095__3003 TSF_1c Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-026	EB2237627-027	EB2237627-028	EB2237627-029	EB2237627-030
				Result	Result	Result	Result	Result
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	----	----	<20	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	----	----	<0.1	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	----	----	0.1	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	0.1	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	70	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	----	70	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	----	282	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	----	----	20	----	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	----	<0.5	----	----
Total Organic Carbon	----	0.5	%	----	----	<0.5	----	----

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	2022095_3004 TSF_2a Tailings	2022095_3005 TSF_2b Tailings	2022095_3006 TSF_2c Tailings	2022095_3007 TSF_3a Tailings	2022095_3008 TSF_3b Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	
Compound	CAS Number	LOR	Unit	EB2237627-031	EB2237627-032	EB2237627-033	EB2237627-034	EB2237627-035	
				Result	Result	Result	Result	Result	
EA001: pH in soil using 0.01M CaCl extract									
pH (CaCl2)	----	0.1	pH Unit	6.4	----	----	5.2	----	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	6.8	6.2	9.1	5.9	8.3	
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t	-4.0	-3.6	-9.7	-4.0	-4.9	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	191	446	379	91	803	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	4.9	5.1	10.6	4.6	7.7	
ANC as CaCO3	----	0.1	% CaCO3	0.5	0.5	1.1	0.5	0.8	
Fizz Rating	----	0	Fizz Unit	0	0	1	0	0	
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%	----	----	----	0.012	0.034	
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%	<1.0	----	----	<1.0	----	
ED005: Exchange Acidity									
∅ Exchange Acidity	----	0.1	meq/100g	----	----	----	0.2	----	
∅ Exchangeable Aluminium	----	0.1	meq/100g	----	----	----	0.2	----	
ED007: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g	3.2	----	----	2.2	----	
Exchangeable Magnesium	----	0.1	meq/100g	0.2	----	----	0.2	----	
Exchangeable Potassium	----	0.1	meq/100g	<0.1	----	----	<0.1	----	
Exchangeable Sodium	----	0.1	meq/100g	0.4	----	----	0.2	----	
Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	2.9	----	
Cation Exchange Capacity	----	0.1	meq/100g	4.0	----	----	----	----	
Exchangeable Sodium Percent	----	0.1	%	9.2	----	----	8.0	----	
Calcium/Magnesium Ratio	----	0.1	-	16.0	----	----	11.0	----	
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	123	----	----	106	----	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.05	0.03	0.02	0.09	
ED045G: Chloride by Discrete Analyser									



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095_3004 TSF_2a Tailings	2022095_3005 TSF_2b Tailings	2022095_3006 TSF_2c Tailings	2022095_3007 TSF_3a Tailings	2022095_3008 TSF_3b Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-031	EB2237627-032	EB2237627-033	EB2237627-034	EB2237627-035
				Result	Result	Result	Result	Result
ED045G: Chloride by Discrete Analyser - Continued								
Chloride	16887-00-6	10	mg/kg	<10	----	----	<10	----
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1	mg/kg	<1	----	----	<1	----
ø Iron	7439-89-6	1	mg/kg	19	----	----	36	----
ø Manganese	7439-96-5	1	mg/kg	2	----	----	1	----
ø Zinc	7440-66-6	1	mg/kg	<1	----	----	<1	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	----	----	<20	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	----	----	<0.1	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	0.2	----	----	<0.1	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.2	----	----	<0.1	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	70	----	----	40	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	70	----	----	40	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	194	----	----	199	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	15	----	----	46	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	<0.5	----	----	<0.5	----
Total Organic Carbon	----	0.5	%	<0.5	----	----	<0.5	----



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095_3009 TSF_3c Tailings	2022095_3010 TSF_4a Tailings	2022095_3011 TSF_4b Tailings	2022095_3012 TSF_4c Tailings	2022095_3013 TSF_5a Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-036	EB2237627-037	EB2237627-038	EB2237627-039	EB2237627-040
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	----	3.5	----	----	3.9
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.2	3.8	6.6	9.2	4.3
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-3.5	-3.1	6.6	-7.6	-2.9
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	357	115	1360	430	133
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	7.8	3.7	5.0	9.7	3.8
ANC as CaCO3	----	0.1	% CaCO3	0.8	0.4	0.5	1.0	0.4
Fizz Rating	----	0	Fizz Unit	0	0	0	1	0
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	0.106	----	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	----	<1.0	----	----	<1.0
ED005: Exchange Acidity								
∅ Exchange Acidity	----	0.1	meq/100g	----	1.5	----	----	0.5
∅ Exchangeable Aluminium	----	0.1	meq/100g	----	1.0	----	----	0.4
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	0.5	----	----	1.5
Exchangeable Magnesium	----	0.1	meq/100g	----	<0.1	----	----	0.2
Exchangeable Potassium	----	0.1	meq/100g	----	<0.1	----	----	<0.1
Exchangeable Sodium	----	0.1	meq/100g	----	<0.1	----	----	0.3
Cation Exchange Capacity	----	0.1	meq/100g	----	3.3	----	----	2.6
Exchangeable Sodium Percent	----	0.1	%	----	8.2	----	----	15.4
Calcium/Magnesium Ratio	----	0.1	-	----	----	----	----	7.5
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	----	137	----	----	<100
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.14	0.02	0.38	0.07	0.03
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	----	<10	----	----	<10



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095_3009 TSF_3c Tailings	2022095_3010 TSF_4a Tailings	2022095_3011 TSF_4b Tailings	2022095_3012 TSF_4c Tailings	2022095_3013 TSF_5a Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-036	EB2237627-037	EB2237627-038	EB2237627-039	EB2237627-040
				Result	Result	Result	Result	Result
ED092: DTPA Extractable Metals								
Ø Copper	7440-50-8	1	mg/kg	----	5	----	----	1
Ø Iron	7439-89-6	1	mg/kg	----	408	----	----	307
Ø Manganese	7439-96-5	1	mg/kg	----	5	----	----	8
Ø Zinc	7440-66-6	1	mg/kg	----	2	----	----	<1
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	----	<20	----	----	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	----	<0.1	----	----	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	----	<0.1	----	----	<0.1
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	<0.1	----	----	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	60	----	----	40
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	60	----	----	40
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	327	----	----	274
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	----	151	----	----	51
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	<0.5	----	----	<0.5
Total Organic Carbon	----	0.5	%	----	<0.5	----	----	<0.5



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095_3014 TSF_5b Tailings	2022095_3015 TSF_5c Tailings	2022095_3016 TSF_6a Tailings	2022095_3017 TSF_6b Tailings	2022095_3018 TSF_6c Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-041	EB2237627-042	EB2237627-043	EB2237627-044	EB2237627-045
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	----	----	4.1	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.3	9.3	4.6	8.2	5.8
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-0.2	-5.8	-2.5	-9.3	-1.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	1070	368	106	1260	530
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	6.3	8.9	3.7	13.9	5.9
ANC as CaCO3	----	0.1	% CaCO3	0.6	0.9	0.4	1.4	0.6
Fizz Rating	----	0	Fizz Unit	0	0	0	1	0
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	----	----	<1.0	----	----
ED005: Exchange Acidity								
Ø Exchange Acidity	----	0.1	meq/100g	----	----	0.5	----	----
Ø Exchangeable Aluminium	----	0.1	meq/100g	----	----	0.3	----	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	----	1.8	----	----
Exchangeable Magnesium	----	0.1	meq/100g	----	----	0.3	----	----
Exchangeable Potassium	----	0.1	meq/100g	----	----	<0.1	----	----
Exchangeable Sodium	----	0.1	meq/100g	----	----	0.2	----	----
Cation Exchange Capacity	----	0.1	meq/100g	----	----	3.0	----	----
Exchangeable Sodium Percent	----	0.1	%	----	----	9.0	----	----
Calcium/Magnesium Ratio	----	0.1	-	----	----	6.0	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	----	----	104	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.20	0.10	0.04	0.15	0.16
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	----	----	<10	----	----
ED092: DTPA Extractable Metals								
Ø Copper	7440-50-8	1	mg/kg	----	----	3	----	----



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095_3014 TSF_5b Tailings	2022095_3015 TSF_5c Tailings	2022095_3016 TSF_6a Tailings	2022095_3017 TSF_6b Tailings	2022095_3018 TSF_6c Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-041	EB2237627-042	EB2237627-043	EB2237627-044	EB2237627-045
				Result	Result	Result	Result	Result
ED092: DTPA Extractable Metals - Continued								
Ø Iron	7439-89-6	1	mg/kg	----	----	367	----	----
Ø Manganese	7439-96-5	1	mg/kg	----	----	28	----	----
Ø Zinc	7440-66-6	1	mg/kg	----	----	2	----	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	----	----	<20	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	----	----	<0.1	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	----	----	<0.1	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	<0.1	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	70	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	----	70	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	----	362	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	----	----	95	----	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	----	<0.5	----	----
Total Organic Carbon	----	0.5	%	----	----	<0.5	----	----



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095_3019 TSF_7a Tailings	2022095_3020 TSF_7b Tailings	2022095_3021 TSF_7c Tailings	2022095_3022 TSF_8a Tailings	2022095_3023 TSF_8b Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-046	EB2237627-047	EB2237627-048	EB2237627-049	EB2237627-050
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	7.6	----	----	7.1	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.3	3.5	7.2	8.0	3.4
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-2.6	3.6	5.4	-4.7	3.6
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	646	1290	658	314	1480
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	4.7	2.2	5.6	5.6	3.1
ANC as CaCO3	----	0.1	% CaCO3	0.5	0.2	0.6	0.6	0.3
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	0.037	0.021	0.255	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	<1.0	----	----	<1.0	----
ED006: Exchangeable Cations on Alkaline Soils								
∅ Exchangeable Calcium	----	0.2	meq/100g	2.8	----	----	3.2	----
∅ Exchangeable Magnesium	----	0.2	meq/100g	<0.2	----	----	<0.2	----
∅ Exchangeable Potassium	----	0.2	meq/100g	<0.2	----	----	0.2	----
∅ Exchangeable Sodium	----	0.2	meq/100g	1.2	----	----	<0.2	----
∅ Cation Exchange Capacity	----	0.2	meq/100g	4.2	----	----	3.4	----
∅ Exchangeable Sodium Percent	----	0.2	%	29.6	----	----	<0.2	----
∅ Magnesium/Potassium Ratio	----	0.2	-	----	----	----	<0.2	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	141	----	----	163	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.07	0.19	0.36	0.03	0.22
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	----	----	20	----
ED092: DTPA Extractable Metals								
∅ Copper	7440-50-8	1	mg/kg	<1	----	----	<1	----
∅ Iron	7439-89-6	1	mg/kg	21	----	----	13	----



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095_3019 TSF_7a Tailings	2022095_3020 TSF_7b Tailings	2022095_3021 TSF_7c Tailings	2022095_3022 TSF_8a Tailings	2022095_3023 TSF_8b Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-046	EB2237627-047	EB2237627-048	EB2237627-049	EB2237627-050
				Result	Result	Result	Result	Result
ED092: DTPA Extractable Metals - Continued								
ø Manganese	7439-96-5	1	mg/kg	2	----	----	<1	----
ø Zinc	7440-66-6	1	mg/kg	<1	----	----	<1	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	----	----	<20	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	----	----	<0.1	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	0.2	----	----	0.1	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.2	----	----	0.1	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	80	----	----	80	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	80	----	----	80	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	355	----	----	170	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	29	----	----	16	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	<0.5	----	----	<0.5	----
Total Organic Carbon	----	0.5	%	<0.5	----	----	<0.5	----



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095_3024 TSF_8c Tailings	2022095_3025 TSF_9a Tailings	2022095_3026 TSF_9b Tailings	2022095_3027 TSF_9c Tailings	2022095_3028 TSF_10a Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-051	EB2237627-052	EB2237627-053	EB2237627-054	EB2237627-055
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	----	3.6	----	----	3.3
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	3.2	4.0	6.3	7.0	3.4
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	6.9	-2.7	-5.9	-5.8	15.4
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	1380	119	345	310	2820
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	2.0	3.6	6.8	7.0	2.3
ANC as CaCO3	----	0.1	% CaCO3	0.2	0.4	0.7	0.7	0.2
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	----	1.2	----	----	1.0
ED005: Exchange Acidity								
Ø Exchange Acidity	----	0.1	meq/100g	----	1.0	----	----	4.2
Ø Exchangeable Aluminium	----	0.1	meq/100g	----	0.7	----	----	5.0
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	1.3	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	----	0.2	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	----	<0.1	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	----	<0.1	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	----	2.6	----	----	----
Exchangeable Sodium Percent	----	0.1	%	----	2.8	----	----	----
Calcium/Magnesium Ratio	----	0.1	-	----	6.5	----	----	----
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	----	----	----	16.5
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	0.2
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	<0.1
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	----	20.1
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	0.5
Calcium/Magnesium Ratio	----	0.1	-	----	----	----	----	82.5



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095_3024 TSF_8c Tailings	2022095_3025 TSF_9a Tailings	2022095_3026 TSF_9b Tailings	2022095_3027 TSF_9c Tailings	2022095_3028 TSF_10a Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-051	EB2237627-052	EB2237627-053	EB2237627-054	EB2237627-055
				Result	Result	Result	Result	Result
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	----	209	----	----	183
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.29	0.03	0.03	0.04	0.58
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	----	<10	----	----	30
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1	mg/kg	----	<1	----	----	4
ø Iron	7439-89-6	1	mg/kg	----	99	----	----	220
ø Manganese	7439-96-5	1	mg/kg	----	5	----	----	32
ø Zinc	7440-66-6	1	mg/kg	----	<1	----	----	9
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	----	<20	----	----	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	----	<0.1	----	----	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	----	<0.1	----	----	<0.1
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	<0.1	----	----	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	80	----	----	180
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	80	----	----	180
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	299	----	----	427
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	----	92	----	----	112
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	<0.5	----	----	<0.5
Total Organic Carbon	----	0.5	%	----	<0.5	----	----	<0.5



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095_3029 TSF_10b Tailings	2022095_3030 TSF_10c Tailings	2022095_3031 TSF_11a Tailings	2022095_3032 TSF_11b Tailings	2022095_3033 TSF_11c Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-056	EB2237627-057	EB2237627-058	EB2237627-059	EB2237627-060
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	----	----	3.3	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	3.0	4.1	3.4	3.2	8.1
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	<0.5	7.0	-0.5	0.8	2.6
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	854	1110	363	726	622
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	2.7	3.4	3.3	2.6	4.7
ANC as CaCO3	----	0.1	% CaCO3	0.3	0.3	0.3	0.3	0.5
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	----	----	<1.0	----	----
ED005: Exchange Acidity								
Ø Exchange Acidity	----	0.1	meq/100g	----	----	1.4	----	----
Ø Exchangeable Aluminium	----	0.1	meq/100g	----	----	1.1	----	----
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	----	0.7	----	----
Exchangeable Magnesium	----	0.1	meq/100g	----	----	<0.1	----	----
Exchangeable Potassium	----	0.1	meq/100g	----	----	<0.1	----	----
Exchangeable Sodium	----	0.1	meq/100g	----	----	<0.1	----	----
Cation Exchange Capacity	----	0.1	meq/100g	----	----	2.2	----	----
Exchangeable Sodium Percent	----	0.1	%	----	----	<0.1	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	----	----	227	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.10	0.34	0.09	0.11	0.24
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	----	----	<10	----	----
ED092: DTPA Extractable Metals								
Ø Copper	7440-50-8	1	mg/kg	----	----	1	----	----
Ø Iron	7439-89-6	1	mg/kg	----	----	168	----	----



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				2022095_3029 TSF_10b Tailings	2022095_3030 TSF_10c Tailings	2022095_3031 TSF_11a Tailings	2022095_3032 TSF_11b Tailings	2022095_3033 TSF_11c Tailings
Sampling date / time				13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	EB2237627-056	EB2237627-057	EB2237627-058	EB2237627-059	EB2237627-060
				Result	Result	Result	Result	Result
ED092: DTPA Extractable Metals - Continued								
ø Manganese	7439-96-5	1	mg/kg	----	----	3	----	----
ø Zinc	7440-66-6	1	mg/kg	----	----	1	----	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	----	----	<20	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	----	----	<0.1	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	----	----	<0.1	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	<0.1	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	90	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	----	90	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	----	429	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	----	----	155	----	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	----	<0.5	----	----
Total Organic Carbon	----	0.5	%	----	----	<0.5	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID		2022095_3034 TSF_12a Tailings	2022095_3035 TSF_12b Tailings	2022095_3036 TSF_12c Tailings	----	----
Sampling date / time			13-Dec-2022 00:00		13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2237627-061	EB2237627-062	EB2237627-063	-----	-----	-----
			Result	Result	Result	Result	----	----	----
EA001: pH in soil using 0.01M CaCl extract									
pH (CaCl2)	----	0.1	pH Unit	4.6	----	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	5.7	4.0	3.6	----	----	----
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t	-3.6	-2.8	-1.6	----	----	----
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	4	374	444	----	----	----
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	3.6	4.6	3.8	----	----	----
ANC as CaCO3	----	0.1	% CaCO3	0.4	0.5	0.4	----	----	----
Fizz Rating	----	0	Fizz Unit	0	0	0	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%	<1.0	----	----	----	----	----
ED005: Exchange Acidity									
Ø Exchange Acidity	----	0.1	meq/100g	0.1	----	----	----	----	----
Ø Exchangeable Aluminium	----	0.1	meq/100g	0.1	----	----	----	----	----
ED007: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g	1.5	----	----	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	<0.1	----	----	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	<0.1	----	----	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	<0.1	----	----	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	1.8	----	----	----	----	----
Exchangeable Sodium Percent	----	0.1	%	<0.1	----	----	----	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)									
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	226	----	----	----	----	----
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.06	0.07	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg	<10	----	----	----	----	----
ED092: DTPA Extractable Metals									
Ø Copper	7440-50-8	1	mg/kg	<1	----	----	----	----	----
Ø Iron	7439-89-6	1	mg/kg	11	----	----	----	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	2022095_3034 TSF_12a Tailings	2022095_3035 TSF_12b Tailings	2022095_3036 TSF_12c Tailings	----	----
Sampling date / time					13-Dec-2022 00:00	13-Dec-2022 00:00	13-Dec-2022 00:00	----	----
Compound	CAS Number	LOR	Unit		EB2237627-061	EB2237627-062	EB2237627-063	-----	-----
				Result	Result	Result	Result	----	----
ED092: DTPA Extractable Metals - Continued									
ø Manganese	7439-96-5	1	mg/kg		2	----	----	----	----
ø Zinc	7440-66-6	1	mg/kg		<1	----	----	----	----
EK055: Ammonia as N									
Ammonia as N	7664-41-7	20	mg/kg		<20	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg		<0.1	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg		0.1	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		0.1	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		50	----	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		50	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		90	----	----	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		5	----	----	----	----
EP004: Organic Matter									
Organic Matter	----	0.5	%		<0.5	----	----	----	----
Total Organic Carbon	----	0.5	%		<0.5	----	----	----	----



Analytical Results

Sub-Matrix: WATER (Matrix: SOIL)				Sample ID	DI water for 1:5	----	----	----	----
				Sampling date / time	13-Dec-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2237627-064	-----	-----	-----	-----
					Result	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		5.6	----	----	----	----
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		<1	----	----	----	----

11.4 Trilab physical reports

EMERSON CLASS NUMBER TEST REPORT

Test Method: AS 1289 3.8.1

Client	RGS Environmental Pty Ltd	Report No.	23010110-EM
		Workorder No.	10574
Address	PO Box 3091, Sunnybank South QLD 4109	Test Date	12/01/2023
		Report Date	17/01/2023
Project	2022095 - Alice River		

Sample No.	23010110	23010111	23010112	23010113	-	-	-
Client ID	2022095_CO 01 - Topsoil	2022095_CO 02 - Waste rock	2022095_CO 03 - Tailings	2022095_CO 04 - Tailings	-	-	-
Depth (m)	Not Supplied	Not Supplied	Not Supplied	Not Supplied	-	-	-
Description	Clayey SAND - brown	Silty Sandy GRAVEL with cobbles pale brown	Silty SAND - pale brown/yellow	Sandy SILT - pale brown/white	-	-	-
Emerson Class Number	3	2	2	2	-	-	-

Sample No.	-	-	-	-	-	-	-
Client ID	-	-	-	-	-	-	-
Depth (m)	-	-	-	-	-	-	-
Description	-	-	-	-	-	-	-
Emerson Class Number	-	-	-	-	-	-	-

Sample No.	-	-	-	-	-	-	-
Client ID	-	-	-	-	-	-	-
Depth (m)	-	-	-	-	-	-	-
Description	-	-	-	-	-	-	-
Emerson Class Number	-	-	-	-	-	-	-

NOTES/REMARKS:

Sample/s supplied by the client

Tested with Distilled water at 21.7°C

Page 1 of 1 REP00402

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Authorised Signatory



Joshua Hawley



Laboratory No. 9926

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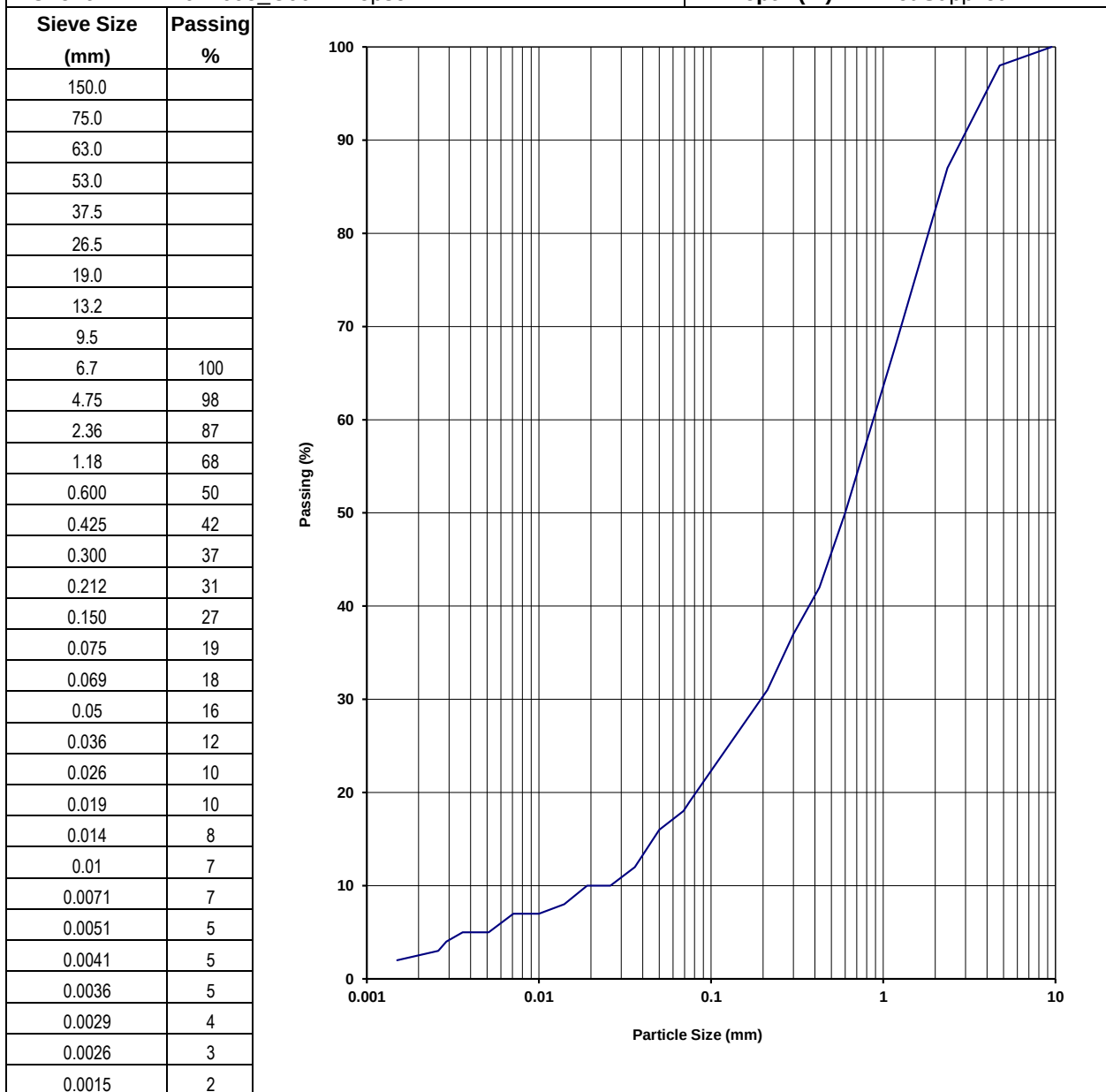
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010110-G
		Workorder No.	0010574
Address	PO Box 3091, Sunnybank South QLD 4109	Test Date	11/1/2023
		Report Date	25/1/2023
Project	2022095 - Alice River		
Client ID	2022095_C001 - Topsoil	Depth (m)	Not Supplied


NOTES/REMARKS:

-
 Moisture Content 0.7% -2.36mm Soil Particle Density(t/m³) 2.56
 Sample/s supplied by the client

Page 1 of 1 REP03904

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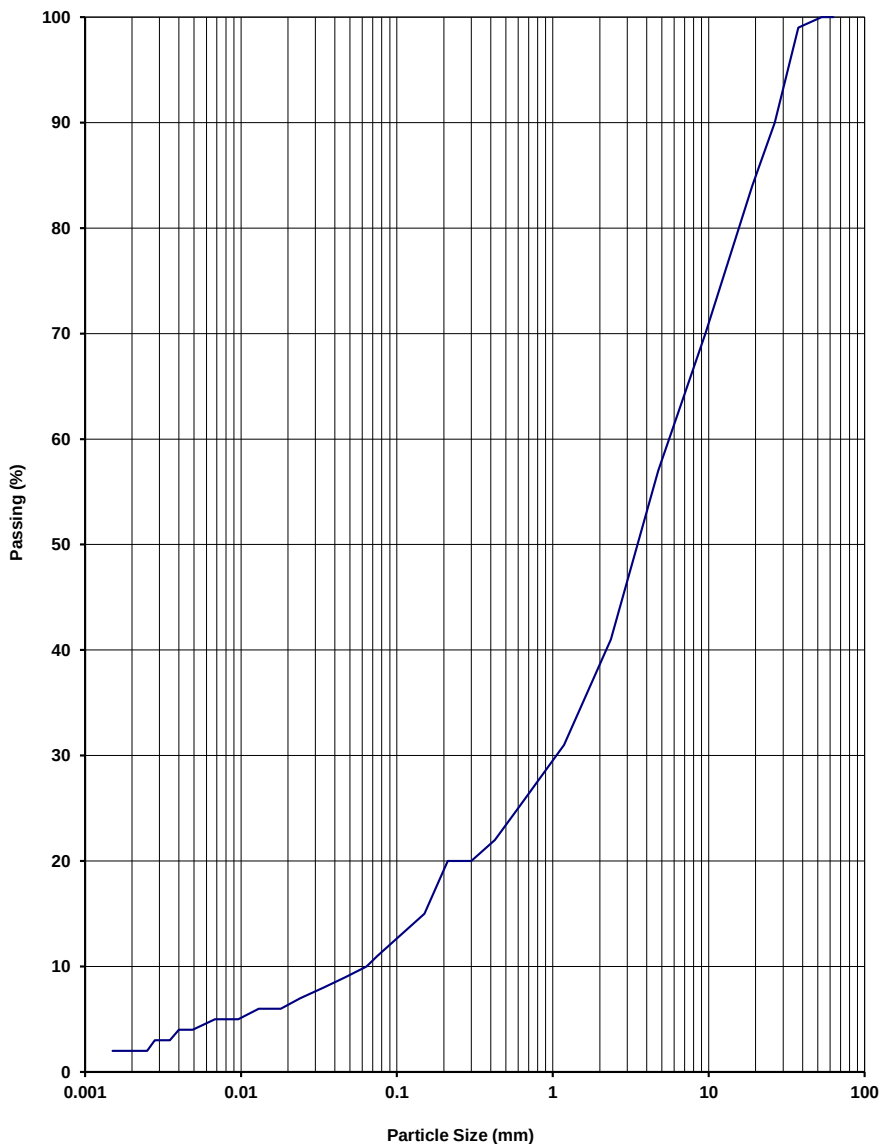
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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010111-G
		Workorder No.	0010574
Address	PO Box 3091, Sunnybank South QLD 4109	Test Date	5/1/2023
		Report Date	27/1/2023
Project	2022095 - Alice River		
Client ID	2022095_C002 - Waste rock	Depth (m)	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	100
37.5	99
26.5	90
19.0	84
13.2	73
9.5	70
6.7	66
4.75	57
2.36	41
1.18	31
0.600	25
0.425	22
0.300	20
0.212	20
0.150	15
0.075	11
0.064	10
0.047	9
0.034	8
0.024	7
0.018	6
0.013	6
0.0096	5
0.0068	5
0.0049	4
0.004	4
0.0035	3
0.0028	3
0.0025	2
0.0015	2



NOTES/REMARKS:	-
Moisture Content	0.7%
-2.36mm Soil Particle Density(t/m ³)	2.58
Sample/s supplied by the client	

Page 1 of 1 REP03904

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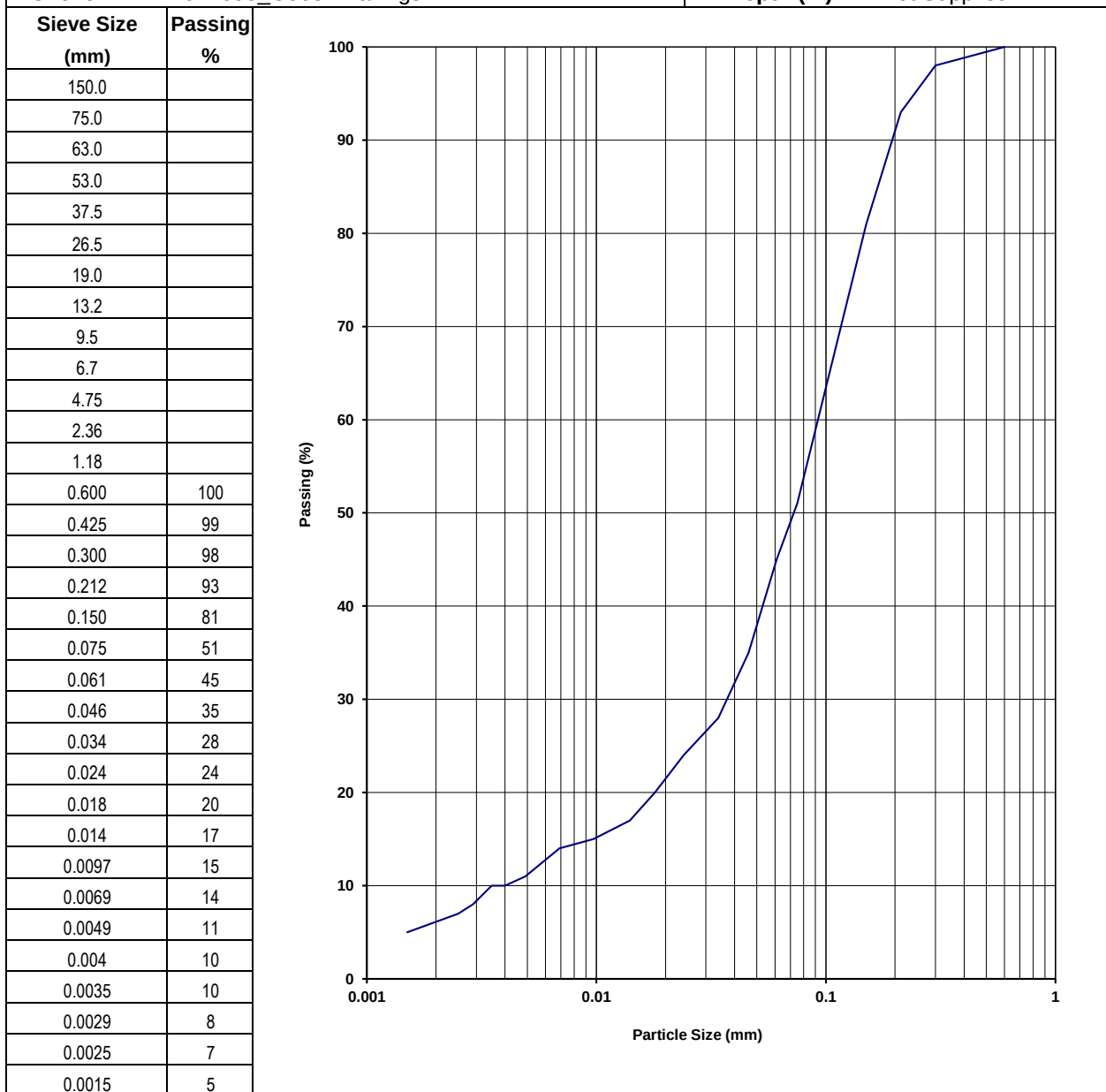
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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010112-G
		Workorder No.	0010574
Address	PO Box 3091, Sunnybank South QLD 4109	Test Date	1/11/2023
		Report Date	25/1/2023
Project	2022095 - Alice River		
Client ID	2022095_C003 - Tailings	Depth (m)	Not Supplied


NOTES/REMARKS:

-
 Moisture Content 0.7% -2.36mm Soil Particle Density(t/m³) 2.59
 Sample/s supplied by the client

Page 1 of 1 REP03904

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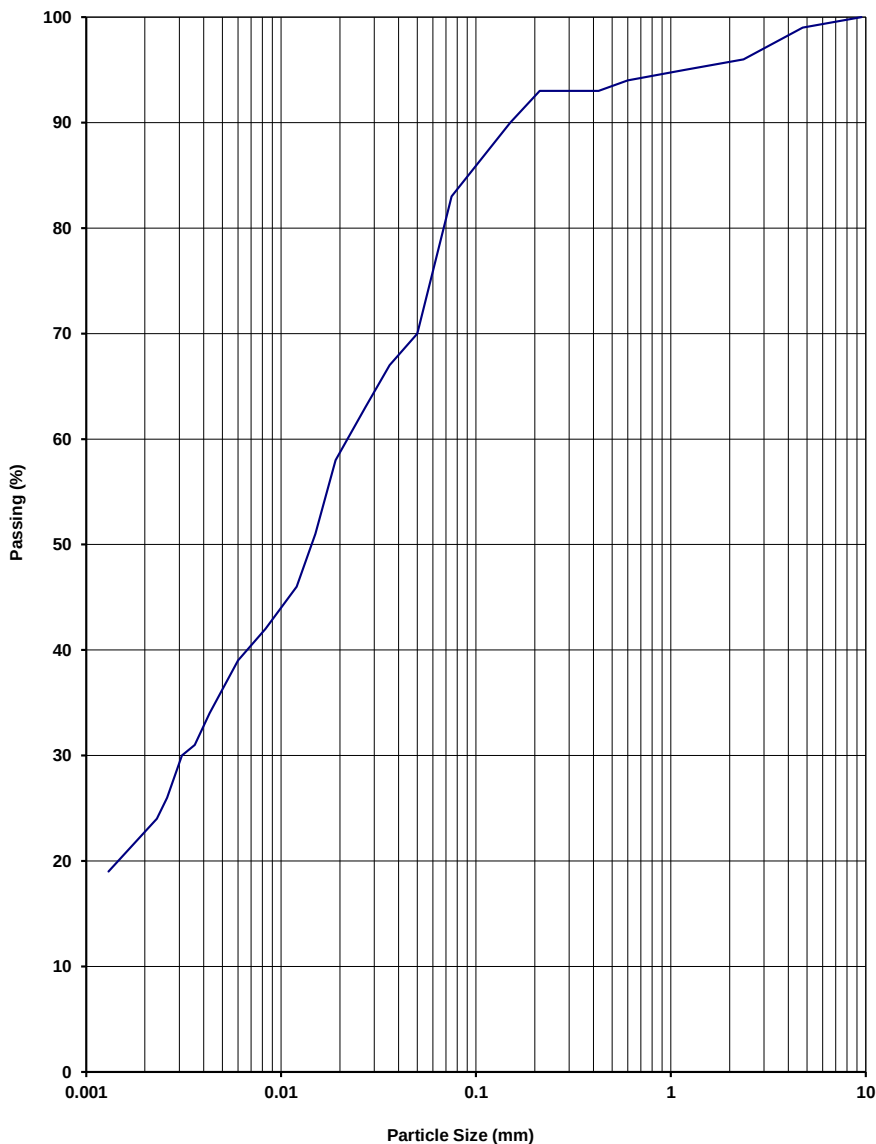
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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010113-G
		Workorder No.	0010574
Address	PO Box 3091, Sunnybank South QLD 4109	Test Date	11/1/2023
		Report Date	25/1/2023
Project	2022095 - Alice River		
Client ID	2022095_C004 - Tailings	Depth (m)	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	100
4.75	99
2.36	96
1.18	95
0.600	94
0.425	93
0.300	93
0.212	93
0.150	90
0.075	83
0.05	70
0.036	67
0.027	63
0.019	58
0.015	51
0.012	46
0.0083	42
0.006	39
0.0043	34
0.0036	31
0.0031	30
0.0026	26
0.0023	24
0.0013	19



NOTES/REMARKS:

-
 Moisture Content 1.2% -2.36mm Soil Particle Density(t/m^3) 2.64
 Sample/s supplied by the client

Page 1 of 1 REP03904

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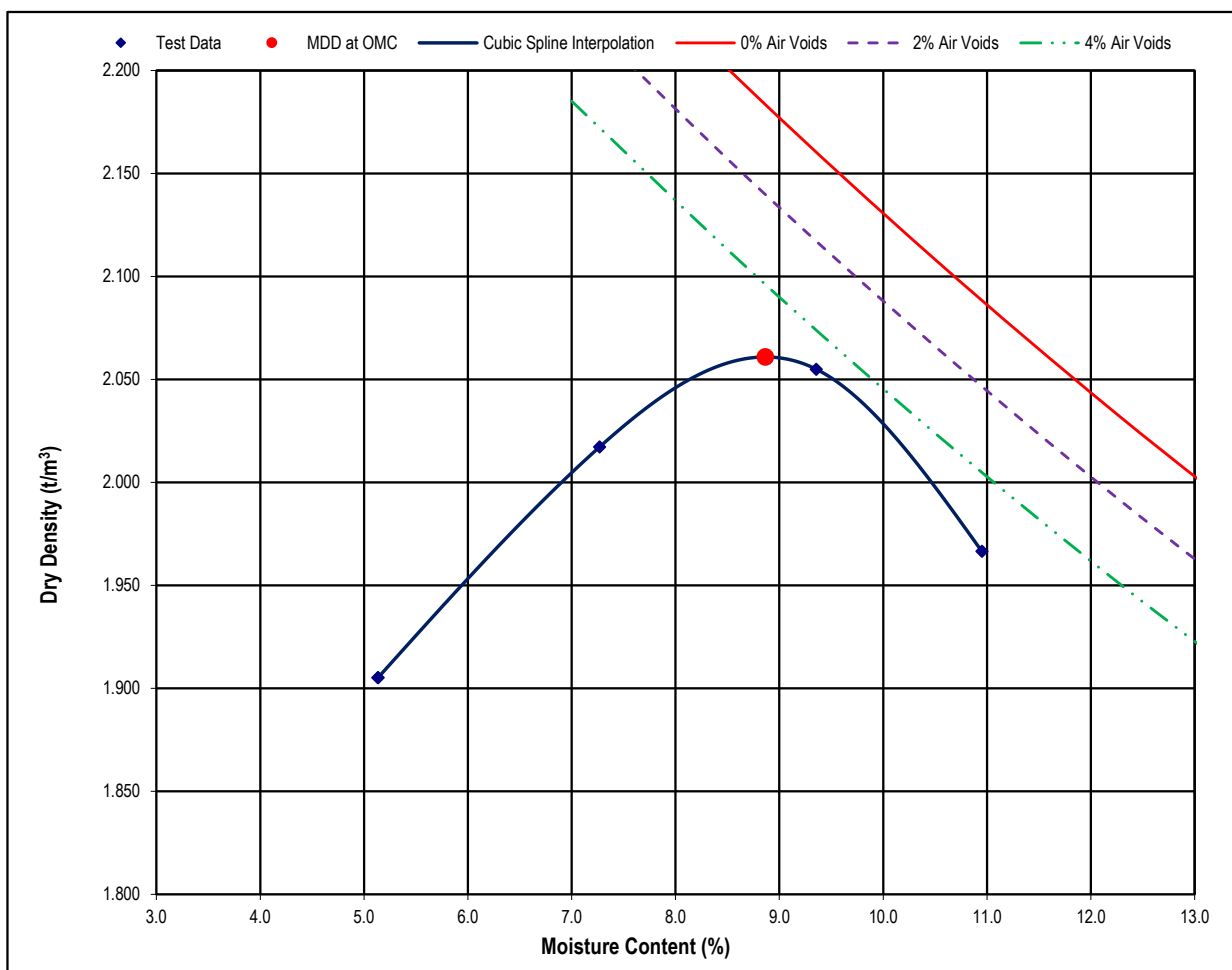
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MOISTURE/DENSITY RELATIONSHIP TEST REPORT

Test Method: AS 1289 5.1.1 (Standard) & AS 1289.2.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010110-MDD
		Workorder No.	0010574
Address	PO Box 3091, Sunnybank South QLD 4109	Test Date	10/01/2023
		Report Date	11/01/2023
Project	2022095 - Alice River		
Client ID	2022095_C001 - Topsoil	Depth (m)	Not Supplied
Description	Clayey SAND-brown		



Maximum Dry Density (t/m³)	2.06	Optimum Moisture Content (%)	8.9
Moisture Content (%)	0.7	Percentage of Oversize/Sieve Size (mm)	0 / 19

NOTES/REMARKS:

Curing Time (hrs): 96 * Based on Visual/Tactile assessment of material.

Sample/s supplied by the client % Voids based on assumed SG of 2.71

Page 1 of 1 REP01304

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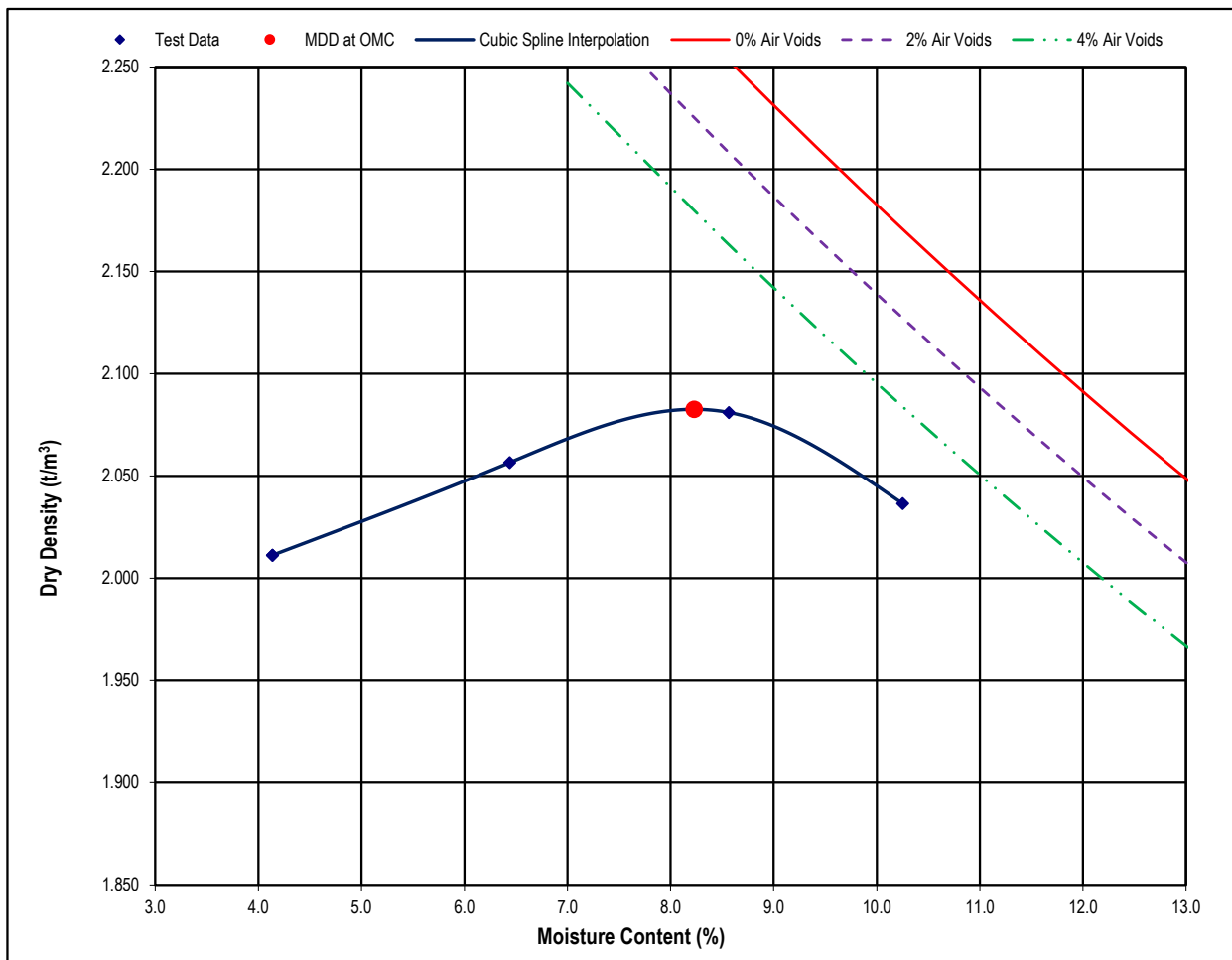
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

MOISTURE/DENSITY RELATIONSHIP TEST REPORT

Test Method: AS 1289 5.1.1 (Standard) & AS 1289.2.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010111-MDD
		Workorder No.	0010574
Address	PO Box 3091, Sunnybank South QLD 4109	Test Date	10/01/2023
		Report Date	11/01/2023
Project	2022095 - Alice River		
Client ID	2022095_C002 - Waste rock	Depth (m)	Not Supplied
Description	Silty Sandy GRAVEL with cobbles-pale brown		



Maximum Dry Density (t/m³)	2.08	Optimum Moisture Content (%)	8.2
Moisture Content (%)	0.7	Percentage of Oversize/Sieve Size (mm)	16 / 19

NOTES/REMARKS:

Curing Time (hrs): 96 * Based on Visual/Tactile assessment of material.

Sample/s supplied by the client % Voids based on assumed SG of 2.79

Page 1 of 1 REP01304

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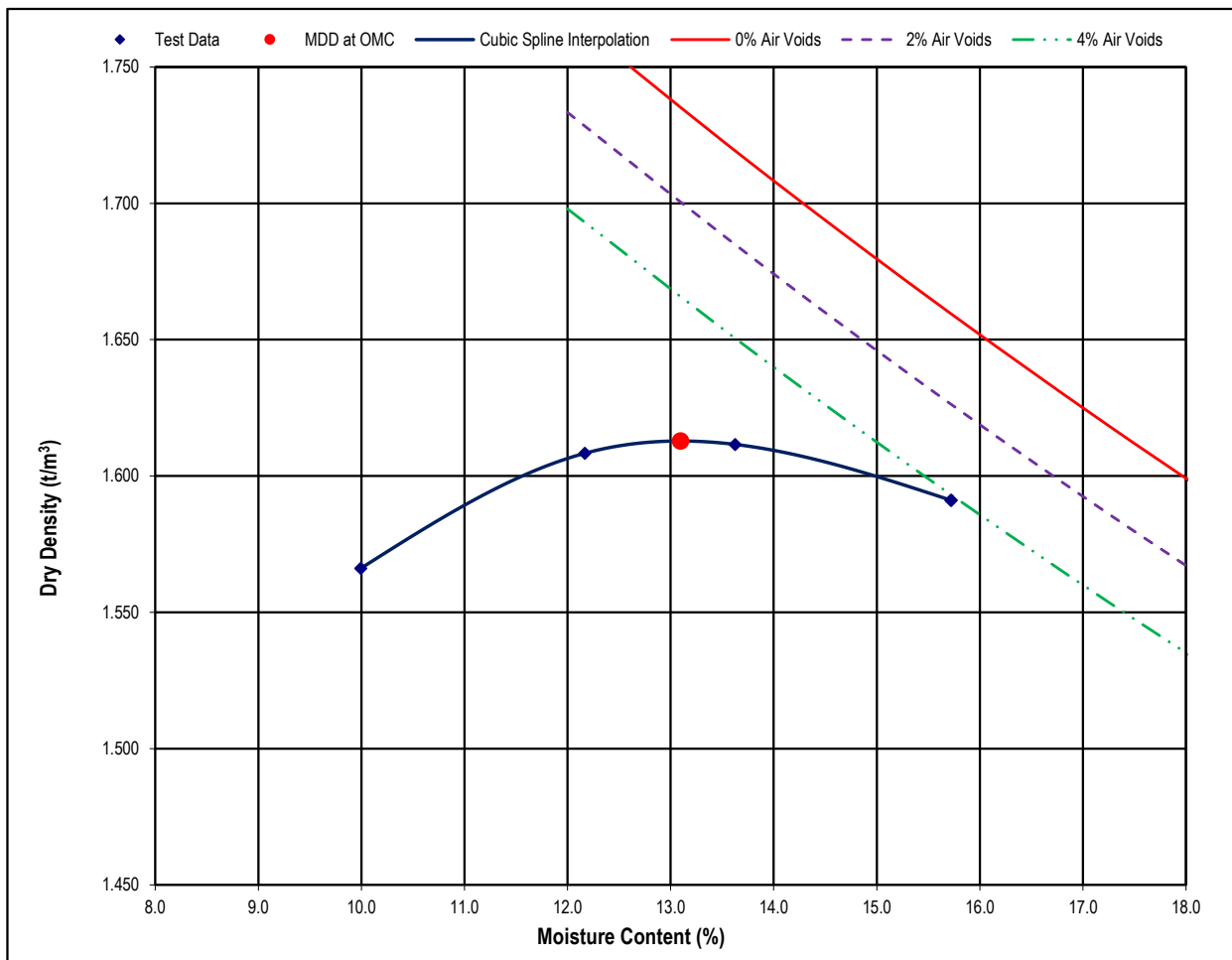
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

MOISTURE/DENSITY RELATIONSHIP TEST REPORT

Test Method: AS 1289 5.1.1 (Standard) & AS 1289.2.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010112-MDD
		Workorder No.	0010574
Address	PO Box 3091, Sunnybank South QLD 4109	Test Date	10/01/2023
		Report Date	11/01/2023
Project	2022095 - Alice River		
Client ID	2022095_C003 - Tailings	Depth (m)	Not Supplied
Description	Silty SAND - pale brown/yellow		



Maximum Dry Density (t/m³)	1.61	Optimum Moisture Content (%)	13.1
Moisture Content (%)	0.7	Percentage of Oversize/Sieve Size (mm)	0 / 19

NOTES/REMARKS:

Curing Time (hrs): 96 * Based on Visual/Tactile assessment of material.

Sample/s supplied by the client % Voids based on assumed SG of 2.25

Page 1 of 1 REP01304

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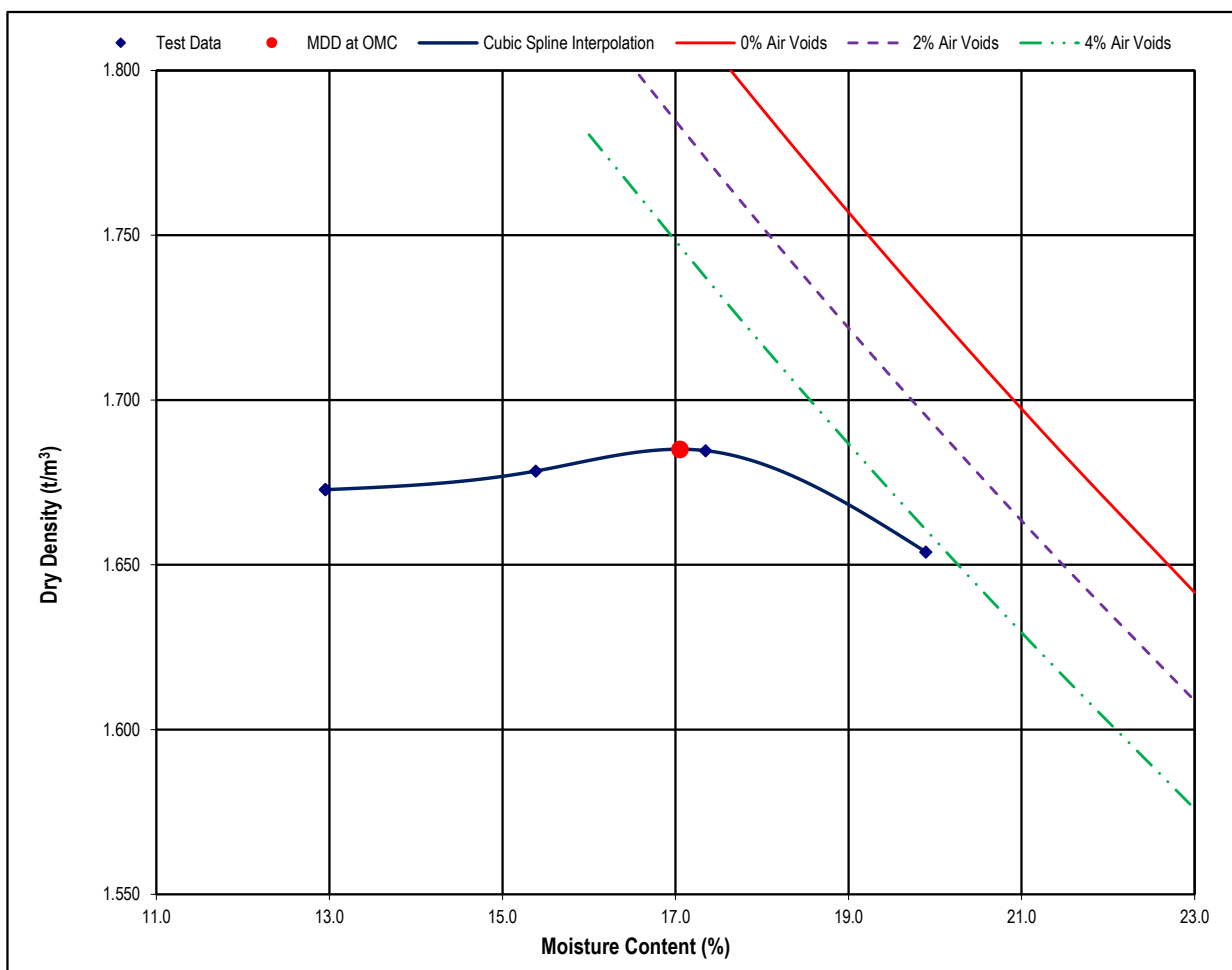
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

MOISTURE/DENSITY RELATIONSHIP TEST REPORT

Test Method: AS 1289 5.1.1 (Standard) & AS 1289.2.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010113-MDD
		Workorder No.	0010574
Address	PO Box 3091, Sunnybank South QLD 4109	Test Date	10/01/2023
		Report Date	11/01/2023
Project	2022095 - Alice River		
Client ID	2022095_C004 - Tailings	Depth (m)	Not Supplied
Description	Sandy SILT-pale brown/white		



Maximum Dry Density (t/m³)	1.69	Optimum Moisture Content (%)	17.1
Moisture Content (%)	1.2	Percentage of Oversize/Sieve Size (mm)	0 / 19

NOTES/REMARKS:

Curing Time (hrs): 96 * Based on Visual/Tactile assessment of material.

Sample/s supplied by the client % Voids based on assumed SG of 2.64

Page 1 of 1 REP01304

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

PERMEABILITY BY CONSTANT HEAD TEST REPORT

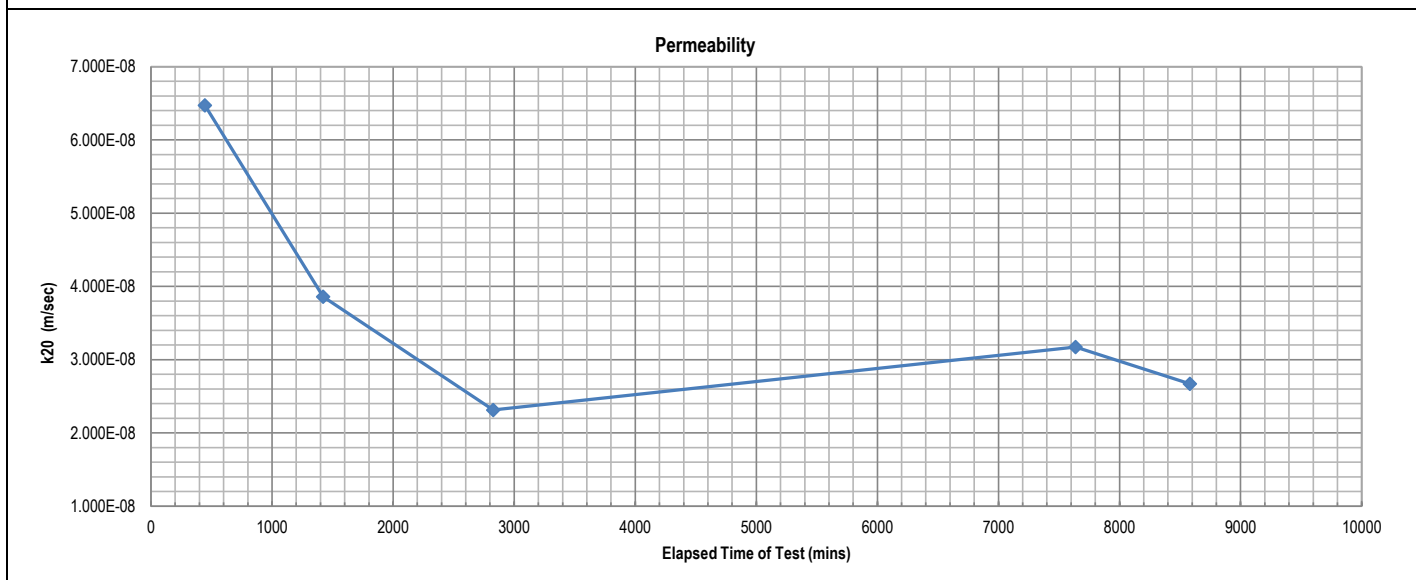
Test Method AS 1289 6.7.1, 5.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010110-CHP
Address	PO Box 3091, Sunnybank South QLD 4109	Workorder No.	0010574
Project	2022095 - Alice River	Test Date	16/01/2023
Client ID	2022095_C001 - Topsoil	Report Date	24/01/2023
Description	Clayey SAND-brown	Depth (m)	Not Supplied
		Sample Type	Remoulded Soil Specimen

RESULTS OF TESTING

Compaction Method	AS1289.5.1.1 - Standard Compaction		
Maximum Dry Density (t/m ³)	2.06	Hydraulic Gradient	1.1
Optimum Moisture Content (%)	8.9	Surcharge (kPa)	2.9
Placement Moisture Content (%)	8.6	Head Pressure Applied (kPa)	1.28
Moisture Ratio (%)	96.3	Water Type	Deaerated
Placement Wet Density (t/m ³)	2.13	Percentage Material Retained/Sieve Size (mm)	0 % / 9.5 mm
Density Ratio (%)	95.3	Sample Height and Diameter (mm)	116.49 / 101.39 mm

PERMEABILITY $k_{(20)} = 2.7 \times 10^{-08}$ (m/sec)



Remarks: The above specimen was remoulded to a target of 95% of Standard Maximum Dry Density and at Optimum Moisture Content.

Sample/s supplied by client

Page: 1 of 1

REP06401

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

PERMEABILITY BY CONSTANT HEAD TEST REPORT

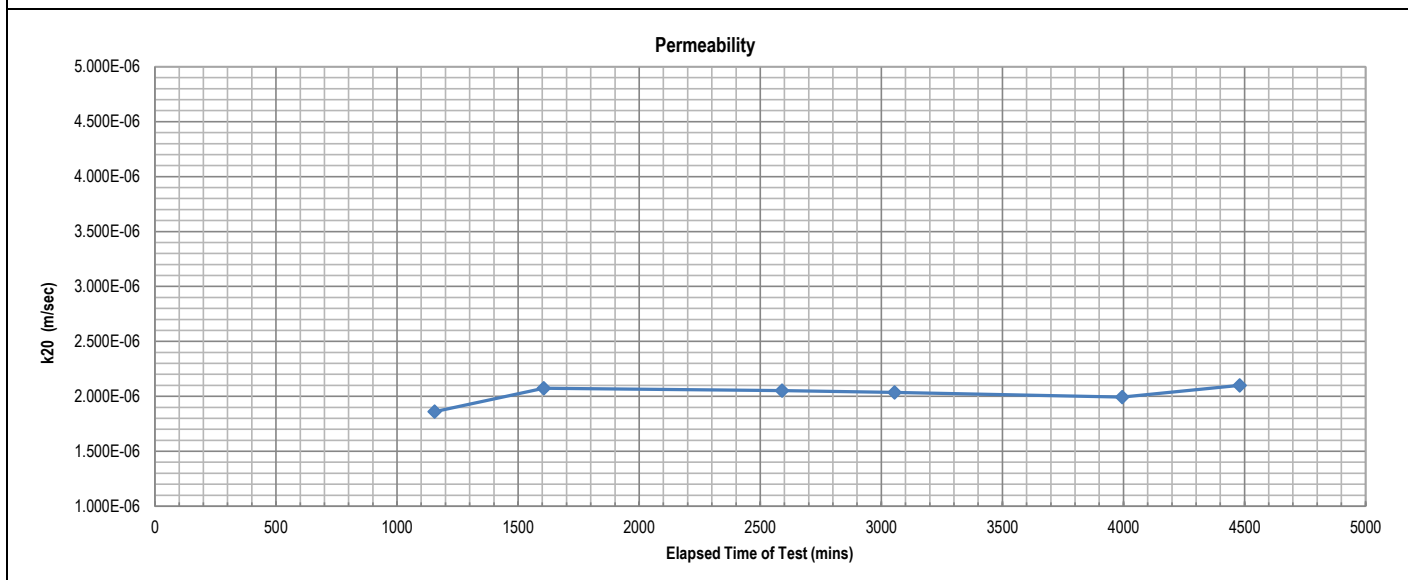
Test Method AS 1289 6.7.1, 5.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010111-CHP
Address	PO Box 3091, Sunnybank South QLD 4109	Workorder No.	0010574
Project	2022095 - Alice River	Test Date	13/01/2023
Client ID	2022095_C002 - Waste rock	Report Date	20/01/2023
Description	Silty Sandy GRAVEL with cobbles-pale brown	Depth (m)	Not Supplied
		Sample Type	Remoulded Soil Specimen

RESULTS OF TESTING

Compaction Method	AS1289.5.1.1 - Standard Compaction		
Maximum Dry Density (t/m ³)	2.08	Hydraulic Gradient	0.3
Optimum Moisture Content (%)	8.2	Surcharge (kPa)	3.6
Placement Moisture Content (%)	7.9	Head Pressure Applied (kPa)	0.29
Moisture Ratio (%)	96.0	Water Type	Deaerated
Placement Wet Density (t/m ³)	2.14	Percentage Material Retained/Sieve Size (mm)	16 % / 19 mm
Density Ratio (%)	95.3	Sample Height and Diameter (mm)	116.46 / 152.5 mm

PERMEABILITY $k_{(20)} = 2.0 \times 10^{-06}$ (m/sec)



Remarks: The above specimen was remoulded to a target of 95% of Standard Maximum Dry Density and at Optimum Moisture Content.

Sample/s supplied by client

Page: 1 of 1

REP06401

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

PERMEABILITY BY CONSTANT HEAD TEST REPORT

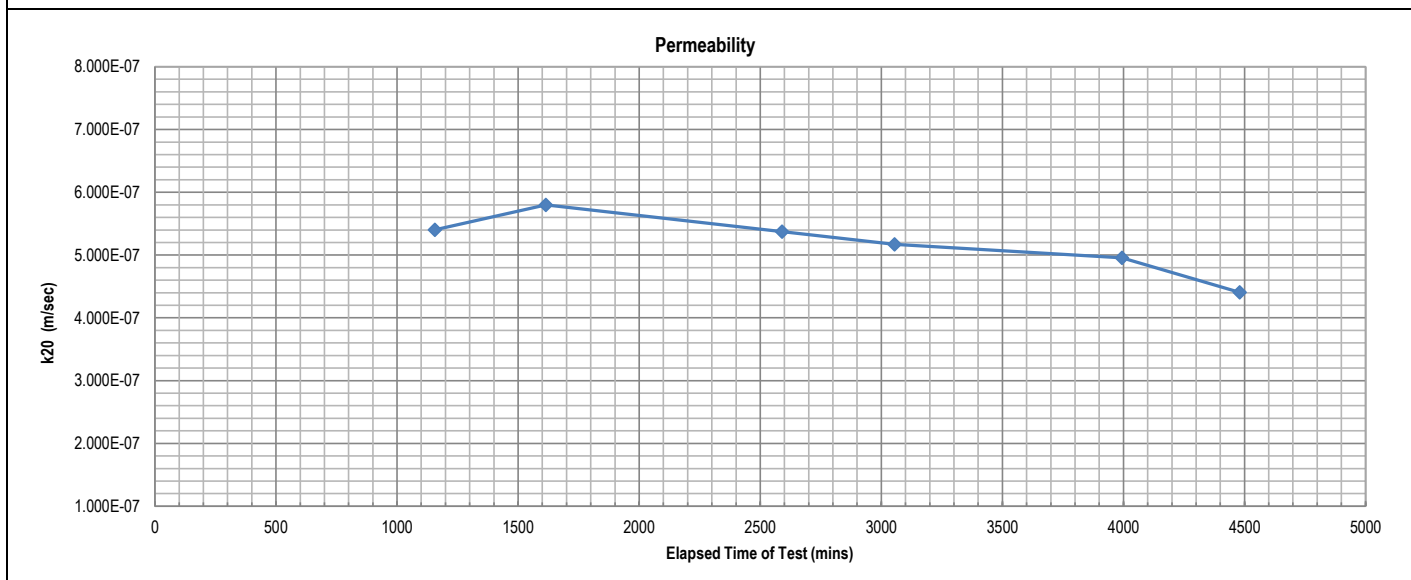
Test Method AS 1289 6.7.1, 5.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010112-CHP
Address	PO Box 3091, Sunnybank South QLD 4109	Workorder No.	0010574
Project	2022095 - Alice River	Test Date	13/01/2023
Client ID	2022095_C003 - Tailings	Report Date	20/01/2023
Description	Silty SAND - pale brown/yellow	Depth (m)	Not Supplied
		Sample Type	Remoulded Soil Specimen

RESULTS OF TESTING

Compaction Method	AS1289.5.1.1 - Standard Compaction		
Maximum Dry Density (t/m ³)	1.61	Hydraulic Gradient	1.1
Optimum Moisture Content (%)	13.1	Surcharge (kPa)	2.9
Placement Moisture Content (%)	13.4	Head Pressure Applied (kPa)	1.28
Moisture Ratio (%)	102.5	Water Type	Deaerated
Placement Wet Density (t/m ³)	1.73	Percentage Material Retained/Sieve Size (mm)	0 % / 9.5 mm
Density Ratio (%)	94.8	Sample Height and Diameter (mm)	116.24 / 101.4 mm

PERMEABILITY $k_{(20)} = 4.7 \times 10^{-07}$ (m/sec)



Remarks: The above specimen was remoulded to a target of 95% of Standard Maximum Dry Density and at Optimum Moisture Content.

Sample/s supplied by client

Page: 1 of 1

REP06401

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

PERMEABILITY BY FALLING HEAD TEST REPORT

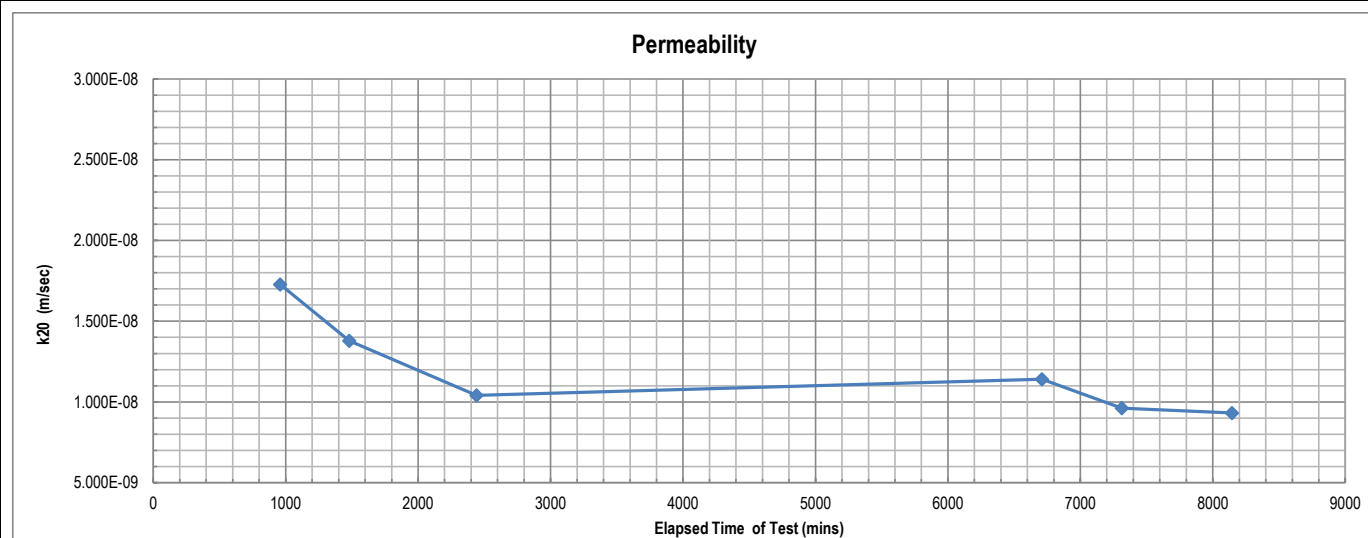
Test Method AS 1289 6.7.2, 5.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010113-FHPT
Address	PO Box 3091, Sunnybank South QLD 4109	Workorder No.	0010574
Project	2022095 - Alice River	Test Date	17/01/2023
Client ID	2022095_C004 - Tailings	Report Date	25/01/2023
Description	Sandy SILT-pale brown/white	Depth (m)	Not Supplied
		Sample Type	Remoulded Soil Specimen

RESULTS OF TESTING

Compaction Method	AS1289.5.1.1 - Standard Compaction		
Maximum Dry Density (t/m ³)	1.69	Hydraulic Gradient	11.2
Optimum Moisture Content (%)	17.1	Surcharge (kPa)	2.9
Placement Moisture Content (%)	17.5	Head Pressure Applied (kPa)	12.75
Moisture Ratio (%)	102.2	Water Type	Deaerated
Placement Wet Density (t/m ³)	1.88	Percentage Material Retained/Sieve Size (mm)	0 % /9.5 mm
Density Ratio (%)	94.7	Sample Height and Diameter (mm)	116.22 / 101.51 mm

PERMEABILITY $k_{(20)} = 9.3 \times 10^{-09}$ (m/sec)



Remarks: The above specimen was remoulded to a target of 95% of Standard Maximum Dry Density and at Optimum Moisture Content.

Sample/s supplied by client

Page: 1 of 1

REP06301

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Trilab Pty Ltd

ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

PINHOLE DISPERSION TEST REPORT			
Test Method: AS 1289 3.8.3			
Client	RGS Environmental Pty Ltd	Report No.	23010110-PHD
		Workorder No.	0010574
Address	PO Box 3091, Sunnybank South QLD 4109	Test Date	18/01/2023
		Report Date	19/01/2023
Project	2022095 - Alice River		
Sample No.	23010110	23010111	23010112
Client ID	2022095_C001 - Topsoil	2022095_C002 - Waste rock	2022095_C003 - Tailings
Depth (m)	Not Supplied	Not Supplied	Not Supplied
Description	Clayey SAND-brown	Silty Sandy GRAVEL with cobbles -pale brown	Silty SAND-pale brown/yellow
Method of Moisture Determination for Remoulding	Optimum Moisture Content	Optimum Moisture Content	Optimum Moisture Content
Initial Moisture Content (%)	0.7	0.7	0.7
Placement Wet Density (t/m³)	2.13	2.06	1.73
Placement Moisture Content (%)	8.6	7.8	13.0
Density Ratio (%)	95	95	95
Variation from Optimum Moisture Content (%)	0	0	0
Curing Time (Days)	1	1	1
Source of Water	Potable	Potable	Potable
Rate of Flow at end of test (mL/sec)	0.68	0.2	0.98
Hole Reformed at 50mm Head Height	No	No	No
PINHOLE DISPERSION CLASSIFICATION: DESIGNATION	D1	ND2	D1
DESCRIPTION	Highly Dispersive	Completely Erosion Resistant	Highly Dispersive
NOTES/REMARKS:			
Sample/s supplied by the client			

PINHOLE DISPERSION TEST REPORT

Test Method: AS 1289 3.8.3

Client	RGS Environmental Pty Ltd	Report No.	23010113-PHD
		Workorder No.	0010574
Address	PO Box 3091, Sunnybank South QLD 4109	Test Date	18/01/2023
		Report Date	19/01/2023
Project	2022095 - Alice River		
Sample No.	23010113		
Client ID	2022095_C004 - Tailings		
Depth (m)	Not Supplied		
Description	Sandy SILT-pale brown/white		
Method of Moisture Determination for Remoulding	Optimum Moisture Content		
Initial Moisture Content (%)	1.2		
Placement Wet Density (t/m³)	1.88		
Placement Moisture Content (%)	17.0		
Density Ratio (%)	95		
Variation from Optimum Moisture Content (%)	0		
Curing Time (Days)	1		
Source of Water	Potable		
Rate of Flow at end of test (mL/sec)	1.2		
Hole Reformed at 50mm Head Height	Not Supplied		
PINHOLE DISPERSION CLASSIFICATION: DESIGNATION	D1		
DESCRIPTION	Highly Dispersive		

NOTES/REMARKS:

Sample/s supplied by the client

Page 1 of 1

REP02003

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Tested at Trilab Brisbane Laboratory

Authorised Signatory



Joshua Hawley



Laboratory No. 9926

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SHRINK SWELL INDEX TEST REPORT

Test Method AS 1289 7.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010110-ISS
		Workorder No.	0010574
Address	PO Box 3091, Sunnybank South QLD 4109	Test Date	31/01/2023
		Report Date	6/02/2023
Project	2022095 - Alice River		
Description	Clayey SAND - Brown		
Sample No.	23010110		
Client ID	2022095_C001 - Topsoil		
Depth (m)	Not Supplied		
RESULTS OF TESTING			
SWELL SPECIMEN			
Swell Pressure (kPa) *	-		
Wet Density (t/m³)	2.13		
Initial Moisture Content (%)	8.5		
Final Moisture Content (%)	11.3		
Swell (%)	-0.1		
SHRINKAGE SPECIMEN			
Estimated Inert Inclusions (%)	<5%		
Extent of Crumbling	Nil		
Extent of Cracking	Nil		
Moisture (%)	8.5		
Shrinkage (%)	0.6		
SHRINK SWELL INDEX (Iss) (%)	0.3		
Notes/Remarks: Single Individual Specimen remoulded to a target density of 95% of Standard Maximum Dry Density at Optimum Moisture Content (minus -2.36mm material tested)			
Sample/s supplied by client		Tested as received	

Page: 1 of 1 REP02304

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

SHRINK SWELL INDEX TEST REPORT

Test Method AS 1289 7.1.1

Client RGS Environmental Pty Ltd	Report No. 23010111-ISS
	Workorder No. 0010574
Address PO Box 3091, Sunnybank South QLD 4109	Test Date 27/01/2023
	Report Date 6/02/2023
Project 2022095 - Alice River	
Description Silty Sandy GRAVEL - pale brown	
Sample No.	23010111
Client ID	2022095_C002 - Waste rock
Depth (m)	Not Supplied
RESULTS OF TESTING	
SWELL SPECIMEN	
Swell Pressure (kPa) *	-
Wet Density (t/m³)	2.13
Initial Moisture Content (%)	9.2
Final Moisture Content (%)	13.1
Swell (%)	-0.2
SHRINKAGE SPECIMEN	
Estimated Inert Inclusions (%)	<5%
Extent of Crumbling	Nil
Extent of Cracking	Nil
Moisture (%)	9.1
Shrinkage (%)	0.2
SHRINK SWELL INDEX (Iss) (%)	0.1
Notes/Remarks: Single Individual Specimen remoulded to a target density of 95% of Standard Maximum Dry Density at Optimum Moisture Content (minus -2.36mm material tested)	
Sample/s supplied by client Tested as received	

Page: 1 of 1 REP02304

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

SHRINK SWELL INDEX TEST REPORT

Test Method AS 1289 7.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010112-ISS
		Workorder No.	0010574
Address	PO Box 3091, Sunnybank South QLD 4109	Test Date	27/01/2023
		Report Date	6/02/2023
Project	2022095 - Alice River		
Description	Silty SAND - Pale brown		
Sample No.	23010112		
Client ID	2022095_C003 - Tailings		
Depth (m)	Not Supplied		
RESULTS OF TESTING			
SWELL SPECIMEN			
Swell Pressure (kPa) *	-		
Wet Density (t/m³)	1.71		
Initial Moisture Content (%)	13.8		
Final Moisture Content (%)	24.8		
Swell (%)	-0.1		
SHRINKAGE SPECIMEN			
Estimated Inert Inclusions (%)	<5%		
Extent of Crumbling	Nil		
Extent of Cracking	Nil		
Moisture (%)	13.6		
Shrinkage (%)	0.2		
SHRINK SWELL INDEX (Iss) (%)	0.1		
Notes/Remarks: Single Individual Specimen remoulded to a target density of 95% of Standard Maximum Dry Density at Optimum Moisture Content (minus -2.36mm material tested)			
Sample/s supplied by client		Tested as received	

Page: 1 of 1 REP02304

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

SHRINK SWELL INDEX TEST REPORT

Test Method AS 1289 7.1.1

Client	RGS Environmental Pty Ltd	Report No.	23010113-ISS
		Workorder No.	0010574
Address	PO Box 3091, Sunnybank South QLD 4109	Test Date	30/01/2023
		Report Date	6/02/2023
Project	2022095 - Alice River		
Description	Sandy SILT - pale brown		
Sample No.	23010113		
Client ID	2022095_C004 - Tailings		
Depth (m)	Not Supplied		
RESULTS OF TESTING			
SWELL SPECIMEN			
Swell Pressure (kPa) *	-		
Wet Density (t/m³)	1.87		
Initial Moisture Content (%)	17.0		
Final Moisture Content (%)	24.6		
Swell (%)	0.0		
SHRINKAGE SPECIMEN			
Estimated Inert Inclusions (%)	<5%		
Extent of Crumbling	Nil		
Extent of Cracking	Minor		
Moisture (%)	16.9		
Shrinkage (%)	0.6		
SHRINK SWELL INDEX (Iss) (%)	0.3		
Notes/Remarks: Single Individual Specimen remoulded to a target density of 95% of Standard Maximum Dry Density at Optimum Moisture Content (minus -2.36mm material tested)			
Sample/s supplied by client		Tested as received	

Page: 1 of 1 REP02304

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

11.5 Levay & Co semi quantitative-XRD (semi-QXRD) report



LEVAY & CO. ENVIRONMENTAL SERVICES

Water Quality, Water Treatment and Environmental Pollution Research Laboratories

Job No.
L&C-22-279

REPORT

QXRD Analysis of Four Samples

RGS Job No. 2022095

Purchase Order No. 2022053

Prepared for:

Dr. Alan M. Robertson,
Director – Principal Geochemist,
RGS Environmental Consultants Pty. Ltd.,
3/30 Lensworth Street,
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Prepared by:

George Levay,
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Levay & Co. Environmental Services,
Unit 8, 62 – 64 West Avenue,
Edinburgh. SA. 5111.

Date: 23rd January, 2023

Unit 8, 62 – 64 West Avenue, Edinburgh SA 5111, Australia



Tel. 61-8-8258 6306, Email: George.Levay@levayandco.com, Web: www.levayandco.com

Introduction

Levay & Co. Environmental Services received four samples (RGS Job No. 2022095 Alice River Gold Mine) from RGS Environmental Consultants on the 23rd December, 2022 to determine the mineralogical content by (semi-) quantitative x-ray diffraction (QXRD) analysis. The sample details are provided in the table below.

Table 1. List of samples received for QXRD analysis

RGS Sample ID.	Levay & Co. ID.	Sample Description
2022095_C001	22-279-01	Soil
2022095_C002	22-279-02	Mine Waste
2022095_C003	22-279-03	Tailings
2022095_C004	22-279-04	Tailings

(Semi) - Quantitative X-Ray Diffraction (QXRD)

X-ray diffraction traces were obtained from the sample with a Panalytical Aeris Research Powder Diffractometer. Operating conditions were 40kV/15mA, Fe K β filter, step scan 0.01/29 secs°2 θ at, 1/2° divergence and a 1.0° ant-scatter slit. Scan range was 5° to 90° 2 θ . Phases were identified by computer search/match of the ICDD PDF4 2022 Database.

Quantitative results have been determined with full pattern Rietveld refinement software. Smectite clay has been identified from sedimented clay fraction samples and glycol intercalation

Results

The results from QXRD analysis of the sample are shown in Table 2 below. Mineralisation includes clay (Illite) and silicate (Quartz, Orthoclase), as the dominant phases. Significant amount of Albite and Kaolinite were also detected. All four samples were sediment air-dried and glycol treated for clay mineralogy verification.

Table 2: QXRD results

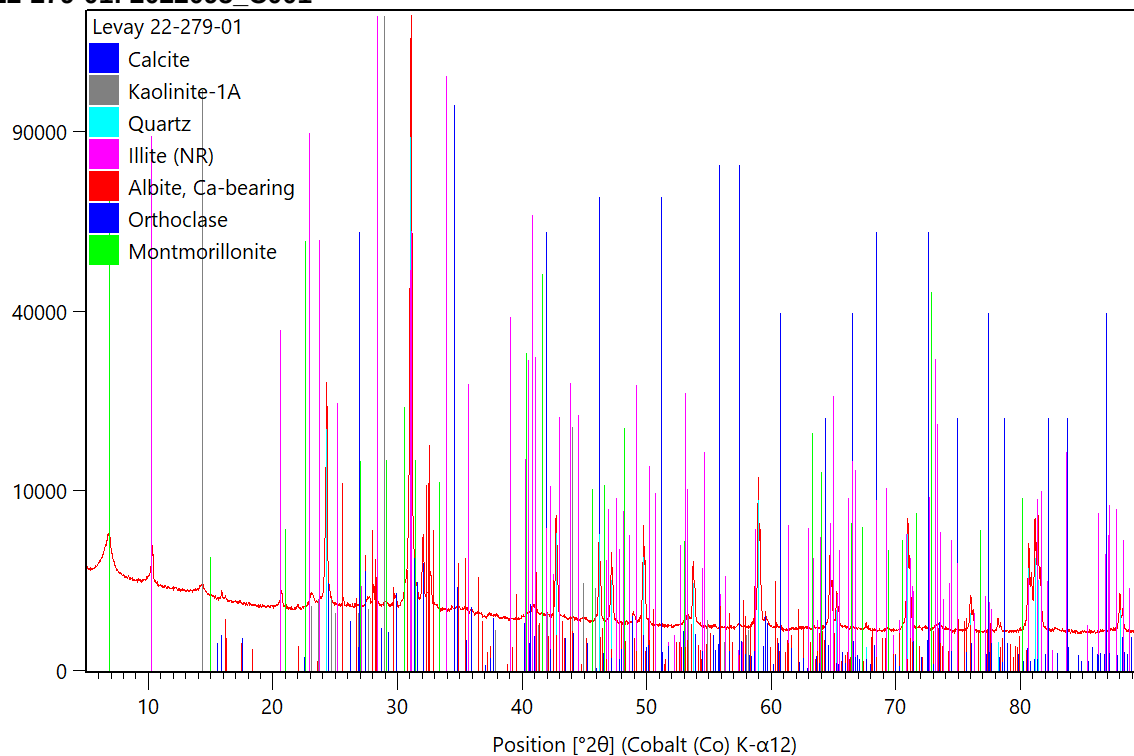
	2022095_C001	2022095_C002	2022095_C003	2022095_C004
Phase	Weight % ¹	Weight % ¹	Weight % ¹	Weight % ¹
Albite	6.7	7.3	2.4	3.9
Ankerite	0.1	0.4	ND ²	ND ²
Calcite	ND ²	0.5	ND ²	0.1
Goethite	0.7	1.7	1.3	1.4
Illite	14.9	28.5	19.6	30.2
Kaolinite	3.6	3.9	4.1	6
Maghemite	ND ²	0.1	ND ²	ND ²
Orthoclase	8.1	15	9.9	11.3
Montmorillonite	4.5	2.8	0.6	0.5
Pyrite	0.4	0.3	0.2	0.4
Quartz	59.8	37.9	61.8	45.8
Rutile	1.2	1.6	0.1	0.4

1 Semiquantitative Detection limit ~0.4 wt. %

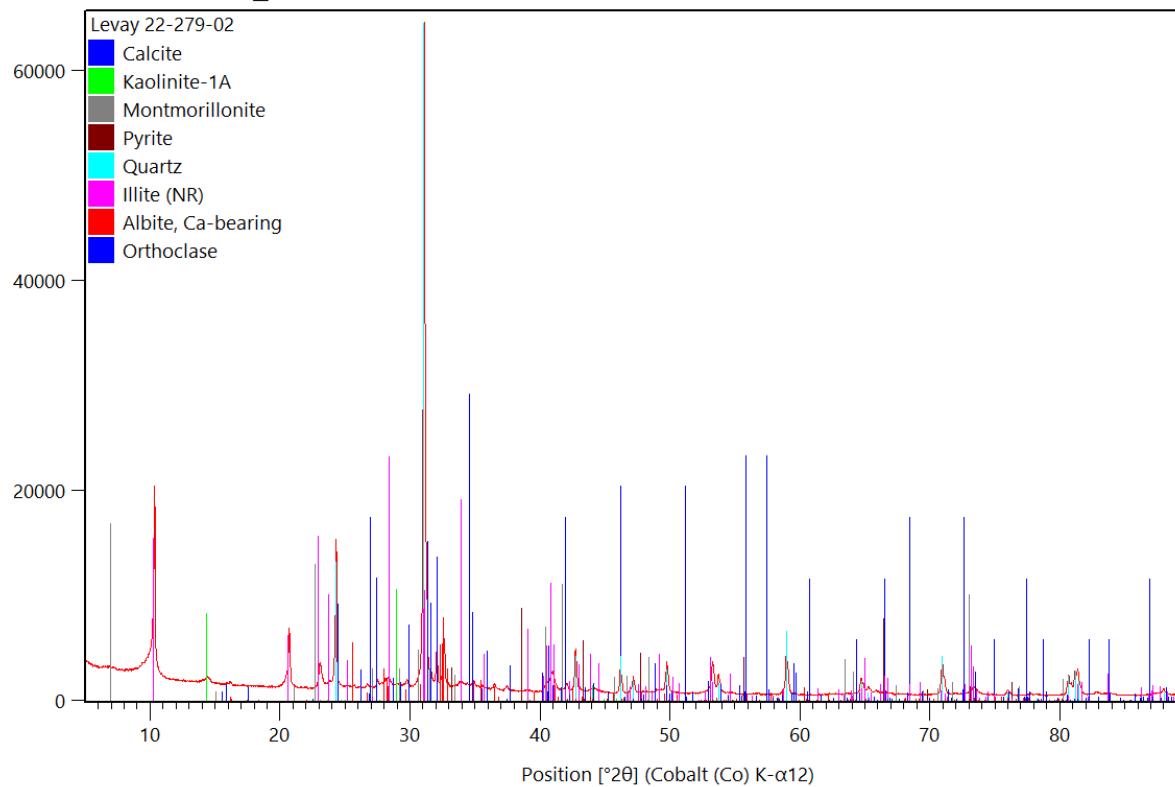
2 ND = Non Detectable

Results Graphical – Phase ID

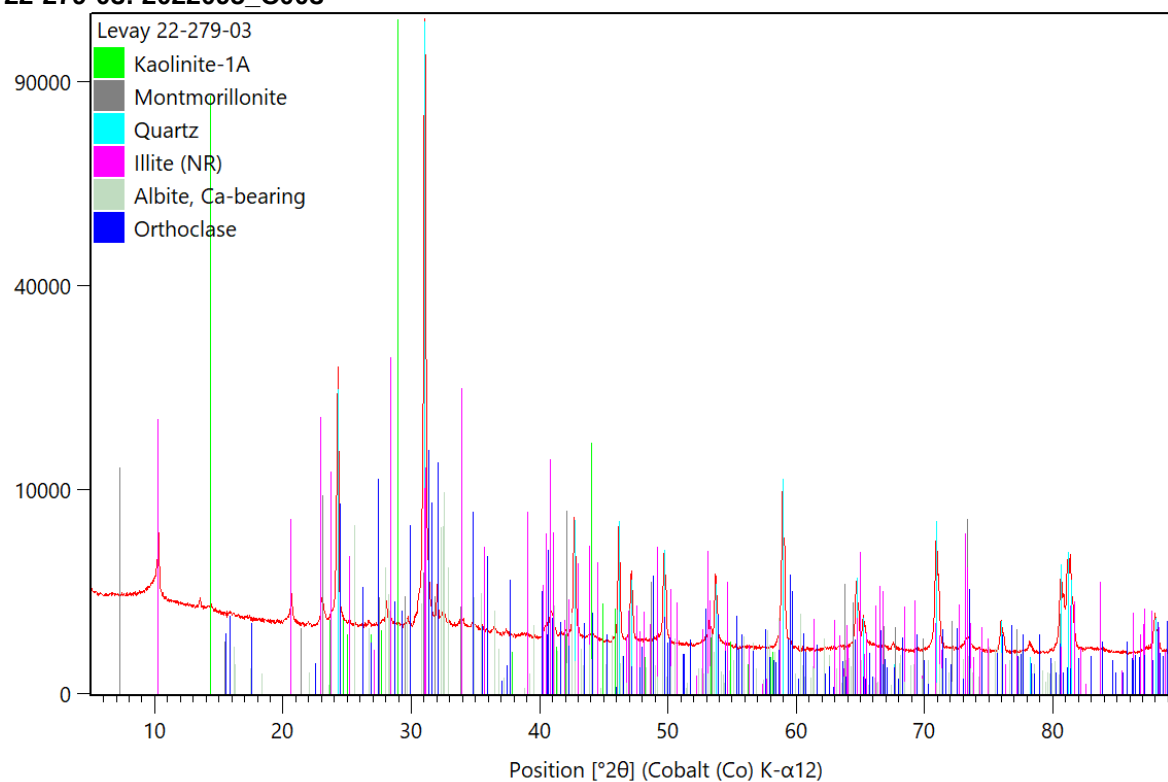
22-279-01: 2022095_C001



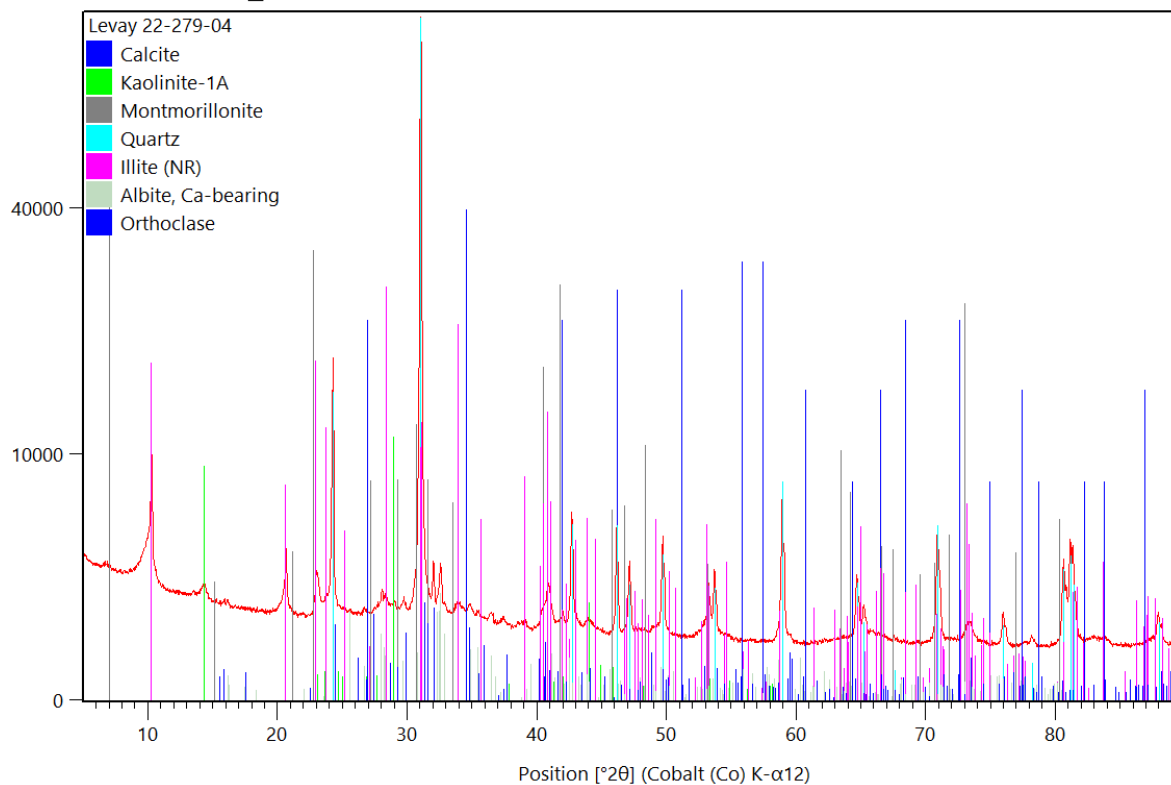
22-279-02: 2022095_C002



22-279-03: 2022095_C003

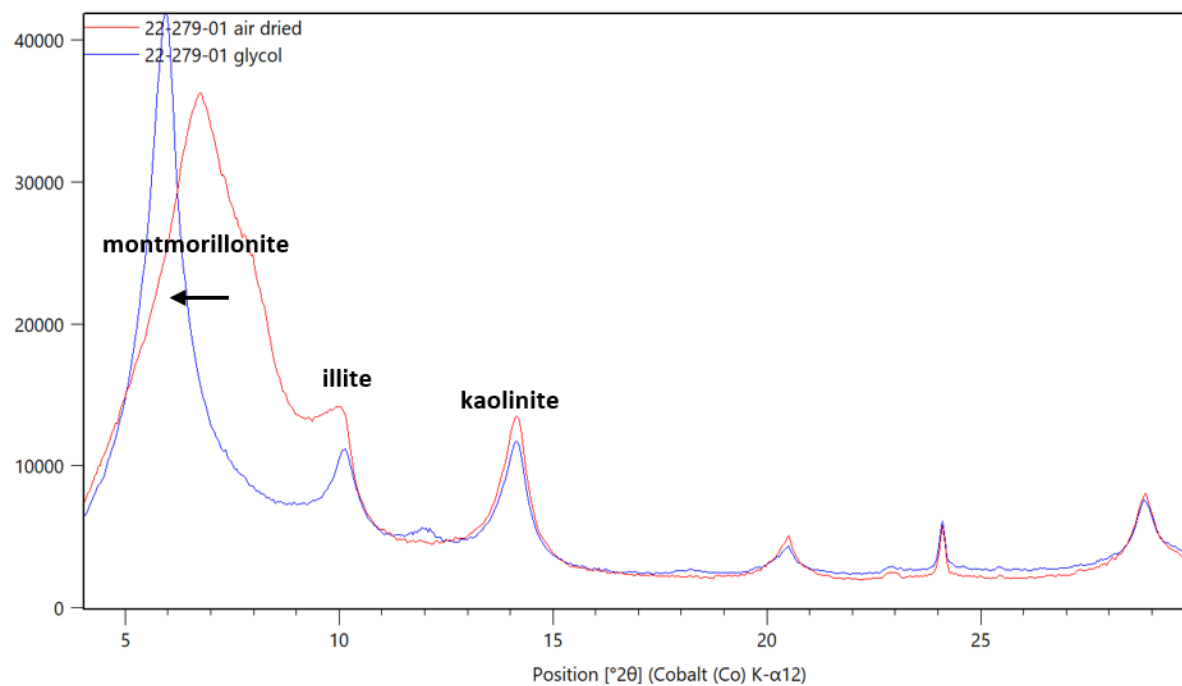


22-279-04: 2022095_C004

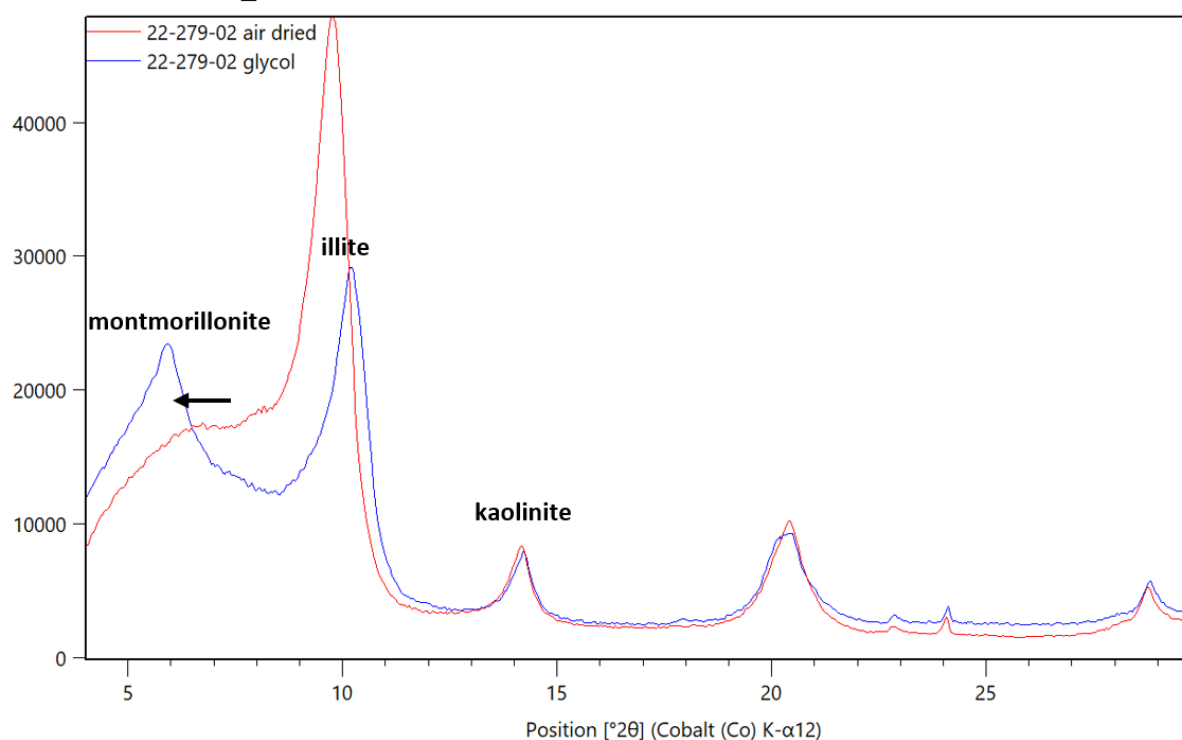


Sedimented Air-Dried and Glycol Treated Results

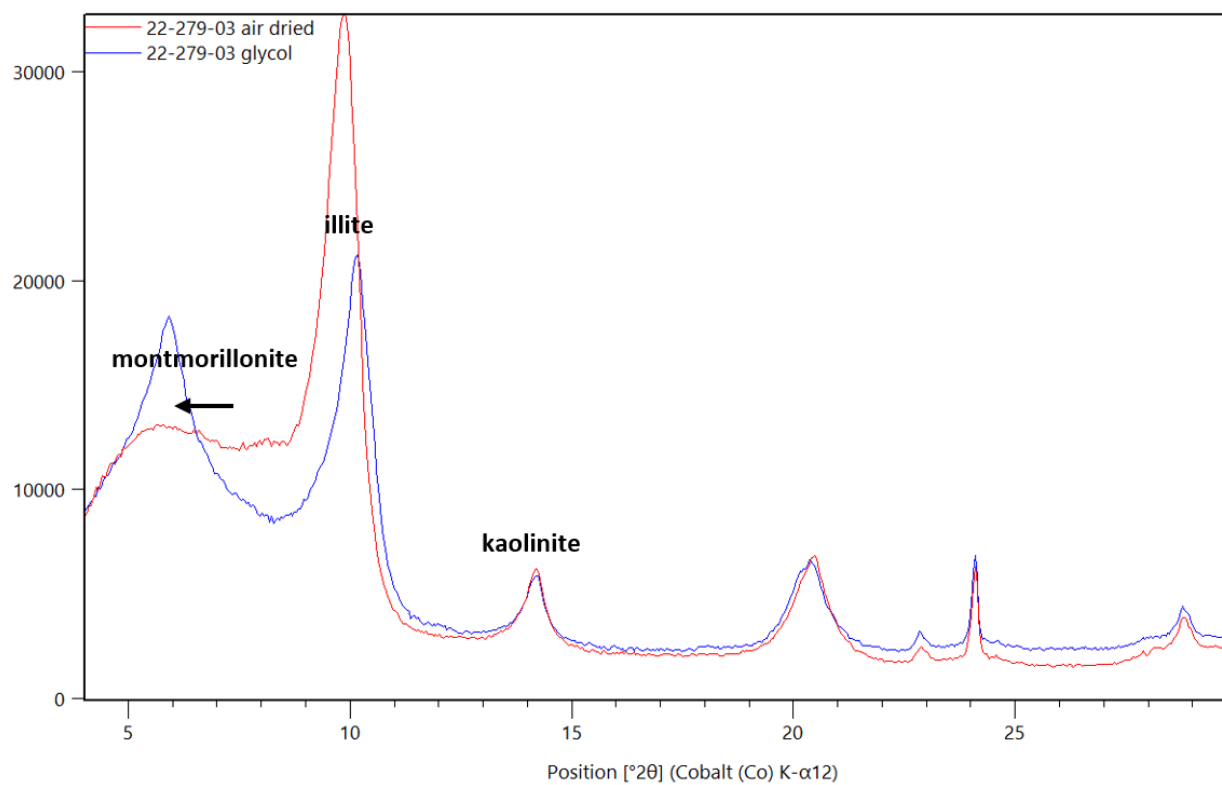
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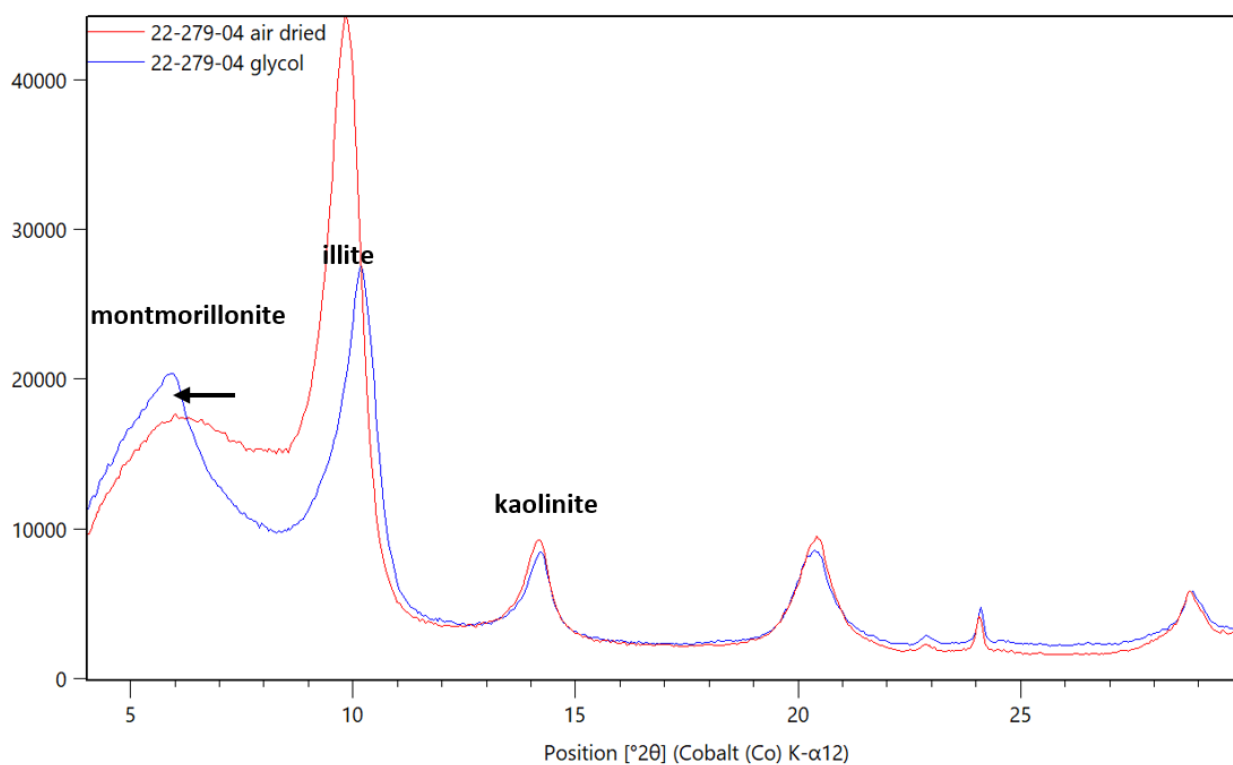
22-279-02: 2022095_C002



22-279-03: 2022095_C003



22-279-04: 2022095_C004



11.6 Soil Water Group Soil Water Characteristic Curves (SWCC) Report

SOIL WATER ANALYSIS

TEST REPORT

Client: RGS Environmental Consultants
Client Contact: Greg Maddocks
Project: Alice River
Client Project #:: 2022095
SWA Job No.: JN0827
Date of Analysis: 7th - 24th February 2023
No. Samples Submitted: 4



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Method:

- Pressure plate method used in accordance with McKenzie, N., Coughlan, K. and Cresswell, H. (2002). Soil Physical Measurement and Interpretation for Land Evaluation, CSIRO Publishing.
- Samples packed to a bulk density of 1.40 g/cm^3 on the pressure plates.
- Samples equilibrated for a 2 week period.

TEST RESULTS

SWA ID	Client ID	Volumetric Moisture Content (%; v/v)					Derived van Genuchten Parameters			
		0 kPa	10 kPa	33 kPa	100 kPa	1,500 kPa	α (1/cm)	N (-)	θ_s (cm^3/cm^3)	θ_r (cm^3/cm^3)
827-01	2022095_C001	34.62	28.33	22.33	13.79	9.72	0.009	1.615	0.3436	0.0805
827-02	2022095_C002	42.68	38.39	32.15	28.65	22.27	0.011	1.390	0.4275	0.1917
827-03	2022095_C003	38.62	32.12	27.54	22.90	19.39	0.016	1.458	0.3859	0.1759
827-04	2022095_C004	44.44	38.92	35.47	31.28	24.59	0.030	1.107	0.4450	0.0263

APPROVED SIGNATURE FOR

A handwritten signature in black ink, appearing to read 'Adam Pratt'.

Adam Pratt
Operations Manager

RGs



MINE WASTE AND
WATER MANAGEMENT

PACGOLD



**13 MARCH
2025**



**15° 25.81' S
143° 17.02' E**

**Groundwater characterisation and site water performance
of Alice River, Cape York Peninsula**
Progressive Rehabilitation and Closure Plan



Document history

Version	Date	Released by	To	Status
1.0	13 March 2025	Tania Kennedy, SBE	Helen Wood AARC	Part draft
1.1	20 March 2025		Geoff Lowe, Pacgold Shane Goodwin, Pacgold Helen Wood, AARC	Full draft
1.2	21 March 2025		Geoff Lowe, Pacgold Shane Goodwin, Pacgold Helen Wood, AARC	FINAL

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Table of Contents

1	Introduction.....	7
1.1	Project location and background.....	7
1.2	Timeline of mine development.....	7
1.3	Context and objectives.....	7
1.4	Work completed since last submission	8
1.5	Scope of this report.....	8
2	Overview of Alice River mine site and project	13
2.1	Site layout and landforms.....	13
2.2	Regulatory framework.....	19
2.3	Monitoring network and recent updates.....	22
2.4	Landforms and planned rehabilitation outcomes.....	24
3	Water and natural systems characterisation	25
3.1	Landscape	25
3.2	Climate.....	28
3.2.1	Rainfall patterns and variability	28
3.2.2	Evaporation.....	29
3.3	Surface water and catchments.....	33
3.3.1	Surface water flow characteristics and pathways.....	33
3.3.2	Investigation: Mapping of site catchments and surface water flow paths	37
3.3.3	Surface water quality	38
3.4	Geology framework.....	48
3.4.1	Regional geology and province	48
3.4.2	Alice River site geology	51
3.5	Materials characterisation	55
3.5.1	Analytical and kinetic assessment.....	55
3.5.2	Investigation: Identifying natural elemental abundance	57
3.6	Hydrogeology and groundwater	59
3.6.1	Groundwater occurrence	59
3.6.2	Hydraulic conductivity.....	61
3.6.3	Groundwater levels and surface.....	62
3.6.4	Groundwater quality over time.....	65
4	Conceptual water system model	72
4.1	Water system investigations.....	72
4.1.1	Investigation: Water quality patterns across the site.....	72
4.1.2	Investigation: Alice Queen Pit lake water quality profile.....	74
4.1.3	Investigation: Recharge and potential hydraulic connection between Alice Queen Pit and MW07 (loggers)	80
4.1.4	Investigation: Arsenic sources and potential hydraulic connection between Alice Queen Pit Lake and MW07	82
4.1.5	Investigation: Arsenic sources and potential hydraulic connection between TSF, MW01 and MW05.....	87
4.2	Working conceptual water system model for Alice River site	91
4.2.1	Overview	91
4.2.2	Water occurrence and flow.....	91
4.2.3	Geochemistry	92
4.2.4	Interaction of landforms (TSF, Alice Queen Pit) with water	93
5	Risk characterisation for water performance in progressive rehabilitation and closure.....	95
5.1	Framing water risks and harm potential at Alice River.....	95
5.2	Water performance at closure	97
5.3	Water performance criteria and monitoring framework.....	98
6	References.....	101
	Appendix A – Summary of water monitoring obligations in current EA	103
	Appendix B – Bore construction logs & photos.....	104



Appendix C – Driller logs for MW09, MW10, MW11.....	107
Appendix D – Geology map series legend.....	112
Appendix E – GAI values and ratios	113
Appendix F – Pit lake photos for level reconciliations	114
Appendix G – Pit water quality chemistry results.....	117



List of Figures

Figure 1 - Location of Alice River mine project.....	9
Figure 2 - View of mining leases and monitoring locations.....	10
Figure 3 – Groundwater characterisation and site water performance review process.....	12
Figure 4 – Site layout, landforms and monitoring network.....	14
Figure 5 - Alice Queen Pit (July 2022)	15
Figure 6 - View of Alice River TSF looking west and from base of low embankment (July 2022 & February 2025).....	16
Figure 7 - Temporary Waste Rock Storage	17
Figure 8 - Historical platform stockpile southwest of Alice Queen pit.....	18
Figure 9 – Site setting in drainage basin, hydrogeology environment, mineralisation types and BOM weather stations	20
Figure 10 - Mitchell Water Plan Area	21
Figure 11 - View over Alice River Mine site	24
Figure 12 - Alice River Mine site elevations and terrain.....	26
Figure 13 - View of landscapes around Alice River: broad, sandy ephemeral drainage lines & low rises.....	27
Figure 14 - Annual rainfalls of BOM rainfall stations.....	30
Figure 15 - Seasonal rainfall by year at Pinnacle Station	30
Figure 16 - Residual rainfall of Laura, Pinnacle and Killarney rainfall station	31
Figure 17- Seasonal and annual rainfall of Laura and Alice River Station	32
Figure 18 - Histogram of Laura and Alice River Station rainfall	32
Figure 19 - One Mile Creek as a dry creek bed (November 2024)	34
Figure 20 - One Mile Creek as a slow flow creek (July 2022).....	34
Figure 21 - Northern tributary limey sandstone/conglomerate - note TSF on RHS (top Jul 2022, bottom Nov 2024)	35
Figure 22 - One Mile Creek in moderate flood (February 2025).....	36
Figure 23 – Alice River Mine catchment map.....	41
Figure 24 - Receiving environment water quality - pH.....	42
Figure 25 - Receiving environment water quality – EC (mS/cm).....	42
Figure 26 - Receiving environment water quality – arsenic (dissolved and total).....	43
Figure 27 - Receiving environment water quality – antimony (dissolved and total).....	44
Figure 28 - Receiving environment water quality – copper (dissolved and total)	45
Figure 29 - Receiving environment water quality – lead (dissolved and total)	46
Figure 30 - Receiving environment water quality – zinc (dissolved and total).....	47
Figure 31 - Regional geology of Alice River (Queensland Geology Map Series, 2018)	49
Figure 32 - Geophysical and geochemical anomaly along shear zone across Pacgold tenements (Pacgold 2024)	50
Figure 33 - View of water level and weathering in Alice Queen pit walls.....	52
Figure 34 - View of weathered granite at surface, and example veining mineralisation with sulphides	52
Figure 35 - Alice Queen shear outcropping in One Mile Creek south of AQ pit.....	53
Figure 36 – Alice River shear zone, mineralisation structures mapping and water intersections	54
Figure 37 - Sample locations for materials characterisation (RGS 2022).....	55
Figure 38 - Acid neutralising capacity (RGS 2022).....	56
Figure 39 - Metals mobility (RGS 2022)	56
Figure 40 – Potential for saline drainage (RGS 2022)	56
Figure 41- Global abundance index (GAI) enrichment from Alice River (from Pacgold 2024a).....	58
Figure 42 - Registered groundwater bores in the One Mile Creek region, including geology (QGlobe 2025).....	60
Figure 43 - Typical ranges of igneous and metamorphic rocks (Freeze and Cherry 1979)	61
Figure 44 - Analytical range estimates of inflow into pit lake	61
Figure 45 - Groundwater standing water levels.....	63
Figure 46 - Groundwater and Alice Queen pit lake relative water levels.....	63
Figure 47 - Groundwater surface for February 2025	64
Figure 48 - Groundwater quality over time - pH	66
Figure 49 - Groundwater quality over time – EC.....	66



Figure 50 - Groundwater quality over time – HCO ₃	67
Figure 51 - Groundwater quality over time – SO ₄	67
Figure 52 - Groundwater quality over time – Cl	68
Figure 53 - Groundwater quality over time – Total organic carbon	68
Figure 54 - Groundwater quality over time – Silica as SiO ₂	69
Figure 55 - Groundwater quality over time – Antimony	69
Figure 56 - Groundwater quality over time – Arsenic	70
Figure 57 - Groundwater quality over time – Strontium	70
Figure 58 - Groundwater quality over time – Copper	71
Figure 59 - Groundwater quality over time – Zinc	71
Figure 60 - Durov diagram showing water quality facies of water across Alice River site	73
Figure 61 – Pit sampling locations	76
Figure 62 - Alice Queen pit water survey – DO, pH, NTU, ORP	76
Figure 63 - Alice Queen pit water survey – EC & TDS	77
Figure 64 - Alice Queen pit water survey – silica and sulphate	77
Figure 65 - Alice Queen pit water survey – metals (where detected)	78
Figure 66 - Alice Queen pit water survey – organics and nutrients	78
Figure 67 - Alice Queen pit water survey – arsenic and antimony	79
Figure 68 - Alice Queen pit water survey – arsenic speciation	79
Figure 69 - Initial MW07 and AQ Pit Lake logged levels with site and Laura rainfall	81
Figure 70 – Relationship of ORP to arsenic	84
Figure 71 - Arsenic speciation - May 2024	84
Figure 72 - Relationship of bicarbonate to arsenic	85
Figure 73 - Relationship of bicarbonate to sodium + potassium	85
Figure 74 - Relationship of silica as SiO ₂ to sodium	86
Figure 75 - Relationship of sulphate to arsenic	86
Figure 76 - Relationship of total organic carbon (TOC) to arsenic	87
Figure 77 - Relationship of strontium to sulphate	89
Figure 78 - View of MW01 and MW05 with other landforms	90
Figure 79 – Water system conceptual model for Alice River mine	94
Figure 80 – Proposed updated surface water and groundwater monitoring network	100

List of Tables

Table 1 - PRCP and rehabilitation requirements index	11
Table 2 - Outcomes under the Water Plan (Mitchell) 2007 for the Alice River mine site	21
Table 3 – Current receiving environment (REMP) monitoring sites	22
Table 4 - Groundwater monitoring bores and details	23
Table 5 - Planned rehabilitation outcomes	24
Table 6 - Palmerville evaporation rates	29
Table 7 - Alice River site catchments, nature and destination	38
Table 8 - Surface water quality trends dashboard	40
Table 9 - Geological units around the Alice River site	49
Table 10 - Nature of structures and veins in site geology	53
Table 11 - Key regulatory water performance criteria	96
Table 12 - Water performance at closure risk and actions summary	97
Table 13 - Recommended water quality criteria and monitoring	99



1 Introduction

1.1 Project location and background

The Alice River mine project is located on Alice River Station, 270 km west of Cooktown in the Cape York Peninsula, and 470 km north-west of Cairns within the Mitchell River Basin and Cape York Biozone (Figure 1).

The project comprises eight granted mining leases (MLs) covering multiple historical gold workings along a shear system that hosts gold mineralisation (Figure 2). Mining landforms are present only on ML2901 and ML3010, which are the focus of progressive rehabilitation and closure planning. The leases are currently held by Pacgold Limited, a gold exploration company focused on discoveries.

The mine lease is on Alice River Station, which is operated as a cattle and agricultural business under term lease. Native Title is determined to exist across for the Olkola people across the exploration permits, and Country is managed through Ut-Alkar Aboriginal Corporation RNTBC. Traditional owners are onsite regularly for surveys and guidance on protecting heritage.

Gold was first discovered at Alice River in 1903, with underground mining operations conducted between 1903 and 1917. During this period, shafts were developed to depths of up to 40 metres along a 3-kilometre strike length, producing approximately 3,000 ounces of gold at an average grade of 30 grams per tonne. Historical shafts were likely absorbed into the Alice Queen pit during later open-pit mining activities.

Mining resumed in the late 20th century, with open-pit operations at the Alice Queen pit between 1999 and 2001, leaving a pit void that has since formed a pit lake. In addition to open-pit mining, this phase of activity resulted in legacy landforms, including tailings storage, run-of-mine (ROM) stockpiles, and waste rock landforms. Some localised surface disturbances also occurred around drill holes with gold intersections, particularly north of the Alice Queen pit.

During the 1999–2001 operations, processing likely used cyanide-in-leach (CIL) methods, incorporating cyanide for gold recovery and significant quantities of lime or limestone to elevate pH and enhance gold extraction. As a result, tailings from this period are expected to exhibit higher alkalinity.

Exploration has continued intermittently over the past two decades and has been reinvigorated under Pacgold's tenure.

1.2 Timeline of mine development

The Alice River project has undergone two distinct phases of mining activity:

- Early development (1903–1917): Underground mining targeted high-grade gold deposits, with shafts reaching depths of up to 40 metres along a 3-kilometre strike length. Gold production during this period totalled approximately 3,000 ounces at an average grade of 30 grams per tonne.
- Late 20th-century operations (1990–2001): Open-pit mining at the Alice Queen pit led to a legacy pit void and pit lake and additional mining landforms, including tailings storage, ROM stockpiles, and waste rock landforms. This phase also involved localised disturbances around drill holes.

Alice River has remained on care and maintenance since operations ceased more than 20 years ago.

1.3 Context and objectives



In July 2022, PacGold submitted an initial Progressive Rehabilitation and Closure Plan (PRCP) for the Alice River mining area to the Department of Environment, Science and Innovation (DESI, now DETSI). At the time, groundwater and pit lake data were limited. DETSI subsequently issued a Request for Information (RFI) in late 2022, requiring further groundwater characterisation and risk assessment in alignment with PRCP Guideline requirements.

An updated PRCP submission is scheduled for March 2025. This report is prepared as a supporting and independent technical investigation and assessment for groundwater and water performance.

1.4 Work completed since last submission

Since the initial PRCP submission, PacGold has undertaken significant additional investigations to improve the understanding of groundwater and water-related processes at the site to address both needs of the RFI and broader water management of the site, including:

- Groundwater monitoring: Nine additional groundwater monitoring wells were installed to establish baseline groundwater levels, quality, and landform performance in two campaigns:
 - Late 2022 - MW04-MW08). Each well has been sampled 4 times since installation.
 - Late 2024 - MW09-MW12). Each well has been sampled twice since installation.
 - One to two additional wells are planned downstream of the site, pending a heritage survey and access approval early in 2025.
- A series of investigations to inform key questions, including:
 - Field landscape and geology site inspections: To delineate site catchments, features, potential sources and water flow paths across the site.
 - Groundwater characterisation and analysis: Assessment of groundwater occurrence, level responses and site-specific background water quality for Alice River site.
 - Surface water and pit lake investigations, including a sampling program to characterise pit lake water chemistry and potential impact to surface water.
 - Extensive water quality sampling across expanded parameters to characterise water populations and active geochemical processes or conditions across the site.
 - Installation of water level loggers into the Alice Queen pit and MW07 in late 2024.

Pit lake void water balance and flood modelling are related and linked packages of work by Engeny (2022a and b). The water balance is also updated in Engeny (2025), to align with investigation findings of updated catchments and groundwater.

1.5 Scope of this report

This report evaluates groundwater and water-related systems at Alice River in the context of PRCP planning, addressing groundwater and water performance needs per the *PRCP Guideline (Queensland Government Department of Environment and Science, n.d.)* as a holistic assessment. Table 1 provides an index of PRCP Guideline requirements to this report, and Figure 3 provides a schematic flow chart of the technical process for site investigation and assessment. This report includes:

- Management framework: Current operations, monitoring, rehabilitation plans, and status.
- Site water and landform characterisation: Detailed assessment of landscape, surface water, geology, materials characterisation, climate, and groundwater interactions.
- Updated conceptual site water model: Holistic update incorporating groundwater, surface water, pit and landform features.
- Updated risk assessment and closure criteria: Focus on water and landform interactions and groundwater management.
- Key findings and recommendations: For water performance conditions and further work.



PACGOLD Alice River Mine Location, River Basins & Biozones



0 50 100 150 km

Figure 1 - Location of Alice River mine project



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Alice River Leases and monitoring locations

Figure 2 - View of mining leases and monitoring locations



Table 1 - PRCP and rehabilitation requirements index

Water aspect	PRCP or Rehabilitation requirement	PRCP guideline reference	Reference section in this report
Hydrogeological assessment	Conduct a comprehensive assessment of the site's hydrogeology, including groundwater levels and properties, to inform rehabilitation planning.	Section 3.1.2.4: Site Hydrology and Fluvial Networks	Section 3
Water conceptual model	Develop a comprehensive conceptual model of the water system (both surface and groundwater) that represents current conditions, potential impacts, and future scenarios.	Section 5.1: Conceptual Water Model Development	Section 4 Section 5
Flooding assessment	Evaluate potential flooding risks and incorporate floodplain management strategies into the rehabilitation plan.	Section 3.6.1.2: Flooding Assessment	Engeny (2022b)
Non-Use Management Areas (NUMAs)	Identify and justify areas designated as NUMAs, ensuring they are managed to minimise environmental harm.	Section 3.2: Non-Use Management Areas	AARC (2025)
Voids in flood plains	Voids located fully or partially within flood plains generally require rehabilitation to a stable condition. Detailed floodplain modelling must demonstrate that proposed voids will not pose unacceptable environmental or safety risks during flood events, ensuring long-term stability.	Section 3.4: Voids in Flood Plains (Queensland Government Department of Environment and Science, n.d.)	Engeny (2022b)
Water quality monitoring	Implement measures to maintain water quality following regulatory standards, including monitoring and treating any contaminated surface water or groundwater.	Section 5.1: Water Quality Monitoring and Management	Section Error! Reference source not found.
Water quality criteria	Establish clear, measurable water quality criteria for surface water and groundwater to ensure that water conditions meet regulatory requirements and support environmental outcomes post-mining. Criteria should address key parameters such as pH, salinity, metals, nutrients, and contaminants to ensure ecological and rehabilitation objectives are achieved.	Section 5.1: Water Quality Monitoring and Management (Queensland Government Department of Environment and Science, n.d.)	Actions for adjustments to monitoring network, surface water monitoring frequency and sampling for 18-24 months of groundwater and surface water to assess variability and review as a milestone
Monitoring and reporting	Monitor water levels, water quality, and surface and groundwater flow patterns regularly, reporting findings to ensure compliance with performance indicators.	Section 8: Monitoring and Reporting Requirements	
Pit void lakes	Establish appropriate closure criteria for pit void lakes, ensuring stability, safety, sustainability, and suitable water quality while considering long-term environmental and community safety.	Queensland Mine Rehabilitation Commissioner (QMRC, 2022)	Section 4.1.2 and Section 4.1.3 Recommended actions for managing water runoff into pit, adjustments to landforms and AQ Pit/One Mile Creek flow mixing modelling

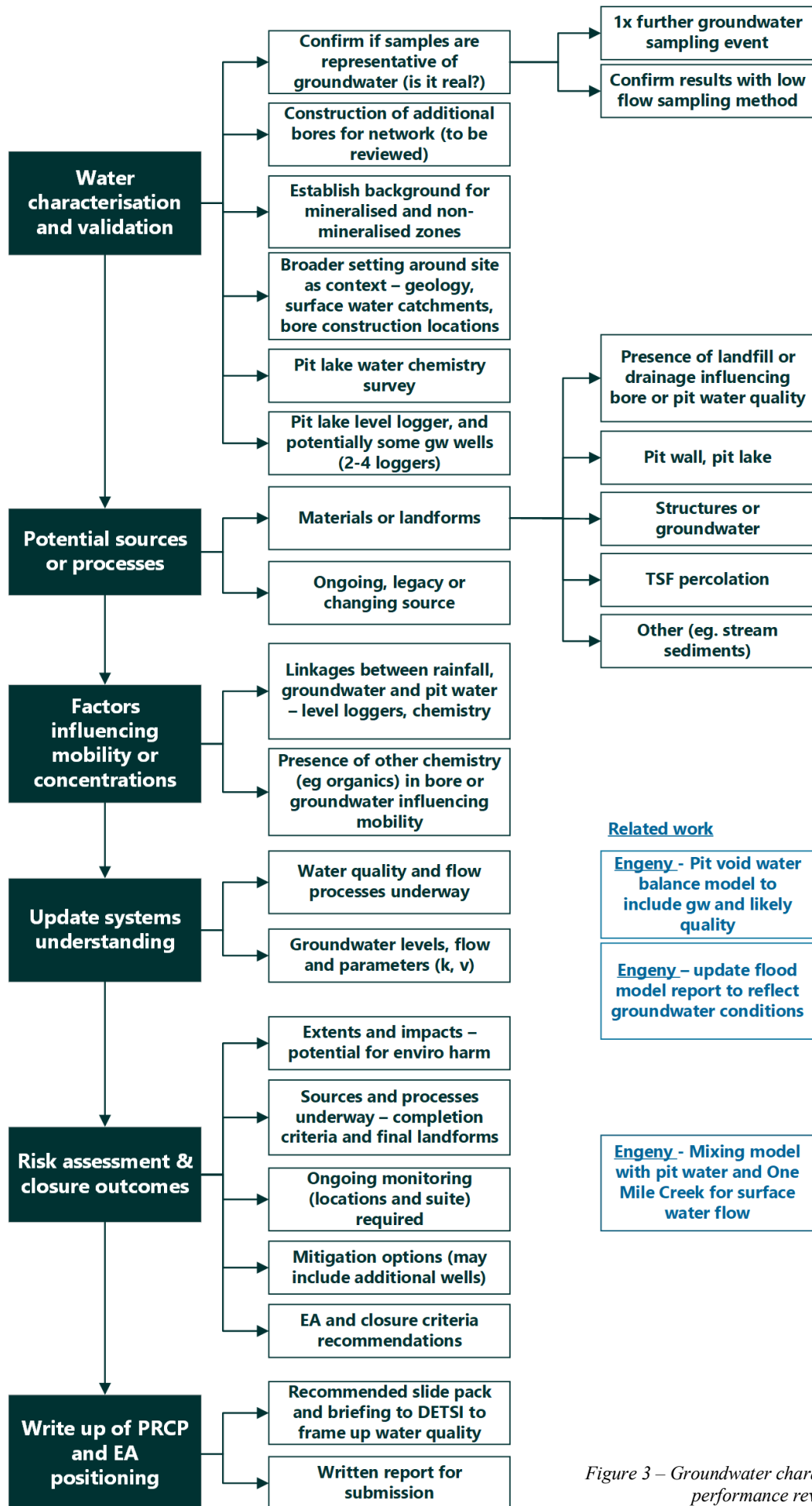


Figure 3 – Groundwater characterisation and site water performance review process



2 Overview of Alice River mine site and project

2.1 Site layout and landforms

The Alice River site occupies a limited footprint, measuring 660m by 230m. It is located north of One Mile Creek, between the main creek and a tributary flowing from the north. The One Mile Creek becomes the Alice River approximately 5km downstream from the site after several other tributaries join it and the drainage grows.

The site is a low-relief area, characterised by sandy soils and minimal changes in relative levels (RL). It is currently used for exploration, with a small accommodation camp and coreyard near the Alice Queen Dam, an existing landholder dam to the northeast. The Alice River Station homestead, from which the site takes its name, is located 4km to the south. The landowners are actively involved in managing and maintaining the mine site as part of a collaborative and mutually beneficial relationship with Pacgold.

Figure 4 shows the current layout of the Alice River project site, including locations, landforms, and the monitoring network.

- **Alice Queen Pit:** The Alice Queen pit is a small historical pit that has developed into a pit lake (Figure 5). The pit receives inflow from the surrounding catchment during rainfall, and the local council installs diversion drains to direct flow into the pit. Additionally, One Mile Creek contributes flow during flood events from the south and the old pit ramp (~117.5mAHD). Minor floods and creek inflows are relatively frequent, occurring every few years. The pit lake is approximately 10-20m deep (based on 2021 depth sounder measurements) and holds an estimated 39,000m³ of water, with a water surface area of around 5,500m². The pit is heavily vegetated along the walls, with permanent vegetation indicating the presence of permanent water and stability in water levels, suggesting a groundwater supply. A distinct maximum water height line is visible. According to the station landowner, the water level in the pit fluctuates by up to 2-3m annually, varying between the dry and wet seasons.
- **Alice River Mine Tailings Storage:** The tailings storage facility occupies a relatively small footprint (2.2ha) and is a low-relief landform, with elevations ranging from 2 to 4m. The area is heavily vegetated, and has a large depression which frequently stores rainfall water, situated in a sunken/concave area of the landform (Figure 6). The low storage has a rock embankment wall adjacent to One Mile Creek and a tributary draining from the north from the water supply dam. The landform acts more as raised earthworks than a typical dam or embankment.
- **Minor Waste Rock and ROM:** These minor stockpiles are remnants of previous operations located southwest of the historical processing area. They have limited material and a small footprint (0.2ha each). These landforms will be removed as part of the final closure state.
- **Temporary Waste Rock Landform:** This small landform, covering 0.35ha in the mining area's northern part, primarily composed of clayey with some visible reactive material. It is expected to be removed and not part of the final closure state (Figure 7).
- **Historical Platform:** A buildup of unknown material across 1.1ha south of the mining areas. This material is well-established and may contain some waste rock and remnants from previous and historical mining phases, as the material has been in place for an extended time (Figure 8).

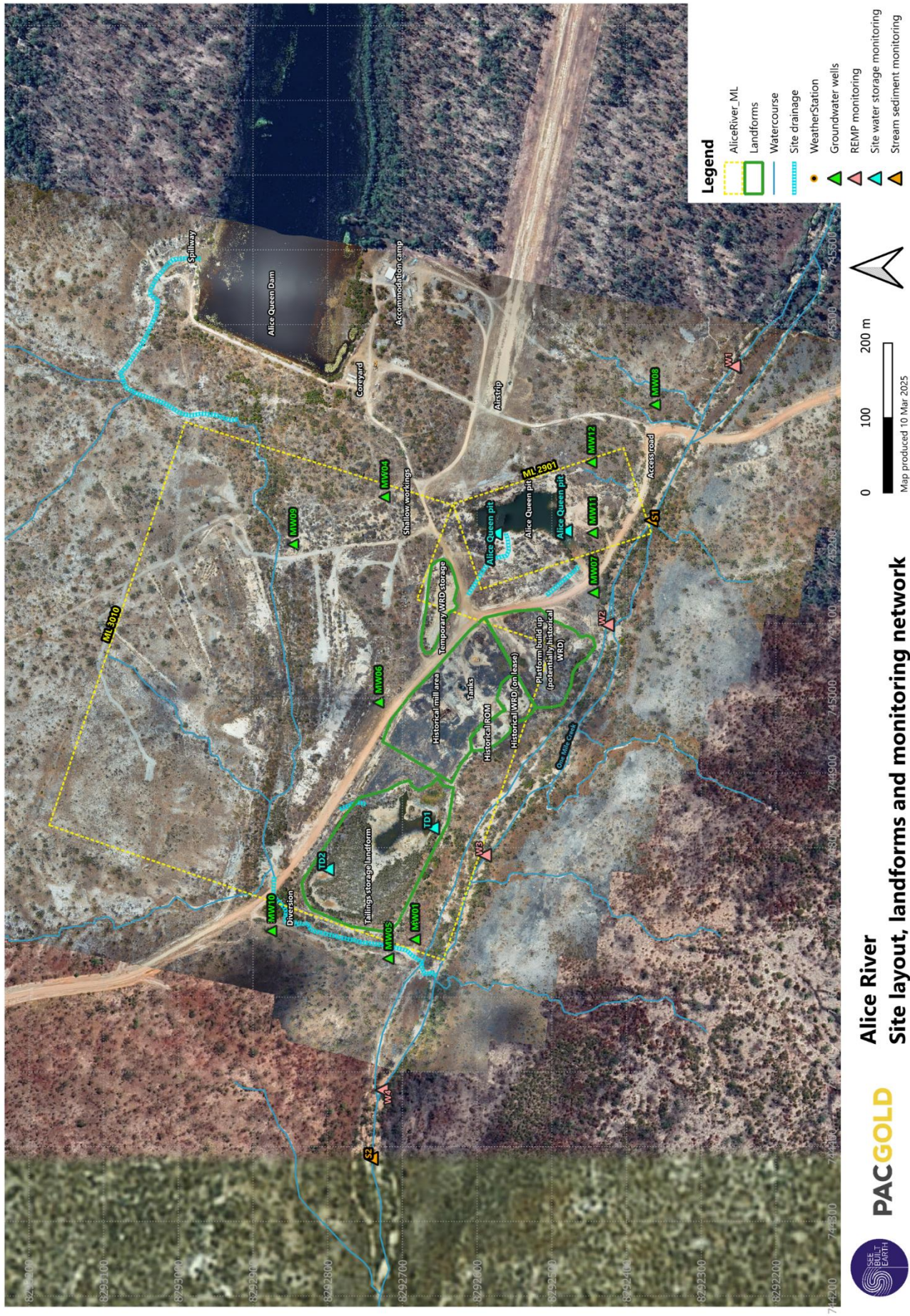


Figure 4 – Site layout, landforms and monitoring network





Figure 5 - Alice Queen Pit (July 2022)



Figure 6 - View of Alice River TSF looking west and from base of low embankment (July 2022 & February 2025)



Figure 7 - Temporary Waste Rock Storage



Figure 8 - Historical platform stockpile southwest of Alice Queen pit



2.2 Regulatory framework

The Alice River mine operates under Environment Authority (EA) EPML00870113, outlining environmental management and monitoring obligations.

The site is located within the Cape York biozone of the Mitchell Basin (Figure 9), approximately 8 km outside the Great Artesian Basin (GAB) management area. The hydrogeology of the mine area is characterised by localised aquifers with generally low productivity, differing significantly in groundwater and surface water characteristics from the GAB, which only applies further downstream in the Mitchell River catchment (Queensland Government, 2012a, 2012b; Ransley & Smerdon, 2012; Jacobsen & Lau, 1987). The mine area and its upstream catchment lie within a mineralised province, hosting gold, copper, and antimony (refer Figure 9).

The broader regulatory framework relevant to water management includes the Water Plan (Mitchell) 2007 (Figure 10), which designates the Alice River as a prescribed watercourse downstream of the site. The mine itself is immediately adjacent to One Mile Creek, a tributary upstream of the Alice River. Notably, One Mile Creek is not designated as a prescribed watercourse under the Mitchell Water Plan.

Key provisions applicable to the Mitchell Basin and the Alice River mine (excluding the prescribed watercourse itself) include:

- Ecological outcomes: Maintaining natural flow variability, supporting native species habitats, and protecting groundwater-dependent ecosystems.
- Monitoring and reporting: Ensuring regular assessment of water-use efficiency, ecological health, and availability.

Table 2 provides a summary of the outcomes currently prescribed under the Mitchell Water Plan (2007) with notes on their applicability to the Alice River mine and PRCP.

The Mitchell Water Plan does not establish Water Quality Objectives (WQOs) for the Alice River or its tributaries, including One Mile Creek. However, it references the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water), which provides general WQOs for surface waters in the broader region. The EPP Water outlines locally relevant WQOs for parameters such as pH, salinity, turbidity, nutrients, and contaminants, ensuring water management aligns with environmental protection and sustainability goals.

Site-specific hydrogeological investigations are recommended to confirm groundwater and surface water connectivity and inform tailored management strategies aligned with these objectives.



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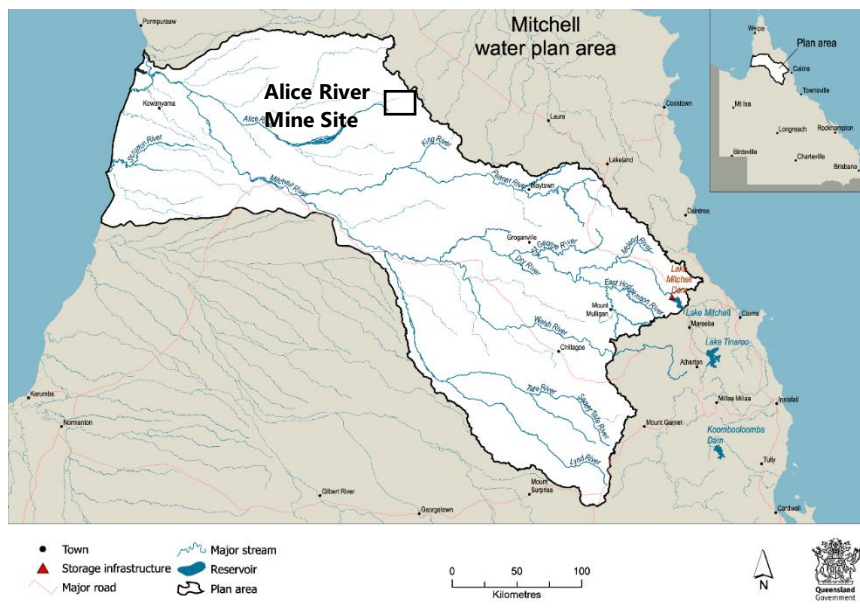


Figure 10 - Mitchell Water Plan Area

Table 2 - Outcomes under the Water Plan (Mitchell) 2007 for the Alice River mine site

Outcome category	Specific outcome	Scope	Source	Applicable to Alice River
General ecological outcomes	Maintain natural variability of flows to support habitats for native plants, animals, and migratory birds.	Basin-wide	WPM 2007, Ch. 3, Sec. 13	May be applicable
	Preserve river system connectivity for aquatic species movement and nutrient/sediment transport.	Basin-wide	WPM 2007, Ch. 3, Sec. 13	May be applicable
	Ensure groundwater contributions sustain surface water flows and ecological refugia in waterholes/lakes.	Basin-wide	WPM 2007, Ch. 3, Sec. 14	May be applicable
Specific ecological outcomes	Maintain flood flows to estuarine and marine environments for breeding and growth cycles for aquatic species.	Specific: Gulf of Carpentaria	WPM 2007, Ch. 3, Sec. 15(b)	Not applicable
	Deliver nutrients and sediments to wetlands, such as the Mitchell River Fan Aggregation.	Specific: Mitchell River Fan Aggregation, Southeast Karumba Plain	WPM 2007, Ch. 3, Sec. 15(c)	Not applicable
	Protect ecosystems dependent on the Alice River as a prescribed watercourse.	Specific: Alice River	WPM 2007, Ch. 2, Sec. 7	May be applicable
Cultural values	Support Aboriginal and Torres Strait Islander communities' water-related cultural values.	Basin-wide	WPM 2007, Ch. 3, Sec. 12(j)	No water-related cultural values are identified within or around the site.
Management strategies	Protect water quality, minimise sediment movement, and preserve riparian and aquatic habitats.	Basin-wide	MWMP, Ch. 4, Sec. 41	May be applicable
	Ensure groundwater use does not impact surface flows or dependent ecosystems.	Basin-wide	MWMP, Ch. 4, Sec. 41	No groundwater use – not applicable
Monitoring and reporting	Assess water use efficiency, critical ecological requirements, and water availability.	Basin-wide	MWMP, Ch. 4, Sec. 43	May be applicable



2.3 Monitoring network and recent updates

The Alice River mine has an established monitoring network covering groundwater, site water storages, and the receiving environment (for locations refer Figure 4). The monitoring program is designed to meet Environmental Authority (EA) EPML00870113 requirements while supporting broader objectives under the Water Plan (Mitchell) 2007. Key monitoring locations include:

- Surface water monitoring:
 - Upstream and downstream reference sites on One Mile Creek to assess potential impacts (refer Table 3).
 - Site water storages, including monitoring the tailings dam ponds: note that this is rainwater storage, not tailings water.
- Groundwater monitoring:
 - Three compliance monitoring bores installed near the pit and tailings storage to assess groundwater levels and quality. Two of these bores were installed since 2022 to maintain compliance with EA conditions (refer Table 4).
 - Seven additional groundwater wells constructed across the site to support hydrogeological characterisation and ongoing monitoring.

In late 2024 to early 2025, additional monitoring was also undertaken and installed for system understanding and geochemical profiling:

- An ad hoc pit lake water level and quality profiling exercise to sample across the pit and at depth to characterise pit water quality.
- Water level loggers for continuous water level monitoring of the Alice Queen Pit and MW07.
- Runoff grab samples during rainfall events from waste rock and ROM areas.

Appendix A provides a summary of EA water monitoring obligations, noting that there is currently a specified monthly frequency of receiving environment sampling. However, One Mile Creek is ephemeral and only flows following significant rainfall in the catchment and is dry for most of the year. Surface water monitoring opportunities are seasonal and conditional, and monthly monitoring is not possible or practical.

Table 3 and Table 4 provide locations and details of the current surface and groundwater monitoring networks. Bore construction details and photos for all wells are in Appendix C and D, including geology logs for MW09-MW12 and driller logs for MW09-MW11.

Table 3 – Current receiving environment (REMP) monitoring sites

Site	Location	East	North
W1	Upstream	745236	8292166
W2	Below Alice Queen Pit	744969	8292292
W3	Below Tailings Storage	744672	8292418
W4	Downstream at the edge of the mine lease	744345	8292575
W7	Downstream at the edge of the mine lease	744550	8292697



Table 4 - Groundwater monitoring bores and details

Site	Location	Status	East	North	Top of collar	Total depth	Screen	Geology
MW01 (GW1)	Downgradient of tailings, alongside One Mile	Existing	744677.738	8292683.6	119.8	12.45	6.5-12.5	Granite/Clays
MW02	Not in use/blocked							
MW03	Not in use given mix-ups in history of naming							
MW04	Upgradient of Alice Queen Pit	New Late 2022	745269.338	8292724.139	125.18	13.9	7.9-13.9	Granite
MW05 (GW2)	GW2 – Downgradient of TSF, across northern tributary, potential limey sandstone	New Late 2022	744651.581	8292719.355	120.7	11.4	5.4-11.4	Granite/other?
MW06	Upgradient of TSF, mid site	New Late 2022	744994.513	8292732.309	122.77	12.7	6.7-12.7	Granite
MW07	Downgradient of Alice Queen Pit near creek, near One Mile	New Late 2022	745141.258	8292444.228	117.73	9.7	3.7-9.7	Granite/dolerite
MW08	GW3 – Upgradient of site, Reference	New Late 2022	745392.47	8292362.135	117.45	9.4	3.4-9.4	Granite
MW09	Upgradient of the site, near northern tributary, Reference	New Late 2024	745205.757	8292846.666	119.97	12.5	6.5-12.5	Orebody quartz and mineralisation
MW10	Upgradient of TSF, mid site along tributary, Reference	New Late 2024	744688.554	8292875.469	121.99	11.5	5.5-11.5	Granite
MW11	Downgradient of Alice Queen Pit	New Late 2024	745315.486	8292447.56	118.53	12	6-12	Dolerite
MW12	East of Alice Queen Pit, other side of mineralised structure	New Late 2024	745269.338	8292724.139	120.83	10.7	4.7-10.7	Granite



2.4 Landforms and planned rehabilitation outcomes

Table 5 summarises the key rehabilitation outcomes proposed for the Alice River mine site, as AARC (2025) describes. The rehabilitation strategy includes:

- Waste rock and ROM material will be relocated within TSF for containment.
- The TSF will be reformed into a rain and runoff shedding structure to minimise percolation and promote surface water runoff for containment. Currently the landform stores water.

Figure 11 shows a drone view over Alice River site with each of the landforms labelled.

Table 5 - Planned rehabilitation outcomes

Landform	Rehabilitation fate	Land-use
Waste rock landforms and ROM	Material will be moved to the tailings dam, and the WRD and ROM pad areas will be regraded and revegetated.	Align with surrounding topography.
Tailings storage landform	The area will be backfilled with WRD and ROM pad material and reprofiled to achieve a water-shedding structure with vegetation.	Low hill, grass community, water shedding landform.
Alice Queen pit	Remain as a pit lake.	Stock water point



Figure 11 - View over Alice River Mine site



3 Water and natural systems characterisation

3.1 Landscape

The Alice River mine sits near the upper reaches of the Mitchell River drainage basin, within the Alice River catchment, on the western side of the Great Dividing Range. The topography comprises predominantly low-relief granite rangelands, forming a broad watershed divide. Land use is predominantly dryland agriculture and cattle. Regionally, the Alice River flows approximately 200 km west, joining the Mitchell River before discharging into the Gulf of Carpentaria (Figure 1 and Figure 5).

The region's drainage systems are broad, low-gradient, and predominantly ephemeral. Flow occurs only after significant rainfall, leaving dry riverbeds during the dry season and extended low-rainfall periods. The rivers in this area are aggrading, with extensive alluvial sands and gravels shaping braided and shifting channels.

The Alice River mine site is broad and low-relief, with natural ground levels varying only by several metres. This results in large, gently drained areas, often characterised by sandy banks and rocky rises (Figure 13). Given the low relief, the region is highly flood-prone during the wet season, significantly constraining access.

DTM analysis shows a topography with a low divide spanning west-east across the site, roughly following the northern side of the east-west access road across the centre of the site (Figure 12). Water drains south of the low divide across the legacy mine landforms towards One Mile Creek. North of the divide, where the ground is predominantly undisturbed, surface water flows towards the northern tributary, which flows into One Mile Creek at the western extent of the mine lease. The predominantly north of the site is the western section of One Mile Creek (downstream of the site), which is at a higher elevation than the eastern portions, creating a lower-lying area upstream of the site where surface water is likely to pool following rainfall events. This topographic variation contributes to the widening of surface water flows, supporting localised sediment deposition and braided channel formation.

The soils across the project are sandy, granular, and poorly developed. They consist primarily of weathered granite, sands, and gravel in various stages of breakdown, with some localised outcrops, particularly around the pit area, in One Mile Creek river banks, and along the strike of the mineralised structure.

The vegetation consists of eucalypt and melaleuca open woodlands, with Darwin stringybark being the dominant species within the Cape York BioZone (Queensland Government, 2021). The surrounding region primarily uses dryland and stock farming, with some irrigated agriculture. Several historical gold mines are located north and south of the site. Key landscape features include:

- One Mile Creek, a tributary of the Alice River, runs along the site's southern boundary, adjacent to the Alice Queen pit and tailings storage landform. The creek forms an ephemeral, wide drainage line with extensive sandy banks, sediment deposition zones, and braided flow patterns.
- To the north and east, overflow from the Alice Queen Dam is diverted around the site, flowing into One Mile Creek near the tailings storage landform.
- Historical mining areas remain disturbed but predominantly stable, with infrastructure and landforms in place for over 25 years.
- Permanent landforms, including the Alice Queen pit and tailings storage landform, are heavily revegetated. The remainder of the site consists of open woodland, sandy or gritty soils, and weathered rock with sparse grass cover.

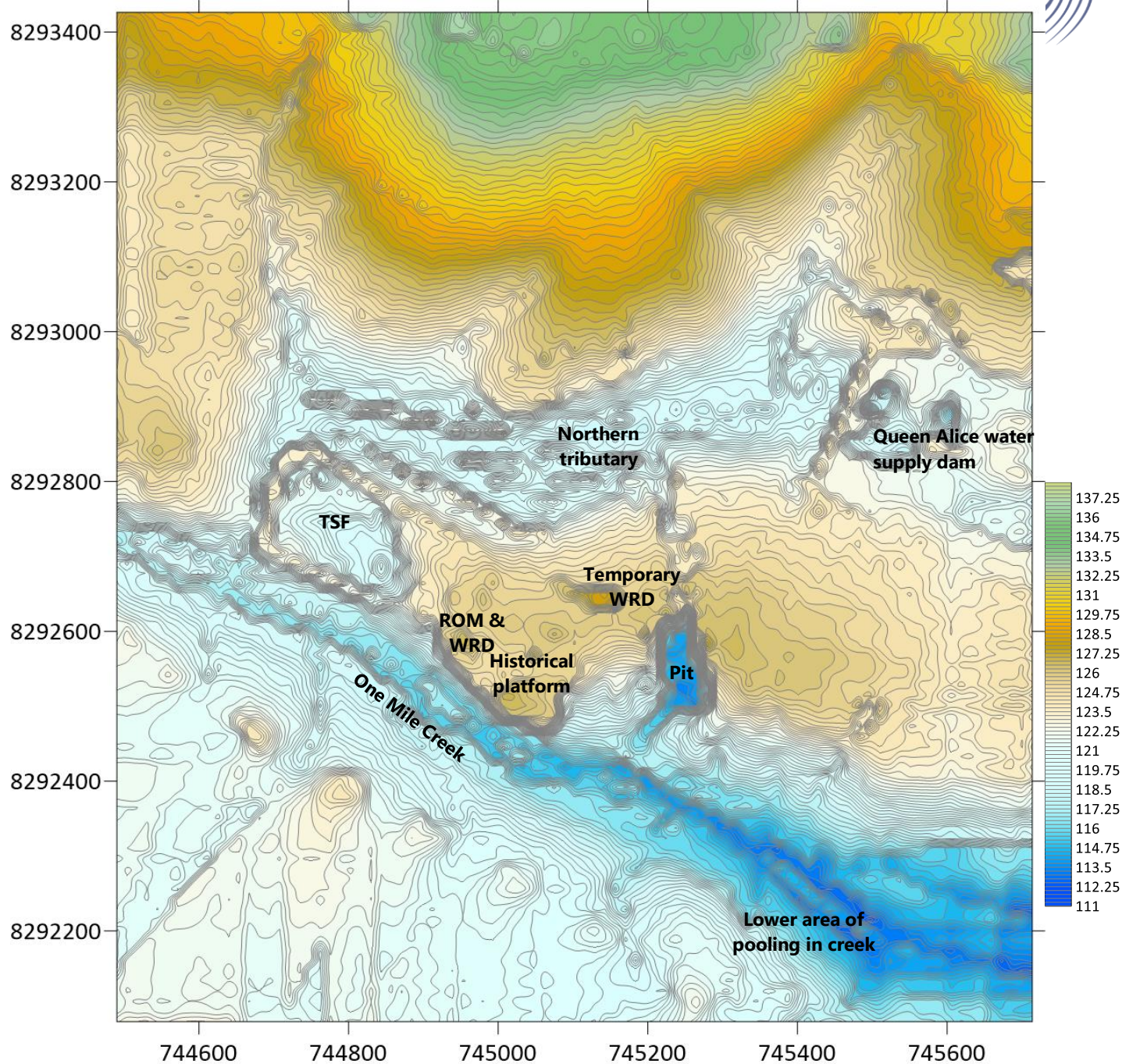
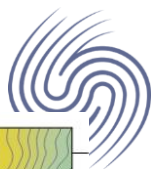


Figure 12 - Alice River Mine site elevations and terrain



Figure 13 - View of landscapes around Alice River: broad, sandy ephemeral drainage lines & low rises



3.2 Climate

3.2.1 Rainfall patterns and variability

The Alice River mine is within the Cape York Peninsula climate zone, a tropical system characterised by high temperatures and highly variable annual rainfall. When rainfall events occur, they can quickly deliver large volumes of water, with several significant flooding events recorded in recent years.

Rainfall is influenced by the El Niño–Southern Oscillation (ENSO) and local factors, including topography and vegetation. The region experiences:

- The majority of rainfall between October and March, driven by thunderstorms, monsoonal lows, and tropical cyclones.
- Extended dry periods (droughts) interrupted by intense wet-season rainfall.
- Extreme wet season events.

Rainfall data for profiling is sourced from several Bureau of Meteorology (BoM) stations (for locations see Figure 9) and since late 2023, a real-time weather station at Alice River Homestead (for location see Figure 2), including:

- 28026 Killarney (23 km east), now retired, with the last read in 1999.
- 28025 Pinnacle (41 km southeast).
- 28000 Laura Post Office (126 km east) – engaged as backup given Pinnacle has sporadic updates online (sometimes 6 months or more between updates).

Since 1970, annual seasonal rainfall (July–June, covering full wet seasons) at Bureau of Meteorology (BoM) stations near the site has predominantly ranged between 700–1,600 mm. However, variability is high, with recorded extremes from as low as 400 mm to over 1,800 mm during cyclonic events (Figure 14).

Figure 15 illustrates daily and cumulative seasonal rainfall at Pinnacle station, highlighting the site's rainfall range and its pattern of extended dry periods punctuated by large rainfall events. Dry conditions dominate, with an average of 279 dry days per year.

Longer-term rainfall variability is also evident. Figure 16 presents a residual rainfall analysis, showing deviations from average rainfall over the past 50 years across three BoM stations. This analysis reveals distinct seasonal patterns and longer-term wet and dry cycles, demonstrating the site's susceptibility to extreme weather variability, including prolonged droughts and significant wet periods. Recent climate trends visible in the residual analysis include:

- Historical trends since mining commenced: Alternating dry and wet periods, demonstrating the site's exposure to high rainfall variability.
- 2012–2018: Extended drought conditions.
- 2019–2021: A return to drier to near-average rainfall.
- 2021–present: Wetter conditions.

A comparison of rainfall recorded at regional stations, such as Laura, with rainfall at Alice River Station is presented in Figure 17, showing cumulative and daily rainfall depths. Over the past two years, Alice River has received approximately 75 mm more rainfall than Laura. This difference is likely due to Alice River's location on the western side of the divide, closer to the Gulf of Carpentaria, where large tropical cyclones and monsoonal lows deliver significant rainfall.



To check on comparability and validation between the sites, a histogram of daily rainfall of each of the two sites shows a strong population correlation, indicating both locations experience similar weather systems (Figure 18). However, recorded rainfall depths at Alice River have been consistently higher in the past two years for the larger events, reflecting localised variability in storm intensity and distribution.

3.2.2 Evaporation

Evaporation data for the Alice River mine have been derived from pan evaporation measurements at Palmerville (028004), the nearest available BoM station with pan evaporation rates.

Table 6 summarises monthly and daily evaporation rates:

- Evaporation rates range from ~5 mm/day in winter to ~4.5 mm/day in October, reflecting high summer heat capacity, particularly before seasonal rains.
- Annual potential evaporation is estimated at ~2,298 mm, significantly exceeding typical annual rainfall (~700–1,400 mm).

The site's water balance is strongly negative, with potential evaporation exceeding rainfall by at least 500-800 mm per year (or 0.5-0.8m) in the wettest years.

Table 6 - Palmerville evaporation rates

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Daily mm	6	5.2	4.9	5	4.7	4.6	5	6.3	8	9.3	8.9	7.6	6.3
Month mm	186	145.6	151.9	150	145.7	138	155	195.3	240	288.3	267	235.6	2,298

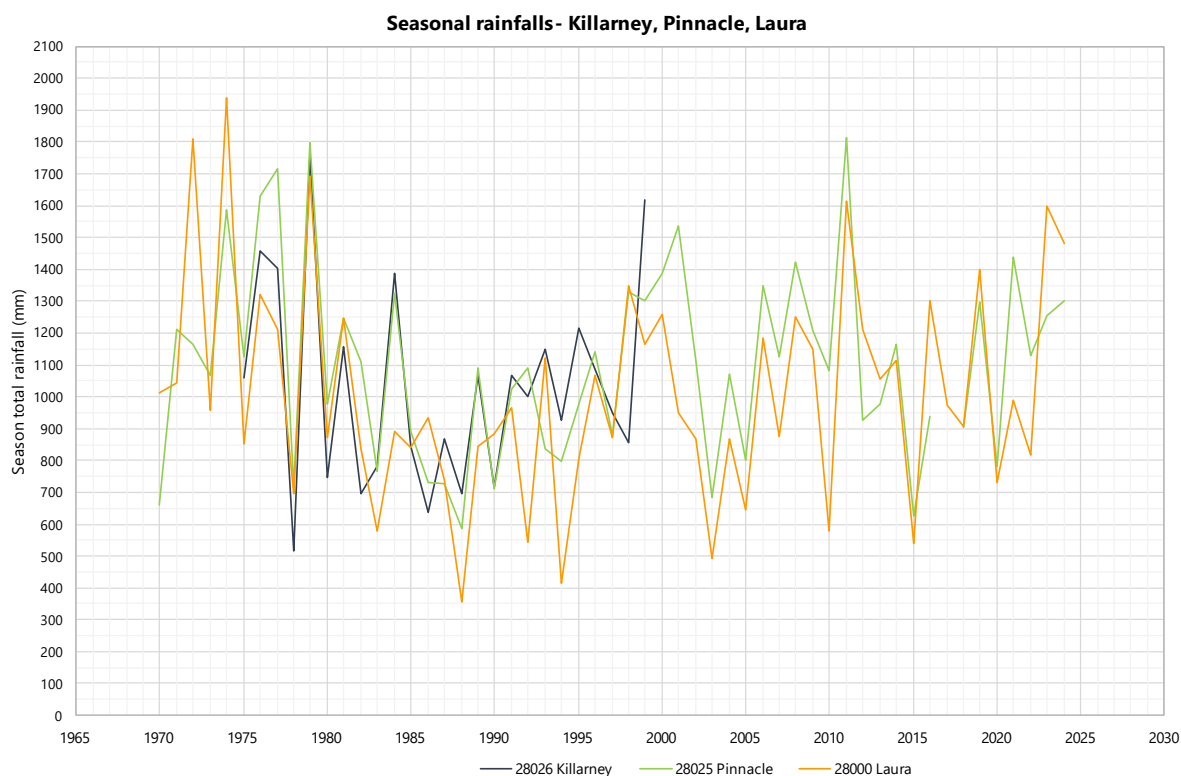


Figure 14 - Annual rainfalls of BOM rainfall stations

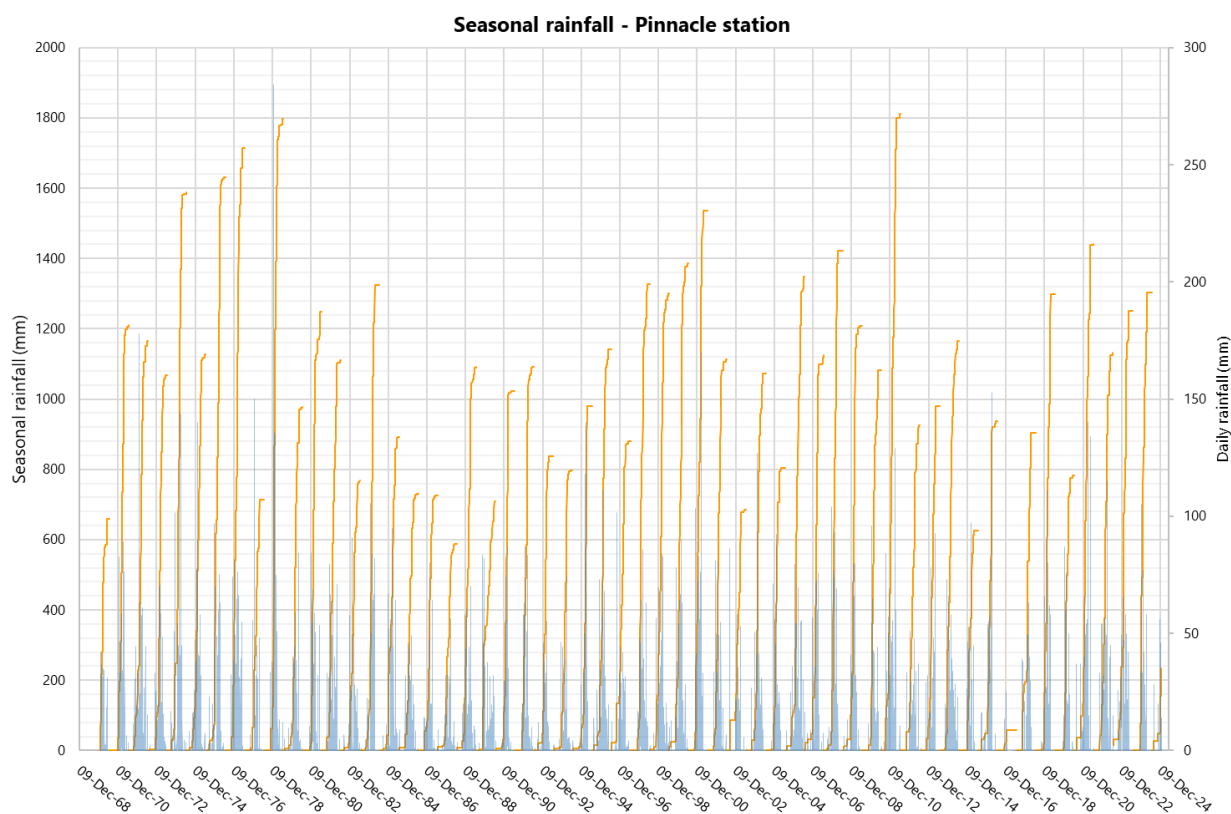


Figure 15 - Seasonal rainfall by year at Pinnacle Station



Residual rainfall- Pinnacle, Laura & Killarney BOM stations

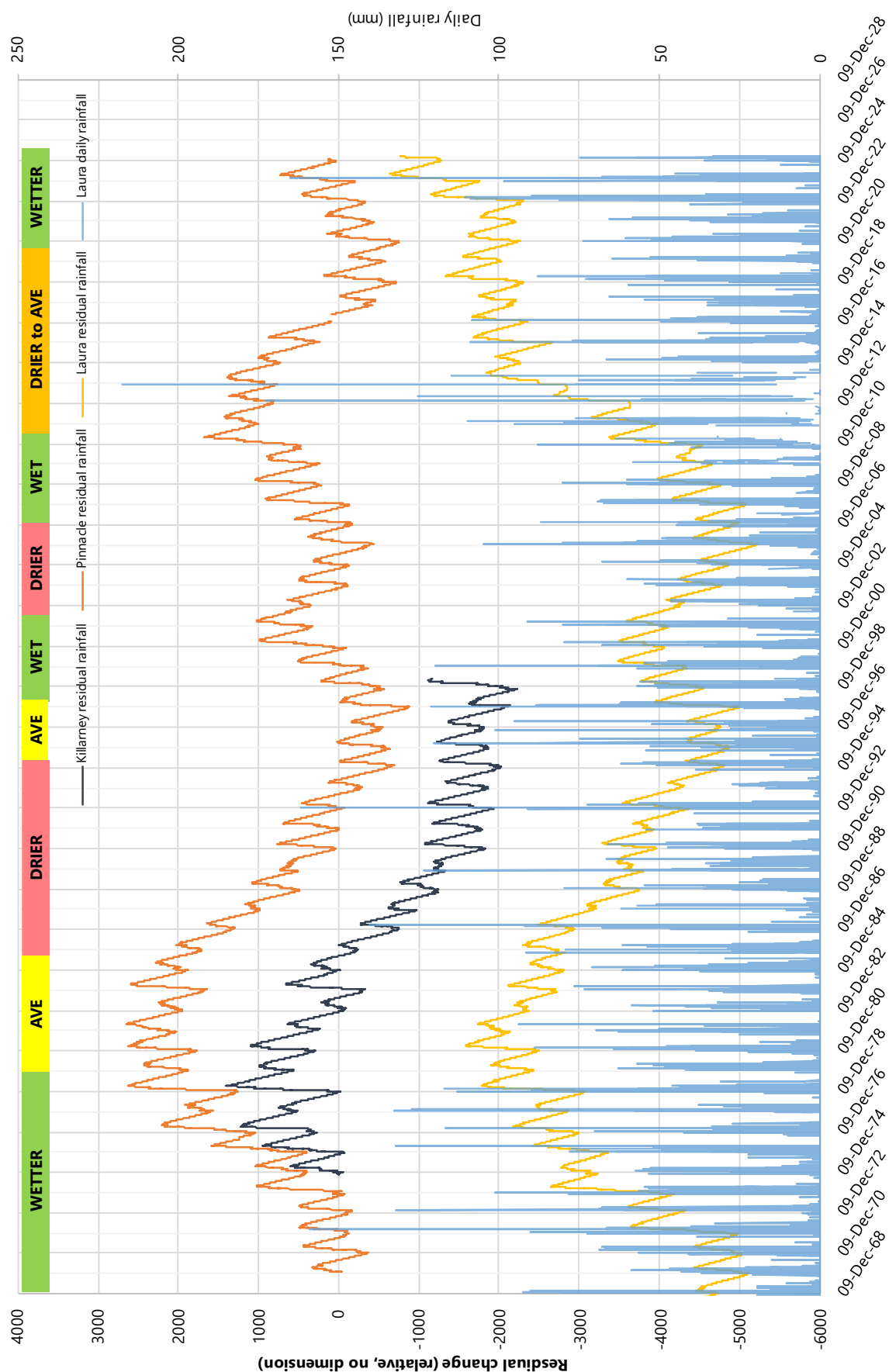


Figure 16 - Residual rainfall of Laura, Pinnacle and Killarney rainfall station



Alice River Station and Laura rainfall (daily and season cumulative) 2023/4 and 2024/25 season

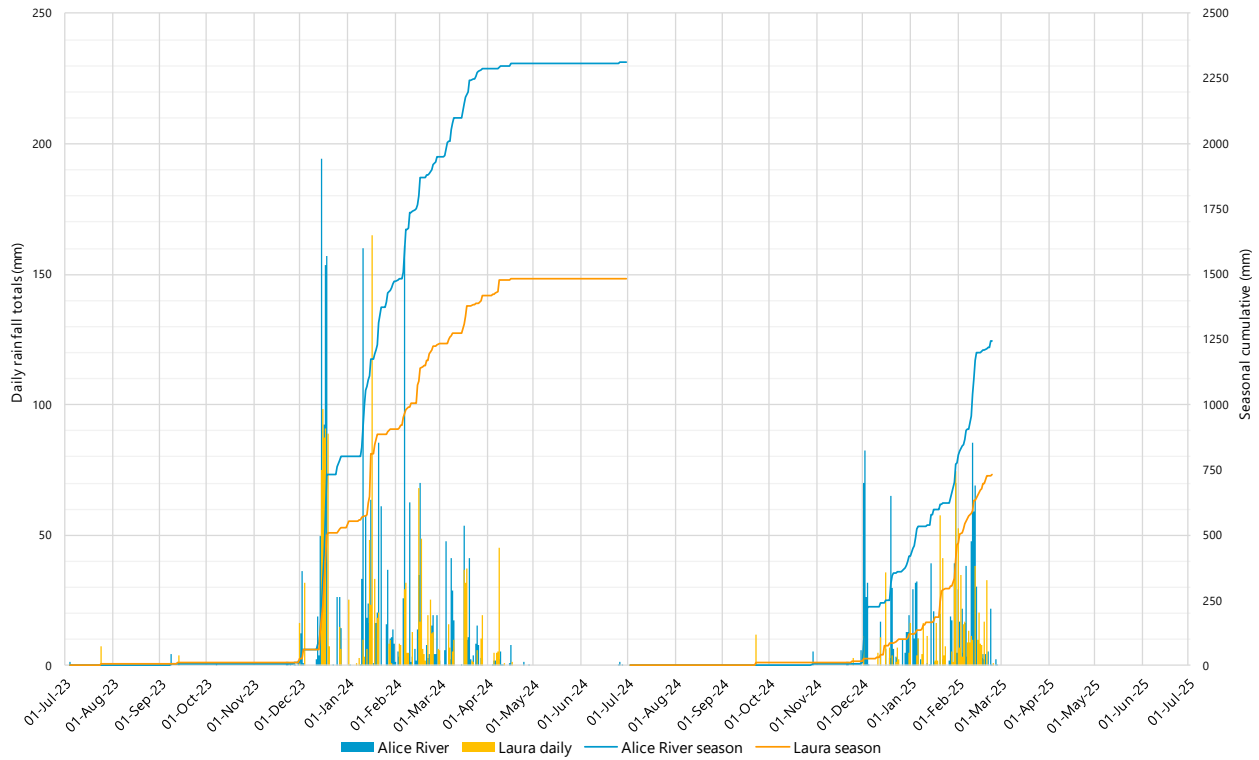


Figure 17- Seasonal and annual rainfall of Laura and Alice River Station

Histogram of Laura and Alice River Station

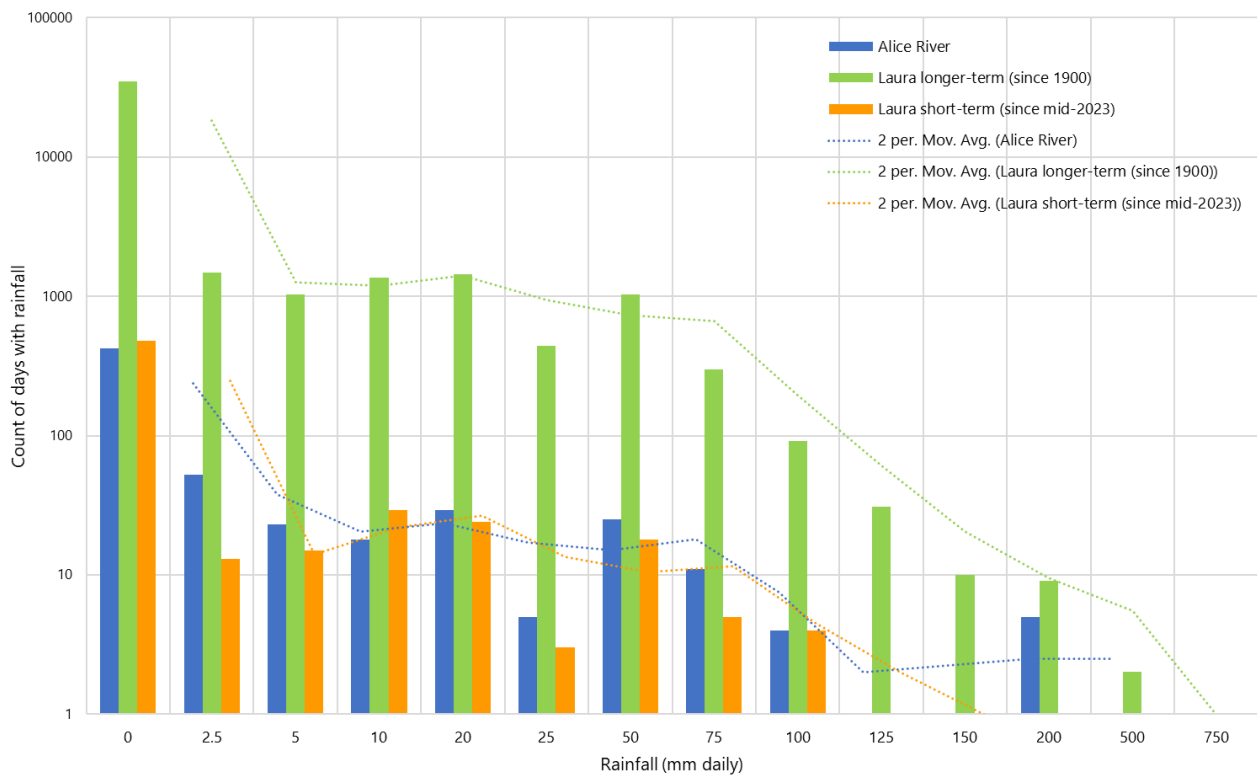


Figure 18 - Histogram of Laura and Alice River Station rainfall



3.3 Surface water and catchments

3.3.1 Surface water flow characteristics and pathways

The dominant water feature for the Alice River mine is One Mile Creek, which is ephemeral, has a low gradient, and has sediment and organics-laden drainage. Flow is highly seasonal and event-driven, with the creek remaining dry for much of the year and only carrying water following significant rainfall, often with high levels of organics within the flow and in river sediments over time. Figure 19 the dry riverbed in November 2024 illustrates its typical condition for much of the year.

The site is towards the top of the One Mile Creek catchment, with a 235km² catchment above it, and rests within a small catchment adjacent to the creek. Rainfall in the above catchment is generally required for flow in One Mile Creek past the site, but it can occur without rain at the site. One Mile Creek typically flows westward, merging with the Alice River approximately 5 km downstream before continuing westward into the Mitchell River, ultimately discharging into the Gulf of Carpentaria.

The One Mile bed generally consists of aggrading, sandy, and sediment-rich deposits, with slow velocity and broad flow, rather than maintaining continuous downstream flow. One Mile Creek functions as a losing stream (Domenico and Schwartz 1998), where surface water is not fed by groundwater flow throughout a year, but rather creek flow from rainfall runoff is slowly lost into the ground, forming either ponds or draining into shallow subsurface alluvials along the drainage line (Domenico and Schwartz 1989). The ponds and alluvial groundwater are often discontinuous, forming pools or localised waterholes unlikely to be sustained as permanent features or broad marshy areas where shallow topography allows. An exception to the alluvial sandy beds occurs west of the TSF, where limey sandstone formations along the northern tributary have formed a boxy incised channel extending 50–100 m, which is likely only a few metres thick but may be present in other areas around the site.

The site's topography also influences flow and water retention within One Mile Creek. The western section of the creek, downstream of the site, sits at a higher elevation than the eastern portions, resulting in a lower-lying area upstream to the site where surface water is likely to pool following rainfall, and resulting in widening of surface water flows past the site (Figure 12).

The site itself has a low-lying divide, with the southern catchment reporting water across the mining landforms, and the northern catchment reporting to the northern tributary before reaching One Mile to the west of the site.

The One Mile Creek and tributary catchment drains a mineralised province, hosting gold (Au), copper (Cu), and antimony (Sb) mineralisation (Figure 9). Mineralised structures also cut across the riverbed and are visible in One Mile Creek and the northern tributary (see site catchments and geology section). As a result, sediment and surface water transported during flow events may contain elevated trace metals, influenced by both natural weathering and historical mining activity in the region.

Over time, One Mile channel morphology shifts, with flow pathways adjusting in response to sediment deposition, vegetation growth, and flood-driven reworking. During major rainfall events, such as those associated with monsoonal systems or cyclonic activity, significant water movement reshapes the streambed and deposits large volumes of sediment and organic material from upstream. Figure 20, captured in early July 2022, provides an example of flow braided across multiple channels following low-level rainfall. Figure 22, taken during the February 2025 flood, illustrates the extent of flow inundation and sediment transport during peak conditions.



Figure 19 - One Mile Creek as a dry creek bed (November 2024)



Figure 20 - One Mile Creek as a slow flow creek (July 2022)

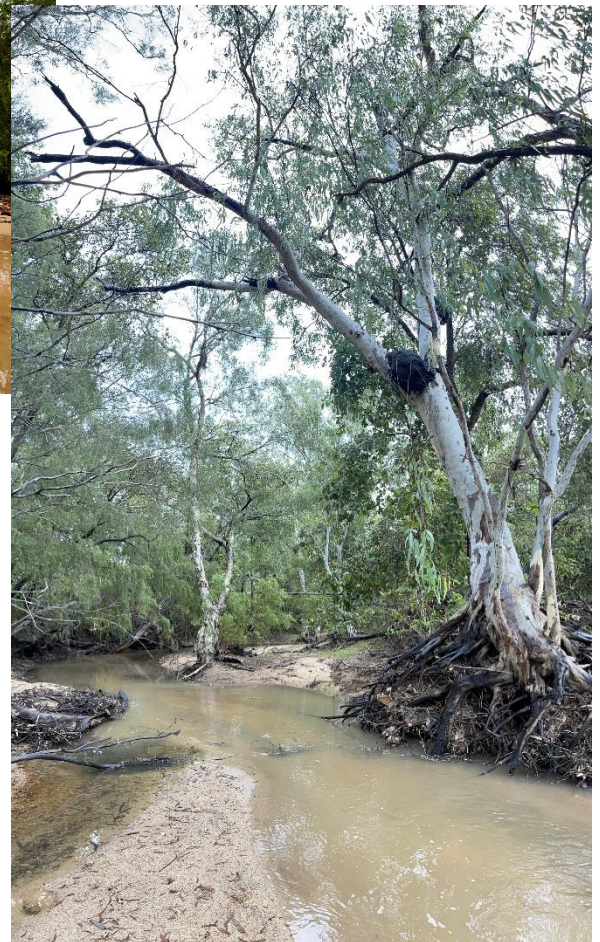




Figure 21 - Northern tributary limey sandstone/conglomerate - note TSF on RHS (top Jul 2022, bottom Nov 2024)



Figure 22 - One Mile Creek in moderate flood (February 2025)



3.3.2 Investigation: Mapping of site catchments and surface water flow paths

Background

The Alice River mine site consists of multiple surface water catchments with distinct drainage patterns influenced by topography, mining infrastructure, and historical landforms and containment. The site's low-relief terrain and previous land use have altered natural flow pathways, and field inspection is required to map catchments to represent system behaviour on the ground to inform further assessment.

Methodology

Catchments were delineated using drone-based terrain modelling, topographic analysis, and field verification during and after rainfall events. Surface flow pathways, discharge points, and standing water were recorded, with particular attention to flow connectivity across mining features such as pits, WRDs, and the TSF. Observations were compared against existing hydrological assumptions to refine the mapped catchment boundaries.

Results and conclusions

Figure 23 provides an updated site catchment map with flow directions and pathways, while Table 7 summarises their size, drainage patterns, and primary flow directions.

The nature of general surface water flow for the site can be described as:

- Pervasive dry conditions with only intermittent flow – The site is predominantly dry, with surface water movement occurring only after significant rainfall. One Mile Creek is ephemeral, flowing seasonally or following high-intensity rain in the upper catchment.
- Flooding dynamics—During wet seasons, One Mile Creek may overflow into the Alice Queen pit, and low-lying areas adjacent to the pit and TSF are also prone to flooding.
- Evaporation and storage—The site experiences high evaporation rates during the dry season. Water that persists throughout the year likely has a groundwater baseflow component (such as the Alice Queen pit). Rainfall events can cause overflow conditions from these storage areas.

Observations of key catchments and potential water quality risks across the site include:

- Alice Queen Pit Catchment
 - Receives drainage from historical workings, mineralised structures, and temporary WRD due to road cut in drains by the local council.
 - Overflow risks exist via a low-lying area between the pit and One Mile Creek.
 - Contact with naturally occurring mineralised structures may influence water chemistry.
- Tailings Storage Facility (TSF) Catchment
 - Receives direct rainfall and runoff from historical mining zones.
 - Persistent ponding within the TSF footprint suggests ongoing seepage and infiltration through tailings material.
 - During heavy rainfall, overflow discharges northward into the roadside catchment, flowing via the western diversion before entering One Mile Creek.
- WRD and ROM in the processing area catchment:
 - Drains towards TSF however is currently able to discharge to One Mile through a breach in the bund wall.
- Temporary WRD-Mullock Catchment
 - Partially drains towards the Alice Queen pit and partially towards the TSF via the site access road.



- Surface water ultimately reports to One Mile Creek via the western diversion.
- Historical WRD
 - Overland flow moves south and eastward towards bore MW07 and drains to One Mile Creek.
 - May influence groundwater quality in areas adjacent to One Mile Creek.
- Observation that the current REMP monitoring network design does not adequately separate potential natural background in the creek from a natural outcrop of the mineralised orebody through One Mile Creek and the northern tributary, which at low creek flows may contribute to water quality. The outcrops are eroded, and they naturally form part of the creek sediments: some network adjustment may be required to characterise the different potential sources. There are also mapped outcrops of dolerite near MW07 (see Section 3.4).

Table 7 - Alice River site catchments, nature and destination

Catchment code	Surface area (m ²)	Nature	Reports to
WRD-Historical	6,579	Draining catchment	MW07-One Mile Creek near pit
AQPit-WaterSurface	5,413	Pond	AQ Pit - Overflow - One Mile near pit
AQPit-EastCatchment	5,481	Draining catchment	AQ Pit - Overflow - One Mile near pit
AQPit-WestCatchment (includes part of temp WRD)	25,058	Draining catchment	AQ Pit - Overflow - One Mile near pit
AQ-Overflow	2,040	Pond	Overflow (note also has undisturbed catchment reporting) - One Mile
Site-AccessRoad (includes part of temp WRD)	26,232	Draining catchment	Western diversion around TSF - OneMile at edge of mine lease
TSF-BroaderCatchment (including runoff from historical processing area)	50,225	Draining catchment	TSF - SiteAccessRoad if overflows – northern tributary - One Mile
TSF-Pond1	6,515	Pond	TSF - SiteAccessRoad if overflows northern tributary - One Mile
TSF-Pond2	846	Pond	TSF - SiteAccessRoad if overflows northern tributary - One Mile
TSF-Pond3	360	Pond	TSF - SiteAccessRoad if overflows northern tributary - One Mile

3.3.3 Surface water quality

Surface water quality has been monitored since the closure of 1990s mining operations, with records extending from 2002 to the present. Since surface water flow only occurs during the wet season or after significant rainfall, the monitoring record needs to be regarded as intermittent, with gaps between years, and extended periods where sampling is not possible, and is representative. Additionally, variations in flow rates and conditions (see earlier figures) suggest expected differences in water quality would be expected under different creek flow rate regimes.

The province's mineralised nature and cross-cutting mineralised structures in both One Mile Creek and its tributary directly around the site means that naturally elevated background levels of some metals are expected. Surface water monitoring locations include:



- W1 as a background water quality site upgradient of the site. However, based on the topography, this site is located in the deeper ponded area of the creek.
- W2/W3, which is located downstream of the pit and historical landforms.
- W4 and W7 both capture water quality on both One Mile Creek and its tributary downgradient of the site.

Figure 24 to Figure 30 present selected water quality results for pH, conductivity, arsenic, antimony, copper, and zinc. Table 8 provides a surface water quality dashboard.

Key observations include:

- pH remains stable, generally around 6–7, consistent with organic loading in surface water, particularly at lower flow rates.
- Low salinity and electrical conductivity.
- Copper and antimony are generally not detected in both total and dissolved concentrations. There is some low-level background copper at W1 and downstream W4, but overall is generally stable.
- Sporadic arsenic spikes in both dissolved and total concentrations were observed between 2014 and 2019, but these have significantly reduced in recent years and have remained stable at low levels since. The total and dissolved metals indicate arsenic being carried is particulate and in solution, suggesting a source-related to runoff or sediments.
- Lead was largely not detected across all periods, except for 2019–2021, with detection and a peak, both at W1 as background and W4 (though the background W1 was lower). Both total and dissolved lead follow a similar pattern, again suggesting a runoff or stream sediment source. The peak has not proven repeatable in sampling since, and since 2021, has not been detected.
- A background presence of zinc at W1, with low levels observed at other sites.

Overall, surface water quality has remained stable since 2019, including during significant rainfall events and does not indicate any ongoing or degradation of water quality for surface water passing by the site.

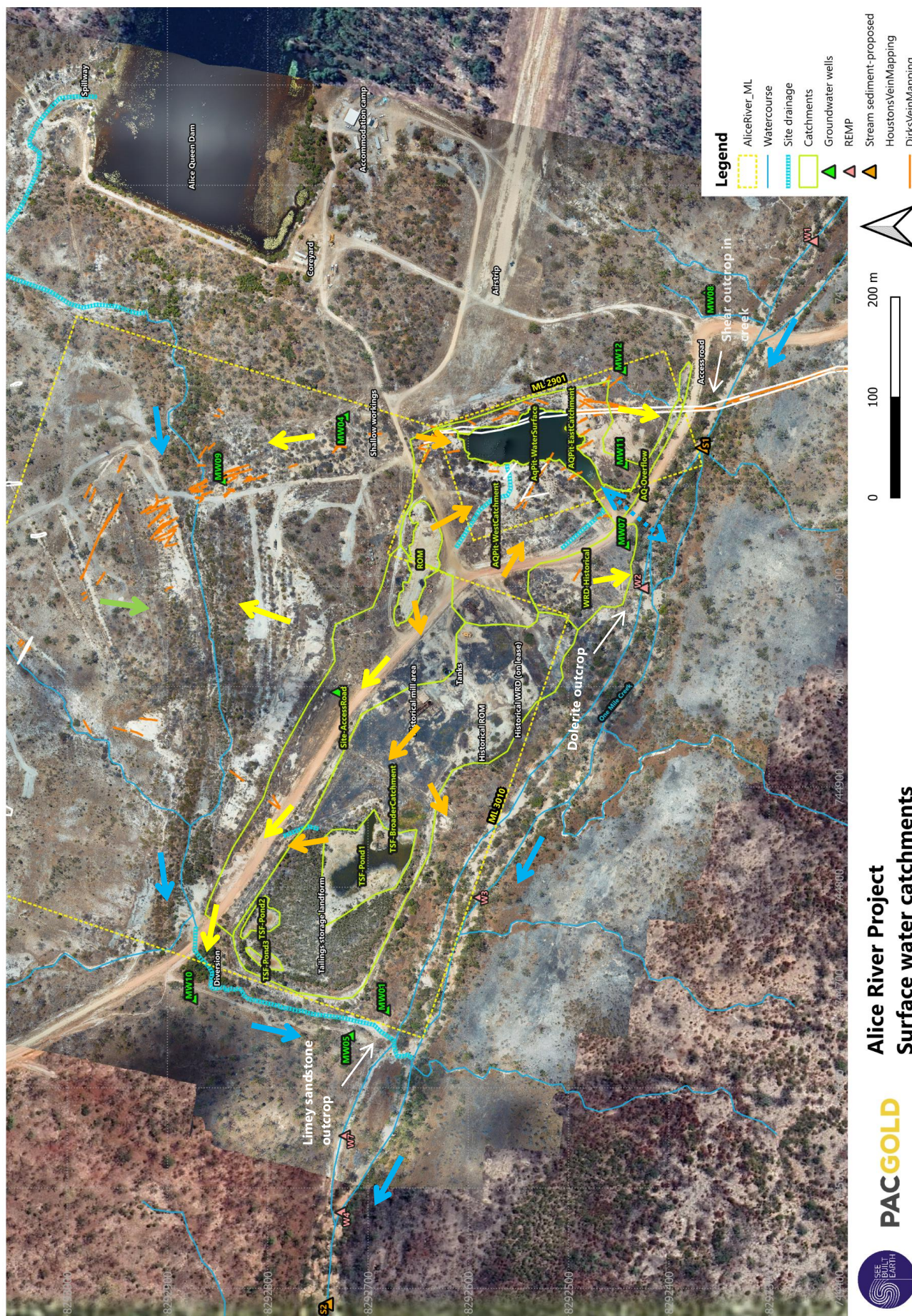
Given the ephemeral nature of One Mile Creek, the existing fixed-interval monitoring program is not well-suited to capturing seasonal variability or flow-related changes in water quality. Updates to the surface water monitoring program have been proposed under revised EA requirements, including flow-based sampling triggers and expanded monitoring locations. Limitation and representative issues for surface water monitoring includes:

- Variability in flow conditions, including different flow rates and seasonal changes.
- Low or no-flow periods, which dominate much of the year.
- Distinct surface water sources and interaction points, such as contributions from runoff, interaction with sediments and outcrops in the bed, banks and around the creek.



Table 8 - Surface water quality trends dashboard

	W1	W2	W3	W4	W7	Note
Location	Background, upstream of site	Mid-site at pit ramp, after outcrop in creek	Mid-site, alongside TSF	Edge of mine lease	Edge of mine lease	
pH	Stable – neutral to slightly acid	Stable – neutral to slightly acid	Stable – neutral to slightly acid	Stable – neutral to slightly acid	Stable – neutral to slightly acid	Reasonable with higher organics in water
Electrical conductivity	<200EC uS/cm, stable since 2019	<200EC uS/cm, stable since 2019	<200EC uS/cm, stable since 2019	<200EC uS/cm, stable since 2019	<200EC uS/cm, stable since 2019	
Sulphate	Not detected	Not detected	Not detected	Not detected	Not detected	
Antimony (dissolved)	Not detected	Not detected	Not detected	Not detected	Not detected	
Arsenic (dissolved)	Low levels (<0.01mg/l) since 2019	Low levels (<0.01mg/l) since 2019, minor increase from before post lease	Low levels (<0.01mg/l) since 2019, minor increase from before post lease	Low levels (<0.01mg/l) since 2019, minor increase from before post lease	Low levels (<0.01mg/l) since 2019, minor increase from before post lease	Life may be from site, OR from contact with mineralised area (outcrops in the creek)
Copper (dissolved)	Not detected since 2014	Not detected since 2014	Not detected since 2014	Not detected since 2014	Not detected since 2014	
Lead (dissolved)	Largely not detected except for period 2019-2021. Present in background.	Largely not detected. Where present, also in background.	Largely not detected. Where present, also in background.	Largely not detected since and before 2021.	Not detected.	Peak may be an error or isolated event as not repeatable.
Zinc (dissolved)	Not detected to occasional low background levels	Not detected to occasional low background levels	Not detected to occasional low background levels	Not detected to occasional low background levels	Not detected to occasional low background levels	



Alice River Project Surface water catchments

PACGOLD



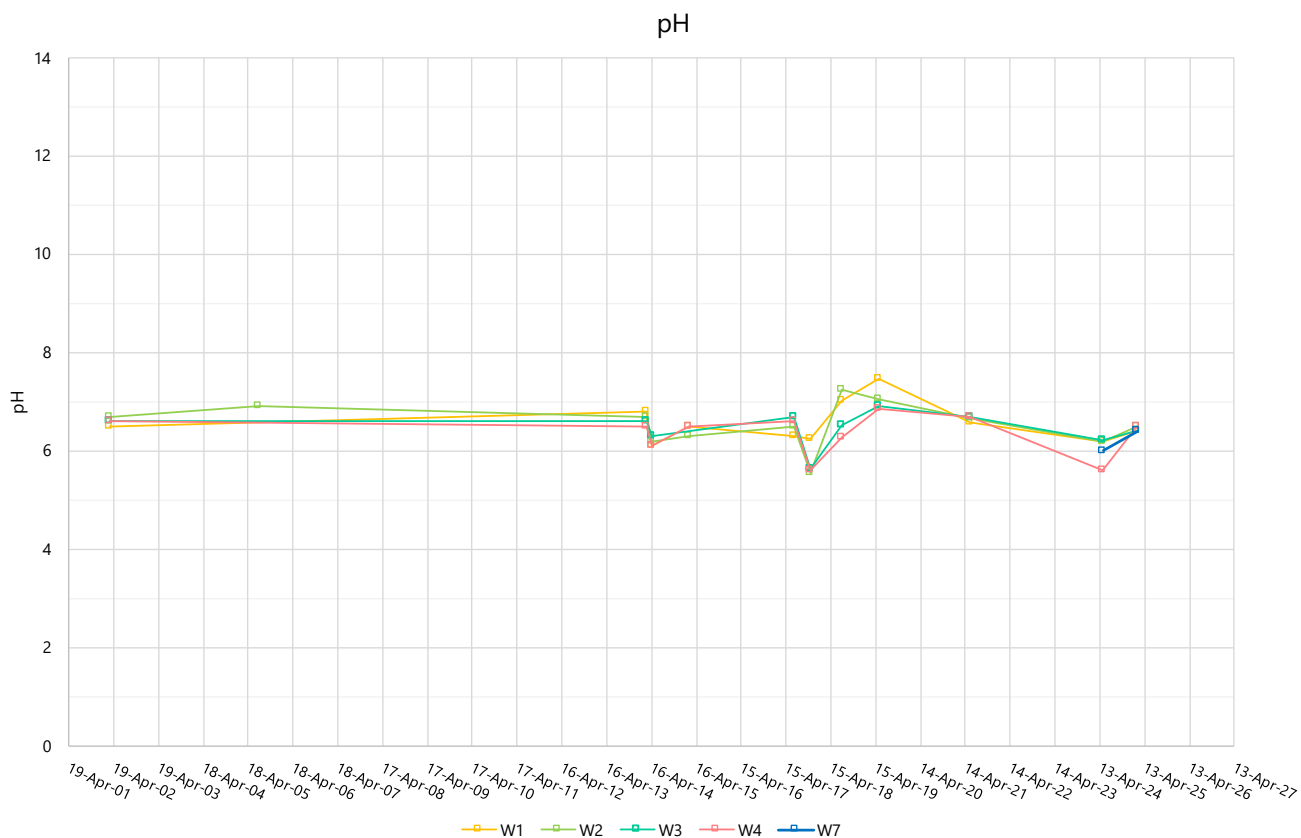


Figure 24 - Receiving environment water quality - pH

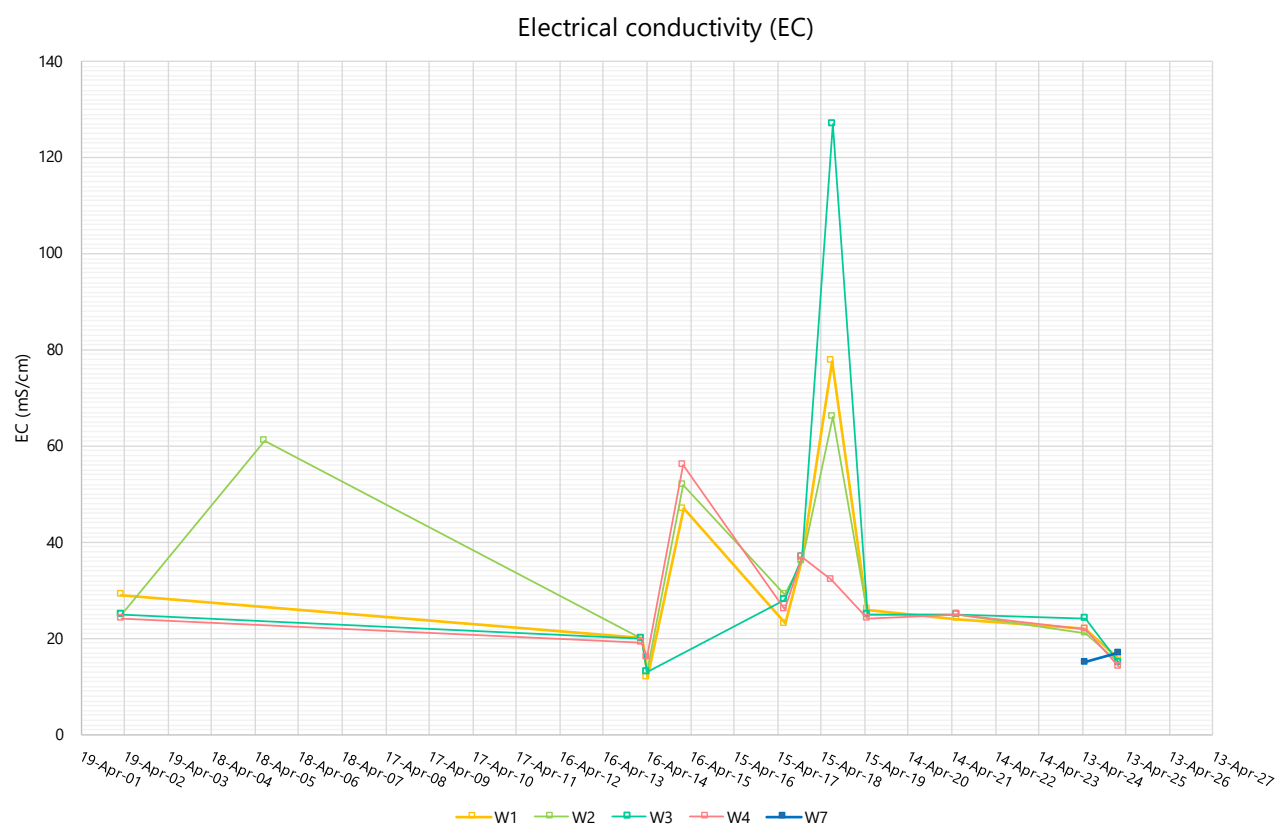


Figure 25 - Receiving environment water quality – EC (mS/cm)

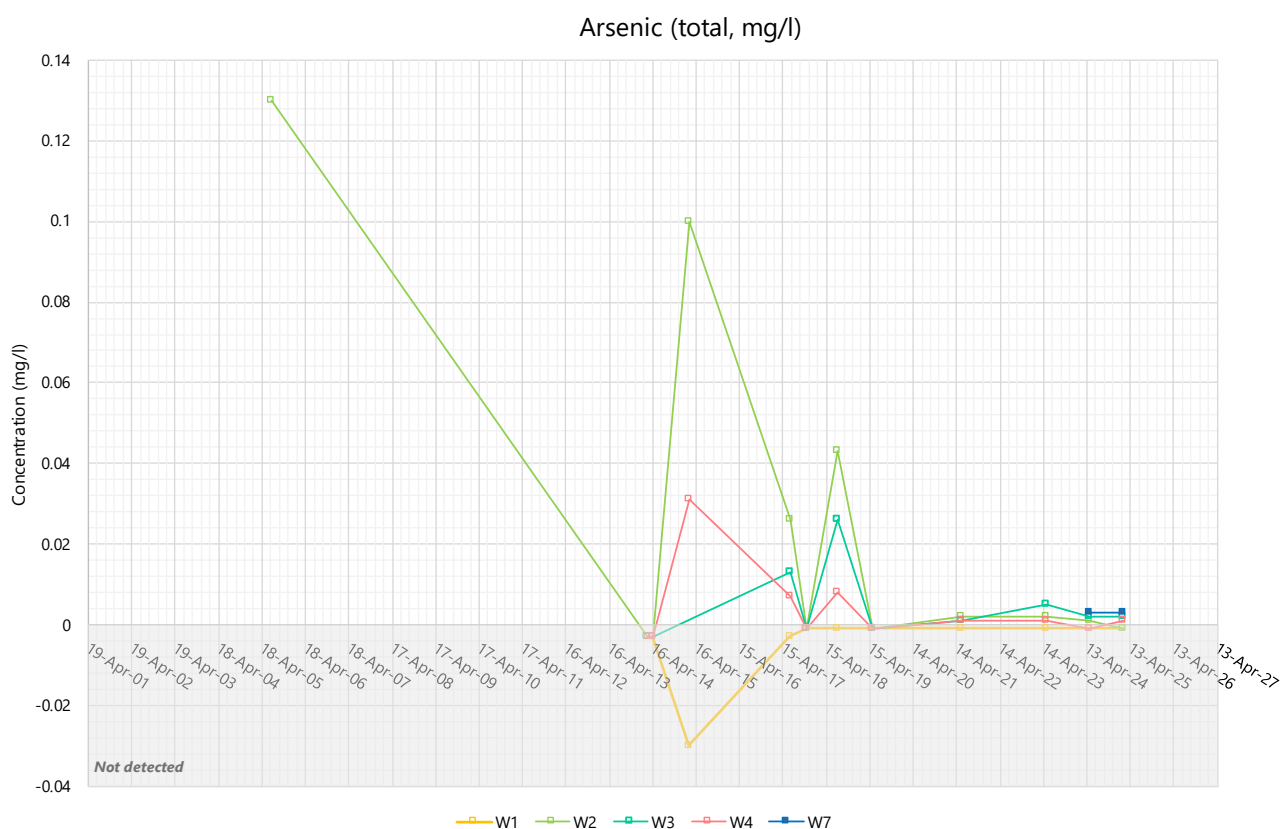
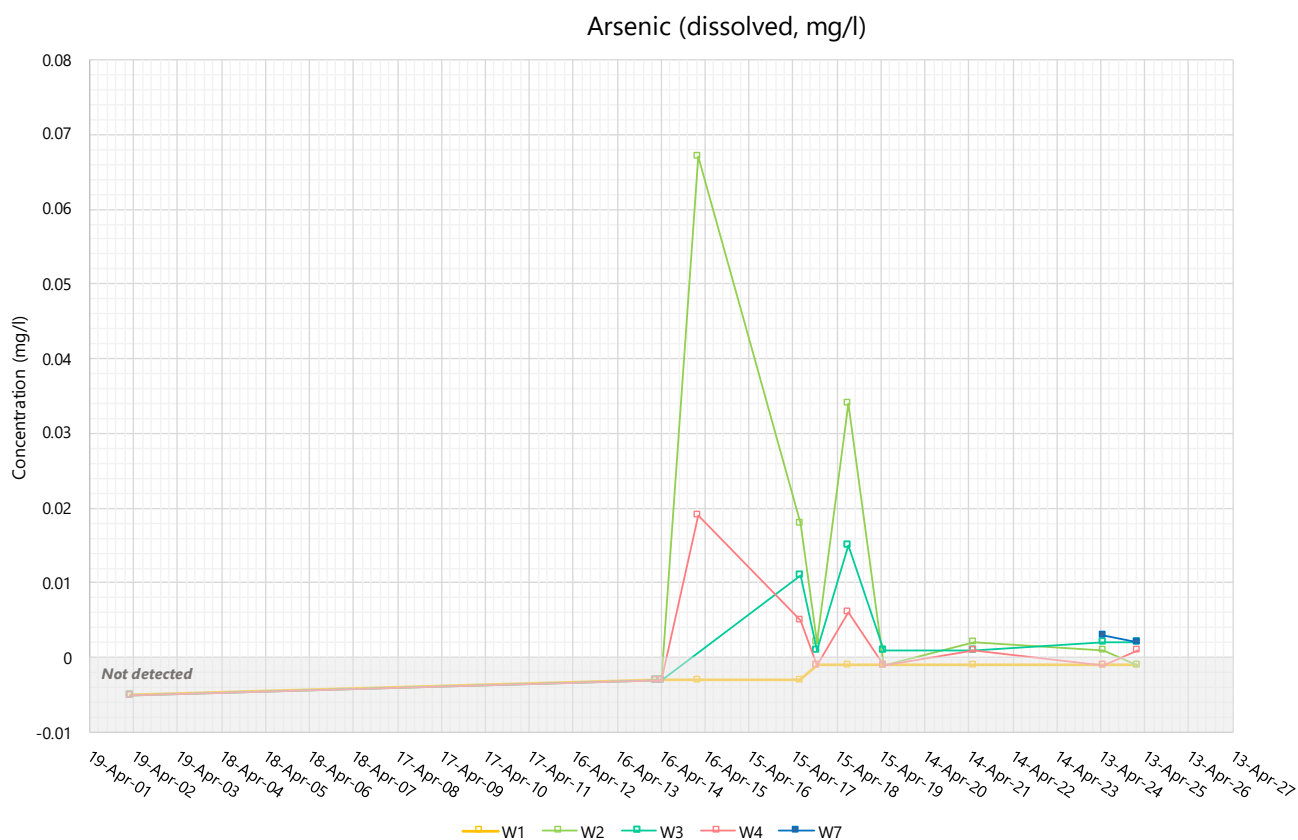


Figure 26 - Receiving environment water quality – arsenic (dissolved and total)

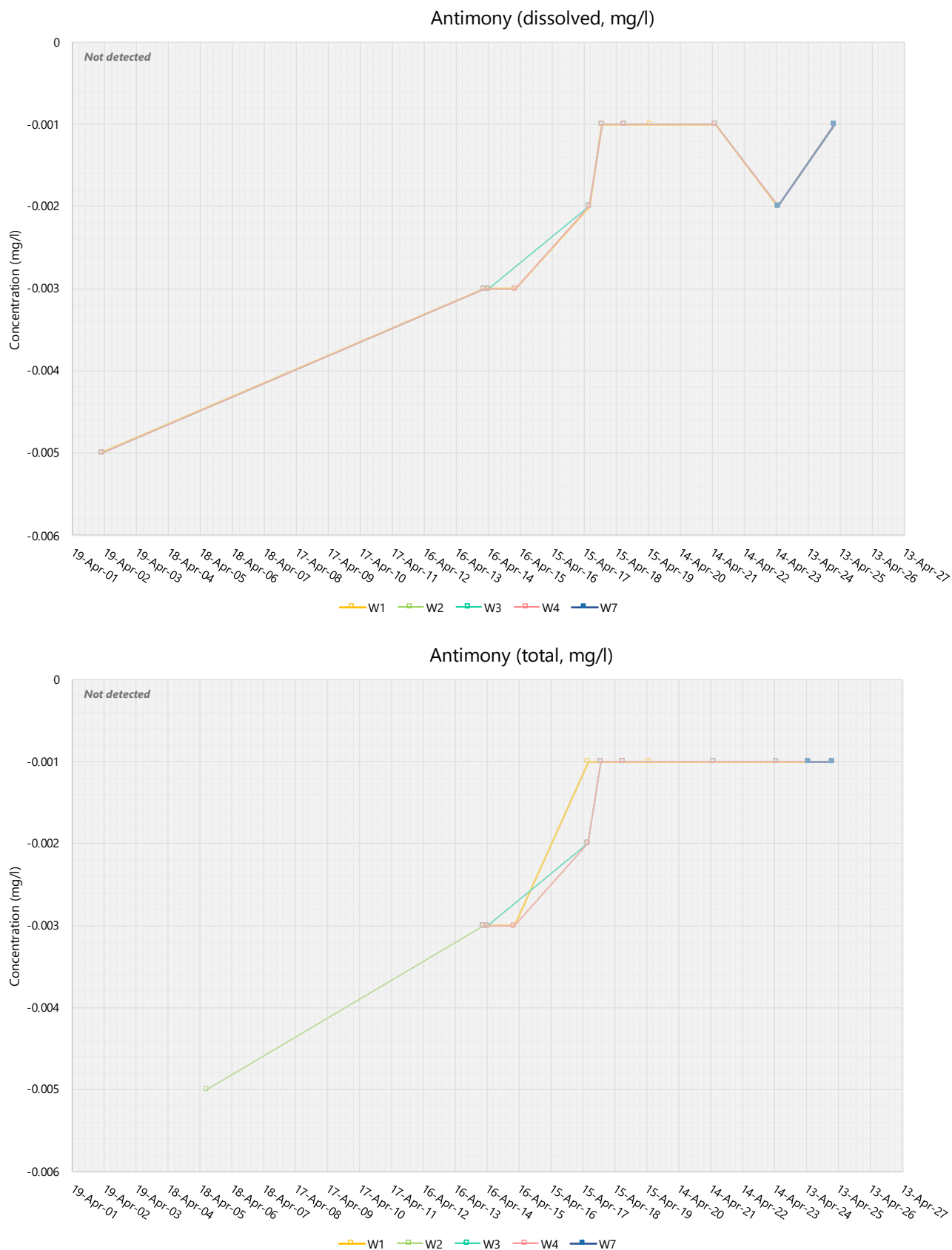


Figure 27 - Receiving environment water quality – antimony (dissolved and total)

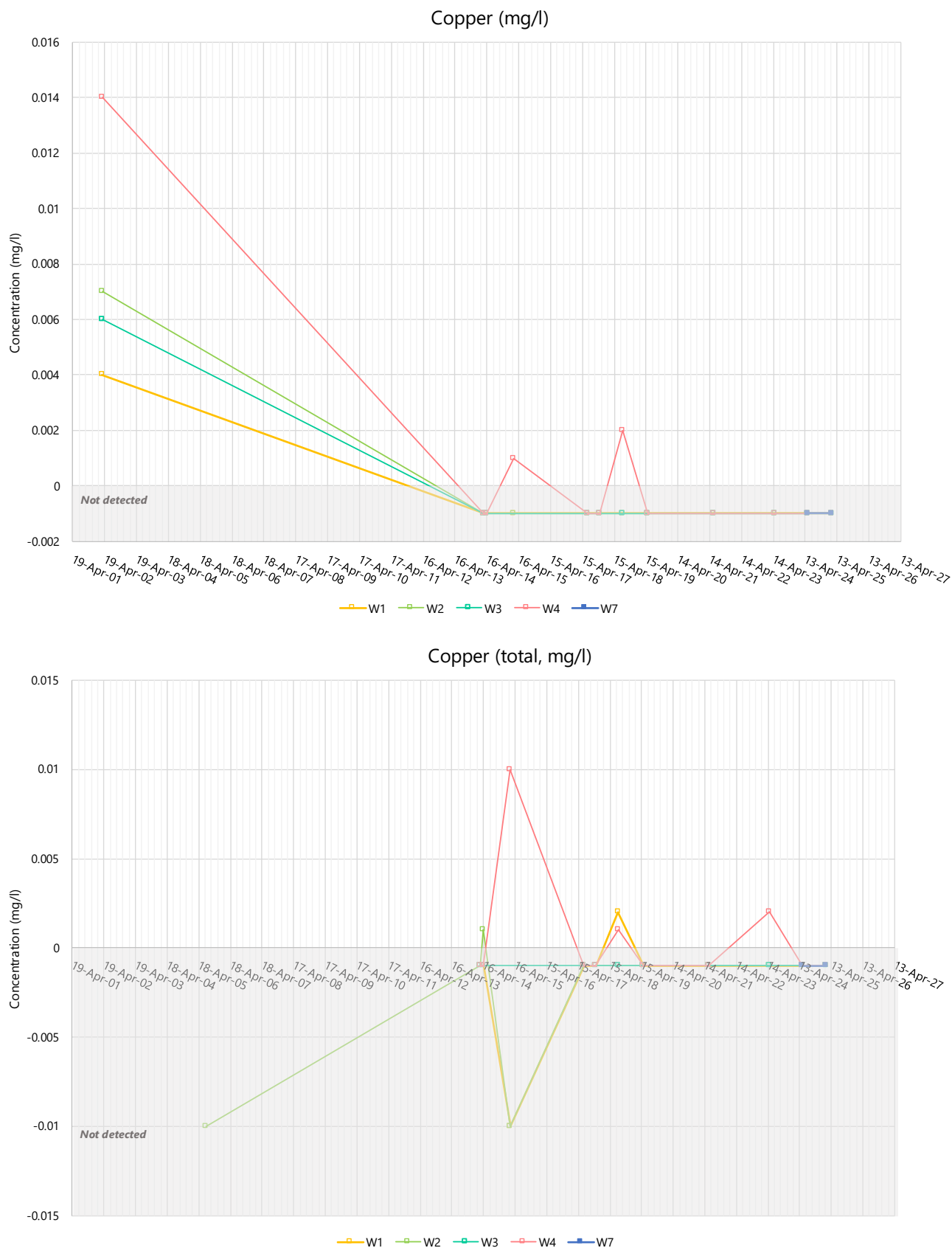


Figure 28 - Receiving environment water quality – copper (dissolved and total)

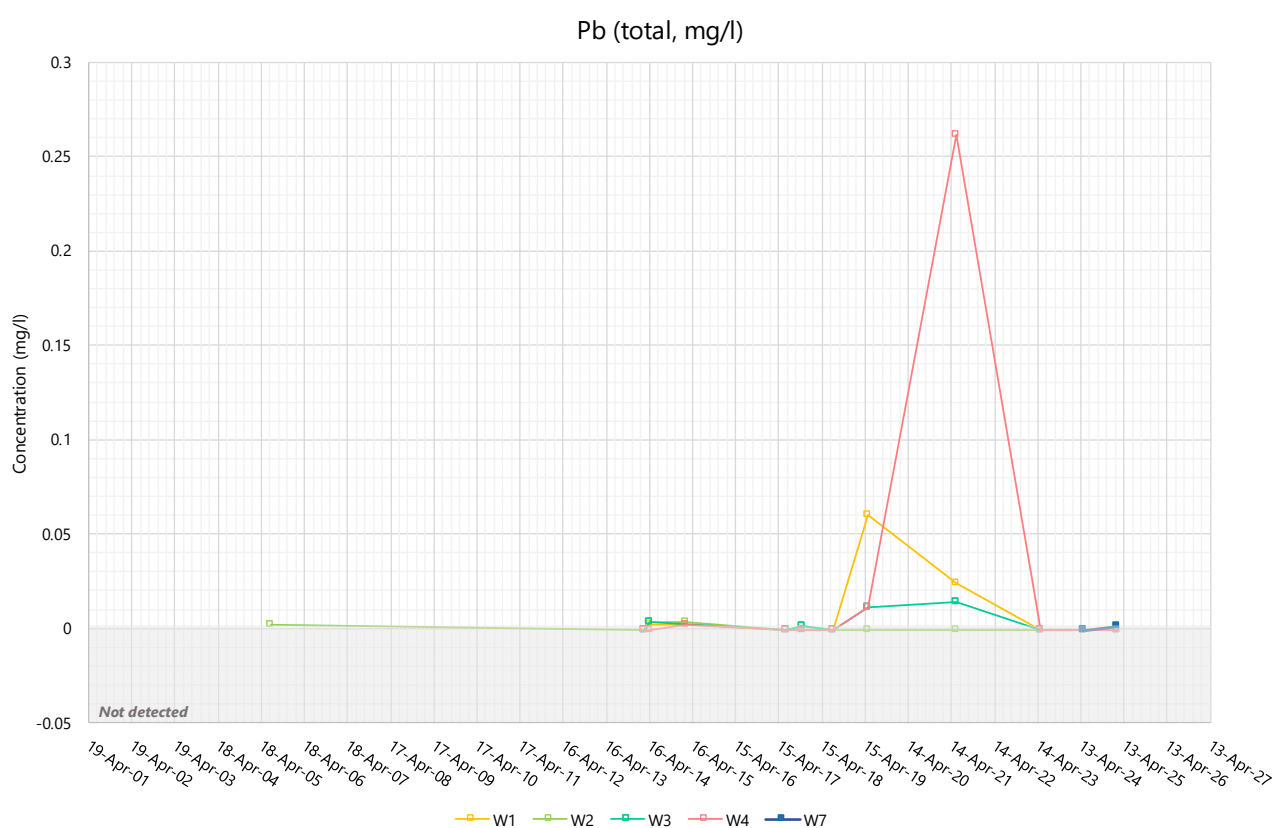
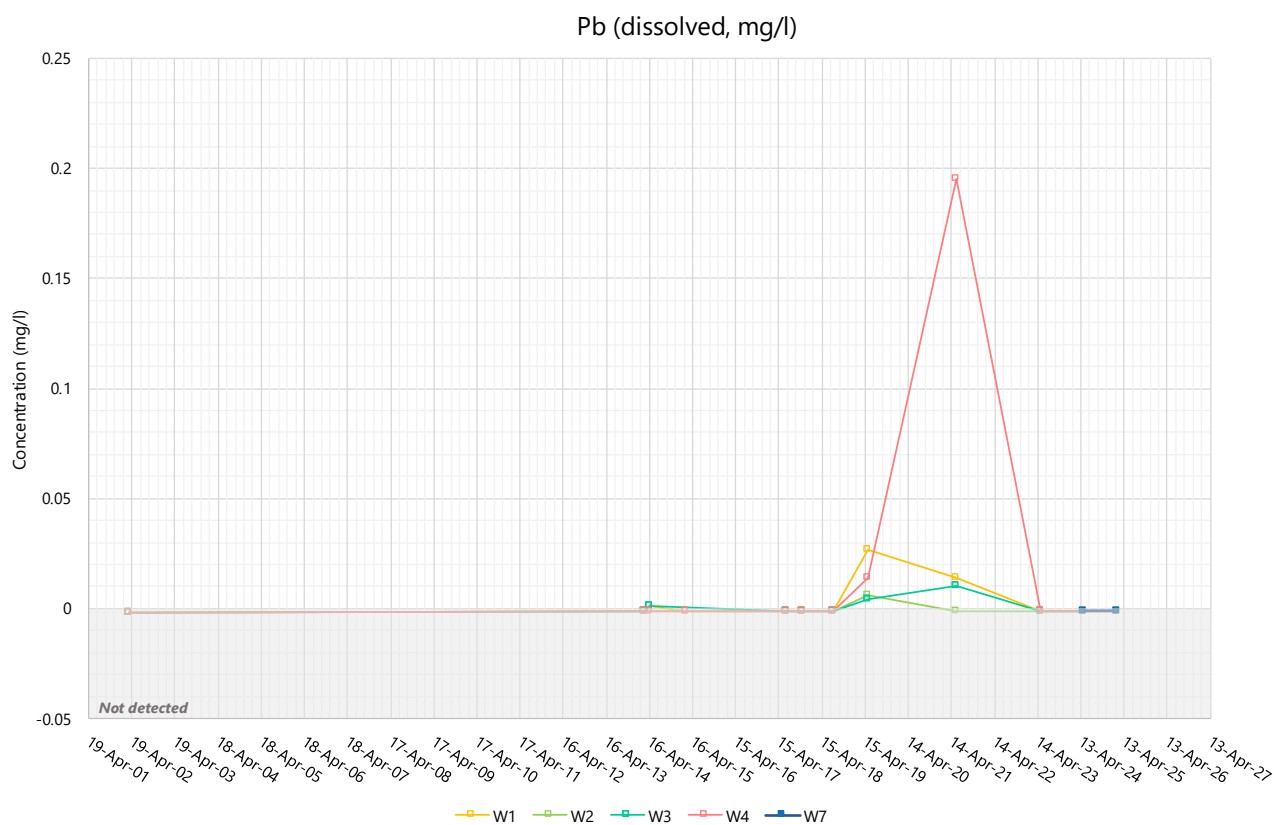


Figure 29 - Receiving environment water quality – lead (dissolved and total)

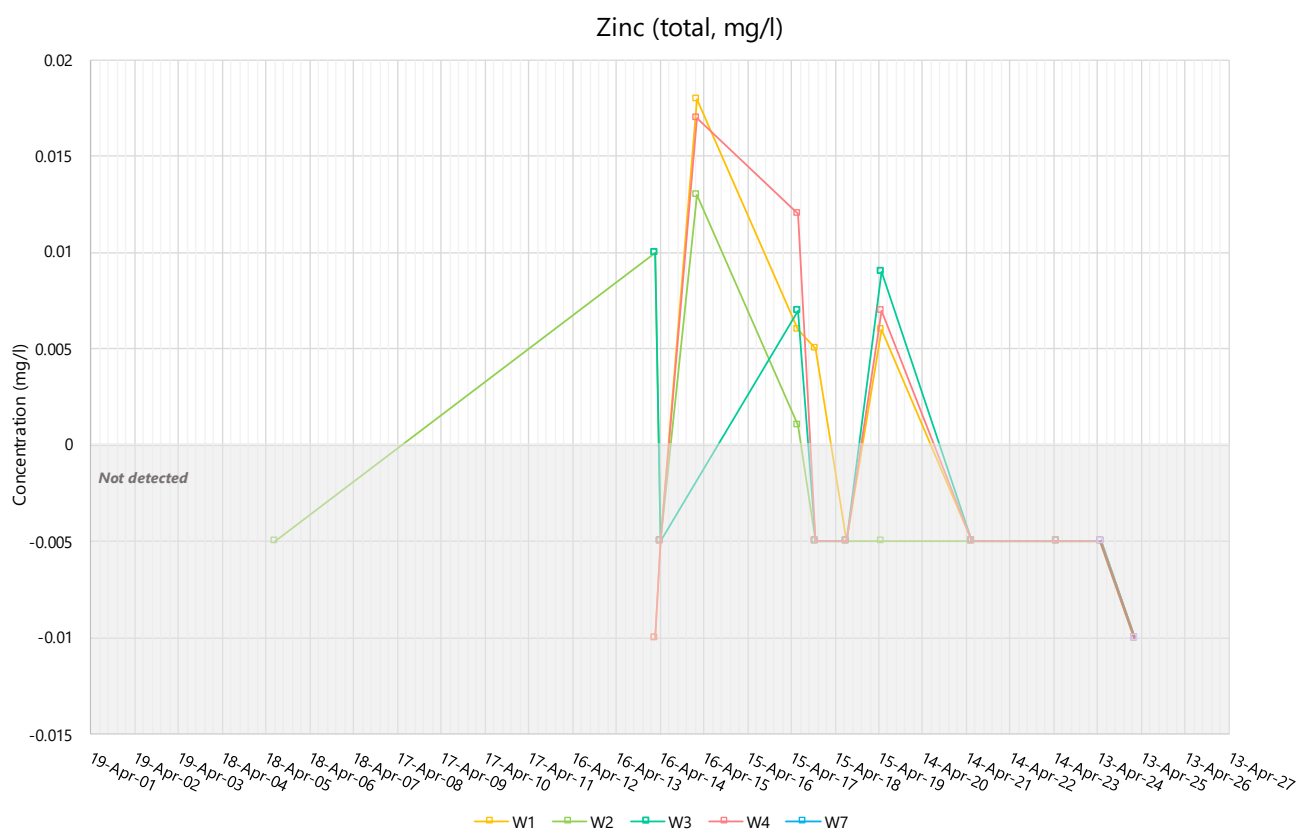
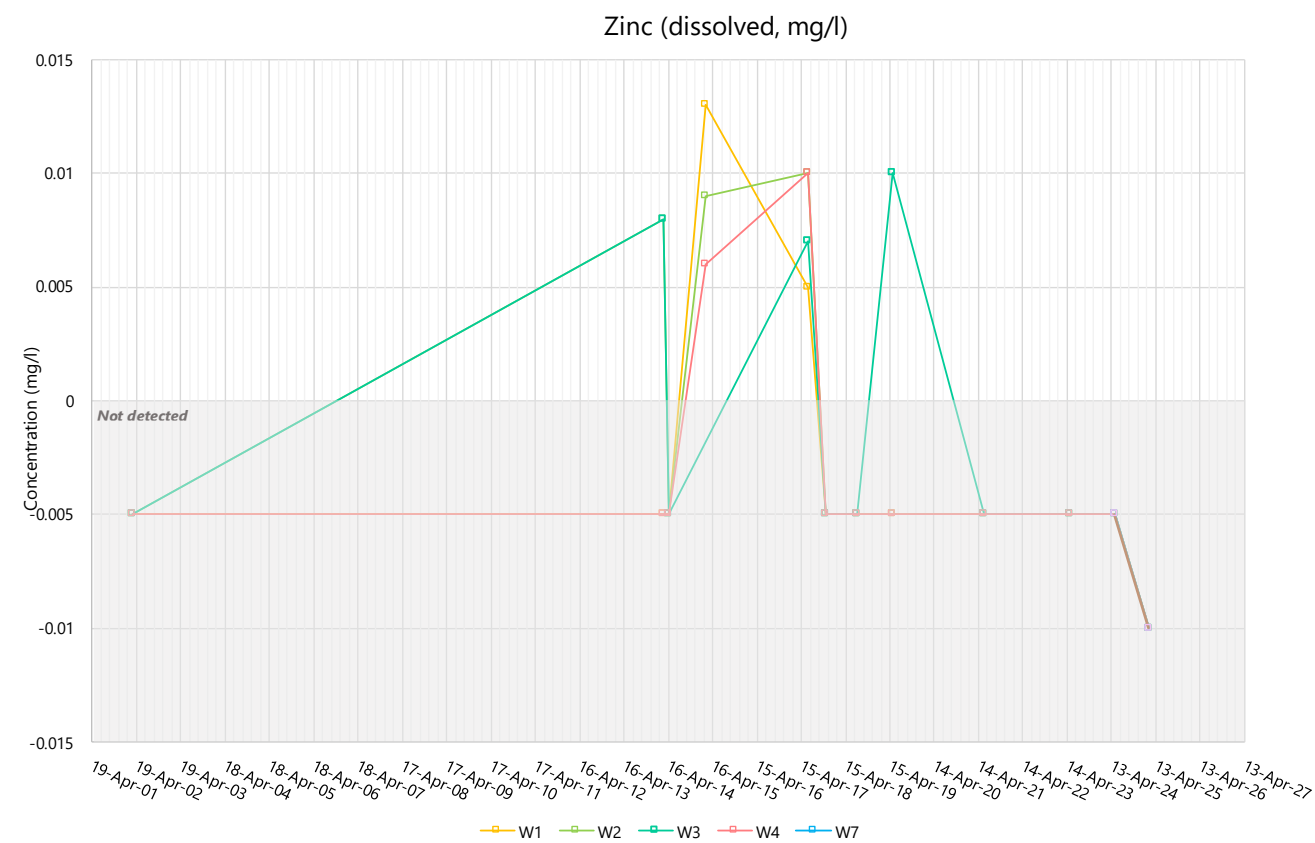


Figure 30 - Receiving environment water quality – zinc (dissolved and total)



3.4 Geology framework

3.4.1 Regional geology and province

The Alice River Project is located within the Savannah Province and is part of a broader mineralised province across northern Australia. Mineralisation is common across the region, the upper reaches of One Mile Creek contain historical gold, copper, and antimony occurrences (Figure 9).

The geology itself comprises Late Silurian to Devonian granitic and granodioritic crystalline bedrock (Figure 31 and Table 9, Geology Map Series legend in Appendix D). The primary basement unit is the Imooya Granite, part of the Kintore Granite Supersuite. (Queensland Geology Map Series, 2018).

The regional geology consists of highly crystalline, discontinuous, and massive igneous and metamorphic rocks: granites, pegmatites, and schist to the north. These rocks host minimal groundwater as they have formed through heat and pressure with minimal pore space. Where present, groundwater is only likely to occur in fracture zones and contacts where secondary porosity (or void space) exists. It may or may not be continuous or connected to other faults.

The dominant structure is the Alice River Shear Zone (ARSZ), a major shear zone and unconformity which is likely an influence in forming a structural boundary to the Great Artesian Basin (GAB) (Figure 9). The ARSZ forms a wide regional shear and fault zone striking NW-SE as a sequence and package of faults through the granite. The ARSZ plays a role in the mineralisation of the Alice River and related deposits and is a key line of inquiry in identifying further mineralisation. Geophysical surveys conducted by Pacgold have specifically identified a 12 km-long sub-surface gold-arsenic-antimony (Au-As-Sb) anomaly along the strike direction of the shear zone as an exploration target (Figure 32, Pacgold, 2024b). In the landscape, this anomaly crosses tributaries of One Mile Creek and the creek itself, and shows the regional nature of mineral enrichment associated with structures for the region. This suggests naturally elevated arsenic and antimony concentrations in local sediments, groundwater, and surface water will exist as a naturally occurring condition in mineralised terrain and province and will require a site-specific approach to establishing meaningful water performance criteria.

The regional state geology and mapping also identifies how ephemeral flow occurs during the wet season and high rainfall across the entire region, forming broad, low flow velocity, depositional sandy and organic rich drainage lines over the crystalline country rocks, sometimes referred to as dry marsh areas (refer Figure 31).

Weathering across the region is shallow, with limited saprolite or laterite development, as indicated by Queensland geology database records and drillhole data (Pacgold 2024a; Queensland Government, 2018). The weathering profile suggests erosion has removed much of the regolith, leaving a thin, variably developed zone over fractured basement rock to outcrop (Davis, 2024).



Table 9 - Geological units around the Alice River site

Code	Colour	Rock type
Dggy	Dgg/l	Pale grey to white granite, pegmatite, aplite
Ph/2	Dgr	Grey, medium to coarse grained schist and gneiss, quartzite
Dgpc	Dgwu	Grey, fine grained granite
Dgwu	Dgpc	Medium to dark grey monzonite, often weathered
Dgr	Ph/2	Undifferentiated miscellaneous granitoids
Dgg/l	Dggy	Pale grey to white granite, leucogranite, pegmatite, aplite

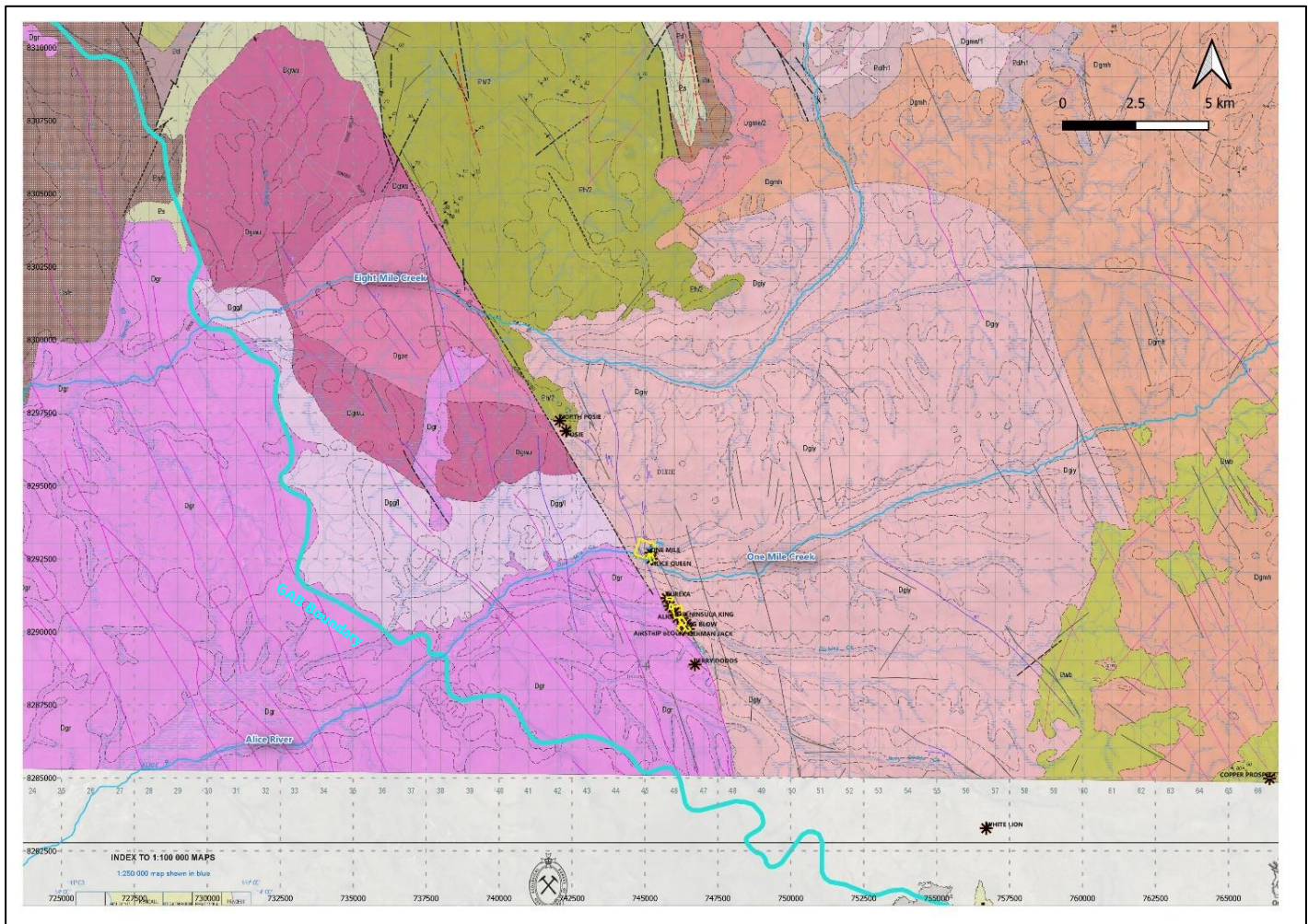


Figure 31 - Regional geology of Alice River (Queensland Geology Map Series, 2018)

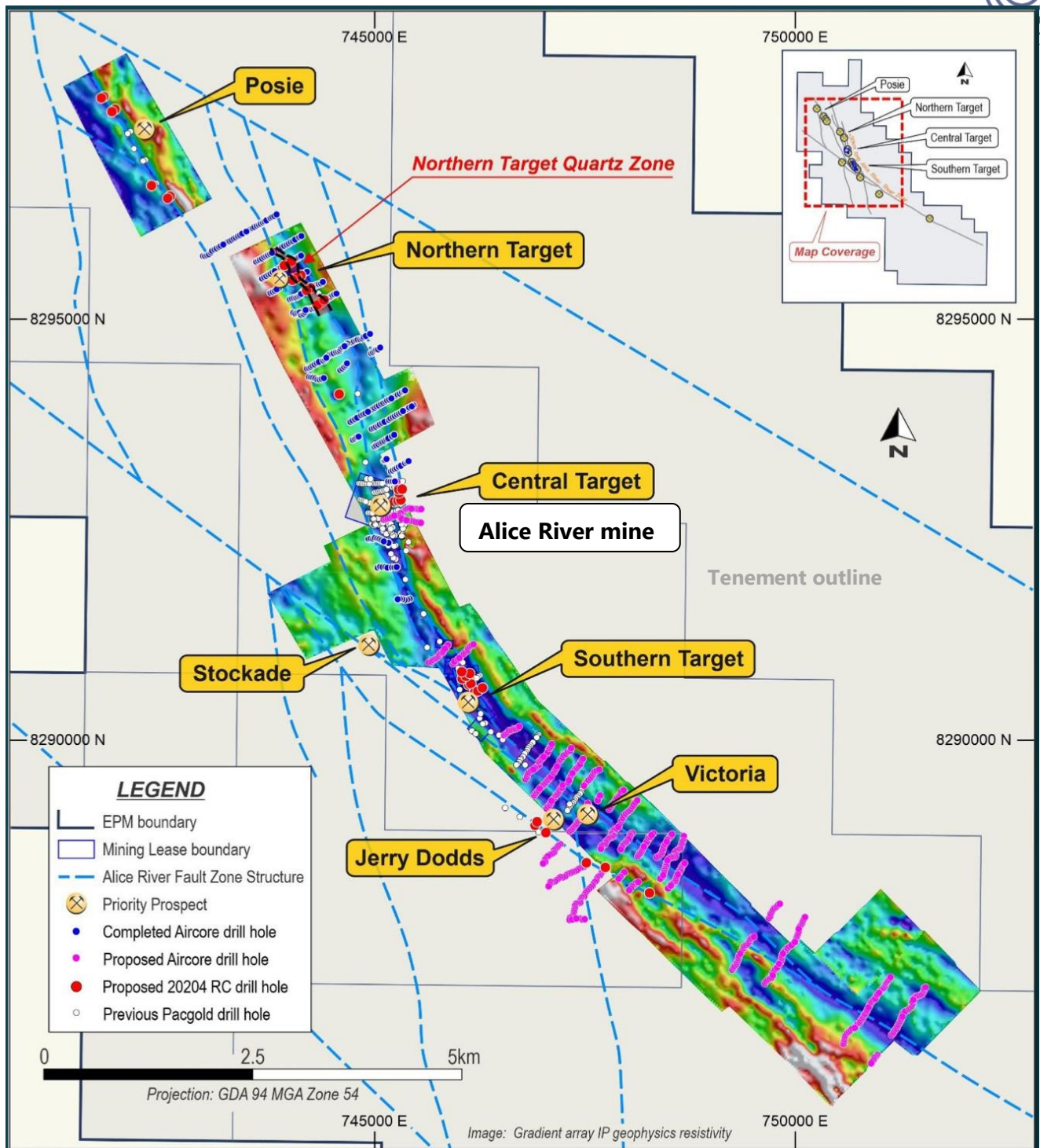


Figure 32 - Geophysical and geochemical anomaly along shear zone across Pacgold tenements (Pacgold 2024)



3.4.2 Alice River site geology

The Alice River site is dominated by the Imooya Granite, a massive, crystalline unit cut by northwest-southeast trending faults and shear zones as part of the Alice River Shear Zone (ARSZ). The shear corridor extends east of the Alice Queen pit to west of the TSF and hosts fractures, faults, breccias, and mineralised quartz veins, with diorite and dolerite intrusions in places. Shear zones vary in strike length, width, and depth across the mining leases and may host diorite dykes, altered chalcedony or silica, milled faults, or brecciated quartz, particularly around the Alice Queen ore zone (Davis 2024).

The Alice River deposit is an epizonal intrusion-related gold system. Gold, arsenopyrite, and stibnite occur in quartz veins and minor breccias. Alteration is typically confined to zones adjacent to mineralised veins, although in some areas, green-white quartz-sericite-epidote alteration extends up to 70m. There is a reasonable coverage of drilling across the site for geological definition for rock type and general information on water presence to characterise the site, with outcrops, particularly along the mineralised structures available for mapping as an insight into the structural framework (Figure 36). The surface outcrops are well known in the area, and it was how the deposit was first discovered (Drake 2024).

The weathering surface is variable and undulating, exposing outcrops of fresh and partially weathered bedrock in places. Elsewhere, the paleo-weathering profile can extend up to 10–15 m below the surface, particularly on hills like those seen in Alice Queen pit walls (Figure 33). Remnants of Jurassic limy-sandstone occur in isolated remnants up to 2 m thick in the northern tributary creek line west of the TSF. They may occur elsewhere in the subsurface or below sediments (Figure 21).

The Alice Queen pit is the most detailed area of known geology. It was developed along a northwest-southeast-trending shear zone that runs through the base of the pit, trending north-northwest to south-southeast. Mapping shows the shear zone at the surface by Davis (2024), Dirks and Bensemann (2017), and Houston (2021) in Figure 36. The shear zone hosts cross-cutting veins and breccias between sub-parallel faults, with discontinuous and variable mineralisation. Minor sulphides (pyrite, arsenopyrite, and stibnite) are fine-grained disseminations or narrow bands in quartz and breccia (Figure 34). The shear extends north and south of the pit and outcrops through the riverbed of One Mile Creek and the northern tributary (Figure 35). This means surface water and creek sediments interact with the mineralised structure, with sulphide oxidation visible near the surface. Table 10 organises the types of fault and vein structures identified by Davis (2024) and Pacgold (G Lowe, personal communication 2024) based on orientation, nature and mineralisation, and identifies a close link between gold mineralisation, arsenopyrite (As) and stibnite (Sb). Given the crystalline, igneous nature of the Imooya Granite, the prevailing geology at Alice River has low primary permeability, limiting groundwater movement except where fractures provide localised porosity. Shear zones and fault breccias form weakened zones, but permeability is further restricted by infill and alteration.

Drilling logs from the Pacgold database (2024) were examined to investigate water presence across the field. Only limited instances of water occurrence were recorded, noted as wet chip samples (RC) or mentions of water presence. Figure 36 shows the locations and depths of water intersections, projected to the surface. The data indicate no consistent pattern in depth or alignment. Despite extensive drilling, water is limited to isolated fractures with no evidence of a connected groundwater system. Where groundwater is intersected, it generally occurs at depth. Groundwater is rarely present at shallow depths (<15m) as a presence.

Near-surface sulphide oxidation affects geochemistry but does not indicate large-scale groundwater flow. Brittle faults and WNW-trending veins may offer some structural continuity but do not appear to support significant groundwater movement. Where fractures remain open, they may act as localised conduits, but mineralisation and infill commonly reduce connectivity.



Figure 33 - View of water level and weathering in Alice Queen pit walls



Figure 34 - View of weathered granite at surface, and example veining mineralisation with sulphides

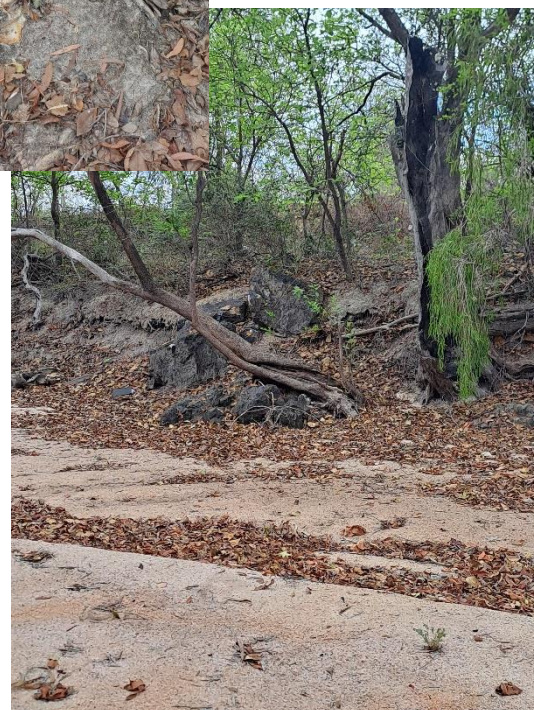
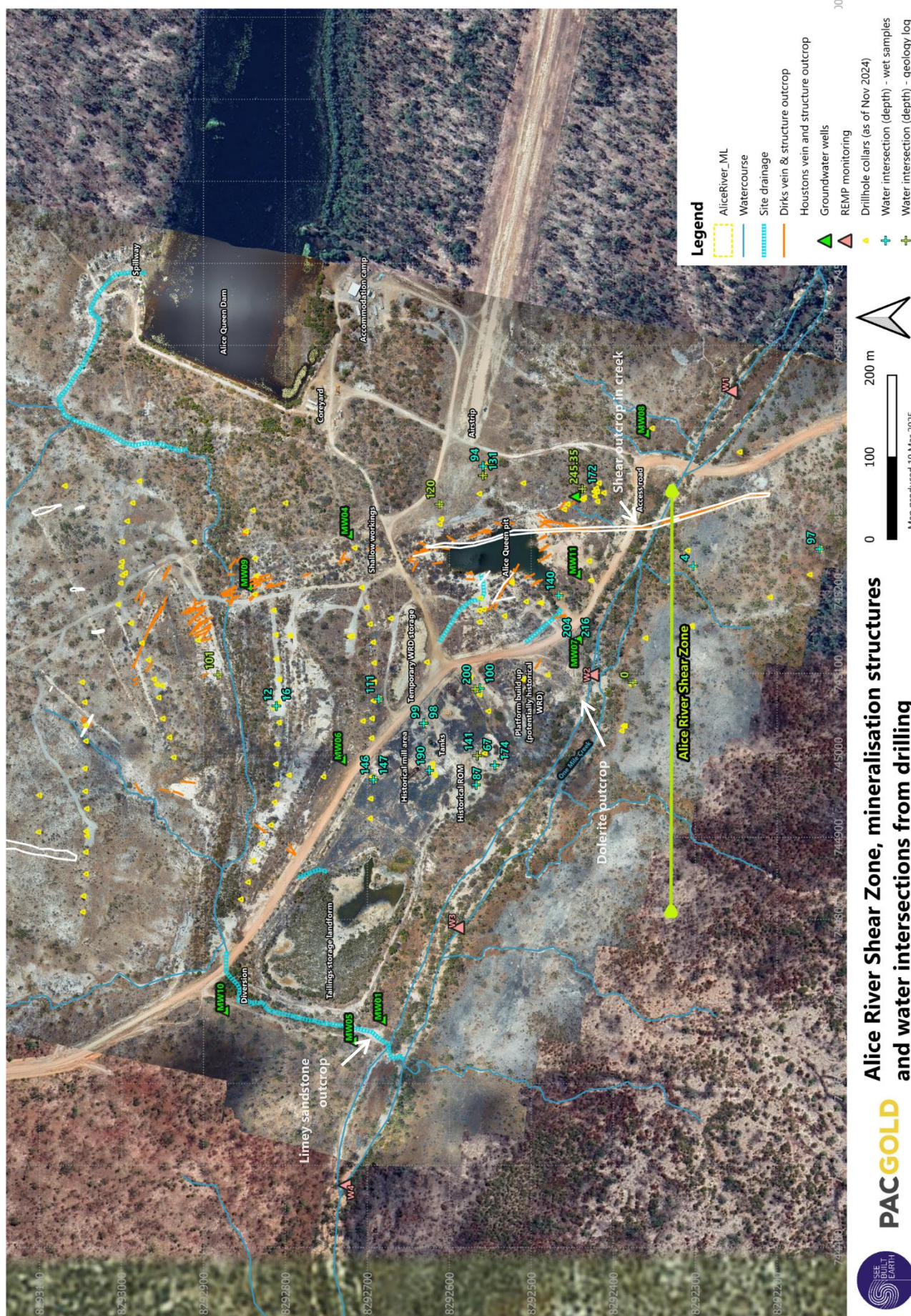


Figure 35 - Alice Queen shear outcropping in One Mile Creek south of AQ pit

Table 10 - Nature of structures and veins in site geology

Structure	Strike	Dip direction & angle	Mineralisation	Reference
Shear-hosted fault breccias	NW-SE (~315°)	Near-vertical (~80°)	Minor sulphides, quartz veining. May host limited and isolated water where brittle fracture has created some void space.	Davis (2024) G Lowe, personal communication (2024)
Gold-bearing quartz veins	NW-SE (~310°-320°)	Steep SW (~70°-85°)	Weak silica alteration, minor pyrite	
Arsenopyrite-stibnite veins	WNW (~280°-290°)	Moderate W (~60°-70°)	Trace arsenic and antimony	
Diorite dyke-hosted fractures	NNW-SSE (~340°-350°)	Vertical	Quartz veining along dyke margins, may have isolated water at contact	Pagold (2024a)



Alice River Shear Zone, mineralisation structures and water intersections from drilling

Figure 36 – Alice River shear zone, mineralisation structures mapping and water intersections

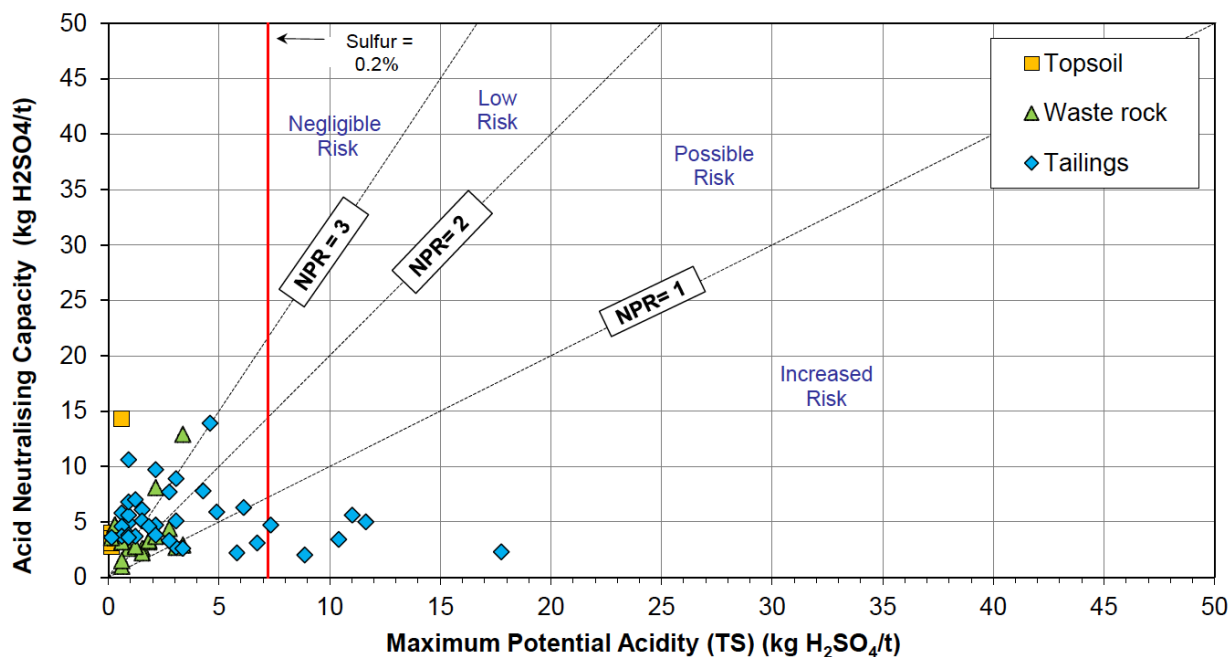


Figure 38 - Acid neutralising capacity (RGS 2022)

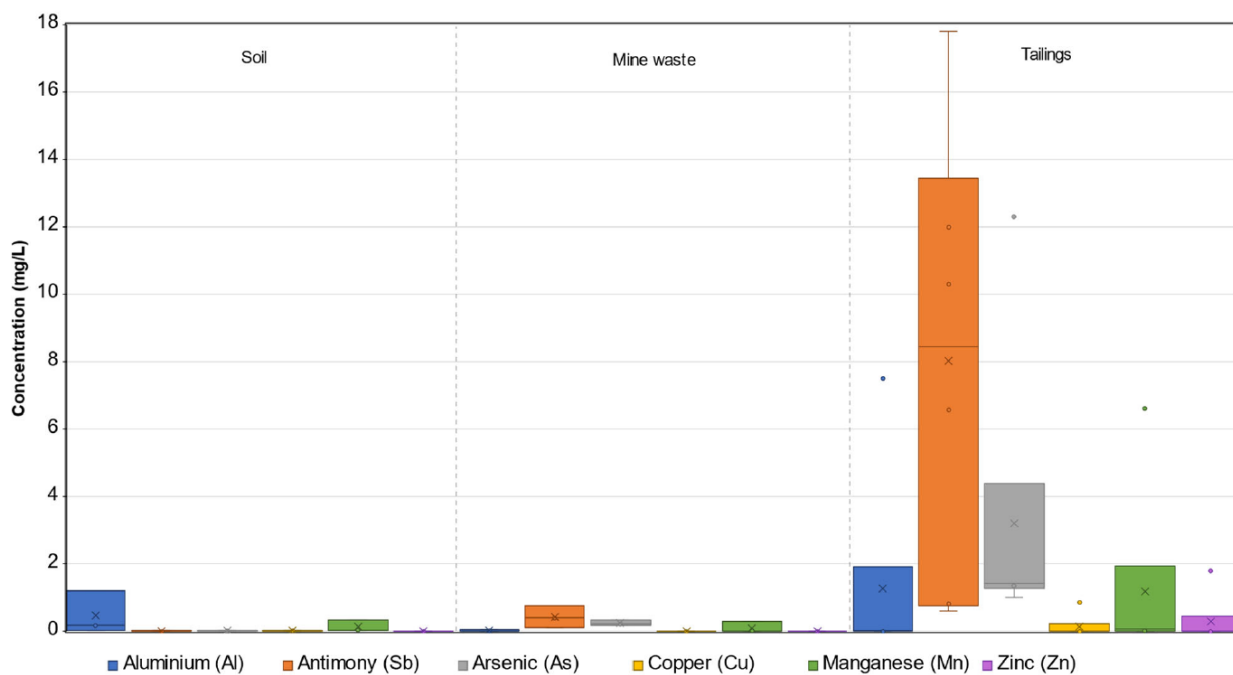


Figure 39 - Metals mobility (RGS 2022)

Electrical conductivity ($\mu\text{S}/\text{cm}$)	Saline drainage hazard ranking	Soil (n = 6)	Mine waste (n = 21)	Tailings (n = 36)
> 2500	Increasing hazard	-	-	1
> 500 to < 2500	Moderate hazard	-	-	17
> 100 to < 500	Low hazard	-	5	16
< 100	Very low hazard	6	16	2

Figure 40 – Potential for saline drainage (RGS 2022)



3.5.2 Investigation: Identifying natural elemental abundance

Background

The global abundance index (GAI) assesses an area's enrichment by comparing element concentrations to values of global crustal abundance to identify what elements are higher at Alice River as a mineralised province than non-mineralised areas as natural background.

Methodology

The analysis is based on the PacGold Alice River geological database (2024a) and available elements compared to standard crustal composition data (Haynes, 2016).

All elements in the dataset were assessed as a statistical population, using percentile thresholds (99.5th and 0.5th percentiles) to define the upper and lower bounds of natural variation. The detection limits below were assigned as half the detection limit.

Elemental concentrations are compared to their respective global abundance index (GAI) values, derived from standard crustal composition data (Haynes, 2016). An enrichment ratio is calculated by dividing observed concentrations by the GAI to the following thresholds:

- Moderately enriched: Between $>1x$ to $3x$ the GAI
- Highly enriched: Greater than $3x$ the GAI

Results

Figure 41 shows a population plot of all elements available for Alice River, with enriched elements highlighted, including:

- Strong enrichment: Gold (Au), Silver (Ag), Aluminium (Al), Arsenic (As), Bismuth (Bi), Calcium (Ca), Iron (Fe), Potassium (K), Magnesium (Mg), Sodium (Na), Sulphur (S), Antimony (Sb), Selenium (Se), Tellurium (Te), Titanium (Ti).
- Moderate enrichment: Barium (Ba), Caesium (Cs), Lithium (Li), Lead (Pb), Rubidium (Rb), Tungsten (W).

A copy of the element analysis and results is in Appendix E.

Conclusions

Alice River as a site and regionally is a mineralised province, with naturally elevated concentrations of metals and other elements, potentially influencing water quality. However, not all elements will be mobile. Elements identified align with work of RGS (2022, 2023) highlighting low sulphur, and an enrichment of many epizonal metals, of which arsenic and antimony are expected to be mobile. The enrichment profile provides a background and context to indicate a site-specific approach to understanding the Alice River's natural baseline and background water quality for determining water quality criteria and the relevant thresholds to protect environmental value.



Alice River element enrichment compared to average crustal abundance (all drilling)

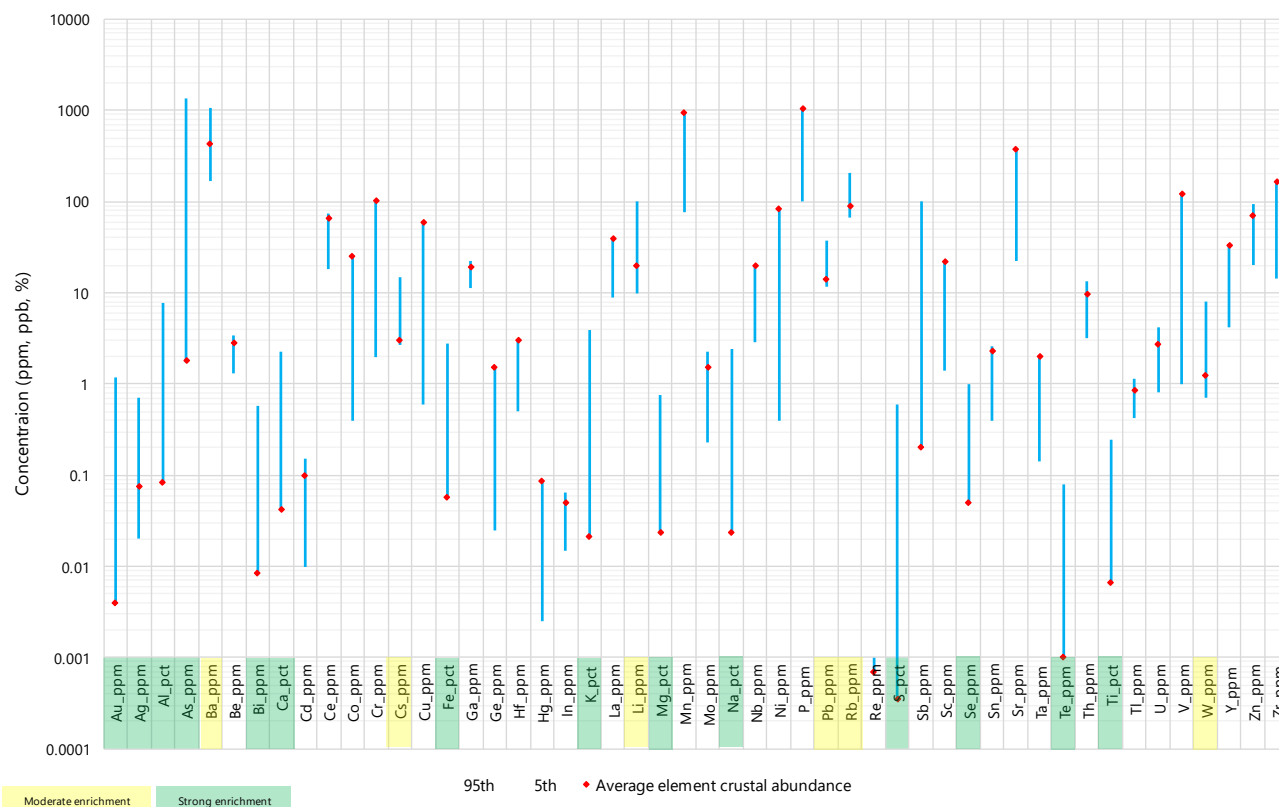


Figure 41- Global abundance index (GAI) enrichment from Alice River (from Pacgold 2024a)



3.6 Hydrogeology and groundwater

3.6.1 Groundwater occurrence

The Alice River mining area's geology severely constrains groundwater's presence, yield and connectivity across the project area. The site is dominated by highly crystalline, massive, igneous intrusive rocks such as granite and diorite, which allow little to no groundwater development, except in structures, fractures, contacts or other sources of secondary porosity. The variable nature and extent of structures with infill, healing and veining mean groundwater presence is highly variable (as in may not be present) and disconnected laterally and with depth across the site.

The poor development and limited presence of groundwater development is indicated by through the conceptual model, but also supported by:

- Site drillhole records indicate limited groundwater intersections (Figure 36), and when they do occur are typically at depths, with no evidence of laterally extensive aquifers. Groundwater presence is highly variable and appears structurally controlled, forming isolated and irregular water instances rather than forming a continuous groundwater system. There is also limited instances of water loss, vugs or voids reported.
- Drilling logs of recent bores (see Appendix C) described as dry bores with no water intersections, with verbal confirmation from driller personnel (B Turner (Centurion Drilling), pers communication 2024): all bores drilled have encountered similar ground. The monitoring bores are shallow, low yield, and generally constructed as dry bores in the weathered profile, likely representing pore pressure storage and/or localised groundwater.
- Historical records (Drake 2024) describe some groundwater inflow during development of the shafts in the early years of Alice River in the 1900's, suggesting there may be limited water within the mineralised primary shear running through modern day Alice Queen pit.
- Review of registered groundwater bores (QGlobe 2025) indicates the site is in a groundwater "desert", with a single well registered on the tributary to the south of One Mile, and no others until 72km downstream (Figure 42). Locations of the few bores further afield correlate to alluvial areas. Bores developed up to 30km upstream from the site at the top of the catchment suggest a different style of groundwater occurrence associated with the Corella Formation, a limestone-rich formation present across the top of the catchment.
- Alignment of the site observations and characterisation aligning to the hydrogeological province as a localised flow system of low productivity (Figure 9, Jacobsen & Lau, 1987).
- The ephemeral flow nature of One Mile Creek is dry for most of the year: if groundwater were a contributor to surface water and One Mile, we would see persistent pooling or longer term within the creek (see Surface water section).

Characterisation of groundwater occurrence for the Alice River site can therefore be described as occurring in three environments:

- Structure-controlled: Groundwater is uncommon, but where it does occur, when found, is in faults, fractures, and contacts within the bedrock where secondary porosity exists, including in mineralised structures. Groundwater in structures is highly localised, low yield, and disconnected across the field, likely creating compartmentalisation of groundwater.
- Weathering profiles: Groundwater is largely transient and undetectable when drilling. Bores in the weathered profile are dry on drilling and given low yield fill over time, reflecting pore pressure, with rises driven by rainfall infiltration.
- Alluvial zones: Within the One Mile Creek and outside of the mining areas, shallow subsurface groundwater may exist in alluvial zones. These likely occur in isolated pockets and are recharged by stream flow during wet seasons.

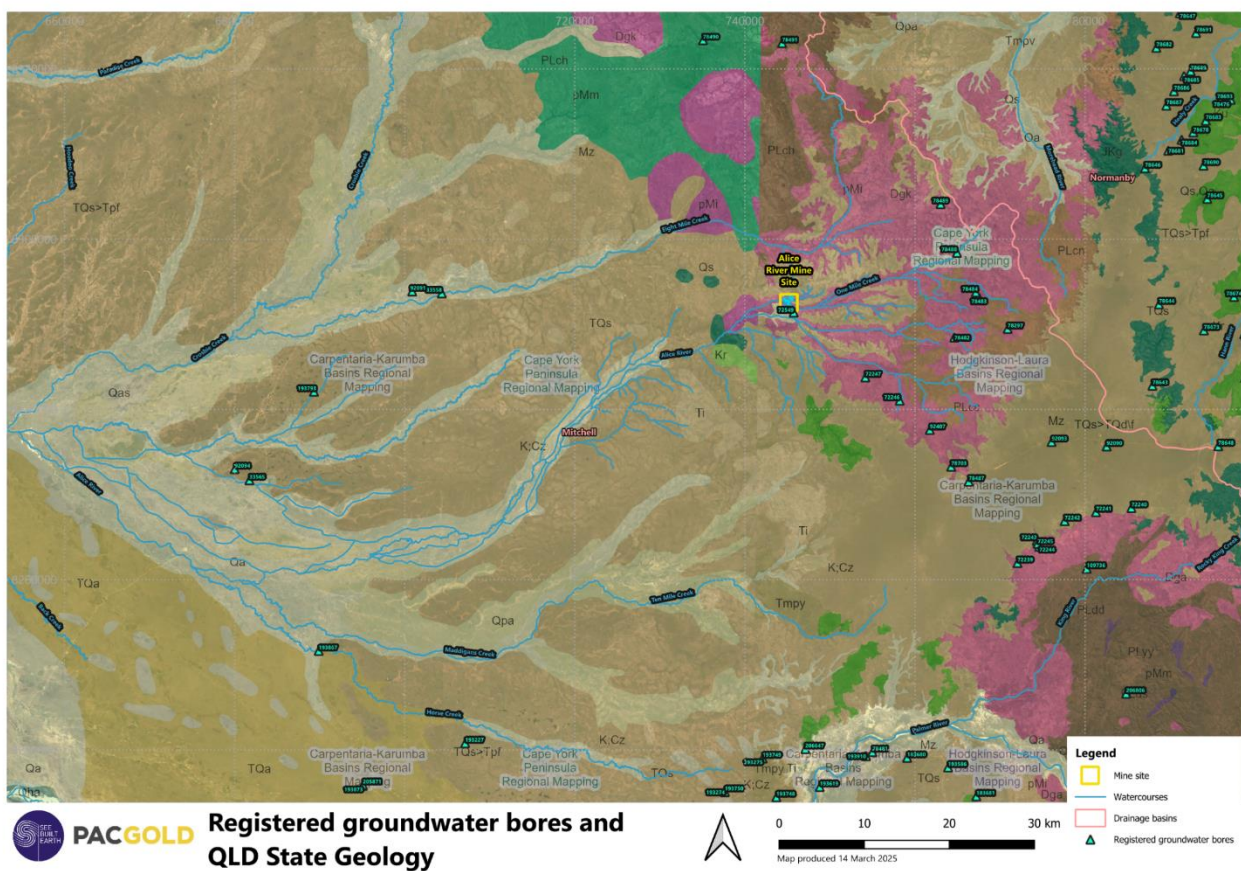
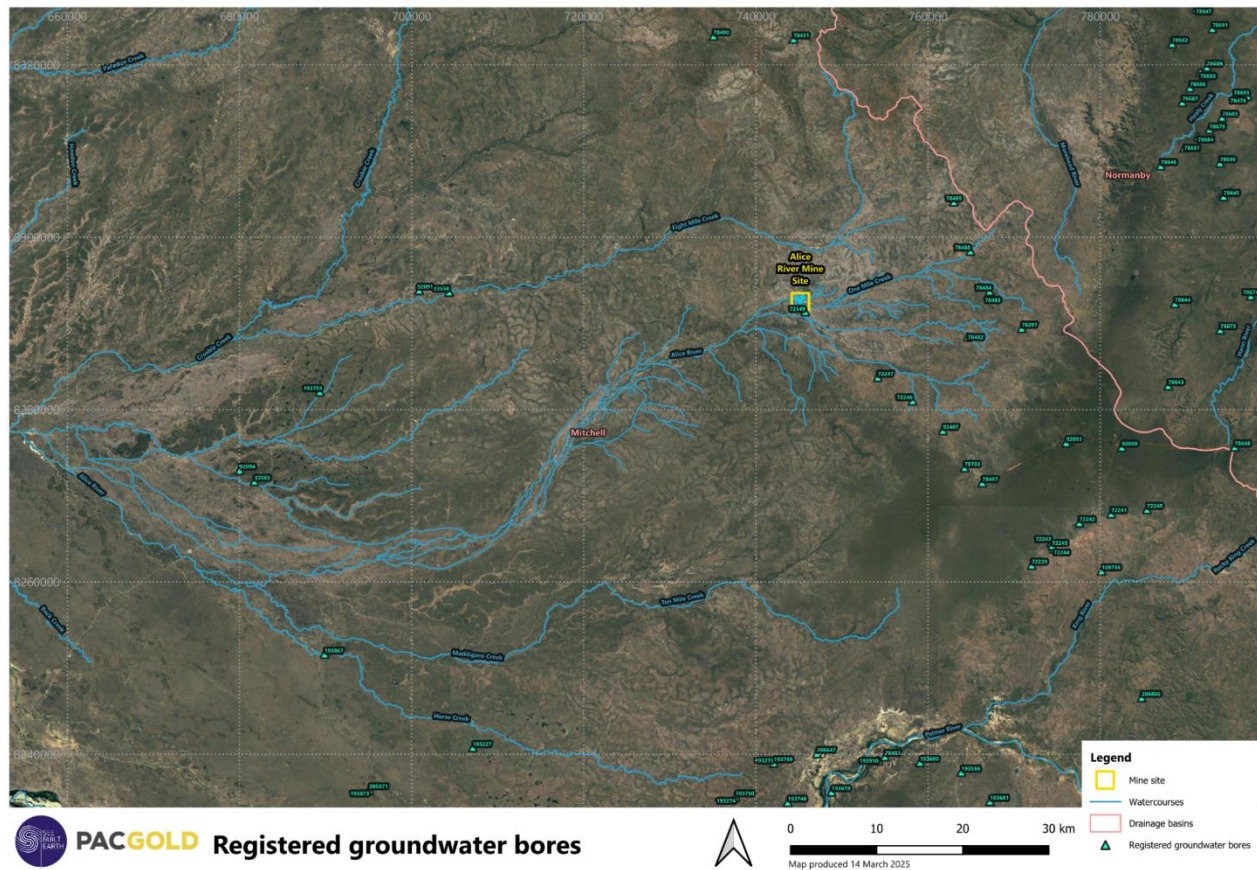


Figure 42 - Registered groundwater bores in the One Mile Creek region, including geology (QGlobe 2025)



3.6.2 Hydraulic conductivity

The crystalline geology and severely limited groundwater occurrence at the Alice River site suggest highly constrained hydraulic conductivity, as evidenced by minimal to absent yields during bore drilling, and the absence of regional bore development.

Recognised ranges of conductivity by rock type provide guiderails for expected conductivities of 10^{-8} to 10^{-5} with some fractures in Figure 43, equating to the effect of clay (Freeze and Cherry 1979). This is outside of the disconnection of fractures across the field.

A basic adaptation of Darcy's Law using the 2D hydraulic gradient of the December 2024 groundwater levels above the pit indicates flow rates of 10^{-4} to 10^{-8} into the pit lake. Engeny (2025) undertook a calibration exercise as a mass balance for the pit lake and identified balance at an inflow rate of 0.01l/s, equating to an effective conductivity of 10^{-7} .

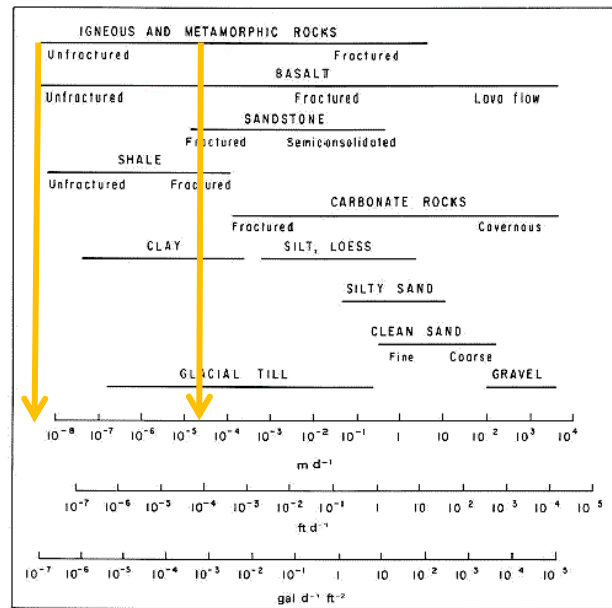


Figure 43 - Typical ranges of igneous and metamorphic rocks (Freeze and Cherry 1979)

k	k	m/s	l/s	ML/d
10^{-4}	0.0001	0.0094817	9.482	0.81922
10^{-5}	0.00001	0.0009482	0.948	0.08192
10^{-6}	0.000001	0.0000948	0.095	0.00819
10^{-7}	0.0000001	0.0000095	0.009	0.00082
10^{-8}	0.00000001	0.0000009	0.001	0.00008

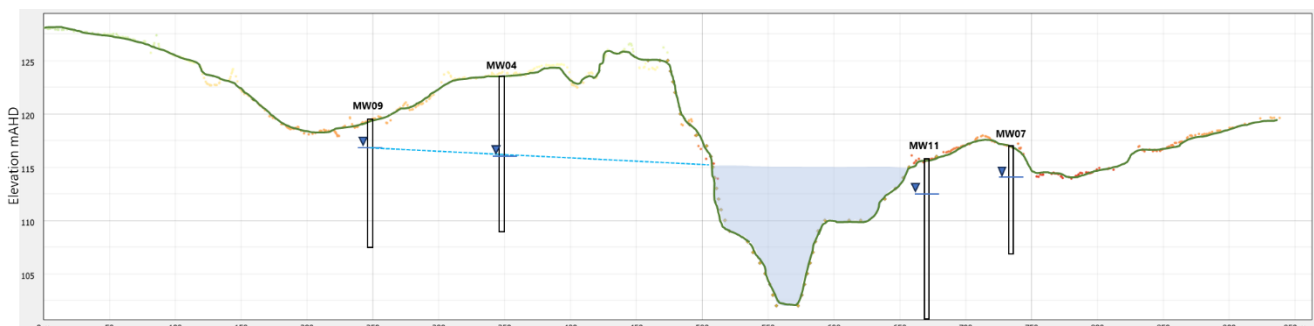


Figure 44 - Analytical range estimates of inflow into pit lake



3.6.3 Groundwater levels and surface

Groundwater levels are monitored across ten bores, installed in three phases: late 2022, mid-2023, and late 2024. The results provide insight into groundwater behaviour: Figure 45 charts the standing water levels (depth from the surface) and Figure 46 shows groundwater elevations relative to key landscape features, including the pit lake, key elevations, and rainfall. Given the low and sparse occurrence, yield and connectivity of groundwater across the project, groundwater levels are considered representative of the potentiometric surface rather than a continuous groundwater surface.

Groundwater levels are generally shallow across the site, with seasonal fluctuations of 0.5-6m depending on the bore and location, influenced by rainfall. Several bores (MW01, MW05, and MW07) exhibit a muted response with a smaller magnitude of fluctuation, while others show a more significant response to the considerable rainfall at the time of measurement. Notably, bores MW08, MW09, and MW10 rose within 2m of the surface during the 2024-25 wet season. These differing responses suggest two distinct environments: the muted bores are closer to the valley and exhibit lower relative water levels, while the others, located higher in the topography, show water level variations driven by rainfall under draining conditions.

The construction of historical pit levels from imagery (see Appendix F) suggests that the pit responds similarly to the lower wells, with fluctuations of only around 1 meter, based on available records (noting significant time gaps between readings), and the consistency of an established tree line around the pit perimeter. The rate of variance in levels is far less than expected from evaporation over the dry season, and it indicates some ongoing groundwater baseflow into the pit, which equilibrates pit water levels.

The groundwater surface in Figure 47 shows a potentiometric surface capable of delivering groundwater flow into the pit from the north, west and east (noting MW01 and MW07 are excluded based on proximity to One Mile Creek). Groundwater inflow is also supported by silica and strontium in pit lake water chemistry (Figure 54 and Figure 57). The gradient continues to the south, and at face value, there is some potential for seepage from the pit to One Mile Creek based on potentiometric elevation. However, the potential seepage would rely on hydraulic connectivity from the pit to the creek, and does not appear to be the case based on evidence of:

- Pit water levels are relatively constant over time, both in recent measurements and the consistent vegetation line around the lake perimeter. There would be more variation in water levels if leakage or drainage were occurring, particularly over dry spells.
- There is no observable evidence of seepage or leakage in the creek, either as seepage, moisture, or vegetation changes near the intersection area (see Figure 35).
- Engeny (2025) pit lake water balance achieved calibration to level measurements with minor groundwater inflow and no leakage as a mass balance.
- Groundwater bore quality south of the pit differs from pit lake water quality (see Section 4.1.2).
- The initial assessment of water level loggers installed in the pit and MW07 in 2024 demonstrated variation in water level responses and recharge sources (see Section 4.1.3).
- There is potential for the "hard rock" potentiometric surface to pass below the base of One Mile Creek (see MW12, MW07 and MW05), with the alluvial and creek bed sitting on top as a separate aquifer or potential for water storage (see Section 4.2) as a perched system.

The surface also illustrates a strong compartmentalisation for water levels across the site, particularly around the mineralised structure, and shows the disconnection formed by structures (see MW12). Closely spaced contours suggest a fault barrier, and hydraulic separation between MW11 and MW12.

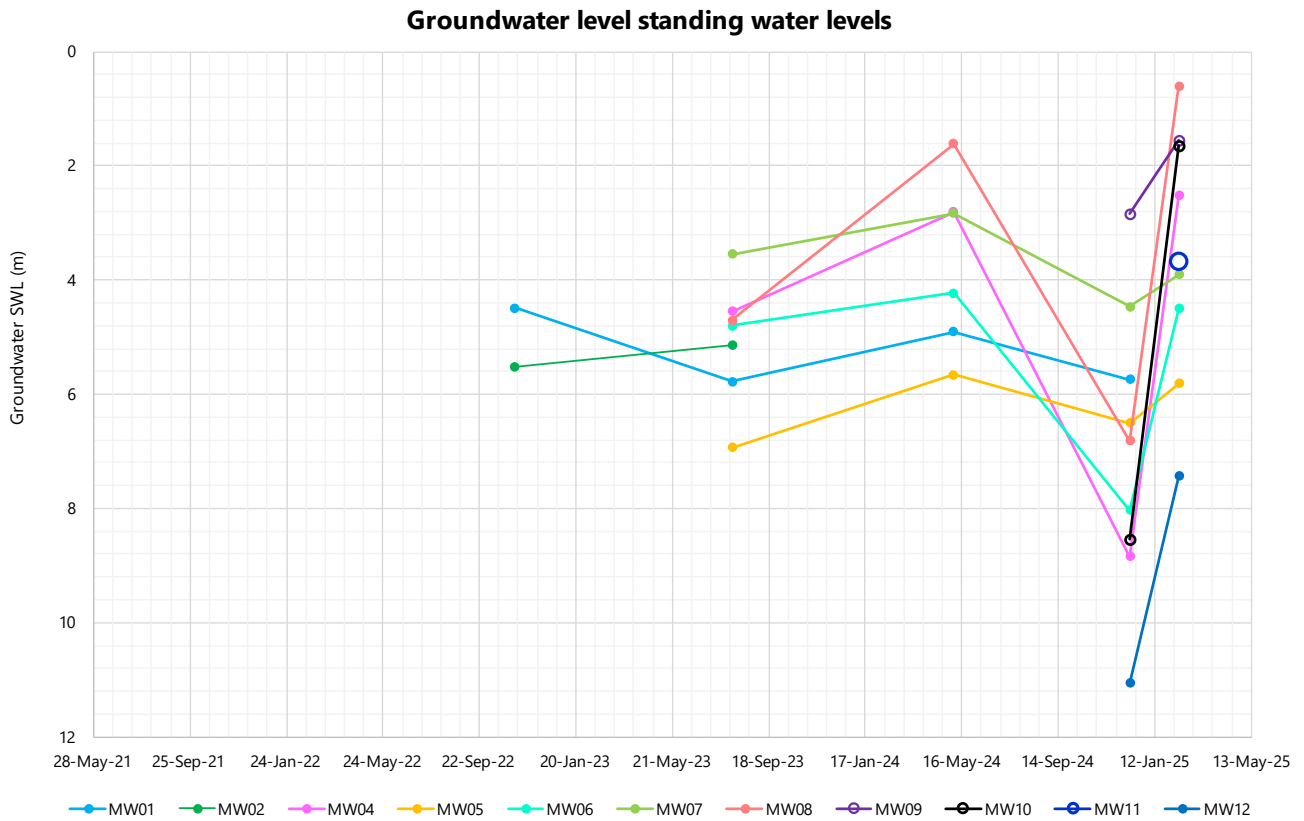


Figure 45 - Groundwater standing water levels

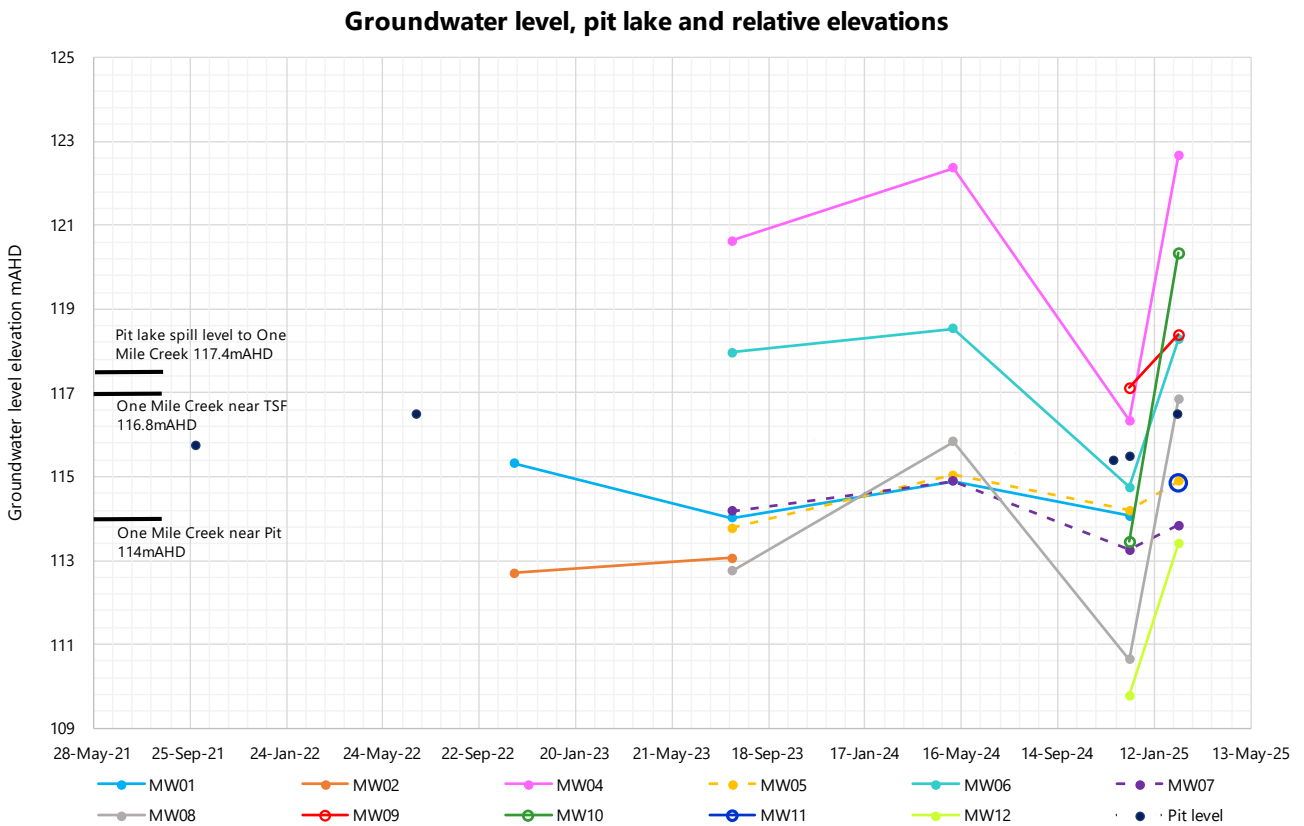
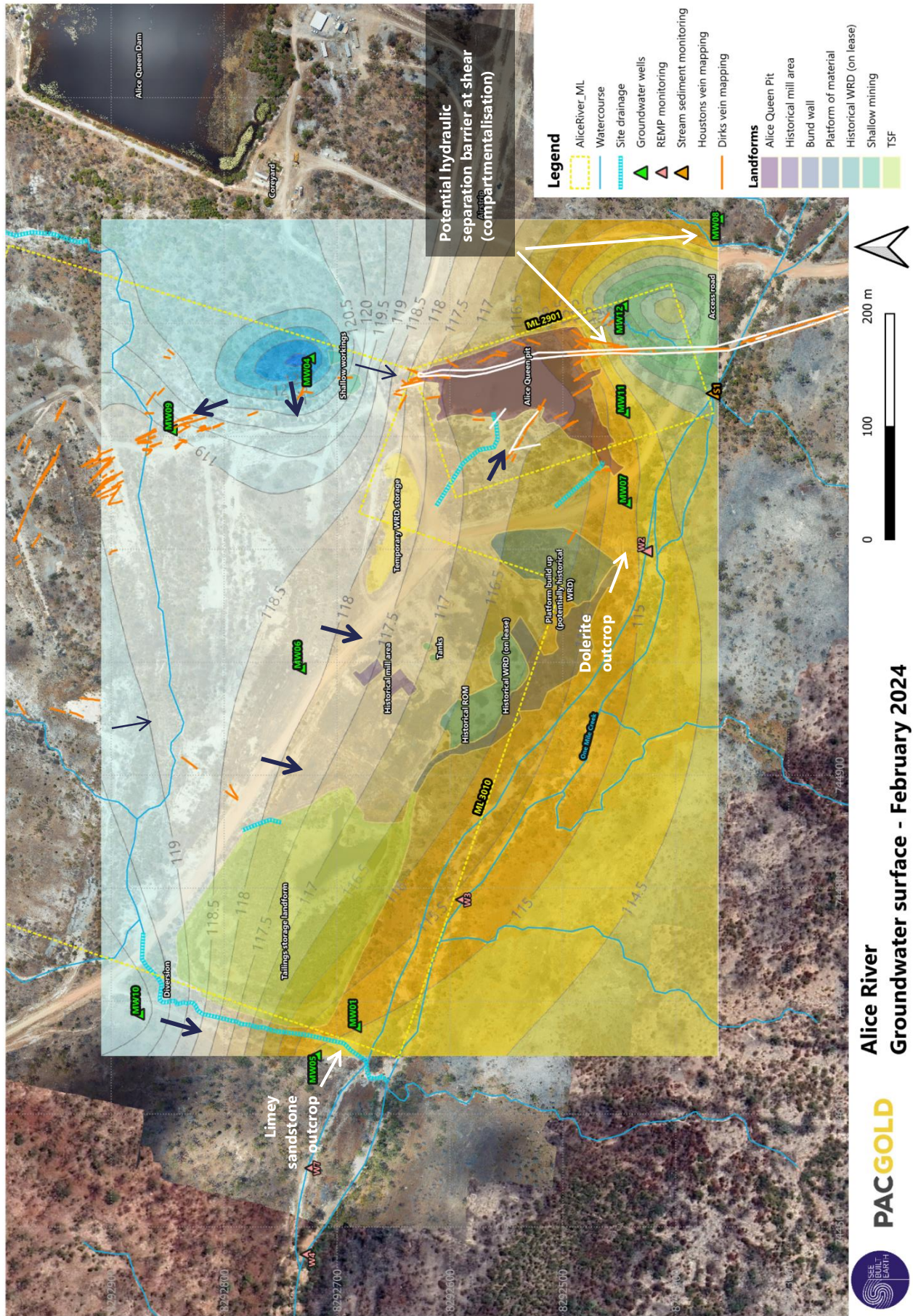


Figure 46 - Groundwater and Alice Queen pit lake relative water levels



Alice River Groundwater surface - February 2024

PACGOLD



Figure 47 - Groundwater surface for February 2025



3.6.4 Groundwater quality over time

Groundwater quality has been monitored across multiple locations to assess natural background conditions, interactions with mineralised zones, and potential influences from historical mining activities.

Current groundwater monitoring locations include:

- MW08 and MW09 represent background groundwater conditions, with MW09 situated within the mineralised ore zone. MW09 exhibits the highest natural arsenic and antimony concentrations, consistent with the mineralised setting.
- MW01, MW05, and MW07 are located near the ephemeral creek, suggesting potential for surface water-groundwater interactions, particularly after significant rainfall. These wells show variations in hydrochemistry, including pH and bicarbonate, which may reflect recharge conditions and interactions with subsurface materials. MW05 is near an outcrop of limestone.
- MW11 is located downgradient of the pit and within the mineralised zone, providing a reference for groundwater quality from the pit.
- MW04, MW06, MW10, and MW12 provide broader spatial coverage of groundwater chemistry variations across the site and surrounding areas: MW04 and MW12 lie in the mineralised area, and MW06 and MW10 upgrade the TSF.

Figure 48 to Figure 59 presents time series trends for key analytes, including pH, electrical conductivity (EC), bicarbonate (HCO_3^-), sulphate (SO_4^{2-}), chloride (Cl^-), total organic carbon (TOC), silica (SiO_2), antimony (Sb), arsenic (As), strontium (Sr), copper (Cu) and zinc (Zn). Key observations include:

- Groundwater across the site is fresh, with low electrical conductivity and chloride concentrations, indicating a strong connection to rainfall recharge rather than evaporation-driven concentration. Though fresh, Wells MW04, MW05, MW06, and MW08 appear more groundwater-based.
- pH is generally stable across the site, with neutral to slightly alkaline conditions, though some variability is observed in response to recharge events.
- Bicarbonate concentrations vary between wells, with higher levels in MW07, MW01, and MW05, suggesting carbonate interactions and buffering capacity. Surface water sampling near MW07 and MW05 recorded higher bicarbonate concentrations than in other locations.
- Total organic carbon (TOC) is elevated in multiple wells, with MW05, MW07, and MW12 showing the highest concentrations. This suggests variability in organic inputs, possibly from surface water interactions, subsurface organic matter, or microbial activity.
- Sulphate is generally low, though episodic variations occur in MW05, indicating potential mineral interaction or recharge influences.
- Silica concentrations are highest in MW05, MW04, MW08, and MW06. This suggests localised dissolution of silica-bearing minerals, which may reflect varying groundwater residence times or geological influences in these areas.
- Arsenic and antimony are highest in MW09 due to its location within the mineralised ore zone: arsenic concentrations in MW01, MW05, and MW07 remain below the highest background levels observed at MW09; however, they are elevated compared to other bores.
- Strontium is slightly elevated in MW05 and MW07, which may be related to groundwater interacting with carbonate or dolerite rocks or variations in water-rock interaction pathways.
- Copper (Cu) and Zinc (Zn) concentrations are generally low across the site,

A detailed analysis of groundwater arsenic as observed in MW01, MW05 and MW07 is in Section 4.1.

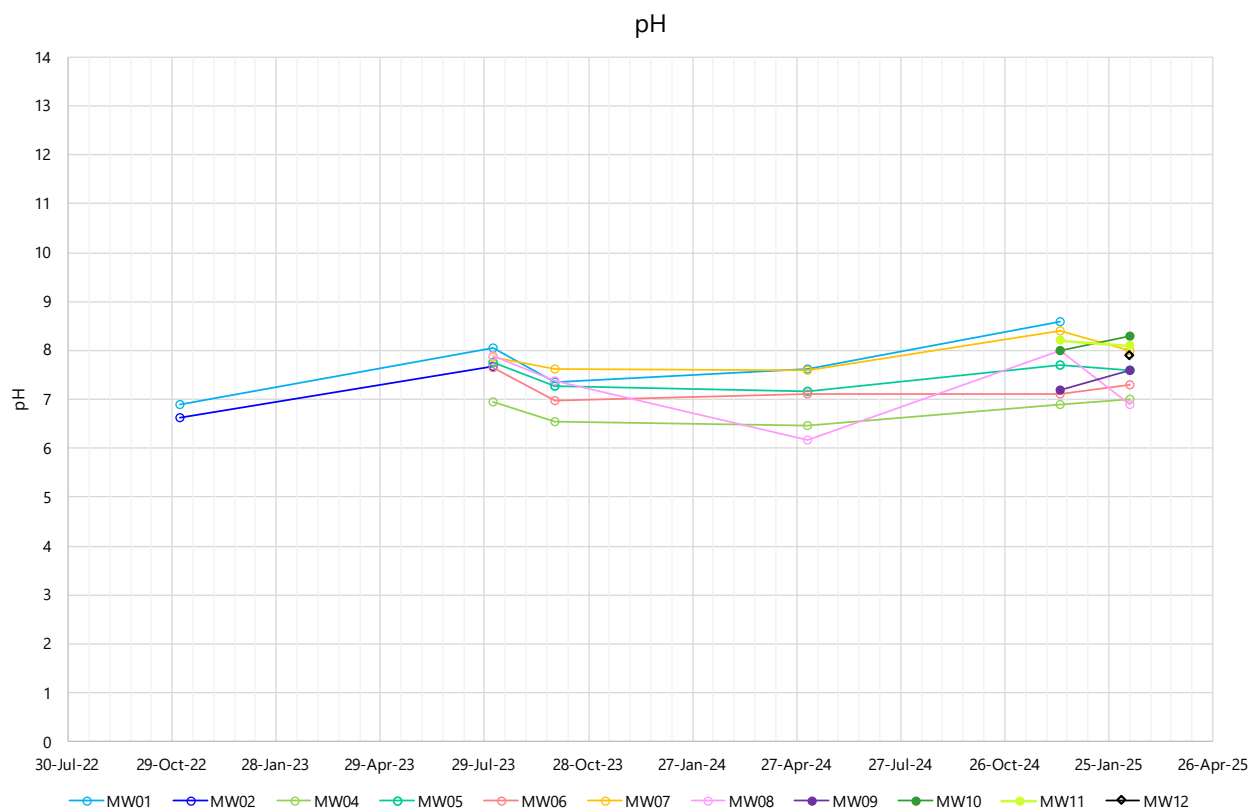


Figure 48 - Groundwater quality over time - pH

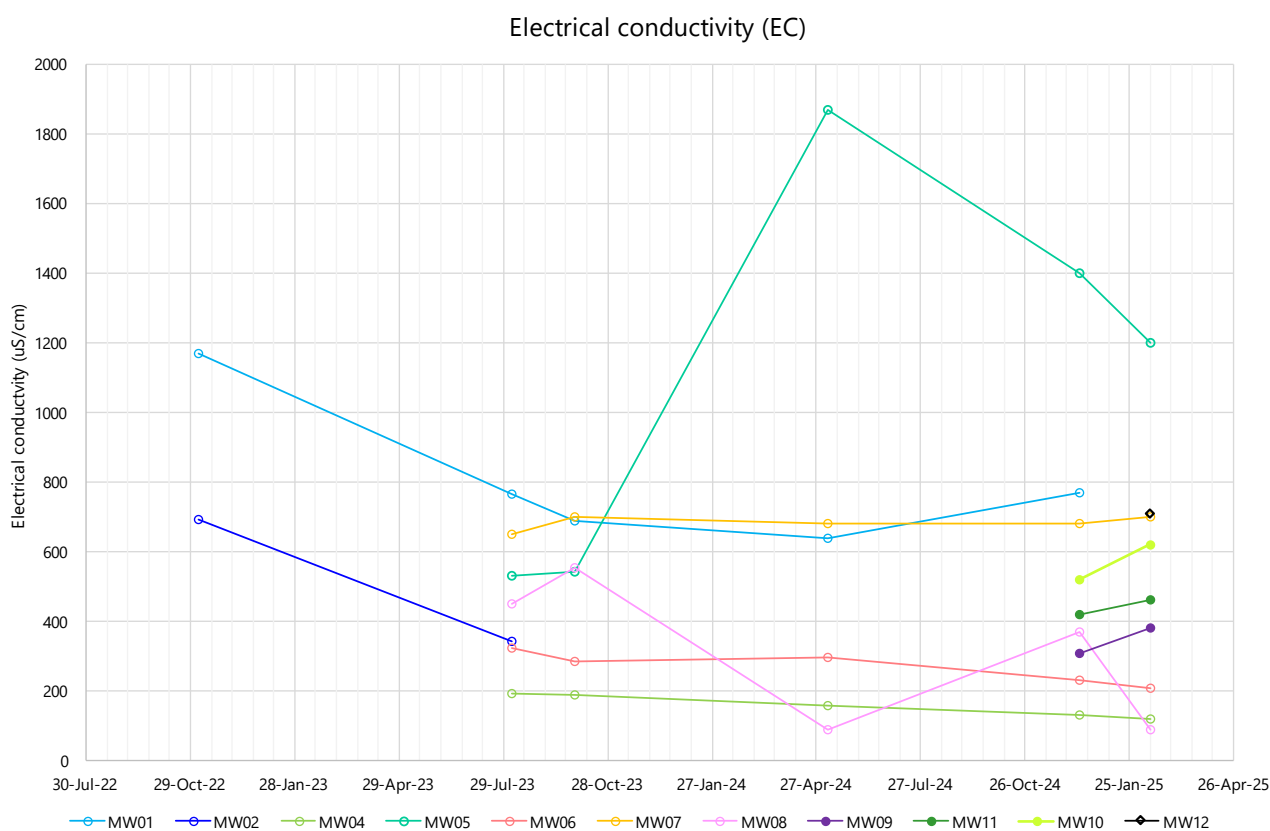


Figure 49 - Groundwater quality over time – EC

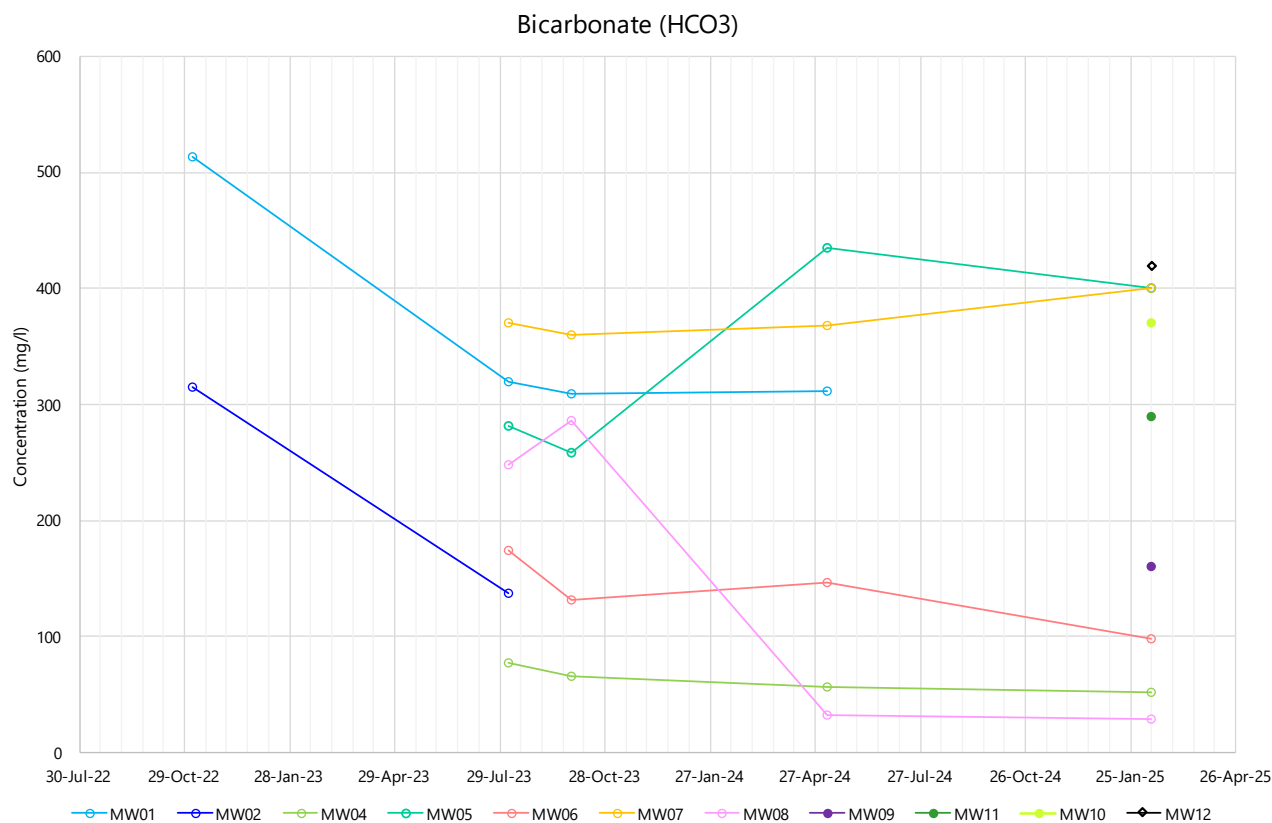


Figure 50 - Groundwater quality over time – HCO_3

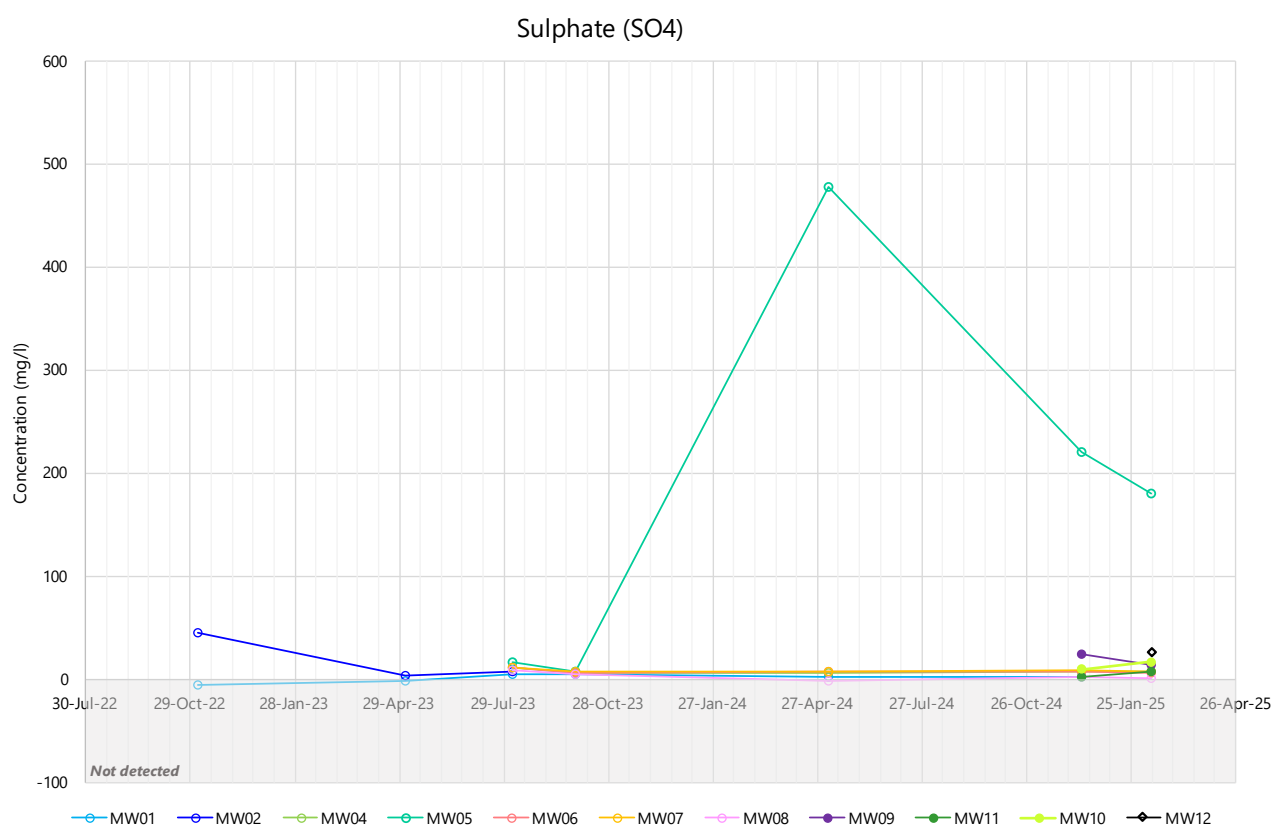


Figure 51 - Groundwater quality over time – SO_4

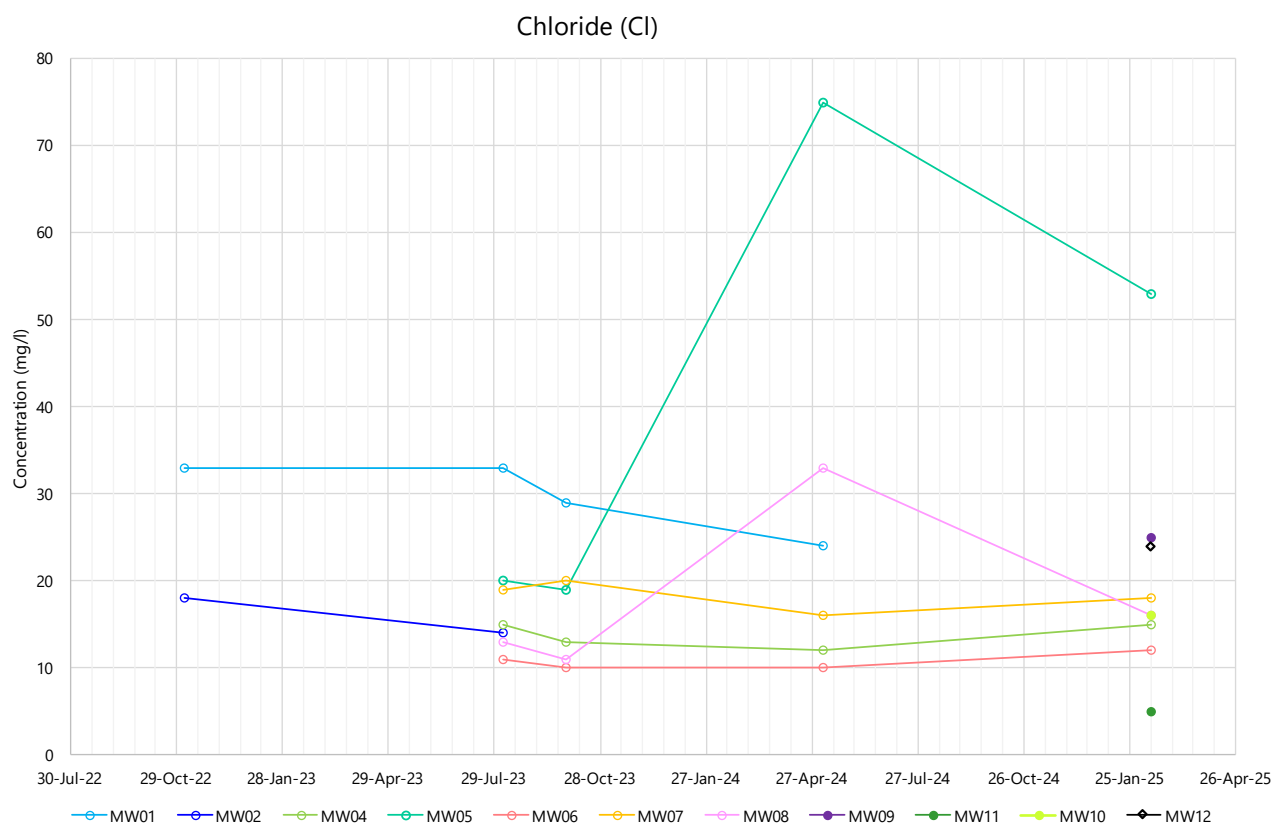


Figure 52 - Groundwater quality over time – Cl

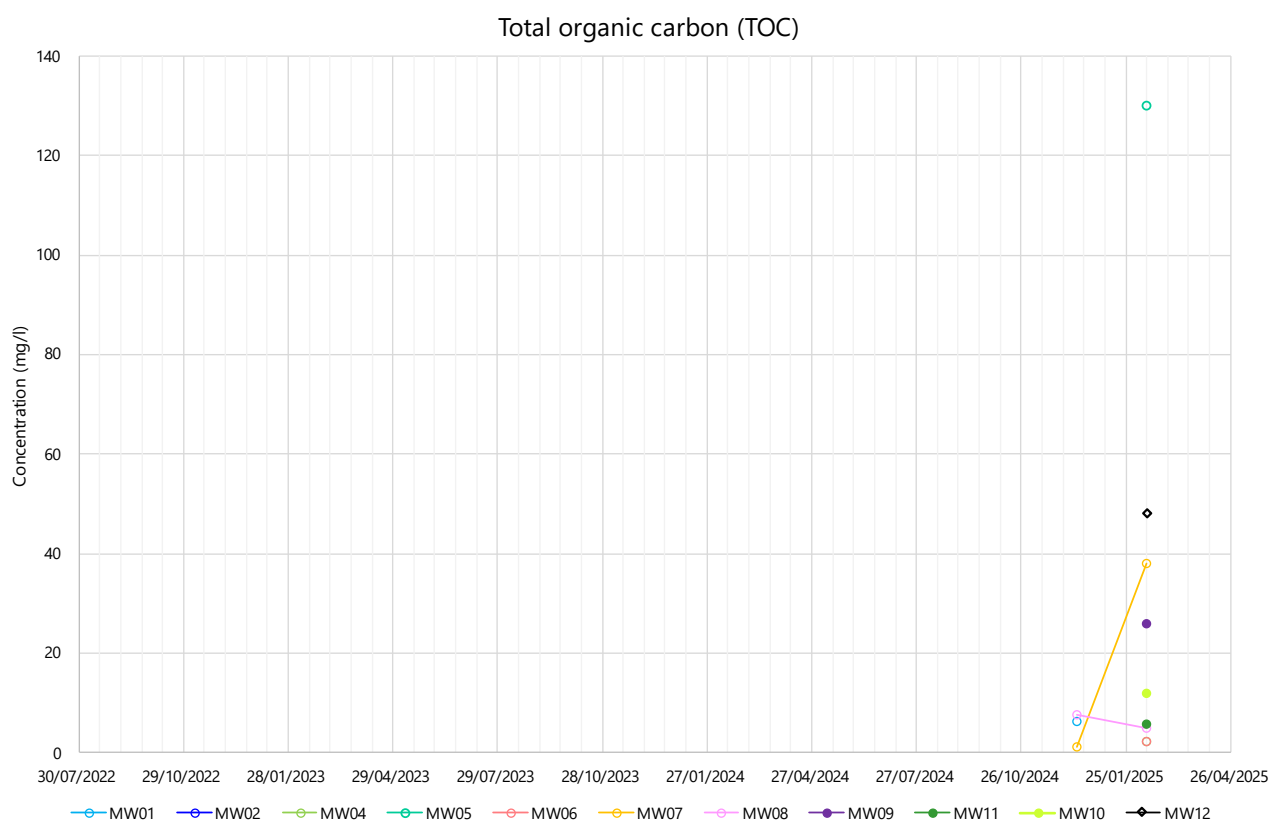


Figure 53 - Groundwater quality over time – Total organic carbon

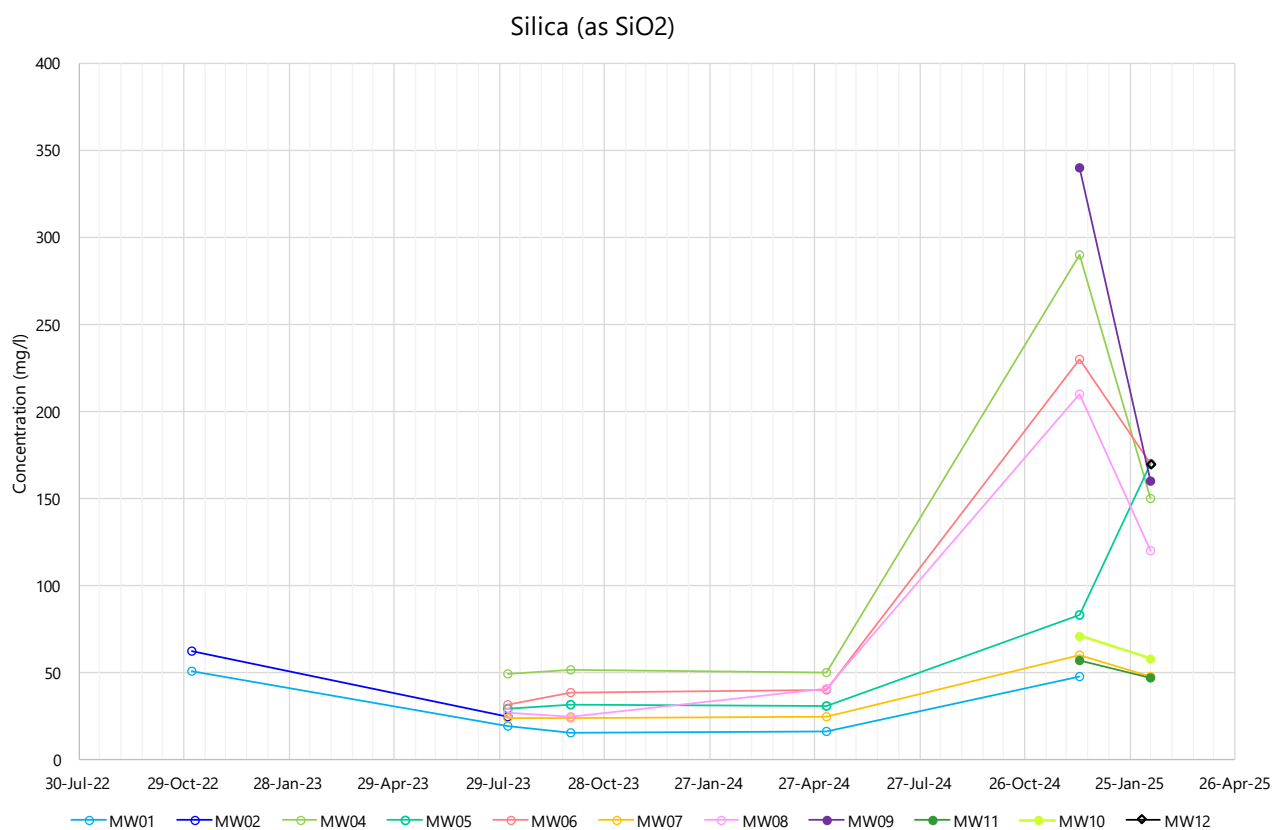


Figure 54 - Groundwater quality over time – Silica as SiO₂

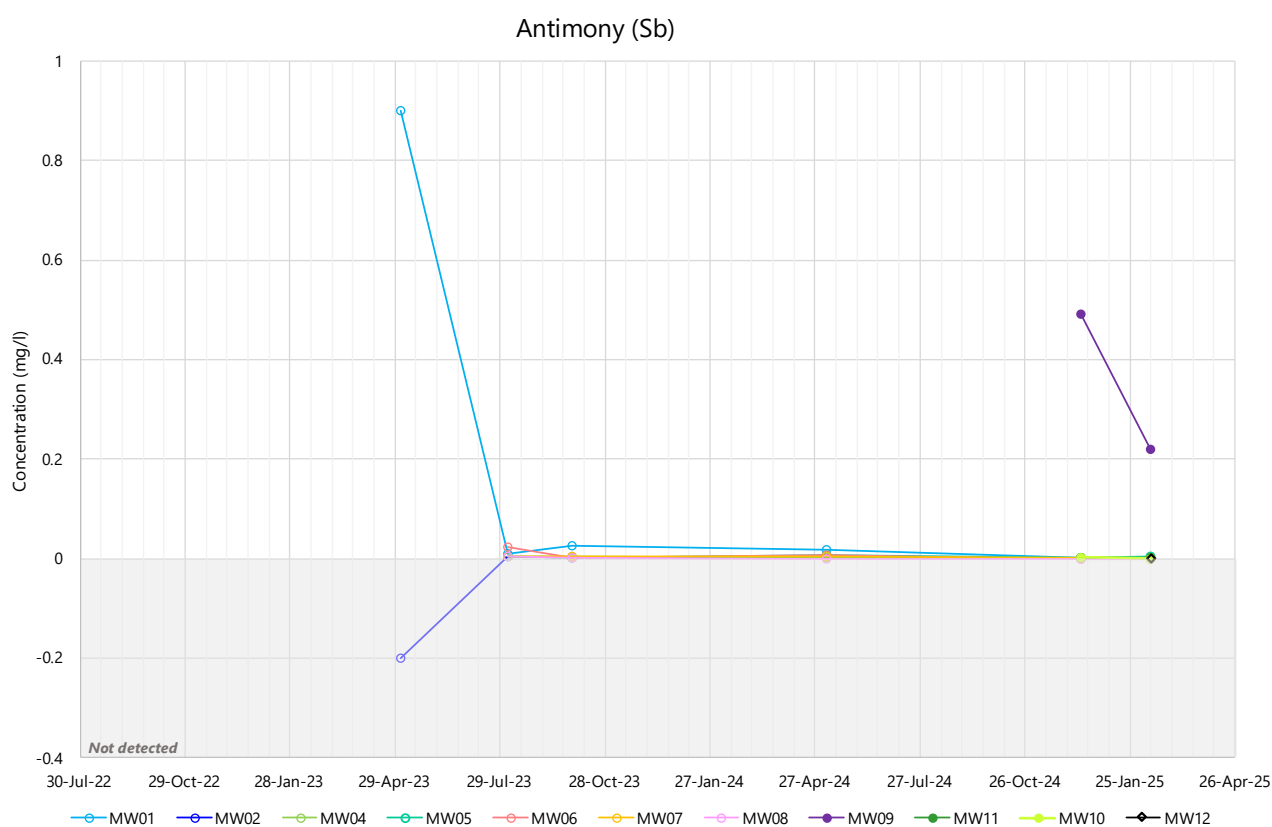


Figure 55 - Groundwater quality over time – Antimony

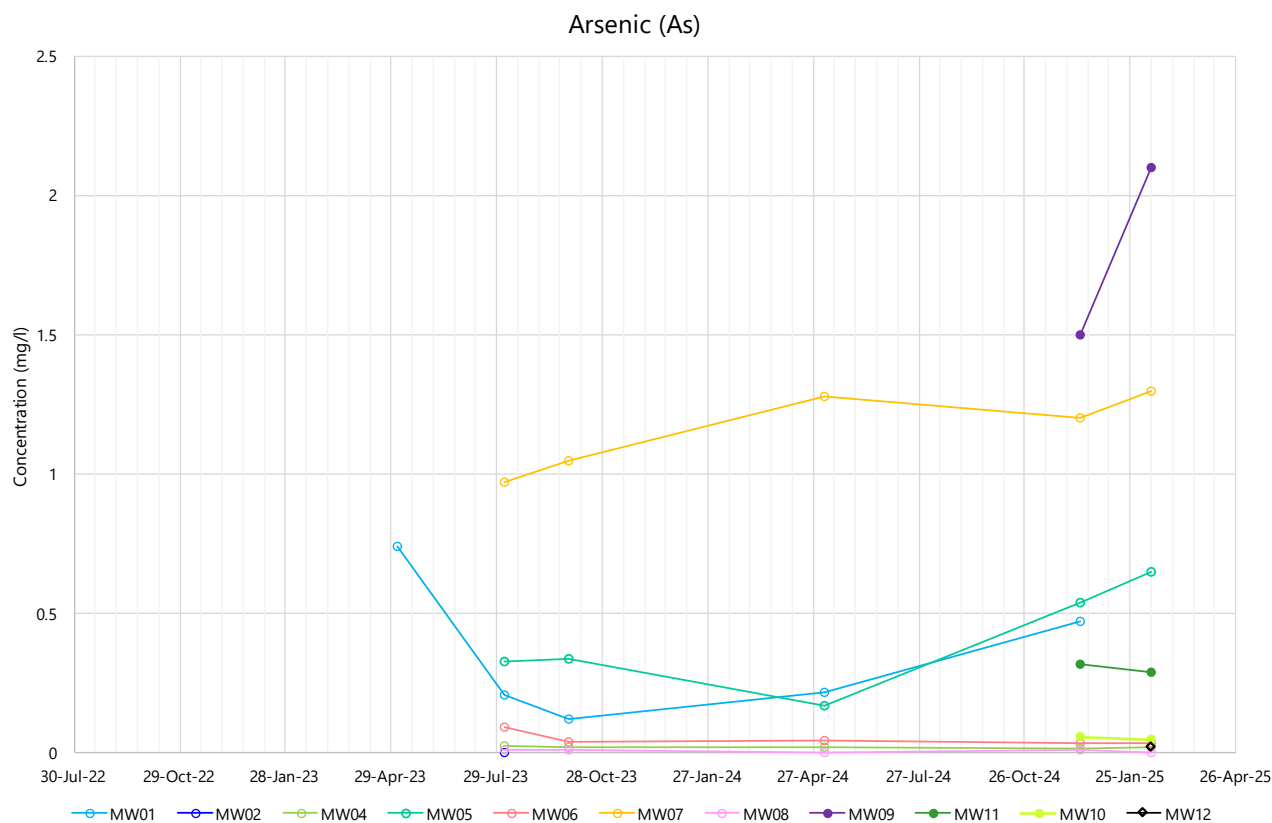


Figure 56 - Groundwater quality over time – Arsenic

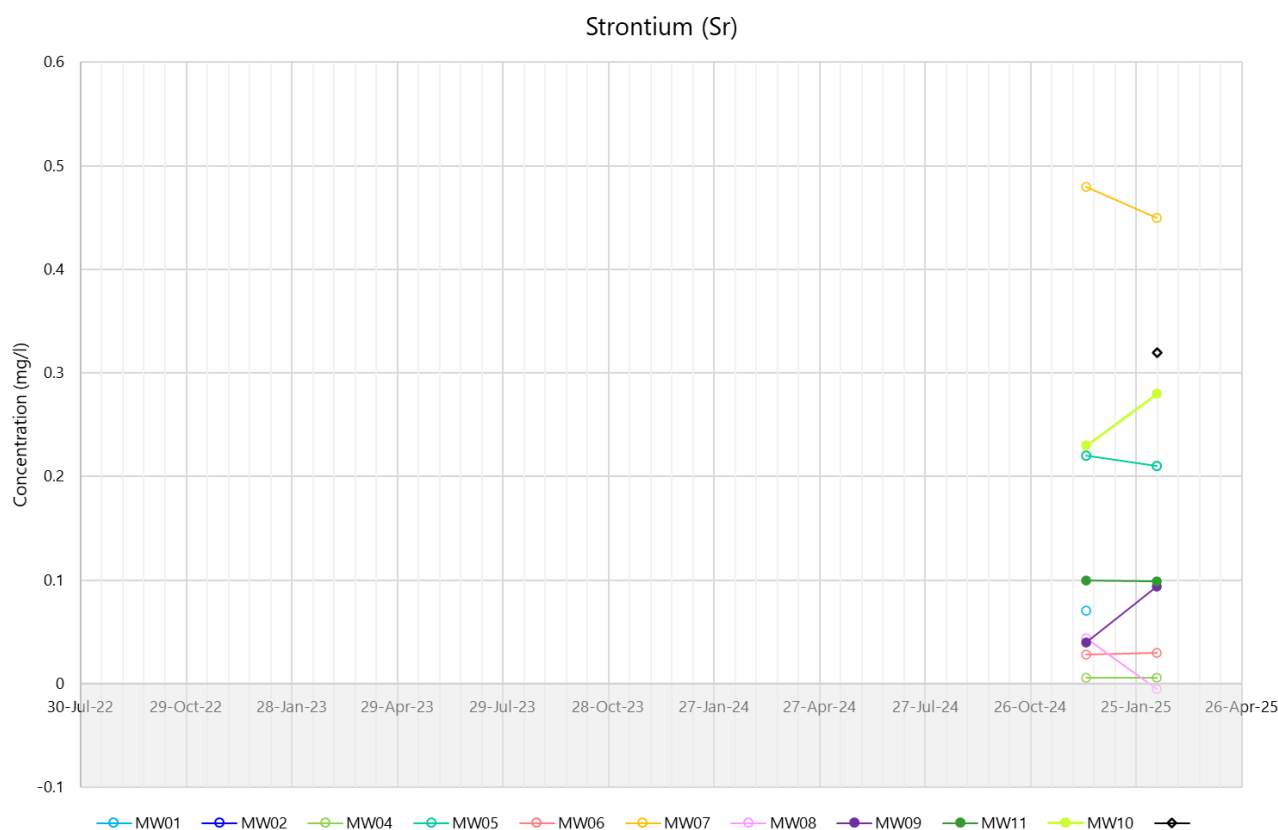


Figure 57 - Groundwater quality over time – Strontium

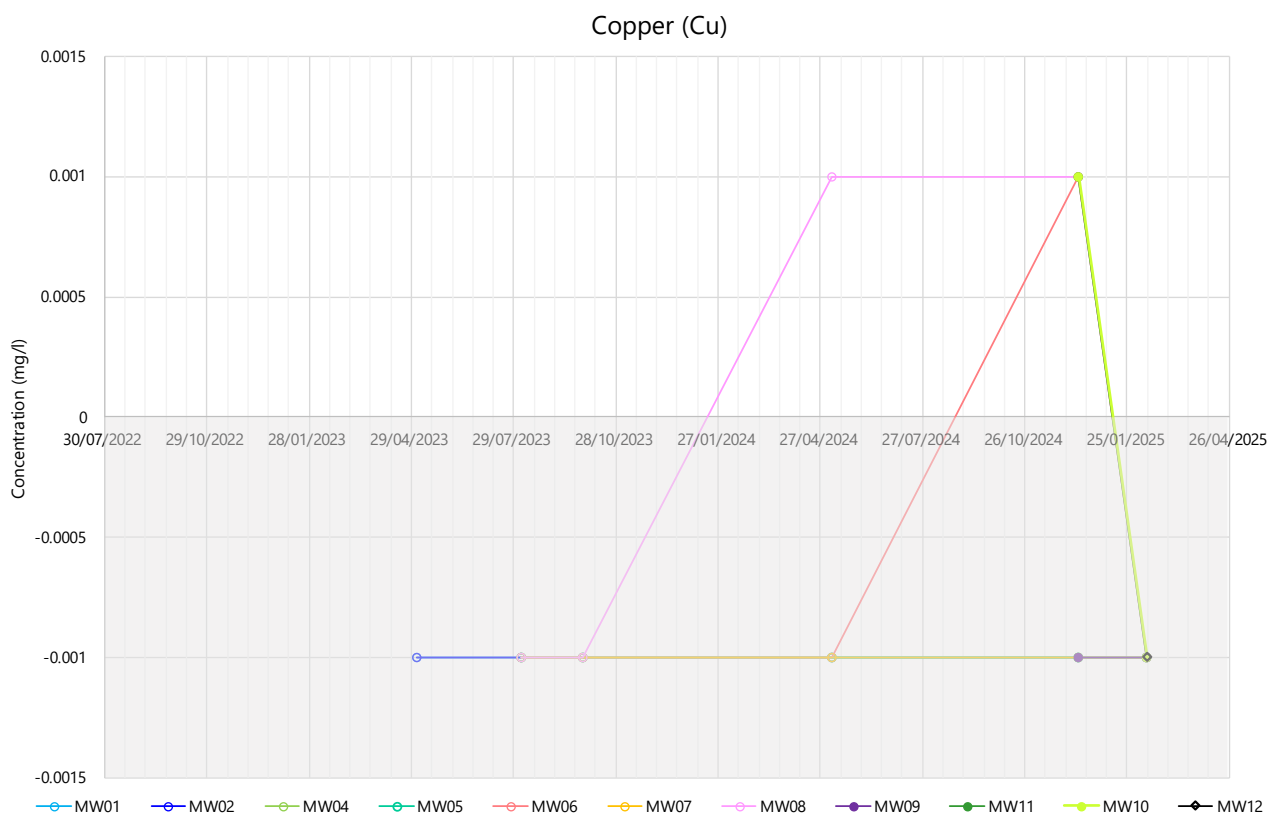


Figure 58 - Groundwater quality over time – Copper

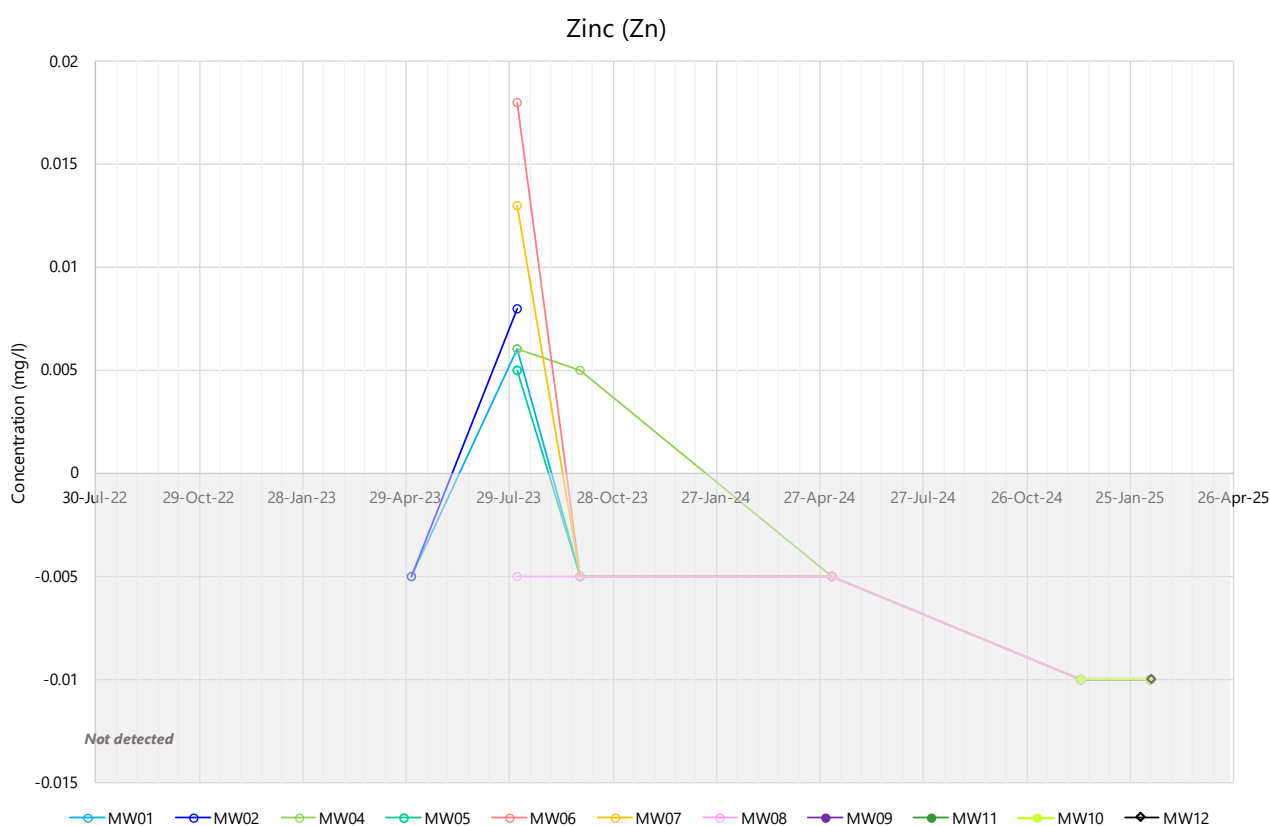


Figure 59 - Groundwater quality over time – Zinc



4 Conceptual water system model

4.1 Water system investigations

4.1.1 Investigation: Water quality patterns across the site

Background

A broad review of water chemistry populations provides insights into key system influences and potential linkages or mixing between water sources across the site. The objective is to identify hydrochemical character of the Alice River site, identify differences and assess potential water quality influences from geology, hydrology, and site activities.

Methodology

This investigation examines groundwater (MW), pit water (AQ), creek water (W), and runoff sources (WR, RM) from sampling events between December 2024 (pit water quality & MW01) and February 2025 (MW, W, RM & WR). The AQ, WR, and RM sites were added to assess pit water and runoff from historical stockpiles during rainfall.

Water chemistry distributions were analysed using a Durov diagram (Figure 60), which plots cations and anions in milliequivalent percentages (meq%) alongside pH and electrical conductivity. The Durov diagram was selected over the Piper diagram due to its ability to:

- Better represent hydrochemical processes, including mixing, ion exchange, and water evolution trends.
- More accurately display low-salinity waters like creek water, which has very low chloride (<3 mg/L), sulphate (<1 mg/L), and bicarbonate (<7 mg/L). These waters are misrepresented in equivalence-based plots like the Piper diagram, which does not reflect their rainfall-derived nature.

Results

Quality area	Key findings
General	All water samples fall within the sodium-bicarbonate facies, indicating interaction with weathered granite and bicarbonate buffering. Variations between sample types are largely due to ionic strength rather than distinct geochemical processes.
Groundwater (MW)	Higher EC (380–1200 $\mu\text{S}/\text{cm}$), neutral to slightly alkaline (pH 6.9–8.6). Chemistry reflects weathered granite, minor carbonate, and fault-related minerals, with low sulphate (<20 mg/L), indicating minimal sulphide oxidation influence. Bicarbonate concentrations are elevated, supporting groundwater evolution via feldspar weathering and cation exchange.
Pit water (AQ)	Low salinity (EC 42–45 $\mu\text{S}/\text{cm}$) with depth-related differences: • Deeper water (D suffix) is more alkaline (pH ~8.1–8.6), while shallow water (S suffix) is slightly acidic (pH ~5.8–6.9). This suggests differences in gas exchange, CO_2 equilibrium, and microbial activity rather than significant water-rock interaction. • Nutrient concentrations increase with depth, particularly nitrogen and phosphorus, likely due to organic matter breakdown and limited mixing at depth.
One Mile Creek (W) and Runoff sources (WR and ROM)	Rainfall-driven with low EC (10–45 $\mu\text{S}/\text{cm}$) and slightly acidic pH (~6.3–6.6). • One Mile Creek is more influenced by organic matter, contributing to bicarbonate buffering and slightly lower pH. • Runoff (WR, ROM) may interact with waste rock or ROM materials, but chemical differences are minor. • Slight differences on the Durov diagram reflect low ionic concentrations, rather than fundamental hydrochemical variation.

Conclusions

1. Sodium bicarbonate (Na-HCO_3) is the dominant facies
 - All water samples fall within the sodium-bicarbonate facies, indicating interaction with weathered granite and the dominance of bicarbonate buffering in the system. Weathering of granites and diorites moves sodium, bicarbonates and silica into water.
 - Minor variations in water chemistry reflect differences in ionic strength and sample type, rather than distinct geochemical processes.
2. Silicate weathering controls water chemistry, with no significant sulphide oxidation
 - Sulphate concentrations are generally low, confirming minimal contribution from sulphide weathering or external sources. There is some salinity variability across groundwater, which likely signifies variable geology and is connected as expected in a compartmentalised, fracture-hosted system: dependent on mineralisation, host geology or sources of recharge.
3. Pit water (AQ) is rainfall-driven and does not show acidity
 - pH varies by depth, with deeper water being more alkaline and shallow water slightly acidic, due to gas exchange and microbial processes rather than water-rock interaction.
 - Water chemistry reflects rainfall inputs, with low salinity and no evidence of acid generation.
4. One Mile Creek and runoff (WR, RM) are rainfall-driven
 - Minor differences between the two are linked to organic input and shallow surface interactions, rather than distinct geochemical processes.

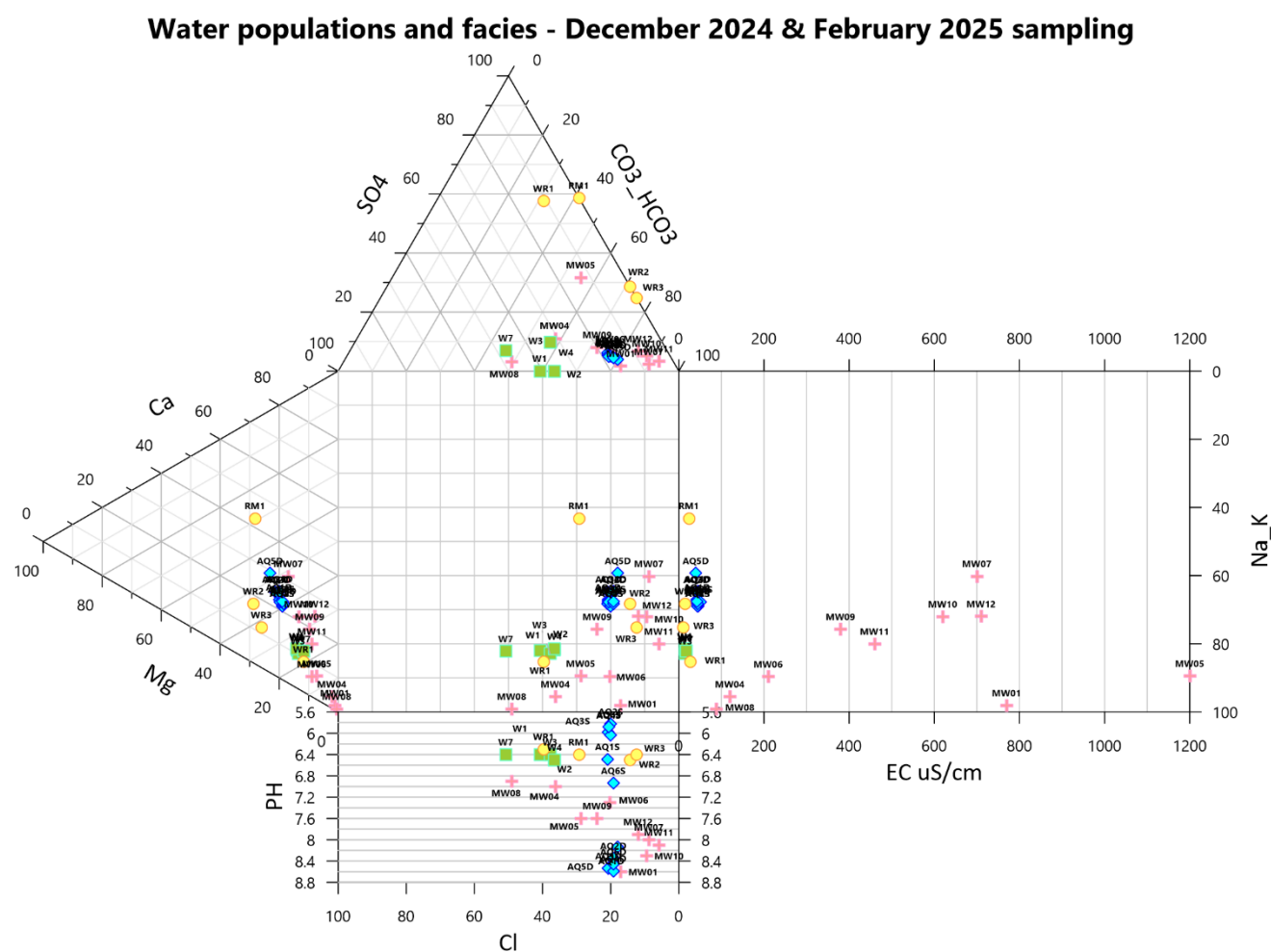


Figure 60 - Durov diagram showing water quality facies of water across Alice River site



4.1.2 Investigation: Alice Queen Pit lake water quality profile

Background

A dedicated pit lake investigation was conducted to assess the hydrology, water chemistry, and stratification of the Alice Queen pit lake at the Alice River site as a survey. The lake receives direct rainfall and surface runoff from the surrounding, with limited groundwater interaction. During high-rainfall events, inflow from One Mile Creek is possible when water levels exceed ~117.5 m AHD.

Routine monitoring identified elevated arsenic concentrations, prompting further investigation into:

- Water quality, including arsenic and antimony concentrations.
- Stratification and seasonal variations in water chemistry.
- Potential geochemical controls on metal mobilisation.
- Hydrological influences, including catchment contributions and limited groundwater interaction.

Methodology

Water quality profiling was conducted at multiple shallow (~1.5 m) and deep (~7.5 m) locations across the pit lake, as shown in Figure 61.

- Field measurements: pH, electrical conductivity (EC), temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP), turbidity.
- Laboratory analysis:
 - Metals (total and dissolved): As, Sb, Fe, Mn, Pb, Zn, Cu, Al, Ba, B, Cd, Cr, Co, Hg, Mo, Ni, Se, Sr, U, V, Bi, W, Sn, Ag.
 - Nutrients: Total nitrogen (TN), ammonia (NH₃), nitrate/nitrite (NO_x), total phosphorus (TP), organic nitrogen.
 - General chemistry: Silica, sulphate (SO₄²⁻), bicarbonate, total organic carbon.
 - Arsenic speciation: As(III) and As(V).

Sampling targeted waste rock runoff, natural pit wall contributions, and depth-dependent variations.

Pit water quality results are provided in Appendix G.

Results

Area	Key findings
Hydrology & water levels	▪ The pit lake has a maximum depth of 10–12 m, with steep eastern and northern walls. ▪ Rainfall and surface runoff dominate the water balance, with limited groundwater input (supported by low salinity and silica trends) (Figure 64). ▪ Low sulphate (<7 mg/L) suggests minimal sulphide oxidation, indicating runoff, not pit wall interaction, as the primary control on water chemistry.
Stratification and water chemistry	▪ Stratification is weak but influences water quality, with small but distinct differences between shallow (~1.5 m) and deep (~7.5 m) water (Figure 62, Figure 63). ○ Shallow water is well-oxygenated (DO ~8.5 mg/L), alkaline (pH 8.5–8.6), and oxidising (ORP positive). ○ Deep water is reducing (DO ~0.2–2.5 mg/L, ORP ~-125 to -135 mV), slightly acidic (pH 5.8–6.5), and contains elevated arsenic. ▪ Bicarbonate and organic carbon increase at depth, supporting microbial activity. This is further supported by field samplers reporting rotten egg smells from water samples at depth in locations AQ-1D, AQ-2D, AQ-3D, AQ-4D, AQ-5D (no smell at AQ-6D in shallower area).



Metals & nutrients	▪ Iron and manganese are very low overall but increase slightly at depth, consistent with weak reductive dissolution (Figure 65). ▪ Nutrients (total nitrogen and ammonia) rise at depth, linked to organic matter breakdown under anoxic conditions (Figure 66). ▪ Creek inflows are likely the main source of organic material, supporting microbial activity and influencing metal mobility.
Arsenic & antimony trends	▪ Arsenic remains low ($\sim <0.02$ mg/L) in shallow water (~ 1.5 m), where oxidising conditions stabilise As(V) (Figure 67, Figure 68) ▪ Arsenic increases at depth (~ 7.5 m) (0.15–0.3 mg/L), driven by microbial breakdown of organic material and iron reduction, releasing As(III) from sediments. ▪ Antimony remains stable across depths, with slightly higher concentrations in shallow water, likely linked to surface runoff.
Key correlations	▪ Arsenic concentrations are strongly linked to redox conditions, with As(III) increasing as ORP decreases. ▪ pH is slightly lower at depth, consistent with organic degradation and weak acidification from microbial activity. ▪ Iron and manganese trends suggest minimal sulphide oxidation, supporting the runoff-driven water balance model.

Conclusions

1. Water quality is controlled by runoff and catchment, not pit wall interaction
 - Low sulphate confirms that water chemistry is dominated by surface runoff rather than sulphide oxidation.
 - Diverting temporary WRD surface inflows could improve pit water quality.
2. Pit lake stratification is weak but influences water chemistry
 - Shallow water (~ 1.5 m) is oxygenated, alkaline (pH 8.5–8.6), and oxidising.
 - Deep water (~ 7.5 m) is reducing, slightly acidic to neutral (pH 5.8–6.5), with increasing arsenic concentrations and organic breakdown.
3. Arsenic mobility is linked to microbial organic breakdown (Oremland & Stolz 2003; Smelley & Kinniburgh 2002)
 - Microbial iron reduction at depth (~ 7.5 m) promotes arsenic (As(III)) release from sediments.
 - Organic material from creek inflows supports these microbial processes, contributing to arsenic mobilisation.
4. Antimony remains stable but shows minor surface influence
 - Slightly higher Sb in shallow water (~ 1.5 m) suggests minor contributions from surface runoff.
5. Flood events likely introduce organic material into the pit lake
 - Creek inflows deliver organic matter, which settles and drives reducing conditions at depth.
6. The risk of water quality changes depends on whether the pit lake remains contained within the pit void
 - Potential long-term water quality impacts should consider hydrological containment and evaporation balance.



Figure 61 – Pit sampling locations

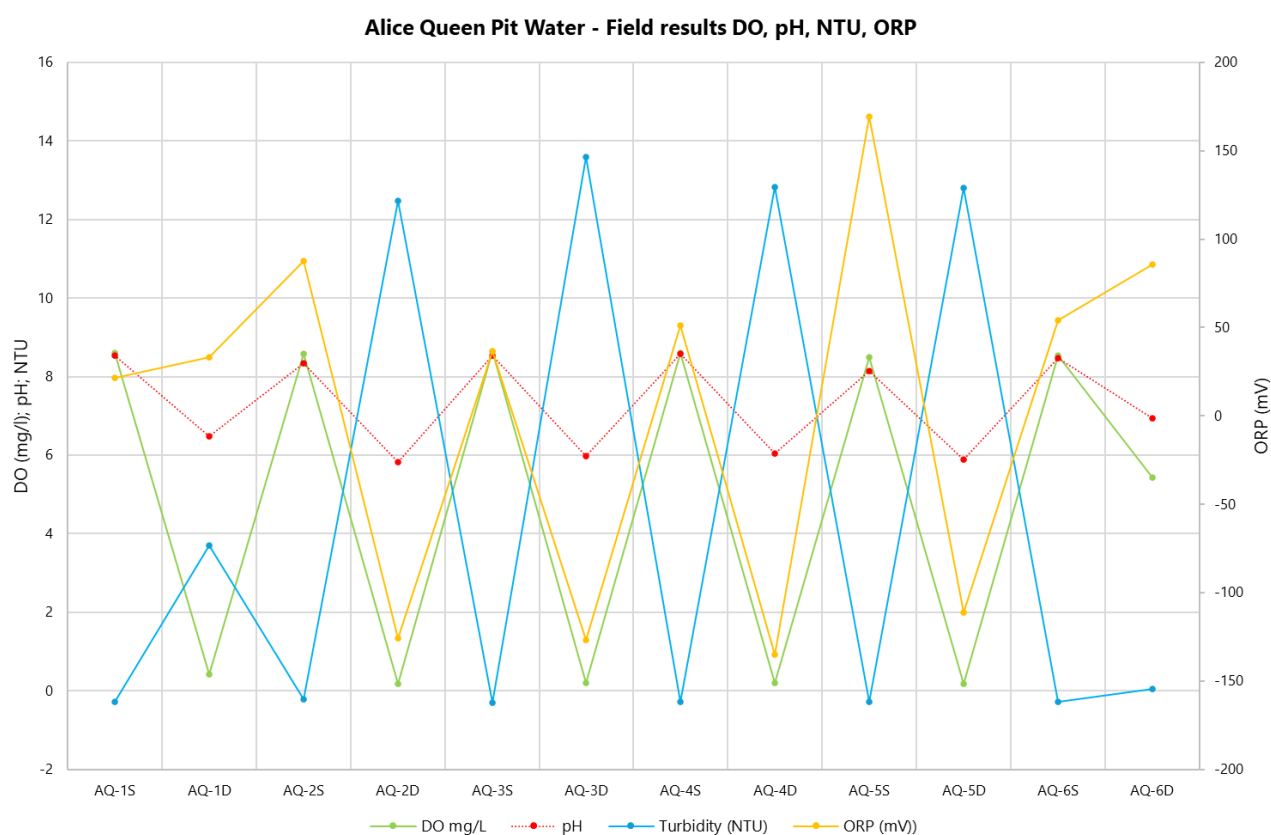


Figure 62 - Alice Queen pit water survey – DO, pH, NTU, ORP

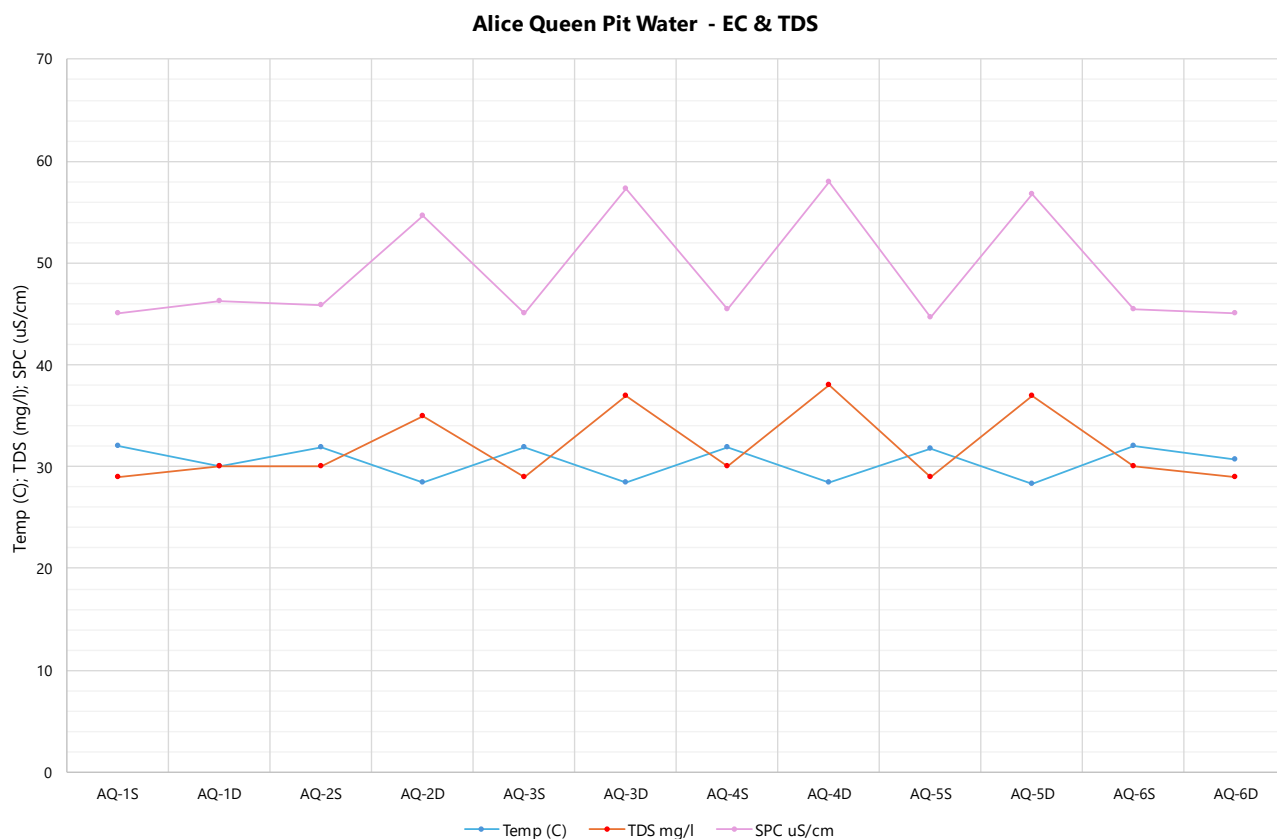


Figure 63 - Alice Queen pit water survey – EC & TDS

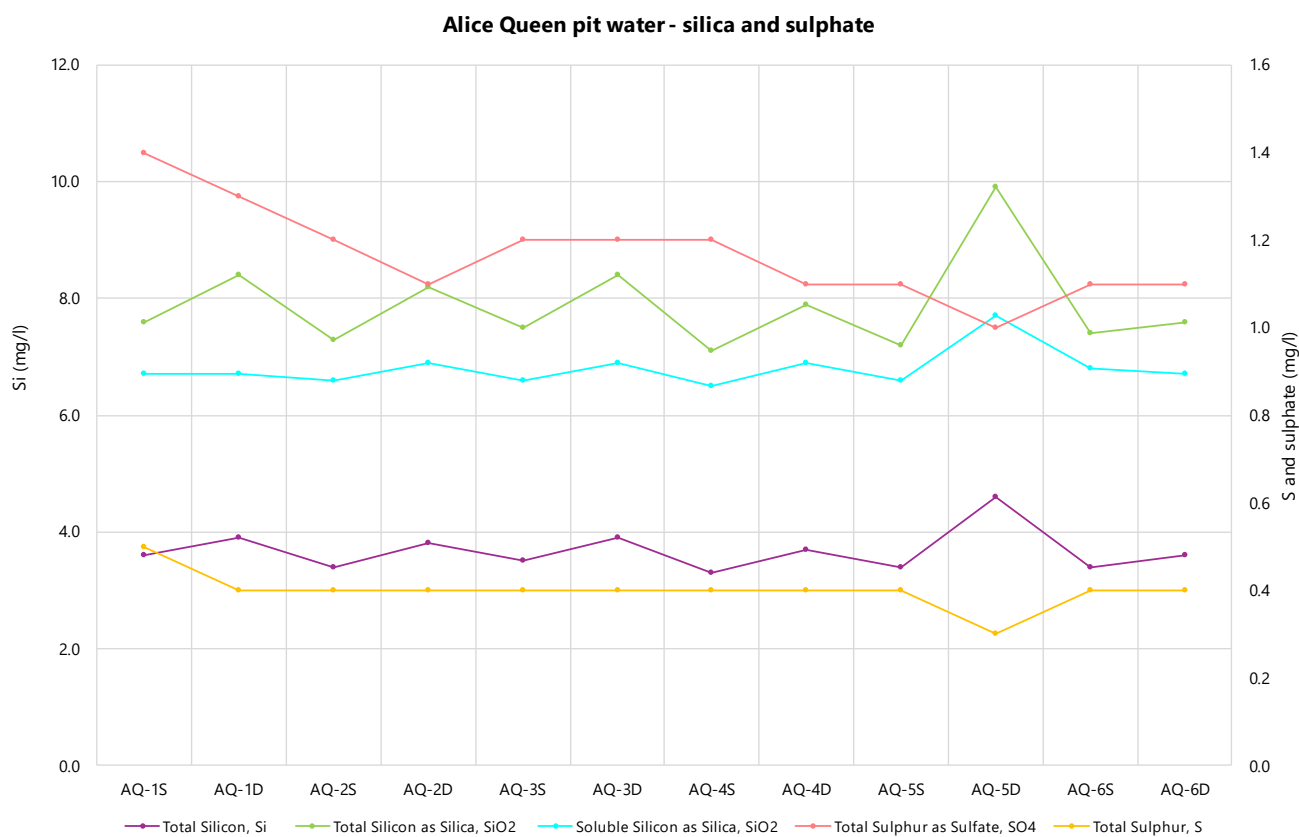


Figure 64 - Alice Queen pit water survey – silica and sulphate

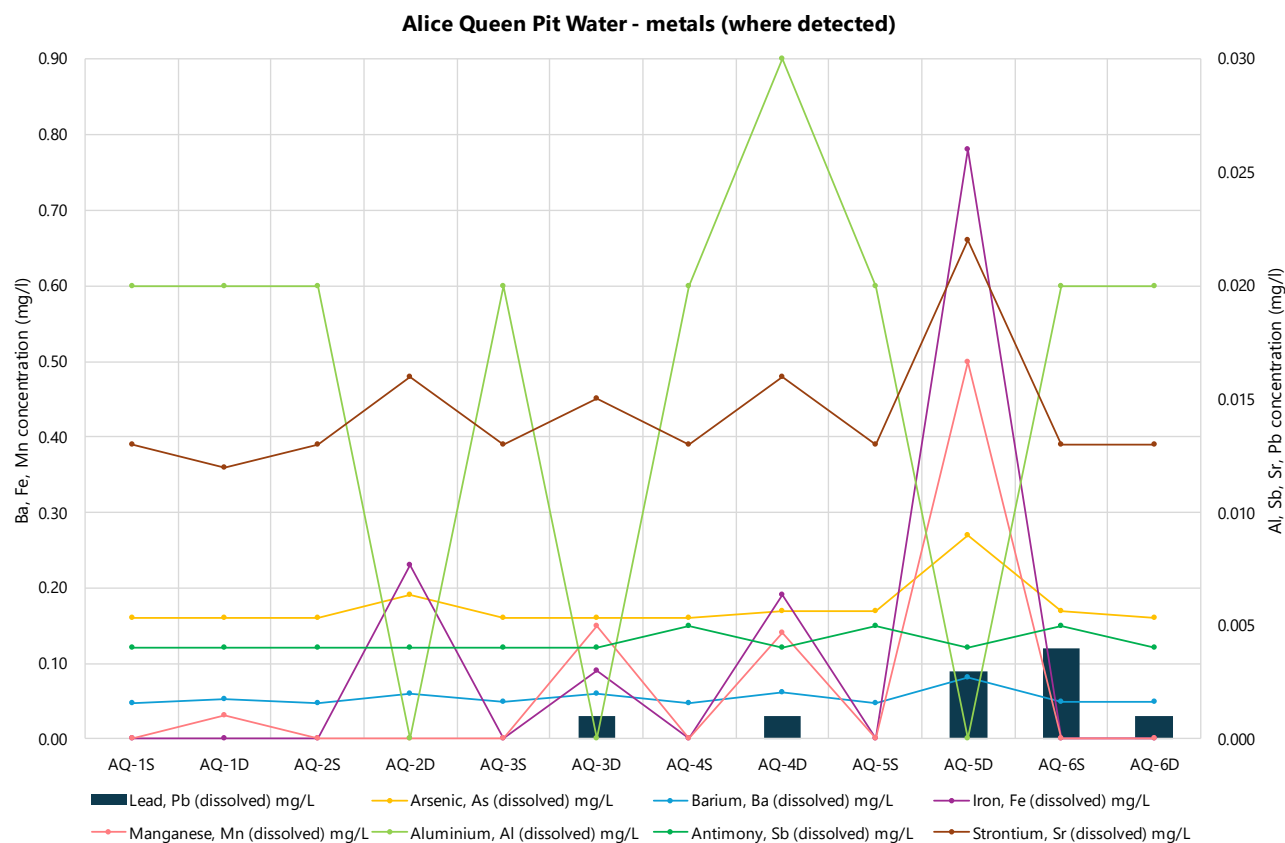


Figure 65 - Alice Queen pit water survey – metals (where detected)

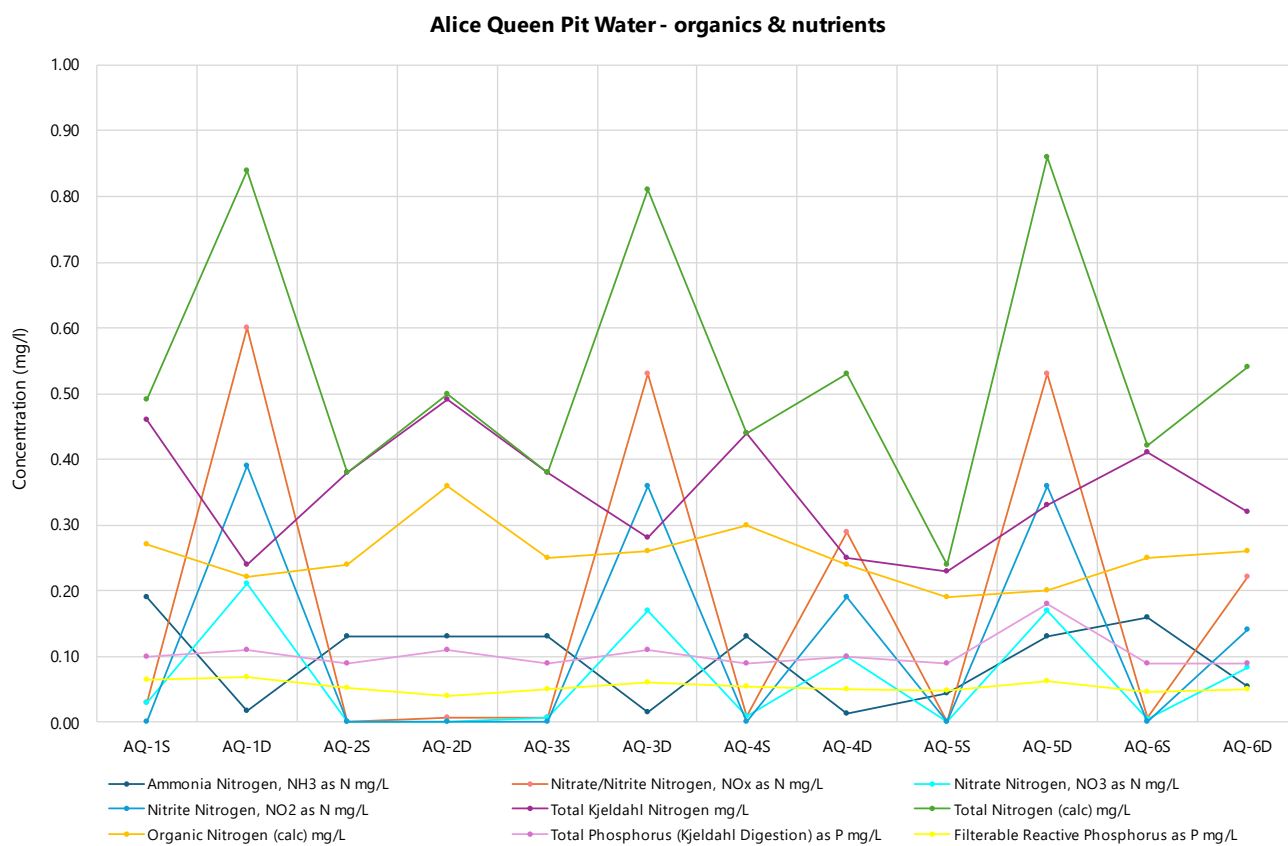


Figure 66 - Alice Queen pit water survey – organics and nutrients

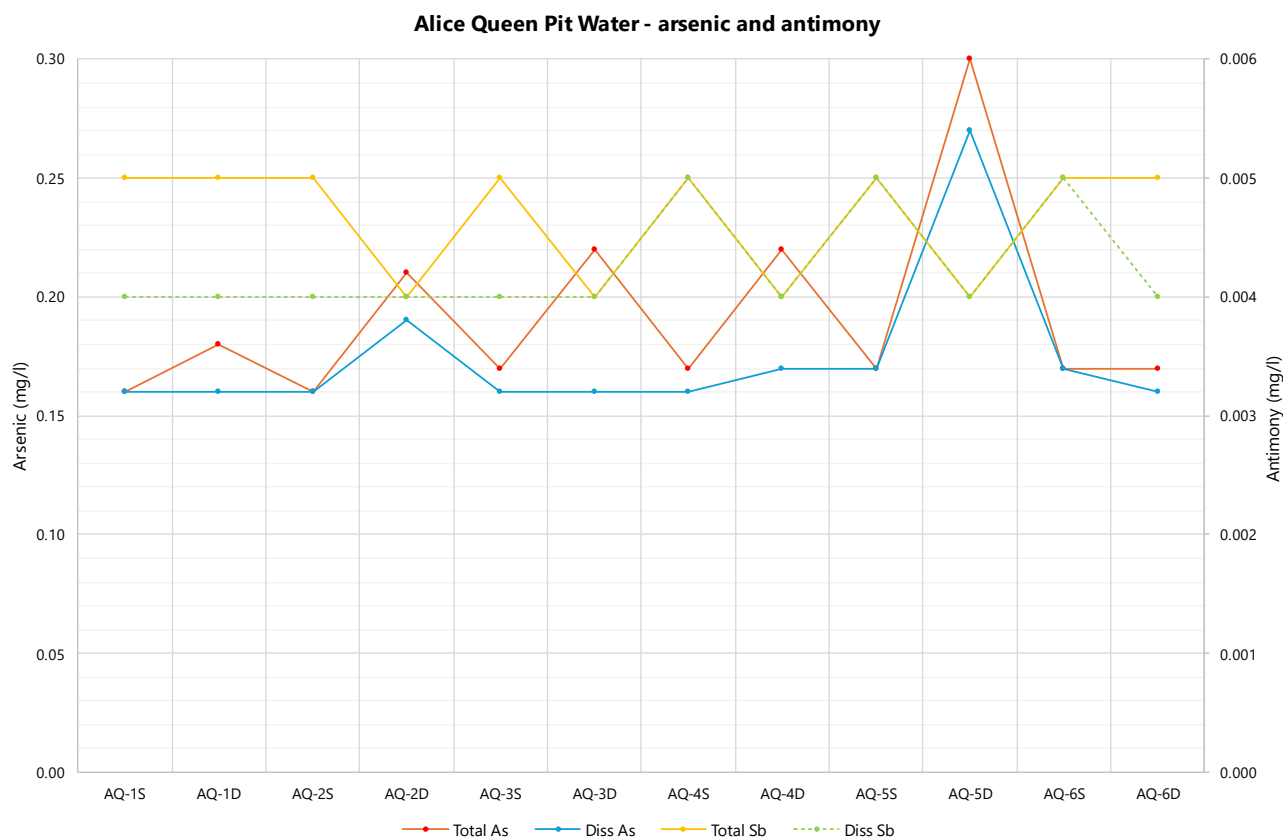


Figure 67 - Alice Queen pit water survey – arsenic and antimony

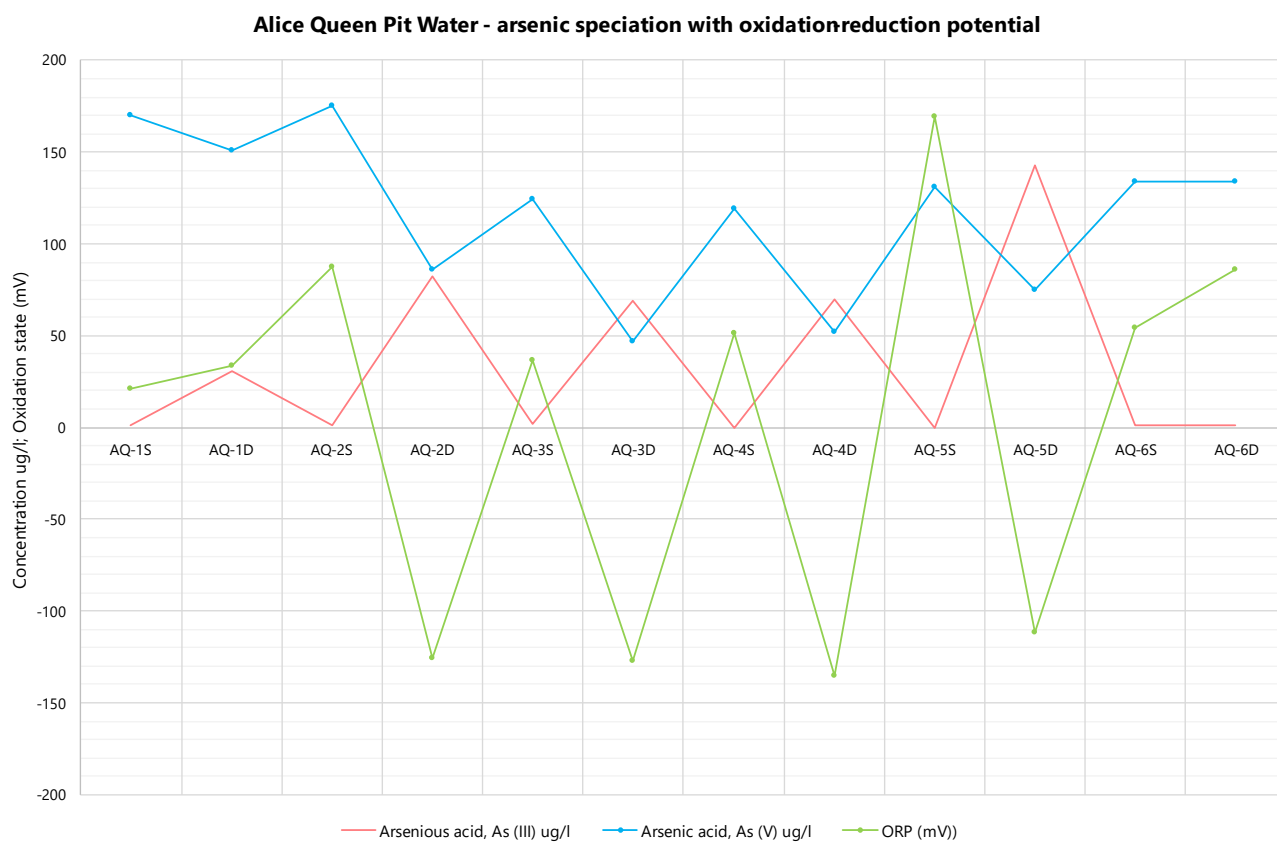


Figure 68 - Alice Queen pit water survey – arsenic speciation



4.1.3 Investigation: Recharge and potential hydraulic connection between Alice Queen Pit and MW07 (loggers)

Background

This investigation examines initial results from water level loggers installed in MW07 (groundwater) and the Alice Queen pit lake, following rainfall events recorded over the past three months at two locations.

Understanding Alice Queen pit lake responses is important for hydrological modelling, improving automated pit water level tracking, and gaining insights into pit and groundwater interactions over time. These data will support assessments of hydraulic connections and system responses under different rainfall conditions. The objective of this investigation is to:

- Monitor water levels over time to understand the hydrological responses and connectivity of MW07 and the Alice Queen pit lake.
- Quantify the relationship between rainfall and MW07/pit lake level changes to support hydrological modelling.
- Determine whether a hydraulic connection exists between the AQ pit lake and MW07.

Methodology

This investigation analyses MW07 groundwater and Alice Queen pit lake levels from two water level vented transducers installed in each location at a set and constant elevation, along with daily site rainfall recorded at Alice River Station Homestead and Laura Post Office, covering the period from mid-December 2024 to February 2025 (Figure 69). Water levels are recorded at hourly intervals. Water levels were assessed to determine:

- The magnitude and timing of MW07 and Alice Queen pit lake responses to rainfall.
- Whether MW07 and the pit lake respond primarily to local rainfall or if MW07 is influenced by upstream creek recharge.
- Whether MW07 and the pit lake exhibit correlated trends, indicating a potential hydraulic connection.

Results

Quality area	Key findings
1. MW07 groundwater response	• First MW07 rise (December 2024): ▪ MW07 increased gradually before significant on-site rainfall, suggesting delayed infiltration or slow drainage from the raised platform and stockpile above it. ▪ No strong correlation with rainfall at any specific lag indicates a slow recharge process rather than a direct response. • Second MW07 rise (January/February 2025): ▪ MW07 rose again before major on-site rainfall, but this time sharper and more pronounced. ▪ A 2–3 day lag with Laura rainfall confirms MW07 is recharged by creek flow from upstream rainfall. ▪ both local infiltration and creek recharge influence MW07's response. • Potential influence from pit lake or stockpile drainage: ▪ Any surrounding catchment infiltration or pit contribution would likely occur as delayed seepage rather than an immediate response. ▪ Further water level and hydrochemical data are needed to confirm if either source contributes to MW07 over time.
2. Alice Queen Pit	• The pit lake responded immediately to rainfall, confirming it is controlled by surface water inputs from direct rainfall and runoff from the surrounding catchment.



lake response	- Once the pit level rises, it does not reduce quickly, indicating a lack of significant seepage or loss. This suggests the pit lake is a relatively closed system with limited drainage or groundwater outflow. - No clear connection between MW07 and the pit lake was observed in this dataset.
3. MW07 and Pit lake potential connection	- MW07 and the pit lake show different response patterns, with MW07 rising before local rainfall events, while the pit lake rises immediately after. - While MW07 is not directly linked to the pit, it may receive slow recharge from the bore catchment (historical stockpiles) or potentially pit seepage via levels (refer Figure 46) over time. However, the pit lake's slow recession suggests minimal water loss, making it less likely to be a significant recharge source for MW07. - Further monitoring is needed to confirm if any delayed interactions exist.

Conclusions (preliminary only)

- MW07 appears to be recharged by both delayed infiltration and creek flow.
 - The first rise (December) was gradual, likely from slow infiltration or drainage from the raised platform and stockpile.
 - The second rise (January/February) was faster, confirming that MW07 is influenced by creek flow from upstream rainfall.
- Alice Queen pit lake is rainfall-driven and does not appear to influence MW07.
 - The pit lake responds immediately to site rainfall, confirming it is surface water-driven.
 - Once the pit rises, it is not quick to reduce in level, indicating a lack of seepage or loss.
- While both act under similar drivers of rainfall +/- creek flow, the pit does not appear connected to MW07. Further review of data logger responses is recommended over time, as well as a review of water level responses of MW11 and MW12 for further definition of potential connection.

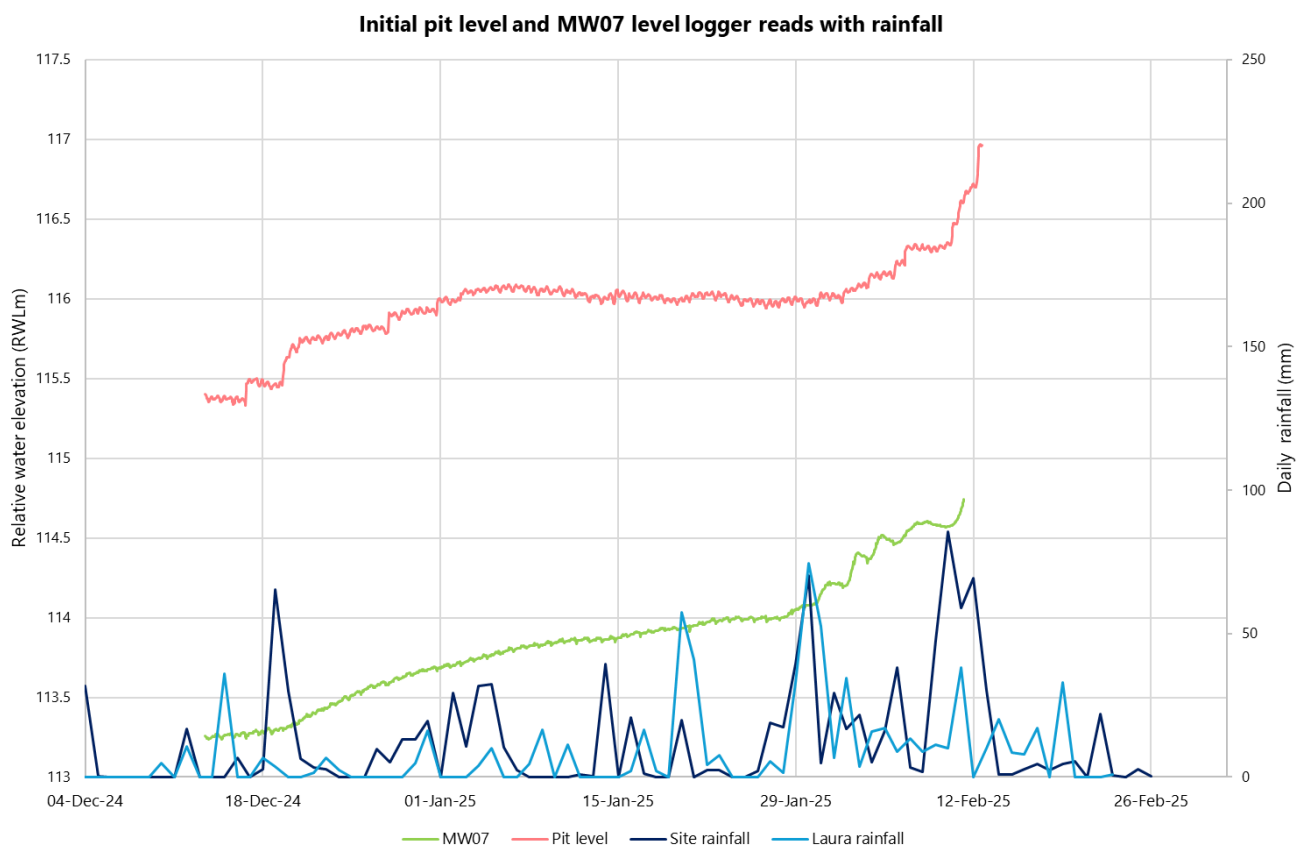


Figure 69 - Initial MW07 and AQ Pit Lake logged levels with site and Laura rainfall



4.1.4 Investigation: Arsenic sources and potential hydraulic connection between Alice Queen Pit Lake and MW07

Background

This investigation assesses whether MW07 and the Alice Queen pit lake (AQ pit) are hydraulically connected and whether arsenic mobilisation in these systems has a common or distinct source.

MW07 has been identified as having elevated arsenic levels, and its geochemical conditions suggest potential groundwater interactions. The AQ pit, in contrast, shows arsenic behaviour influenced by redox conditions at depth. The study evaluates whether these features indicate direct hydraulic connection or distinct geochemical evolution pathways.

MW07 is situated between One Mile Creek and the AQ Pit, is likely constructed in dolerite and mineralisation, and also receives runoff from the historical platform material (see Figure 8 & Figure 35).

Key questions guiding this investigation:

- Is there a hydraulic gradient strong enough to drive water movement between MW07 and AQ pit?
- Do arsenic concentrations and speciation suggest a common or separate source?
- What geochemical indicators (e.g., bicarbonate, silica, sulphate) support or refute a connection?

Methodology

To assess potential hydraulic connection and arsenic sources, the following approaches were used:

1. Water chemistry and arsenic speciation

- Major ions (Na, Ca, Mg, Cl, HCO_3^- , SO_4^{2-}) were analysed in MW07 and AQ pit to compare geochemical signatures.
- Arsenic speciation (As(III) and As(V)) was measured to evaluate redox influences on arsenic mobility.
- Total organic carbon (TOC) and oxidation-reduction potential (ORP) were assessed to determine the role of microbial breakdown.

2. Indicators of hydraulic connection

- Hydraulic gradient was calculated based on measured water levels.
- Silica (Si) concentrations were used to indicate silicate weathering and groundwater evolution.
- Bicarbonate (HCO_3^-) concentrations were assessed to evaluate groundwater-rock interactions.

3. Differentiating arsenic sources

- Sulphate concentrations were measured to assess potential sulphide oxidation.
- The relationship between TOC, pH, and arsenic was analysed to evaluate surface runoff contributions.
- Arsenic depth profiles were compared to assess trends consistent with groundwater mixing.

Results

Quality area	Key findings
Water chemistry and arsenic speciation	• MW07 is oxidising, with arsenic predominantly in the oxidised As(V) form (~1.3 mg/L) despite the field ORP of -64mV • The AQ pit shows lower arsenic concentrations (0.16–0.27 mg/L) at the surface, increasing at depth under reducing conditions.



	• ORP measurements in the AQ pit are negative at depth, coinciding with arsenic present as As(III), likely due to microbial iron reduction. • These results indicate that the same redox processes do not mobilise MW07's arsenic as in the pit lake (Figure 70 & Figure 71, also see Figure 68 for AQ pit).
Bicarbonate and silica as groundwater indicators	• MW07 has significantly higher bicarbonate (400 mg/L) compared to the AQ pit (~22–26 mg/L) (Figure 72). • MW07 also has higher silica (14 mg/L) than the AQ pit (~4 mg/L), suggesting greater silicate weathering influence (Figure 74). • If there is a presence of dolerite near MW07, then bicarbonate may be sourced from: ○ Silicate weathering of plagioclase feldspar in dolerite. ○ Carbonate dissolution within secondary alteration minerals in mafic rocks. ○ CO₂-rich groundwater interacting with MW07, further enhancing bicarbonate concentrations. • These differences suggest that MW07 is influenced by deeper groundwater, whereas the AQ pit's chemistry is more surface-driven.
Sulphate and pit wall contributions	• Sulphate concentrations are low in MW07 and the AQ pit (1–8 mg/L), suggesting arsenic is not sourced from sulphide oxidation. If arsenic were from pit wall weathering, higher sulphate and iron would be expected, but this is not observed across the lake (Figure 75). • MW07's arsenic is not correlated with TOC (~38 mg/L), while deeper pit lake water has higher TOC (~75 mg/L) (Figure 76). This suggests organic matter influences arsenic release in the pit lake but not in MW07. • These findings indicate that arsenic mobilisation in MW07 is geologically controlled, not from pit wall weathering, pit leakage or surface runoff.
Hydraulic connection likelihood	• MW07's water level (113.9 m AHD) is lower than the AQ pit lake (~116.5 m AHD), creating a 2.6 m hydraulic gradient. • However, given the weak gradient and contrasting water chemistry, there is no evidence of active flow between MW07 and the AQ pit. • MW07's higher bicarbonate, higher silica, and more oxidising conditions contrast with the AQ pit's lower bicarbonate, lower silica, and reducing conditions at depth. • These findings indicate MW07 is influenced by deeper groundwater sources rather than direct inflow from the pit lake.

Conclusions

1. MW07 and the AQ pit lake are unlikely to be hydraulically connected.
 - The 2.6 m hydraulic gradient is weak and does not indicate active groundwater flow.
 - Differences in water chemistry (bicarbonate, silica, redox conditions) suggest MW07 and the pit lake have difference sources.
2. Arsenic in MW07 is likely mobilised through silicate weathering, not sulphide oxidation or pit wall interactions.
 - High bicarbonate and silica suggest groundwater interaction with dolerite.
 - Low sulphate and iron do not support sulphide oxidation as a major source.
3. Microbial processes drive the pit lake's arsenic concentrations at depth (lower concentrations in shallow waters).
 - Higher TOC at depth (~75 mg/L) correlates with microbial iron reduction and As(III) release.
 - Surface runoff and organic matter appears to drive arsenic mobilisation at depth.
4. Further assessment is recommended to check and increase confidence in MW07's and potentially MW11's and MW12's geochemical controls, including:
 - Ongoing monitoring over 18-24 months to gauge the groundwater system's seasonal variability and longer-term trends.
 - Geology and isotopic analysis to verify arsenic sources in MW07.

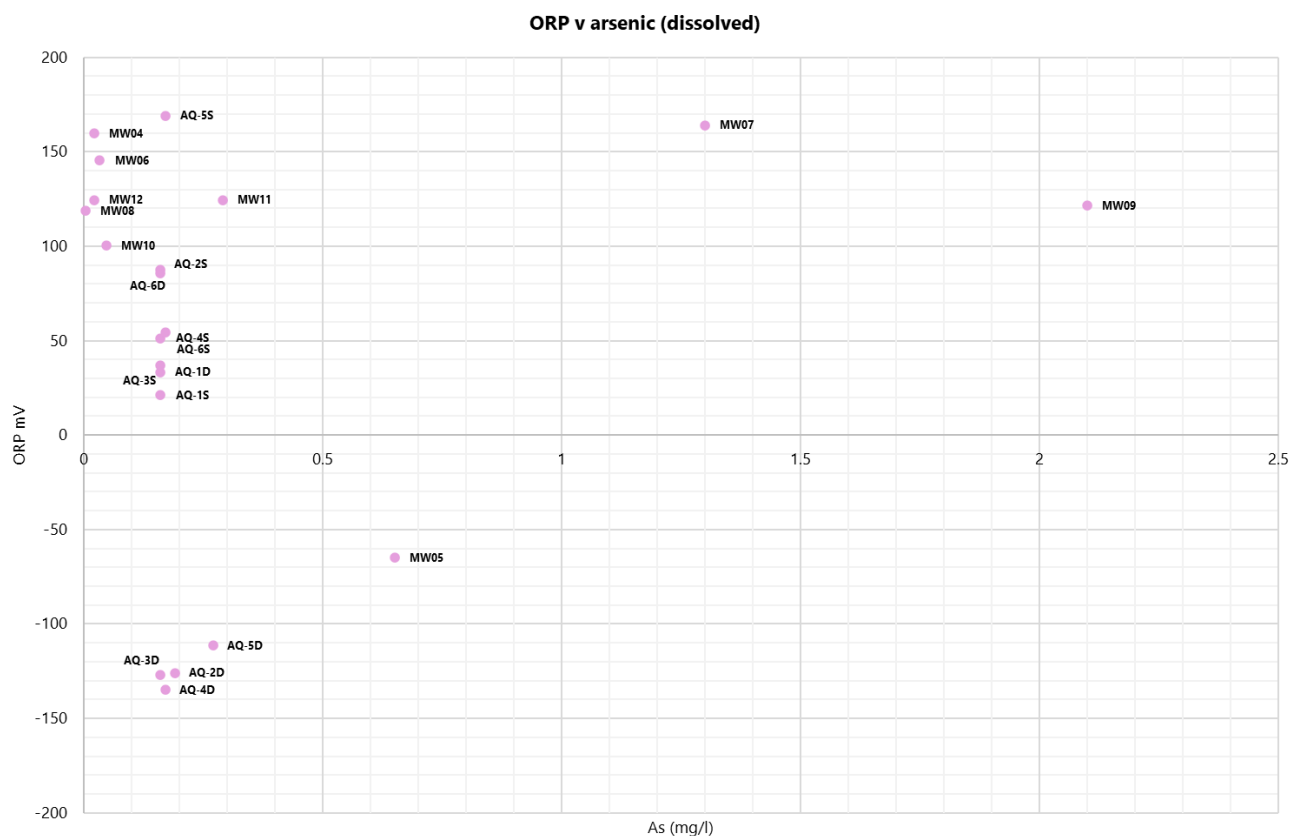


Figure 70 – Relationship of ORP to arsenic

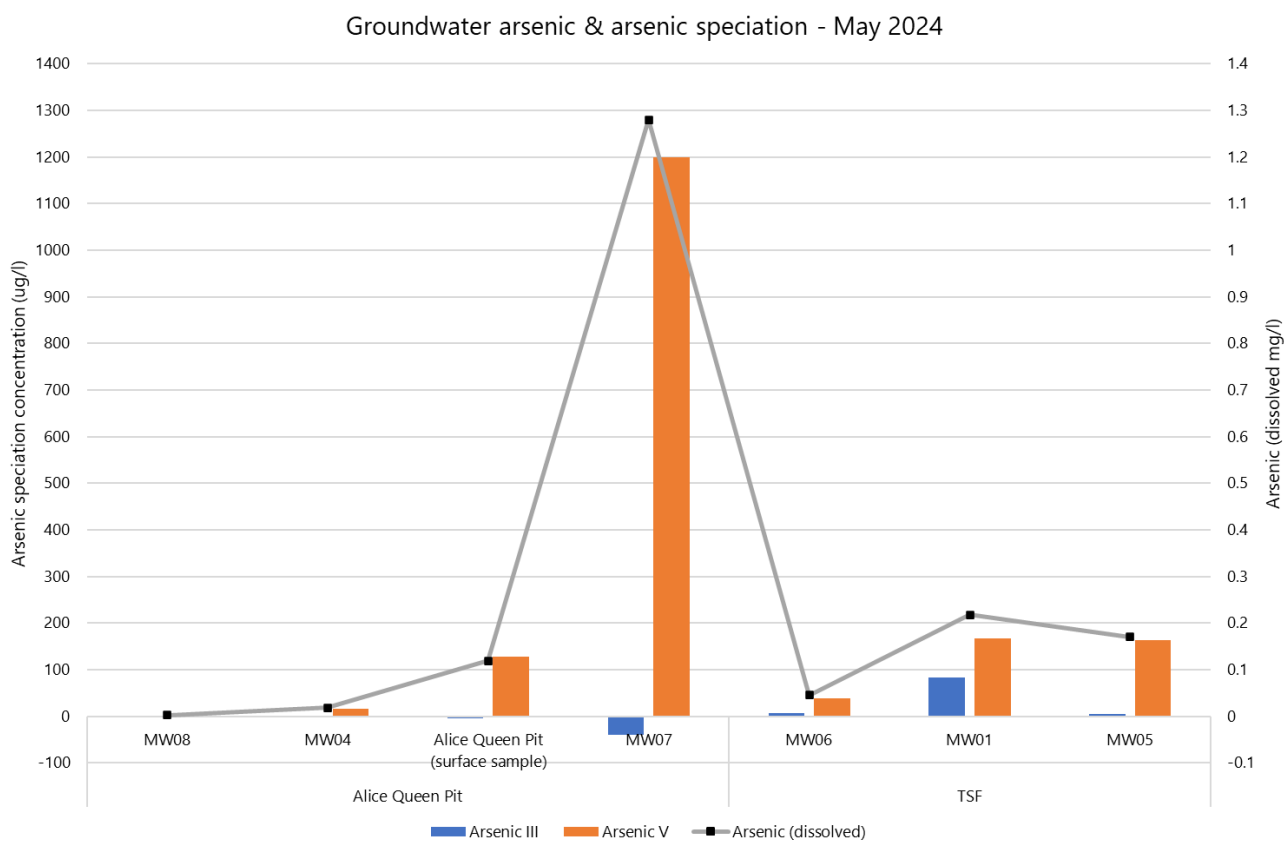


Figure 71 - Arsenic speciation - May 2024

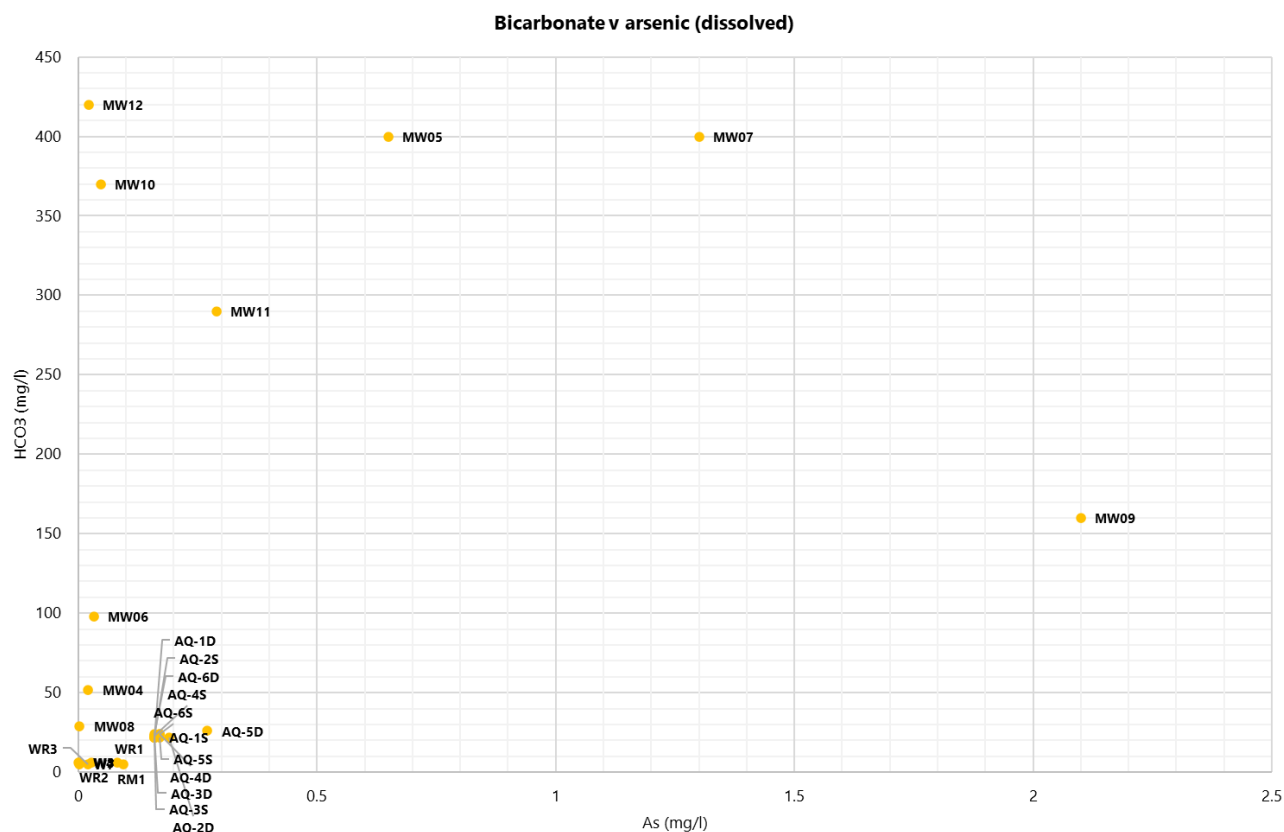


Figure 72 - Relationship of bicarbonate to arsenic

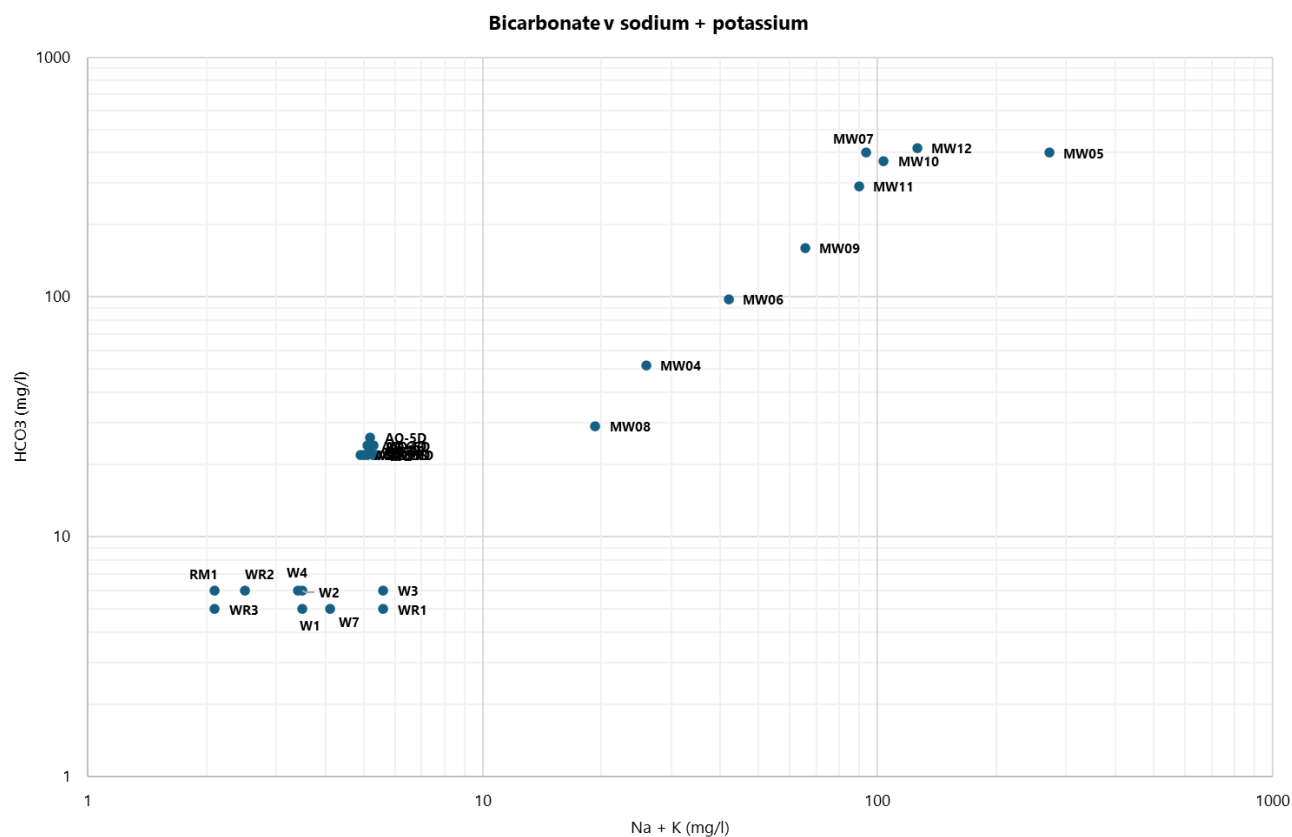


Figure 73 - Relationship of bicarbonate to sodium + potassium

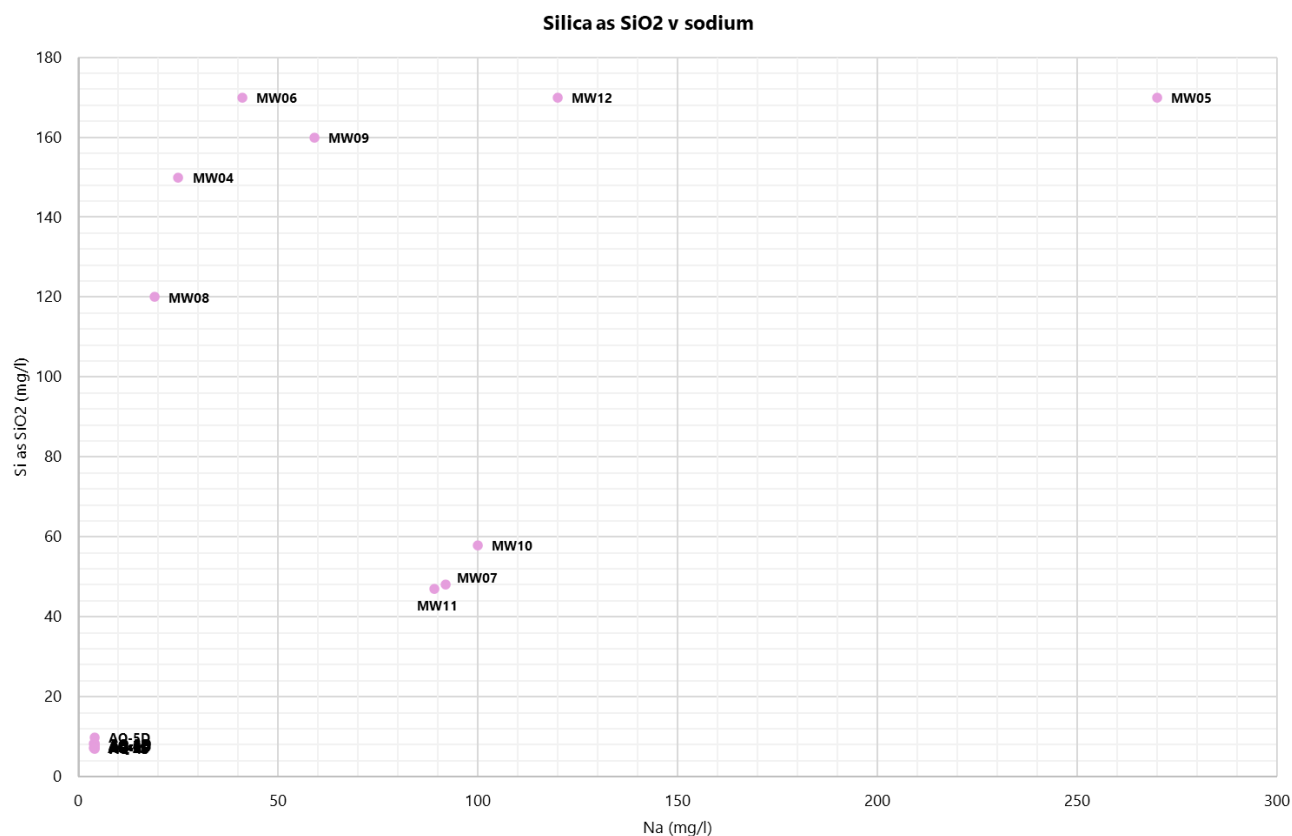


Figure 74 - Relationship of silica as SiO₂ to sodium

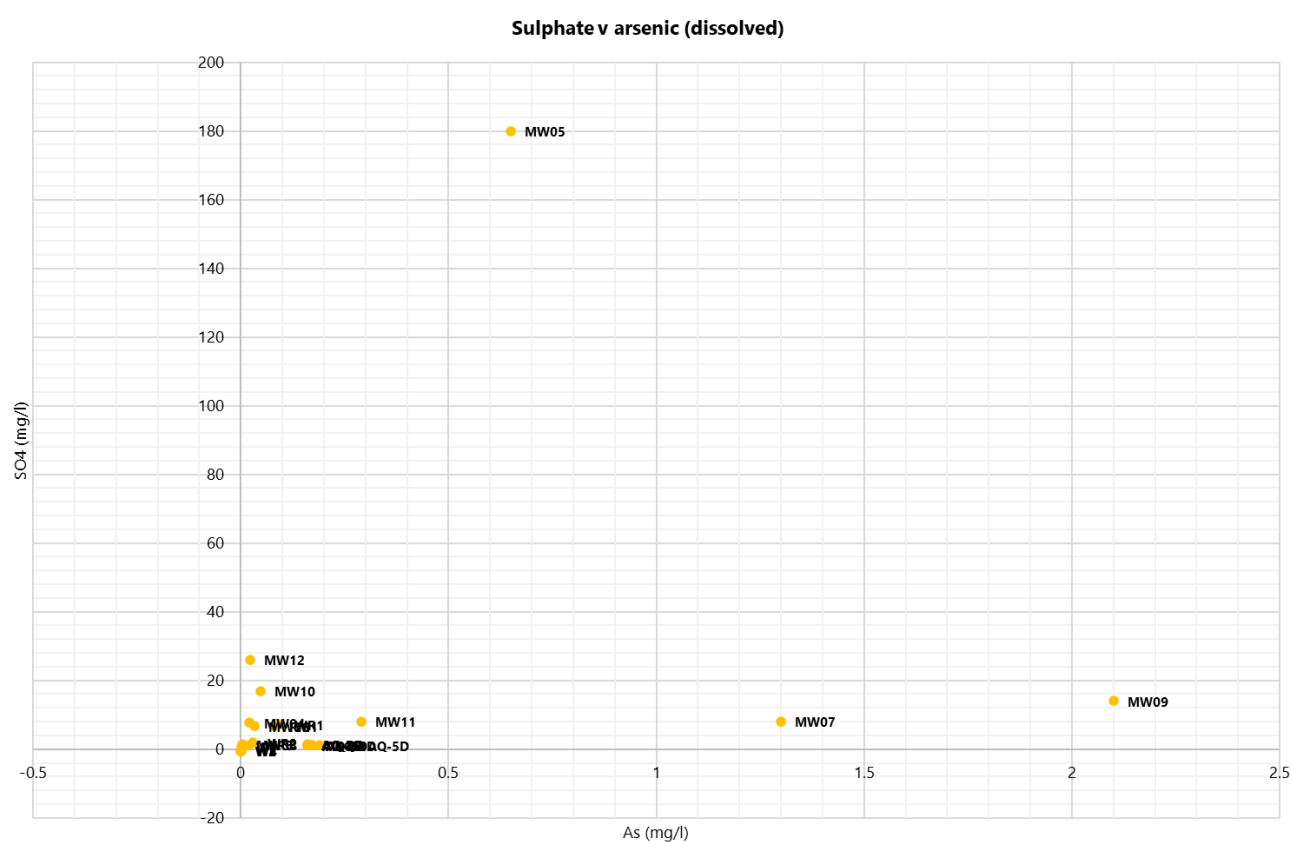


Figure 75 - Relationship of sulphate to arsenic

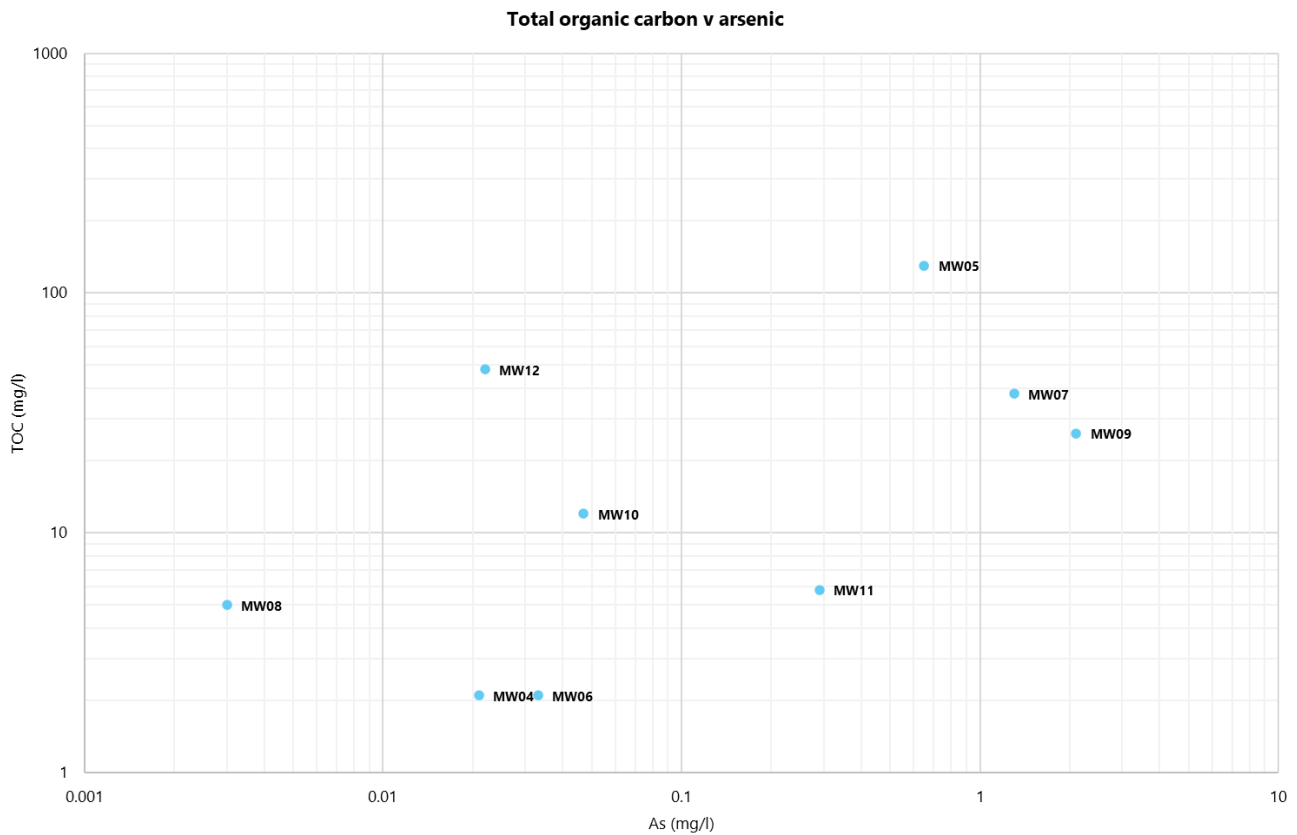


Figure 76 - Relationship of total organic carbon (TOC) to arsenic

4.1.5 Investigation: Arsenic sources and potential hydraulic connection between TSF, MW01 and MW05

Background

This investigation examines arsenic sources in MW05 and MW01, two groundwater monitoring locations near a historical tailings storage facility (TSF). MW05 is located across a tributary from the TSF (Figure 78), near limey sandstone outcrops, while MW01 is closer to One Mile Creek and is regularly flooded (not sampled in February 2025 due to flood). MW10, located upgradient of MW05, serves as a reference point for background groundwater conditions.

The objectives are to:

- Assess whether arsenic in MW05 and MW01 is influenced by TSF seepage or natural geochemical processes.
- Compare groundwater quality with MW10 (as a background bore upgradient of MW05 and the TSF) and W7 (creek sample) as potential sources.
- Evaluate key water chemistry parameters, including arsenic speciation, sulphate, bicarbonate, redox-sensitive elements, organic carbon, and associated metals (Sb, Pb, Cu, Zn, Sr).

Methodology

Water chemistry was assessed at MW05, MW01, MW10, and W7, with a focus on:

1. Arsenic and speciation:
 - Total arsenic, dissolved arsenic, and speciation (As(III)/As(V)) to assess mobility and oxidation state.
2. Geochemical indicators of arsenic mobilisation:
 - Sulphate and bicarbonate distinguish the TSF influence from carbonate weathering.



- Iron and manganese are redox-sensitive elements influencing arsenic mobility.
 - Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC) to evaluate microbial activity.
3. Associated metals (Fe, Mn, Sb, Pb, Cu, Zn, Sr):
- To assess potential TSF influence or natural sources.

Results

Area	Key findings
Arsenic trends and speciation	• MW05 has elevated dissolved arsenic (0.65 mg/L), predominantly as As(V) (194 µg/L) (Figure 70 & Figure 71, also see Figure 68 for AQ pit.). • MW10, upgradient of MW05, has lower dissolved arsenic (0.047 mg/L), mostly as As(V) (44 µg/L). • MW01 has no detectable dissolved arsenic, but total arsenic (370 µg/L), suggesting particulate-bound arsenic rather than dissolved arsenic. • W7, a creek sample, has very low dissolved arsenic (0.002 mg/L) and minimal As(III) (1 µg/L), confirming no significant arsenic transport to surface water. • Arsenic concentrations are highest in MW05 but remain in the oxidised (V) form, suggesting mobilisation through geochemical conditions rather than strong reductive dissolution from a source like the TSF.
General water chemistry and Redox indicators	• MW05 has higher EC (1200 µS/cm) and bicarbonate (400 mg/L) than MW10 (EC 620 µS/cm, HCO₃ 370 mg/L) and MW01 (EC 770 µS/cm, HCO₃ 309 mg/L). • MW05's sulphate (180 mg/L) is elevated, while MW10 has moderate sulphate (17 mg/L) and MW01 has low sulphate (5 mg/L), suggesting a geochemical source rather than TSF influence. • MW05's manganese (0.68 mg/L) is higher than MW10 (0.17 mg/L), but both iron and manganese remain low (0.04 mg/L in MW05, 0.18 mg/L in MW10). • MW05 has high TOC/DOC (130 mg/L), compared to MW10 (TOC 12 mg/L, DOC 11 mg/L), suggesting more active organic processes in MW05. • MW05 has slightly reducing conditions, evidenced by some manganese, but not fully reducing, as iron remains low and As V. High TOC/DOC suggests microbial activity, potentially influencing arsenic solubility (Oremland & Stolz 2003; Smelley & Kinniburgh 2002) (Figure 76).
Associated metals: antimony, lead, copper, zinc, and strontium	• Antimony is detected in MW05 (0.003 mg/L) but not in MW10, MW01, or W7. • Lead, copper, and zinc were not detected in MW05, MW10, MW01, or W7, further ruling out a TSF-related metal signal. • Strontium (0.21 mg/L in MW05 and 0.28 mg/L in MW10) suggests carbonate weathering as a contributing factor (Figure 77): MW05's chemistry aligns, suggesting a strong potential for natural carbonate interactions, and no clear TSF-related metal signature was observed as a system response.
Comparison to MW10 and W7	• MW10 has lower arsenic, bicarbonate, and sulphate than MW05, suggesting MW05 is experiencing additional geochemical effects. • W7 has very low arsenic (0.002 mg/L) and sulphate (0.6 mg/L), confirming localised arsenic in groundwater in MW05.

Conclusions

1. No strong evidence of TSF-related arsenic mobilisation has been identified at MW05 or MW01, but some uncertainties remain.
 - MW05 contains elevated dissolved arsenic (predominantly As(V)), with weak reductive dissolution.



- MW05's higher bicarbonate, strontium and sulphate, compared to MW10 and MW01, suggest geochemical interactions rather than TSF seepage.
 - MW01, closer to the TSF, lacks dissolved arsenic and has low sulphate, ruling out widespread TSF influence.
 - MW10 has arsenic and sulphate but at lower levels, suggesting a potential background of arsenic in groundwater, but with potential further mobilisation in MW05 by local groundwater processes.
 - W7 does not show arsenic or metal trends linking MW05 to surface water, suggesting no significant surface discharge.
2. Further assessment is recommended to refine these findings and reduce uncertainties.
- It is recommended that MW01, MW05, and MW11 be monitored continuously and surface water sampling along One Mile Creek and the northern tributary be conducted to capture seasonal variations and potential for other sources of water quality.
 - Installation of two additional wells:
 - On the south side of One Mile to MW05 as insurance for near TSF potential seepage.
 - Further down One Mile Creek near the REMP site as a final criterion well for closure and water quality leaving Alice Creek site.
 - Confirmation of sources to test and improve the confidence of sources, interactions and geology at MW01 and MW05, such as potential for:
 - Sulphate isotope analysis ($\delta^{34}\text{S}$, $\delta^{18}\text{O}$) to differentiate sulphate sources from natural and TSF-related inputs.
 - Strontium isotopes ($^{87}\text{Sr}/^{86}\text{Sr}$) to determine whether MW05's strontium aligns with carbonate rock sources or another influence.

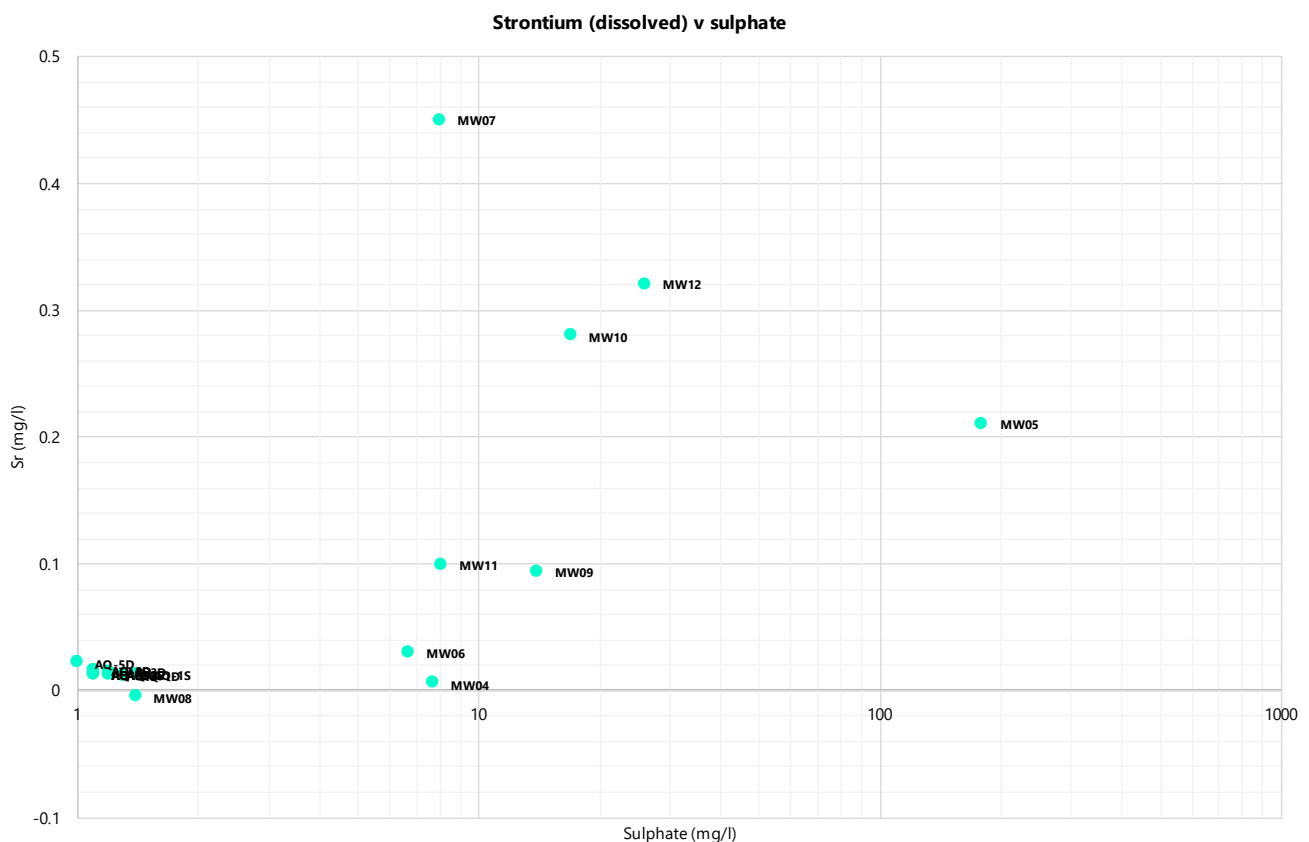


Figure 77 - Relationship of strontium to sulphate



Figure 78 - View of MW01 and MW05 with other landforms



4.2 Working conceptual water system model for Alice River site

4.2.1 Overview

The conceptual water system model for the Alice River site integrates groundwater, geology, surface water, geochemistry, and landform interactions to describe water movement, chemistry, and interactions with mining landforms. Since mining ceased over 20 years ago, the site has been relatively stable, allowing for an assessment of current hydrological and geochemical conditions.

The Alice River site presents several challenges due to its complex geology, historical mining legacy, and extreme climate conditions.

- Geology is highly variable, with mineralised structures that naturally contain arsenic-bearing minerals as a background state across other non-mineralised zones. This geology cuts across both the northern tributary and One Mile Creek, and it is foreseeable there may be a level of natural anomaly in sediments and surface water as a natural outcome (this is the process of stream sediment and water sampling used across the industry for exploration).
- The site has an extensive mining history, with past operations conducted under very different regulatory settings and practices. The current site has been mapped in detail to learn how the system behaves in the present day.
- Climate extremes create a water environment of extremes for the site: prolonged and substantial dry conditions dominate most of the year, punctuated by intense rainfall and flooding during the wet season.
- Groundwater is poorly developed, with limited connectivity and compartmentalisation.

Water at Alice River occurs within four key domains:

- Surface water (REMP monitoring locations) – One Mile Creek and the northern tributary are ephemeral, with flow driven by wet season rainfall.
- Runoff water (catchment-based flow) – Localised surface drainage from mining landforms and undisturbed terrain.
- Groundwater – Hosted in fractured granite, with movement controlled by structural features.
- Pit lake water – The Alice Queen Pit lake is a semi-isolated waterbody with limited interaction with groundwater.

Figure 79 illustrates how the conceptual water system works as a cross-section and diagram.

4.2.2 Water occurrence and flow

Water movement at Alice River is controlled by seasonal rainfall, with limited groundwater connectivity between different water types. Evaporation (~2,300 mm annually) significantly exceeds rainfall (~700–1,400 mm), creating a strongly net negative water balance that influences surface water availability and groundwater recharge potential.

Surface water (One Mile Creek and Northern Tributary)

Surface water is ephemeral, with flow occurring only after significant rainfall in the catchment above. One Mile Creek and the northern tributary act as losing streams, where water infiltrates into sandy alluvial sediments formed along the low-gradient drainage lines.

Monitoring at REMP sites indicates episodic variability in arsenic and other trace elements, particularly following rainfall events. These variations are consistent with a mineralised terrain, where natural geochemical contributions from weathered bedrock and shear zones are expected. However, distinguishing between natural background and potential mining-related influences requires ongoing monitoring.



Runoff and catchment-driven flow

Runoff follows site topography and modified drainage pathways. Key flow pathways include:

- Surface drains cut into access roads, particularly directing flow toward Alice Queen Pit.
- Localised ponding in depressions within the TSF following rainfall, and potential for overflows to be released from the TSF landform (fully vegetated) to the northern tributary.
- Runoff from waste rock areas, though no sustained changes in downstream water quality have been recorded.

Groundwater movement and hydraulic properties

Groundwater is hosted within a fractured granite system with low porosity and low hydraulic conductivity. It moves primarily along discrete structural pathways rather than through a continuous aquifer.

Key observations from monitoring bores include:

- Limited lateral connectivity, with groundwater movement restricted to fractures.
- The groundwater monitoring network is relatively new and requires further monitoring over different climatic conditions and time to assess natural variability and system responses.

Pit Lake water and potential connectivity

- The Alice Queen Pit Lake receives direct rainfall and local runoff, with limited groundwater inflow from the north, west and east. Water levels fluctuate 2–3 m annually, consistent with wet-season inflows and dry-season evaporation and an ongoing baseflow of water into the pit.
- MW07, located downgradient of the pit, does not appear to be hydraulic connected.
 - Pit lake chemistry is distinct from surrounding groundwater, but potential slow rock-water interactions require further characterisation.
 - Water level stability suggests limited hydraulic connectivity.
 - There is an absence of seepage or vegetation growth in One Mile Creek to suggest an ongoing seepage flow

4.2.3 Geochemistry

The Alice River site lies within a mineralised terrain, with a natural background of arsenic and other trace elements. Both natural geological conditions and historical mining activities influence geochemical processes.

General water quality observations

- The geochemical system appears relatively stable.
- pH remains neutral to slightly acidic (6–7) across all water domains.
- Sulphate concentrations are low (except MW05) with no strong evidence of active acid generation.
- Electrical conductivity (EC) is consistently low (<200 $\mu\text{S}/\text{cm}$).
- Variability in arsenic and metals appears to align with known nor likely mineralised zones but requires continued assessment.

Arsenic and trace metals

- MW09 confirms naturally elevated arsenic in groundwater, consistent with mineralised shear zones.
- MW07 and MW05 show elevated arsenic, which could reflect interaction with mineralised structures or slow-moving groundwater transport.



- Surface water occasionally records arsenic variability and requires further investigation.

4.2.4 Interaction of landforms (TSF, Alice Queen Pit) with water

Mining landforms influence local hydrology but do not exhibit clear, ongoing groundwater interactions. However, further monitoring is needed to confirm long-term trends.

Tailings Storage Facility (TSF)

- There is no active drainage or observed seepage around the TSF.
- Ponding occurs within depressions with the current landform state, which acts as a potential driver for percolation.
- While existing data suggests minimal TSF influence on groundwater, long-term monitoring remains necessary to confirm this trend. Planned rehabilitation will reshape the TSF to reduce infiltration potential.

Alice Queen Pit

- Pit lake levels are controlled by rainfall, runoff and evaporation, with no clear hydraulic connection to MW07.
- The pit lake appears to function largely as a closed system and will have ongoing monitoring to review across multiple seasons.
- Arsenic concentrations at depth in the pit lake are slightly higher than in groundwater but are stable and are driven by runoff from temporary waste rock areas, mineralised structure drainage and microbial processes occurring at depth. Microbial processes are breaking down organic material deposited in the pit from runoff and creek flood inflow, and the reducing conditions encourage arsenic to be in solution.
- Planned rehabilitation of moving the temporary WRD, and changed drainage

Other landforms (Waste Rock and ROM Areas)

- Runoff follows expected drainage patterns, with no clear groundwater impact observed.
- Planned rehabilitation of moving all historical stockpiles (WRD and ROM) to storage within the TSF will limiting interaction potential.



Alice River Conceptual Model As @ February 2025

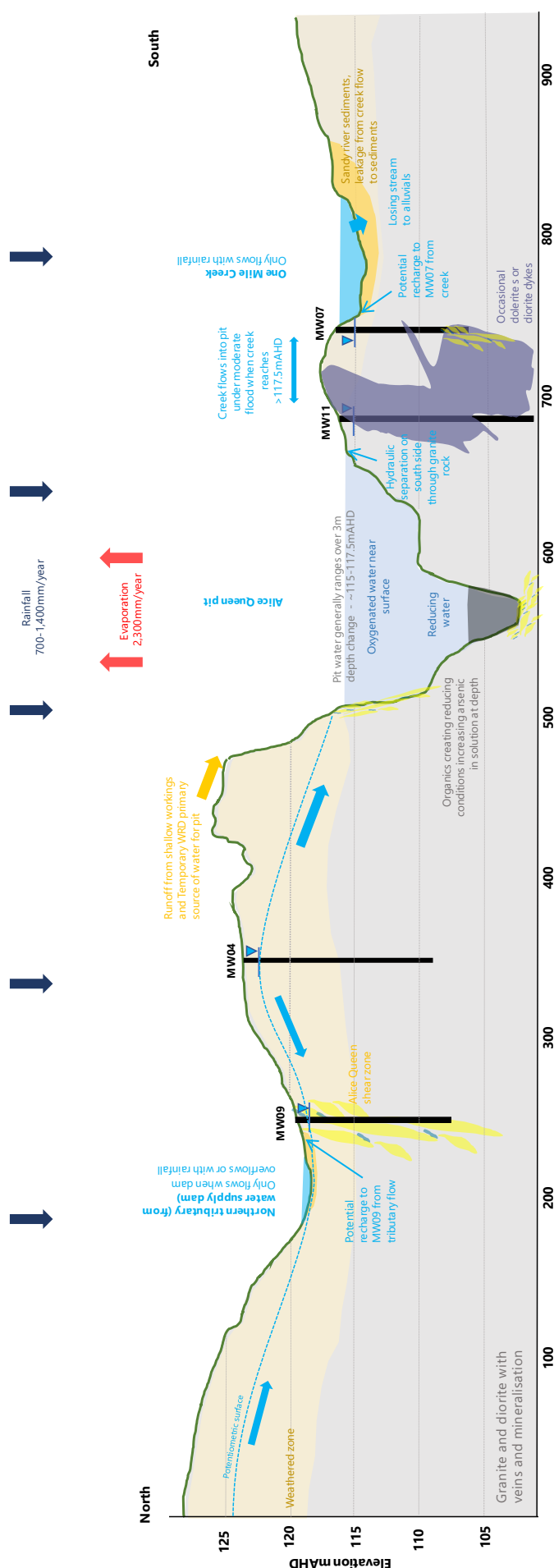


Figure 79 – Water system conceptual model for Alice River mine





5 Risk characterisation for water performance in progressive rehabilitation and closure

5.1 Framing water risks and harm potential at Alice River

The Alice River site has a small footprint, limited groundwater presence and movement, a natural background in some metals from geology, and ephemeral surface water flow. The key challenge for the definition of PRCP is distinguishing natural background conditions from mining-related impacts, ensuring that water quality criteria and monitoring milestones are both practical and protective of environmental values.

Several site-specific site conditions reduce the potential for water-related risks:

- Small-scale mining footprint (~660m x 230m) with low-relief TSF and pit landforms, limiting interaction with regional water systems.
- Ephemeral surface water system, with One Mile Creek flowing only after significant rainfall for short periods. When water is present, substantial flow volumes originate from higher in the catchment, meaning local site contributions are diluted within broader creek flows. However, the site experiences dry conditions and water scarcity most of the year.
- Localised, low-permeability geology consisting of crystalline granite and dolerite, with minimal groundwater in fractures and lithological contacts. Hydraulic conductivity is low (10^{-8} to 10^{-7} m/s), restricting groundwater mobility. Where groundwater is present, it is unlikely to travel due to hydraulic constraints.
- Natural mineralisation in host rocks across the site contributes to elevated background concentrations of arsenic, lead, copper, and other trace metals in some locations (e.g., MW09, MW10, and W1 monitoring sites).
- All water onsite interacts with weathered granite or dolerite, is stable within pH and stable and is low and stable sulphate and salinity.
- Metals on site are characterised as:
 - Not detected: Cadmium (Cd), mercury (Hg), chromium (Cr), cobalt (Co) and silver (Ag).
 - Detected at low levels under certain conditions or past events: Copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), lead (Pb), selenium (Se), strontium (Sr) and antimony (Sb), zinc (Zn).
 - Primary element of interest: Arsenic (As)
- AQ pit lake is a groundwater sink with minimal baseflow based on the potentiometric surface. Water levels and chemistry comparisons between MW07 and the pit lake indicate that the lake is primarily supplied by rainfall and runoff, with containment to the south.
- The TSF is heavily vegetated and low relief, with no visible seepage. While MW05 has elevated arsenic, MW01 does not. Initial assessments suggest arsenic originates from natural background sources (MW10 reference site), with local bore conditions influencing further mobility.

Conversely, certain site conditions may contribute to elevated water risks, requiring active management, including:

- Legacy infrastructure, including the historical WRD, ROM, temporary WRD, and historical platform, may contribute to sediment and metal loads via current drainage pathways.
- Flood conditions periodically flow into Alice Queen pit, introducing organic material that may increase arsenic mobility at depth. However, these flood inflows freshen and mix with the



shallow pit water depending on the flow magnitude. The pit is contained outside of flooding conditions (Engeny 2025, 2022b).

- Shallow ponding on the current TSF after rainfall may increase percolation through stored tailings, potentially mobilising soluble constituents.
- There is potential to discharge TSF pond overflow into the northern tributary and One Mile Creek, requiring controls to prevent offsite migration.

The site-specific conditions at Alice River define how water risks are managed within PRCP implementation. The natural background of some metals, low groundwater mobility, and ephemeral surface water conditions mean that closure criteria must:

- Differentiate natural background from mining-related influences,
- Establish practical and measurable monitoring milestones, and
- Ensure water performance remains stable within site-specific constraints.

The regulatory framework provides the basis for defining site-specific risks, monitoring strategies, and closure criteria. Table 11 outlines the key regulatory requirements relevant to water management at Alice River, ensuring alignment with progressive rehabilitation obligations.

Table 11 - Key regulatory water performance criteria

Regulatory requirement	Relevant criteria for Alice River	Reference
PRCP – Progressive Rehabilitation and Closure	• Water management must ensure stability, self-sustaining, non-polluting conditions. – • Pit lake must not become a long-term contamination source.	QLD PRCP Guidelines (2023)
Mitchell Basin Water Plan	• Rehabilitation must maintain natural surface water flow patterns. • No adverse impact on downstream water users. • Contaminant levels must remain within natural background variability.	QLD Mitchell Basin Water Plan (2007)
Queensland Rehabilitation Commissioner – Pit Lakes Guidance	• Pit lake must not present an ongoing environmental or safety risk. • Water quality must remain stable and not degrade over time. • Final landform must integrate with surrounding landscape and surface water flow pathways. • Pit lake closure criteria must be defined with measurable indicators.	QLD Rehabilitation Commissioner Guidelines (2022)



5.2 Water performance at closure

Table 12 - Water performance at closure risk and actions summary

Harm or impact	Potential pathway	Risk position	Actions for improvement
Groundwater contamination	General	Further groundwater monitoring is required to define the natural background and inform longer-term water quality criteria	- Short term: Continue groundwater monitoring across all bores for 18-24 months to capture natural variability - Milestone for closure: Determination of longer-term groundwater closure criteria
	Pit void and lake	- AQ pit lake is hydraulically contained and does not exhibit significant baseflow exchange. - Minimal connection between MW07 and the pit lake. - Arsenic and metals remain stable, consistent with background mineralisation.	- Short-term: Continue MW07, MW11, MW12 monitoring to confirm groundwater variability, including MW07 and pit water level logging. Update a pit lake water balance model to track long-term quality trends. - Closure: Post-mining land use as NUMA or stock water use.
	TSF seepage into groundwater	- The TSF is low-relief and heavily vegetated, with no visible seepage. - MW05 has elevated arsenic, but MW01 does not. - Initial assessments indicate natural arsenic background (MW10 reference) and local bore conditions driving further mobility.	- Short-term: Minimise TSF ponding and limit the potential for impacted waters to overflow. Maintain MW01, MW05, and MW10 monitoring for confirmation of long-term trends. Confirm geology in MW01 and MW05. Consider isotope testing to identify source rocks. Install an additional groundwater well downstream of the site or potentially on the south side of the creek from TSF. - Closure: Cover and convert into a water shedding, stable landform to reduce infiltration at closure.
Surface water contamination	General	Further surface water monitoring is required to define the natural background different source waters joining One Mile and inform longer-term water quality criteria	- Short term: Adapt surface water monitoring to identify and characterise potential different water and sediment sources and adapt EA requirements to practical frequency for the natural climate. - Milestone for closure: Determination of longer-term groundwater closure criteria
	Runoff from historical WRD, ROM, and platform	Drainage from legacy infrastructure may contribute to sediment and metal loads into surface water.	- Short-term: Relocate temporary WRD and historical ROM/WRD to improve water quality. - Closure: Implement erosion control measures and revegetation.
	Flood conditions increasing	One Mile Creek floods into the pit lake periodically, introducing	Short-term: Model flood-driven arsenic mobility scenarios under



Harm or impact	Potential pathway	Risk position	Actions for improvement
	arsenic mobility in pit lake	- organic material that may mobilise arsenic. - However, floodwaters freshen and mix with shallow pit water, stabilising overall conditions.	- flood flow as a mixing and REDOX model. - Closure: Define adaptive management triggers for water quality post-event.
	TSF ponding and overflow into the northern tributary	- Shallow ponding on the TSF after rainfall could increase percolation through tailings. - Potential overflow into the northern tributary and One Mile Creek, requiring controls.	- Short-term: Reduce water loading in TSF and modify drainage structures. - Closure: Establish long-term landform stability.
Hydrological changes and water resource depletion	Groundwater drawdown	- Groundwater is not regionally connected and not relied on by groundwater-dependent ecosystems (GDEs) (Engeny 2025) - Minimal potential for drawdown effects given no extraction and minimal groundwater present.	
	Surface water diversion	The final rehabilitated landform will modify flow paths, but overall hydrology is expected to stabilise post-rehabilitation.	

5.3 Water performance criteria and monitoring framework

Given the natural variability of host materials, land use, and the water system setting at Alice River, water performance criteria must be informed by site-specific data. This means recognising natural background conditions and identifying different sources or influences on water to distinguish between natural background variability and potential mining-related impacts.

In the short term, and considering the prevailing land use, it is recommended that the ANZG (2018) stock water guidelines be adopted as interim water quality criteria. At the same time, a site-specific derivation process following the Queensland Water Quality Guidelines (QWQG, 2009) will be used to establish final water quality thresholds. This will be based on monitoring data collected over 18–24 months to ensure the criteria are practical and reflective of site conditions for closure.

Water quality criteria and monitoring data will be reviewed at:

- 6–12 months – Initial assessment of expanded groundwater dataset.
- 18–24 months – Finalisation of site-specific water quality criteria.
- Post-closure reviews

Each review will evaluate:

- Changes in water quality trends and natural variability baselines.
- Long-term seepage risks from TSF and WRD.
- Hydrological stability of rehabilitated landforms.
- Potential for environmental harm downgradient from the site.
- Requirements for monitoring network and program to rationalise longer term monitoring once characterisation is reached where possible whilst maintaining effective and representative monitoring for water related risk.



Table 13 - Recommended water quality criteria and monitoring

Component	Locations	Frequency	Interim Water Quality Criteria (Adapted from ANZG 2018 – Stock Water Limits)
Groundwater	All monitoring bores, including additional well downstream (Figure 80)	Quarterly	pH: 6.5 – 8.5 EC: <5,000 µS/cm Arsenic: <500 µg/L Sulphate: <1,000 mg/L Metals (diss) (Al, Cu, Zn, Fe, Mn, Mo, Pb, Se, Sr, Sb): No increasing trend Cation/anions (Ca, Mg, Na, K, Cl, HCO₃, CO₃, SO₄). SiO₂ TOC, DOC
Surface water (One Mile Creek and northern tributary)	All updated locations (Figure 80) Compliance at W4	Seasonal (when flowing) based on event: - Initial flows - Peak flows - Ebbing flow Minimum of 6 samples per year unless drought year	Visual flow record pH: 6.0 – 8.5 EC: <1,000 µS/cm Arsenic: <100 µg/L Sulphate: <250 mg/L Metals (diss and total) (Al, Cu, Zn, Fe, Mn, Mo, Pb, Se, Sr, Sb): No increasing trend Cation/anions (Ca, Mg, Na, K, Cl, HCO₃, CO₃, SO₄). SiO₂ TOC, DOC
Pit lake quality	Surface and depth profile	Annually	pH: 6.5 – 7.5 EC: 200 – 500 µS/cm Arsenic: <500 µg/L Sulphate: <400 mg/L Metals (diss and total) (Al, Cu, Zn, Fe, Mn, Mo, Pb, Se, Sr, Sb): No increasing trend Cation/anions (Ca, Mg, Na, K, Cl, HCO₃, CO₃, SO₄). SiO₂ TOC, DOC
TSF and potential pit seepage (if present)	TSF embankment One Mile Creek	Annual inspections after wet season	Visual assessment of seepage and embankment stability

Note: The ANZG (2018) stock water limits have been adopted as interim groundwater criteria, reflecting the prevailing land use and expected low-density stock water consumption. These interim values will be reviewed and refined based on expanded site-specific monitoring data over the 18–24-month assessment period, ensuring alignment with QWQG (2009) and PRCP closure objectives.



Water monitoring network Existing and new/adjusted/proposed

PACGOLD



Figure 80 – Proposed updated surface water and groundwater monitoring network



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Appendix A – Summary of water monitoring obligations in current EA

Alice River - EA Water & Sediment Sampling AT-A-GLANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Surface water#												
Site water#*												
Groundwater												
Stream sediment												

Weekly during periods where site is discharging

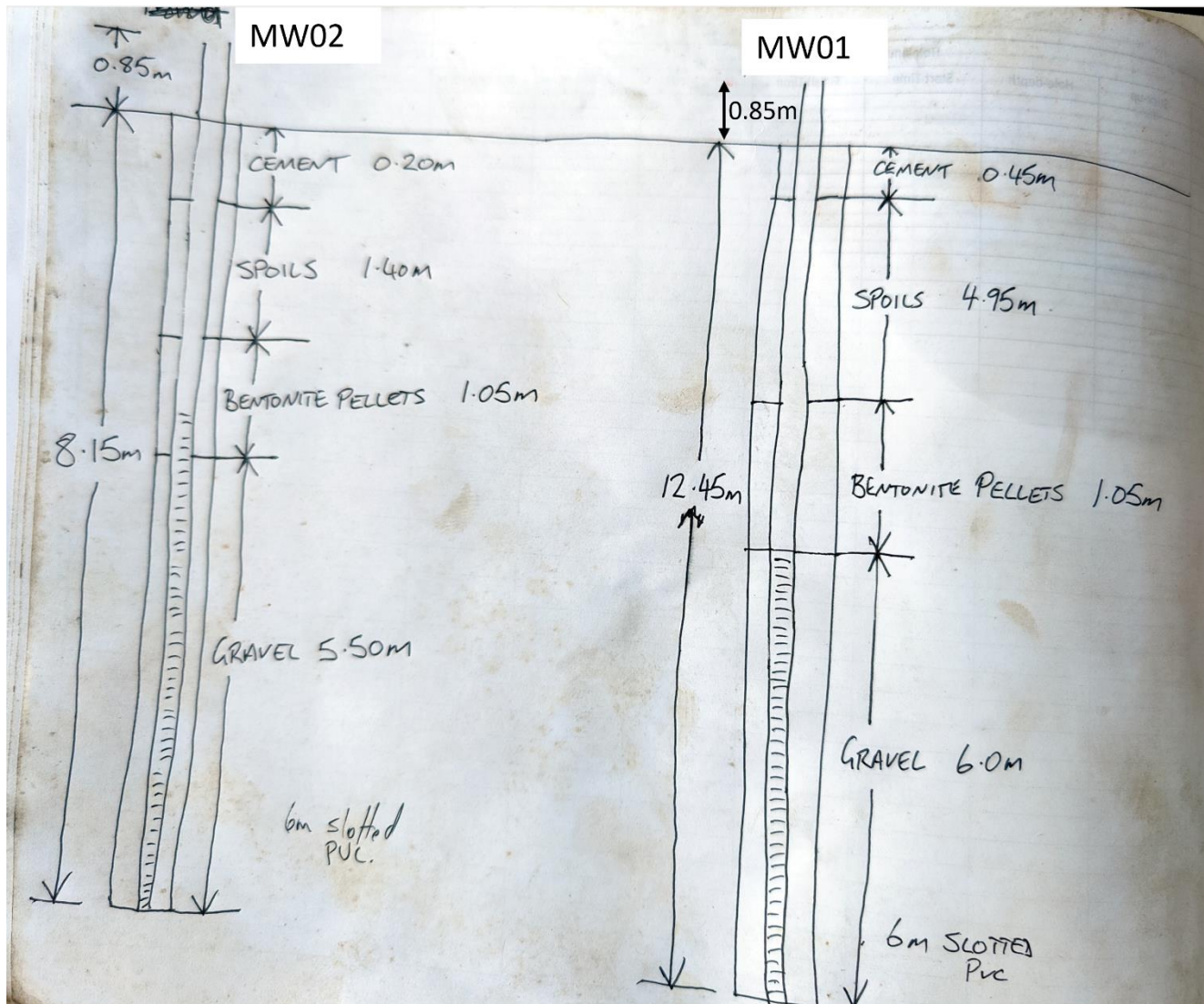
* Only TSF defined in EA

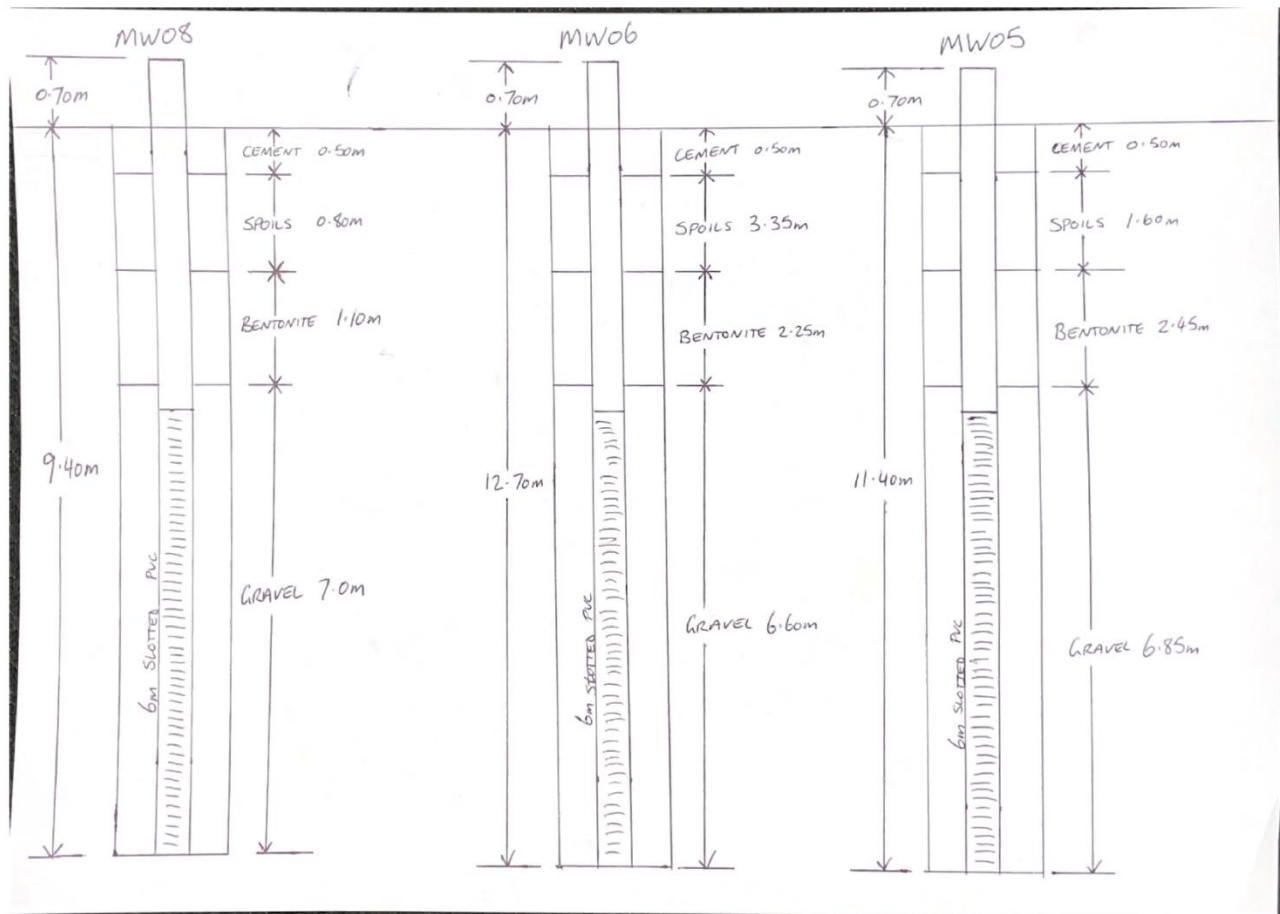
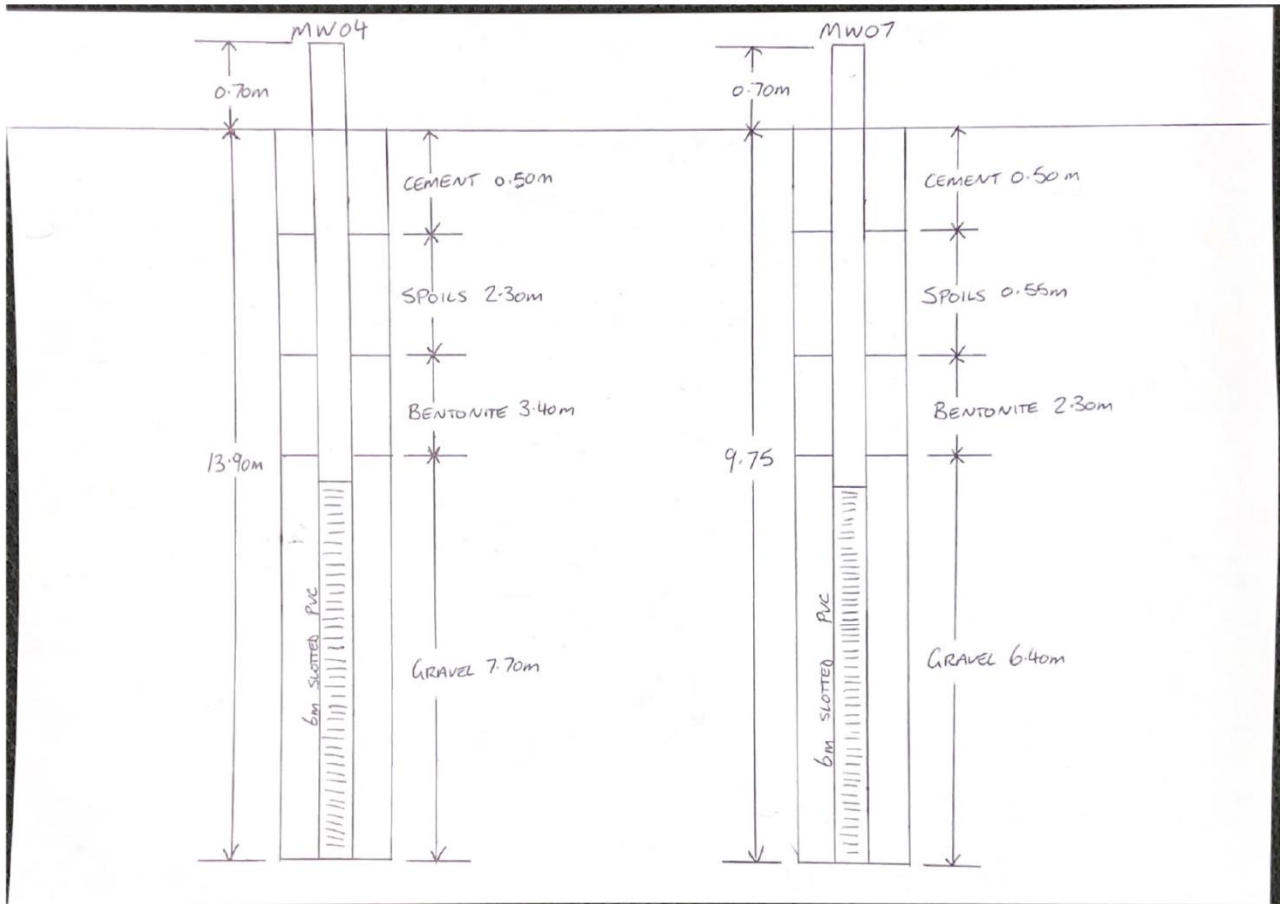
Purpose	Sites	Field analytes	Lab analytes
Compliance Quarterly	GW1 (MW01) GW2 (MW05) GW3 (MW08)	Groundwater level (standing from top of collar) pH Electrical conductivity (EC) Temperature	pH, EC (use field by preference) Sulphate Arsenic (As III, As V) Antimony Copper Zinc Lead Cyanide total
Supplement (not EA)	MW04 MW06 MW07 MW08	Flow state Dissolved oxygen (DO)	Arsenic dissolved Cobalt dissolved Molybdenum dissolved Nickel dissolved Manganese dissolved Iron dissolved Total organic carbon Total dissolved carbon
Compliance Twice per year	S1 S2	Nil	Once/year: Ca, Mg, K, Na, HCO ₃ , CO ₃ , Cl, Si, F Arsenic Cyanide Antimony Copper Lead Zinc
Supplement (not EA)	Nil	Nil	Nil

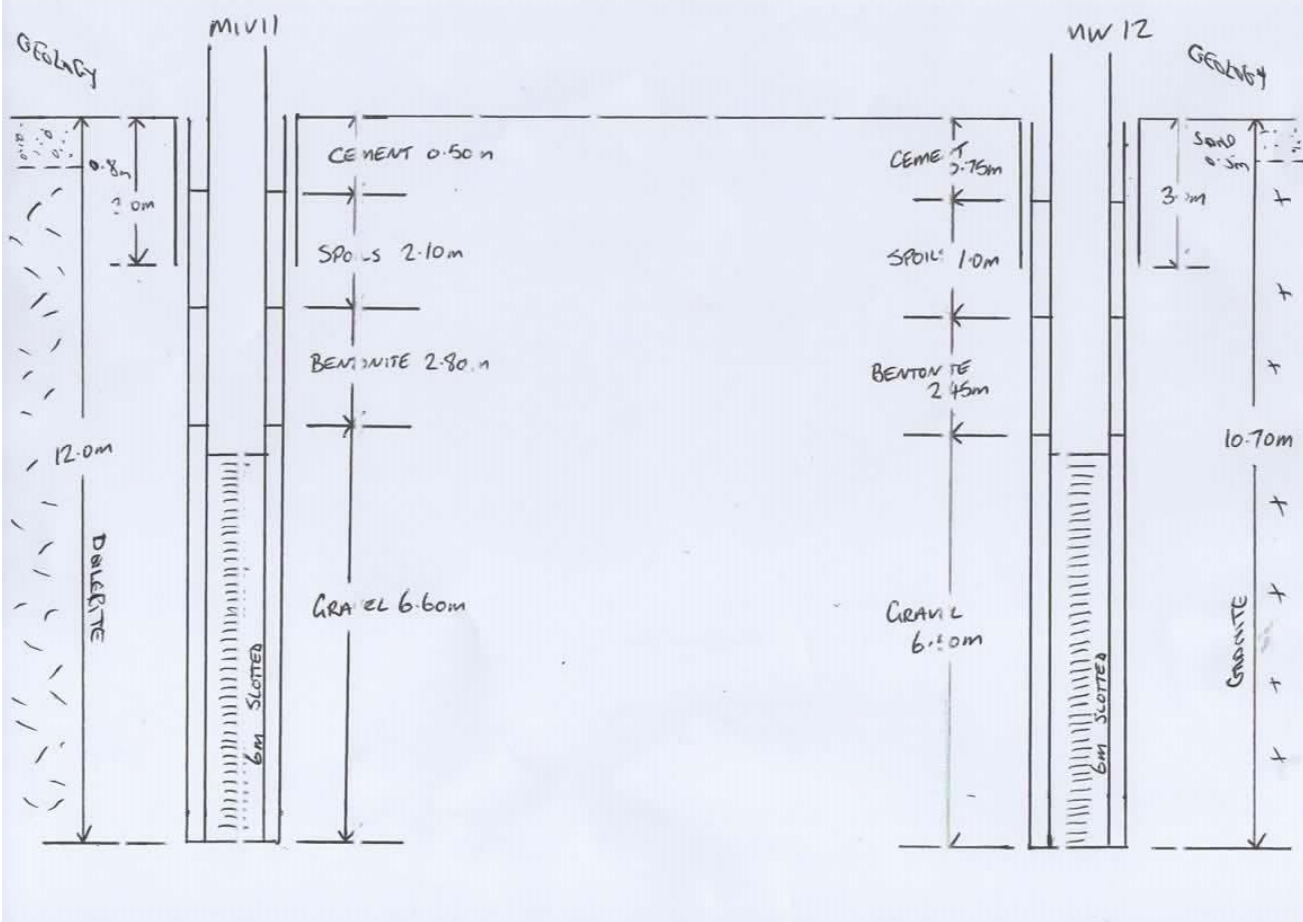
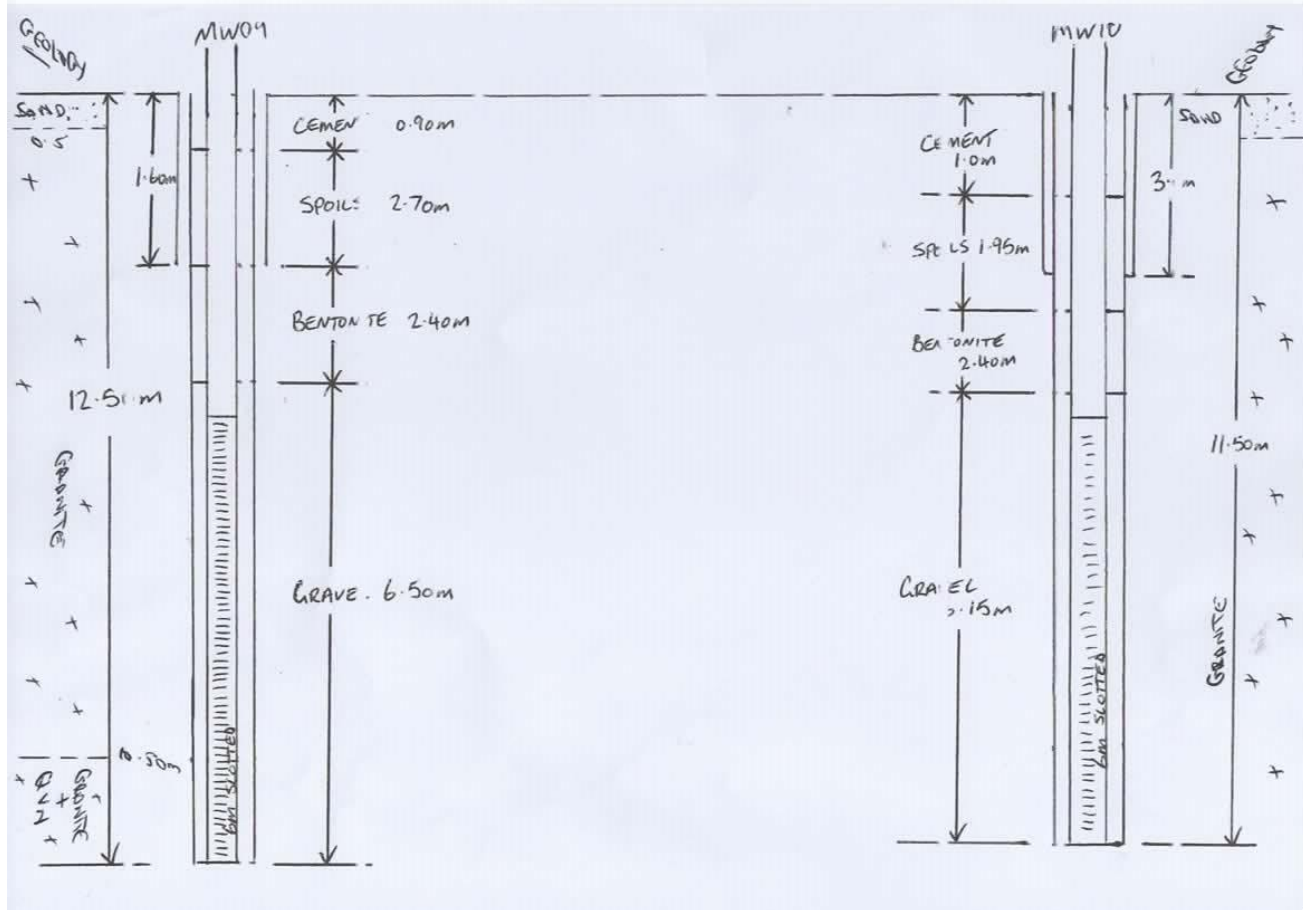
Purpose	Sites	Field analytes	Lab analytes
Compliance Monthly, weekly when discharging	Alice River leases W1 W2 W3 W4	pH Electrical conductivity (EC) Temperature	pH, EC (use field by preference) Dissolved Oxygen Turbidity Sulphate Arsenic speciation (As III, As V) Antimony Copper Zinc Lead Cyanide total
Supplement (not EA)	W5 W6 W7	Colour Flow state Dissolved oxygen (DO)	Arsenic total Cobalt total Molybdenum total Once/year: Ca, Mg, K, Na, HCO ₃ , CO ₃ , Cl, Si, F
Compliance Monthly	TSF TD1 and TD2	pH Electrical conductivity (EC) Temperature Colour Flow state	pH, EC (use field by preference) Dissolved Oxygen Turbidity Sulphate Arsenic speciation (As III, As V) Antimony Copper Zinc Lead Cyanide total
Supplement (not EA)	AQ Pit Freshwater dam	Colour Flow state Dissolved oxygen (DO)	Arsenic total Cobalt total Molybdenum total Once/year: Ca, Mg, K, Na, HCO ₃ , CO ₃ , Cl, Si, F



Appendix B – Bore construction logs & photos









Appendix C – Driller logs for MW09, MW10, MW11

Drill log form

Authorisation details
Registered number
Development permit number
Works reference number

Queensland Government
1043647

SECTION A – LOCATION DETAILS
Name of landholder
Alice River Mine
Postal address
Dive Road, Alice River Station Qld
Postal code
4982
Postal property description
Lot
119-713 AL
Plan
or Bore location GPS
Latitude
Longitude
Easting
745205.8
North
829284.7
Datum
Zone

SECTION B – BORE COMPLETION DETAILS
Date commenced
19/12/24
Date completed
19/12/24
SECTION C – DRILLING METHOD
☐ Rotary mud
☐ Cable tool
☐ Auger
☒ Rotary air

SECTION D – HOLE SIZE
Diameter (mm)
120.6
From
0
To
12.5m
SECTION E – CASING DETAILS
Type
PVC, steel etc
Size O.D. (mm)
60.35
Wall thickness (mm)
1.1
Location (metres)
From
0
To
6.5
SECTION F – CENTRALISERS TYPE
Type
KULF 210
Location (metres)
From
Every 3m
To

SECTION G – PERFORATIONS / SLOTS / SCREENS
Type
Size O.D. (mm)
Aperture (mm)
Location (metres)
From
To
SECTION H – CEMENTING / GRAVEL PACK / ANNUAL FILL DETAILS
Type
Hole diameter (mm)
Casing diameter (mm O.D.)
Location (metres)
From
To
SECTION I – PARTICULARS OF STRATA
Strata description (use more than one line if required)
SAND
GRANITE
Water bed (m³)

SECTION J – WATER BEARING BEDS
Depth struck (metres)
Water rose to (metres)
Supply (litres/second)
Quality (e.g. potable, brackish, salty)
SECTION K – SUB-ARTESIAN BORE ON COMPLETION
Depth to standing water level from ground level (metres)
Depth to pump suction or bottom of drill stem (metres)
Type of test used
☐ Est. supply (litres/second)
☐ Duration of test (hours)
☐ Drawdown level from surface (metres)
☐ Pressure (kPa)
☐ Free flow (litres/second)
☐ Temperature (°C)

SECTION L – REMARKS
DRY BORE
Shallow
Monitoring
SECTION M – CERTIFICATION
I hereby certify that the bore is drilled and constructed according to the conditions of my driller's licence and the information provided in sections A to E and section H above is true, accurate and complete to the best of my knowledge and belief.
Driller
Damen Wenzel
Driller's Licence No.
3331
Trainee
Brendan Turner
Driller's Licence No.
Signature of Driller
Date
19/12/24
Contractor
Centuria Drilling

While – forward to the Department of Environment and Resource Management. Pink – provide to landholder. Blue – Driller to retain.

Information being collected in this form will be used by this department for the purpose of processing your drill log form to record your water bore drilling activity under the authority of section 313 of the Water Act 2000. Your personal details will be accessed only by authorised officers within this department. I will not be disclosed to any other third party without your consent, except where required by law. The information collected will be retained as required by the Public Records Act 2002 (Qld) and may be stored in a departmental database. For more information on the department's privacy commitment, please visit www.dem.qld.gov.au/privacy.

03/09/2010 #28874



Drill log form

Authorisation details

Registered number Development permit number

Works reference number

Queensland Government

1043646

SECTION A—LOCATION DETAILS

Name of landholder Alice River Mine

Phone No.

Postal address

Real property address Dixie Road, Alice River Station Old

Postcode 4982

Real property description Lot

Plan 113.996 RL

or Bore location GPS. Latitude

Easting 7446886 Northing 8292875

Datum

SECTION D—HOLE SIZE

Diameter (mm) From 120.6 To 11.5

SECTION I—BORE PURPOSE

☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial ☐ Urban ☐ Industrial ☐ Other (please specify) Mounding

SECTION E—CASING DETAILS

Type PVC, steel Size O.D. (mm) Wall thickness (mm) Location (metres) From To

PVC 60.35 1.5 11.5

SECTION F—CENTRALISERS TYPE

Type Kwikzid Location (metres) From To

Kwikzid Every 3m

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type Size O.D. (mm) Aperture (mm) Location (metres) From To

PVC 60.35 1 8.05 11.5

SECTION H—CEMENTING/ GRAVEL PACK/ ANNULAR FILL DETAILS

Type Hole diameter (mm) Casing diameter (mm O.D.) Location (metres) From To

CEMENT 120.6 60.35 11.5 7m

Grout 120.6 60.35 7m 6m

Grout 120.6 60.35 6m 0

SECTION K—WATER BEARING BEDS

Depth struck (metres) Water rose to (metres) Supply (litres/second) Quality (e.g. potable, brackish, salty)

SECTION L—SUB ARTESIAN BORE ON COMPLETION

Depth to standing water level from drill stem (metres) Depth to pump suction or bottom of ground level (metres)

Type of test used Est. supply (litres/second) Duration of test (hours) Drawdown level from surface (metres)

Pressure (kPa) Free flow (litres/second) Temperature (°C)

SECTION M—ARTESIAN BORE ON COMPLETION

Pressure (kPa) Free flow (litres/second) Temperature (°C)

SECTION N—REMARKS

py Shallow Bore.

SECTION O—CERTIFICATION

I hereby certify that the bore is drilled and constructed according to the conditions of my driller's licence and the information provided in sections A to E and section H above is true, accurate and complete to the best of my knowledge and belief.

Driller Daniel Broadbent's Licence No. 3331

Trainee Braden Driller's Licence No.

Signature of Driller Turner Date 21/12/24

Contractor Carter Drilling

White — forward to the Department of Environment and Resource Management. Pink — provide to landholder. Blue — Driller to retain.

Information being collected in this form will be used by this department for the purpose of processing your drill log form to record your water bore drilling activity under the authority of section 313 of the Water Act 2002. Your personal details will be accessed only by authorised officers within this department at www.derm.qld.gov.au/privacy.



Drill log form

Authorisation details
Registered number

Development permit number

Works reference number

MW 11

Queensland
Government

1043645

SECTION A - LOCATION DETAILS

Name of landholder

Alice River Mine

Phone No.

Postal address

Real property address Dixie Road, Alice River Station Qld

Postcode 4982

Real property description Lot

Plan 119-895 AL

or Bore location GPS, Latitude

Eastings 745221.2

Longitude

Datum 8252875

SECTION B - BORE COMPLETION DETAILS

Date commenced 19/12/24

Date completed 19/12/24

SECTION C - DRILLING METHOD

☐ Rotary mud

☐ Cable tool

☐ Auger

☒ Rotary air

SECTION D - HOLE SIZE

Diameter (mm)

From 0 To 12

SECTION I - BORE PURPOSE

☐ Domestic

☐ Stock

☐ Irrigation

☐ Commercial

☐ Other (please specify)

Montgomery Bore

SECTION J - PARTICULARS OF STRATA

Strata description

(use more than one line if required)

Topsoil Sandy

Water bed

(m)

SECTION K - WATER BEARING BEDS

Depth struck (metres)

Water rose to (metres)

Supply (litres/second)

Quality (e.g. potable, brackish, salty)

Conductivity (EC)

pH

SECTION L - SUB ARTESIAN BORE ON COMPLETION

Depth to standing water level from drill stem

Depth to pump suction or bottom of drill stem

Type of test used

Est. supply (litres/second)

Duration of test (hours)

Drawdown level from surface (metres)

Pressure (kPa)

Free flow (litres/second)

Temperature (°C)

SECTION M - ARTESIAN BORE ON COMPLETION

Pressure (kPa)

Free flow (litres/second)

Temperature (°C)

SECTION N - REMARKS

Day Bore Shallow monitoring use.

SECTION O - CERTIFICATION

I hereby certify that the bore is drilled and constructed according to the conditions of my driller's licence and the information provided in sections A to E and section H above is true, accurate and complete to the best of my knowledge and belief.

Driller: Daniel Woodruff's Licence No. 3351

Trainee Driller: Brenden Turner

Driller's Licence No. 3351

Signature of Driller: Brenden Turner

Date: 23/12/24

Contractor: Centurion Drilling

White - forward to the Department of Environment and Resource Management. Pink - provide to landholder. Blue - Driller to retain.

Information being collected in this form will be used by the department for the purpose of processing your drill log form to record your water bore drilling activity under the authority of section 313 of the Water Act 2002. Your personal details will be accessed only by authorised officers within this department and will not be disclosed to any other third party without your consent except where required by law. The information collected will be retained as required by the Public Records Act 2002 (Qld) and may be stored in a departmental database. For more information on the department's privacy commitment, please visit www.derm.qld.gov.au/privacy.

03/09/2010 #28874



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MW08



MW09



MW10



MW11



MW12





Appendix D – Geology map series legend

SYMBOL	LITHOLOGY SUMMARY
Dgr	Undifferentiated miscellaneous granitoids; low magnetisation (S-types?)
Dgyl	Pale grey to buff or white, sparsely porphyritic to equigranular, muscovite-biotite granite, garnet-muscovite granite and garnet-biotite-muscovite leucogranite; pegmatite, apfite
Dgab	Medium to dark grey equigranular biotite monzogranite
Dggh	Medium to dark grey equigranular to slightly porphyritic biotite monzogranite
Dgpe	Dark grey, equigranular biotite monzogranite, extremely weathered
Dgwb	Medium to dark grey equigranular biotite monzogranite
Dgww	Medium to dark grey equigranular biotite monzogranite, extremely weathered
Dgyw	Dark grey sparsely to moderately porphyritic biotite-hornblende granodiorite
Dgpc	Grey, fine grained, equigranular to sparsely porphyritic muscovite biotite granite
Dgbu	Pale grey equigranular muscovite-biotite granite. Forms prominent boulders
Dgsu	Pale grey to buff equigranular muscovite-biotite granite, weakly foliated in places
Dgdx	White to pale buff, coarse, very uneven-grained to seriate or weakly porphyritic biotite-garnet-muscovite leucogranite
Dge	White to pale cream or pink garnet-biotite-muscovite leucogranite, pegmatite, and apfite
Dgy	Very pale grey to white muscovite-biotite to biotite-muscovite granite and leucogranite; pegmatite, apfite
Dgg	Pale grey to buff equigranular muscovite-biotite granite (muscovite poor), garnet-muscovite leucogranite; pegmatite, quartz and zoned microgranite-pegmatite veins and pods
Dgk	Pale grey to cream or brown, even-grained to slightly porphyritic biotite-muscovite granite, locally garnet-bearing, K-feldspar phenocrysts typically 2-4cm long, moderately deformed
Dgme/2	Pale grey to white, uneven-grained biotite-muscovite leucogranite (felsic phase)
Dgme/1	Pale grey to white, uneven-grained biotite-muscovite leucogranite to muscovite-biotite granite, abundant metasedimentary enclaves (mafic phase)
Dgmh	Pale grey to buff or white, sparsely porphyritic to equigranular, muscovite biotite granite, garnet muscovite granite, and garnet biotite muscovite leucogranite; pegmatite, apfite
Dgw	Pale grey to buff, equigranular muscovite-biotite granite; commonly foliated; abundant aligned K-feldspar phenocrysts in the south
Dgm	Medium grey, porphyritic, fine medium-grained garnet-muscovite-biotite granite, prominent quartz phenocrysts 5-10mm
Dgs	Pale grey to cream, abundantly porphyritic muscovite-biotite granite
SDgk	Pale to mid-grey, fine-grained, muscovite-biotite granite
Eed	Saccharoidal quartzite interbedded with muscovite-quartz slate and phyllite, graded bedding in places
Ece/2	Metamorphic rocks, high magnetisation
Ece/1	Metamorphic rocks, medium magnetisation
Ebl	Biotite-muscovite-quartz schist with graphite, sillimanite, garnet, andalusite, K-feldspar, staurolite, chloritoid, tourmaline and kyanite (very rare); quartzite bands in south, mica-feldspar gneiss in east, phyllite in northwest
Egl	Muscovite quartzite, sillimanite-muscovite-quartz schist, andalusite, garnet or graphite locally
En	Grey to purple thin-bedded slate, sandy slate and green metasediments with rippled bedding, quartzite in southeast, locally tourmaline-mica schist, garnet, andalusite, chloritoid, staurolite
Er	Dark grey medium-grained equigranular hornblende-feldspar amphibolite; discordant greenish black metabasalt, metadolomite, tremolite/actinolite or hornblende amphibolite, with garnet, chlorite, talc, ilmenite, chromite
Era	Dark grey medium-grained equigranular hornblende-feldspar amphibolite
Et	Cream saccharoidal quartzite interbedded with crenulated garnet-muscovite phyllite and spotted slate; local cordierite, garnet; grades into garnet-andalusite-biotite-muscovite schist
Pa	Grey slate, locally spotted, metasediments, ripple cross-laminated metasediments, some fine graphite-muscovite schist with biotite, ilmenite and tourmaline; andalusite-staurolite-mica-quartz schist, garnet-graphite-mica schist, flaggy muscovite-quartz psammite, phyllite
Eaf	Andalusite-staurolite-mica-quartz schist, garnet-graphite-mica schist, flaggy muscovite-quartz psammite, phyllite schist, metadolomite in places
Eaf	Grey, fine to medium-grained andalusite-graphite-mica-quartz schist, garnet-graphite-mica schist, flaggy muscovite-quartz psammite, muscovite-biotite phyllite schist with interbedded minor quartzite
Es	Purple to cream quartzite, thick bedded, locally graded, minor slate and phyllite sequence coarsens upwards, purple, brown, pink mica quartzite, psammite muscovite-biotite schist (rare garnet), sillimanite(?) - mica-quartz schist and andalusite, cordierite(?), graphite
Esk	Purple, brown, pink mica quartzite, psammite muscovite-biotite schist (rare garnet), sillimanite(?) - mica-quartz schist; andalusite, graphite in places
Ese	Light olive grey, fine to medium-grained muscovite-biotite schist, partly medium-grained andalusite-garnet-biotite-muscovite schist interbedded with minor quartzite (low mica content)
Eh/2	Grey, medium to coarse-grained (garnet) muscovite-biotite schist and gneiss; some quartzite and sillimanite-mica schist; gneissic areas commonly associated with pegmatite
Ed	Grey sillimanite(?) - graphite-mica schist, commonly quartzose, relic andalusite and cordierite
Edh/1	Grey silver muscovite-biotite schist, sillimanite-mica schist, muscovite-garnet gneiss; some graphite-mica schist and quartzite
Edh/2	Grey sillimanite(?) - graphite-mica schist, commonly quartzose, relic andalusite and cordierite
Ewb	Muscovite biotite quartz gneiss, foliation common, garnet rare, locally andalusite sillimanite muscovite quartz schist, rare quartzite, amphibolite. Intruded by and interlayered with muscovite (biotite) granite, mylonite in places

GEOLOGICAL SYMBOLS					
TOPOGRAPHICAL AND CULTURAL SYMBOLS					



Appendix E – GAI values and ratios

		50th	95th	5th	Average element crustal abundance	Count	Ratio	GAI
Au_ppm	Gold	0.02	1.19	0.005	0.004	11494	297.5	8.216745858
Ag_ppm	Silver	0.06	0.71	0.02	0.075	11405	9.466666667	3.242856524
Al_pct	Aluminium	6.87	7.69	3.51	0.0823	11298	93.43863913	6.545947357
As_ppm	Arsenic	48.2	1365	1.7	1.8	11405	758.3333333	9.566688329
Ba_ppm	Barium	600	1080	170	425	11405	2.541176471	1.345496566
Be_ppm	Beryllium	2.15	3.3775	1.3	2.8	11405	1.20625	0.270528942
Bi_ppm	Bismuth	0.1	0.58	0.02	0.0085	11405	68.23529412	6.092446249
Ca_pct	Calcium	0.58	2.27	0.06	0.0415	11298	54.69879518	5.773437151
Cd_ppm	Cadmium	0.03	0.15	0.01	0.1	11405	1.5	0.584962501
Ce_ppm	Cerium	45.6	74.375	18.45	66	11405	1.126893939	0.172351739
Co_ppm	Cobalt	0.7	8.075	0.4	25	11405	0.323	-1.63039393
Cr_ppm	Chromium	4	25	2	102	11298	0.245098039	-2.028569152
Cs_ppm	Cesium	7.31	14.75	2.65	3	11405	4.916666667	2.297680549
Cu_ppm	Copper	1.5	11.875	0.6	60	11405	0.197916667	-2.337034987
Fe_pct	Iron	1.11	2.81	0.77	0.0563	11298	49.91119005	5.641291398
Ga_ppm	Gallium	18.1	22.2	11.3	19	11405	1.168421053	0.224560258
Ge_ppm	Germanium	0.11	0.25	0.025	1.5	11405	0.166666667	-2.584962501
Hf_ppm	Hafnium	1.1	2	0.5	3	11405	0.666666667	-0.584962501
Hg_ppm	Mercury	0.016	0.048	0.0025	0.085	1689	0.564705882	-0.824428435
In_ppm	Indium	0.036	0.065	0.015	0.05	11267	1.3	0.378511623
K_pct	Potassium	2.98	3.86	1.24	0.0209	11298	184.6889952	7.528954095
La_ppm	Lanthanum	22.1	36	8.8	39	11405	0.923076923	-0.115477217
Li_ppm	Lithium	29.9	102	9.9	20	11405	5.1	2.350497247
Mg_pct	Magnesium	0.14	0.75	0.06	0.0233	11298	32.1888412	5.008488736
Mn_ppm	Manganese	188	586	76	950	11405	0.616842105	-0.697026849
Mo_ppm	Molybdenum	0.74	2.23	0.23	1.5	11405	1.486666667	0.572081209
Na_pct	Sodium	0.57	2.41	0.04	0.0236	11298	102.1186441	6.674102477
Nb_ppm	Niobium	6.5	10.9	2.9	20	11405	0.545	-0.875671865
Ni_ppm	Nickel	1.1	10.1	0.4	84	11405	0.120238095	-3.056034035
P_ppm	Phosphorus	360	610	100	1050	11298	0.580952381	-0.78350818
Pb_ppm	Lead	29.5	37.9	11.6	14	11405	2.707142857	1.436771021
Rb_ppm	Rubidium	146	206	66	90	11405	2.288888889	1.194647431
Re_ppm	Rhenium	0.001	0.001	0.001	0.0007	11405	1.428571429	0.514573173
S_pct	Sulfur	0.07	0.5982	0.01	0.00035	11298	1709.142857	10.73905727
Sb_ppm	Antimony	10.9	102	1.38	0.2	11403	510	8.994353437
Sc_ppm	Scandium	3.5	9.6	1.4	22	11405	0.436363636	-1.196397213
Se_ppm	Selenium	0.5	1	0.5	0.05	11405	20	4.321928095
Sn_ppm	Tin	1.1	2.6	0.4	2.3	11405	1.130434783	0.176877762
Sr_ppm	Strontium	85.2	253	22.5	370	11405	0.683783784	-0.548387886
Ta_ppm	Tantalum	0.4	0.91	0.14	2	11405	0.455	-1.13606155
Te_ppm	Tellurium	0.025	0.08	0.025	0.001	11405	80	6.321928095
Th_ppm	Thorium	7.8	13.55	3.1425	9.6	11405	1.411458333	0.497186541
Ti_pct	Titanium	0.047	0.244	0.02	0.0066	11298	36.96969697	5.208271313
Tl_ppm	Thallium	0.79	1.14	0.43	0.85	11405	1.341176471	0.423499078
U_ppm	Uranium	1.9	4.2	0.8	2.7	11405	1.555555556	0.637429921
V_ppm	Vanadium	2	49	1	120	11298	0.408333333	-1.292180751
W_ppm	Tungsten	2.1	8.1	0.7	1.25	11405	6.48	2.695993813
Y_ppm	Yttrium	8.6	20.4	4.2	33	11405	0.618181818	-0.693896872
Zn_ppm	Zinc	47	94	20	70	11405	1.342857143	0.425305835
Zr_ppm	Zirconium	32	66.6	14.21	165	11402	0.403636364	-1.308871942



Appendix F – Pit lake photos for level reconciliations

Date	Pit level	Basis
3/10/2021	115.75	Estimate from drone image
5/07/2022	116.5	Estimate from photo/pit contours
23/11/2024	115.4	Estimate from photo/pit contours
13/12/2024	115.5	Estimate from photo/pit contours
11/02/2025	116.5	Estimate from photo/pit contours

DTM contours & 3 October 2021 (drone photo)





July 2022



November 2024





December 2024



11 February 2025 (water 6" up on boat after these photos)





Appendix G – Pit water quality chemistry results

Site	AQ-15	AQ-10	AQ-25	AQ-20	AQ-35	AQ-30	AQ-45	AQ-55	AQ-50	AQ-65	AQ-60
Date	10-Dec-24	10-Dec-24	10-Dec-24	10-Dec-24	10-Dec-24	10-Dec-24	10-Dec-24	10-Dec-24	10-Dec-24	10-Dec-24	10-Dec-24
Time	1845	1849	1617	1230	1811	1819	1712	1741	1439	1516	1908
Total depth	8.20	8.20	12.30	12.30	10.60	10.60	8.70	10.35	10.35	5.60	4.50
Depth of sample	1.50	7.00	1.50	7.50	1.50	7.50	1.50	7.50	1.50	7.50	1.50
Easting											
Northing											
Temp (C)	32	30.1	31.9	28.5	31.9	28.4	31.9	28.5	31.8	28.3	32
DO-m/L	117.3	117.3	117.3	2.3	117.3	2.5	117.3	2.4	117.3	2.1	116.8
DO-mg/L	8.6	8.59	8.59	0.18	8.64	0.2	8.6	0.19	8.5	0.17	8.54
SPC-µs/cm	45.1	46.2	45.8	54.6	45.1	57.3	45.5	57.9	44.6	56.8	45.4
TDS-mg/L	29	30	30	35	29	37	30	38	29	37	30
pH	8.53	6.49	8.35	5.83	8.54	5.98	8.59	6.04	8.14	5.88	8.46
ORP (mV)	21.3	33.4	87.6	-125.9	36.8	-126.9	51.3	-135	169.2	-111.3	54.2
Turbidity (NTU)	-0.29	3.71	-0.21	12.46	-0.31	13.6	-0.28	12.82	-0.28	12.8	-0.29
Colour	Clear	Clear	Clear	Mostly clear slight brown	Clear	Clear	Clear	Overall clear, slightly brown	Clear	Slight brown grey	Clear
Comments		Sample taken at 7m, medium stinky	Moved to shallower water closer to shore	Nutrients taken (glass bottle), Weakly smelly			Major stinky		Smelly	Smelly like eggs	Sample taken at 4.5m, no smell
pH**	7.1	6.9	7.3	7.2	7.2	6.9	7.2	7.0	7.3	6.7	7.3
Conductivity @ 25 C	µS/cm	43	44	43	45	45	45	44	51	44	42
Dissolved Oxygen	mg/L	7.6	4.8	7.7	4.4	8.0	4.1	8.7	4.4	9.0	8.0
Dissolved Oxygen (percent saturation)	%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Turbidity	NTU	3.4	2.9	2.1	6.6	2.8	5.4	2.4	7.8	2.6	17
Total Sulphur, S	mg/L	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4
Total Sulphur as Sulfate, SO4	mg/L	1.4	1.3	1.3	1.2	1.2	1.2	1.1	1.0	1.1	1.0
Total Zinc	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc, Zn	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Sb	mg/L	0.005	0.005	0.005	0.004	0.005	0.004	0.005	0.004	0.005	0.005
Total As	mg/L	0.16	0.18	0.16	0.21	0.17	0.22	0.17	0.22	0.17	0.17
Total Copper	mg/L	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Lead	mg/L	0.001	0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	0.036	0.015
Diss Sb	mg/L	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.005	0.004
Diss As	mg/L	0.16	0.16	0.16	0.19	0.16	0.16	0.16	0.17	0.27	0.16
Lead, Pb	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	0.003
Copper, Cu	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Cyanide	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Sample Subcontracted	No unit	See attached	See attached	See attached	See attached	See attached	See attached	See attached	See attached	See attached	See attached
Ammonia Nitrogen, NH3 as N	mg/L	N.A.	N.A.	N.A.	0.13	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Nitrate/Nitrite Nitrogen, NOx as N	mg/L	N.A.	N.A.	N.A.	0.006	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Nitrate Nitrogen, NO3 as N	mg/L	N.A.	N.A.	N.A.	<0.005	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Nitrite Nitrogen, NO2 as N	mg/L	N.A.	N.A.	N.A.	<0.005	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Total Kjeldahl Nitrogen	mg/L	N.A.	N.A.	N.A.	0.49	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Total Nitrogen (calc)	mg/L	N.A.	N.A.	N.A.	0.50	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Organic Nitrogen (calc)	mg/L	N.A.	N.A.	N.A.	0.38	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Total Phosphorus (Kjeldahl Digestion) as P	mg/L	N.A.	N.A.	N.A.	0.11	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Filterable Reactive Phosphorus as P	mg/L	N.A.	N.A.	N.A.	0.039	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Total Organic Carbon as NPOC	mg/L	N.A.	N.A.	N.A.	NVL	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Dissolved Organic Carbon as NPOC (passing 0.45um filter)	mg/L	N.A.	N.A.	N.A.	NVL	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
pH**	7.1	6.9	7.3	7.2	7.0	6.9	7.2	7.0	7.3	6.7	7.3
Conductivity @ 25 C	µS/cm	43	44	42	45	43	45	45	44	51	44
Dissolved Oxygen	mg/L	7.6	4.8	7.7	4.4	8.0	4.1	8.7	4.4	9.0	8.0
Turbidity	NTU	3.4	2.9	2.1	6.6	2.8	5.4	2.4	7.8	2.6	17
Total Sulphur, S	mg/L	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4
Total Sulphur as Sulfate, SO4	mg/L	1.4	1.3	1.3	1.2	1.2	1.2	1.1	1.0	1.1	1.0
Total Zinc	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Aluminum	mg/L	0.32	0.60	0.20	0.46	0.28	0.50	0.15	0.33	0.19	0.84
Total Barium	mg/L	0.056	0.073	0.052	0.068	0.053	0.077	0.051	0.070	0.053	0.094
Total Boron	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Iron	mg/L	0.13	0.27	0.08	0.51	0.09	0.48	0.08	0.49	0.08	1.2
Total Manganese	mg/L	0.009	0.039	0.006	0.15	0.007	0.16	0.006	0.15	0.006	0.52
Total Silicon, Si	mg/L	3.6	3.9	3.4	3.9	3.5	3.9	3.3	3.4	4.6	3.4
Total Silicon as Silica, SiO2	mg/L	7.6	8.4	7.3	8.2	7.5	8.4	7.3	7.9	7.2	9.9
Total Calcium	mg/L	1.6	1.7	1.5	1.8	1.6	1.9	1.5	1.9	1.5	2.5
Total Magnesium	mg/L	0.8	0.9	0.8	0.9	0.8	1.0	0.8	0.9	0.8	1.2
Total Sodium	mg/L	4.1	4.1	4.1	3.9	4.0	4.1	4.1	4.0	3.8	4.0
Total Potassium	mg/L	1.2	1.3	1.1	1.1	1.1	1.2	1.1	1.2	1.1	1.2
Total Organic Carbon as NPOC	mg/L	N.A.	N.A.	N.A.	0.49	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Dissolved Organic Carbon as NPOC (passing 0.45um filter)	mg/L	N.A.	N.A.	N.A.	0.38	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Total Alkalinity as CaCO3	mg/L	22	22	23	1.5	22	22	23	24	22	26
Bicarbonate Alkalinity as CaCO3	mg/L	22	22	23	1.5	22	22	23	24	22	26
Carbonate Alkalinity as CaCO3	mg/L	<5	<5	<5	1.5	<5	<5	<5	<5	<5	<5
Hydroxide Alkalinity as CaCO3	mg/L	<5	<5	<5	1.5	<5	<5	<5	<5	<5	<5
Total Hardness	mg CaCO3/L	7	8	7	8	7	8	7	11	7	11
Fluoride by ISE	mg/L	<0.1	<0.1	<0.1	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride, Cl	mg/L	3	3	3	1.5	3	3	3	3	3	3
Silicon, Si	mg/L	3.1	3.1	3.1	3.2	3.1	3.2	3.0	3.2	3.1	3.6
Soluble Silicon as Silica, SiO2	mg/L	6.7	6.7	6.6	6.9	6.6	6.9	6.5	6.9	6.6	7.7
Total Antimony	mg/L	0.005	0.005	0.005	0.004	0.005	0.004	0.005	0.004	0.005	0.005
Total Arsenic	mg/L	0.18	0.18	0.16	0.21	0.17	0.22	0.17	0.22	0.17	0.30
Total Copper	mg/L	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Lead	mg/L	0.001	0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.010	<0.001	0.036
Total Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001
Total Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Cobalt	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Mercury	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Total Molybdenum	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Nickel	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Selenium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Strontium	mg/L	0.015	0.015	0.014	0.018	0.015	0.018	0.015	0.019	0.015	0.025
Total Uranium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Vanadium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Bismuth	mg/L	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Tungsten	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Tin	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Aluminum, Al (dissolved)	mg/L	0.02	0.02	0.02	<0.02	0.02	<0.02	0.02	0.03	<0.02	0.02
Antimony, Sb (dissolved)	mg/L	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.005	0.004
Arsenic, As (dissolved)	mg/L	0.16	0.16	0.16	0.19	0.16	0.16	0.16	0.17	0.27	0.16
Silver, Ag (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth, Bi (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium, Ba (dissolved)	mg/L	0.048	0.052	0.048	0.060	0.049	0.059	0.048	0.061	0.048	0.082
Boron, B (dissolved)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Copper, Cu (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Cd (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium, Cr (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt, Co (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury (dissolved)	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Iron, Fe (dissolved)	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese, Mn (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum, Mo (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001						



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Appendix E. Landholder Agreements

The landholders of the Alice River Station (the underlying landholder) have provided written agreement for the retention of certain improvements to the land. A redacted version of this agreement is provided below. The unredacted version has been provided electronically to the DES.

Alice River Station
[REDACTED]

Cairns QLD 4892
[REDACTED]

28 June 2017

Tinpitch Pty Ltd
C/- UTM Global
GPO Box 1661
Brisbane, QLD, 4001

To Tinpitch Pty Ltd, holders of Mining Leases 2901, 2902, 2907, 2908, 2957, 2858, 3010 and 3011.

We the landholders of Alice River Station, [REDACTED] agree that certain improvements made by past mining operators/owners at the Alice River Gold Mine, be left on the property after the cessation of mining. These improvements include access tracks, haul roads, flat areas around the old plant, cement slabs (except the slab under the plant which should be removed), flat benches on the waste rock dumps and the Alice Queen open-cut (which should be made safe for cattle and personnel).

Your faithfully,

[REDACTED]

Mr. S Goodwin
Sustainability Manager
Pacgold Ltd
Level 38, 71 Eagle Street,
Brisbane QLD 4000

Dear Shane,

Regarding: Alice River ML's Progressive Rehabilitation and Closure Plan for ML3010

Following our recent discussions regarding the Progressive Rehabilitation and Closure Plan (Plan) for the Alice River Mining Leases, we agree that the Tailings Dam located on ML3010 is not immediately suitable for stock mainly due the slope on the northern dam wall. Therefore we wish to provide consent that in accordance with the Plan, the Tailings Dam is backfilled with the waste dumps (near the camp gate), fenced, and seeded for grasslands. The fenced area of the dam covers an area of 2.75Ha.

We would like to draft a formal agreement with Pacgold at the appropriate time to cover details of the management of the Tailings Dam area, including cost of fencing (if the current fence needs maintaining, repairing or replacing), the cost of the seeding and the ongoing monitoring of the fencing and dam area.

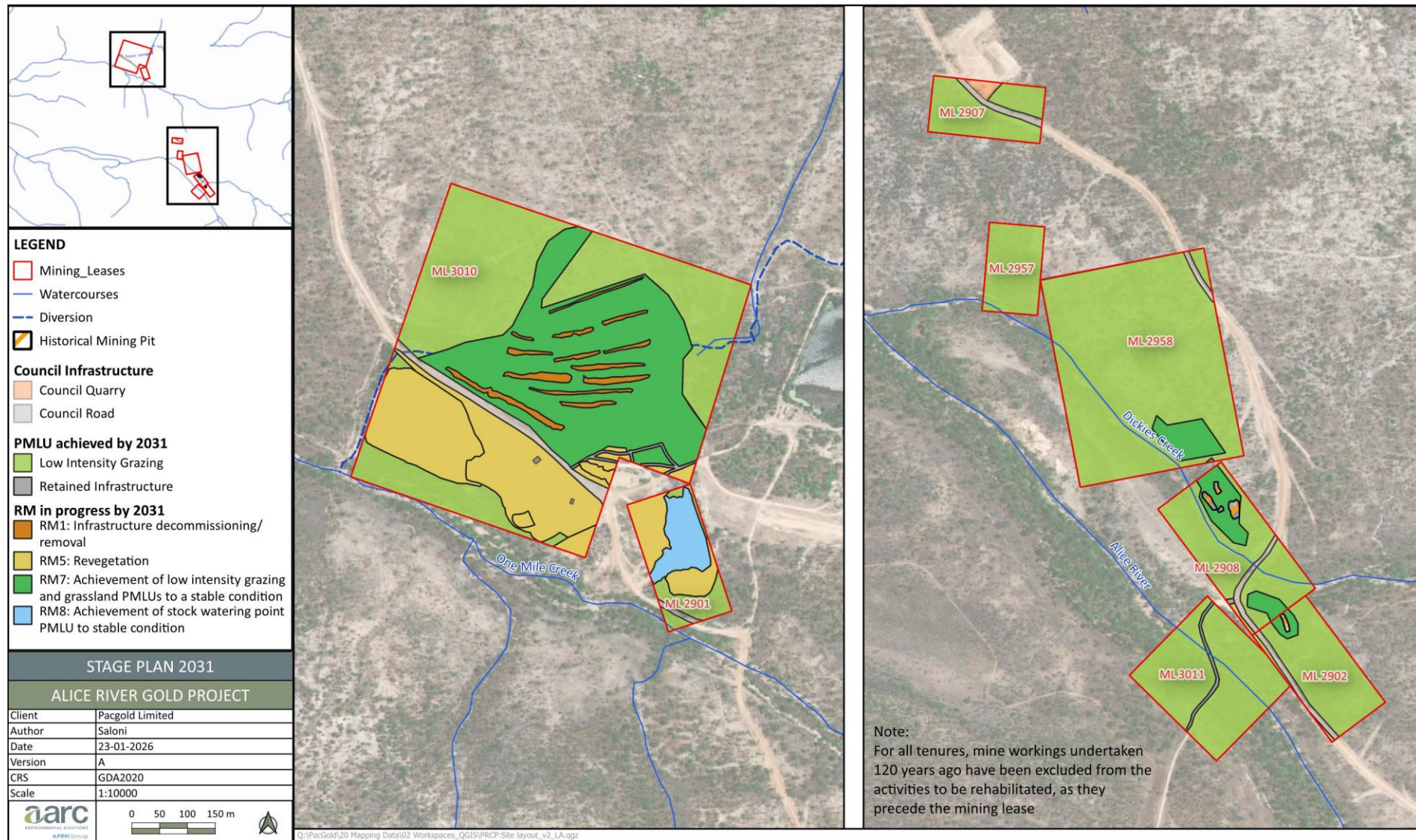
Yours Sincerely,

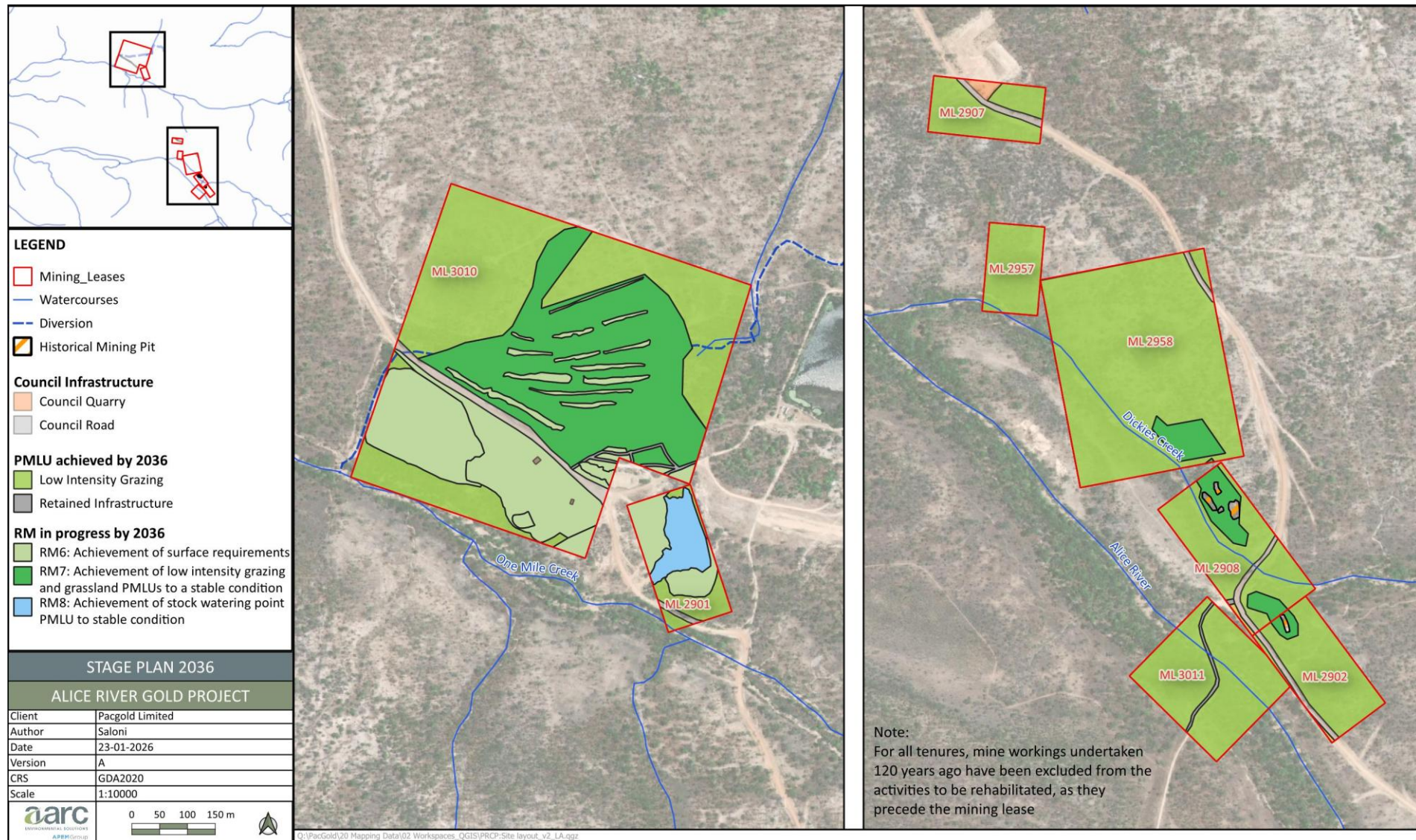
David Woodside
Woodside

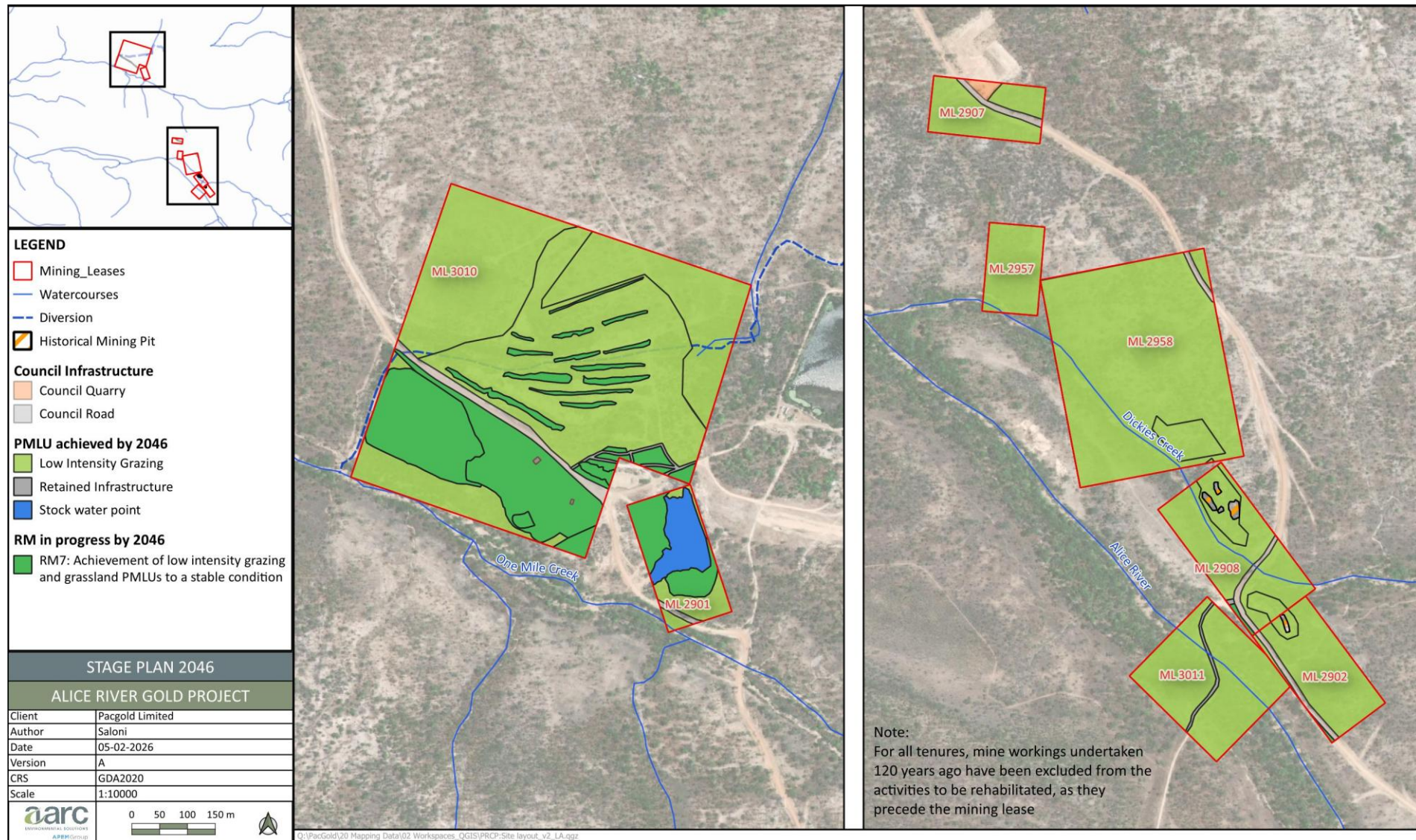
David and Allison Woodside

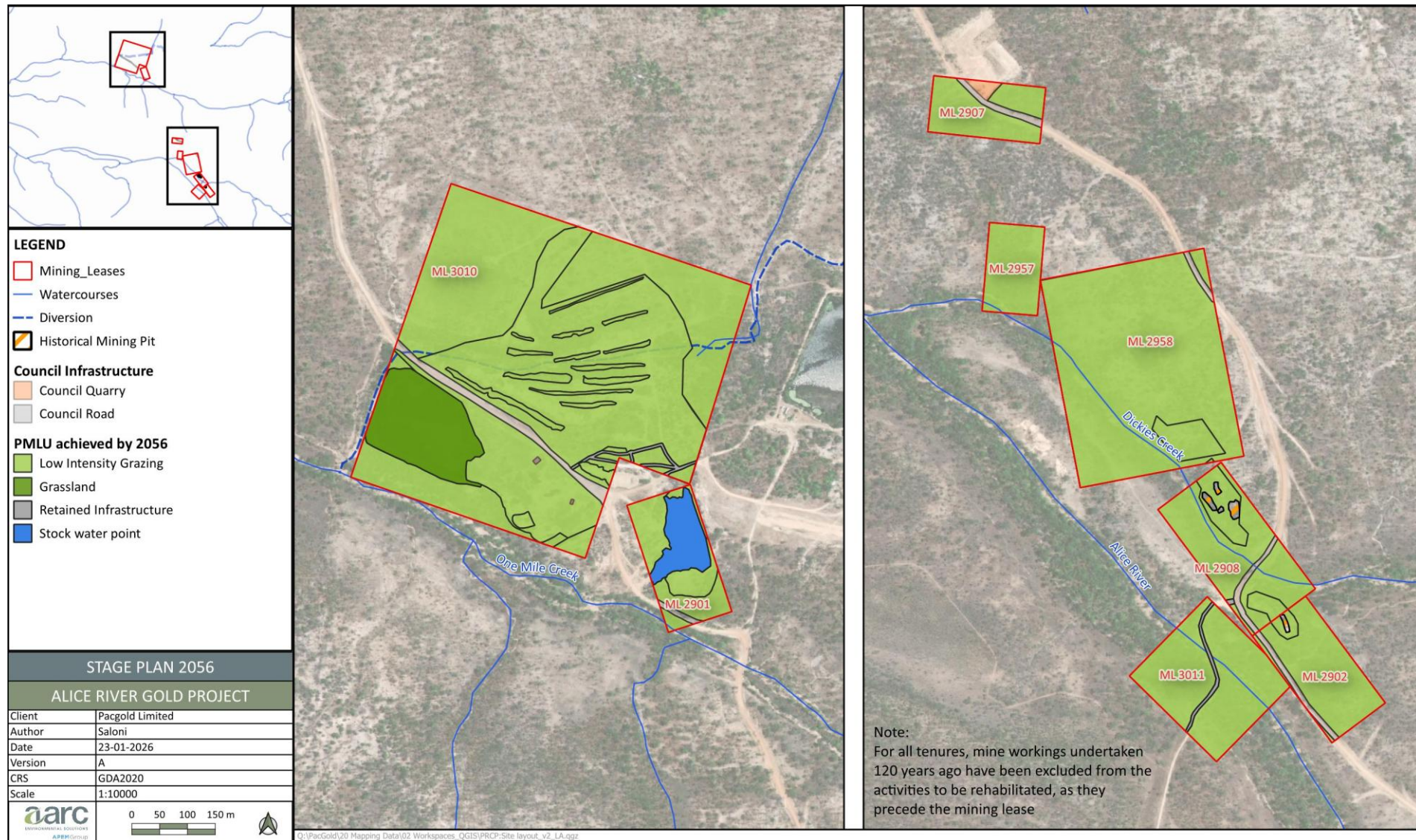
Date: 28th Oct 2025

Appendix F. Alice River Stage Plans









Appendix G. Alice River Mine Rehabilitation Design Report

ALICE RIVER GOLD MINE REHABILITATION DESIGN REPORT

PREPARED FOR
TINPITCH PTY LTD

JULY 2019



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Name of Client:	TinPitch Pty Ltd
Name of Project:	Alice River Gold Mine
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ALICE RIVER GOLD MINE REHABILITATION DESIGN REPORT

INDEX

1.0	INTRODUCTION	1
1.1	BACKGROUND.....	1
1.2	SITE LOCATION AND DESCRIPTION.....	1
1.3	PURPOSE AND SCOPE OF DOCUMENT	1
2.0	REHABILITATION OBJECTIVES AND CRITERIA	4
2.1	REHABILITATION POLICY IN QUEENSLAND	4
2.2	SITE SPECIFIC EA CONDITIONS.....	4
2.2.1	Schedule A – General.....	4
2.2.2	Schedule F – Land Management	5
2.3	GOALS AND OBJECTIVES.....	6
2.4	INDICATORS AND SUCCESS CRITERIA	6
3.0	REHABILITATION MONITORING LOCATIONS	10
4.0	METHODOLOGY	14
4.2	LAND CAPABILITY ASSESSMENT.....	15
4.3	PRODUCTIVITY MEASUREMENT	15
4.4	VEGETATION MONITORING	16
4.5	WATER QUALITY MONITORING.....	16
	REFERENCES.....	18

LIST OF FIGURES

Figure 1	Project Location	2
Figure 2	Mining Leases and Associated Watercourses.....	3
Figure 3	Northern Rehabilitation Monitoring Sites	12
Figure 4	Southern Rehabilitation Monitoring Sites	13

LIST OF TABLES

Table 1	Schedule F – Table 1 (Final Land Use and Rehabilitation Approval Schedule) (re-created from the Project's EA).....	5
Table 2	Schedule F – Table 3 (Landform design) (re-created from the Project's EA)	6
Table 3	Success Criteria.....	7
Table 4	Rehabilitation Monitoring Sites	11
Table 6	Land capability classes	15
Table 7	Stock Watering Water Quality Objectives.....	17

LIST OF ABBREVIATIONS

<	-	less than
>	-	greater than
AARC	-	AARC Environmental Solutions Pty Ltd
ANZECC	-	Australian and New Zealand Environment and Conservation Council
ARMCANZ	-	Agriculture and Resource Management Council of Australia and New Zealand
cm	-	centimetre(s)
DES	-	Department of Environment and Science
DNRM	-	Department of Natural Resources and Mining
DNRME	-	Department of Natural Resources, Mining and Energy
DoEE	-	Department of Environment and Energy
DSITI	-	Department of Science, Information Technology and Innovation
EA	-	Environmental Authority
EC	-	Electrical Conductivity
EHP	-	Department of Environment and Heritage Protection
EP Act	-	Environmental Protection Act 1994 (Qld)
GDA	-	Geocentric Datum of Australia
H	-	Height
ha	-	hectare(s)
kgDM/ha	-	kilograms of dry mass per hectare
km	-	kilometre(s)
m	-	metre(s)
mg/L	-	milligram(s) per Litre
ML	-	Mining Lease
NATA	-	National Association of Testing Authorities

ND	-	No data
Qld	-	Queensland
RDR	-	Rehabilitation Design Report
The Project	-	Alive River Gold Mine
TinPitch	-	TinPitch Pty Ltd
V	-	Vertical
WQO	-	Water Quality Objectives
WRD	-	Waste Rock Dump

1.0 INTRODUCTION

1.1 BACKGROUND

AARC Environmental Solutions Pty Ltd (AARC) was commissioned by TinPitch Pty Ltd (TinPitch) to prepare a Rehabilitation Design Report (RDR) for the Alice River Gold Mine (the Project). The Project's Mining Leases (MLs) are authorised by Environmental Authority (EA) EPML00870113, which took effect on the 27th July 2017, following approval of an EA Amendment Application by the Department of Environment and Science (DES).

1.2 SITE LOCATION AND DESCRIPTION

The Project is located approximately 310 kilometres (km) north-west of Cairns on the southern Cape York Peninsula. The Project occupies eight MLs, with the largest (ML 3010) containing the Project's historic gold processing plant, tailings dam and waste rock dumps (WRD). The adjoining ML 2901 contains the historical Alice Queen open pit. No mining or processing activities have taken place at the project since the year 2000, and the mine has essentially been in "care and maintenance mode" for the past 19 years. TinPitch also holds a number of Exploration Permits for Minerals (EPMs) that surround the 8 MLs. Figure 1 outlines the location of the Project within a regional context. Figure 2 outlines the Project's MLs and associated watercourses.

1.3 PURPOSE AND SCOPE OF DOCUMENT

The scope of works is to prepare a Rehabilitation Design Report for the ongoing monitoring of rehabilitated areas within the Alice River Mining Leases.

To do this, AARC has prepared a Rehabilitation Design Report with the purpose of determining the success of the rehabilitation methodologies through quantitative assessment over time.

The is to be achieved by:

- Establishing permanent rehabilitation and analogue monitoring locations in representative sites;
- Undertaking annual surveys to monitor progress of rehabilitation towards achieving success criteria;
- Analysing the success of rehabilitation through statistical analysis of ecological parameters;
- Reporting on the success of the established rehabilitation methodologies with respect to meeting the relevant rehabilitation goals, objectives and success criteria for the Project; and
- Providing recommendations for consideration in the design and scheduling of future site rehabilitation works.

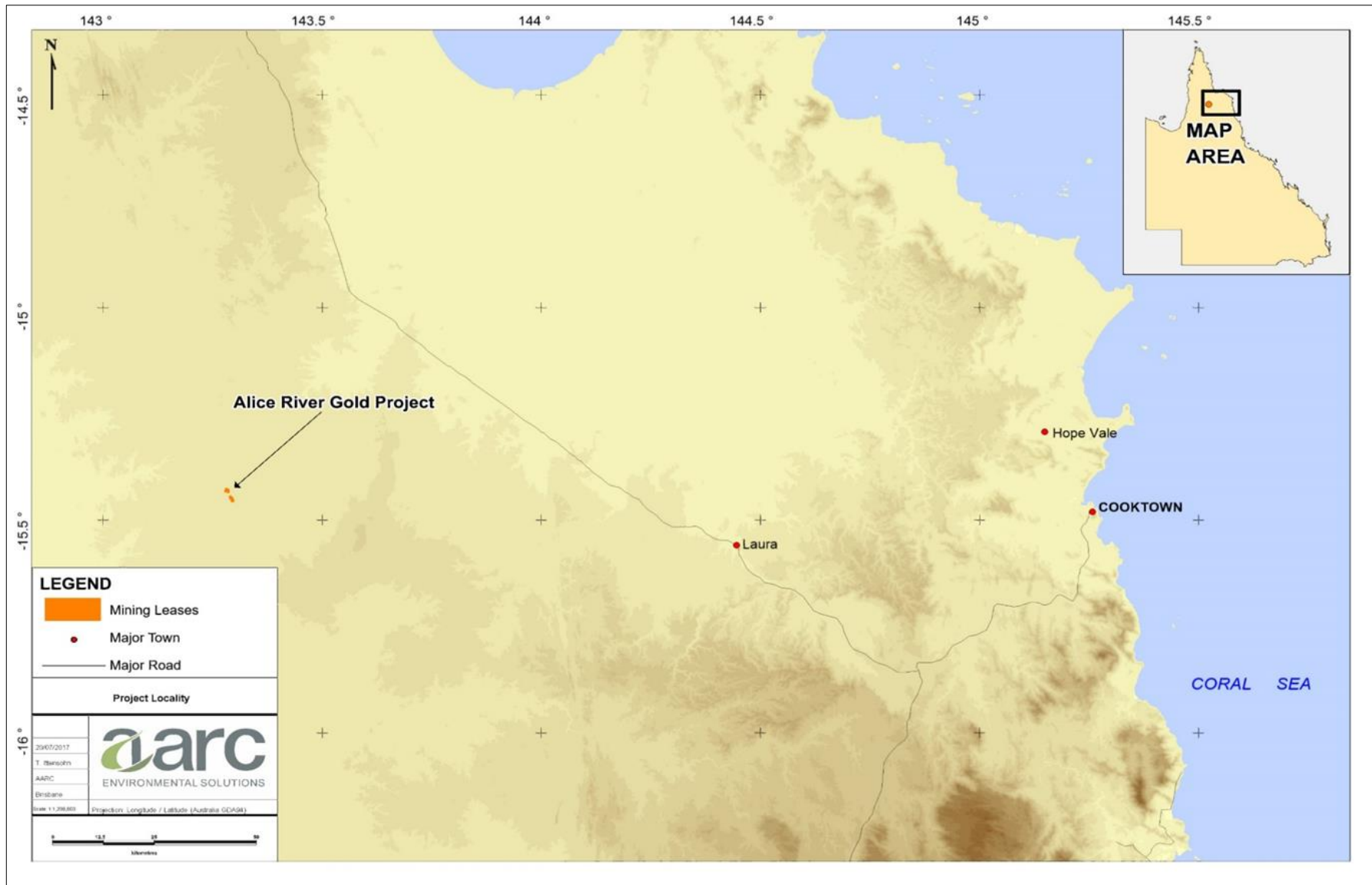


Figure 1 Project Location

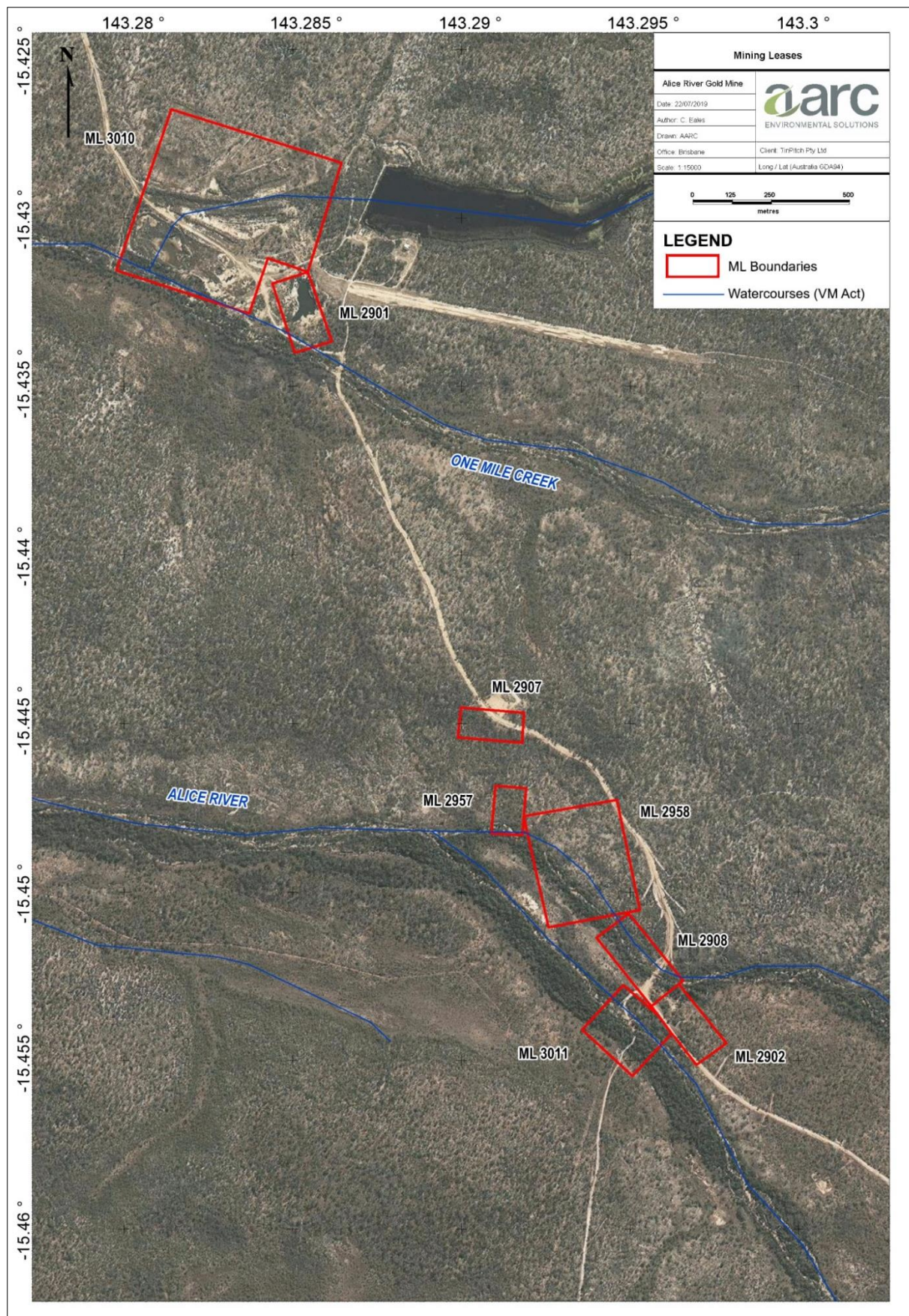


Figure 2 Mining Leases and Associated Watercourses

2.0 REHABILITATION OBJECTIVES AND CRITERIA

2.1 REHABILITATION POLICY IN QUEENSLAND

In Queensland, rehabilitation is required under the *Environmental Protection Act 1994 (Qld)* (EP Act), with site specific requirements often flowing through to project EA conditions.

The administering authority must be satisfied with completed rehabilitation, before it can certify progressive rehabilitation, or accept the surrender of an environmental authority either in whole or part, of a project site. An administering authority decision on certifying progressive rehabilitation is based on an assessment of either a progressive rehabilitation report for part of the project (section 318Z) or a final rehabilitation report (Section 264) for the whole project, or for the part being surrendered.

The holder of an EA for mining activities must prepare a progressive / final rehabilitation report and submit it to the administering authority for assessment. The administering authority must consider the relevant completion criteria (section 318ZI or section 268) when deciding whether to certify progressive rehabilitation or whether to approve a surrender application.

The government's policy objectives for rehabilitation are called general rehabilitation goals, to distinguish them from the rehabilitation objectives selected by mining companies in their rehabilitation strategies for a particular mine. The rehabilitation goals have been developed from the EP Act policy framework, especially in relation to; intergenerational equity, the polluter pays principle, protection of biodiversity and the maintenance of essential ecological processes. The four general rehabilitation goals require rehabilitation of areas disturbed by mining to result in sites that are:

- Safe to humans and wildlife;
- Non-polluting;
- Stable; and
- Able to sustain an agreed post-mining land use.

Rehabilitation objectives provide a clear description of proposed rehabilitation outcomes within the individual domains of the project site. The objectives within each mine domain will be assigned rehabilitation indicators and success criteria. Indicators are the parameters by which rehabilitation success is measured and success criteria form the minimum requirements which must be met in order to demonstrate that the objective have been achieved.

2.2 SITE SPECIFIC EA CONDITIONS

The following conditions (A9-1, F1-1, F1-2, F2-1 and F2-2) are outlined in the current EA (EPML00870113) and are detailed below in Schedule A and F.

2.2.1 Schedule A – General

Exploration

(A9-1) All exploration activities carried out on the relevant mining tenure must comply with each of the standard environmental conditions contained in the most recent version of the 'Eligibility criteria and standard conditions for exploration and mineral development projects'.

2.2.2 Schedule F – Land Management

Rehabilitation Landform Criteria

(F1-1) All areas significantly disturbed by mining activities must be rehabilitated to the final land description as defined in Schedule F - Table 1 (Final Land Use and Rehabilitation Approval Schedule) and compared to an analogue site in an adjacent undisturbed area with similar grazing management practices.

Grazing Pasture Outcome

(F2-1) Areas which are to be rehabilitated / progressively rehabilitated to grazing pasture must comply with the following outcomes;

- Generate a self sustaining vegetation with projective cover, species composition and species distribution comparable to analogue sites at two locations (E 744882, N 8292570 adjacent to processing area and E 745297, N 8292349 adjacent to airstrip) identified as AS1 and AS2 on Schedule I – Figure 1 – Authorised Activities and locations; and
- All areas disturbed by mining activities must be rehabilitated to the landform design criteria defined in Schedule F – Table 3 (Landform design); and
- Landforms are stable with rates of erosion comparable to analogue sites; and
- A measure of productivity (e.g. sustainable dry matter production, stock live weight gain) are comparable to analogue sites at two locations (E 744882, N 8292570 adjacent to processing area and E 745297, N 8292349 adjacent to airstrip) identified as AS1 and AS2 on Schedule I – Figure 1 – Authorised activities and locations.

(F2-2) Complete an investigation into rehabilitation of disturbed areas and submit a report to the administering authority proposing acceptance criteria to meet the outcomes in (F2-1) and landform design criteria in Schedule F – Table 3 (Landform design) by 26 July 2018.

Table 1 Schedule F – Table 1 (Final Land Use and Rehabilitation Approval Schedule) (re-created from the Project's EA)

Disturbance Type	Disturbance Area ha	Pre-mine Land Description	Post-mine Land Description	Pre-mine Land Capability Classification	Post-mine Land Capability Classification	Analogue Site Identification
Mine Pit	2.0	Low intensity grazing	Stock water point	VII	VII	AS1 and AS2
Mullock Dumps	0.5	Low intensity grazing	Low intensity grazing	VII	VII	AS1 and AS2
Burrow Pits/Costeans	0.6	Low intensity grazing	Low intensity grazing	VII	VII	AS1 and AS2
Tailings Dam	3.0	Low intensity grazing	Low intensity grazing	VII	VII	AS1 and AS2
Run-of-Mine Pad	1.1	Low intensity grazing	Low intensity grazing	VII	VII	AS1 and AS2
Plant Area	2.0	Low intensity grazing	Low intensity grazing	VII	VII	AS1 and AS2

Roads and Tracks	2.0	Low intensity grazing	Low intensity grazing	VII	VII	AS1 and AS2
Exploration Areas	13.33	Low intensity grazing	Low intensity grazing	VII	VII	AS1 and AS2
Exploration	3.0	In accordance with condition A9-1				

Key: ha hectare(s)

Table 2 Schedule F – Table 3 (Landform design) (re-created from the Project's EA)

Identification	Slope range (%)	Projective surface area (ha)
Waste rock dump/s	1 (V) : 3 (H)	1

Key: V vertical
H height

2.3 GOALS AND OBJECTIVES

Rehabilitation objectives and completion criteria were developed based on the Project's pre-mining land use of low intensity cattle grazing. Rehabilitation aims to return land impacted by the Project to an equivalent final land use, as outlined in the Project's EA.

The major final land use goal is to enable low intensity cattle grazing, which was the predominant previous site use, as well as the current use of the adjoining land. This post mining land use is understood to meet relevant stakeholder and landowner expectations. Areas suitable for grazing will include improved pasture species already established on site.

2.4 INDICATORS AND SUCCESS CRITERIA

Rehabilitation indicators provide measures of progress towards rehabilitation objectives. Completion criteria are the standards which provide a clear definition of successful rehabilitation and take the form of a set of measurable benchmarks against which the rehabilitation indicators can be compared, to determine whether objectives are being met. Rehabilitation is deemed successful when completion criteria for each rehabilitation goal and objective are consistently met. Proposed completion criteria for the RDR are outlined for each disturbance type in Table 3.

In order to demonstrate that rehabilitation has been successful, monitoring of indicators is repeated annually, with data compared over time. It is envisaged that acceptance criteria will need be met for a minimum period of three consecutive years, prior to certification occurring.

Trend analysis will be used to assess if rehabilitation results are moving towards success criteria. If data is trending away from success criteria, an investigation will be undertaken to assess if there is an underlying issue and what additional maintenance is required. Monitoring may also suggest the implementation of other measures of success.

Table 3 Success Criteria

Domain	Post-Mine Land Use	Rehabilitation Objective	Acceptance Criteria
Mine Pit <i>Alice Queen Open Pit</i>	Stock Watering Point	- Safe and stable for humans and animals now and in the foreseeable future. - Suitable for stock consumption. - Non-polluting.	- Certification in rehabilitation report that ground is structurally sound and safe to people and animals. - Water quality complies with stock watering limits (ANZECC 2000 Guidelines). - Water quality in the receiving environment is consistent with upstream levels. - Land capability assessment identifies a minimum of Class VII as per post mine land capability.
Mullock Dumps <i>Waste Rock Dump</i>	Low intensity grazing	- Safe and stable for humans and animals now and in the foreseeable future. - Suitable for low intensity cattle grazing. - Non-polluting.	- Evidence in rehabilitation report that ground is structurally safe and sound. - Final Landform meets slope criteria (1 (V) : 3 (H)) as per EA condition (Schedule F - Table 3). - Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). - Water quality in the receiving environment is consistent with upstream levels. - Rate of erosion is consistently similar to analogue sites (AS1, AS2). - Pasture productivity is consistently similar to analogue sites (AS1, AS2). - Land capability assessment identifies a minimum of Class VII as per post mine land capability.
Burrow Pits/Costeans <i>Big Blow Borrow Pit, Peninsula King Borrow Pit</i>	Low intensity grazing	- Safe and stable for humans and animals now and in the foreseeable future. - Suitable for low intensity cattle grazing. - Non-polluting.	- Evidence in rehabilitation report that ground is structurally safe and sound. - Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). - Water quality in the receiving environment is consistent with upstream levels. - Rate of erosion is consistently similar to analogue sites (AS1, AS2). - Pasture productivity is consistently similar to analogue sites (AS1, AS2). - Land capability assessment identifies a minimum of Class VII as per post mine land capability.
Tailings Dam	Low intensity grazing	Safe and stable for humans and animals now and in the foreseeable future.	Evidence in rehabilitation report that ground is structurally safe and sound.

Domain	Post-Mine Land Use	Rehabilitation Objective	Acceptance Criteria
		- Suitable for low intensity cattle grazing. - Non-polluting.	- Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). - Water quality in the receiving environment is consistent with upstream levels. - Rate of erosion is consistently similar to analogue sites (AS1, AS2). - Pasture productivity is consistently similar to analogue sites (AS1, AS2). - Land capability assessment identifies a minimum of Class VII as per post mine land capability.
Run-of-Mine Pad <i>Ore Stockpile, Scrap yards</i>	Low intensity grazing	- Safe and stable for humans and animals now and in the foreseeable future. - Suitable for low intensity cattle grazing. - Non-polluting	- Evidence in rehabilitation report that ground is structurally safe and sound. - Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). - Water quality in the receiving environment is consistent with upstream levels. - Rate of erosion is consistently similar to analogue sites (AS1, AS2). - Pasture productivity is consistently similar to analogue sites (AS1, AS2). - Land capability assessment identifies a minimum of Class VII as per post mine land capability.
Processing Plant <i>Ball mills, Gold room, metal screening, tanks.</i>	Low intensity grazing	- Safe and stable for humans and animals now and in the foreseeable future. - Suitable for low intensity cattle grazing. - Non-polluting	- Evidence in rehabilitation report that ground is structurally safe and sound. - Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). - Water quality in the receiving environment is consistent with upstream levels. - Rate of erosion is consistently similar to analogue sites (AS1, AS2). - Pasture productivity is consistently similar to analogue sites (AS1, AS2). - Land capability assessment identifies a minimum of Class VII as per post mine land capability.
Roads and Tracks	Low intensity grazing	- Safe and stable for humans and animals now and in the foreseeable future. - Suitable for low intensity cattle grazing.	- Evidence in rehabilitation report that ground is structurally safe and sound. - Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). - Rate of erosion is consistently similar to analogue sites (AS1, AS2). - Pasture productivity is consistently similar to analogue sites (AS1, AS2).

Domain	Post-Mine Land Use	Rehabilitation Objective	Acceptance Criteria
			Land capability assessment identifies a minimum of Class VII as per post mine land capability.
Exploration Areas <i>Drill pads / holes</i>	Low intensity grazing	- Safe and stable for humans and animals now and in the foreseeable future. - Suitable for low intensity cattle grazing. - Non-polluting	- Evidence in rehabilitation report that ground is structurally safe and sound. - Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). - Water quality in the receiving environment is consistent with upstream levels. - Rate of erosion is consistently similar to analogue sites (AS1, AS2). - Pasture productivity is consistently similar to analogue sites (AS1, AS2). - Land capability assessment identifies a minimum of Class VII as per post mine land capability.
Exploration	Low intensity grazing	- Safe and stable for humans and animals now and in the foreseeable future. - Suitable for low intensity cattle grazing. - Non-polluting	- Evidence in rehabilitation report that ground is structurally safe and sound. - Vegetation structure and condition (e.g. cover, composition) is consistent with analogue sites (AS1, AS2). - Water quality in the receiving environment is consistent with upstream levels. - Rate of erosion is consistently similar to analogue sites (AS1, AS2). - Pasture productivity is consistently similar to analogue sites (AS1, AS2). - Land capability assessment identifies a minimum of Class VII as per post mine land capability.

3.0 REHABILITATION MONITORING LOCATIONS

In order to determine the success of rehabilitation areas, monitoring sites are proposed to be established at various locations representative of the different rehabilitation areas and trials, throughout the Project site.

Permanent analogue sites are to be established at locations that were not impacted by past mining activities. Analogue sites are intended to provide a benchmark (a final land use of open pasture) for measuring rehabilitation performance. Upon site inspection in May 2019; the analogue site AS1 as per the Projects EA was found to occur within a previously disturbed area, as such it has been relocated to an unimpacted site.

The two analogue sites were selected as they are representative of the natural topography, vegetation type and the post-mine land use of 'open pasture'.

At the current stage of mine life, rehabilitation has only been undertaken in the exploration areas. It is recommended that as further domains are made available for rehabilitation, this RDR be reviewed to include additional rehabilitation monitoring sites in those domains.

Locations of monitoring sites are shown in Figure 3.

Table 4 Rehabilitation Monitoring Sites

Site Name	GDA 94		Location	Site Type	Disturbance Type / Domain	Post-mine Land Capability Classification	Monitoring Methods					
	Latitude	Longitude					Erosion	Productivity Measurement	Vegetation	Water Quality Monitoring	Slope ^a	Land Capability Assessment
AS1	143.2849	-15.4272	North of ML 3010	Analogue	Low Intensity Grazing	VII	X	X	X	-	-	X
AS2	143.2870	-15.4328	East of ML 3010	Analogue	Low Intensity Grazing	VII	X	X	X	-	-	X
EX1	143.2836	-15.4298	ML 3010	Rehabilitation	Exploration Areas	VII	X	X	X	-	-	X
EX2	143.2845	-15.4286	ML 3010	Rehabilitation	Exploration Areas	VII	X	X	X	-	-	X
Pit	143.2850	-15.4330	ML 2901	Rehabilitation	Alive River Mine Pit	VII	X	-	X	X	-	X
RM1	143.2841	-15.4313	ML 3010	Rehabilitation	ROM Pad (Scrap yard)	VII	X	X	X	-	-	X
BP1	143.2962	-15.4533	ML 2902	Rehabilitation	Adjacent to Big Blow Borrow Pit	VII	X	X	X	-	-	X
BP2	143.2952	-15.4516	ML 2908	Rehabilitation	Adjacent to Peninsula King Borrow Pit	VII	X	X	X	-	-	X

Note: AS1 has been relocated to the coordinates outlined above.

GDA Geocentric Datum of Australia 94

a. Slope is only to be monitored at sites located at the Waste Rock Dump.

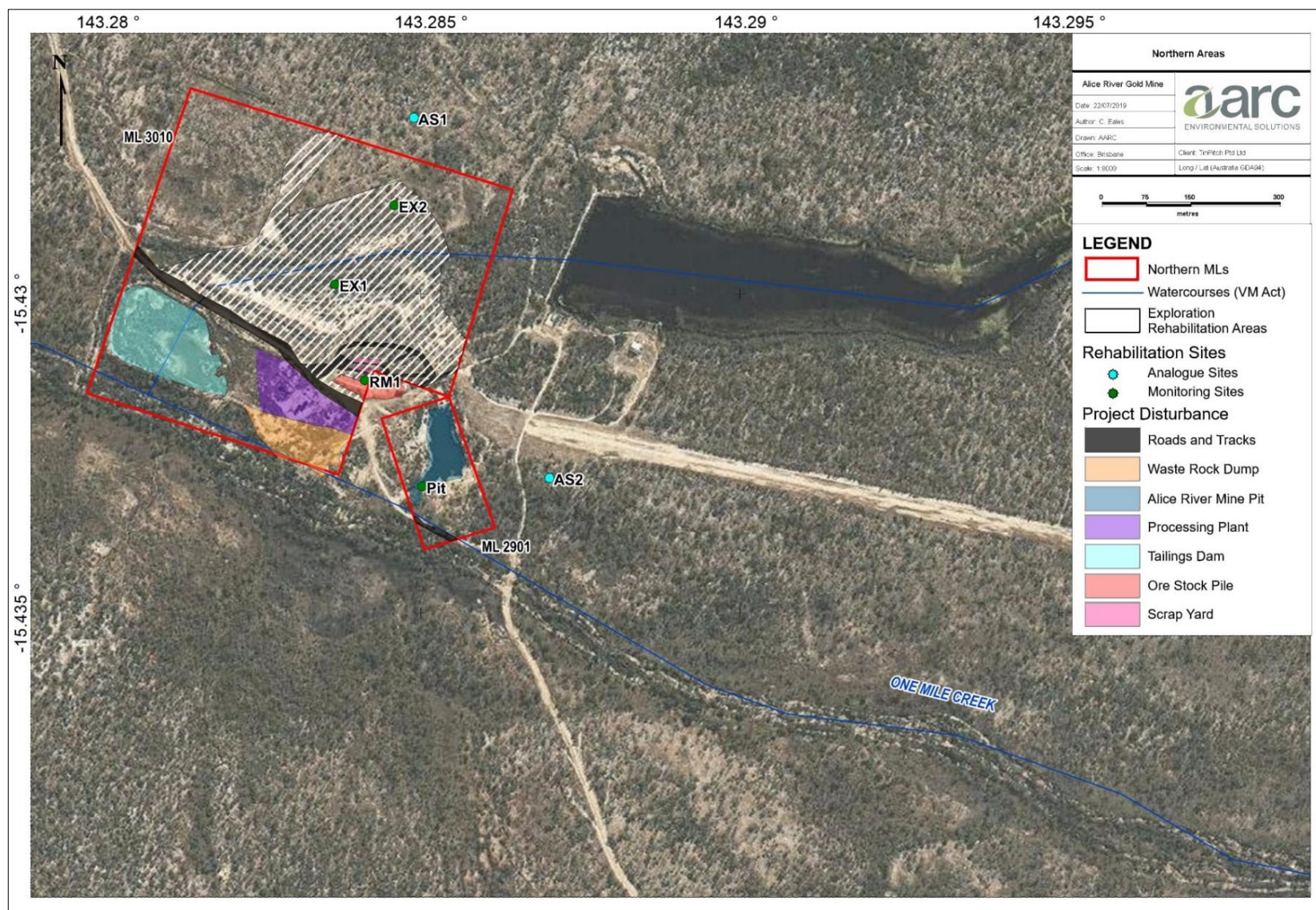


Figure 3 Northern Rehabilitation Monitoring Sites

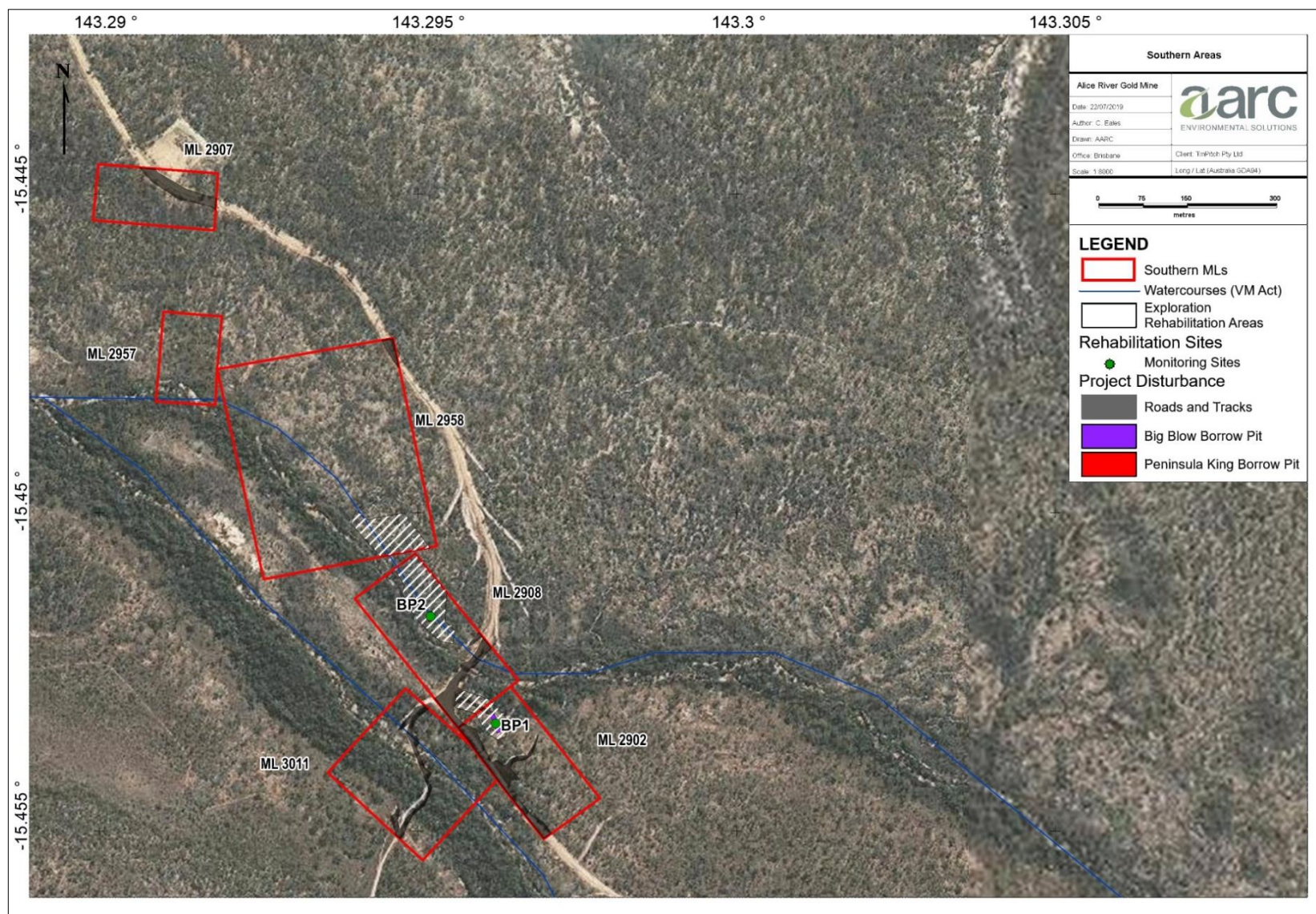


Figure 4 Southern Rehabilitation Monitoring Sites

4.0 METHODOLOGY

The RDR is designed to collect sufficient spatial and temporal data to establish scientifically justifiable conclusions of rehabilitation success. A minimum of three consecutive years of meeting acceptance criteria would likely be required to demonstrate rehabilitation success.

The following methods are employed at each monitoring site:

- Erosion monitoring;
- Land capability assessment;
- Productivity measurement;
- Slope monitoring;
- Vegetation monitoring (monitoring of ground cover, species richness, woody stem density, canopy cover, and weed species and diversity); and
- Water Quality Monitoring.

Additionally, observations recorded while walking between the permanent transects are to be incorporated in the results.

4.1 EROSION MONITORING

Erosion at the survey sites is monitored through visual assessment over time. Assessment is undertaken by traversing the 50 metres (m) transect on foot and recording the number and average depth of any erosion features or rill lines. However, the placement of the permanent transects does not adequately capture the level of erosion across the entire rehabilitation landforms, and observations during the surveys have also been considered for the preparation of each monitoring report.

Table 5 is used to record and classify these observations. The overall classification of the erosion on each transect is determined by the higher classification attributed to either the number of rills, or the average depth. This is to recognise that while a transect may present only one or two rills, if such rills are 50 centimetres (cm) deep, it will lead to a classification of 'severe' erosion.

Table 5 Erosion Classifications

Erosion Characteristics	Minor	Moderate	Severe	Extreme
No. of rills	< 15	15 – 30	31 – 50	> 50
Average Depth (cm)	< 10	10 – 30	30 – 60	> 60

Key: < less than
> greater than

In addition, the use of high-resolution satellite imagery to monitoring and identify changes in erosion features over time is to be utilised at each identified rehabilitation site.

4.2 LAND CAPABILITY ASSESSMENT

The land capability classification used in Queensland uses eight classes, with limitations and hazards to agricultural and pastoral use becoming progressively greater from class I to class VIII, accompanied by a decreasing adaptability and choice of use (Table 6). The post-mine land capability classes for the Project are defined as Class VII. Land capability assessments will be conducted in accordance with the 'Guidelines for Agricultural Land Evaluation in Queensland; Second Edition' (DSITI & DNRM 2015).

Table 6 Land capability classes

Class	Description
I	Suitable for all agricultural and pastoral uses. Highly productive. Presents no limitations to use of machinery or choice of implements. Wind and water erosion hazard are low even under intensive cultivation.
II	Land suitable for all agricultural uses but with slight restrictions to use for cultivation in one or more of the following categories: • minor limitation to the choice of crops, and/or slight restrictions to productivity. • minor impediment to the use of cultivation machinery. • cultivated cropping that requires simple conservation practices to reduce soil loss to an acceptable level.
III	Suitable for all agricultural uses but with moderate restrictions to use for cultivation in one or more of the following categories: • moderate limitations to the choice of crops and/or moderate restrictions to productivity. • moderate impediment to the use of cultivation machinery. • cultivated cropping that requires intensive conservation practices to reduce soil loss to an acceptable level.
IV	Primarily suited to pastoral use but which may be safely used for occasional cultivation with careful management. Potential limitations: • choice of crops is severely restricted, and/or existing conditions severely limit productivity under cropping. • severe impediment to the use of cultivation machinery. • land cannot be used safely for permanent cultivation. If cropped, a pasture phase must be the major component of the cropping program to limit soil loss to an acceptable level.
V	Land that in all other characteristics would be arable but has limitations that, unless removed, make cultivation impractical and/or economic – examples include swampy land that may be drained, or land that contains surface rock that could be removed at a cost.
VI	Land that is not suitable for cultivation but is well suited to pastoral use and on which pasture improvement involving the use of machinery is practicable.
VII	Land that is not suitable for cultivation but on which pastoral use is possible only with careful management; pasture improvement involving the use of machinery is not practicable
VIII	Land that has such severe limitations that it is unsuited for either cultivation or grazing

4.3 PRODUCTIVITY MEASUREMENT

In order to assess the quantity of pasture available for grazing a calculation of herbage mass is to be conducted at each site. Herbage mass refers to the total amount of pasture present; including both green and dead material and is expressed as a form of kilograms of dry matter per hectare (kgDM/ha). Every 5 m along the 50 m monitoring transect a pasture meter will be used to provide a measure of kgDM/ha for that site. These observations are then averaged to provide an estimate of the mean quantity of dry matter. This method is a non-destructive measure. The plate meter uses a weight disk to assess the settled height above ground to pasture mass beneath the disk. The disk is gently lowered onto the

pasture after the central rod is placed on the ground surface. The height of the disk is recorded after approximately 5 to 10 seconds of settling time.

4.4 VEGETATION MONITORING

Vegetation monitoring involves the collection of quantitative data on ground cover, composition, species richness, woody stem density, and canopy cover at each 50 m monitoring transect. A star picket is installed at each end point of the transect, to consistently and precisely identify the permanent transect location.

To measure species richness, all vascular plants occurring within 5 m of either side of the 50 m transect are recorded. Any species unable to be identified is collected for later identification. Percentage ground cover for each species is recorded within ten 1 m by 1 m quadrats placed every 5 m along the 50 m transect. In each quadrat the percentage cover of rock, bare ground, organic litter and live plant species present is recorded. Live plant species are classified into one of the following six groups for reporting purposes:

- Native pasture grass species (grass species that are palatable to stock);
- Exotic pasture grass species (grass species that are palatable to stock);
- Non-pasture grass species (grass species that are not palatable to stock);
- Shrubs;
- Forbs and other non-grass species (sedges and non-declared weeds); and
- Restricted invasive plants as listed in the *Biosecurity Act 2014 (Qld)*.

All tree and shrub species present within the 10 m by 50 m plots are counted. This allows for the calculation of the total density of trees and shrubs as well as the density of each individual species.

This methodology is based on the Queensland Herbarium survey techniques.

4.5 WATER QUALITY MONITORING

Water quality sampling is to be carried out in accordance with the 'Queensland Monitoring and Sampling Manual 2009' (DES 2018a) methodology. Field readings of pH, Dissolved Oxygen, Turbidity, Electrical Conductivity (EC) and Temperature are also to be recorded. In-situ measurements are to be collected using a multi-parameter water quality meter that is laboratory calibrated to the manufacturers' specifications.

Grab samples at all water monitoring sites are to be collected at a depth of 10 cm to 20 cm where sufficient water is available. Two water samples, one total (unfiltered) and one dissolved (field filtered) are to be collected at each site. Water quality samples are to be analysed under laboratory testing conditions for the parameters listed in Table 7.

The Project occurs within the Mitchell River Basin and the Alice River Sub-basin; these basins have not had their water types defined nor have any water quality objectives (WQO) been identified due to limited or no water quality data being available. According to the 'Queensland Water Quality Guidelines' (DES 2013) the ANZECC 2000 Guidelines (ANZECC & ARMCANZ 2000) are not particularly appropriate for the region. As such it is recommended that the receiving environment water quality assessments be compared with upstream values and against the stock watering WQO (Table 7).

Table 7 Stock Watering Water Quality Objectives

Parameter	WQO
Stock watering	
Total Dissolved Solids	3000 mg/L
Aluminium	5 mg/L
Arsenic	0.5 (up to 5 ³) mg/L
Beryllium	ND
Boron	5 mg/L
Cadmium	0.01 mg/L
Chromium	1 mg/L
Cobalt	1 mg/L
Copper	0.4 (sheep), 1 (cattle), 5 (pigs), 5 (poultry)
Fluoride	2 mg/L
Iron	not sufficiently toxic
Lead	0.1 mg/L
Manganese	not sufficiently toxic
Mercury	0.002 mg/L
Molybdenum	0.15 mg/L
Nickel	1 mg/L
Selenium	0.02 mg/L
Uranium	0.2 mg/L
Vanadium	ND
Zinc	20 mg/L

Key: mg/L – milligrams per litre
ND – No data

Samples are to be collected in suitable sample collection bottles provided by the laboratory, with preservative added where required. All water samples are to be kept on ice or refrigerated during storage and transport to a National Association of Testing Authorities (NATA) accredited laboratory for analysis.

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