Calliope Limestone Quarry - Progressive Rehabilitation and Closure Plan

Graymont Limited



Calliope Limestone Quarry
PROGRESSIVE REHABILITATION AND CLOSURE PLAN

Calliope Limestone Quarry - Progressive Rehabilitation and Closure Plan

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Acronyms

Acronym	Description
AQP	Appropriately Qualified Person
BoM	Bureau of Meteorology
°C	Degrees Celsius
cm	Centimetres
CPESC	Certified Professional in Erosion and Sediment Control
CSEP	*Calliope Stakeholder Engagement Plan*
CSIRO	Commonwealth Scientific and Industrial Research
CO_3	Carbonate
DAFF	Department of Agriculture Fisheries and Forestry
DES	Former Department of Environment and Science (now DESI)
DETSI	Department of Environment, Tourism, Science, and Innovation
DoR	Former Department of Resources
DNRMMRRD	Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development (formerly DoR)
DSDIGP	Department of State Development, Infrastructure and Planning
EA	Environmental Authority
EC	Electrical conductivity
EMP	Environmental Management Plan
ENSO	El Niño Southern Oscillation
EP Act	*Environmental Protection Act 1994*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EP Regulation	*Environmental Protection Regulation 2019*
EP Water	*Environmental Protection Policy (Water and Wetland Biodiversity) 2019*
EOML	End of Mine Life
ERA	Environmentally Relevant Activities
ESCP	Erosion and Sediment Control Plan
ESP	Exchangeable Sodium Percentage
FSL	Full Supply Level
GAWB	Gladstone Area Water Board
GBR	Great Barrier Reef
GDE	Groundwater Dependent Ecosystems
GIS	Geographical Information Systems
GRC Planning Scheme	The Gladstone Regional Council Planning Scheme
ha	Hectares
$HC0_3$	Bicarbonate
ID	Identification
IQA	Institute of Quarrying Association QLD
IR	Information Request
km	Kilometres
km^2	Square kilometres
Km/h	Kilometres per hour
kVA	Kilovolt-ampere
L	Litres
LGA	Local Government Area
LOD	Land Outcome Document

Acronym	Description
LOM	Life of Mine
L/s	Litres per Second
m	Metres
mAHD	Australian Height Datum
mBGL	Below Ground Level
MCA	Minerals Council Australia
m/d	Metres per Day
M^3/d	Cubic Metres per Day
MERFP Act	*Mining and Energy Resources (Financial Provisioning) Act 2018*
ML	Mining Leases
MPa	Megapascals
MSES	Matter of State Environmental Significance
Mtpa	Million tonnes per annum
Mg/L	Total suspended solids
MJ/ m^2	Megajoules per square metre
Mm	Millimetres
MP	Member of parliament
Mya	Million years ago
NC Act	*Nature Conservation Act 1992*
NLAA	National Lime Association Australia
TSS	Total Dissolved Solids
NPK	Nitrogen phosphorus and potassium
NTU	Turbidity
NUMA	Non-use management areas
PCCC Land Trust	Port Curtis Coral Coast Land Trust
pH	pH Unit
PIE	Public interest evaluation
PMLU	post mine land use
PMF	Probable Maximum Flood
PMR	Protected Matters Report
PCB	Polychlorinated biphenyls
PRC Plan	Progressive Rehabilitation and Closure Plan
QA/QC	Quality Control and Quality Assurance
QFES	Queensland Fire and Emergency Services
QG	Queensland Government
QGlobe	Queensland Globe
QRC	Queensland Resource Council
RA	Rehabilitation Areas
RAP	Remediation Action Plan
RE	Regional Ecosystem
RL	Relative Level
ROM	Run of Mine
RPP	Rehabilitation Planning Part
SAQP	Soil Analysis and Quality Plans
Spp	Species
t	Tonnes
t/m^3	Tonnes per Cubic Metres

Acronym	Description
TSF	Tailings Storage Facility
TSS	Total Suspended Solids
UQ	University of Queensland
WRD	Waste Rock Dump
%	Percent
µS/cm	Micro Siemens per centimeter

1. Rehabilitation Planning Part

1.1. Introduction

The Calliope Limestone Quarry (the Project) is an existing quarry operated by Graymont (Calliope) Pty Ltd (Graymont), which is a subsidiary of Graymont Pty Ltd. The Project involves the operation of an open cut limestone quarry that produces approximately 0.8 million tonnes per annum (Mtpa) of limestone products. The Project commenced operations in 1967 and noting potential future changes in reserves and yearly sales quantities, has a planned end of mine life (EOML) in 2100. Rehabilitation activities are forecast to be completed by 2110, with annual monitoring proposed to be undertaken until 2115.

The Project is located approximately 11 kilometres (km) south of the township of Calliope and 30 km south of Gladstone in Central Queensland within the Gladstone Local Government Area (LGA) (see **Figure** 1). The current and maximum disturbance areas are displayed in **Figure 2** and **Figure 3**.

The Project has approval under a resource Environmental Authority (EA) EPML00969013 which covers the following Mining Leases (ML): ML3594, ML3595, ML3596, ML3597, ML3598, ML3599, ML3600, ML3602, ML3603, ML3604, ML3605, ML3606, ML3608, ML3609, ML80036, ML80189, ML80190, ML80191, and ML80192 (the MLs).

This Progressive Rehabilitation and Closure (PRC) Plan has been prepared to address the requirements of:

- The *Mining and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act)
- Sections 126B, 126C and 126D of the *Environmental Protection Act 1994* (EP Act)
- Progressive Rehabilitation and Closure Plans Guideline (ESR/2019/4964) (PRC Plan Guideline) (DES 2024
- Schedule 8A of the *Environmental Protection Regulation 2019*

1.1.1. Purpose of Plan

Following cessation of limestone extraction governed under the EA, all disturbed areas within the MLs will be rehabilitated to a stable post-mining land-use (PMLU). The purpose of this PRC Plan is to outline rehabilitation requirements that:

- Meet landholder expectations for final land use
- Achieve a decommissioned site that is safe, fit for purpose and non-polluting
- Eliminate residual impact or liability for community and future land holders following rehabilitation
- Achieve an appropriate post mining land-use for each nominated rehabilitation area (RA)
- Return the landform to an agreed pre-mine condition

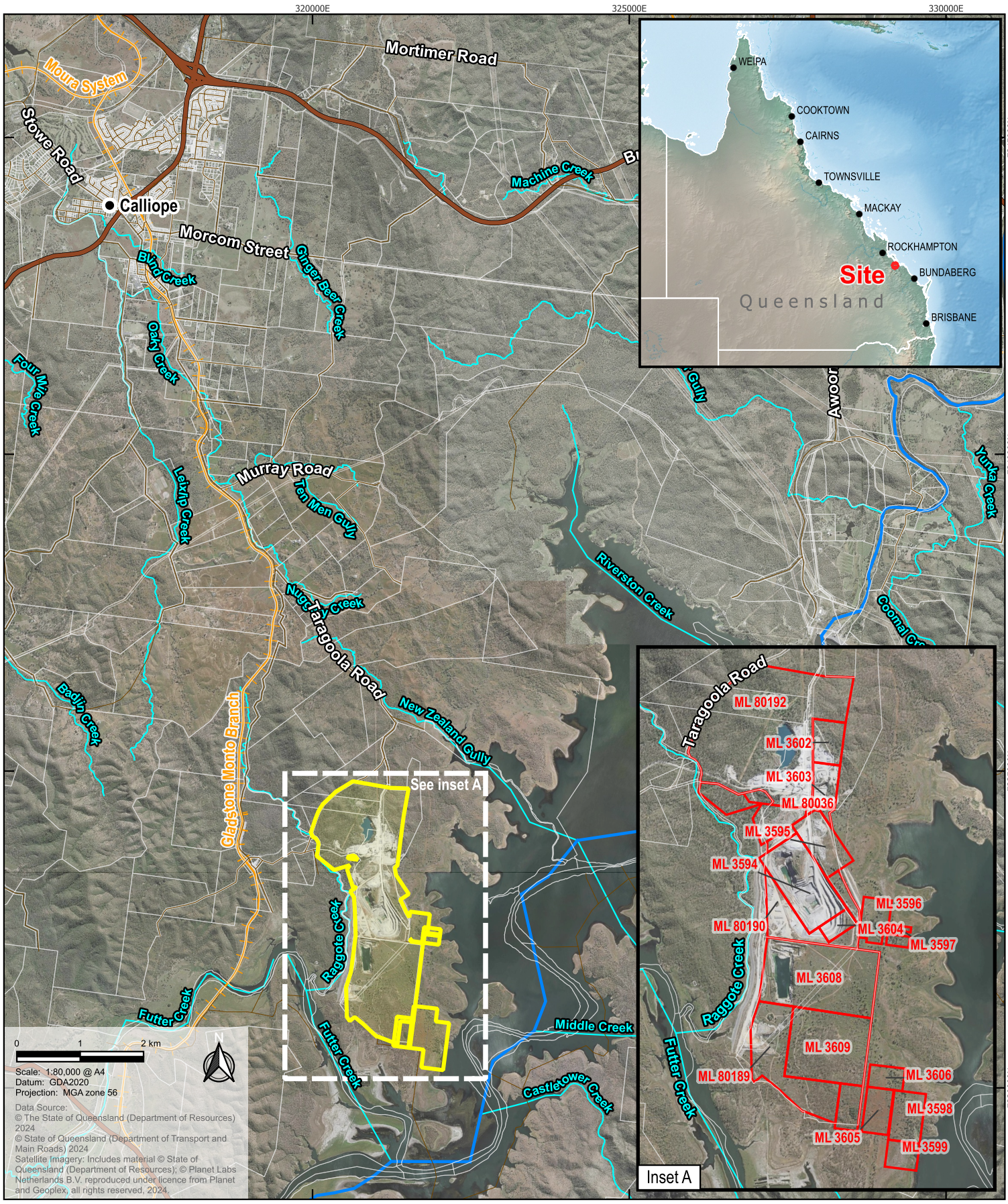
The PRC Plan ensures the Project area has an agreed PMLU, describes how rehabilitation of the area will be carried out progressively over the life of mine (LOM), and specifies the condition to which Graymont will rehabilitate the land before the EA is surrendered. The PRC Plan outlines the Project and rehabilitation planning, post-closure requirements, community

consultation, PMLU, rehabilitation methods and goals, risk assessment, monitoring and maintenance, and PRC Plan schedule (the PRC Plan schedule is provided in **Appendix A**). The PRC Plan accompanies the application form (ESR/2019/4967) and spatial file submission prepared in accordance with ESR/2018/4337.

For existing operations transitional arrangements mean that existing 'land outcomes' (PMLUs - and associated milestone criteria) secured in a 'land outcome document' (LOD) received by the Department of Environment, Tourism, Science and Innovation (DETSI) (formerly DES) (and not rejected) before December 2018 can be carried forward and do not need community consultation or stakeholder agreement. For the Project, the primary LOD is the EA EPML00969013.

To ultimately align this PRC Plan with the EA, an EA amendment application (the EA amendment) was submitted to the Administrating Authority at the time of preparing this PRC Plan. The EA amendment included proposed maximum disturbance areas required to facilitate another nominal 75 years of mining. The EA amendment could not initially be submitted prior to the PRC Plan due to issues being resolved with the former Department of Resources (DoR, now Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development (DNRMMRRD)). These issues were associated with the identified discrepancy in the location of the ML boundaries historically used at Calliope and the ML boundaries within the DNRMMRRD database and have since been rectified since the PRC Plan's initial submission. An information request (IR) notice was received for the amendment application, and a response to the notice was subsequently submitted on 20 August 2025. A decision approving the major amendment was finalised on 19 December 2025.

The PRC Plan IR notice (dated 10 October 2025) identified a risk of pooling around the Southern WRD, which subsequently necessitated a second (minor) EA amendment application for the redesign of the Southern WRD (refer **Figure 4**). This was submitted on 19 June 2026. The minor amendment application included updates to proposed maximum disturbance areas to accommodate a safe and stable final landform. This PRC Plan aligns with the outcomes of both amendment applications and is therefore consistent with the current EA.



Filepath: --BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 PRCP\Rev 3\Figure 1 Regional location.ggz

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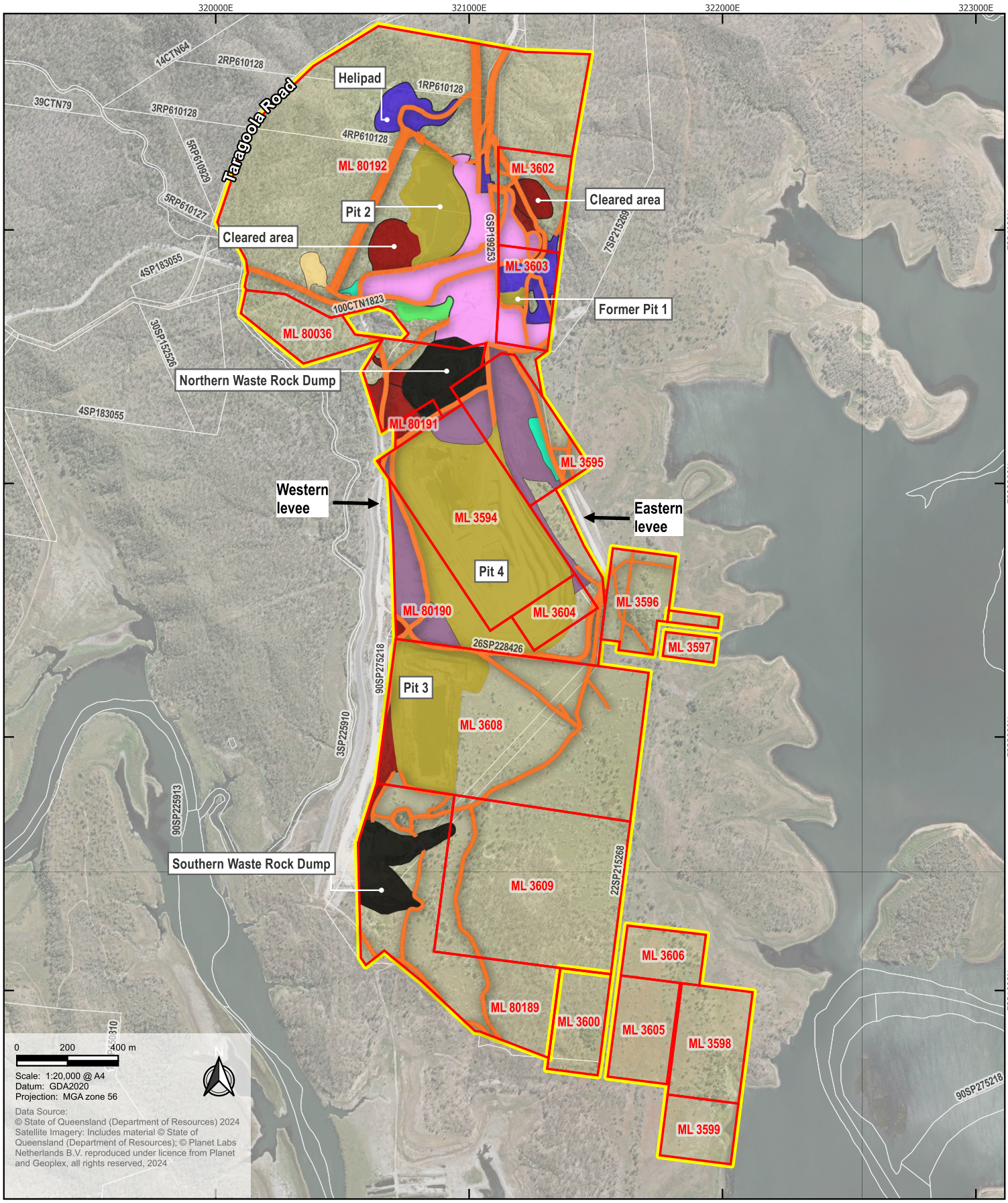
- Site boundary
- Mining leases
- Cadastre (DCDB)
- State controlled roads
- Roads and tracks
- Railways

Watercourses

- Major
- Minor

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Calliope Limestone Quarry
Progressive Rehabilitation and Closure Plan

Figure 1
Regional location



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Legend

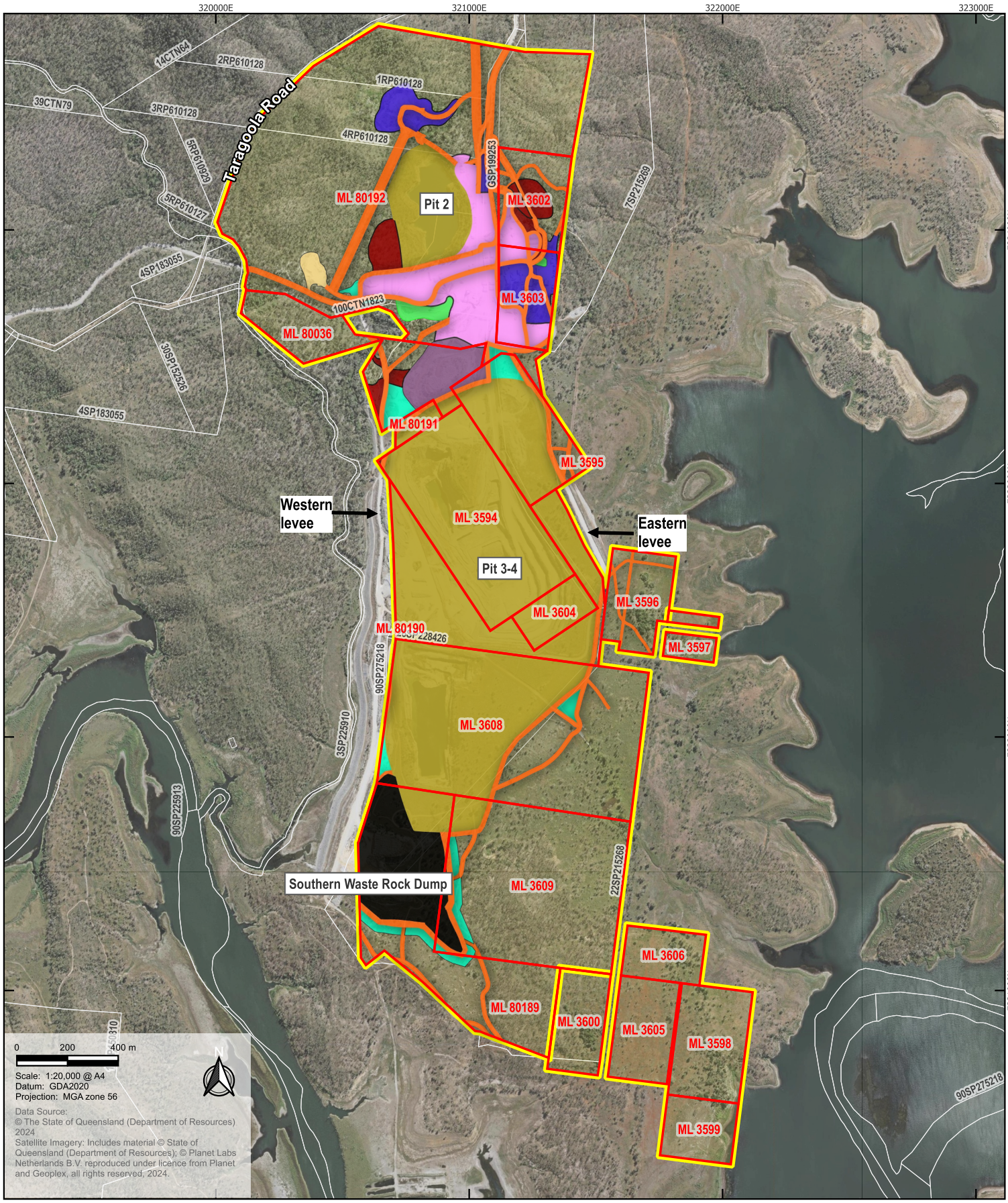
- Site boundary
- Mining Leases
- Cadastre (DCDB)

Current disturbance

- Access tracks
- Cleared areas and laydowns
- Infrastructure and plant
- Sediment pond
- Pit
- ROM processing area
- Silt dump
- Temporary spoil storage area
- Topsoil stockpile
- Waste rock dump

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Figure 2
Current disturbance area



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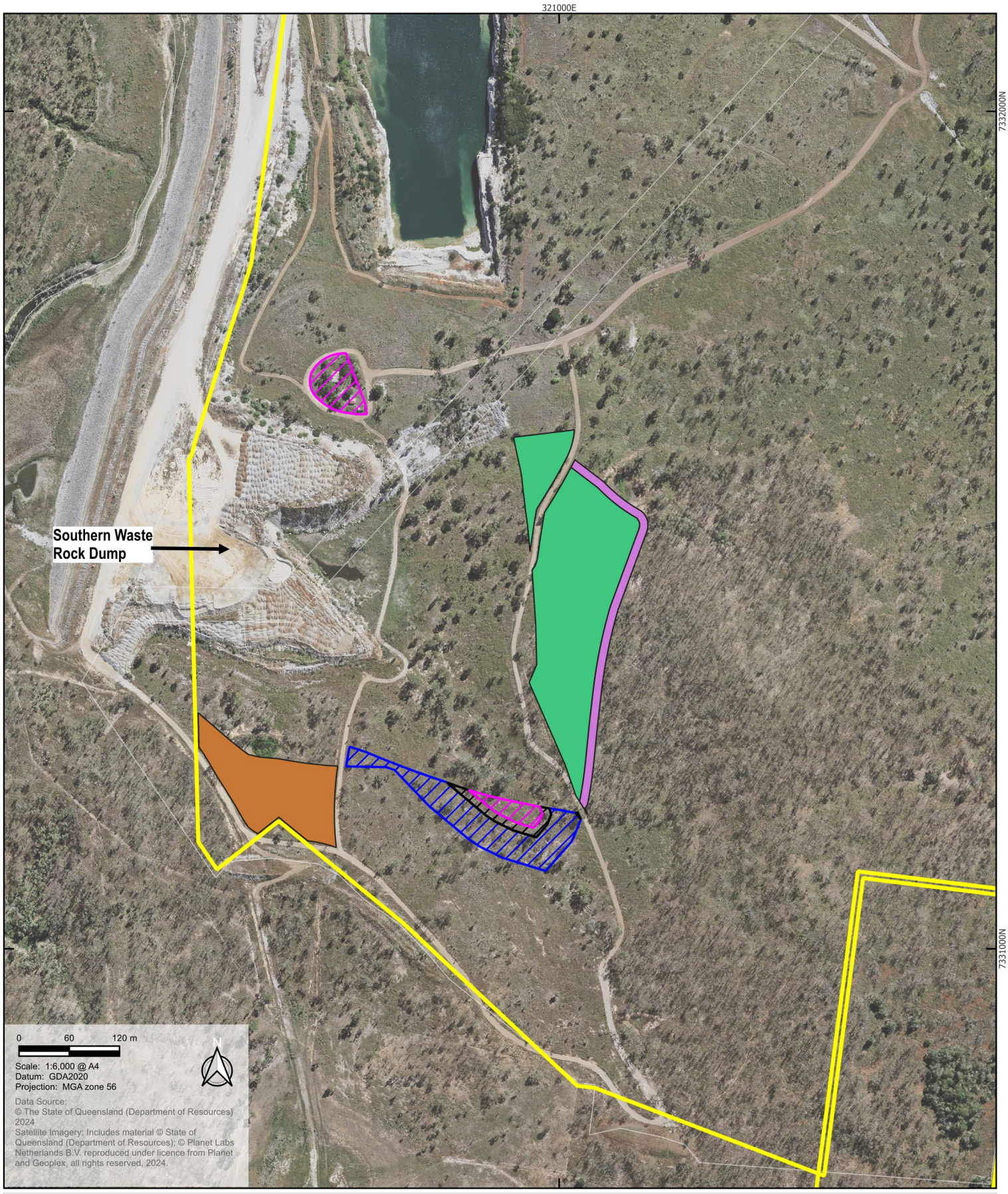
- Site boundary
- Cadastre (DCDB)
- Mining Leases

Maximum disturbance

- Access tracks
- Cleared areas and laydowns
- Infrastructure and plant
- Sediment pond
- Pit
- ROM processing area
- Silt dump
- Temporary spoil storage area
- Topsoil stockpile
- Waste rock dump

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Figure 3
Maximum disturbance extent



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Legend

- Site boundary
- Cadastre (DCDB)

Proposed change

- Authorised disturbance being removed - Access tracks
- Authorised disturbance being removed - Topsoil stockpile
- Authorised disturbance being removed - Waste rock dump
- Proposed - Access tracks
- Proposed - Topsoil stockpile
- Proposed - Waste rock dump

Note: The main change is occured around southern waste rock dump. Northern and central area remain same.

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Figure 4
New disturbance area

2. Project Planning

This section of the PRC Plan provides baseline information on the Project, including site location details, a description of Project operations and information on rehabilitation / improvement planning.

2.1. Baseline Information

Mining operations at Calliope commenced in 1967 and noting potential future changes in reserves and yearly sales quantities, is planned to continue until EOML in 2100. The following sections have been prepared based on a combination of historical and currently available information since mining operations commenced at Calliope in 1967.

2.1.1. Site Location

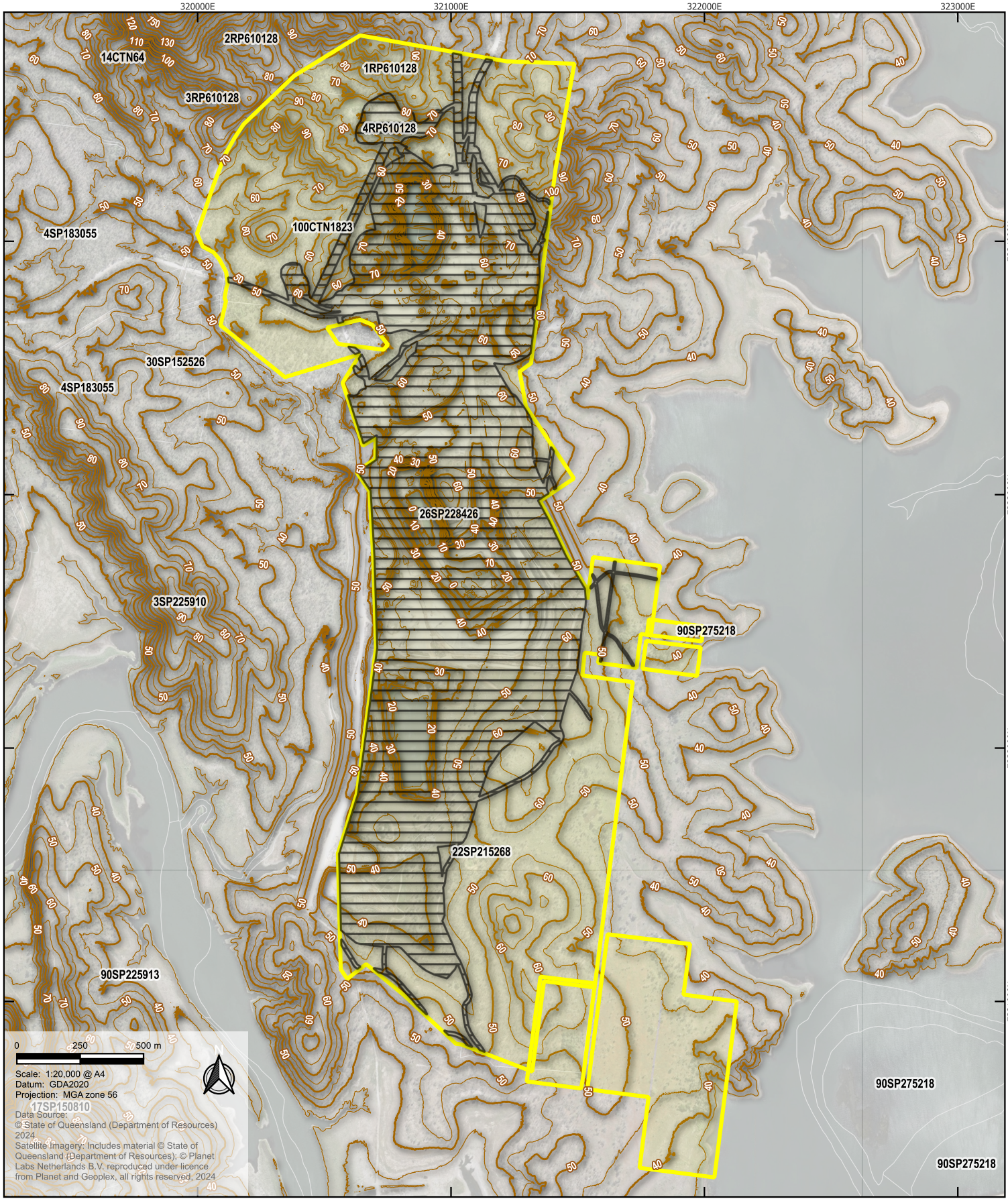
The Project is wholly located within the Gladstone LGA, in Taragoola, near the Central Queensland coast (see **Figure 1**). The Project area and surrounds are zoned as Rural under the Gladstone Regional Council Planning Scheme 2017 (GRC Planning Scheme, GRC 2017).

The south, east and west of the site adjoins Lake Awoonga which is owned and operated by the Gladstone Area Water Board (GAWB). The primary access route to the site is via Taragoola Road to Charters Crossing Road to the north of the site. Taragoola Road intersects Nuggety Road and Rail Siding Road which provides an alternative access route to the west of the site. An unnamed road managed by GAWB borders the western and south-western boundaries and the closest residential area is mapped approximately 4 km north of the Project. Surrounding land is primarily freehold land owned by the GAWB and is used for grazing and native vegetation conservation. Regionally, the Project is located 11 km south south-east of the township of Calliope, approximately 28 km south south-west of Gladstone and approximately 142 km north north-west of Bundaberg. Neighbouring townships include:

- Benaraby, approximately 13 km north north-east of the Project
- Bororen, approximately 31 km south-east of the Project
- Nagooren, approximately 30 km south of the Project

2.1.2. Site Topography

The topography in the vicinity of the Project area is hilly with elevations ranging from 40 to 100 metres Australian Height Datum (mAHD), as shown in **Figure 5**. Topography falls to the east, south, and west to Lake Awoonga. The land surrounding the Project is low intensity grazing land for cattle. The Project is offered some protection from inundation from floods by the Eastern and Western bunds constructed at the site. A 1,900 m long earth and rock wall has been constructed adjacent to Raggote Creek, with a smaller wall constructed along the eastern perimeter of the Project area. Both bunds are also used as access tracks. The crest of these walls is approximately 52 mAHD. The walls are protected by a clay liner and outer rock layer to an elevation of 47 m (the estimated 1 in 100-year flood level). These works were completed as part of a cooperative agreement between the previous owners of the site and the GAWB.



Filepath: --BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 PRCP\Rev 3\Figure 5 Topography and final landform.qgz

Legend

- Site boundary
- Maximum disturbance extent

Elevation contours

- 5m intervals
- 10m intervals

Graymont
Calliope Limestone Quarry
Progressive Rehabilitation and Closure Plan

Figure 5
Topography and final landform

2.1.3. Climate

The Project is located within Queensland's subtropical climatic zone which is characterised by high summer temperatures, warm dry winters, and distinct wet and dry seasons. It lies within the southeast trade wind belt but is too far south to experience monsoonal influence from the northwest and too far north to benefit from higher altitude cold fronts (Bureau of Meteorology (BoM) 2025a).

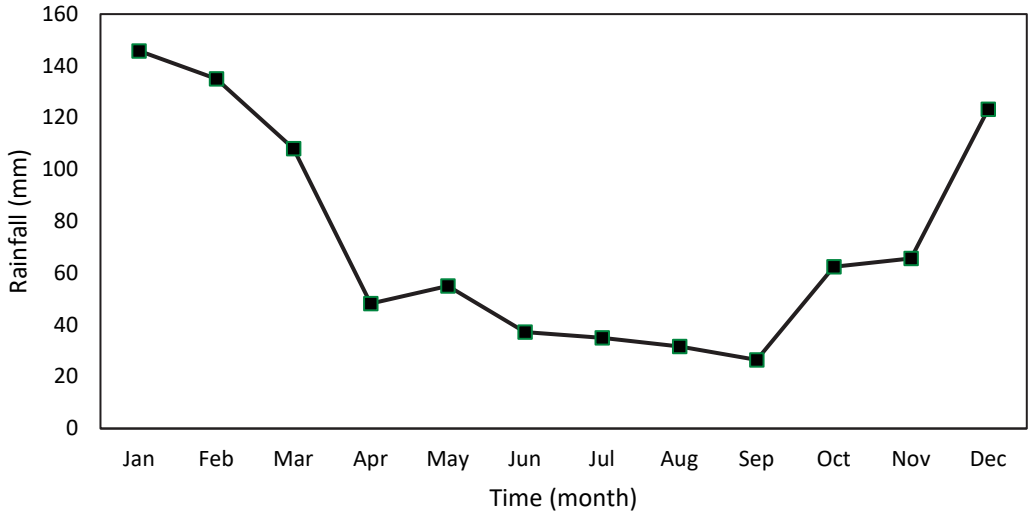
Climate data for the region have been captured by the Gladstone Radar Weather station (station no. 39123) from 1957 to2026 (BoM 2025b). Based on the climate data collected from this weather station, the region experiences an annual mean maximum temperature of 27.8 degrees Celsius (°C), an annual mean minimum temperature of 18.7°C and a mean total annual rainfall of 870.4 millimetres (mm). The long-term mean temperature and the mean monthly rainfall are presented in **Table 1**.

Table 1. Long-term mean temperature since 1957 (BoM weather station 39123, Gladstone)

Temp (mean °C)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min	22.6	22.5	21.7	19.7	17.0	14.4	13.5	14.4	16.6	18.8	20.6	22.0
Max	31.4	31.1	30.3	28.4	25.7	23.4	23.0	24.4	26.7	28.5	30.1	31.2

Rainfall data show distinct wet and dry seasons, with high rainfall from December to March and low rainfall from June to September (**Figure 6**). Winds are primarily south-easterly; however, during the warmer months there is often a north-easterly sea breeze. The region is subject to the effects of tropical cyclones and tropical lows during the summer months which can produce wind and rainfall events that are typically short-lived and intense. The resulting run-off can cause localised flooding in the region (BoM 2025a). Local climatic conditions have been considered in rehabilitation and closure planning. Seasonal rainfall patterns influence the timing of revegetation, topsoil placement and rehabilitation activities, while extreme rainfall events associated with tropical lows and cyclones have informed erosion and sediment control measures, drainage design and final landform development to support long-term rehabilitation success and landform stability.

Evaporation rates influence soil moisture availability, vegetation establishment, rehabilitation performance and mine water balance and are therefore relevant to rehabilitation and closure planning. Mean solar exposure based on climatic data recorded at the nearest meteorological stations (Gladstone (site no. 39123), located approximately 25 km from the Project area indicate a seasonal trend with monthly values ranging from an average of 13.8 megajoules per square metre (MJ/m2) during the winter (June) to 25.6 MJ/m2 in summer (December) (BoM 2025b). The mean annual evaporation is 1,800 mm, with an approximate range of 80 mm during the winter (June) to 250 mm during the Summer (January) (BoM 2016).



Data accessed in April 2025 for BoM weather station 39123, Gladstone (BoM 2025b). The data range spans from 1957 to April 2025. The weather station remains active as of April 2025

Figure 6. Mean monthly rainfall

2.1.3.1. Long term projections of weather events

Storms

Although there is no defined season or period when severe weather events are most likely to occur in Queensland, severe storms tend to frequently occur during summer months (October to April) and periods of heatwave (Queensland Fire and Emergency Services (QFES) 2023). Severe storms can result in damaging or destructive wind gusts, flash flooding and large hailstones (greater than five centimetres (cm) in diameter) (QFES 2017).

Cyclones

Tropical cyclones are low pressure systems that form over warm tropical waters (Commonwealth Scientific and Industrial Research Organisation & BoM 2015) usually from early November to late April (QFES 2017). In Queensland, tropical cyclones typically affect the Gulf of Carpentaria, Cape York Peninsula and eastern coastline extending from the northern tip of Queensland to central coastal regions. However, there are records where tropical cyclones have moved inland from the north and east of Queensland (QFES 2017).

The number of tropical cyclones making landfall in Australia is influenced by a number of factors, however, tends to be strongly influenced by the El Niño Southern Oscillation (ENSO), with the Queensland coast experiencing three to four times as many cyclones during La Niña years compared to El Niño years (CSIRO 2024). There have been three cyclones documented as occurring within 50 km of the Project since 1969, and a further four within 100 km of the Project area. The majority of these cyclones occurred during the period from 1970 – 1992, with one cyclone occurring in recent decades (2015 Severe Tropical Cyclone Marcia, approximately 40 km south-west of the Project area).

Impacts from tropical cyclones depend on the category, wind speed, rainfall intensity and duration, and riverine flooding as a result of prolonged deluges (QFES 2023; BoM 2025c).

The average number of cyclonic wind gust events over 75 kilometres per hour (km/h) in 10 years is 0.1, with no cyclonic wind gust events occurring in excess of 150 km/h in the 30 years preceding 2014 (former Department of Agriculture and Fisheries (DAF) 2014). Although the potential for cyclone influence to occur exists, the intensity is likely to be a Category 1, with the potential for damage to mine infrastructure considered to be negligible to minor. Category 1 cyclones have a maximum mean wind of 63-68 km/h and typical strongest gusts of <125 km/h (BoM 2025c).

Floods

The Project is located within the Boyne River Basin, which covers approximately 2,590 square kilometres (km2). The area is bound by the Many Peaks Range to the east, Dawes Range to the south, Calliope Range to the south-west and Boyne Range to the west. The terrain is relatively steep with heights ranging from 600 to 850 m above sea level. Several other towns are also located within the catchment including Nagoorin, Ubobo and Builyan. The Boyne River Basin Plan area comprises a single catchment with one major river system (the Boyne River) and a number of tributaries (including Ridler, Degalgil, Marble and Diglum Creeks) that drain to Gladstone Harbour and the Great Barrier Reef. Flooding can occur along these river systems causing isolation of towns. As a result, BoM operates a flood warning system using rainfall and river stage observations (BoM 2025d).

The Project area is located within a Rapid Hazard Assessment area, and Basin level Flood Modelling for the Booyne River Basin maps the Project as having the potential for being partially inundated in 1% annual exceedance probability (AEP) events (State of Queensland 2025a). A concept final landform flooding assessment is provided in **Appendix I**.

Bushfires

Bushfire risk is influenced by a combination of increased temperatures, higher winds, lower rainfall and woody vegetation. The GRC Planning Scheme (GRC 2017) and the State-wide mapping of the Bushfire Hazard Area (developed by Department of State Development, Infrastructure and Planning (DSDIP)) indicates that the Project is located partially within Very High, High and Medium Potential Bushfire Intensity areas with some potential impact buffer.

The Project area is within the Brigalow Belt bioregion and is characterised by brigalow forests and woodlands, although they are not predominant through the entire region. Other ecosystems include eucalypt forest and woodlands, grasslands, dry rainforest, cypress pine forest and woodland and riparian communities.

As winters are typically dry with little rain received, wildfires can occur in the spring and early summer. The likelihood of a fire weather day or sequence of days gradually increases from the start of the dry season, peaking around September and decreasing into the wet season (Queensland Government 2012).

Earthquakes

Queensland is considered seismically active, with the highest hazard region lying along the eastern coast and near offshore regions (University of Queensland (UQ) 2025). Between 1977 and 2000, an average of 110 earthquakes per year have been recorded by the Queensland seismic network (ESSCC 2021); the majority of which were of a very low magnitude. Based

on the data provided by the UQ Seismological Observatory, it has been determined that the potential for earthquakes to occur within or surrounding the Project area is low (UQ 2025).

Droughts

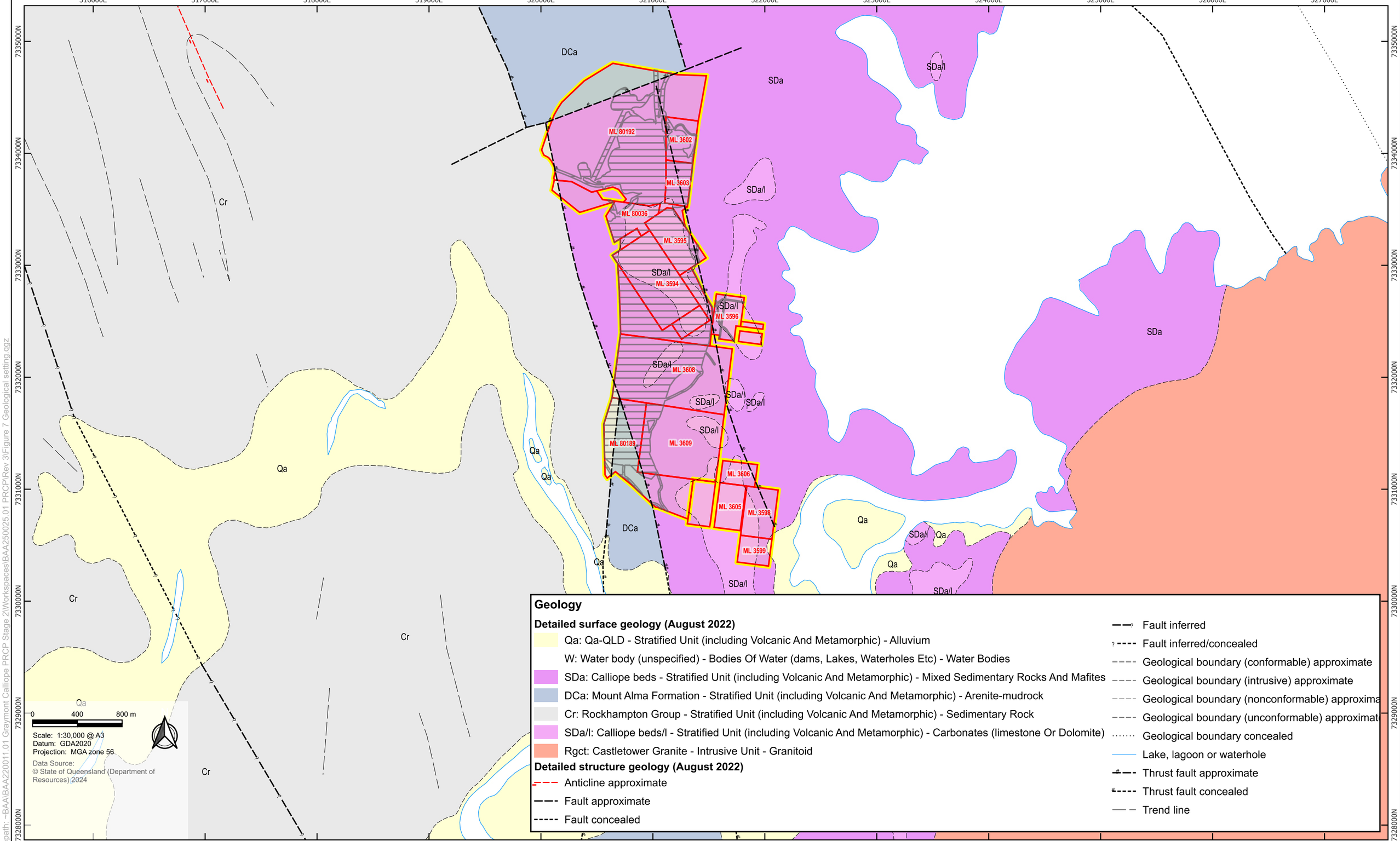
Queensland is particularly vulnerable to natural rainfall variability. Droughts are common in Queensland and generally associated with El Niño conditions. As of 3 March 2022, there were a total of 34 councils and three-part council areas drought-declared in Queensland (Queensland Government (QG) 2022). These declarations represented 64.7 percent of the land area of the state (QG 2022). As of 1 April 2025, there are no drought declared LGAs in Queensland (GG 2025). The most recent drought in Calliope occurred between January 2017 and December 2019, with below average rainfall annually and the lowest rainfall on record in the cool season (April to September). Calliope also experienced the Millennium drought between 1997 and 2009, with very much below average rainfalls. Historical droughts occurred in 1982 to 1983, and in 1965 to 1966 just prior to operations commencing in 1967. Future drought cycles are expected across much of Queensland and Australia, and are likely to also impact the Project area (QFES 2023).

2.1.4. Geological Setting

The Project's limestone deposits occur within the Early Devonian age (419-million years ago (Mya)) Calliope Beds. The Beds occupy a north-northwest striking belt about 40 km long and 3-4 km wide. They comprise predominantly volcanic rocks with relatively minor inter-bedded sedimentary rocks, including limestone. The rocks have been subjected to folding and faulting. Overburden consists of a shallow cover of soil. Boulders and cobbles of limestone and volcanics occur in much of the layer (Sibelco 2018a). The geological setting is illustrated in **Figure 7**.

As described in the geotechnical assessment provided in **Appendix B**, underlying the overburden is predominantly limestone. Discontinuities within the limestone are clay-filled and karst features are prevalent to a depth up to approximately 15 meters below ground level (mBGL). Below this depth, karst and infill becomes less prevalent and apertures become tight. Bedding surfaces within the limestone generally dip very steeply towards the west. The major axes of the pits are parallel to the strikes of the beds. This characteristic is consistent within the regional geological structure. The geological and geotechnical characteristics of the site have been considered in rehabilitation and closure planning. In particular, the limestone bedrock, karst features and structural geology influence final landform design, surface water drainage and long-term stability considerations.

The volcanics exposed in the walls of the pits include predominantly basic basalt and intermediate olive green andesite. The basalt occurs as lava flows. It is exposed primarily in the upper benches of the east and south walls of Pit 4. It is dark grey, has high to very high strength and is slightly weathered. The andesite generally occurs as steep dipping dykes following vertical to sub-vertical bedding and joints within the limestone. Two dominant systems strike north-north-west and east. Their widths range from stringers to a few meters. Reduced vertical stresses at shallower depths have allowed the andesite to extrude along shallow dipping joints. It has high to very high strength and is moderately to slightly weathered (Rocktest 2026).



Geology

Detailed surface geology (August 2022)

- Qa: Qa-QLD - Stratified Unit (including Volcanic And Metamorphic) - Alluvium
- W: Water body (unspecified) - Bodies Of Water (dams, Lakes, Waterholes Etc) - Water Bodies
- SDa: Calliope beds - Stratified Unit (including Volcanic And Metamorphic) - Mixed Sedimentary Rocks And Mafites
- DCa: Mount Alma Formation - Stratified Unit (including Volcanic And Metamorphic) - Arenite-mudrock
- Cr: Rockhampton Group - Stratified Unit (including Volcanic And Metamorphic) - Sedimentary Rock
- SDa/l: Calliope beds/l - Stratified Unit (including Volcanic And Metamorphic) - Carbonates (limestone Or Dolomite)
- Rgct: Castletower Granite - Intrusive Unit - Granitoid

Detailed structure geology (August 2022)

- Anticline approximate
- Fault approximate
- Fault concealed
- Fault inferred
- Fault inferred/concealed
- Geological boundary (conformable) approximate
- Geological boundary (intrusive) approximate
- Geological boundary (nonconformable) approxima
- Geological boundary (unconformable) approximat
- Geological boundary concealed
- Lake, lagoon or waterhole
- Thrust fault approximate
- Thrust fault concealed
- Trend line

Legend

- Site boundary
- Mining leases
- Maximum disturbance extent

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Calliope Limestone Quarry
Progressive Rehabilitation and Closure Plan

Figure 7
Geological setting

2.1.5. Site Hydrology and Fluvial Networks

2.1.5.1. Catchment Overview

The Project is located within the Fitzroy catchment region within the Boyne River Basin, which covers approximately 2,590 km2 (see **Figure 8**). The area is bound by the Many Peaks Range to the east, Dawes Range to the south, Calliope Range to the south-west and Boyne Range to the west. The terrain of the bounding ranges is relatively steep with heights ranging from 600 to 850 m above sea level. Several other towns are also located within the catchment including Nagoorin, Ubobo, and Builyan. The Boyne River Basin Plan area comprises a single catchment with one major river system (the Boyne River) and several tributaries (including Ridler, Degalgil, Marble and Diglum Creeks) that drain to Gladstone Harbour and the Great Barrier Reef (GBR).

2.1.5.2. Watercourses and Waterways

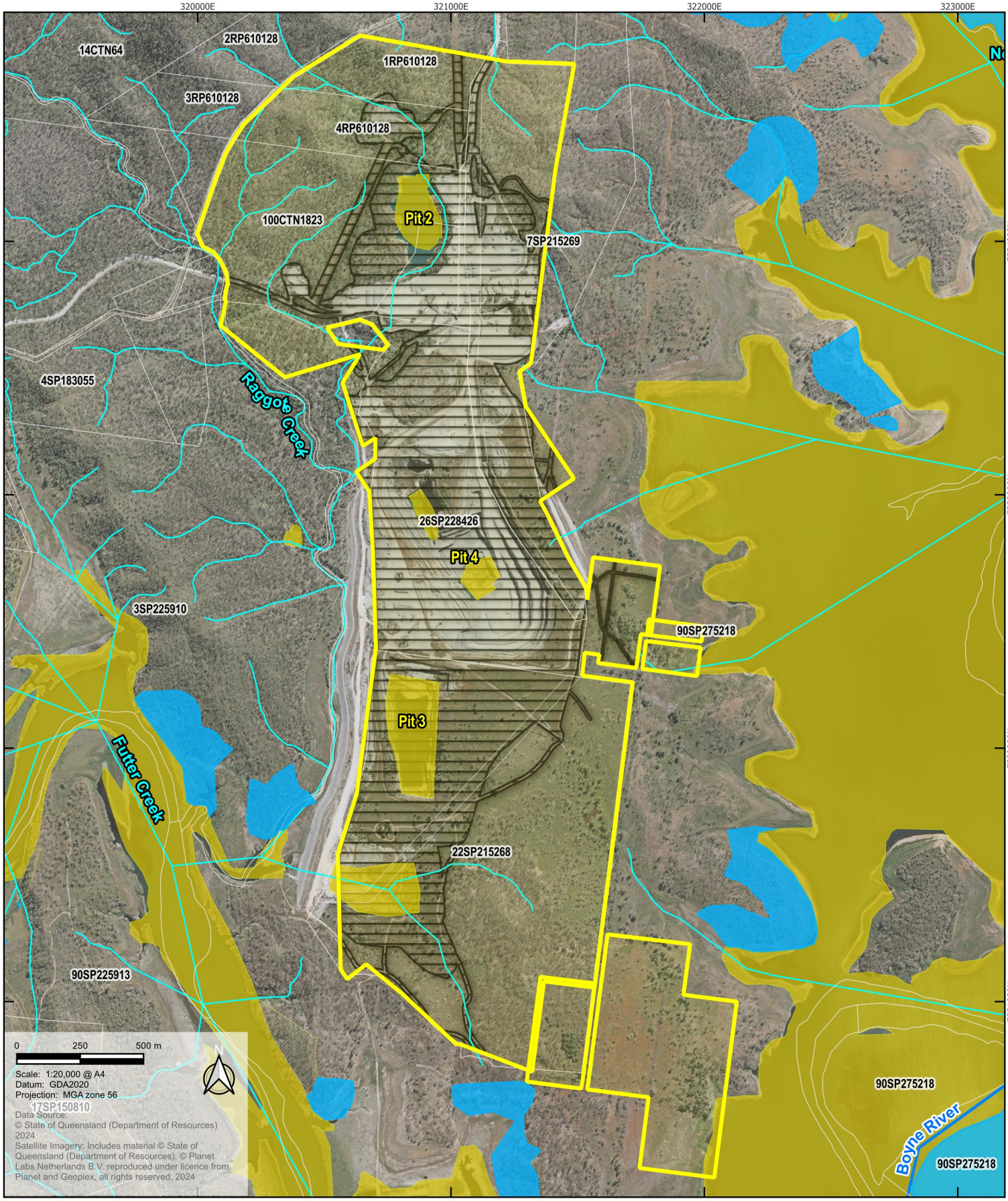
The Project is bound by Lake Awoonga to the east, south and west. Lake Awoonga forms the drinking water supply dam from the surrounding catchment area for the GAWB.

To the west of the site is a significant bund wall adjacent to Pit 3 and Pit 4. The water body adjacent to the bund wall is known as Raggote Creek, which is a tributary that flows into Lake Awoonga (see **Figure 8**). The eastern side of Pit 4 has another bund wall to prevent inundation of the mine site. GAWB has plans to increase the height of this bund wall in anticipation of raising the water level within Lake Awoonga. The lake is fed by a series of drainage lines traversing the MLs. Several of which have a direct impact on the extraction and processing activities on the site.

Review of the Queensland waterways for waterway barrier works under the Fisheries Act 1994 (viewed in Queensland Globe (QG 2025a)) indicates several low (green) first order waterways intercepting the Project area, a high (red) waterway bordering the site to the west (corresponding to Raggote Creek), and the major (purple) waterways of Futter Creek and Boyne River to the southwest, south, and east, as shown in **Figure 9.** DETSI Biomap mapping online also revealed ‘buffered streams of conservation significance: Queensland Murray Darling Basin’ bordering the Project area that correspond to the high (red) waterway and Futter Creek.

2.1.5.3. Wetlands

Lake Awoonga is mapped as a lacustrine wetland, as shown in **Figure 8**. The existing farm dam adjacent to the Southern Waste Rock Dump (WRD) is mapped as a hydrologically modified or artificial lacustrine wetland. There are no internationally important wetlands within the vicinity of the Project area; the closest Internationally Important Wetland is located greater than 1,000 km away. There are no Matters of State Environmental Significance (MSES) - High ecological significance wetlands mapped within the Project area. The closest of which is approximately 4 km east of the Project area.



Legend

- Site boundary
- Cadastre (DCDB)
- Maximum disturbance extent

Watercourses

- Major
- Minor

Matters of State Environmental Significance

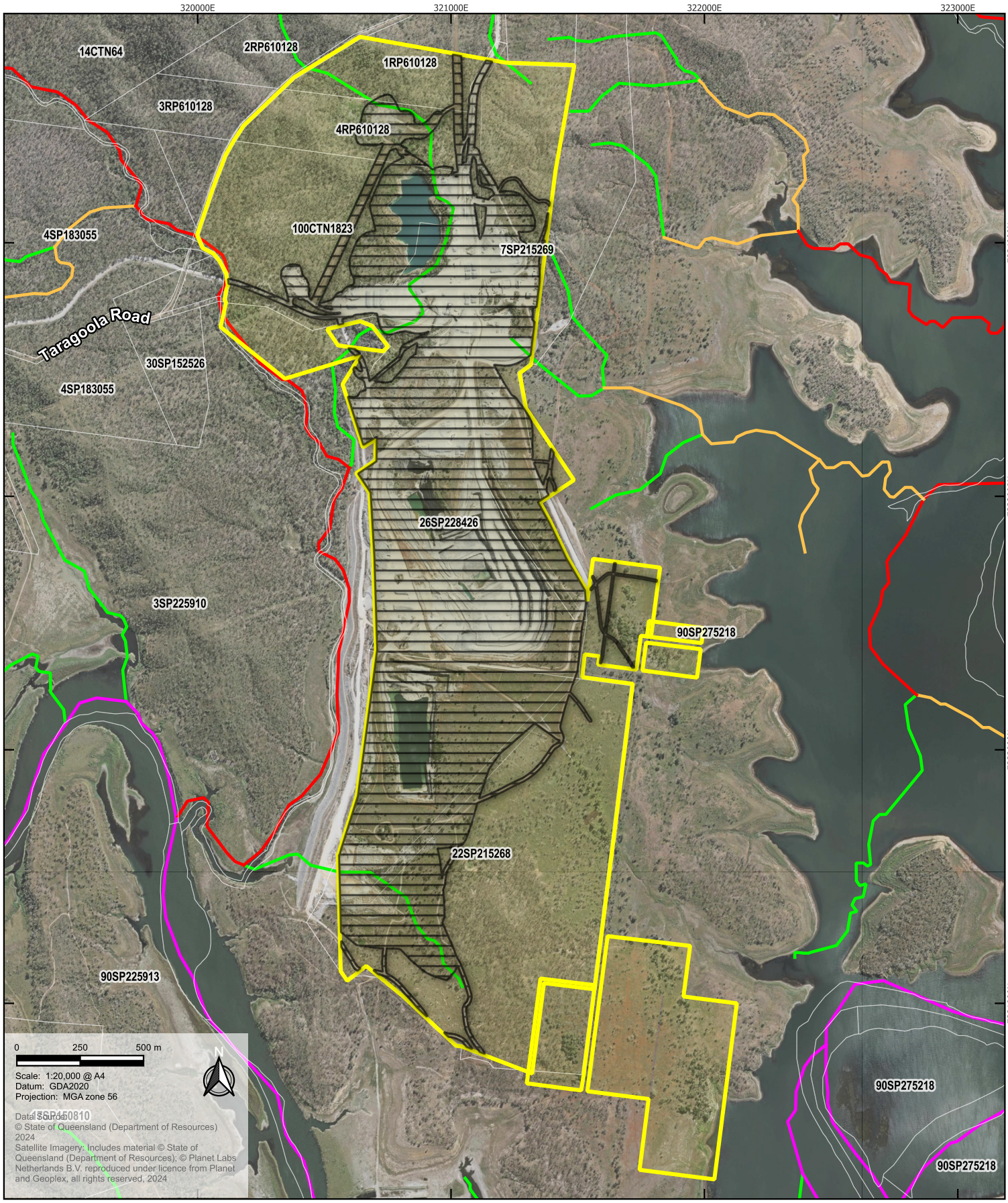
- Regulated vegetation (100m from wetland)

Wetland areas (Qld Wetland Mapping v6.0)

- Lacustrine Wetlands (hydrologically modified or artificial)
- Contains Wetlands (1 - 50%)

Graymont
Calliope Limestone Quarry
Progressive Rehabilitation and Closure Plan

Figure 8
Watercourses and wetlands



Filepath: --BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 PRCP\Rev 3\Figure 9 Waterways for waterway barrier works.qgz

Legend

- Site boundary
- Cadastre (DCDB)
- Maximum disturbance extent

QLD waterways for waterway barrier works

- Low
- Moderate
- High
- Major

Graymont
Calliope Limestone Quarry
Progressive Rehabilitation and Closure Plan

Figure 9
Waterways for waterway barrier works

2.1.5.4. Onsite Water Infrastructure

The Project currently comprises three pits (only Pit 4 is currently used for extraction) and two sediment ponds. The three pits each have a small local catchment which directs most runoff from disturbed areas within the Project area back into the pits. There is a small catchment in proximity to the stockpile areas which is directed to the sediment pond for treatment prior to discharge into Raggote Creek, and a farm dam directly east of the Southern WRD. Water for process use is sourced from onsite water tanks (stormwater) and Pit 2.

The three main Project water storage areas are summarised as follows (see **Figure 2**):

- Pit 2 - a water storage used for the supply of water to the wash plant
- Pit 3 - a water storage and stormwater surge capacity during periods of high rainfall
- Water tanks (four) - located within the operational stockpile areas and supply the wash plant.

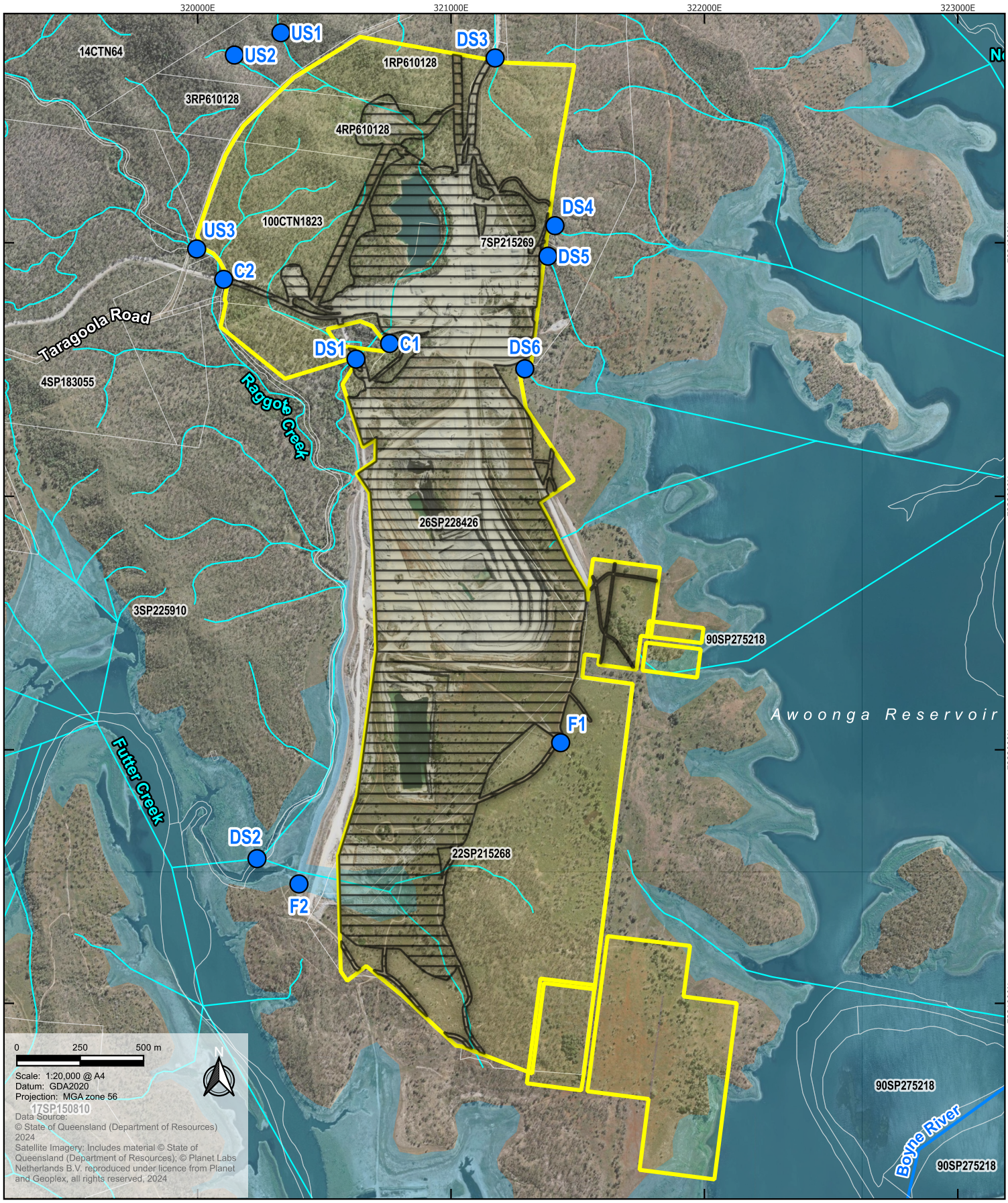
2.1.5.5. Water Quality

The release of mine impacted waters must only occur from the release points specified in Conditions C1-C6 of the EA. Water quality monitoring has been undertaken at the Project at the release points in the EA (release points F1, F2, C1 and C2). Release point F1 contained sufficient water for sampling during one sampling event (6 April 2022) prior to water being diverted to Release point C1. Release point C2 has had ponded water, and at times, insufficient water volume for adequate sampling. Release point F2 could not be safely accessed for monitoring. The summary of water quality data collected at Release Point C1 for all sampling events during 2023, 2024 and 2025 is provided in **Table 2**.

Table 2. Water quality data from release point C1 and F1 from 2023 to 2025

Release Point	Measurement	pH	Electric Conductivity (EC)	Total Suspended Solids (TSS)
C1	20th percentile	7.88	520	5
	Median	8.09	564	6.5
	80th percentile	8.18	591.8	10.6
F1	20th percentile	7.838	727	5
	Median	8.085	741	6
	80th percentile	8.168	760	7

Monitoring data collected at release points C1 and F1 indicate generally stable water quality conditions. Recorded pH values ranged from 7.57 to 8.31 at C1 and from 8.08 to 8.21 at F1, indicating neutral to slightly alkaline conditions. Electrical conductivity values were also relatively consistent, ranging from 482 to 611 µS/cm at C1 and from 729 to 782 µS/cm at F1. The surface water monitoring locations proposed for closure are shown in **Figure 10**.



Legend

- Site boundary
- Cadastre (DCDB)
- Maximum disturbance extent
- Awoonga Reservoir

Watercourses

- Major
- Minor
- Surface water monitoring point

Graymont
Calliope Limestone Quarry
Progressive Rehabilitation and Closure Plan

Figure 10
Surface water monitoring locations

Water quality data from samples collected in March 2025 from Pit 3 and Pit 4 have been summarised in **Table 3**, along with the relevant water quality guidelines. This data shows that recorded water quality does not exceed guideline values. The water quality within the water storages is considered appropriate to support a water storage PMLU, as further described in **Section 7.7.4** and **Appendix O.**

Table 3. Pit water quality (collected 19/03/25)

Parameter	Units	Australian drinking water guideline	ANZECC stock watering guideline	Pit 3 Seepage	Pit 3	Pit 4
pH	pH units	6.5 - 8.5	6 - 8.5	8.1	8.1	8.2
Electrical Conductivity	µS/cm	-	5970	1144	733	472
Dissolved Oxygen	mg/l	-	-	6.5	5.7	3.9
Turbidity	NTU	-	-	24.1	9.59	5.7
Suspended Solids	mg/L	-	-	<5	<5	<5
Total Alkalinity as CaCO3	mg/L	-	-	242	89	116
Sulfate as SO4 - Turbidimetric	mg/L	-	-	55	37	47
Chloride	mg/L	-	-	143	142	18
Calcium - Dissolved	mg/L	-	-	126	60	50
Magnesium - Dissolved	mg/L	-	-	7	7	7
Sodium - Dissolved	mg/L	-	-	87	59	24
Potassium - Dissolved	mg/L	-	-	<1	<1	<1
Calcium - Total	mg/L	-	-	137	63	58
Magnesium - Total	mg/L	-	-	8	8	8
Sodium - Total	mg/L	-	-	94	64	26
Potassium - Total	mg/L	-	-	<1	<1	<1
Aluminium - Dissolved	mg/L	-	-	<0.01	<0.01	<0.01
Arsenic - Dissolved	mg/L	-	-	<0.001	<0.001	<0.001
Cadmium - Dissolved	mg/L	-	-	<0.0001	<0.0001	<0.0001
Chromium - Dissolved	mg/L	-	-	<0.001	<0.001	<0.001
Copper - Dissolved	mg/L	-	-	<0.001	0.001	<0.001
Nickel - Dissolved	mg/L	-	-	<0.001	<0.001	<0.001
Lead - Dissolved	mg/L	-	-	<0.001	<0.001	<0.001
Zinc - Dissolved	mg/L	-	-	0.007	0.01	<0.005
Iron - Dissolved	mg/L	-	-	<0.05	<0.05	<0.05
Aluminium - Total	mg/L	0.1	5	0.03	0.04	0.06
Arsenic - Total	mg/L	0.01	0.5	<0.001	<0.001	<0.001
Cadmium - Total	mg/L	0.002	0.01	<0.0001	<0.0001	<0.0001
Chromium - Total	mg/L	0.05	1	<0.001	<0.001	<0.001
Copper - Total	mg/L	2	1	<0.001	<0.001	<0.001
Nickel - Total	mg/L	0.02	1	<0.001	<0.001	<0.001
Lead - Total	mg/L	0.01	0.1	<0.001	<0.001	<0.001
Zinc - Total	mg/L	3	20	<0.005	<0.005	<0.005
Iron - Total	mg/L	-	-	<0.05	<0.05	0.06

Parameter	Units	Australian drinking water guideline	ANZECC stock watering guideline	Pit 3 Seepage	Pit 3	Pit 4
Mercury - Dissolved	mg/L	-	-	<0.0001	<0.0001	<0.0001
Mercury - Total	mg/L	-	-	<0.0001	<0.0001	<0.0001

2.1.5.6. Flooding

As described in **Section 2.1.3.1**, the Project is not within the flood warning area, and it is not located within a mapped floodplain or flood hazard area under the GRC Planning Scheme (GRC 2017). The Project area is located adjacent to areas that can be affected by major floods. BoM operates a flood warning system for the Boyne River using rainfall and river stage observations (BoM 2021d).

A hydrologic model was prepared in June 2025 to inform the development and assessment of the final landform. Refer to **Section 7.3** for further information on the hydrologic model.

2.1.5.7. Existing Water Use

Pit 2 and on-site water tanks provide water for current operations at the site. A 50,000 L water truck collects water from the Pit and completes all dust suppression onsite, including spoil piles and the washdown area at the workshop, runoff of which is captured by the interceptor for washdown of vehicles.

At a regional level, Lake Awoonga is the primary drinking water supply source for the greater Gladstone region. As such, maintaining suitable water quality within the Lake is important for water supply as well as protecting its environmental values (Sibelco 2018a).

The catchment area contributing to Lake Awoonga is 2,240 km^2 and is surrounded by the Boyne, Dawes, and Many Peaks Ranges. The lake is located approximately 20 km upstream of the mouth the Boyne River. Downstream of the lake, a limited amount of freshwater is allowed to flow downstream of the lake. The main use of the Boyne River is for recreational fishing. However, the lake is the main source of drinking water for the greater Gladstone area. The catchment area of the mine is approximately 700 hectares (ha), which represents less than 0.4 percent of the overall lake catchment (SKM 2012a).

2.1.6. Hydrogeology

There have been ongoing hydrogeological assessments occurring at the Project, predominantly since 2018 (Graymont 2020). The most recent hydrogeological assessment is provided in **Appendix F**. The Calliope limestone mining operations are located within the Calliope beds rock unit. The Calliope limestone beds limestone and volcanics are predominantly an aquitard because there is no primary porosity, but connected fractures can create a secondary porosity that forms a low yielding fractured rock aquifer. Regional recharge is in topographic elevated positions associated with thin soil cover and discharge is in topographic lows associated with deep soil and regolith (Graymont 2026a, refer **Appendix F**).

2.1.6.1. Hydraulic Conductivity

Groundwater levels respond rapidly to rainfall recharge and indicate hydraulic conductivity anisotropy. The groundwater divide provides a natural buffer against Awoonga Dam water level rises. Slug testing undertaken across the groundwater monitoring network indicates that

groundwater flow occurs within a generally low-yield fractured rock aquifer system. Hydraulic conductivity from slug testing varies from very low in limestone to high. Limestone hydraulic conductivity is consistently very low whereas volcanic hydraulic conductivity is variable from low to high and reflects differences in fracture development and connectivity (Graymont 2026a). This is further described in **Appendix F**.

2.1.6.2. Groundwater Geochemistry

The Project's groundwater monitoring bores provide the most consistent time series data available for the area. The remaining data from the Queensland State database is limited with no time series data available. However, the data has been compiled along with lithological type to assess water quality trends between the two main rock types of the area being limestone and volcanics (andesite and basalt).

In July 2012, Sibelco (owners of the site prior to Graymont) developed and implemented a Background Groundwater Monitoring Program in accordance with MINB100942509 groundwater conditions C17-25 for the Project (formerly called Taragoola Limestone Site). Groundwater monitoring results from FM5 and FM6 taken until October 2013 were used to create EPML00969013 groundwater trigger values. There are now ten groundwater bores located onsite, described in **Section 2.4.4** and shown in **Figure 11**. The results of background monitoring, trigger values and monitoring results for FM5A, FM5B, FM6, FM7, FM8 and FM9 during the reporting period 2023-2026 are shown in **Table 4**. Bore logs have been provided in **Appendix G**.

The Australian Drinking Water Guidelines (ADWG) (NHMRC 2011) provide a basis for determining the quality of water to be supplied to consumers in all parts of Australia. The livestock drinking water guidelines (Australian and New Zealand Guidelines (ANZG) 2023) provides recommended values for biological, chemical and radiological substances that may occur in livestock drinking water. Both guidelines have been considered against available data for the Project in **Table 4**. The guidelines for groundwater quality protection in Australia supports the objective of the National Water Quality Management Strategy (NWQMS) to enhance and protect groundwater quality to support the nominated EVs and preventing groundwater contamination.

Recent mean water quality data presented in **Table 4** indicates physical and chemical characteristics in groundwater (including water in or pumped from the void) within the ML generally meets drinking water and stock water quality guidelines. Sulphate exceeds the EA trigger value (20 mg/L) across FM5A, FM5B and FM6 throughout the 2023 - 2026 monitoring period, indicating elevated sulphate is a regional characteristic of the groundwater system. Electrical conductivity (EC) exceeded the 1,500 µS/cm trigger value on one occasion in FM5B (1,577 µS/cm in September 2024), after which no further exceedances were recorded. FM8 recorded an exceedance of magnesium above the 35 mg/L EA trigger value on two occasions (52 mg/L in November 2025 and 58 mg/L in January 2026). FM8 also recorded exceedances of sodium above the 100 mg/L EA trigger value on two occasions (146 mg/L in November 2025 and 145 mg/L in January 2026). FM7 recorded TSS above the 1,500 mg/L trigger on two of three sampling events (2,420 mg/L in September 2025 and 2,490 mg/L in November 2025). The elevated TSS in FM7 is likely attributable to bore development conditions during the initial sampling events following installation rather than a systemic groundwater quality issue. All

other monitored parameters remain below their respective EA trigger values (Graymont 2026a).

The major ion chemistry between FM5 and FM6 is generally similar, with the relatively recent exception of sulphate. Sulphate in FM5 and FM6 was similar until the installation of Bore FM5B. Recent 2025 sampling activities have shown that there is hydraulic connection between FM5 and the adjacent deeper FM5B. The cause of sulphate increases in FM5 and FM5B is attributed dissolution of gypsum ($CaSO_4$) and leaching of sulphate ions into groundwater.

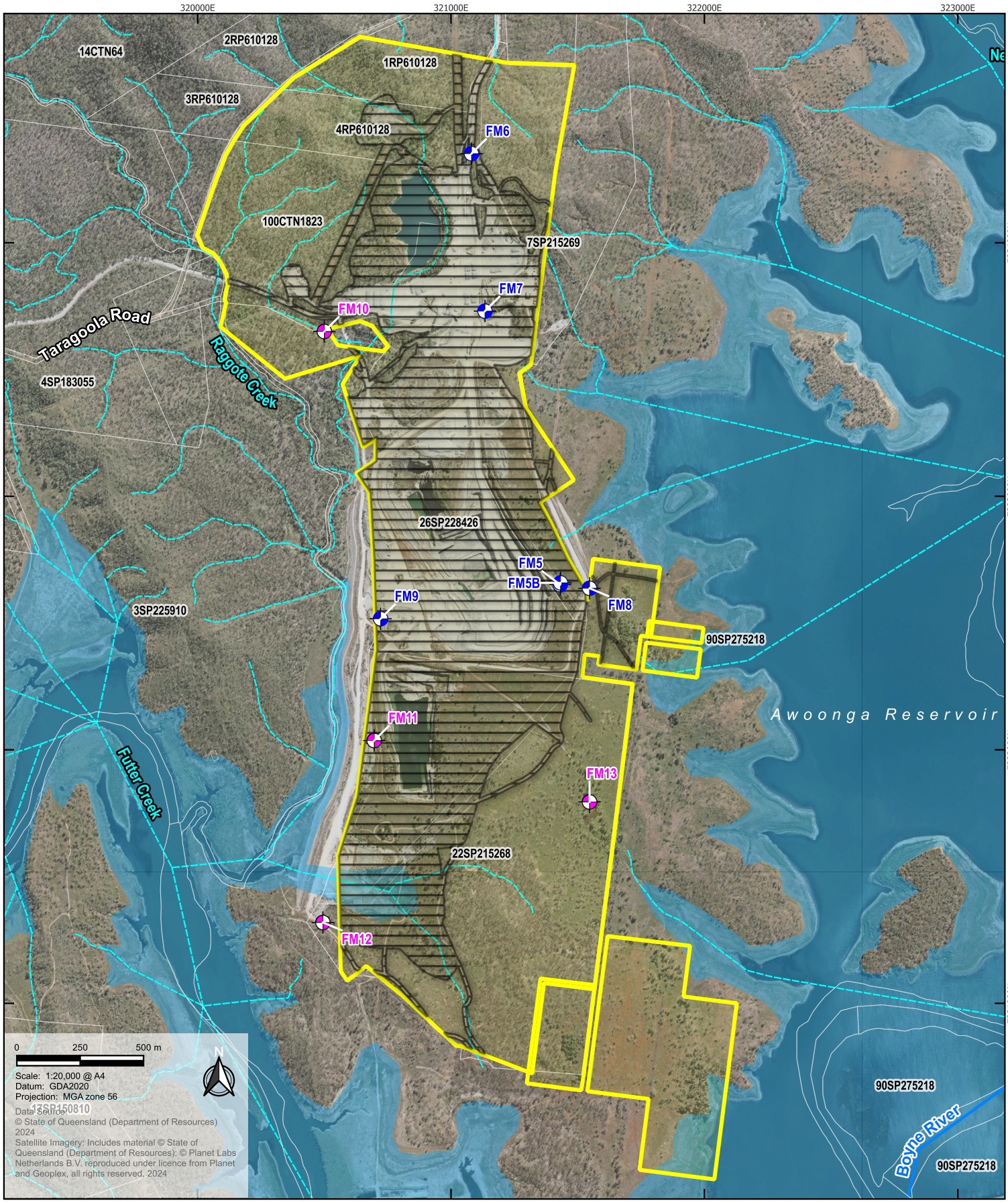
Table 4. Groundwater results (2023 – 2026)

Water Quality Indicator	Aust Drinking Water Guidelines		Stock Water Guideline	EA Trigger Value	FM5A			FM5B			FM6			FM7			FM8			FM9		
	Health	Aesthetic			Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Electrical Conductivity (µS/cm)	-	-	-	1,500	956	1,223	1,400	1,033	1,246	1,577#	789	1,035	1,435	972	987	1,011	816	1,097	1,314	656	674	687
pH	-	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.6	6.80	7.29	6.5	7.00	7.80	6.5	6.90	8.00	6.9	7.00	7.10	7.2	7.30	7.50	7.1	7.30	7.60
Total Suspended Solids (mg/L)	-	-	-	1,500	5	112	407	5	135	451	5	31.0	309	1,480	2,130	2,490#	293	781	1,250	105	261	497
Carbonate (CO_3) (mg/L)	-	-	-	500	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate (HCO_3) (mg/L)	-	-	-	500	326	387	420	374	426	488	384	463	507	398	414	432	265	467	630	243	247	250
Calcium (mg/L)	-	-	-	250	165	180	185	160	187	206	143	163	188	48	106	139	58	84.0	120	111	116	121
Magnesium (mg/L)	-	-	-	35	13	14.0	15.0	9	14.9	16.0	9	12.1	15.0	11	16.3	25.0	13	41.0	58.0#	4	4.30	5.00
Sodium (mg/L)	-	180	-	100	60	63.7	68.0	43	68.1	81.0	27	46.3	66.0	61	71.7	90.0	63	118	146#	27	30.3	35.0
Potassium (mg/L)	-	-	-	5	<1	1.20	2.00	<1	1.30	3.00	<1	1.40	5.00	<1	1.70	3.00	2	2.70	3.00	<1	1.00	1.00
Chloride (mg/L)	-	250	-	200	47	64.3	77.0	43	57.1	87.0	12	43.7	77.0	38	40.3	42.0	54	60.0	69.0	25	28.3	32.0
Sulphate (SO_4) (mg/L)	-	250	1,000	20	78#	137	168#	6	147	212#	6	28.8	236#	54#	71.0	96.0#	29#	50.7	85.0#	56#	64.0	79.0#
Arsenic (mg/L)	0.01	-	-	-	-	<0.001	0.001	-	<0.001	0.001	-	<0.001	0.002	-	<0.001	0.007	-	0.007	0.013	-	<0.001	0.001
Cadmium (mg/L)	0.002	-	-	-	-	<0.0001	<0.0001	-	<0.0001	<0.0001	-	<0.0001	<0.0001	-	<0.0001	<0.0003	-	<0.0001	<0.0001	-	<0.0001	<0.0001
Chromium (mg/L)	0.05	-	-	-	-	0.002	0.005	-	0.001	0.004	-	<0.001	0.001	-	0.003	0.007	-	0.002	0.003	-	0.001	0.002
Copper (mg/L)	2	1	-	-	-	0.012	0.023	-	0.011	0.028	-	0.005	0.016	-	0.098	0.277	-	0.033	0.079	-	0.003	0.004
Nickel (mg/L)	0.02	-	-	-	-	0.003	0.009	-	0.004	0.012	-	0.011	0.030	-	0.014	0.025	-	0.015	0.021	-	0.004	0.007
Lead (mg/L)	0.01	-	-	-	-	0.009	0.025	-	<0.001	0.002	-	<0.001	0.002	-	0.004	0.007	-	0.003	0.006	-	<0.001	0.001
Zinc (mg/L)	-	3	-	-	-	0.086	0.268	-	0.053	0.232	-	0.031	0.053	-	0.040	0.068	-	0.036	0.049	-	0.025	0.049
Total Petroleum Hydrocarbons (TPH)																						

Water Quality Indicator	Aust Drinking Water Guidelines		Stock Water Guideline	EA Trigger Value	FM5A			FM5B			FM6			FM7			FM8			FM9		
	Health	Aesthetic			Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
C6-C9 Fraction (µg/L)	-	-	-	-	<20	-	<20	<20	-	<20	<20	-	<20	<20	-	<20	<20	-	<20	<20	-	<20
C10-C14 Fraction (µg/L)	-	-	-	-	<50	-	70	<50	-	<50	<50	-	<50	<50	-	<50	<50	-	<50	<50	-	<50
C15-C28 Fraction (µg/L)	-	-	-	-	<100	-	<100	<100	-	2,070	<100	-	190	<100	-	<100	<100	-	110	<100	-	<100
C29-C36 Fraction (µg/L)	-	-	-	-	<50	-	<50	<50	-	80	<50	-	<50	<50	-	80	60	-	80	<50	-	<50
C10-C36 Sum (µg/L)	-	-	-	1,000	<50	-	70	<50	-	2,150	<50	-	190	<50	-	80	60	-	190	<50	-	<50
Total Recoverable Hydrocarbons (TRH) - NERM 2010																						
C6-C10 Fraction (µg/L)	-	-	-	-	<20	-	<20	<20	-	<20	<20	-	<20	<20	-	<20	<20	-	<20	<20	-	<20
C6-C10 minus BTEX (µg/L)	-	-	-	-	<20	-	<20	<20	-	<20	<20	-	<20	<20	-	<20	<20	-	<20	<20	-	<20
>C10-C16 Fraction (µg/L)	-	-	-	-	<100	-	<100	<100	-	<100	<100	-	<100	<100	-	<100	<100	-	<100	<100	-	<100
>C16-C34 Fraction (µg/L)	-	-	-	-	<100	-	<100	<100	-	2,100	<100	-	200	<100	-	120	<100	-	160	<100	-	<100
>C34-C40 Fraction (µg/L)	-	-	-	-	<100	-	<100	<100	-	<100	<100	-	<100	<100	-	<100	<100	-	<100	<100	-	<100
>C10-C40 Sum (µg/L)	-	-	-	-	<100	-	<100	<100	-	2,100	<100	-	180	<100	-	120	<100	-	160	<100	-	<100
BTEXN																						
Benzene (µg/L)	1	-	-	-	<1	-	<1	<1	-	<1	<1	-	<1	<1	-	<1	<1	-	<1	<1	-	<1
Toluene (µg/L)	800	25	-	-	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2
Ethylbenzene (µg/L)	300	3	-	-	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2

Water Quality Indicator	Aust Drinking Water Guidelines		Stock Water Guideline	EA Trigger Value	FM5A			FM5B			FM6			FM7			FM8			FM9		
	Health	Aesthetic			Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
m- & p-Xylene (µg/L)	-	-	-	-	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2
o-Xylene (µg/L)	-	-	-	-	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2
Total Xylenes (µg/L)	600	20	-	-	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2	<2	-	<2
Sum of BTEX (µg/L)	-	-	-	-	<1	-	<1	<1	-	<1	<1	-	<1	<1	-	<1	<1	-	<1	<1	-	<1
Naphthalene (µg/L)	-	-	-	-	<5	-	<5	<5	-	<5	<5	-	<5	<5	-	<5	<5	-	<5	<5	-	<5

 # Denotes exceedance of EA trigger value.



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 PRCP\Rev 3\Figure 11 Groundwater monitoring locations.qgz

Legend

- Site boundary
- Cadastre (DCDB)
- Maximum disturbance extent
- Awoonga Reservoir

Watercourses

- Major
- Minor
- Existing compliance bores
- New compliance bores

Graymont
Calliope Limestone Quarry
Progressive Rehabilitation and Closure Plan

Figure 11
Groundwater monitoring locations

2.1.6.3. Springs and other Groundwater Dependent Ecosystems (GDE)

No Groundwater Dependent Ecosystems (GDEs), in the categories of surface expression, terrestrial, and subterranean potential GDE's, are shown as occurring in the Ragotte Creek and adjacent catchment in publicly available mapping (QG 2025a).

2.1.6.4. Existing Groundwater Use

The primary groundwater affecting activity in the Project area is the mining activity itself which leads to groundwater level drawdown. Groundwater could also be potentially affected by leakage of storages that contain fuel, oils and lubricants. As there is no direct groundwater discharge from the Project area, no groundwater-dependent ecosystems or groundwater users have been identified as being significantly affected by drawdown based on investigations completed to date.

Groundwater use in the region, apart from re-use of mine pit water, is primarily for stock and domestic use because of poor bore yields. Project operations re-use water collected in the operating pit void for processing plant operation and dust suppression on access tracks. Currently the mine operation uses approximately 33,000 L per month for the wash plant (5% of all pit re-use water) and 727,000 L litres average per month for dust suppression (95% of all re-used pit water). The water is a combination of rainfall run-off and groundwater seepage (Graymont 2026a).

The groundwater that discharges internally in the Project area (to the pits) is mixed with surface water and this is monitored regularly to ensure quality specifications are met before being released to Lake Awoonga. While the groundwater affecting activities do not impact downstream environments, the groundwater level drawdown at the mine pits may potentially induce leakage from Lake Awoonga. Studies undertaken thus far indicate that significant leakage rates from Lake Awoonga are unlikely (SKM 2012b, **Appendix F**).

2.1.6.5. Groundwater Levels

FM1, FM5 and FM5B groundwater levels are presented with Awoonga Dam water levels in **Plate 1**. As noted in the Hydrogeological Assessment provided in **Appendix F**, groundwater levels and chemistry respond to recharge. Therefore, groundwater is driven by infiltration rather than seepage from Awoonga Dam (Graymont 2026a). This is further described in **Section 7.2** and **Appendix F**.

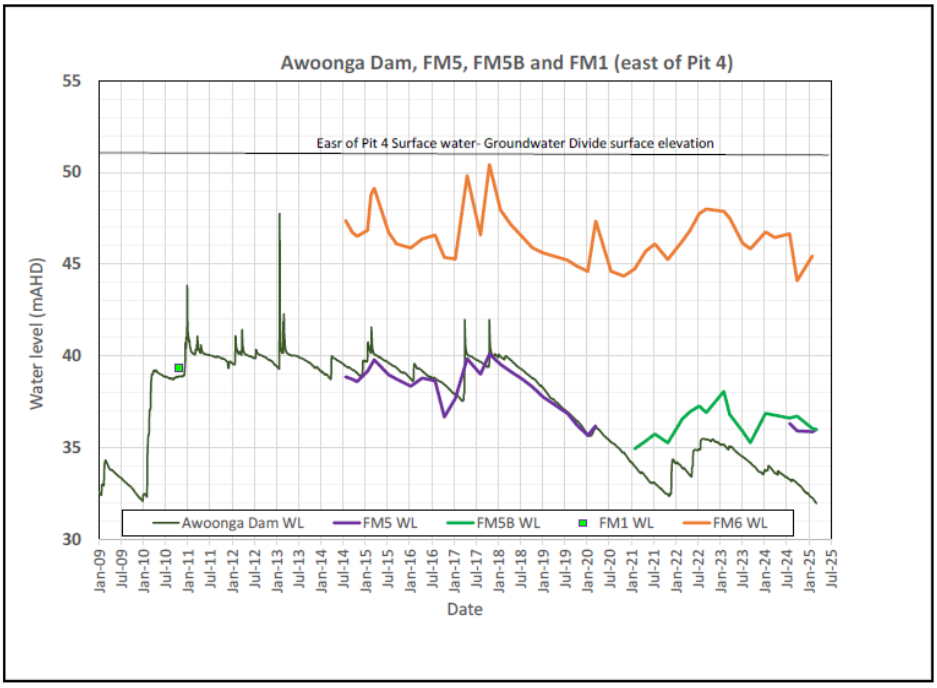


Plate 1. FM5, FM5B and FM6 groundwater levels with Awoonga Dam water level

Source: Graymont 2026a

2.1.7. Soil Types, Properties and Productivity

A search on the Queensland Government's Soils Data Portal (accessed 8 March 2023) identified that the area lies within the boundaries of Map 3 of the Land Systems of the Capricornia Coast (scale 1:250 000) prepared by the Queensland Department of Primary Industries (1995) (State of Queensland 2026). The map provided in Figure F6 of **Appendix C** and shows that the investigation area lies within the Clifton (Cf) land system (Epic 2025a). The landform and major soils of the Clifton land system are described in **Table 5**.

Table 5. Description of the Clifton land system (Queensland Department of Primary Industries 1995)

Map code	Land system	Landform and geology	Major soils	Native vegetation
Cf	Clifton	Steep to rolling hills on steeply dipping sedimentary rocks with minor volcanic intrusions	Shallow, stony brown and black massive loams and clay loams; bleached sandy and loamy surface, brown and grey, alkaline sodic duplex soils	Eucalypt woodland (lemon-scented gum, narrow-leaved ironbark, pink bloodwood, Queensland peppermint) with mixed understory

A search of Queensland Soil and Land Information (SALI) site listings (soil descriptions logged for previous government sponsored land resource surveys accessed through Queensland Globe (QG 2025a) identified four soil mapping sites (archived profile descriptions collected during previous soil and land surveys) within the site.

Details of each soil site are summarised in **Table 6** and full soil and landform information reports are provided in **Appendix C** (Epic 2025a).

Table 6. Soil and mapping site details

ID	Australian Soil Classification (ASC) and Description		Soil Code	Substrate lithology	Slope (%)	Landform	Disturbances
CCL187	Chromosol	Sodic, Eutrophic, Brown Chromosol; medium, non-gravelly, clay loamy, clayey, moderate	Bo (Bondoola)	Colluvium	6	Low hills	Limited clearing
CCL236	Dermosol	Haplic, Eutrophic, Red Dermosol; medium, non-gravelly, clayey, moderate	Cm (Cammoo)	Limestone	Not recorded	Hillslope	Extensive clearing
CCL237	Dermosol	Haplic, Eutrophic, Red Dermosol; medium, non-gravelly, clayey, very deep	Cm (Cammoo)	Limestone	5	Hillslope	Extensive clearing
CCL238	Vertosol	Endo-calcareous, Self mulching, Black Vertosol; non-gravelly, fine, very fine, very deep	Cw (Cardowan)	Limestone	3	Alluvial Plain	Not recorded

A soil survey was undertaken across the undeveloped portions of the Project area in June 2023. The survey comprised sampling and soil analysis at 19 locations, with an additional seven observational (non-analytical) locations. Detailed observations, field and analytical results from the survey are provided in **Appendix C.** Eight Soil Mapping Units (SMUs) were identified across five soil landscapes, as detailed in **Table 7** and presented in **Figure 12.**

Table 7. Summary of soil landscapes and SMUs

SMU	Soil landscape description	Survey locations (analysed sites in bold)	Surface area (ha)	% of study area
Landscape A: Limestone and marble of the Calliope Beds (SDa/l)				
A1	Very deep, gradational, pale brown to brown moderate structured clay loam to clay surface soil over moderate to well-structured dark brown clay subsoil with very few (<2%) subangular, fine gravels (2-6mm) at the surface. (ASC: Brown Dermosols)	TP10, TP11, OB08 OB04	9.5	16.8
Landscape B: Arenite-mudrock of the Mount Alma Formation (DCa)				
B1	Shallow, gradational, brown to black, moderately structured light clay over dark yellowish brown, weakly to moderately structured very stony clayey sand to medium clay with very few (2%) fine to coarse (2-60 mm) subangular/subrounded gravel fragments at the surface. (ASC: Leptic Rudosol)	TP07, TP08, MO02, MO01	5.5	9.8
B2	Deep, uniform, dark grey, very slightly mottled weakly structured medium clay over black, increasingly mottled moderately to well-structured medium clay grading to moderately gravelly mottled yellow medium clay at depth with few (2-10%) fine to medium (2-20mm) subrounded/rounded gravels at the surface. (ASC: Redoxic Hydrosol)	**TP01** OB02	1.5	2.7

SMU	Soil landscape description	Survey locations (analysed sites in bold)	Surface area (ha)	% of study area
Landscape C: Made ground / disturbed largely on limestone substrate				
C1	Deep, disturbed mixed regolith reddish brown; clay loam sandy to light clay; moderate to extremely abundant (20-90%) fine gravels to boulders (2-2000 mm) at the surface. (ASC: Spolic Anthroposol)	TP02, MO05, MO03	4.4	7.8
Landscape D: Sedimentary rocks of the Rockhampton Group (Cr)				
D1	Shallow, gradational, moderately to well-structured slightly to very stony dark grey; light clay over extremely stony, mottled weathered parent material with very few (<2%) fine to medium gravels (2-20mm) at the surface. (ASC: Leptic Rudosol)	**TP03,** TP09	1.5	2.6
Landscape E: Mixed sedimentary and mafic rocks of the Calliope Beds (SDa)				
E1	Deep, texture contrast, brown to yellowish brown weakly structured, moderately stony sandy clay loam to clay loam sandy surface soil over strong brown well-structured, moderately stony heavy clay with very few to few (2-10%) fine to medium gravels (2-20mm) at the surface. (ASC: Brown Chromosol)	**TP04,** MO06, MO04	19.3	34.3
E1(s)	E1 shallow phase Moderately deep, texture contrast, dark yellowish brown, weakly structured, stony sandy clay loam over moderately structured, reddish brown, moderately stony medium clay with few (2-10%) fine gravels (2-6 mm) at the surface. (ASC: Brown Chromosol)	TP06	2.2	3.9
E2	Deep, gradational, very dark brown very slightly stony, massive clay loam sandy over brown, increasingly stony, massive clay loam sandy with very slightly to moderate (<2-50%) fine to medium (2-20mm) angular/subangular gravels at the surface. (ASC: Brown Kandosol)	**TP05,** MO07	12.4	22.0

The Agricultural Land Audit (DAFF 2013) identifies land currently used for agriculture and land with the potential to be used for agriculture using the Agricultural Land Class (ALC) scheme (DSITI & DNRM 2015). The Project area is mapped as Class C2 (Suitable for grazing on native pastures, with or without the introduction of pasture) under the ALC.

A Land suitability assessment was conducted for the undeveloped parts of the project as part of the soil survey. The suitability assessment was based on rainfed cattle grazing based on the ALC class, the surrounding land use and nominated PMLU. Land was classified into five land suitability classes (LSC), as outlined in **Table 8**. The outcomes of the land suitability assessment are presented in **Table 9** which shows each limitation class and the overall LSC for each SMU soil type. The suitability assessment excluded the 'man-made' disturbed soils classified as Spolic Anthroposols.

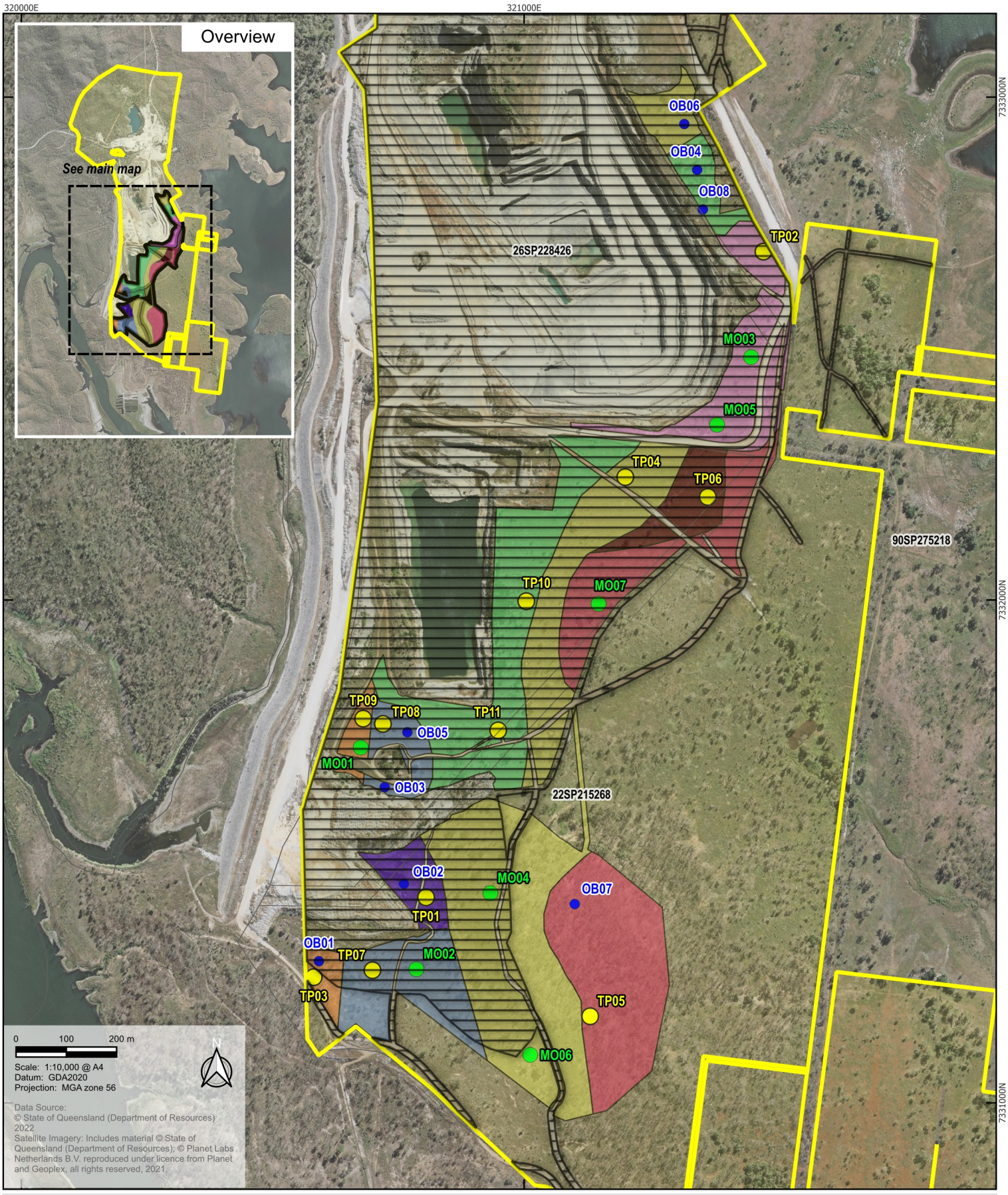
The Land suitability assessment was consistent with the ALC and the surrounding land use and provides a good indication of the productivity of the land that has previously been disturbed by mining and may be disturbed during LOM (Epic 2025a).

Table 8. Land suitability classes

Land Suitability Class	Description	Definition
1	Suitable land with negligible limitations	This is highly productive land requiring only simple management practices to maintain economic production.
2	Suitable land with minor limitations	Either reduce production or require more than the simple management practices of class 1 land to maintain economic production.
3	Suitable land with moderate limitations	Either further lower production or require more than those management practices of class 2 land to maintain economic production.
4	Unsuitable land with severe limitations (also referred to as marginal land)	Presently considered unsuitable due to severe limitations. The long-term significance of these limitations on the proposed land use is unknown or not quantified. The use of this land is dependent upon undertaking additional studies to determine whether the effect of the limitation(s) can be reduced to achieve sustained economic production.
5	Unsuitable land with extreme limitations	Extreme limitations that preclude its use.

Table 9. Land suitability class for rainfed beef grazing

Limitation	Limitation class for each SMU						
	A1	B1	B2	D1	E1	E1(s)	E2
Water availability (PAWC)	1	3	1	4	1	3	1
Nutrient deficiency	3	3	2	3	2	2	3
Soil physical factors	2	2	1	1	1	2	2
Salinity	1	1	1	1	1	1	1
Rockiness	1	1	1	1	1	1	1
Microrelief	1	1	1	1	1	1	1
pH	2	1	3	2	2	1	1
Exchangeable Sodium Percentage (ESP)	1	1	1	1	1	1	1
Wetness	1	1	3	1	1	1	1
Topography	1	1	1	1	1	1	1
Water erosion	2	2	1	2	1	2	2
Flooding	1	1	2	1	1	1	1
Vegetation regrowth	2	2	2	2	2	2	2
Overall land suitability class	3	3	3	4	2	3	3



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 PRCP\Rev 3\Figure 12 Soil mapping units.qgz

Legend

- Site boundary
- Cadastre (DCDB)
- Maximum disturbance extent

SMU and ASC classification

- A1 Brown Dermosol
- B1 Leptic Rudosol
- B2 Redoxic Hydrosol
- C1 Spolic Anthroposol
- D1 Leptic Rudosol
- E1 Brown Chromosol
- E1(s) Brown Chromosol
- E2 Brown Kandosol

Soil survey sites

- Detailed site
- Observation site
- Semi-detailed site

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Calliope Limestone Quarry
Progressive Rehabilitation and Closure Plan

Figure 12
Soil mapping units

2.1.8. Land Stability

The pre-mining land use at the MLs was low intensity grazing. No information is available on pre-mining lease land stability, however, reference to available topographical information and aerial imagery indicates the MLs were predominantly vegetated with undulating surface levels prior to mining commencing. Mapped geological landforms are shown in **Figure 7.**

No significant erosion features were identified in the soil survey of un-mined areas at the Project and landform design development has specifically addressed long-term stability. Soil stability will be considered in rehabilitation efforts (**Appendix C,** Epic 2025).

2.1.9. Vegetation Communities and Ecological Data

The Project area is located within the Brigalow Belt bioregion. Current Regional Ecosystem (RE) and Regulated Vegetation mapping for the site includes remnant and regrowth RE 11.11.15 eucalypt woodland dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*) with an understorey of native tussock grasses (**Figure 13**). This RE is listed as Least concern under the *Vegetation Management Act 1999* (VM Act).

RE 11.11.15 is described as Eucalyptus crebra +/- Corymbia erythrophloia +/- E. populnea +/- E. melanophloia +/- C. tessellaris +/- C. clarksoniana woodland to open woodland often with a shrubby layer. Eucalyptus exserta and E. platyphylla are present in the central coastal part of the bioregion occurring on undulating rises and low hills, often with a distinct strike pattern formed on moderately to strongly deformed and metamorphosed sediments and interbedded volcanics and Permian sediments. During ecological field surveys undertaken in 2023 (**Appendix N**), no rare, vulnerable, or endangered species were found in the Project area (Epic 2023b).

Queensland regulated vegetation mapping indicates the majority of the Project area is Category X non-remnant vegetation, with areas of Category B, C and R vegetation mapped in the far northern and southern portions of the Project area (**Appendix N,** QG 2025a). The extent of this mapping within the Project area is detailed in **Table 10**. Current DNRMMRRD vegetation community mapping identified three REs within the Project area mapped as a mix of homogenous and heterogenous polygons. The REs are described in **Table 11** and depicted in **Figure 13.**

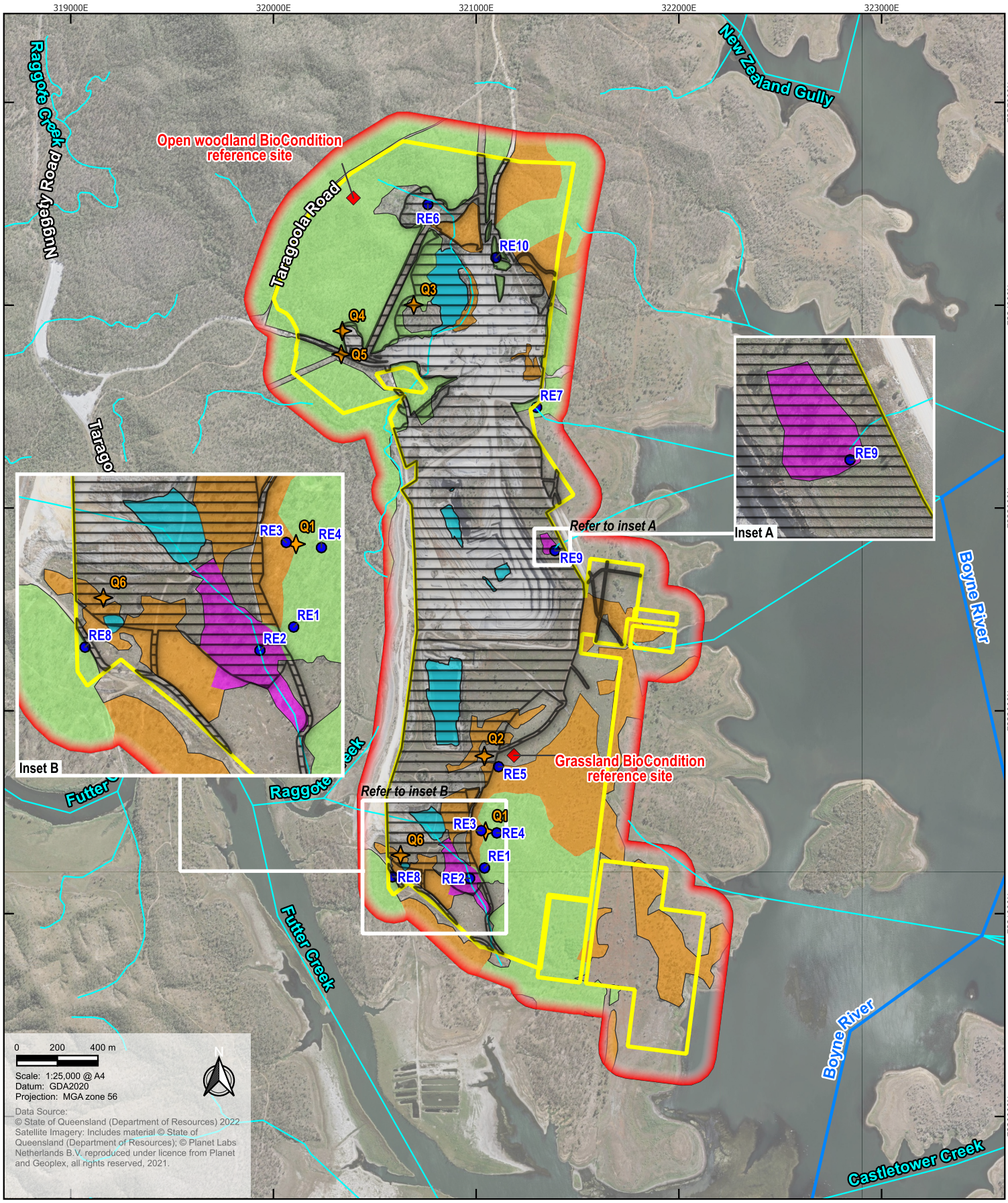
No Matters of State Environmental Significance (MSES) are impacted by Project disturbance onsite (Epic 2023b).

Table 10. Regulated vegetation mapped within the Project area

Regulated vegetation category	Extent (ha)
Category X (non-remnant)	278.50
Category B (remnant)	103.50
Category C (high-value regrowth)	28.60
Category R (riverine regrowth)	18.90

Table 11. Regional ecosystems currently mapped within the Project area

RE	Short description (Queensland Herbarium 2021)	VM Act status	EP Act status
11.11.15	*Eucalyptus crebra* woodland to open woodland on deformed and metamorphosed sediments and interbedded volcanics.	Least concern	No concern at present
11.11.4	*Eucalyptus crebra* woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges.	Least concern	No concern at present
11.11.4a	*Eucalyptus tereticornis* dominated woodland. Other tree species listed above may occur as sub or co-dominant species. Not a wetland.	Least concern	No concern at present



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 PRCP\Rev 3\Figure 13 Ground-truthed regional ecosystems.qgz

Legend

- Site boundary
- Maximum disturbance extent
- Survey area

Ground-truthed Regional Ecosystems

- 11.11.15 (Regrowth)
- 11.11.15 (Remnant)
- 11.3.25 (Remnant)
- Non-remnant
- Water

Vegetation management watercourses v7.0

- Major
- Minor

Survey sites

- Quaternary RE
- Secondary RE
- BioCondition

Graymont
Calliope Limestone Quarry
Progressive Rehabilitation and Closure Plan

Figure 13
Ground-truthed regional ecosystems

2.1.10. Fauna Presence and Populations

A desktop ecological assessment identified 27 fauna species listed as conservation significant under the NC Act as potentially occurring within proximity to the Project area (source WildNet [Wildlife Online] database search and the Protected Matters Report (PMR) generated by the Protected Matters Search Tool). This included the Squatter Pigeon (southern) (*Geophaps scripta scripta*) which is listed as vulnerable under the *Nature Conservation Act 1992* (NC Act) and EPBC Act, and the Koala (*Phascolarctos cinereus*) which is listed as endangered under the NC Act and EPBC Act (Epic 2023b, **Appendix N**).

An ecology survey undertaken by Epic Environmental in March 2023 identified a total of 23 fauna species (or evidence of) within the Project area, including three non-native species. The faunal assemblage was dominated by common diurnal birds, particularly those species that are tolerant of disturbance and able to utilise cleared open areas. A range of microhabitats suitable for various fauna occurred on site. Rock piles were common and likely provide suitable habitat for reptiles and small mammals. Several small farm dams also occur within the southern portion of the Project area and likely provide drinking water for a range of mammals and birds. It may also support native and exotic aquatic fauna species (Epic 2023b).

2.1.11. Pre-Mining Land Use

Prior to mining activities, the Project area was used for low intensity-grazing of native improved pasture. This is consistent with the grazing land surrounding current operations (refer **Figure 14)**. The original mixed eucalypt woodland which occurred in the Project area has been significantly altered by clearing, grazing and mine/quarry activities since 1967. Other regional changes have been brought about by agriculture and the extensive land inundation caused by Lake Awoonga. The Project area and surrounds are zoned as rural under the GRC Planning Scheme (GRC 2017). The nominated post-mining land use is consistent with the historical land use and the surrounding rural grazing landscape, supporting the long-term integration of rehabilitated areas with adjoining land uses.

2.1.12. Identification of Underlying Landholders

The Project is located across 19 MLs owned by Graymont, covering an area of approximately 425 ha. The Project does not overlap with any other mineral tenements. The main tenure across the ML and surrounds is mapped as freehold land owned by Graymont and / or GAWB. There are seven tenders within the Project area, Graymont is the landholder for six of these, with one (Lot 90 on SP275218) owned by GAWB.

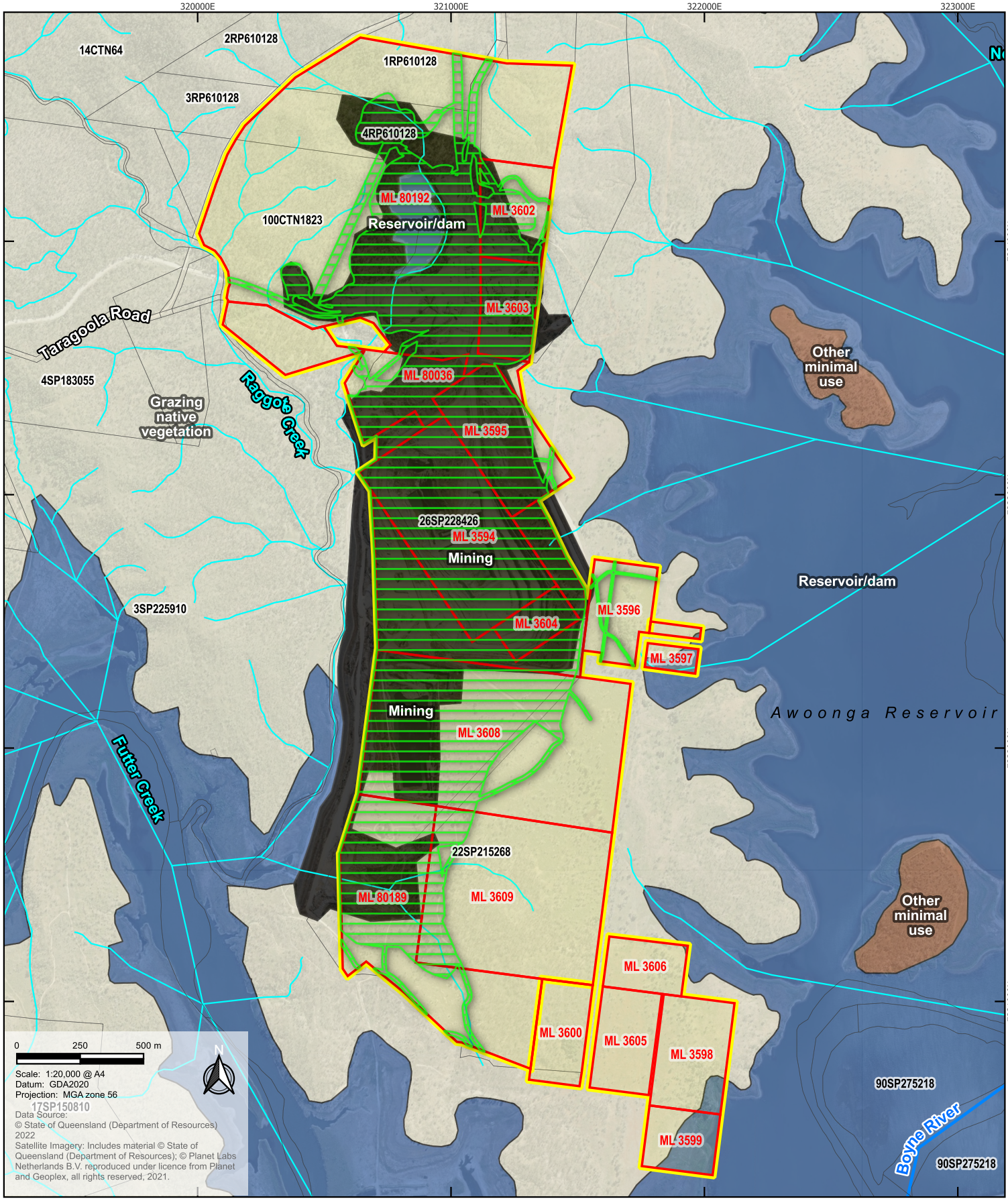
The underlying landholders for the Project area and the tenure type, are identified in **Table 12**.

Table 12. Tenure and landholder details

Permit	Property	Holder	Tenure	Granted	Expiry	Area (ha)	Current Usage
ML3594	7SP215269 26SP228426 90SP275218	Graymont	Freehold	1 March 1964	28 February 2041	32.3729	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land
ML3595	7SP215269 26SP228426 90SP275218	Graymont	Freehold	22 January 1986	28 February 2041	15.7903	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land
ML3596	7SP215269 90SP275218	Graymont	Freehold	1 June 1972	28 February 2041	9.1029	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land
ML3597	90SP275218	Graymont	Freehold	1 March 1964	31 December 2041	2.8328	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land
ML3598	90SP275218	Graymont	Freehold	22 January 1986	31 December 2041	12.4694	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land
ML3599	90SP275218	Graymont	Freehold	19 February 1976	31 December 2041	6.7987	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land
ML3600	90SP275218 22SP215268	Graymont	Freehold	28 September 1972	28 February 2041	8.0937	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land
ML3602	7SP215269	Graymont	Freehold	7 March 1988	31 March 2027	10.2284	Mining, Access/roads, Infrastructure, Spoil areas

Permit	Property	Holder	Tenure	Granted	Expiry	Area (ha)	Current Usage
ML3603	7SP215269 26SP228426 90SP275218	Graymont	Freehold	7 March 1988	31 March 2027	8.3416	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land
ML3604	7SP215269 26SP228426	Graymont	Freehold	1 March 1965	29 February 2028	4.8562	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas
ML3605	90SP275218	Graymont	Freehold	10 March 1988	31 July 2028	9.4444	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land
ML3606	90SP275218	Graymont	Freehold	7 March 1988	31 July 2028	5.61	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land
ML3608	26SP228426 22SP215268	Graymont	Freehold	26 October 1972	31 October 2030	60.0705	Native bush, Infrastructure, Access/Roadways, mining, Topsoil areas, spoil areas
ML3609	90SP275218 22SP215268	Graymont	Freehold	18 April 1988	31 October 2030	43.3519	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land
ML80036	7SP215269 26SP228426 90SP275218 100CTN1823	Graymont	Freehold	15 June 2001	30 June 2022	18.73	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land
ML80189	7SP215269 90SP275218 22SP215268	Graymont	Freehold	13 May 2013	31 May 2043	36.05	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land
ML80190	26SP228426	Graymont	Freehold	13 May 2013	31 May 2043	22.5	Mining, Access/roads,

Permit	Property	Holder	Tenure	Granted	Expiry	Area (ha)	Current Usage
	90SP275218						Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land
ML80191	26SP228426	Graymont	Freehold	13 May 2013	31 May 2043	1.6	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas
ML80192	7SP215269 26SP228426 90SP275218 100CTN1823 1RP610128 4RP610128	Graymont	Freehold	14 May 2013	31 May 2043	121.5	Mining, Access/roads, Infrastructure, Spoil areas, Topsoil areas, Native bush/grazing land



Filepath: --BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 PRCP\Rev 3\Figure 14 Land uses.qgz

Legend

- Site boundary
- Mining leases
- Cadastre (DCDB)
- Maximum disturbance extent

Watercourses

- Major
- Minor

QLD Land use mapping (secondary)

- Other minimal use
- Grazing native vegetation
- Mining
- Reservoir/dam

Graymont
Calliope Limestone Quarry
Progressive Rehabilitation and Closure Plan

Figure 14
Land uses

2.2. Project Description

2.2.1. Mining Tenements

The Project has approval under EA EPML00969013 which covers the following Mining Leases: ML3594, ML3595, ML3596, ML3597, ML3598, ML3599, ML3600, ML3602, ML3603, ML3604, ML3605, ML3606, ML3608, ML3609, ML80036, ML80189, ML80190, ML80191, ML80192 (refer **Figure 1)**. The Project's mining tenements and tenement holders are described in **Table 12**. It is noted that ML107805, ML107814, ML107808, ML107813, ML107806, and ML107807 are not proposed to be disturbed as part of the Project and, therefore, no rehabilitation activities are currently anticipated within these leases.

2.2.2. Primary Mine Features

The Project comprises a range of mining, processing, and infrastructure activities distributed across the MLs. The primary mine features are summarised in **Table 13.** It is noted that whilst there are undisturbed areas within the Project's MLs, the Queensland Fire Emergency Services (QFES) conducts regular controlled burning of these areas to manage bushfire risk and maintain access adjacent to Lake Awoonga. **Table 13** includes the maximum disturbance area per activity type during the mine life. It is noted that some of these areas are transitioning to alternative activities throughout the mine life to avoid needing to utilise additional undisturbed land as much as possible.

Table 13. Primary mine features and maximum disturbance areas

Disturbance Type	Relevant Tenures	Details of disturbance types	Maximum Disturbance Area until EOML (ha)
Access Tracks	ML3602, ML3603, ML3604, ML3594, ML3604, ML3608, ML3609, ML80036, ML80036, ML3594, ML3595, ML80189, ML80190, ML80191, ML80192	This includes all existing access tracks (unsealed, gravel). All access tracks will be retained throughout LOM, noting there will be new access tracks proposed around the perimeters of the southern WRD and Pit 3-4, as the current access tracks are encompassed within the maximum disturbance footprints of these features.	20.31
Infrastructure	ML3602, ML3603, ML80192	This incorporates the processing and logistics infrastructure, including administration office, workshop, storage infrastructure, crushing and screening plant, wash plant, processing area; powerlines, conveyors, concrete pads, communications towers, groundwater bores, fuel storage and water storage tanks, hardstand areas, laydown yards, equipment, and proposed helipad to be constructed for emergency services.	27.34
Open pit (Voids)	ML3595, ML3594, ML3603, ML3604, ML3608, ML80190, ML80192	Existing quarry disturbance areas: Pit 1 – Historical pit, non-operational, completely backfilled Pit 2 – Residual void used for water supply for operations Pit 3 - Residual void used as water storage Pit 4- Current quarry pit, will be amalgamated with Pit 3 to become Pit 3-4 at EOML	121.18

Disturbance Type	Relevant Tenures	Details of disturbance types	Maximum Disturbance Area until EOML (ha)
Cleared Areas and Laydowns	ML3595, ML3602, ML3603, ML3608, ML80036, ML80189, ML80190, ML80191, ML80192	Cleared areas and lay downs used to support operations. This includes the 'graveyard' where old machinery is stored, areas for staff parking and truck access, and previously disturbed areas within the Project area.	11.22
Spoil Piles	ML3595, ML3594, ML3603, ML3608, ML80036, ML80190, ML80191, ML80192	This includes all current and proposed future spoil pile areas, including the area currently used as the Northern WRD.	26.38
Topsoil Areas	ML3595, ML3604, ML3608, ML80190	This includes areas for topsoil stockpiles and the silt dump located within the Project area.	7.84
Sediment Ponds	ML3603, ML80192	Two sediment ponds located adjacent to the processing and infrastructure areas onsite.	1.46
Waste Rock Dump	ML3609, ML80036, ML80189, ML80191, ML80192	Maximum extent of the southern waste rock dump, including buffer area for overburden from Pits.	15.83
Silt Dump	ML80192	Area used for lime silt storage.	1.11
		Total Disturbance	**232.67**

2.2.3. Type and Duration of Mining Operation

Limestone mining has been ongoing at Calliope since 1967, with Graymont managing operations since 2019. Situated just west of Lake Awoonga, the quarry produces approximately 0.8 Mtpa of limestone products, with an estimated 142,000 tonnes (t) of overburden and waste rock extracted annually (Sibelco 2012; Sibelco 2018b). The quarry intersects 19 MLs and adjoins land owned and operated by the GAWB, with some shared access tracks in the area used by both Graymont and the GAWB (Sibelco 2018b). The current disturbance area of the Project is shown in **Plate 2** and **Figure 2,** and maximum disturbance extents anticipated during the LOM shown in **Figure 3.**



Plate 2. Drone footage of Calliope Limestone Quarry in February 2023

Source: Epic Environmental 2023a

Mining operations have remained consistent throughout the LOM and consists of conventional open cut benching methods. Mining begins with topsoil and subsoil stripping followed by removal of clay rich overburden and waste rock which is hauled to designated spoil dumps. Limestone ore is then extracted by drilling and blasting, then crushed, screened, and washed onsite at the Run of Mine (ROM) pad (Sibelco 2018a). The site is equipped to continue onsite processing of limestone with purpose-built infrastructure including the crushing and screening plant and wash plant, that have a rate of production of up to 20,000 t a week. Limestone is loaded by a 120 t excavator onto 85 t and 100 t off road dump trucks to be transported to customers off site for further downstream processing into quicklime and hydrate production. There is a second 75 t excavator on site which is utilised as a backup for the open cut operations (Sibelco 2018b).

Approximately 23,500 trucks (including single body, truck and quad dogs and B doubles) transport 0.8 Mtpa of limestone products from the Project via Taragoola Road (graded, partially unsealed road) to the town of Calliope where they connect to Gladstone via Dawson Highway (Sibelco 2018b). Historically, limestone was loaded onto trains via Rail Siding Road (to the west of the site) to be transported to Gladstone, however it is now transported via Taragoola Road to the north of the site. As the rail infrastructure still exists, there may be potential in the future for limestone export to commence again via rail.

Uses for Graymont's products include purification of water for drinking, soil pH adjustment, stock feed, road construction, and the production of materials essential to our modern economy such as steel, cement, paper, and metals. Limestone, overburden and waste rock of different grades and suitable physical properties are also used as process feed for road base production.

Overburden rock materials have been used for the construction of barriers to prevent surface water inundation of the quarry workings due to the recent and possible future raising of the Awoonga Dam wall. These material placements were conducted under the direction of the

GAWB. The Pits and most access tracks onsite have material placed along the perimeters to safely prevent access and control surface water flows. Future material placement to prevent Lake Awoonga inundation will continue to be conducted in collaboration with the GAWB. There are no geochemically reactive or acid forming wastes, tailings dams, or heap leach pads onsite, and the environmental risks from the inert waste rock are considered low/negligible (Epic 2026, refer **Appendix J**). A maximum of 10 to 20 scrap tyres will be temporarily stored onsite in the infrastructure area and will be regularly collected and transported to an appropriately licensed waste facility.

The current Project schedule includes limestone ore to be mined exclusively from the existing open cut mining pit, Pit 4, which is located centrally within the Project area. Blasting in Pit 4 occurs approximately once a month. Lateral and vertical expansion of Pit 4 is projected over the next 70 years to occur in four stages from north to south, with amalgamation of Pit 3 expected to occur during the southern expansion (**Figure 3**). A south to north mining approach has also been considered in the final landform design (Graymont 2026b).

EOML is currently scheduled for 2100, but this may change depending on the reserves onsite and yearly sales quantities. A PRC Plan amendment will be undertaken if there are any material changes to operations that will impact the rehabilitation staging of the Project. All future disturbance until EOML will be authorised by, and undertaken in accordance with, the amended EA.

2.3. Design for Closure

Mine operations and mine planning commenced in 1967. In line with contemporary approaches during the 20th century, limited consideration of closure requirements was undertaken in the mine engineering. The current layout of the Project is largely a legacy of the historical activities, rather than a reflection of current contemporary approaches to mine planning. Extractive activities are authorised and conducted under the resource EA (EPML00969013) and the prescribed EA (EPPR00881913) (not associated with this PRC Plan). EA EPML00969013 includes the following resource environmentally relevant activity (ERA) from Schedule 3 of the EP Regulation:

- ERA 21 – A mining activity that is an ineligible ERA, other than a mining activity mentioned in items 9 to 20

Notwithstanding the above, the following section provides an outline of how Graymont has considered design for closure in all planned future activities. These considerations have included the Rehabilitation Hierarchy, namely:

- **Avoid** disturbance that will require rehabilitation
- **Reinstate** a “natural” ecosystem as similar as possible to the original ecosystem
- **Develop** an alternative outcome with a higher economic value than the previous land use
- **Reinstate** previous land use (e.g., grazing or cropping)
- **Develop** lower value land use

- **Leave** the site in an unusable condition or with a potential to generate future pollution or adversely affect environmental value.

2.3.1. Location of Mine Features / Infrastructure

An assessment of the consideration of locations of mines features / infrastructure is provided in **Table 14**, for the planned future expansions of the Project, including:

- South and eastern expansion and amalgamation of Pit 3 and Pit 4
- Additional topsoil and spoil stockpiles
- Eastern expansion of the southern waste rock dump.

All remaining mine features / infrastructure are historical or legacy disturbances that continue to support operations.

Table 14. Closure considerations for new mine features/infrastructure

Location of mine features/infrastructure, having regard to the following considerations:	South and eastern expansion and amalgamation of Pit 3 and Pit 4	Eastern expansion of the southern WRD	Additional spoil stockpiles across the site
Protection of environmental values of the site and receiving environment, including matters of National Environmental Significance (MNES), MSES and matters of Local Environmental Significance (MLES)	Limited environmental values have been identified south and east of the existing Pit 3 and Pit 4. Expanding south and east does not impact on any identified MNES, MSES or MLES.	The eastern expansion of the southern WRD will impact on existing mapped area of MSES regulated vegetation (Cat B). This area has also been ground truthed as containing 'of concern' regional ecosystem as has been assessed as part of the major EA amendment previously provided for the Project. The impact to this area will be authorised under the environmental authority and offset in accordance with the Environmental Offset Act 2014. No MNES or MLES have been identified within the proposed WRD expansion.	Additional spoil stockpiles have been located at various locations that do not impact on identified areas of potential MNES, MSES, or MLES.
Surrounding land uses and proximity to sensitive receptors	No sensitive receptors are located within 5 km of the extent of the proposed Pit 3 and Pit 4 expansion. The expansion of the pits will have no additional impact on surrounding land-uses. The edge of the proposed expansion will remain >600 m from the Project boundary.	No sensitive receptors are located within 5 km of the extent of the proposed WRD expansion. The expansion of the WRD will have no additional impact on surrounding land-uses. The edge of the proposed expansion will remain >600 m from the Project boundary.	No sensitive receptors are located within 5 km of the extent of a proposed spoil stockpile location.
Proximity to the open pit exit or exits	Not applicable – Pit 3 and Pit 4 are open pits. Any impacts to internal exits or tracks will be managed through operations and maintained as required through closure activities.	Open pit exits and exits have been repositioned within the mine plan to allow for the expansion of the WRD.	Spoil stockpiles have been positioned to not impact on any open pit exits and/or other exits.
The gradient of the footprint area, both for the direction of drainage from the landform and for the dumping costs	Pit 3 and 4 expansions will be a continuation of the legacy mine plan. The amalgamation of the pits will increase the containment capacity within a larger pit lake. Surface gradients will ensure surface waters will continue to grade into the amalgamated pit to ultimately form a pit lake.	A gradient suitable to maintain geotechnical stability of the batters has been designed and considered in the position of the WRD.	Spoil stockpiles have been positioned to not impact on any open pit exits and/or other exits.
Local and regional topography	Pit 3 and Pit 4 expansion will be a continuation of the legacy mine plan and	The local topographic slopes range between 20 and 14o. The WRD final landform will have slope ranges of	Spoil stockpiles have been positioned to not intersect any drainage paths and

Location of mine features/infrastructure, having regard to the following considerations:	South and eastern expansion and amalgamation of Pit 3 and Pit 4	Eastern expansion of the southern WRD	Additional spoil stockpiles across the site
	will have a negligible impact on local and regional topography.	approximately 13o to remain consistent with local topography. The WRD will have negligible impacts on undulating regional topography.	remain consistent with topographic slopes.
Surface and ground water features (quality, quantity, and seasonal variation)	Pit 3 and 4 expansion will not increase the rate of groundwater inflows or intersect any surface water features. No groundwater dependent ecosystem has been identified within the Project boundary.	The legacy extent of the southern WRD has previously intersected a tributary of Futter Creek (stream order 1). This tributary is a mapped watercourse, however, is no longer flowing into Futter Creek as a result of the location of the existing WRD. The proposed expansion will not increase any impacts to Futter Creek. The expanded southern WRD is located at surface and will not impact on any groundwater feature. The expanded southern WRD does not impact on any identified GDE.	Spoil stockpiles have been positioned to not intersect any drainage paths. Spoil stockpiles are positioned on elevations that will not impact on groundwater features. No groundwater dependent ecosystem has been identified within the Project boundary.
Geotechnical conditions (i.e. soil/rock characteristics) and suitability for the structure type (i.e. presence of structural features that may transmit seepage)	The Pit 3 and 4 expansion will not limit the ability for the final landform to be geotechnically stable.	A gradient suitable to maintain geotechnical stability of the batters has been designed and considered in the position of the WRD.	Residual spoil stockpiles at the EOML will be used to construct the required abandonment bunds and stormwater controls.
Competing water and land use	Pit 3 and 4 expansion will limit grazing land available for the post mining land-use.	The southern WRD expansion will be returned to a grazing land-use post mining.	Spoil stockpiles will not impact on competing water and land-uses.
Visual impact	The expanded pit lake of Pit 3 and 4 will not create any additional visual impact from a publicly accessible viewpoint or landholder.	The expanded southern WRD will not create any additional visual impact from a publicly accessible viewpoint or landholder.	Residual spoil stockpiles at the EOML will not create a visual impact from a publicly accessible viewpoint or landholder.

2.3.2. Design of Mine Features

Design considerations for planned mine features / infrastructure have been detailed in **Table 15**.

Table 15. Design considerations for planned mine features/infrastructure

Mine Feature / Infrastructure	Size, Shape and Design Considerations
Southeastern expansion and amalgamation of Pit 3 and Pit 4	The size and shape of the Pit 3 and Pit 4 expansion have been designed to consolidate the existing pits into a single residual void at closure. Amalgamation of the pits reduces the number of separate voids requiring long-term management and enables the formation of a single pit lake, simplifying closure implementation and reducing long-term liabilities. The pit design incorporates benched highwalls to maintain long-term geotechnical stability and support safe closure outcomes. Abandonment bunds will be constructed around the residual void in accordance with relevant safety requirements to restrict unauthorised access and provide a long-term safety barrier around the final pit lake.
Additional spoil stockpiles	Spoil stockpiles will be utilised for establishment of abandonment embankments and drainage features.
Eastern expansion of the Southern WRD	The size and shape of the southern WRD have been designed to achieve a stable post-mining landform suitable for supporting a grazing PMLU. Final batter gradients and surface drainage controls have been developed to minimise erosion, ponding and long-term maintenance requirements. A suitable growth medium (topsoil) will be applied to support vegetation establishment and facilitate achievement of rehabilitation completion criteria. Final landform planning promotes effective drainage and minimises the potential for water accumulation (ponding) and pore pressure development within the rehabilitated landform.

2.3.3. Mining Methods

Mining operations will remain consistent throughout the LOM and consist of conventional open cut benching methods. These methods will ensure the residual pit walls are geotechnically stable post closure.

2.4. Rehabilitation / Improvement Planning

The rehabilitation area will encompass the entirety of the current and future disturbance areas, shown in **Figure 2** and **Figure 3**.

2.4.1. Objectives

Following the removal of limestone and cessation of mining operations, Graymont aims to return the site to a stable condition, achieving a balance of locally native ecological communities, low intensity grazing land and stabilised residual voids. Areas not subject to significant disturbance (i.e. areas outside the residual void) will generally be rehabilitated such that the land represents low intensity grazing that is likely to have occurred onsite prior to mining and being analogous to surrounding undisturbed areas. The objectives of mine rehabilitation are to:

- Create a landscape safe for humans and wildlife into the foreseeable future
- Create a stable landform with natural rates of erosion

- Establish vegetation communities that resemble those originally found onsite, which blend visually with the surrounding landscape and vegetation
- Establish functional, self-sustaining vegetation communities
- Establish ecosystems that resemble neighbouring undisturbed areas in their ability to respond to fire and droughts
- Ensure minimal post-mining impacts on surface catchments
- Provide water supply infrastructure for ongoing use by landowners
- Provide a stable non-polluting hardstand area for ongoing use by landowners.

2.4.2. Duration of Relevant Activities

The Project has been operational since 1967. The duration of each relevant activity is outlined in **Table 16**. Whilst the exact year that each activity commenced cannot be confirmed, the final year of operations for current activities is known and is the basis for this PRC Plan.

Table 16. Duration of quarry activities

Rehabilitation Area Description	Duration of Activity
Historical Pit 1	1967- ~1970 as a Pit 2025- 2100 as for stockpiling and aglime production
Cleared Areas	1967- 2045(for this purpose) Note: northern cleared area will be used for infrastructure (helipad)
Pit 2	1967 - ~1970 for quarrying ~1970 – 2100 for water supply
Infrastructure and laydown areas	1967- 2100
Southern WRD	1967 - 2100
Northern WRD	Pre 2000s - 2008
Future Pit 3-4	1967 – 2100
Spoil pile areas	1967 - 2100
Sediment ponds	1967 - 2100
Topsoil stockpile areas and silt dump	1967 - 2100
Access tracks	1967 - 2100

2.4.3. Extent and Proposed Rehabilitation of Relevant Activities

It is acknowledged that this Project is a legacy mine site that was not necessarily designed for closure. Therefore, to minimise environmental harm from additional disturbance, existing disturbed areas will be preferentially used for alternative activities as needed to support mining until EOML. With the intended expansion of the Pit as mining progresses, disturbed areas will become constrained and opportunities to undertake rehabilitation of disturbed areas prior to EOML are therefore limited. To ensure implementation of an adaptive rehabilitation program, Graymont will seek opportunities to rehabilitate areas of the Project prior to EOML if proposed operations change in the future. Proposed duration of operations and rehabilitation areas is further described in the latter sections.

2.4.3.1. Access Tracks and Levees

Most of the access tracks at Calliope have existed for many decades since initial construction of the quarry. Graymont's use of the access tracks for mine haulage, general and land maintenance access is shared with GAWB who require access to Lake Awoonga and the eastern and western levees for monitoring and maintenance activities. The access tracks to the north are also utilised by cattle grazers who work in the undisturbed areas.

The location of future realigned access tracks required due to the expansion of Pit 3-4 and the southern WRD are displayed in **Figure 3**. Access tracks will be used throughout the LOM and to facilitate access for rehabilitation activities. As Graymont are the underlying landholders for most of mining tenures, the access tracks and eastern and western levees are proposed to be retained at EOML to facilitate access for future GAWB maintenance requirements and surrounding land uses (refer **Figure 15**). Evidence of agreement for proposed infrastructure to be transferred for ownership at the EOML has been provided in **Appendix E**.

There are existing levees running along the eastern and western boundaries of the Project that are also used as access tracks. The levees control surface water flows across the site and will also be retained for GAWB's management requirements (**Plate 3**).



Plate 3. Western bund (levee) facing north

Source: Epic Environmental 2023a

2.4.3.2. Mine Infrastructure Area

Infrastructure for the Project is located within ML3602, ML3603, and ML80192 (refer **Figure 2**) and accommodates processing and logistics infrastructure and plant, which includes the following:

- Administration office and weighbridge (refer Plate 3)
- Workshop office, shed and container
- Duty Operations office

- Storage infrastructure
- Crushing and screening plant
- One 140 Finlay impact crusher
- Three LG250 Volvo loaders
- One 984 Finlay screen
- Wash plant
- Processing area
- Powerlines
- Communication towers
- Access tracks
- 88,000 L double self-bunded fuel storage tank
- Flammable and combustible liquid storage area
- Four water tanks
- Hardstand areas
- Laydown yards
- Humeceptor
- Amenities block
- Crib room
- Old duty operations shed
- Boilermaker shed
- Oil shed
- Proposed Helipad (to be constructed for emergency services)
- 415-voltage transmission line supplying 1,000 kVA to the Project
- Transformer compound
- Mobile lighting tower
- Two 988 Caterpillar loaders
- One C1550 Finlay cone
- One WA600 loader
- Two WR80 mobile conveyors
- One PC1250 Komatsu excavator
- One TR80 track conveyor
- One 375 Caterpillar excavator
- One TR65 track conveyor
- Two 785 Komatsu dump truck
- Two miscellaneous mobile conveyors
- Two EH1700 Euclid dump trucks
- One fuel truck
- One 773 B water truck
- Pug Mill
- One 966 Caterpillar tyre handler
- Eight light vehicles (service truck, Utes)
- Existing groundwater compliance bores



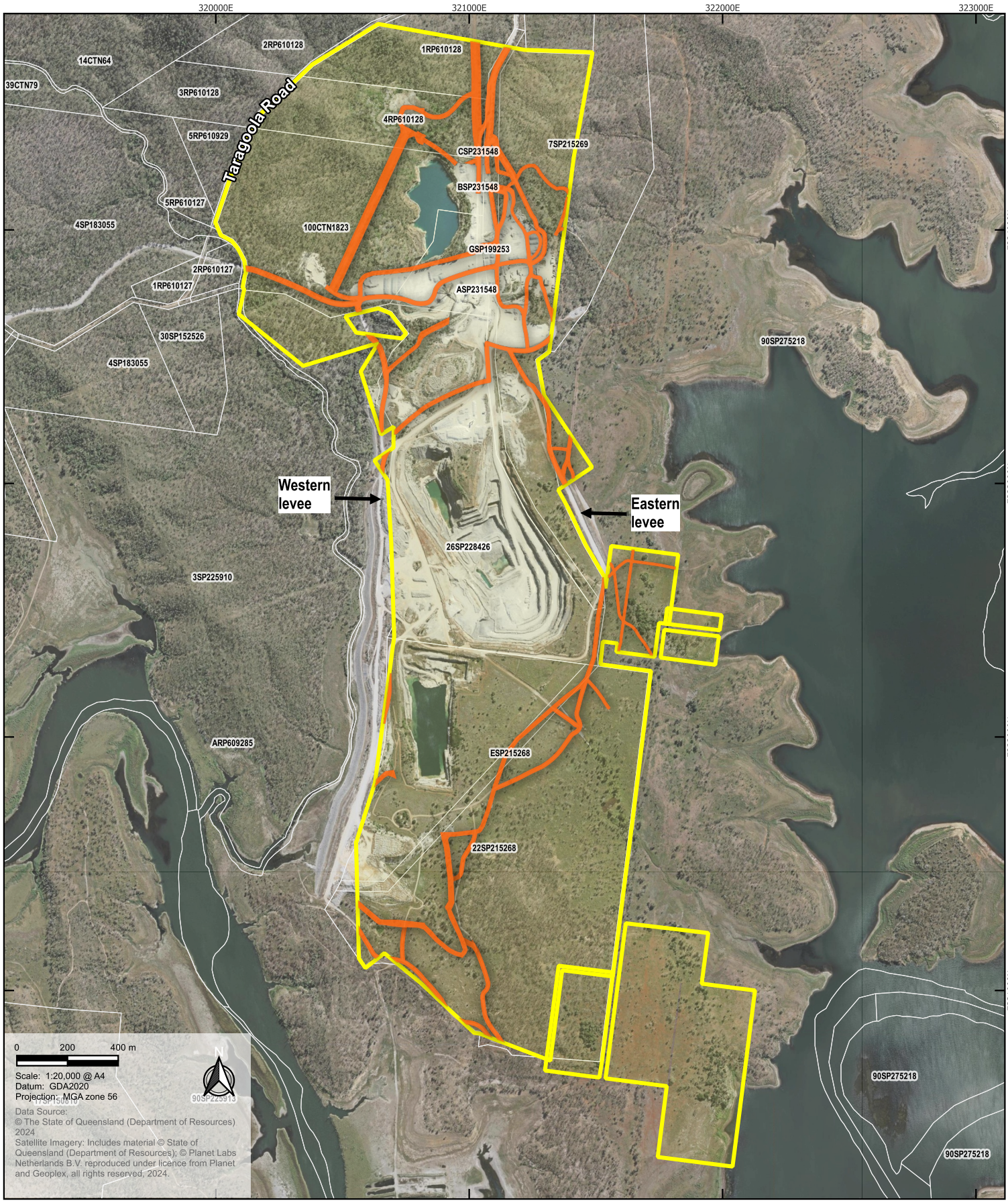
Plate 4. Site office and weighbridge at site entrance (from Taragoola Road)

Source: Epic Environmental 2023a

The infrastructure area will be decommissioned prior to closure, as outlined in **Section 7.12**. Contaminated land investigations will be undertaken at the appropriate time to identify if there is any contaminant leaching from the fuel tanks stored in the infrastructure area onsite. After this has occurred, the infrastructure areas will be rehabilitated to low intensity grazing land.

2.4.3.3. Tailings Storage Facility

There is no tailings storage facility (TSF) at Calliope.



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 PRCP\Rev 3\Figure 15 Infrastructure being retained.ggz

Legend

- Site boundary
- Cadastre (DCDB)

Retained infrastructure

- Access tracks

Graymont
Calliope Limestone Quarry
Progressive Rehabilitation and Closure Plan

Figure 15
Infrastructure being retained

2.4.3.4. Pit 1 and the Northern WRD

Pit 1 is a former mined pit that was located within ML3603 adjacent to the current infrastructure area (refer **Figure 2** and **Plate 5**). This was an open cut mine pit which has not been operational since the 1970's. Historically (pre Graymont ownership) it is understood scrap tyres have been buried in Pit 1. Since Graymont commenced operations in 2019, no scrap tyres have been buried in Pit 1. Where possible, any new scrap tyres acquired in future operations will be transported offsite to an appropriately licensed facility. To ensure compliance with conditions E1, E2, E3 and E4 of the EA (EPML00969013), any scrap tyres requiring temporary storage onsite will be placed in a trench on the Southern WRD, noting the following:

- They will be stored in stable stacks. Each stack will be separated by a minimum of 10 m to any scrap tyre storage stack, or combustible or flammable material, including vegetation
- All reasonable and practicable fire prevention measures will be implemented, including removal of grass and other materials within a 10 m radius of the scrap tyre storage area, and
- Scrap tyres temporarily stored on the Southern WRD will not impede saturated aquifers or compromise the stability of the consolidated landform.



Plate 5. View of former Pit 1 from western access point

Source: Epic Environmental 2023a

The base of Pit 1 was located above the water table and did not have any standing water within it. Overburden rock from the Northern WRD, located in ML80036, ML3595, and ML3594, was transported by dozer to backfill Pit 1 prior to and throughout 2024. To achieve the requirements of low intensity grazing, Pit 1 was backfilled to achieve a relative grade

consistent with the surrounding area so that it could be used for lime production and as a stockpile area.

Remaining material from the Northern WRD (if any) is proposed to be placed in the Pit floor of Pit 4 (if the northern pit floor is established), or on the Southern WRD buffer area depending on the staging of future Pits 3 and 4. At EOML this area will be available for rehabilitation to a low intensity grazing PMLU.

The Northern WRD has not been used since 2008 when the Southern WRD was commissioned, therefore it is not required to support current or future operations (**Plate 6**). However, the disturbed land where the Northern WRD is currently, as shown in **Figure 2**, will be required for spoil piles during future operations. Therefore, this area will not be available for rehabilitation until EOML in 2100 and is proposed to be rehabilitated to a low intensity grazing PMLU.



Plate 6. Drone footage of Northern Waste Rock Dump facing east

Source: Epic Environmental 2023a

2.4.3.5. Pit 2

Pit 2 is an open- cut mine pit located in ML112092 in the northern extent of the site (refer **Figure 2** and **Plate 7**). This pit has been non-operational since the 1970's and is currently utilised for water storage. A 50,000 L water truck collects water from the Pit and completes all dust suppression onsite, including spoil piles and the washdown area at the workshop that leads into the interceptor for washdown of vehicles.

Pit 2 will be required for operations as a water storage PMLU until EOML, with progressive rehabilitation occurring over a three year period, commencing in 2100. The western side of Pit 2 currently does not meet the final design specifications for EOML stability, described further in the Geotechnical Assessment in **Appendix B**. Prior to closure, the western batter slopes of Pit 2 will be established, and it is intended that adjoining undisturbed land will not need to be disturbed.

Final landform design for Pit 2 will be suitable for a PMLU of water storage. A hard rock perimeter abandonment bund will be constructed with a minimum offset distance from the top of the slopes to prevent access, further described in **Section 7.10.2.1**. This is consistent with

the requirements of the 'Safety Bund around Abandoned Open Pit Mines Guideline' (DIR 1997). The abandonment bund is considered to be the outer extent of the Pit disturbance area.



Plate 7. View of Pit 2 facing south

Source: Epic Environmental 2023a

The north-east, north, west and south-east sides of Pit 2 are steep and have remained largely undisturbed and/or subject to natural regrowth as shown in **Plate 8**. The remaining area along the southern and eastern sides adjoin access tracks and spoil pile areas that are proposed to be rehabilitated to a grazing PMLU. As disturbance within the exclusion zone between the pit crest and abandonment bund is limited, and these areas will be unsafe to access following closure, active revegetation is not proposed. Natural regeneration will be allowed to continue where appropriate. The rehabilitation completion criteria described in this PRC Plan will be applied to demonstrate achievement of the intended water storage PMLU.



Plate 8. Drone Footage of Pit 2 facing south

Source: Epic Environmental 2023a

2.4.3.6. Pit 3 and Pit 4

Pit 3 is a residual non-operational mine pit in ML3608 that has not been mined for many years (refer **Figure 2** and **Plate 9**). Pit 3 is currently used for water storage. While it is not currently operational, it is not available for rehabilitation as it is proposed to be dewatered and amalgamated with Pit 4 in future operations.



Plate 9. View of Pit 3 from northern ramp

Source: Epic Environmental 2023a

Existing Pit 4 is located centrally within the Project area within ML3594 and ML3604 and is the only operational pit (refer **Figure 2, Plate 10,** and **Plate 11**). Vertical and lateral expansion of the pit is projected to occur in the form of a range of cutbacks (using conventional drilling and blasting methods) on the current pit. Blasting occurs approximately once a month within the confines of ML3594, ML3604, ML3608 and ML80190. Following blasting, dozers transport loose material i from Pit 4 to the ROM pad for processing. Expansion of Pit 4 is proposed to occur in four stages from north to south, over a period of approximately 75 years. Expansion will involve widening Pit 4 to the north and south, with Pit 3 being amalgamated with Pit 4 to form the final pit design, Pit 3-4.



Plate 10. View of Pit 4 northern sump facing south

Source: Epic Environmental 2023a



Plate 11. Drone footage of southern end of Pit 4 facing southwest

Source: Epic Environmental 2023a

Pit 3-4 is planned to be mined in four stages, with indicative timeframes as follows:

- Stage 1- 2027 - 2060
- Stage 2- 2050 – 2070
- Stage 3- 2060 - 2090
- Stage 4- 2080 – 2100

Stage 1 and 2 will occur over 35 years focusing on the northern extent of the Pit. The maximum disturbance extent will be established, with final bench design and pit floor depth being achieved. Stage 3 will commence approximately 10 years prior to Stage 1 and 2 being

finalised. During Stage 3, Pit 3-4 will become amalgamated, with the eastern and western walls of the central Pit being pushed out to the maximum disturbance extent. Similarly, Stage 4 will commence approximately 10 years prior to Stage 3 being finalised and will involve final mining operations in the southern extent of the Pit. It is intended that backfilling of the Northern and Southern WRDs could occur in the northern extent of Pit 3-4. This will occur once the entire pit floor has been established and quarrying activities have shifted to the southern extent of the pit (Graymont 2026b). This PRC Plan has been developed based on the north-to-south pit progression, with the south-to-north progression considered as an alternative mine design,

Quarrying activities in future Pit 3-4 will continue for approximately 75 years until EOML in 2100. Therefore, waste percentages and calculations for available reserve volumes will be updated periodically over the LOM. A detailed mine plan is prepared for Calliope for a five-to-ten-year period, and it is likely that future mine plans and unforeseen mine parameters might delay or change intended schedules for future Pit 3-4. These mine parameters include the extent of known reserves, future changes in saleable product quantities and other variables that may impact on operational mine scheduling, and consequently, rehabilitation scheduling. It is noted that conservative estimates of the LOM, with an EOML of 2100, have been prepared based on the material balance and final landform design for the purpose of this PRC Plan. However, if refinements from future calculations will impact when Pit 3-4 can cease quarrying activities, an amendment to this PRC Plan will occur to ensure consistency with mine planning.

As the Pit 3-4 maximum disturbance extent encroaches into adjacent land, spoil pile areas will be required to store overburden and accommodate a safety clearance area around the top of the pit. Where possible, future spoil pile areas have been allocated around the Pit, with topsoil areas to be placed adjacent to the spoil pile areas, but farthest from the top of Pit 3-4. Additionally, a currently undisturbed area adjacent to the eastern side of future Pit 3-4 is proposed for temporary topsoil and subsoil stockpiling associated with future pit expansion. Where practicable, existing disturbed areas will continue to be preferentially utilised for material storage to minimise additional disturbance (Graymont 2026b).

At EOML, future Pit 3-4 is proposed to form a permanent residual void and pit lake supporting a water storage PMLU. Consistent with the closure requirements for Pit 2, a hard rock perimeter bund will be constructed with a minimum offset distance from the top crest of Pit 3-4 also, as per the requirements of the ‘Safety Bund around Abandoned Open Pit Mines Guideline’ (DIR 1997). This is further described in **Section 7.10.2.1**. The abandonment bund is considered to be the outer extent of the Pit disturbance area.

The western, southern, northern and north-eastern extents of the future Pit 3-4 adjoin existing disturbed areas proposed to be retained access track or rehabilitated to a grazing PMLU. The area to the south-east is undisturbed, as shown in **Plate 12**. The exclusion zone between the top of the crest to the abandonment bund will be partially undisturbed, or unsafe to access, therefore active revegetation is not proposed within these areas. Natural regeneration will be allowed to continue where conditions are suitable and safe access is not required. Pit 3-4 will be available for rehabilitation once backfilling activities have been completed.



Plate 12. Drone footage of Pit 3 facing north

Source: Epic Environmental 2023a

2.4.3.7. Southern WRD

Overburden rock has been placed on the Southern WRD, in ML80189 and ML3609, since it was commissioned in 2008 and will continue to be used for this purpose until EOML (refer **Plate 13**). The maximum disturbance extent of the Southern WRD has been determined based on the material balance prepared for the site, including the quantity of overburden to be taken out of Pit 3-4 and the material currently on the Northern WRD (Graymont 2026b). The southern WRD will be formed with nominal 23 % slopes, which is intended to be pushed to form 12 % slopes at the EOML (refer **Table 40**). This is further described in **Section 7.6.6.** It is intended that some of the overburden material from Pit 3-4 will be returned to Pit 3-4 once the pit floor is established.



Plate 13. Southern WRD facing west

Source: Epic Environmental 2023a

Graymont have considered final landform design of the Southern WRD based on the alternative south to north quarrying staged plan for Pit 3-4. If Pit 3-4 was to be quarried from

south to north, ongoing backfilling of material from the southern and northern WRDs would be delayed until the pit floor is established in the south. Therefore, the overburden from the Northern WRD would need to be shifted for this area to be available for spoil piling. To account for this, a WRD buffer has been included into the final landform design.

The Southern WRD was redesigned through development of this PRC Plan to manage the risk of ponding. The redesigned Southern WRD shown in **Figure 4** optimises existing topography by infilling low points where water could pond. It will be constructed into the side of the western levee adjacent to the edge of the ML80189 where the topography naturally slopes towards the existing Pits 3 and 4. During operations, the Southern WRD will have slopes greater than 12 % to minimise additional disturbance area. During the final stages of mining, additional clean rock from the Southern WRD will be backfilled into Pit 3-4.

The Southern WRD redesign incorporates a 5 m buffer for safety and flexibility in future operations, as backfilling activities are time-dependent on when the Pit 3-4 pit floor is established. A drain will be constructed at the toe of the dump to allow water from the south and east to drain to the north into the Pit 3-4 void, thereby ensuring mine-affected water is completely contained onsite within the Pit which will function as a dedicated water storage at the EOML. The drainage infrastructure will be co-located with an access track for maintenance and facilitating access to other areas of the site for monitoring purposes. Therefore, this area has been shown as ‘access track.’ This same co-located drain and access track is also proposed directly north of the Southern WRD to achieve the same purpose and ensure drainage paths are installed. It is proposed that topsoil material being stripped off the new footprint can be progressively pushed and temporarily stored adjacent to the WRD, so it is readily accessible for reuse during rehabilitation.

Access tracks around the base of the dump provide access to various parts of the site predominantly for monitoring purposes. To reduce the risk of Southern WRD slope failure, clay loam topsoil will be stripped from the surface prior to placement of the first fill lift. Subsequent lifts use the top-down method whereby trucks end dump materials near the crests and a dozer then spreads, shapes, and compacts the materials. The slopes are advanced in the same directions as the topography. No major drainage paths are blocked by the toes of the dump. As the Southern WRD is designed for grazing the slopes have very high factors of safety as calculated and indicated in the geotechnical assessment provided in **Appendix B**.

After the EOML, the principal strategies to reduce the risks applicable to the WRD will be:

- Restricting public access to the site
- Ripping the access roads to and around the dump
- Ensuring all slopes have acceptable stabilities and the toe of the northern slope is a sufficient distance from the crest of the south wall of Pit 4
- Promoting controlled drainage through rock armouring at the north and south toe of the dump
- Visually monitoring the performance of the dump over the medium to long-terms to ascertain whether the design continues to perform acceptably
- Preparedness to modify plans, designs and/or site works if the dump deviates from the design and/or its performance does not comply with the completion criteria

The Southern WRD is intended to have a PMLU of low intensity grazing that will support grasses, consistent with the existing natural regrowth that this landform can support (refer **Plate 13**). The Southern WRD will be available for rehabilitation once all backfilling activities into Pit 3-4 have been completed, and this may extend beyond the cessation of extraction activities in 2100 at the EOML.

2.4.3.8. Cleared Areas and Laydown Areas

All cleared areas and laydown areas onsite will be rehabilitated to a PMLU of low intensity grazing land, consistent with surrounding land uses. The northern most cleared area at the site is currently not used for operations, however, emergency services requested Graymont to develop this area into a helipad (refer **Plate 14**). For this reason, it is not available for rehabilitation and will remain as infrastructure until EOML, at which time it will be rehabilitated to low intensity grazing land.

The cleared area adjacent to the south-western edge of Pit 2 was historically used for operations and is currently partially revegetated. This area is required for material storage for short-term operations, therefore rehabilitation of this area to a low intensity grazing PMLU is proposed to commence in 2045 once it is no longer required for operations (refer **Plate 15**). As rehabilitation activities at the site will first be undertaken in this area, it is proposed that this area will be used as a rehabilitation trial to refine approaches before future rehabilitation commences.

The laydown area adjacent to the infrastructure areas on the eastern side of the site supports operations by providing a storage area. The laydown area located in ML80036 and ML80191, referred to as the ‘Graveyard,’ is located within GAWB land, and is used by both GAWB and Graymont. The Graveyard is used to store Graymont’s old plant and some of GAWB’s monitoring equipment. The Graveyard will continue to store equipment for both parties until EOML, at which time any remaining equipment will be removed offsite. Both areas will be available for rehabilitation at EOML in 2100 and are proposed to support a grazing PMLU.



Plate 14. Cleared area to become helipad for emergency services



Plate 15. Cleared area adjacent to Pit 2

Source: Epic Environmental 2023a

2.4.3.9. Topsoil Storage

There are topsoil stockpile areas onsite that are used for storage of topsoil and subsoil stripped from operational areas (refer **Plate 16**). As these storages are temporary, it is expected that topsoil stockpiles may shift as required, based on operations throughout the LOM. Prior to drill and blast activities, vegetation consisting predominantly of pasture grasses, along with approximately 0.25 m topsoil, is cleared from above the limestone ore body and placed in stockpiles and stored for future use in site rehabilitation. Topsoil is also stripped ahead of mining and is generally used to create safety bunds on the pit edge with overburden rock. Stockpiles are built less than two metres in height and have been seeded where they are to be stored for a long period. Many of the topsoil spoil piles contain a high proportion of clay and soil. It is anticipated that these spoil piles can be processed to recover enough material to cover the required areas during rehabilitation. The recovered material is considered to be a good growing medium for establishing regrowth.

Based on the material balance, topsoil areas required at EOML are mostly consistent with ongoing operations (Sibelco 2018b). The future Pit 3-4 and Southern WRD maximum disturbance extents will require stripping and topsoil and subsoil stockpiling in close proximity to these landforms so the soil can be used for rehabilitation of these areas. Therefore, topsoil and subsoil to be stripped for the final Pit 3-4 will be placed onto new topsoil areas outside of the disturbance footprint, on currently undisturbed land. Due to the extent of future Pit 3-4 encroaching into some areas that are currently used for topsoil storage, additional disturbed areas that have other uses will also be required for this purpose. All topsoil areas will be rehabilitated to a low intensity grazing PMLU at EOML, after the majority of the topsoil and subsoil has been hauled to and evenly spread across adjoining disturbed areas where required. There is potential that, based on the size and history of the site, additional imported topsoil will be required for rehabilitation purposes. This material will be stored in this area as needed until it can be moved to other RAs ready for surface preparation to commence.



Plate 16. Drone footage of topsoil stockpile adjacent to eastern bund

Source: Epic Environmental 2023a

2.4.3.10. ROM Processing Area

The ROM processing area is used for current operations to store limestone products for sale (refer **Plate 17**). The ROM processing area hosts the crushing and screening plant and wash plant that have a rate of production of 10-20,000 t/week (Sibelco 2018b). Lime aggregate is stockpiled based on size and intended product use (e.g. to Cement Australia) so it is ready to be transported offsite. Based on the current scale of yearly sales and trucking movements, the ROM processing area required for future operations will be relatively consistent.



Plate 17. Drone footage of operational spoil pile area facing west

Source: Epic Environmental 2023a

2.4.3.11. Spoil Piles

There are various overburden rock safety bunds and spoil storage areas adjacent to access tracks and around the perimeter edge of the existing Pits. The area that currently supports the Northern WRD footprint is also proposed to be transitioned for use for storing spoil in the future, as the existing areas will be encroached by Pit 3-4 as mining progresses. All spoil pile areas will be required to support operations until EOML, at which time all stockpiled

unprocessed raw limestone or graded limestone products remaining at EOML will be backfilled onto the established Pit 3-4 floor. These areas will be available for rehabilitation once backfilling activities have been completed which may extend beyond the cessation of mining activities at the EOML in 2100. The proposed PMLU is low intensity grazing.

2.4.3.12. Sediment Ponds

There are two sediment ponds located on-site adjacent to the operational areas in ML80192 and ML3603. Both sediment ponds capture water runoff from operations as well as surface water flow over the site from rain events (refer **Plate 18**). The sediment ponds are not proposed to be retained and will be dewatered, backfilled and rehabilitated to a low intensity grazing PMLU at EOML. The sediment ponds will remain in place until the adjoining areas have progressed rehabilitation and any required water management measures have been appropriately identified and implemented as needed.



Plate 18. Drone footage of sediment pond adjacent to spoil pile area facing south-east

Source: Epic Environmental 2023a

2.4.3.13. Silt Dump

Lime silt is a waste product from operations onsite that is hauled to the designated silt dump, located on Rail Siding Road in the north-western extent of the site (**Plate 19**). This area will be required to store silt until EOML. Graymont are looking into opportunities to sell this lime silt so it can be processed into lime products (quick lime etc.). Alternatively, this lime silt may be reintroduced to topsoil during rehabilitation if required.



Plate 19. Drone footage of silt dump
Source: Epic Environmental 2023a

2.4.4. Groundwater Bores

There are ten groundwater bores located onsite as shown in **Figure 11**. Two monitoring bores, FM5 (State water database RN187863) and FM6 (State water database RN151688), were installed in 2012 and water monitoring data collected in the period 2012-13 from these bores was used to construct action trigger levels for these bores (Graymont 2026a). The bores were installed to benchmark the natural condition of groundwater flow into quarry voids. FM5 is next to an active working pit and benchmarks groundwater entering Pit 4 from the west. FM5 is deeper and, whilst showing similar trends to FM6, it is more subdued (Graymont 2026a). FM5 benchmarks radial inward groundwater flow to Pit 4 from the east. FM6 is next to an inactive pit to the north in a non-working area, and benchmarks radial inward groundwater flow into Pit 2 (Graymont 2026a).

An additional nested monitoring bore located close to the original FM5 was drilled in January 2021 due to low groundwater levels in FM5 during mid-2019 to late-2020. Monitoring of FM5B has occurred since January 2021 and largely indicates that bores FM5 and FMB5 behave similarly, but slightly differently. Bore FM5B is currently used by Graymont as a monitoring bore but not for compliance monitoring purposes under the current EA (Graymont 2026a).

Three additional monitoring bores (FM7, FM8 and FM9) were installed and commenced quarterly monitoring from September 2025 as part of a groundwater investigation initiated by Graymont in January 2025. These new bores are located to the west, north and south of the main mining area. Following a review of the suitability of the groundwater monitoring network for the Project, new groundwater bores (FM10, FM11, FM12, and FM13) were drilled on 6 to 9 February 2026 to provide an expanded spatial coverage of groundwater conditions across the site. Details of the existing bores and newly installed compliance bores are summarised in **Table 17.** Further description is provided in Section 8.2.5 of the Hydrogeological Assessment provided in **Appendix F**.

Table 17. Groundwater monitoring bores

Monitoring bore	Hydrogeological Unit	Bore depth (m)	Location	
			Easting (GDA2020 / MGA zone 56)	Northing (GDA2020 / MGA zone 56)
Existing compliance bores				
FM5	Limestone Aquifer	30	321430.6541	7332651.421
FM5b	Volcanic	30	321432.0776	7332658.128
FM6	Volcanic	60.5	321080.6545	7334350.421
FM7	Limestone Aquifer	30	321133.7934	7333730.139
FM8	Volcanic	30	321546.5801	7332636.828
FM9	Volcanic	30	320721.6894	7332516.483
New compliance bores				
FM10	Volcanic	7.7	320542.8698	7333666.417
FM11	Volcanic	24.8	320703.8191	7332099.299
FM12	Volcanic	31	320459.3772	7331326.934
FM13	Volcanic	31	321526.2118	7331832.704

At EOML, the on-site bores will be surrendered and the bore decommissioned in consultation with the DNRMMRRD according to the preferred practices nominated in the Minimum Construction Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee 2020). The bore casing will be cut off at least 0.5 m below the surface and decommissioned by fully grouting from the bottom of the bore to the surface.

Groundwater investigations have progressively expanded the monitoring network to ten monitoring bores across the site, providing improved spatial coverage of groundwater conditions and supporting ongoing refinement of the conceptual hydrogeological model.

2.4.5. Existing Rehabilitation

It is unknown if any rehabilitation has occurred in the Project area prior to Graymont acquiring operations in 2019, however there has been no certified rehabilitation undertaken since the 2019 acquisition. The northernmost cleared area of the site (displayed in **Plate 14**) was identified as not being required for operations and has been previously grass seeded in 2020/2021. This area was not submitted for progressive certification under the EP Act because it was later identified by emergency services as an area required for helipad construction. This area will be cleared and flattened to support this infrastructure and will be retained until the EOML.

2.4.6. Overview of Rehabilitation Areas

The rehabilitation areas (RAs) will encompass the entirety of the disturbed areas contained within the MLs. Areas within the disturbance footprint will be rehabilitated to achieve the approved post-mining land use description. Ten RAs have been nominated for the Project, summarised in **Table 18** and displayed in **Figure 16.**

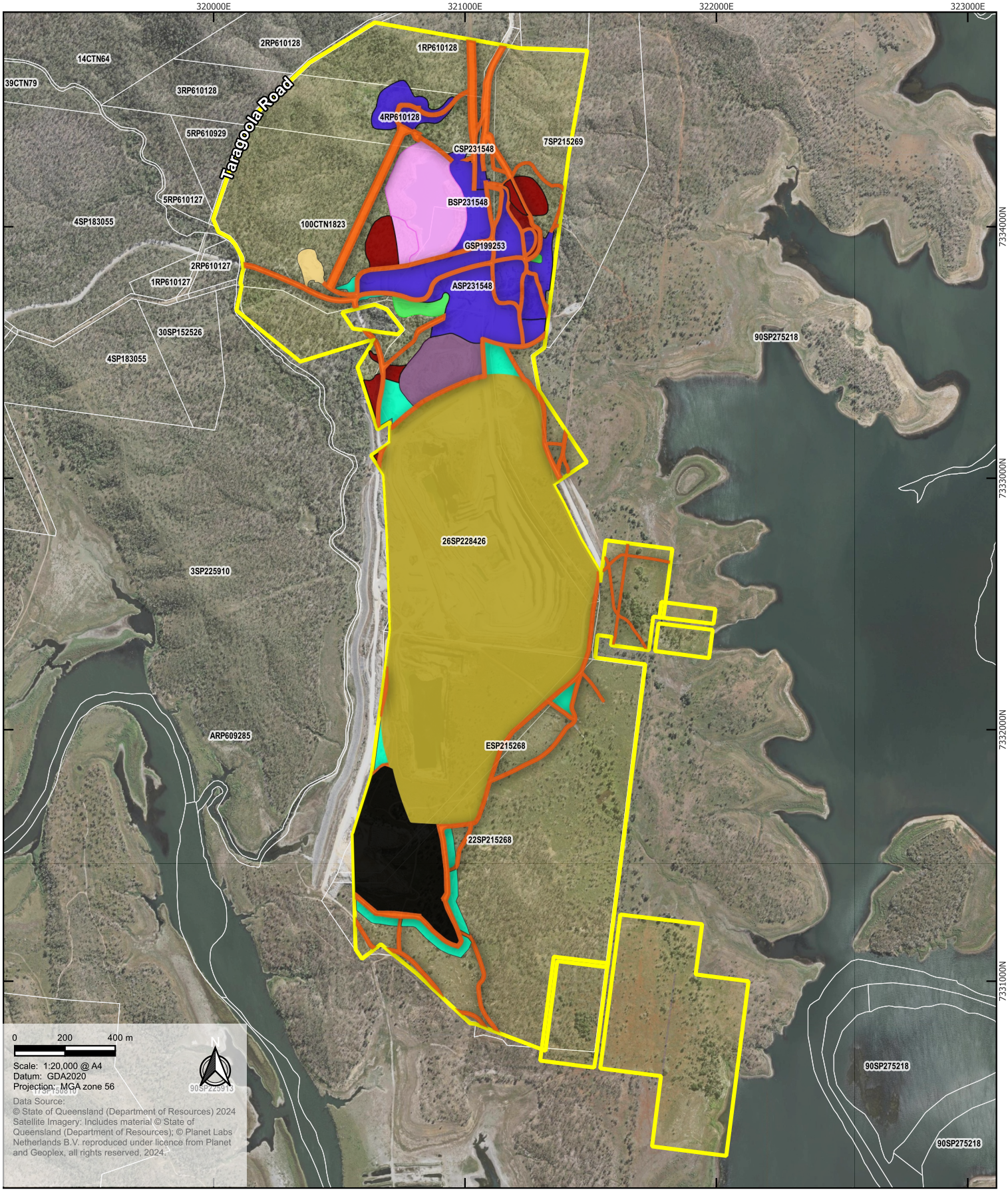
All areas that will remain undisturbed throughout the LOM are not included within the scope of rehabilitation, as shown in **Figure 17.** It is noted that there are areas of transitioning

disturbance throughout the mine life, therefor the total authorised disturbance area and total area of assigned RAs are different.

Table 18. Rehabilitation areas

Rehabilitation area ID	Rehabilitation Area Description	Rehabilitation Period		Applicable milestone criteria	Post mining land use (PMLU)	Area (ha)
		Start	End			
RA 1	Cleared areas and laydowns- this includes laydown areas, the cleared area in the northern extent of the site (within ML80192) that was previously required for operations, and inactive Pit 1 which has been backfilled with material from the Northern WRD.	2045	2056	RM5, RM6, RM8, RM9, RM11	Low intensity grazing	5.72
		2096	2107			
RA2	Silt dump- this incorporates the maximum extent of the silt dump.	2096	2108	RM2, RM5, RM6, RM8, RM9, RM11	Low intensity grazing	1.11
RA 3	Pit 2- inactive Pit currently used to supply water for operations (including for dust suppression, processing, etc). Footprint includes surrounding disturbed and undisturbed area within the extent of the perimeter abandonment bund.	2100	2110	RM3, RM7, RM9, RM10	Water storage	11.46
RA 4	Infrastructure and ROM pad- this incorporates the run-of-mine infrastructure, administration, workshop, and storage infrastructure, crushing and screening plant, wash plant, and processing area; inclusive of all buildings, powerlines, conveyors, concrete pads, communications towers, groundwater bores, fuel storage, hardstand areas, and equipment. This incorporates former Pit 1 which has been backfilled and is intended to be used for aglime production and stockpile area.	2100	2113	RM1, RM2, RM5, RM6, RM8, RM9, RM11	Low intensity grazing	27.34
RA 5	Southern WRD- this includes the current, future, and buffer areas of the southern WRD. The footprint includes an exclusionary area comprising a perimeter access track and rock armour bund around the base of the WRD.	2101	2112	RM4, RM6, RM8, RM9, RM11	Low intensity grazing	15.83
RA 6	Pit 3-4 – this incorporates the extent of the existing and proposed quarry disturbance area of the future amalgamated Pit 3-4. Footprint also includes surrounding disturbed area	2102	2113	RM3, RM7, RM9, RM10	Water storage	109.71

Rehabilitation area ID	Rehabilitation Area Description	Rehabilitation Period		Applicable milestone criteria	Post mining land use (PMLU)	Area (ha)
		Start	End			
	within the extent of the perimeter abandonment bund.					
RA 7	Spoil pile areas- this includes all areas required for spoil pile storage until end of mine life, outside of the Pit 2 and Pit 3-4 abandonment bunds. This will also incorporate the (former) Northern WRD area at end of mine life.	2103	2115	RM1, RM5, RM6, RM8, RM9, RM11	Low intensity grazing	6.03
RA 8	Sediment ponds- this incorporates the extent of the two sediment ponds onsite.	2104	2116	RM2, RM5, RM6, RM8, RM9, RM11	Low intensity grazing	1.46
RA 9	Topsoil stockpile areas- this includes all areas required for topsoil and subsoil storage until the end of mine life, outside of the Pit 2 and Pit 3-4 abandonment bunds.	2105	2117	RM5, RM6, RM8, RM9, RM11	Low intensity grazing	7.84
RA 10	Access tracks- this includes all existing and proposed access tracks required for operations until end of mine life, and eastern and western levees.	2100	2110	RM5, RM7, RM9, RM12	Access tracks	17.94
					Total (ha)	**204.47**



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Legend

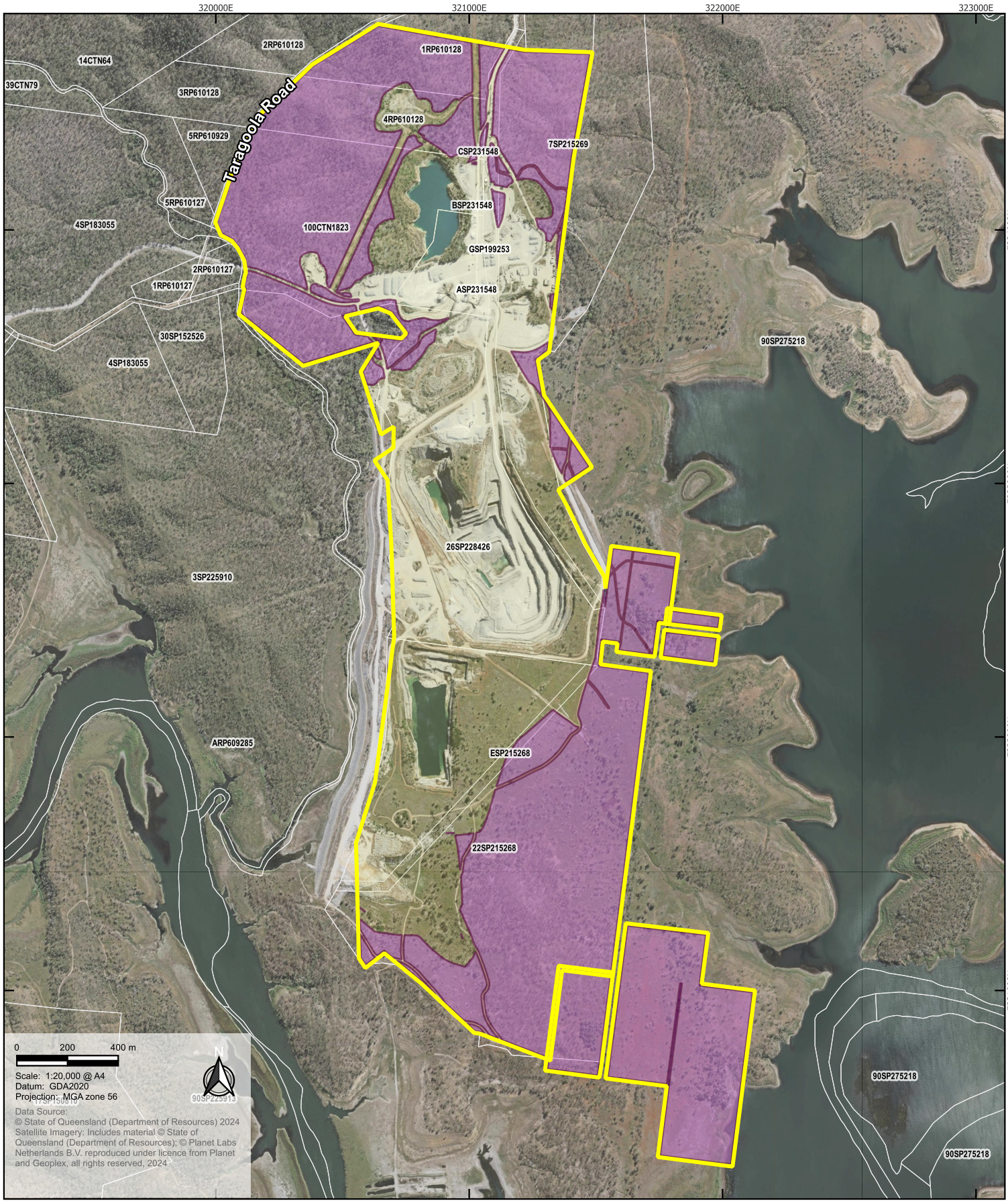
- Site boundary
- Cadastre (DCDB)

Rehabilitation areas

- RA01 - Cleared areas and laydowns
- RA02 - Silt dump
- RA03 - Pit 2
- RA 4 - Infrastructure and laydown areas
- RA05 - Southern waste rock dump
- RA06 - Pit 3-4
- RA07 - Spoil piles
- RA08 - Sediment ponds
- RA09 - Topsoil areas
- RA10 - Access tracks

Graymont
Calliope Limestone Quarry
Progressive Rehabilitation and Closure Plan

Figure 16
Rehabilitation areas



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Legend

- Site boundary
- Cadastre (DCDB)
- Undisturbed area

Graymont
Calliope Limestone Quarry
Progressive Rehabilitation and Closure Plan

Figure 17
Undisturbed areas

2.4.7. Rehabilitation Staging

Figure 18 shows the proposed rehabilitation staging of each RA, corresponding to the further detail provided in the PRC Plan Schedule (refer **Appendix A**).

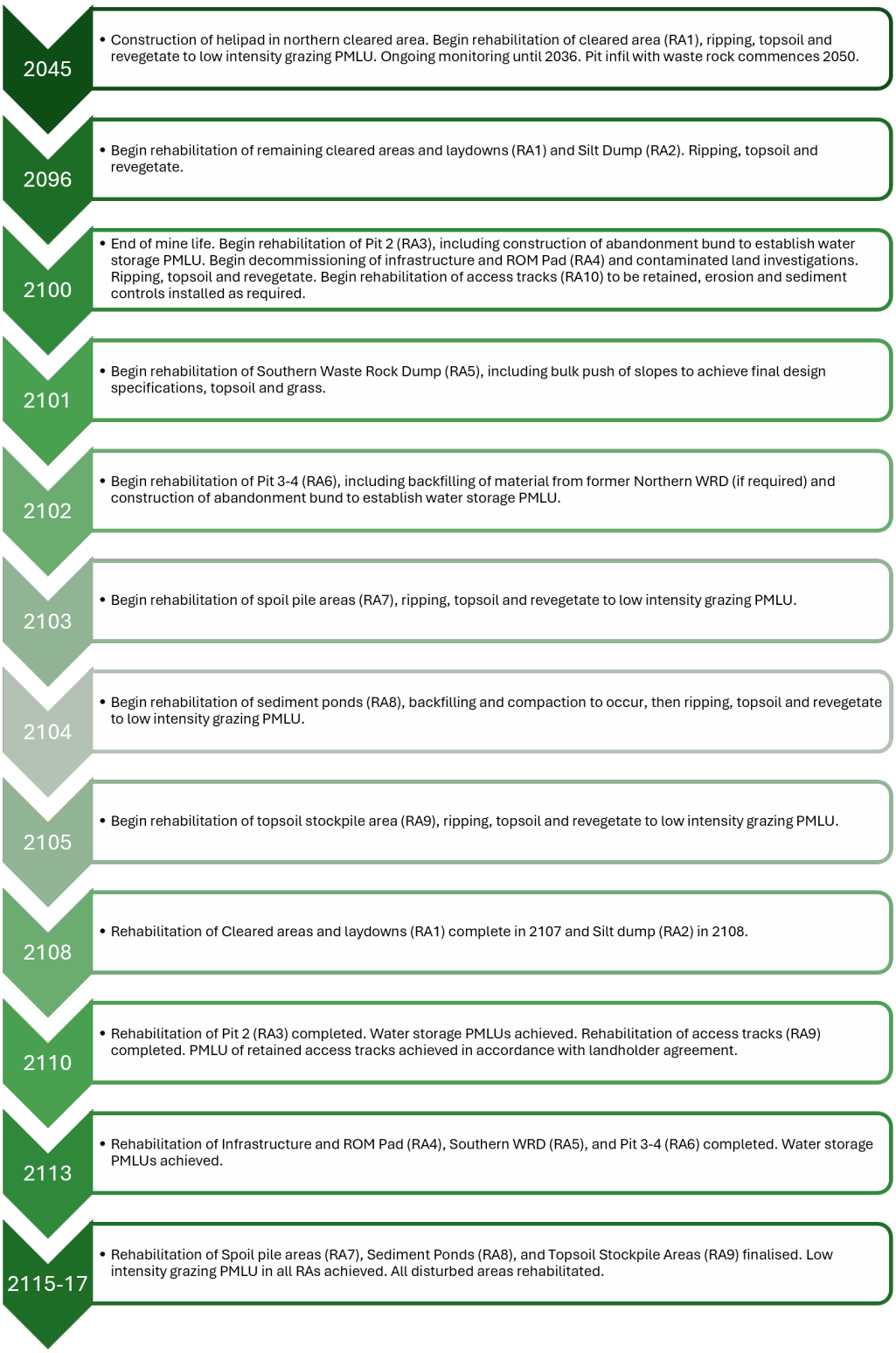


Figure 18. Rehabilitation staging

3. Community Consultation

This section of the PRC Plan outlines information on stakeholder and community consultation. Notwithstanding, Graymont has engaged with the community and relevant stakeholders throughout the rehabilitation process and in accordance with the existing Calliope Stakeholder Engagement Plan (CSEP).

3.1. Calliope Stakeholder Engagement Plan

The CSEP has been prepared to outline key objectives, performance indicators and methods adopted for engagement with the relevant stakeholders and the surrounding community. Key objectives of the engagement process are:

- Provide long-term security to site operations (current and proposed activities)
- Utilise existing advocates and supporters to positively position Graymont
- Build stronger, more engaging relationships with key regulators and decision makers
- Engage with Gladstone Regional Council specifically in relation to managing pre-existing compliance obligations, and negotiation of favourable outcomes for Graymont
- Engage proactively with local communities to build awareness and support of Graymont, its operations, and its various community development initiatives
- Undertake proactive engagement with stakeholders, in addition to what is required by law or in response to specific events
- Monitor activity of stakeholders that may potentially pose a risk or threat to operations or reputation

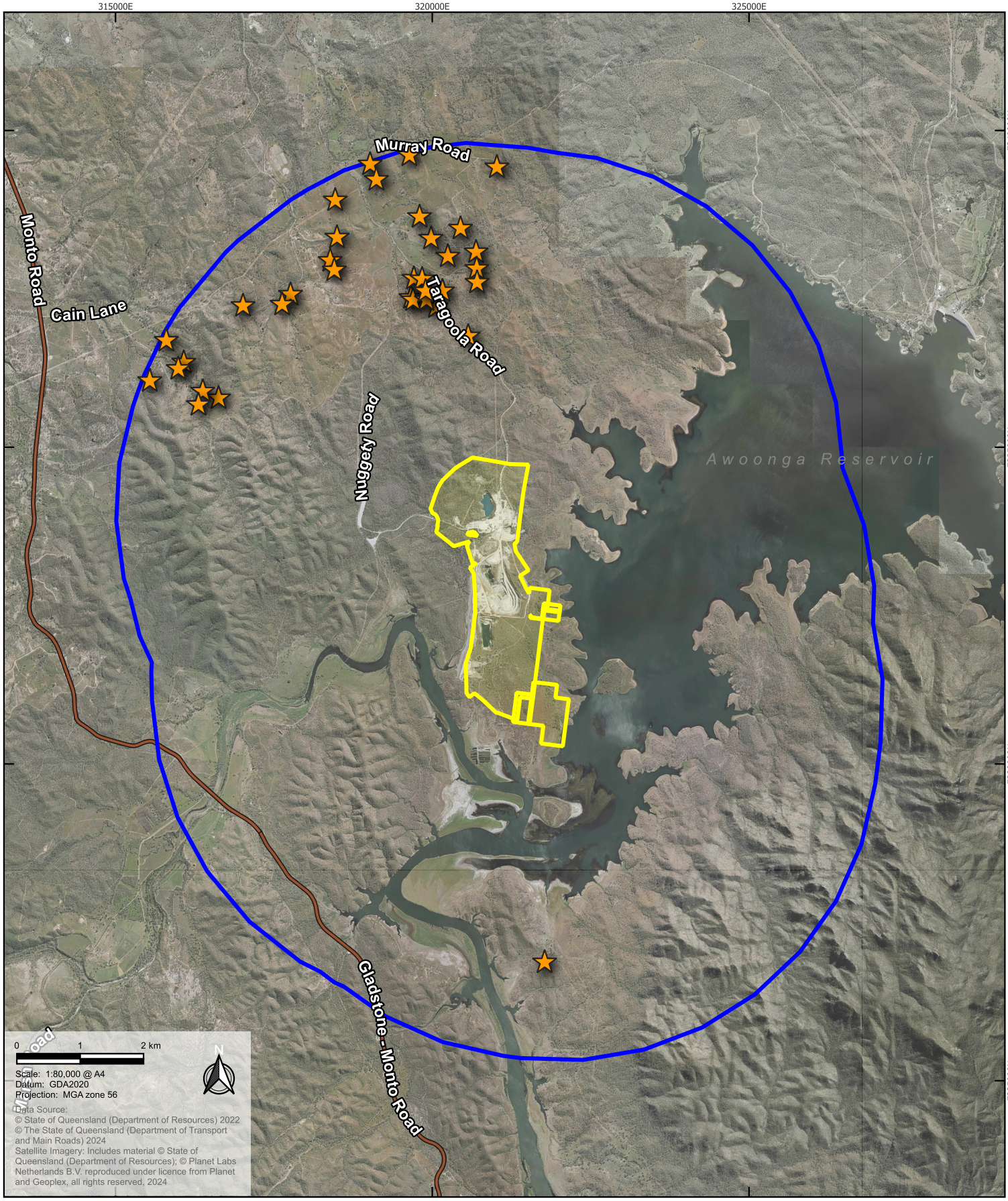
Graymont has maintained a Community Engagement Register throughout ownership of the site and updated as needed. PMLUs have been previously approved through an existing land outcome document (the EA) and under transitional arrangements have been included in the PRC Plan. There has been no material change to the proposed PMLU for any of the disturbance types.

3.1.1. Relevant Stakeholders

For the purpose of this PRC Plan, the community area has been defined as the communities and surrounding areas of the town of Calliope in the Gladstone Regional Council LGA. As the Project is located in a rural area, the community area encompasses sensitive receptors (landholders) within a 5 km radius of the site as well as members of the community and various organisations (including government, industry, service providers, adjoining landholders) who may have an interest in rehabilitation and the post mining land use of the site (refer **Figure 19). Table 19** provides a categorisation of the stakeholders as they relate to the identified stakeholder groups.

Table 19. Categorisation of relevant stakeholders

Category	Relevant Stakeholder
Direct landholders	Landholders whose property the mine infrastructure may be located. Property owners within the MLs.
Adjoining landholders	Residents located adjoining the site which may experience impacts during operation and rehabilitation (visual impact, noise, dust, traffic). Adjoining neighbours to the MLs.
Federal, State and Local Government Representatives	Government representatives at the Federal, State and Local level, including, local representatives and Government agencies responsible for the regulation of the site. Police, emergency services, drug and alcohol services, housing, Indigenous, employment and social services. Many of these are provided by Gladstone Regional Council. All infrastructure and utilities providers that the site could have an impact on during either operation or rehabilitation.
Indigenous Stakeholders	Traditional owner groups, local land councils and other Indigenous organisations, where these are related to the site.
Business Operators and Representatives	Business operators and employees in the locality may experience indirect impacts on business operations. Regional business groups, local accommodation operators and local Chambers of Commerce.
Special Interest Groups	Community organisations and groups such as the local Lions Clubs, Schools and Childcare facilities and environmental groups.
Local Community	Residents or visitors to the Gladstone region may have an interest in the site.



Filepath: --BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 PRCP\Rev 3\Figure 19 Sensitive Receptors.qgz

Legend

- Site boundary
- 5km buffer
- State controlled roads
- Sensitive receptors

Graymont
Calliope Limestone Quarry
Progressive Rehabilitation and Closure Plan

Figure 19
Sensitive Receptors

Table 20 provides a list of stakeholders included in each of these groups that have been identified as relevant for this PRC Plan.

Table 20. Stakeholder group and identified stake holders

Stakeholder Groups	Stakeholders
Direct landholders	• The Project covers approximately 700 ha, with approximately 685 ha owned by Graymont. The remainder is owned by the GAWB, who also own contiguous landholdings outside the site
Adjoining landholders	• Landholders within a 5 km radius of the Project boundary (30 properties as identified in **Figure 19**)
Federal, State and Local Government Representatives and Agencies	**Federal** • Colin Boyce MP, Federal Member for Flynn
	State • Department of Environment, Tourism, Science and Innovation • Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development
	Local Government • Gladstone Regional Council- Mayor and Councillors
Indigenous Stakeholders	• First Nations Bailai, Gurang, Gooreng Gooreng, Taribelang Bunda People Aboriginal Corporation RNTBC
Business Operators and Groups	• Cement Australia • Port Curtis Coral Coast (PCCC) Land Trust • Retail businesses in Calliope including Australia Post; grocery shops and hardware shops
Emergency Services	• Calliope Urban Fire Brigade • Calliope Ambulance Service
Broader Community	• All residents in the town of Calliope • Calliope State School and Calliope Kindergarten • Other interested members of the Gladstone region in Queensland.

With respect to Indigenous community stakeholders, there are no native title determinations or claims over the site, however there is an Aboriginal cultural heritage party registered for the area (Bailai, Gurang, Gooreng Gooreng, Taribelang Bunda People).

The broader community is defined as all residents in Calliope town, comprising a population of 4,396 people (as in 2021 Census, Australian Bureau of Statistics (ABS) 2023). Whilst there were some special interest groups identified within the town of Calliope, they have not been included within the scope of this PRC Plan as the residents of Calliope that are members of these groups have been contacted within the scope of the 'broader community.'

3.1.2. Stakeholder and Community Engagement

The CSEP outlines key methods for undertaking engagement. Identified methods include newsletter / community update, letter, complaints, individual meetings, the Quarry Open Day, and phone calls / emails. The anticipated methods for future engagement of stakeholders are provided in **Table 21**.

Table 21. Stakeholder and community engagement

Stakeholders	Type of Engagement					
	Passive			Active		
	Newsletter / community update	Letter	Complaints Register	Individual meetings	Quarry Open Day	Phone calls / Emails
Direct Landholders	✓	✓	✓	✓		✓
Adjoining Landholders	✓	✓	✓		✓	
Federal Member for Flynn	✓					✓
Department of Environment, Tourism, Science and Innovation				✓		✓
Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development				✓		✓
Gladstone Regional Council	✓	✓			✓	✓
Indigenous Stakeholders	✓	✓	✓			✓
Business Operators and Groups	✓		✓		✓	
Emergency Services	✓					✓
Broader Community	✓	✓	✓		✓	

3.2. Public Interest Considerations

NUMAs are defined under s112 of the EP Act as an area of land the subject of a PRC Plan that cannot be rehabilitated to a stable condition after all relevant activities for the PRC Plan carried out on the land have ended. The final rehabilitated landform of the site will not include any NUMAs.

As there are no NUMAs, a public interest evaluation (PIE) under the EP Act is not required.

3.3. Consultation Register

A consultation register was developed to document details of past and future engagement undertaken with stakeholders regarding rehabilitation and closure. The register is provided in **Table 22** and will be updated periodically as required.

Table 22. Consultation register

Date	Stakeholder	Type of consultation	Provided information	Issues raised	How were they considered?	Action items	Commitments
22 February 2023	Emergency Services (Calliope Urban Fire Brigade, Calliope Ambulance Station)	Community Consultation Letter and Open Day Invitation (via post)	• Who is Graymont • Overview of Calliope operations • Existing EA and MLs • EA Amendments proposed • PRC Plan description including PMLUs, RAs, Graymont contact information to provide comment	Nil, supportive of PRC Plan.	N/A	Calliope Urban Fire Brigade undertakes regular controlled burning on undisturbed areas of MLs (adjacent to Lake Awoonga). Next burning is April 2024.	N/A
22 February 2023 (ongoing)	Direct Landholder (GAWB)	Community Consultation Letter and Open Day Invitation (via email)	Who is Graymont Overview of Calliope operations Existing EA and MLs EA Amendments proposed PRC Plan description including PMLUs, RAs, Graymont contact information to provide comment	Nil	N/A	GAWB are aware that access tracks will be retained.	Periodic updates as required
27 February 2023	Adjoining Landholders	Community Consultation Letter and Open Day Invitation (via letterbox drop)	• Who is Graymont • Overview of Calliope operations • Existing EA and MLs • EA Amendments proposed • PRC Plan description including PMLUs, RAs, Graymont contact information to provide comment	Nil	N/A	N/A	Periodic updates as required
2 March 2023	Indigenous Stakeholders	Community Consultation Letter and Open Day Invitation (via email)					
2 March 2023	PCCC Land Trust	Community Consultation Letter	Who is Graymont Overview of Calliope operations Existing EA and MLs EA Amendments proposed	Nil	N/A	N/A	Periodic updates as required

Date	Stakeholder	Type of consultation	Provided information	Issues raised	How were they considered?	Action items	Commitments
			PRC Plan description including PMLUs, RAs, Proponent contact information to provide comment				
4 March 2023	Adjoining Landholders, Broader Community (140 people attended), Emergency Services (Calliope Rural Fire Brigade), Local Government Representatives (Three Councillors from Gladstone Regional Council), Business Operators	Quarry Open Day	• Invite to Open Day sent to all residents of Calliope via letterbox drop • Who is Graymont • Overview of Calliope's current and future operations and site tours • Printed copy of existing EA and registration certificate • EA Amendments proposed • PRC Plan description including PMLUs, RAs, Graymont contact information to provide comment • Historical imagery of the site • Maps of PMLUs, RAs, current and future disturbance extents, undisturbed areas, location of nearest sensitive receptors • Rehabilitation staging and RA definitions • Copy of Community Consultation Letter	Nonrelevant to PRC Plan, all in agreeance with PRC Plan. One community member enquired about the status of rail line use for transporting limestone.	Graymont explained use of trucks for moving saleable product, rail has not been used for some time. Rail line is non-operational infrastructure managed by Qld Rail.	Graymont to contact Qld Rail about potential future opportunities to use rail infrastructure to support operations.	N/A
Q3 2023	Direct Landholders, Adjoining Landholders, Broader Community, Indigenous Landholders	Newsletter / community update (in local newspaper)	Update of approvals progress as required and provide opportunity to provide comment				Periodic updates as required

Date	Stakeholder	Type of consultation	Provided information	Issues raised	How were they considered?	Action items	Commitments
April 2025	Direct Landholders, Adjoining Landholders, Broader Community, Indigenous Landholders	Public notification- website and newspaper advertisement	• Scope of the EA amendment and PRC Plan • Rehabilitation areas and PMLUs • Proposed maximum disturbance areas	No submissions made during public notification	N/A	N/A	N/A
20 August 2025	Direct Landholders (GAWB), Broader Community	Flyer	Flyer advertising the Quarry Open Day	Nil	N/A	N/A	N/A
30 August 2025	Broader Community	Quarry Open Day	• Who is Graymont • Overview of Calliope's current and future operations and site tours • Information about the EA amendment and public notification details • FAQs with details on the PRC Plan, including PMLU figures and the progressive rehabilitation staging plan	Nil	N/A	N/A	N/A
November 2025	Direct Landholders (GAWB)	Various ongoing communication	Ongoing consultation about groundwater bore monitoring and access	Nil	N/A	N/A	N/A
Monthly	Direct Landholders (GAWB)	Regular conversations (phone calls and emails) occur with GAWB about operations / maintenance access.	• Operations / rehabilitation updates as required				Periodic updates as required

Date	Stakeholder	Type of consultation	Provided information	Issues raised	How were they considered?	Action items	Commitments
State and Local Government Representatives and Agencies							
29 April 2022 - ongoing	State Government- DES (now DETSI)	Pre-Lodgement Meeting	Project background Site location and description Current activities PRC Planning Key matters / actions, including disturbance areas and EA Amendment	Discrepancy in ML boundaries	EA Amendment to be undertaken and discussion with DNRMMRRD	Preparation of EA Amendment and PRC Plan	Regular updates to the Administrating Authority as required
15 December 2022 - ongoing	State Government- DoR (Now DNRMMRRD)	Email Correspondence	• Pre-lodgement meeting request form • Map of mining lease boundaries • Description of current and future operations until the EOML	Discrepancy in ML boundaries used at Calliope and the state's ML boundaries	Reviewed by DNRMMRRD, additional information and surveying requested	Surveying to be undertaken to ground truth ML boundaries	Arrangement of pre-lodgement meeting to confirm actions going forward
10 - 24 February 2023	State Government- DES (now DETSI)	Email Correspondence and Phone Call	Questions sent to the Administrating Authority regarding: ML tenure boundaries Layout of disturbance areas in EA amendment Technical studies to be undertaken PMLU of southern WRD	Inconsistency between currently approved EA and proposed PRC Plan submission	Phone discussion to understand legislative requirements and proposed next steps	Summary of EA Amendment changes provided in the PRC Plan (this report) so final landform can be assessed	Submission of PRC Plan by 17 March 2023, major EA amendment to be submitted once ML tenement discrepancy resolved with DNRMMRRD
3 May 2023	State Government- DES (now DETSI)	Pre-lodgement meeting	• Status of the Project in relation to the EA Amendment and PRC Plan applications • Not Properly Made Notice actions and questions	Timing implications of resolving the ML discrepancy with DNRMMRRD	Ongoing discussions with DNRMMRRD to progress ML boundary discrepancy, and updates to DETSI if needed	Update PRC Plan and EA Amendment based on Department feedback	Resubmission of PRC Plan with all items actions from Not Properly Made Notice by 30 June 2023

Date	Stakeholder	Type of consultation	Provided information	Issues raised	How were they considered?	Action items	Commitments
5 March 2025	State Government-DETSI	Pre-lodgement meeting	• Status of Project approvals • Application particulars and ongoing investigations • Groundwater and compliance matters	Additional EA amendment may be required for groundwater	Graymont to consider best approach	Graymont to continue groundwater investigations and consider an EA amendment as required	Ongoing communication with DETSI
25 November 2025	State Government-DETSI	Project meeting	Draft EA conditions Groundwater matters	Nil	Outstanding matters conditioned in the approval	Groundwater data to be provided to the DETSI for consideration when groundwater trigger limits are being revised	N/A
As required	State Government-DETSI	Pre-lodgement meeting	• Discussion regarding major EA amendment and associated PRC Plan amendments at any time in the future				

3.3.1. Community Consultation Letter

In December 2022, a letter was prepared for identified stakeholders to describe the Project and provide an opportunity for stakeholders to comment. The letter included a description of the EA and PRC Plan, the proposed EA Amendments, PMLUs, rehabilitation areas and staging as part of the PRC Plan, Graymont's contact details, and enclosed the existing EA. As Graymont acquired operations in 2019, the letter included a description of Graymont's business and operations across Australia and internationally, and a description of Calliope's current and future planed operations. No responses were received from the letter (refer **Table 22**).

3.3.2. Calliope Limestone Quarry Open Day

On Saturday 4 March 2023, Graymont held an Open Day at the Calliope Limestone Quarry. Open Day invitations were sent out to all residents of Calliope town, the First Nations Bailai, Gurang, Gooreng Gooreng, Taribelang Bunda People Aboriginal Corporation RNTBC, the Mayor and Councillors from Gladstone Regional Council, GAWB, PCCC Land Trust, and the Rural Fire Service on 22 February 2023. The Open Day invitation was on display at the grocery stores, butchery, and hardware stores in the town in the week prior. 140 people attended the site to meet with Graymont personnel, participate in a tour of the site, and discuss current and future operations and rehabilitation plans.

Information about the EA Amendment and PRC Planning was on display for the attendees, and they were provided an opportunity to comment on proposed plans (refer **Plate 22**). The outcomes of this engagement are provided in the Consultation Register in **Table 22**.

Based on the interest and attendance at the 2023 Open Day, Graymont held another Open Day on the 30 August 2025. This event followed a similar format, with Project information, figures and FAQs available on the day (refer **Plate 20**). Attendees were also able to speak with Graymont employees and undertake a site tour. The event had approximately 240 visitors and was well supported by the community with organisations such as the Calliope Rural Fire Brigade providing services and support on the day (refer **Plate 21**).



Plate 20. Information Stand at open day at Calliope Limestone Quarry 2025

Source: Graymont 2025



Plate 21. Visitors and personnel at open day at Calliope Limestone Quarry 2025

Source: Graymont 2025



Plate 22. Information about PRC planning and EA amendment on display at Calliope Limestone Quarry 2023

Source: Graymont 2023

3.4. Consultation Plan

A consultation plan has been developed to document engagement planned with the community and stakeholders, provided in **Table 23**. It is noted that no complaints have been received by Graymont in the time since they acquired operations in 2019. Consultation will be undertaken at key rehabilitation, closure and relinquishment milestones, including commencement of rehabilitation areas, decommissioning of major infrastructure, proposed amendments to the PRC Plan, achievement of rehabilitation milestones and preparation for final relinquishment. Stakeholder feedback will be recorded and considered as part of ongoing rehabilitation and closure planning.

Table 23. Consultation plan

Engagement type	Consultation frequency	Information to be included	How will comments / feedback be considered
Newsletter / community update	As required	Closure and rehabilitation status updates	Feedback will be requested to be provided by email or phone and will be documented in the consultation register. Consideration of all feedback will be undertaken during site management meetings.
Letter	As required	Details of the closure activities that will have an indirect/direct impact on the stakeholder	Feedback will be requested to be provided by email or phone and will be documented in the consultation register. Consideration of all feedback will be undertaken during site management meetings.
Complaints Register	When received	Response to complaint matter	Reason for complaint and response provided will be documented in the consultation register. Consideration of the complaint will be undertaken during site management meetings.
Individual Meetings	As required	Closure and rehabilitation status updates	Meeting notes will be documented in the consultation register. Consideration of all matters raised at the meeting will be undertaken during site management meetings.
Individual Meeting (DETSI)	As required	Where an update to the PRC Plan or Schedule is required	Meeting notes will be documented in the community consultation register. Consideration of advice provided by the Administrating Authority will be considered any update to the PRC Plan or Schedule.
Quarry Open Day	Prior to closure	Closure and rehabilitation status updates	Feedback will be requested to be provided by email or phone and will be documented in the consultation register. Consideration of all feedback will be undertaken during site management meetings.
Phone calls	As required	Closure and rehabilitation status updates	Discussion notes will be documented in the consultation register. Consideration of all feedback will be undertaken during site management meetings.

4. Post-Mining Land Use

4.1. PMLU Criteria and Relevant Legislation

In accordance with section 126C(1)(d) of the EP Act, the Rehabilitation Planning Part (RPP) of the PRC Plan must state the extent to which each post-mining land use for land identified in the PRC Plan schedule for the Plan is consistent with:

a. The outcome of consultation with the community in developing the Plan, and
b. Any strategies or plans for the land of a local government, the State or the Commonwealth.

In order for a proposed PMLU to be accepted, the PRC Plan schedule must demonstrate that the land can be rehabilitated to a stable condition in accordance with the section 111A of the EP Act:

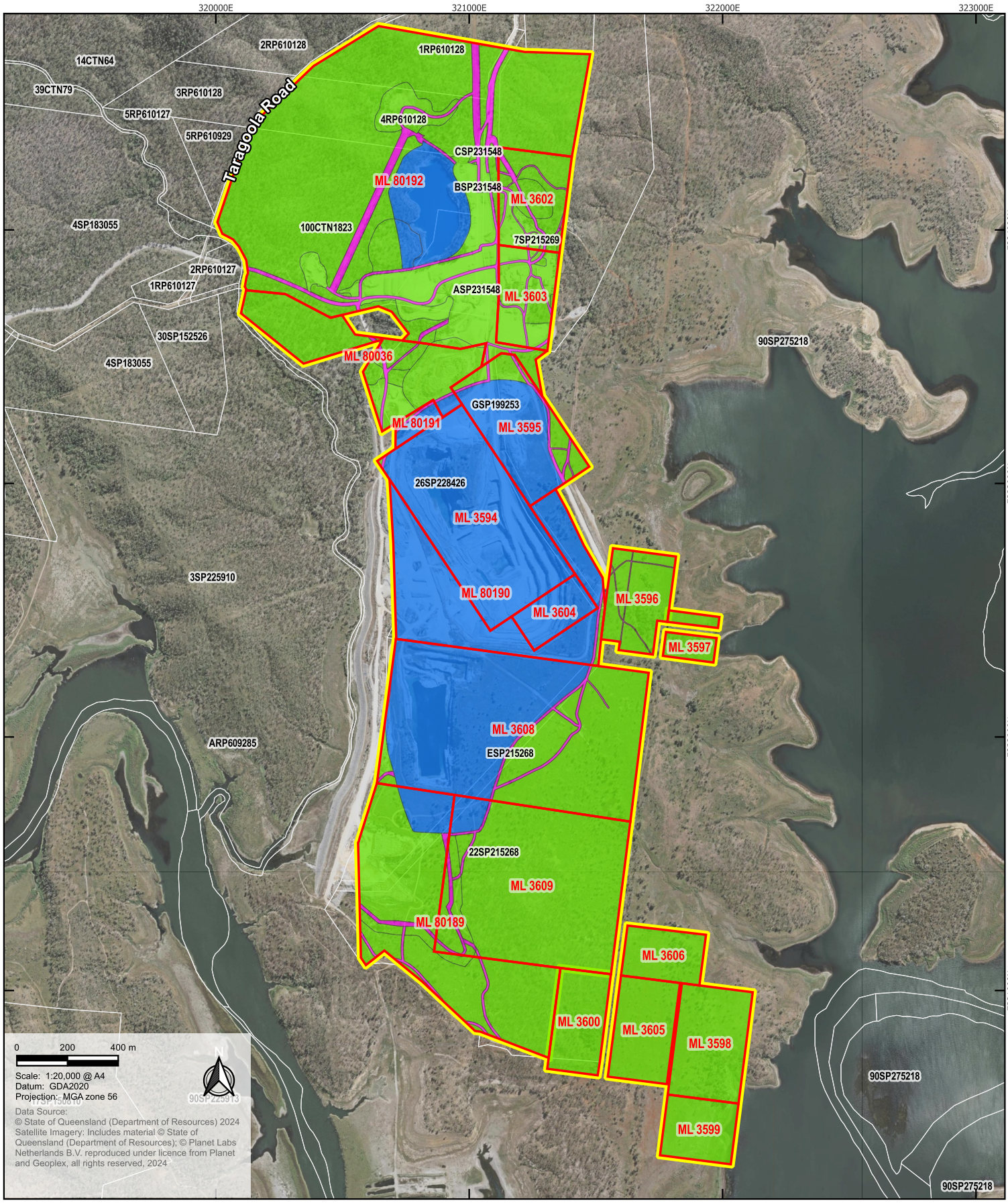
Land is in a stable condition if—

a. The land is safe and structurally stable; and
b. There is no environmental harm being caused by anything on or in the land; and
c. The land can sustain a post-mining land use.

Schedule 8A, Part 3, Table 1 of the EP Regulation further states that each PMLU –

a. Is viable, having regard to the use of land in the surrounding region; and
b. Satisfies at least one of the following –
  i. The use is consistent with how the land was used before a mining activity was carried out on the land
  ii. The use is consistent with a development approval relating to the land
  iii. The use is consistent with a use of the land, other than a use that is mining, permitted under a State or Commonwealth Act, including, for example, a planning instrument under the Planning Act 2016
  iv. The use will deliver, or is aimed at delivering, a beneficial environmental outcome.

The site and surrounding areas are zoned as rural under the GRC Planning Scheme mapping (GRC 2017). The nominated PMLUs proposed for the site is consistent with zoning under the Planning Scheme and are displayed in **Figure 20**.



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Legend

- Site boundary
- Mining leases
- Cadastre (DCDB)

Post mining land uses

- Grazing
- Access tracks
- Water storage

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Progressive Rehabilitation and Closure Plan

Figure 20
Post mining land uses

4.2. Assessment of PMLU Options

As part of the assessment of PMLU options, it is acknowledged that land will need to be rehabilitated according to the relevant legislation.

The proposed PMLUs for the site (refer **Table 24**) are considered appropriate as they are consistent with pre-mining land use and surrounding land uses. The return of the site to predominantly low intensity grazing land will ultimately provide a beneficial environmental outcome, with low intensity grazing of the southern WRD, amongst other site features considered the most stable and suitable option for rehabilitation.

Graymont's Murgon Limestone Quarry has an existing rehabilitated WRD onsite that has been appropriately topsoiled and grassed (ELA 2022). The proposed rehabilitation was successful for this type of landform, allowing for a self-sustaining condition.

It is noted that PMLUs included within the EA Amendment will be consistent with the current EA, but contemporised to suit the terminology and expectations of the PRC Plan Guideline (shown in **Figure 20**), noting that:

- Residual voids (Pit 2 and future Pit 3-4) will be retained as water storage, including installation of an exclusion zone and perimeter abandonment bunds, for the intended use of water management for purposes including drought mitigation and fire fighting
- All access tracks will be retained to facilitate future site access to Lake Awoonga for GAWB's maintenance activities, consistent with the landholder agreement in **Appendix E**
- All remaining areas (infrastructure, spoil piles, cleared areas and laydowns, topsoil, sediment ponds, Southern WRD and existing and proposed groundwater bores) will be rehabilitated to low intensity grazing land, with the Southern WRD to be grassed

No other legislation (at a State or Commonwealth level) has been identified as relevant to the land use of the surrounding area. There are also no development approvals relevant to the land.

The methodology employed for determining PMLU options was an evidence-based comparison, and subsequent justification of possible PMLU options. The methodology involved the incorporation of community feedback and consultation (**Section 3**), assessment of potential PMLU options specified in the PRC Plan Guideline and identification of regulatory constraints (Local, State and Commonwealth). A ranking scale was also developed to enable comparison and decision making on the appropriateness of each potential PMLU against the PRC Plan Guideline criteria for the Project. A higher score indicates a more appropriate / well suited PMLU:

- A 'Yes' response has a score of 2
- A 'Partially' response has a score of 1
- A 'No' response has a score of 0

The options analysis includes consideration of each PMLU against the following:

- Complies with regulatory considerations / constraints (Commonwealth, State and Local), including the GRC Planning Scheme zoning
- Able to appropriately manage physical constraints and chemical characteristics

- Meets or exceeds available rehabilitation methods
- Cost effective
- Able to provide potential economic, environmental, and social benefits
- Compatibility with surrounding landscape and pre-mined landscape
- Optionality for retaining / transitioning infrastructure and/or utilities

The reference map and final site design map have been provided with the PRCP schedule in **Appendix A.**

Table 24. Potential PMLU options analysis

PMLU Options (per PRC Plan Guideline)	Assessment of Potential PMLUs									
	Native Ecosystem	Habitat & Ecosystem Services	Low Intensity Grazing	Agriculture	Forestry	Cropping	Industrial	Landfill	Water Storage	Access Tracks
No regulatory constraints on, or objects for, the proposed land use (e.g., Indigenous Land Use Agreements, site management plan (contaminated land), local and regional land use plans, endangered species, or registered heritage places)?	2	2	2	2	0	2	1	0	1	2*
No physical constraints (e.g., slopes, voids, geology) preventing this PMLU from being achieved?	0	0	2	0	0	0	0	0	2	2
No concern of achieving this PMLU based on chemical characteristics (e.g., residual contamination from tailings or other waste disposal)?	2	2	2	1	1	1	2	0	2	2
Does this PMLU meet or exceed rehabilitation expectations, including best practice (e.g., backfill, profile, capping)?	2	2	2	2	2	2	2	1	2	2
Are the relative costs of this rehabilitation option effective?	2	2	2	1	1	1	0	0	2	2
Are there potential economic benefits of this post mining land use (e.g., tourism, public use, grazing, forestry products, agricultural use)?	1	1	2	2	2	2	1	1	2	2
Is this post mining land use able to provide environmental benefits (e.g., create wildlife corridors, revegetation, creation of native habitat)?	2	2	2	1	1	1	0	0	1	0
Is this post mining land use able to provide social benefits (e.g., recreational use, public amenity, employment)?	2	2	2	2	2	2	2	2	2	2
Is this post mining land use compatible with surrounding land uses (e.g., agriculture, ecosystem)?	2	2	2	2	1	1	0	0	1	1
Is this post mining land use compatible with the land use before the mining activity commenced (grazing)?	1	1	2	1	1	1	0	0	1	0
Are there options for retaining / transitioning infrastructure and utilities such as road and rail transport accessibility as well as power, communications and water management systems with this post mining land use option?	0	0	2	1	1	1	1	0	2	2
TOTAL SCORE	**16**	**16**	**22**	**15**	**12**	**14**	**9**	**4**	**18**	**17**

*Consistent with landholder agreement with GAWB, provided in **Appendix E**

4.2.1. Alternative Post Mining Land Use

The PMLU for Pit 1 in the EA is currently water storage, however, it was determined that low intensity grazing would be a more appropriate PMLU due to backfilling activities that have been undertaken at the site. Pit 1 sat above the water table and does not hold any water, therefore overburden material from the Northern WRD was placed into Pit 1 so that this area could become available for use as spoil storage and aglime production when Pit 3-4 is extended to its northern-most extent during Stages 1 and 2. The backfilling activity is further described in the geotechnical assessment provided in **Appendix B.**

Table 8 of the EA lists PMLUs by ML, which include:

- ML3595 (grazing)
- ML3604 (grasses and access tracks)
- ML80190 (roadways)

At the time the EA was approved, the LOM duration and consequent staging and disturbance areas for ongoing operations were not known. Through developing this PRC Plan, maximum disturbance areas in each ML and activity type have been determined which include amended PMLUs corresponding to these areas, largely associated with the amalgamating Pit 3-4 as follows:

- ML3595 (water storage, access tracks and low intensity grazing)
- ML3604 (water storage)
- ML80190 (water storage)

5. Non-Use Management Areas

There are no NUMAs proposed for the Project.

6. Voids in Flood Plains

The site is located outside of existing floodplains, consequently there are no voids proposed in flood plains at the site.

7. Rehabilitation Management Methodology

7.1. General Rehabilitation Practices

As per the PRC Plan Guideline, this section outlines the range of information applicable to the PRC Plan which underpins its development and shape the rehabilitation method. All proposed methods/techniques are designed to rehabilitate the land to a stable condition in a way that supports the rehabilitation milestones under the PRC Plan Schedule.

7.2. Hydrogeology

The hydrogeological assessment for the Project, provided in **Appendix F,** has been continually updated with additional groundwater data collected from investigations onsite. The assessment includes:

- An updated conceptual site model for the site, and cross sections of geological features
- Details of a groundwater investigations including influences on groundwater inflows
- Existence and depth of aquifers and aquitards
- Location of regional and local groundwater recharge and discharge locations
- Groundwater quality within each of the aquifers
- Current and potential future uses of groundwater including extraction bores
- Potential impacts on environmental values
- Updated pit water fill modelling and a prediction of post mining pit water equilibrium
- Parameters which influence pit water volume and chemistry

7.2.1. Groundwater Occurrence

Groundwater is observed in limestone and volcanics across the Project area; ranging in depth from 15 to 20 metres below the natural surface. The Calliope beds limestone and volcanics are predominantly an aquitard because there is no primary porosity, but connected fractures can create a secondary porosity that forms a low yielding unconfined fractured rock aquifer (Graymont 2026a).

7.2.2. Groundwater Recharge and Discharge

As noted in Section 8.4 of the Hydrogeological Assessment (Graymont 2026a), regional recharge is in topographically elevated positions associated with thin soil cover, such as east of Pits 3 and 4 within volcanic rock. Potential groundwater discharge is in topographic lows associated with deep soil and regolith, such as to the west of Pits 3 and 4. Investigation drilling at the Project demonstrates that the most elevated groundwater levels coincide with the most topographically elevated position and that the surface water divide coincides with a groundwater divide. Groundwater level and chemistry respond to recharge; therefore, groundwater is driven by infiltration rather than seepage from Awoonga Dam (Graymont 2026a). Refer to **Appendix F** for further information.

7.2.3. Groundwater Quality and Levels

Groundwater quality data has been summarised in **Table 4,** with further description provided in **Appendix F.** The water quality of the final pit void is predicted to be a mix of current Pit 3 and

Pit 4 water quality based on the final void water balance modelling and groundwater investigations. Pit 3 water is a mixed type whereas Pit 4 is a Calcium-Magnesium-Bicarbonate type water (Graymont 2026a).

7.2.4. Groundwater Flow

Groundwater flow has been determined from investigative drilling and bore monitoring. Groundwater gradients flow toward the pit voids and act as groundwater sinks, however, hydrogeological investigations indicate that groundwater inflow rates are generally low and form a minor component of the overall pit water balance. Groundwater flow is north to south from Pit 2 to southeast of Pit 4 while also flowing easterly and westerly from the groundwater divide. The predicted future water table will function as a closed system (Graymont 2026a). This is described further in the Hydrogeological Assessment provided in **Appendix F**.

The groundwater divide aligns with the surface water divide. A natural topographic high and surface water divide lies to the east of Pits 3 and 4 within volcanic rock, which is a local recharge area for infiltration to groundwater. To the west of Pits 3 and 4 is a natural topographic low and is an area for potential groundwater discharge. Mining of limestone in Pit 3 has exposed the volcanic limestone contact and groundwater is present at 32mAHD. A black large organic clay ed area located west of Pit 3 indicates that prior to mining a surface depression existed at this location (refer Figure 13 in **Appendix F**). The Pit 3 surface water inflow point is a natural topographic low and any water shedding from within or from the WRDs, which are permeable as identified by GAWB in 2002, will naturally flow into the topographic low and then into Pit 3 (Graymont 2026a).

7.2.5. Groundwater Uses

As noted in **Section 2.1.6.4,** regional groundwater in the Boyne Basin is primarily used for pastoral, horticultural, and domestic purposes, however available information indicates that yields of registered bores within 9 km of Calliope are low (maximum of 1.5 L/sec, **Appendix F**). The mine operation re-uses pit water but does not have a pumping bore due to the low yields, so it is considered unlikely that there would be future significant groundwater use at or near the site (Graymont 2026a). The construction of the Awoonga Dam has led to permanent water being now present in what were previously ephemeral drainage lines. Groundwater and surface water interaction in parts of the surrounding area may now depend upon water levels in Lake Awoonga, and the mixing of the water and its uses is already established. Potential impacts and risks to environmental values is considered further in Section 4.8.1 of the Hydrogeological Assessment provided in **Appendix F**. There is a negligible risk to human groundwater beneficial users and supply to GDEs in the Boyne River Basin as a result of the Project. It is expected that future uses for groundwater in the surrounding region would remain similar to as currently used, with no significant changes due to the limited available yields (Graymont 2026a).

7.2.6. Water Balance Modelling of Final Pit Void

Updated details of water balance modelling developed to predict water levels of the final void at the EOML are provided in **Appendix F**. The following sub-sections summarise the components and assumptions used for the main pit void water balance and the water balance model (Graymont 2026a). An analytical spreadsheet-based model was used to formulate the Water Balance Model. The analytical final void Pit 3-4 Water Balance model was created

based on the formula: **Pit water inflow = direct rainfall capture +surface water run-off + groundwater inflow – pit evaporation** (Graymont 2026a).

The updated water balance modelling was informed by the revised conceptual hydrogeological model, groundwater monitoring data, groundwater quality assessments and slug testing results. These investigations indicate that groundwater inflow is a relatively minor contributor to final void water accumulation compared with direct rainfall capture and surface water runoff, which represent the dominant inflow sources to the final void system (Graymont 2026a).

7.3. Flooding

A final landform flood assessment was undertaken by Engeny (2023), which included development of hydrologic and hydraulic models to determine runoff hydrographs for a range of storm durations (refer to **Appendix I**). The Probable Maximum Flood (PMF) was applied to key overland flow paths with consideration of future mine domains and landforms to determine the flood risk profile in relation to the final landform. The areas around the pits between the two levees and the natural contour highs to the north and east of the pits are relatively flat. Based on the assessment provided in **Appendix I**, most rainwater falling during heavy intensity and/or long duration rainfall events will pool in low points on the surfaces, with standing water expected to occur both within and external to the voids.

It is noted that there are 4 locations at Pit 3-4, and 1 location at Pit 2, where inflow to the voids is observed by overtopping of the pit abandonment bunds. Void inflows are caused by local catchment runoff only. It is understood through site experience of water overtopping the east wall of Pit 4 from previous intense rainfall events that this does not typically cause significant instability of exposed benches. However, modelled water velocities at these inflow locations are more than 1.5 m/s and the potential exists for gullying formation at the pit crest due to scouring and erosion. Therefore, it is apparent that this requires mitigation to ensure the long-term stability of the final landform at EOML and such locations will be suitably protected with rock armouring to minimise scour potential and ensure the stability of the final landform (Rocktest 2026). Additional areas adjacent to Pit 2 and south of the Southern WRD, where flow velocities are predicted to exceed 1.5 m/s, will also be assessed during detailed closure design and, where required, stabilised using appropriately designed rock armouring or equivalent erosion protection measures. These controls will form part of the final landform design and be incorporated into closure planning and rehabilitation cost estimates.

A final landform drainage review focusing on the redesigned Southern WRD was prepared by Engeny (2026) as an addendum to their flood assessment. Both reports have been provided as **Appendix I**. The review identified that the redesign will significantly reduce the ponded area extent, with ponded water directed towards future Pit-3-4 via the drainage system. This is represented in **Figure 21**.

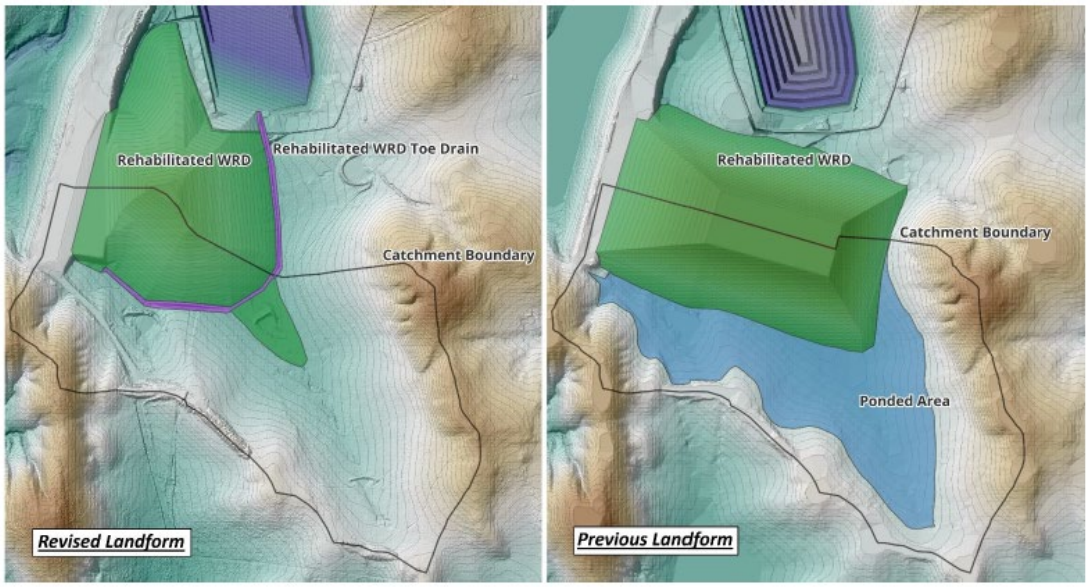


Figure 21. Change in extent of ponding from Southern WRD redesign

Source: Engeny 2026, Appendix I

The updated water assessments in **Appendix I** and **Appendix O** found that under the maximum disturbance scenario (incorporating the proposed Southern WRD redesign), the existing farm dam catchment will flow into Pit 3-4. As a result, the catchment area for Pit 3-4 in the maximum disturbance will encompass the current catchments for Pit 3, Pit 4, and the Farm Dam. The existing natural and constructed surface water that divides to the east and the west of the Project's MLs remain unchanged, maintaining a closed surface water system in which all runoff is contained within the Project's MLs (Engeny 2026, Epic Environmental 2025b). This is considered This is considered consistent with the proposed water storage PMLU for Pit 3-4 and the final landform design, which aims to retain site runoff within the closed catchment system. The water balance for the proposed redesign indicates that overtopping of site water storages is unlikely, even during extreme rainfall events (Graymont 2026b).

The drain will relieve water pooling around the Southern WRD final landform and thus will improve the ability for this adjacent undisturbed and disturbed land to support a grazing PMLU. A rehabilitation milestone criterion has been added into the PRC Plan schedule noting that updated flood assessments will be undertaken prior to closure to consider potential impacts from flooding and if any mitigating activities need to be implemented.

7.4. Soil and Capping Material Assessment

7.4.1. Capping Material

The only out of pit waste landform remaining at EOML is the Southern WRD. As discussed in **Section 7.5.3**, the Southern WRD will contain benign waste and will have the characteristics of a 'very low' Risk Category WRD. Therefore, there is no requirement for either a working layer, capillary break layer, low permeability layer or a top rock layer.

As no capping material is required, no specific assessment of capping material characteristics and suitability is required.

7.4.2. Soil Quality and Suitability for the Nominated PMLU

Soil quality assessments have been conducted on:

- Five topsoil stockpiles (See **Appendix D**)
- Areas to be cleared and stripped ahead of planned future mine expansion (see **Appendix C**)

Soil suitability is based on a post mine land use of low intensity grazing on native pastures comprised of locally occurring grasses including Slender Bamboo Grass, Black Speargrass, Kangaroo Grass, Pitted Bluegrass, Hairy Panic and Barbed-wire Grass.

Management recommendations for soil stripping and stockpile management for areas of future disturbance are provided in see **Appendix C**.

7.4.2.1. Stockpiled Soil Quality and Quantity

There are five topsoil stockpiles currently at the project with quantities provided in **Table 25**. The stockpiled material has been assessed for its suitability for supporting the establishment and maintenance of the nominated PMLU (low intensity grazing – or grazing on native pastures).

Table 25. Topsoil stockpile volumes

Stockpile ID	Approximate volume (m^3)
SP01	20,000
SP02	120
SP03	90
SP04	3,000
SP05	6,300

A summary of the soil quality analysis at each of the stockpile locations is provided in **Table 26**. Physically, the soils are free from significant limitations. Although a single reliable elevated ESP and moderate salinity result was recorded in one of the 23 samples, the soils are considered to be non-sodic and have a low salinity hazard. No lime or gypsum amelioration is required.

The samples had relatively low CEC and are not inherently fertile. In addition to the generally low available phosphorus results, the soils were also low in exchangeable potassium and relatively low in organic matter and available nitrogen. These limitations can be overcome to make the soils suitable for the proposed PMLU of grazing on native pastures. However, they will require amelioration with a compound (Nitrogen Phosphorus and potassium (NPK)) fertiliser would be recommended during grass establishment.

7.4.2.2. Additional Soil Quality and Quantity

A description of the soils present in undisturbed parts of the mining lease that may be disturbed by future mining activities is provided in **Section 1.1.1**. Section 7 of **Appendix C** provides a detailed assessment of the suitability of topsoil and subsoil resources for use in rehabilitation. For the most widespread soils that make up 70% of the area, there were no physical or chemical limitations to the recovery and re use of topsoil or subsoil material down to at least 1.0 m depth. One soil type was too shallow to allow topsoil recovery, and one soil type was a man-made soil previously disturbed by mining but currently vegetated and not recommended for topsoil stripping.

A summary of soil limitations, soil management recommendations and stripping depth is provided in **Table 27**.

If possible, subsoils will be stripped and stockpiled separately so that full soil profiles can be recreated on rehabilitations areas where soils are thin or on the Southern WRD where the substrate will be poorly graded waste rock.

Table 26. Summary of significant soil quality indicators (stockpiled soils)

Stockpile ID	No. of samples collected	Indicator	Units	Results	Comments
SP01	14	pH	pH	8.1 – 8.3	Alkaline soils
		EC	dS/m	0.13 – 0.22	Low to very low salinity
		Cation Exchange Capacity	cmol/kg	10 – 13	Low
		Extractable phosphorus	mg/kg	4 – 7	Very low to low
		Exchangeable Sodium Percentage	%	0.6 – 2.1	Non-sodic soil
		Emerson aggregate test	Class	2 - 4	Some apparent dispersion but significant dispersion hazard not supported by other electrochemical data
		Textural class (PSD)	-	Silty loam to silty clay	No limitation
SP02	1	pH	pH	8.3	Alkaline soil
		EC	dS/m	0.13	Low salinity
		Cation Exchange Capacity	cmol/kg	29	High
		Extractable phosphorus	mg/kg	7	Low
		Exchangeable Sodium Percentage	%	0.6	Non-sodic soil
		Emerson aggregate test	Class	4	No dispersion - stable
		Textural class	-	Silty loam	No limitation
SP03	1	pH	pH	8.1	Alkaline soil
		EC	dS/m	0.17	Very low salinity
		Cation Exchange Capacity	cmol/kg	14	Low
		Extractable phosphorus	mg/kg	6	Low
		Exchangeable Sodium Percentage	%	0.5	Non-sodic soil
		Emerson aggregate test	Class	4	No dispersion - stable
		Textural class	-	Silty clay	No limitations
SP04	2	pH	pH	8.5	Alkaline soils
		EC	dS/m	0.14 – 0.46#	Low to high salinity#
		Cation Exchange Capacity	cmol/kg	3 - 8	Very low to low

Stockpile ID	No. of samples collected	Indicator	Units	Results	Comments
		Extractable phosphorus	**mg/kg**	**3 – 5**	**Very low**
		Exchangeable Sodium Percentage	%	1.3 – 13.1*	Non-sodic soil
		Emerson aggregate test	Class	4	No dispersion - stable
		Textural class	-	Silty loam	No limitation
SP05	5	pH	pH	8.5 – 8.7	Alkaline to strongly alkaline soils which can occur in young soils on freshly weathered alkaline parent material or in soil with solid phase calcium carbonate as at Calliope)
		EC	dS/m	0.13 – 0.22	Low to moderate salinity
		Cation Exchange Capacity	cmol/kg	7 – 19	Low to moderate
		Extractable phosphorus	mg/kg	<2 – 6	Very low to low
		Exchangeable Sodium Percentage	%	1.0 – 7.9	Non-sodic to sodic (one sample)
		Emerson aggregate test	Class	2 - 4	Slight dispersion in one sample that coincides with a sodic ESP. Overall dispersion risk considered negligible given emerson aggregate test class and overwhelming number of stable non-dispersive results obtained
		Textural class	-	Silty loam	No limitation

Although the 1:5 extract EC suggested high salinity in one sample, the soluble chloride concentration was c. 300 mg/kg (0.03%) which is indicative of moderate salinity and may indicate that other non-toxic salts such as sulfates are also present and contributing to the apparently elevated 1:5 EC. The results or not high enough to limit a grazing PMLU on native pasture and a single sample with moderate EC does not constitute a widespread salinity hazard.

* The Carbon Exchange Capacity of the sample with the apparent high ESP was 3 $cmol^+/kg$. ESP determinations in soils with very low CEC are unreliable and the soil would not be expected to be sodic.

Table 27. Soil quality and stripping recommendation for areas potentially disturbed by future mining activities

SMU	Topsoil stripping depth (mbgl)	Subsoil stripping depth (mbgl)	Limitations and management recommendations	Area within maximum disturbance (ha)	Available topsoil[1] (m^3)	Available subsoil[1] (m^3)
A1 Brown Dermosol	0 to 0.3	0.3 to 1.0	There are no significant limitations to topsoil re-use. The pH is elevated, but this will not restrict rehabilitation to a PMLU of cattle grazing or native vegetation. Subsoils also suitable for stripping and reuse as a subsoil material if required. For pasture establishment on re-instated topsoil, an application for a broad based NPK fertiliser will be required. The rate of application should be determined by soil analysis of stockpiled material prior to removal and application.	9.5	28,473	66,437
B1 Leptic Rudosol	0 to 0.2	Not recommended	There are no limitations to topsoil re-use. Subsoils are not suitable for stripping and reuse due to high coarse fragment content and potential sodicity issues. For pasture establishment on re-instated topsoil, an application for a broad based NPK fertiliser will be required. The rate of application should be determined by soil analysis of stockpiled material prior to removal and application.	4.3	8,589	0
B2 Redoxic Hydrosol	Not recommended	Not recommended	Waterlogging and high clay content mean that it will be difficult to strip and store topsoils from this SMU without causing serious damage that could affect their quality and suitability for rehabilitation. Therefore, stripping and recovery is not recommended. Subsoils are strongly sodic and prone to dispersion and are not suitable for reuse.	1.5	0	0
C1 Spolic Anthroposol	Nil	0 to 1.0	Due to the disturbed nature and high coarse fragment content of this SMU, it is only recommended for reuse as a subsoil material.	4.2	0	42,317
D1 Leptic Rudosol	0 to 0.3	Not recommended	There are no limitations to topsoil re-use. Subsoils are not suitable for stripping and reuse due to high coarse fragment content and potential sodicity issues. For pasture establishment on re-instated topsoil, an application for a broad based NPK fertiliser will be required. The rate of application should be determined by soil analysis of stockpiled material prior to removal and application.	1.1	3,244	0
E1	0 to 0.3	0.3 to 1.0	There are no limitations to topsoil re-use. Subsoils also suitable for stripping and reuse as a subsoil material.	12.9	38,686	90,267

SMU	Topsoil stripping depth (mbgl)	Subsoil stripping depth (mbgl)	Limitations and management recommendations	Area within maximum disturbance (ha)	Available topsoil[1] (m^3)	Available subsoil[1] (m^3)
Brown Chromosol			For pasture establishment on re-instated topsoil, an application for a broad based NPK fertiliser will be required. The rate of application should be determined by soil analysis of stockpiled material prior to removal and application.			
E1(s) Brown Chromosol (shallow phase)	0 to 0.2	0.2 to 0.5	There are no limitations to topsoil re-use. Although subsoils have a moderate course fragment content, they would be suitable for stripping to the depth of the weathered parent material for reuse as a subsoil material. For pasture establishment on re-instated topsoil, an application for a broad based NPK fertiliser will be required. The rate of application should be determined by soil analysis of stockpiled material prior to removal and application.	2.2	4,379	6,569
E2 Brown Kandosol	0 to 0.3	0.3 to 1.0	There are no limitations to topsoil re-use. Subsoils also suitable for stripping and reuse as a subsoil material. For pasture establishment on re-instated topsoil, an application for a broad based NPK fertiliser will be required. The rate of application should be determined by soil analysis of stockpiled material prior to removal and application.	4.2	12,439	29,025

1 Volumes exclude bulking factor.

An estimated topsoil balance was prepared to evaluate the availability of soil resources required to support the proposed rehabilitation methodology. This material balance assumes placement of 200 mm topsoil material on relevant RAs. The overall topsoil material balance is presented in **Table 28** and demonstrates a deficit of soil material relative to the volumes required for rehabilitation. Additional suitable topsoil material will be sourced locally to support the rehabilitation methodology and will be assessed for physical and chemical suitability prior to use in rehabilitation works.

Table 28. Topsoil material balance

Rehabilitation Area	Project Component	Area Requiring Topsoil Placement (ha)	Topsoil Volume (m^3)
RA1	Cleared areas and laydowns	5.72	11,440
RA2	Silt dump	1.11	2,220
RA3	Pit 2	0	0
RA4	Infrastructure and ROM pad	27.34	54,680
RA5	Southern WRD	15.83	31,660
RA6	Pit 3-4	0	0
RA7	Spoil pile areas	6.03	12,060
RA8	Sediment ponds	1.46	2,920
RA9	Topsoil stockpile areas	7.84	15,680
RA10	Access tracks	0	0
	Required Topsoil Material (m^3)[1]	**N/A**	**130,660**
	Available Topsoil Material (m^3)[2]	**N/A**	**125,319**
	Surplus (+)/Deficit (-)	**N/A**	**(-) 5,341**

1 Based on the required topsoil placement depth of 200 mm across the relevant rehabilitation areas.
2 Derived from the material volumes outlined in **Table 25** and **Table 26.**

7.4.3. Topsoil Placement

As soil quality can change during stockpiling, soil analysis will be conducted prior to the soils being recovered from the stockpiles for use in rehabilitation and advice on amelioration sought from an Appropriately Qualified Person (AQP) at that time. Following grass establishment, monitoring of soil nutrient levels will be conducted to determine on-going fertiliser requirements until rehabilitation completion criteria and ground cover targets have been achieved.

The application and preparation of soil should occur as follows:

- Compacted areas (i.e., former hardstand or product stockpile areas) will be ripped to a depth of 500 mm at 500-800 mm spacings
- Prior to applying the soil cover, appropriate weed control will be conducted as required
- Where subsoil material has been stripped and stockpiled, as much material will be applied as allowed for the materials balance (prioritising use on the Southern WRD and product stockpile areas)
- An average of 200 mm of recovered topsoil will form the final cover
- Where available topsoil resources are insufficient to achieve the target placement depth, additional suitable topsoil or growth media will be sourced and assessed for physical and chemical suitability prior to use in rehabilitation works.
- The Southern WRD will be ripped to at least 300 mm following placement of subsoils (where available) and topsoil materials
- If there is a delay in seeding, further weed control will be conducted as required

- Prior to seeding (see **Section 7.8**), topsoils should be ameliorated with an appropriate fertilizer at a rate recommended by an AQP based on the results of stockpiled soil testing results

7.5. Waste Characterisation

A mine waste characterisation memo has been prepared by Epic (2024) and is provided in **Appendix J**. This assessment includes:

- Identification of mine waste
- Verification that the geology and mineralogy of the deposit poses a very low risk of acid, saline and metalliferous drainage, noting that there is therefore a limited requirement for standard mine waste assessment using static and kinetic methods that are undertaken on metalliferous and coal deposits
- Development of a standalone soil capping, soil quality, geochemical and physical sampling and analytical program to be delivered during future operations

7.5.1. Acid Mine Drainage Potential

As described in the Mine Waste Characterisation Memo undertaken by Epic (**Appendix J**), the occurrence of potential environmental hazards associated with acid, saline and metalliferous drainage (AMD) are not expected. This is due to the nature of the limestone deposit and the abundance of calcium-bearing carbonate minerals that occur throughout the deposit have acid neutralising capacity (ANC) values in the order of 1,000 kg H_2SO_4/tonne ANC. Where these minerals are mixed with mined material in an in-pit or ex-pit environment, any future seepage is likely to generate circumneutral to mildly alkaline runoff.

An assessment of acid base accounting test work on samples collected by Graymont was completed by Epic for both the northern and southern WRDs and production bench blast drill chips a detailed methods and results are available within (**Appendix J**). In summary, the results showed:

- Very low levels of total sulfur (<0.1%) across all three locations
- Strongly negative Net Acid Producing Potential (NAPP) values (markedly less than negative 20 kg H_2SO_4/t) across all three locations, indicating that all tested material was acid consuming
- Net Acid Generation (NAG) pH values above 7 across all three locations
- Net Potential Ratios (NPRs) markedly greater than three (3) across all samples (INAP 2009)

Due to the very low total sulfur concentrations, there is no need to further account for the different forms of sulfur present (such as oxidised forms of sulfur; sulfates) to improve the assessment of AMD risk (Epic 2026).

NAG pH and NAPP have been plotted on **Figure 22**. All of the data confirms that the waste rock and production (drill chip) material is classified as non-acid forming (NAF) (AMIRA 2002).

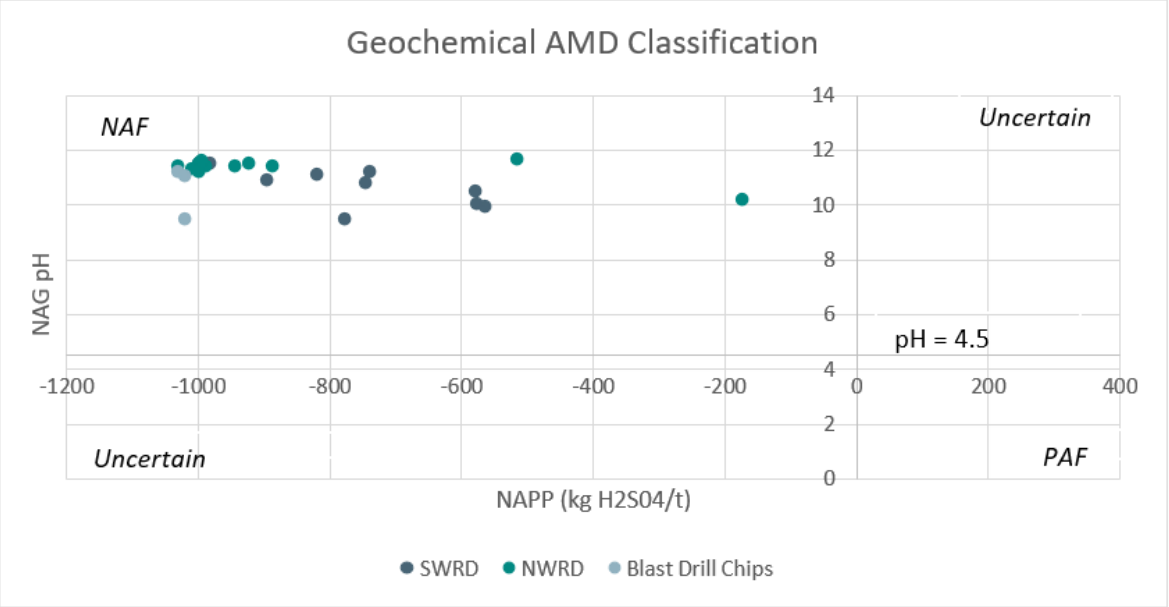


Figure 22. Geochemical AMD classification plot for three locations based on NAG pH and NAPP

Source: AMIRA 2002

7.5.2. Petrographic Analysis

The petrographic analysis completed in 2023 has shown that the limestone rock produced at Calliope is 93%- 99% calcite (calcium carbonate) with the balance being goethite (iron oxide-hydroxide). The analysis also indicated that sulfides were not observed in the samples.

Given that carbonate mineralogy of the material and the lack of observable sulfides, there is no risk of AMD generation from exposed limestone in the void wall (refer **Appendix J**).

Additionally, the limestone contains negligible chloride. Together with the lack of AMD generation potential and the negligible risk of neutralisation salts formation, the results indicate a very low risk of saline mine drainage generation.

7.5.3. Metal and Metalloid Analysis

Concentrations of metals and metalloids were mostly below laboratory limits of reporting (LOR). Samples with concentrations greater than the LOR were below compared to the median crustal abundance for un-mineralised soils (refer GARD Guide, Bowen (1979)). Enrichment of metals and metalloids can be evaluated on a log10 scale and expressed in increments from 0 to 6, where:

- GAI 0 – less than 3-fold enrichment
- GAI 1 – 3-6 fold enrichment
- GAI 2 – 6-12 fold enrichment
- GAI 3 – 12-24 fold enrichment
- GAI 4 – 24-48 fold enrichment
- GAI 5 – 48-96 fold enrichment
- GAI 6 – greater than 96 fold enrichment.

Generally, where a sample reveals a concentration and GAI of 3 or greater, it warrants further assessment. Samples analysed reported concentrations below the average crustal

abundance and with GAIs of 0 or 1, indicating the materials are not enriched in metals and metalloids (Epic Environmental 2026).

7.5.4. Summary and Implications

The waste rock and ore at Calliope have been categorised as NAF. There is negligible risk of acid generation from the WRDs or exposed rocks in the void wall. The results are consistent with the geology of the Project and the lack of acid pH values in water quality results from water that collects in the void presented in the PRC Plan. The results indicate the materials are not enriched in metals and metalloids. Given the consistently low sulfur concentrations, strongly negative NAPP values, NAG pH values above 7 and the carbonate-rich mineralogy of the deposit, additional kinetic testing is not considered necessary at this stage.

Based on the waste characterisation, according to risk category characteristics in Table 4 of the '*User Guide for Estimated Rehabilitation Cost Calculator for Mining',* 'the Risk Category' for the Southern Waste Rock Dump would be very low; benign waste rock materials minor (non-potential acid forming (PAF)) seepage. According to Table 5 of the '*User Guide for Estimated Rehabilitation Cost Calculator for Mining'* there is no requirement for either and working layer, capillary break layer, low permeability layer or a top rock layer for very low Risk Category WRDs. The default thickness for growth media is 0.15 m and will be exceeded at Calliope (where 0.2 m of topsoil will be applied). The waste characterisation results demonstrate that the Southern WRD comprises benign, non-acid forming materials with negligible potential for acid, saline or metalliferous drainage. Accordingly, an engineered cover system is not required, and rehabilitation can be achieved through direct placement of growth media and establishment of vegetation consistent with the proposed grazing PMLU.

Graymont has previously had success at their Murgon operation in revegetating WRDs to a grazing PMLU. These WRDs have been topsoiled without a specific capping / cover system on similar NAF waste rock materials.

7.6. Landform Design

Only one significant out of pit post-mine landform will remain at closure. This is referred to as the Southern WRD. The existing material Northern WRD will be removed and material used to backfill Pit 4 and product stockpile, infrastructure and laydown areas will be levelled as part of rehabilitation and closure. Access tracks are to be retained in accordance with the landholder agreement between Graymont and GAWB, provided in **Appendix E**. No specific landform requirements or commitments that have arisen though stakeholder consultation to date, but no major earthworks or landform design works for the tracks will be required for closure.

A final landform design has been prepared for the Southern WRD (**Appendix M**). The design ensures long-term geotechnical stability and is suitable for the establishment and maintenance of the nominated PMLU of grazing. The final WRD geometry was informed by erosion modelling and geotechnical analyses undertaken as part of the PRC Plan, which demonstrated that reprofiling to slopes of 12% or less significantly reduces erosion risk and supports achievement of the proposed grazing PMLU. The landform design for the Southern WRD is supported by the geotechnical assessment provided in **Appendix B.**

The development of Pit 4 has been planned to provide space for in-pit backfill as soon as practicable to minimise the quantity of waste material required to be placed outside the void.

The following sections summarise the design specifications for the final landform design for the Southern WRD and the erosion modelling and critical geotechnical stability data. The waste movement that governs the waste placement strategy and staging is also described in this Section, but the closure and stability of the final residual voids is described in **Section 7.10**.

The final landform design is summarised below, and includes the following considerations:

- 3D design plans of the final landform, including slope profiles and dimensions
- Documented testing regime (i.e., monitoring and performance)
- Limitations and assumptions of the landform design and methods for minimising risk
- Structure location, footprint, and height (including proposed lift heights) of the final landform
- Materials available for landform rehabilitation
- Waste placement strategy
- Void closure planning including options available for minimising final void area and volume
- Rehabilitation strategies
- Preliminary material balance for the site, summarised also in **Section 7.6.10**

The geotechnical assessment provided in **Appendix B** includes:

- Modelling to predict the long-term stability of the final landform design
- Quality Assurance / Quality Control (QA/QC) requirements (completion criteria)
- Trial methodology to verify the predicted success of the final landform design
- Description of the Southern WRD landform, considering rainfall events and the composition and texture of the rock
- Monitoring to determine performance of drainage controls, erosion mitigation measures and final landform stability
- Consideration of long-term erosion

7.6.1. Pit 4 Cut Stage 1 and Southern Waste Rock Dump

Pit 4 Cut Stage 1 concentrates on the northern end of Pit 4 to provide a void for placement of in-pit backfill as shown in **Plate 23**. During this stage waste backfill will be placed in the Southern WRD as shown in **Plate 24** (note this shows the expected maximum extent and dimensions of the Southern WRD during operations).

It is possible that a small quantity of waste material may be placed as in-pit backfill prior to completion of the full Stage 1 cut; however, the material balance and landform design conservatively assume that the Southern WRD provides the primary waste storage capacity during this phase of mining (Graymont 2026b, **Appendix M**).

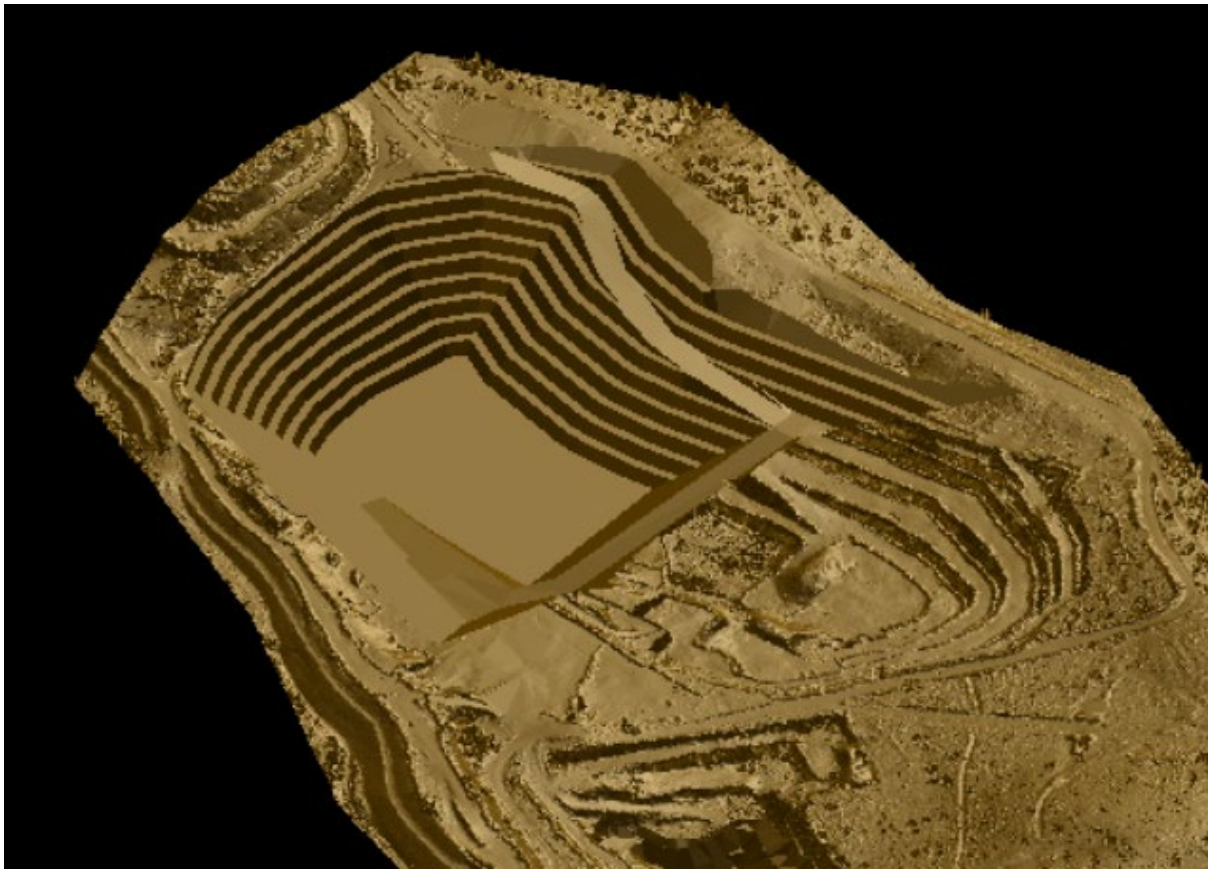


Plate 23. Pit 4 cut stage 1

Source: Graymont 2026b, Appendix M



Plate 24. Southern waste rock dump (operational stage only)

Source: Graymont 2026b, Appendix M

7.6.2. Pit 4 Cut Stage 2 and Stage 1 In-pit Backfill

Pit 4N Cut Stage 2 expands the Stage 1 cut to the south. This material is placed in the void that was created during Cut Stage 1 as shown in **Plate 25** (Graymont 2026b).

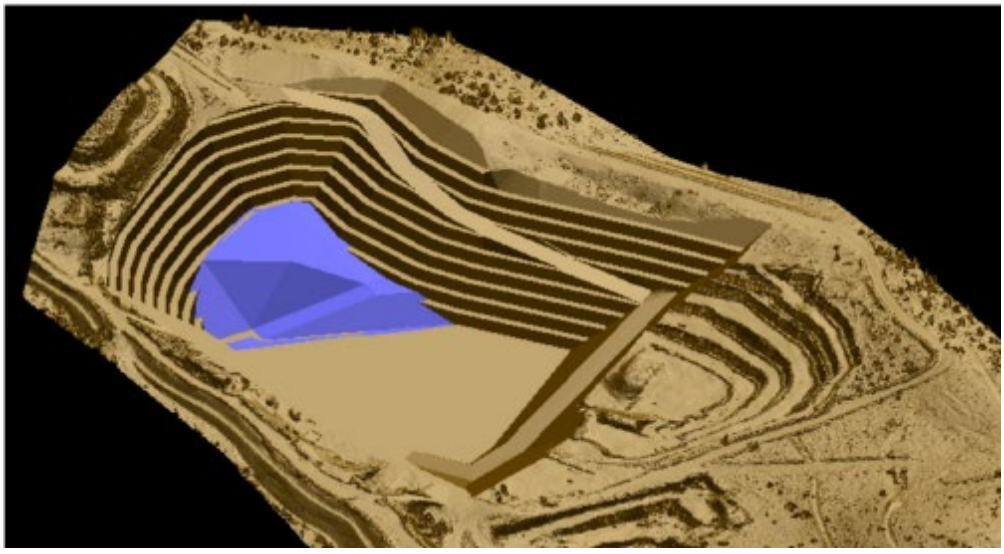


Plate 25. Inpit backfill after north cut Stage 2

Source: Graymont 2026b, Appendix M

7.6.3. Pit 4 Cut Stage 3 and Stage 2 In-pit Backfill

Pit 4N Cut Stage 3 widens the stage 2 cut to the south. This material is placed in the void created during Stage 1 and 2 Cuts as shown in **Plate 26**. Access is maintained to the southern upper benches with a south-eastern ramp (Graymont 2026b).

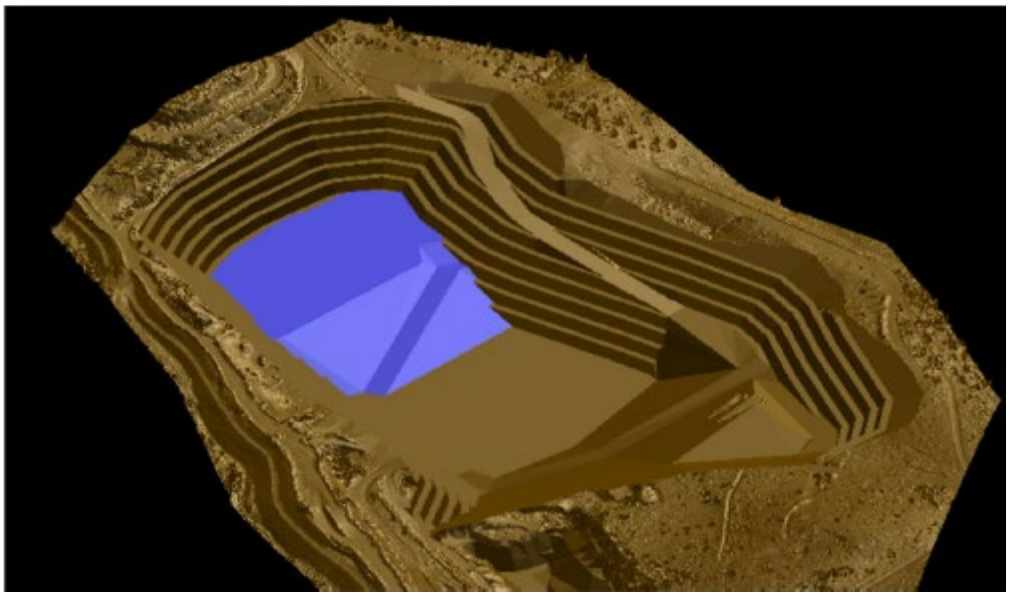


Plate 26. Inpit backfill after north cut Stage 3

Source: Graymont 2026b, Appendix M

7.6.4. Pit 4 Cut Stage 4 / Inpit Backfill Stage 3

Pit 4N Cut Stage 4 takes out the bridge between Pit 4 and Pit 3 and completes mining of the combined pit to full extent. This material is placed in the void created during Cut Stage 3 as shown in **Plate 27**. A void will remain in the southern end of the pit to approximately -56 mRL, as backfill cannot be placed on the pit floor while mining activities associated with Cut Stage 4 are ongoing. This area will subsequently accommodate additional backfill during the final stages of mine closure and landform construction (Graymont 2026b).

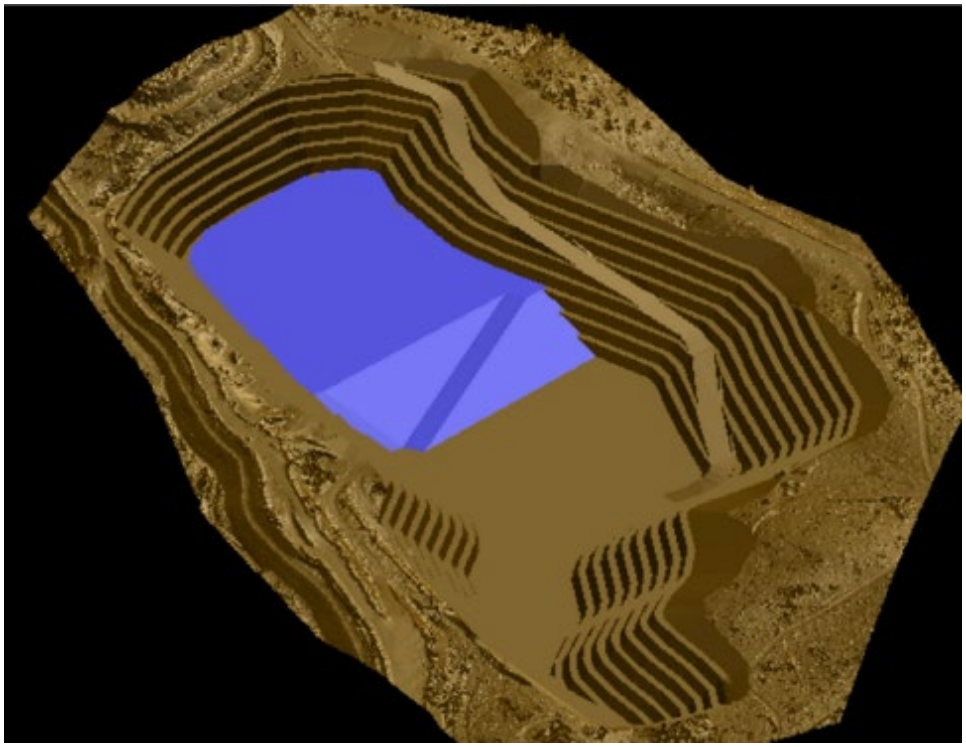


Plate 27. Inpit backfill after north cut Stage 4

Source: Graymont 2026b, Appendix M

7.6.5. North out of Pit Dump and Laydown Area and Abandonment Bund

During the final stages of mining the northern out of pit dump is backfilled into the northern end of Pit 4 and the laydown area is levelled. Construction of the abandonment bund can be in-around the top of pit 2 and pit 3-4 as shown in **Plate 28** (Graymont 2026b).

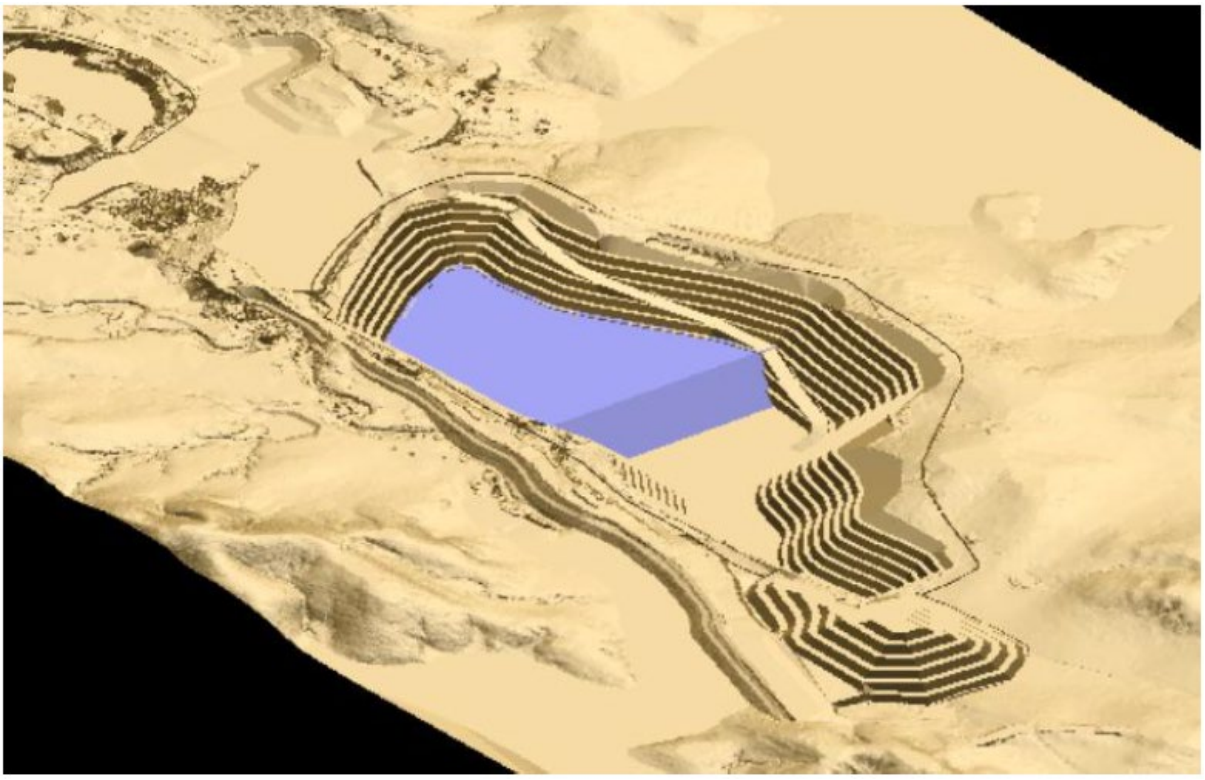


Plate 28. In-pit backfill at end of mine life and removal of the northern out of pit dump and levelling laydown area

Source: Graymont 2026b, Appendix M

7.6.6. Reprofiling Southern WRD

During the design phase for the Southern WRD erosion modelling based on the full operational out of pit dimensions shown in **Plate 24** indicated that the maximum rate of erosion for some of the slopes may be unacceptably high (greater than 10 t/ha/yr) and this would net provide a stable final landform. In addition, the slopes for the operational Southern WRD design will exceed the maximum slope limitation for Class 3 land suitability for beef cattle grazing PMLU for the final landform (Short 2023). Class 3 land is defined by a maximum 15 % slope for the topography limitation and 12 % slope for the erosion hazard limitation (for non-sodic soils like those observed at the Project) (refer to **Appendix C**).

Mine planning and sequencing was reviewed to determine if additional pit backfilling could be conducted to reduce the amount of material remaining in the Southern WRD at end of mine life and allow for a final landform design that includes shallower slopes to minimise erosion and optimise slopes for the proposed grazing PMLU.

Although the Southern WRD will remain as per the preliminary design during the operational phase, at the end of mine life, the Southern WRD will be reprofiled to create slopes of 12 % or less. Any excess material will be placed in the southern end of the pit 3-4 void and will be used to complete the abandonment bund around the top of pit 2 and pit 3-4 as shown in **Plate 29**.

Additionally, the WRD design has been optimised to minimise localised water accumulation (ponding), with the design promoting effective surface drainage and minimising pore pressure development within the rehabilitated landform. An assessment of the landform drainage and

residual risk of ponding from the Southern WRD redesign has been captured in **Section 7.3.** (Graymont 2026b)

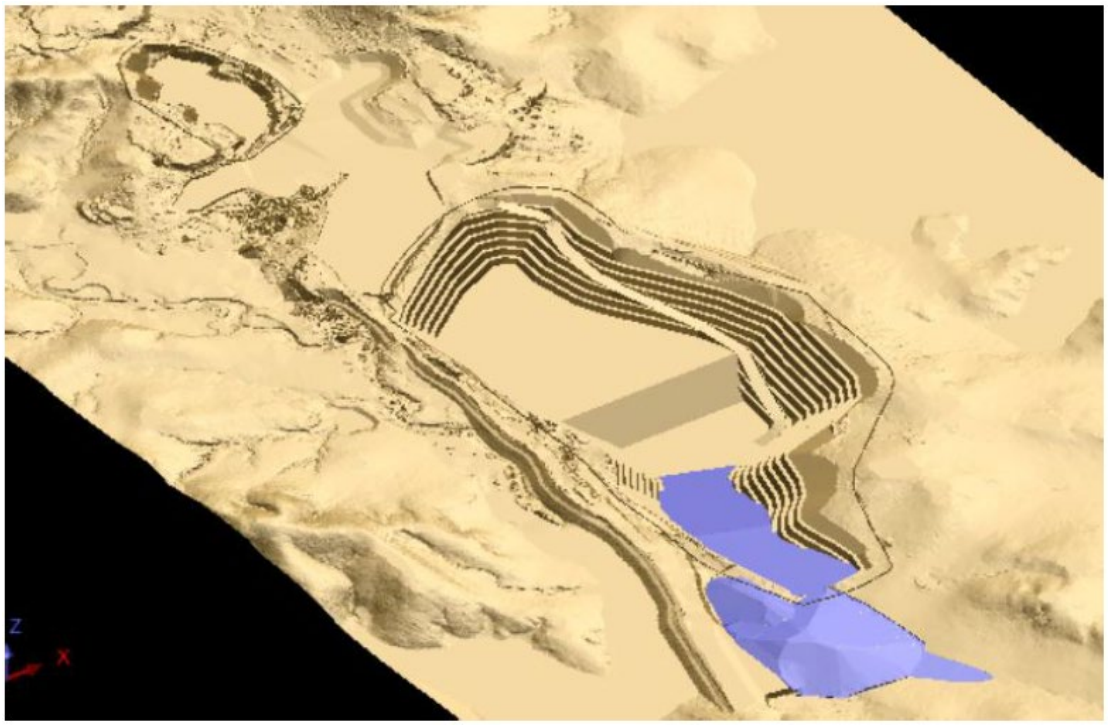


Plate 29. Reprofiled (final) Southern WRD, southern in-pit fill and abandonment bund
Source: Graymont 2026b, Appendix M

7.6.7. Option 2 Working the Pit from South to North

Pit 3-4 may also be worked from south to north rather than north to south, however, the north-to-south progression is the preferred mine sequence and has been considered in this PRC Plan. To determine the best direction to mine the pit further consideration will be given to potential added limestone reserves in the area, water management of Pit 2 and further economic assessment of North-South and South-North scenarios.

A south to north mining direction will follow a similar strategy as described in **Plate 23** to **Plate 28** but in reverse order. The southern end of the pit will be mined first to establish in pit backfill room. Waste generated during this phase will be spoiled in the Southern WRD (Graymont 2026b).

7.6.8. Final Landform Specifications

The elevations of the final landforms are shown in **Table 29**, with cross sections of the final Southern WRD landform shown in **Figure 23**.

Table 29. Proposed final Southern WRD design parameters

Design element	Design specification
Trend of major axis	North-south
Length of major axis along footing	c. 560 m
Length of minor axis along footing	c. 345 m
Maximum height of dump	25 m
Maximum overall slope angles	12% (6.8°)

Design element	Design specification
Minimum distance of the toe of a slope from a pit crest	10 m
Concave grade on upper levels for drainage	2°

Source: Rocktest 2026, Appendix B

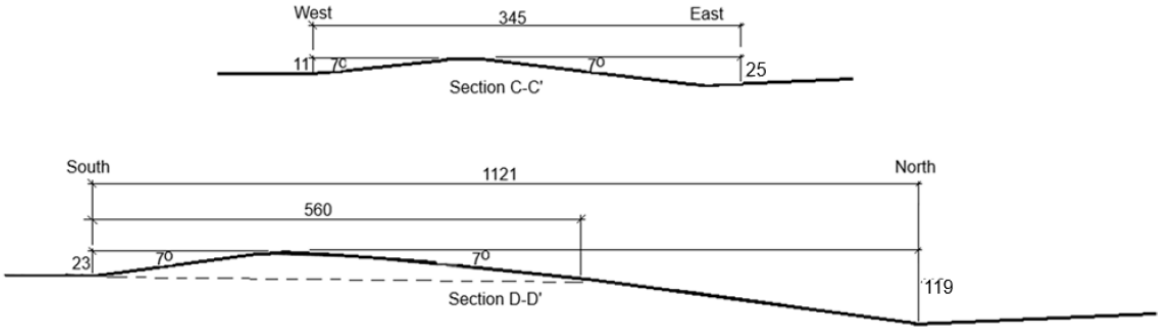


Figure 23. Southern WRD final landform cross section

Source: Rocktest 2026, Appendix B

7.6.9. Southern WRD Erosion Modelling Assessment

According to the Office of the Queensland Mine Rehabilitation Commissioner's Technical Paper *Applying erosion and Landscape Evolution Models to assess post-mining landform stability* (Hancock et al. 2025), the choice of model should reflect the prediction requirement, i.e., there is little point in using a complex Landform Evolution Model with many parameters if an erosion rate prediction is required for a simple hillslope for landform design purposes. Hancock et al. (2025) state that the Revised Universal Soil Loss Equation (RUSLE) erosion model is an ideal tool to quantify hillslope erosion rates for simple non-complex landforms. The RUSLE erosion model is also suitable for use on low-risk waste landforms that do not contain high risk PAF material for which a Landform Evolution Model would be more appropriate. Waste characterisation at Calliope has demonstrated that waste rock is NAF and has a very low risk of saline mine drainage generation (**Section 7.5**).

RUSLE has previously been employed by other proponents in the preparation of approved PRC Plans. It has been used for assessing post-mine landform stability, particularly for testing different design parameters such as slope angle and minimum vegetation cover requirements to control erosion to acceptable levels and is considered appropriate for assessment of the WRD design specifications for Calliope.

All the necessary data (including relevant soils data) available for the development of site specific inputs for the RUSLE model. It is noted that this assessment was undertaken based on a previous iteration of the WRD design prior to the refinement of the landform to minimise ponding. Rehabilitation of the Southern WRD is not expected to commence until 2101. Further design refinement will occur closer to rehabilitation to incorporate operational considerations and best practice approaches. The purpose of the current assessment is to demonstrate that the proposed landform concept is capable of achieving long-term erosional stability using the available soil resources, rather than to assess the final detailed design. Nevertheless, the

outcomes of the RUSLE modelling remain applicable, as the overall slope specifications and batter geometries are consistent with the proposed final landform.

The RUSLE model outputs for the assessed final landform assuming the establishment of 80% ground cover are shown in **Table 30**.

Table 30: Predicted erosion rate for the proposed SWRD final landform design

Slope aspect	Average erosion rate (t/ha/yr)
North	6.2
East	6.2
South	6.2
West	4.9
Top	0.32
Whole of landform	5.7

The assessed Southern WRD predicted maximum erosion rates are 6.2 t/ha/yr under 80% ground cover for individual slopes and under 6 t/ha/yr for the whole landform. The predicted erosion rates are considered to be low and demonstrate long-term stability. However, they are based on conservative C-factor values for newly established pasture (i.e., relevant for the early post-construction period) and would be expected to fall in the long term once the grass cover is well established and the C Factor increases.

Revised modelling will need to be undertaken, in accordance with Hancock et al. (2025), during the detailed design phase to determine the minimum groundcover requirements for long-established pasture prior to rehabilitation of the proposed final landform. Achievement and maintenance of the target ground cover will be assessed through rehabilitation monitoring to verify that erosion rates remain consistent with the assumptions adopted in the landform design and erosion modelling assessment.

7.6.10. Waste Rock Material Balance

The material balance for the current LOM design as of the 21 November 2025 is shown in **Table 31**. The total waste quantity has been calculated from the 2025 geological block model. It is noted that the actual waste generated over time may vary from that predicted in this model based on geological uncertainty, ore recovery and markets for ore and waste products.

The mass balance shows that the full Interim Southern WRD volume of 3.5 Mm^3 is required to provide capacity to create in-pit backfill space. It is assumed that some in-pit backfill room will be available prior to completing each cut stage as shown in **Table 31** (Graymont 2026b).

Table 31. Calliope LOM cut and fill material balance

Calliope LOM Plan Cut vs Fill Material Balance							
Cut			Waste Rock Dump Capacity				
Location	Description	Waste lcm	Southern WRD Interim m3	Stage 1 Floor m3	Stage 2 Floor m3	Stage 3 Floor m3	In-Pit North & In-Pit South Dump m3
			3,461,700	**653,185**	**1,593,267**	**2,446,138**	**5,280,430**
Stage 1	Stage 1 cut to Southern WRD	3,626,388	3,461,700	164,688			
Stage 2	Stage 2 cut to Stage 1 floor	713,715		488,497	225,218		
Stage 3	Stage 3 cut to Stage 2 floor	1,684,456			1,368,049	316,407	
Stage 4	Stage 4 cut to Stage 3 floor	3,482,260				2,129,731	1,352,529
Northern out-of-pit WRD	Northern out-of-pit WRD to Stage 4 floor	1,081,159					1,081,159
Southern WRD reprofile	SWRD to Southern in-pit dump	2,732,709					2,732,709
	Dump balance remaining room		-	-	-	-	**114,033**

Source: Graymont 2026b, Appendix M

7.6.11. Cover Design

No reactive wastes or geochemically unstable materials that require the placement of an engineered capping layer will remain on-site at Calliope at EOML (refer to discussion of Waste Characterisation in **Section 7.5** and specifically the conclusion in **Section 7.5.3**).

7.7. Water Management

7.7.1. Water Quality Objectives and Environmental Values

The EP Act and the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water) aim to provide ecologically sustainable development.

Environmental values (EVs) and water quality objectives (WQOs) are being progressively determined for Queensland waters. EVs define the uses of the water by aquatic ecosystems and for human uses (e.g. drinking water, irrigation, aquaculture, recreation). WQOs define objectives for the physical, chemical and biological characteristics of the water (e.g. nitrogen content, dissolved oxygen, turbidity, toxicants, fish).

As described in **Appendix F**, the EPP water type for this area is listed as “Lowland Fresh Waters” and environmental values zone includes “Northern Boyne tributaries and Lake Awoonga”. The Project area is mapped as having ‘Moderately Disturbed waters’ under the EPP Water, which is defined as waters in which the biological integrity of the water is adversely affected by human activity to a relatively small but measurable degree. The management intent for the site will be to maintain WQOs or improve towards WQOs.

EVs to be considered will include the immediate area around the Graymont Calliope limestone mining leases and downstream via Lake Awoonga. As noted in the Hydrogeological Assessment (Graymont 2023a), the current standing groundwater level is consistent with the levels in Lake Awoonga. There are no discharges to groundwater from operations, however there is a relationship with groundwater that will be investigated further.

The surface water monitoring and reporting process as conditioned in the EA (EPML00241213) provides a management tool for water management at the site for operations. Historic surface water monitoring has met the required limits set out in the EA. The EA includes conditions that there is to be no releases to groundwater at the site.

Upstream and downstream surface water quality locations have been selected to monitor the risk of environmental harm when rehabilitation activities are underway. These sites are summarised in **Table 32**. These locations have been included in the PRCP schedule in **Appendix A** and been selected within Graymont’s MLs where waterways are closest to the Project to ensure impacts to the receiving environment can be appropriately considered.

Table 32. Surface water monitoring locations

Monitoring Locations	Receiving waters location description	Easting (GDA2020 / MGA zone 56)	Northing (GDA2020 / MGA zone 56)
Upstream monitoring locations			
US1	Upstream tributary to Raggote Creek	320328.5	7334828
US2	Upstream tributary to Raggote Creek	320144.8	7334740
US3	Upstream Raggote Creek	319837.7	7334044
Downstream monitoring locations			
DS1	Downstream Raggote Creek (exit from ML in the northwest)	320062.3	7333792
DS2	Downstream Raggote Creek (exit from ML in the southwest)	320157.3	7331482
DS3	Downstream tributary to New Zealand Gully	321173.8	7334729
DS4	Downstream tributary into Lake Awonga	321547.3	7334039
DS5	Downstream tributary into Lake Awonga	321409.1	7333890
DS6	Downstream tributary into Lake Awonga	321348.1	7333439

The Lake Awoonga water supply is the main environmental value in the local area which may indirectly impact on downstream EV's. It is noted that in the recent major flood events (namely the 2011 floods), the Lake Awoonga levels rose and inundated the site. Whilst water flows over the site do not discharge to Lake Awoonga in normal conditions, there is a potential for contamination and water quality impacts from flood events when flood waters rise.

The EVs for the Project's receiving surface water environment has been defined as WQ1311—Boyne River in Schedule 1 of the EPP Water. The specific EVs applicable to the Project are detailed in the supporting EPP Water document, *Curtis Island, Calliope River and Boyne River Basins Environmental Values and Water Quality Objectives* (EPP 2014) and have been summarised in **Table 33** with consideration of water pathways and on-going management requirements provided in **Appendix F**.

Table 33. Water quality objectives

Value	Icon	Description	Pathway/Receptor Linkage
Aquatic Ecosystems		The site is adjacent to Lake Awoonga, a tributary to Boyne River. Areas downstream may support aquatic ecosystems.	Possible
Irrigation		The site is in proximity to a few groundwater bores that may be used for irrigation, however, the site is not considered to impact irrigation use of Lake Awoonga.	Low
Farm Supply Use		The Project has a farm dam which does not support any farming activities, and therefore is not considered to impact on water used for farming.	Low

Value	Icon	Description	Pathway/Receptor Linkage
Stock Water		The site is not considered to impact on the water used for livestock on Lake Awoonga or Boyne River.	Low
Aquaculture		The site is not located in proximity to any aquaculture facilities.	Unlikely
Human Consumer		Areas downstream from the site may be utilised for the consumption of aquatic foods, including fish.	Possible
Primary Recreation		Areas adjacent to the site support recreational activities including swimming and diving. Water discharges from the site may only contaminate Lake Awoonga during a flood event when dam levels rise	Unlikely
Secondary Recreation		Lake Awoonga supports recreational fishing and boating activities.	Unlikely
Visual Recreation		The site is located approximately 7 km southwest of the Lake Awoonga lookout, boat ramp, and camping area, and is not clearly visible from this location. Potential contamination at the site is unlikely to be contributing to deterioration of the aesthetics of Lake Awoonga.	Low
Drinking Water		Raw water from Lake Awoonga is processed at water treatment plants for drinking.	Low
Cultural and Spiritual Values		The site is not considered to impact on the cultural and spiritual values of Lake Awoonga.	Low
Groundwaters (aquatic ecosystems, irrigation, farm supply/use, stock water, drinking water)		Mining activities occur above the groundwater table so any discharges to groundwater are unlikely.	Unlikely

7.7.2. Description of Contaminants that Pose a Risk to Environmental Values of the Receiving Environment

Limestone quarrying is a relatively low risk form of mining that does not involve any chemicals in processing activities. Graymont maintain a hazardous chemicals register for all products onsite, and besides the fuel storage tank, all chemicals are contained within the office or workshop for the purpose of machinery maintenance, cleaning, etc. Therefore, there is a low risk of impact to environmental values of the receiving water environment from contaminants onsite during closure (refer **Appendix F**).

The potential risk of discharge of sediment laden water from the mining operation into the receiving environment was considered in the context of potential impact upon the EVs of

Raggote Creek, Lake Awoonga (as a lacustrine wetland), and the larger Great Barrer Reef catchment area (Epic Environmental 2026a). The discharge of sediment laden water from mining operations is expected to have a negligible impact on the receiving environment, including the EVs of Raggote Creek and Lake Awoonga (as a lacustrine wetland). Waste characterisation studies undertaken by RGS (2023a) and Epic (2024) confirm the absence of acid and metalliferous drainage (AMD) materials in waste rock. In the unlikely event of uncontrolled releases, potential impacts to water quality are expected to be limited to temporary localised increases of turbidity, suspended solids and nutrients.

Any future seepage and leaching of waste deposits is likely to generate circumneutral to mildly alkaline runoff that is consistent with the water qualities of the receiving environments (RGS 2023a). Furthermore, given the carbonate mineralogy of the material and the lack of observable sulfides, there is no risk of AMD generation from exposed limestone in the void wall (**Appendix J**).

As noted in the hydrogeological assessment provided in **Appendix F**, the Pits are sinks and results from the metals tested onsite indicate there is not a contaminant source that poses a risk to the receiving environment (refer **Section 7.5.3**).

7.7.3. Infiltration and Seepage Intervention and Collection Controls

Pit 3-4 is a passive hydraulic sink. After the EOML, water will seep from its eastern and western walls from the locations identified in **Appendix B**. The water originates in Lake Awoonga and its tributaries, and the rates of seepage increase as the depths of water in the sources increase. Seepage and groundwater flow pathways before and during mining are displayed in **Appendix F** (Graymont 2026a). Seepage waters draining into the pit voids are a mixture of surface run-off and groundwater from surrounding country rock. The flows likely occur within permeable sediments between the sources and the pit walls and within karst fill. They may also occur along east-west striking joints.

Water will not be pumped out of Pit 3-4 after closure; therefore, the Pit's water level will increase progressively to form a pit lake. The upper surface of the lake will stabilise at a level at which the losses due to evaporation from the surface of the water and other outflows equate to the combined inflows. This level will be similar to those of the water in Lake Awoonga and its tributaries. There will typically be a time lag for the levels to equate (Rocktest 2026).

As the residual pits are proposed to be water storages at EOML, no interventions or controls are proposed to control seepage. The Pit 3-4 lake will be predominantly within durable unweathered limestone. Seasonal cycles of wetting and drying of the limestone over the long term will not significantly reduce its strength. Hence, progressive reduction in the support of the walls that the limestone in the lower benches provides is unlikely (Rocktest 2026).

7.7.4. Water Management Requirements

An abandonment bund around the top of Pit 3-4 will be installed to manage long-term access across the site after the EOML. The eastern and western levees will also be retained for this purpose and to ensure ongoing water management at the site. Water in Pit 3-4 will contribute to stabilities by negating any detrimental outcomes resulting from hydrostatic pressures within the walls, further assessed in **Appendix B**.

Overland flow into Pit 2 will be managed by ensuring all mine affected water is directed to the Pit through landform reshaping and water management structures as required. Pit 2 is planned to remain a water storage facility for the current LOM and post-mine. The Pit 2 water level is assumed to continue at current water levels of 40 m RL (Graymont 2026a).

Water quality in Pit 2 meets the drinking water and stock water quality guidelines, except for the aesthetic drinking water salinity (EC) guideline value and would be expected to meet the guidelines post-mining. Therefore, no treatment is required.

As described in **Appendix B**, the natural surface is relatively flat between the crests of the east and west walls of Pit 3-4, the levees, and between the crests or the north and south walls, and the contour highs beyond them. Most rainwater that falls during heavy intensity and/or long duration rainfall events will pool in low points on the surface. During significant events, overland flows may erode some sediments exposed in the upper benches and/or cause slumping of these sediments, however, this will not be a significant hazard (Rocktest 2026).

A surface water impact assessment undertaken by Epic (2025b) indicates that the existing sediment basins have sufficient capacity to manage runoff under both current and maximum (end of mine life) disturbance conditions, thereby minimising the potential for uncontrolled releases into the receiving environment. Mitigation measures caprured in the Sediment and Erosion Control Plan provided in **Appendix L** are appropriate for minimising risks to the receiving environment.

7.7.5. Dewatering Requirements

Pit 4 will be dewatered progressively as required to access the limestone resource prior to being a water storage at the EOML. Dewatering activities will also be required in Pit 3 prior to amalgamation with Pit 4. A local groundwater gradient toward the Pit 3-4 void is set to continue as mining and dewatering progresses with mining. Groundwater seepage from surrounding bedrock in addition to surface water run-off accumulates in the mine void. Following cessation of mining, the mine voids will recharge with water as pressure differentials equalize with the surrounding bedrock and a new equilibrium is established (Graymont 2026a).

7.8. Revegetation

This section summarizes the Revegetation Plan provided in **Appendix H** and outlines the activities that will enable establishment of self-sustaining vegetation communities that are appropriate for the low intensity grazing PMLU. Methods proposed in this report are consistent with the Office of the Queensland Mine Rehabilitation Commissioner's (OQMRC's) Technical Paper for grazing as a PMLU (State of Queensland 2024b).

7.8.1. Revegetation Program

In accordance with the EA and nominated RAs, a Revegetation Plan has been developed for the Project area and provided in **Appendix H**. The Revegetation Plan outlines the revegetation objectives, milestones, proposed native species and densities, and locations for all RAs being rehabilitated to low intensity grazing PMLU, including:

- RA1 Cleared areas and laydowns
- RA2 Silt dump
- RA4 Infrastructure and ROM pad

- RA5 Southern WRD
- RA7 Spoil pile areas
- RA8 Sediment ponds
- RA9 Topsoil stockpile areas

Topsoil areas and sediment ponds are proposed to be planted in accordance with the Revegetation Plan, and all remaining areas with the low intensity grazing PMLU will be revegetated with native grasses.

Following cessation of mining operations, Graymont's objective is to return certain portions of the Project area to land that is suitable for the nominated PMLUs (refer **Section 4**), analogous to the surrounding unmined areas. The objectives of rehabilitation and revegetation are to:

- Create a landscape safe for humans and wildlife into the foreseeable future
- Create a stable landscape with natural rates of erosion
- Establish vegetation communities that resemble those originally found onsite, which blend visually with the surrounding landscape and vegetation
- Establish functional, self-sustaining vegetation communities
- Establish ecosystems that resemble neighbouring unmined areas in their ability to respond to fire and droughts
- Ensure minimal post-mining impacts on surface catchments

It is noted that RA3 Pit 2, and RA6 Pit 3-4 have an intended PMLU of water storage, consistent with Table 8 of the EA. Additionally, RA10 access tracks will be retained post-closure in accordance with landholder agreements. These areas are not suitable for supporting a vegetated asset as:

- Existing tracks will remain in situ post-closure to achieve intended PMLU by facilitating undisrupted access through the site
- Pit 2 and Pit 3-4 will require installation of an abandonment bund set back from the top of the Pit to exclude access. To minimise risks to humans or livestock, no access or rehabilitation activities will occur within the extent of the abandonment bund as further described in **Section 2.4.3.5** and **Section 2.4.3.6**

The Revegetation Plan (Epic 2025) proposes a native grass seed mix for RA1 cleared areas and laydowns, RA2 silt dump, RA4 infrastructure and ROM pad, and RA7 spoil pile areas, as shown in **Table 34**, and a tree and shrub species planting mix for RA8 sediment ponds and RA9 topsoil spoil pile areas, as shown in **Table 35.** The selected pasture species play a role in providing sustainable forage and land capability outcomes.

Table 34. Native grass seed species and quantities

Common name	Species name	Seed mix %
Slender Bamboo Grass	*Austrostipa verticillata*	50
Black Speargrass	*Heteropogon contortus*	10
Kangaroo Grass	*Themeda triandra*	10
Pitted Bluegrass	*Bothriochloa decipiens*	10
Hairy Panic	*Panicum effusum*	10
Barbed-wire Grass	*Cymbopogon refractus*	10

Table 35. Tree and shrub species planting mix

Common name	Species name	Planting density (plants/100 m²)
Trees		
Narrow-leaved Ironbark	*Eucalyptus crebra*	2
Red Bloodwood	*Corymbia erythrophloia*	1
Shrubs		
Pretty Wattle	*Acacia decora*	4
Corky Apple	*Planchonia careya*	1
Wild Orange	*Capparis canescens*	1
Currant Bush	*Carissa ovata*	1

The proposed planting schedule is provided in **Table 36**.

Table 36. Planting and maintenance schedule

Year	Season			
	Summer	Autumn	Winter	Spring
1	Site preparation Targeted weed removal Spread topsoil	Sow native grass seeds Herbicide spot spray Commence maintenance and irrigation (as necessary)		Broad-scale non-residual herbicide application
2	Weeds survey	Plant tree and shrub tubestock (**RA8 and RA9 only**) Herbicide spot spray	End irrigation	Broad-scale non-residual herbicide application
3	Weeds survey	Herbicide spot spray		
4	Weeds survey	Herbicide spot spray End maintenance (weeding control and supplementary planting)		
5	Weeds survey			
6	Weeds survey			
7	Weeds survey			
8	Weeds survey			
9	Weeds survey			
10	Final weed survey	PMLU achieved		

7.8.2. Reference Sites

Reference sites have been assessed within the Revegetation Plan provided in **Appendix H**. Two distinct vegetation areas – open woodland and grassland – have been identified as viable areas for reference sites for benchmarking rehabilitation via revegetation. For open woodland benchmarks, a BioCondition reference site was established within remnant bushland in the far north-west of the site, while for the grassland benchmarks, a BioCondition reference site was established in a cleared grassland area in the south of the site (**Figure 13)**. A total of seven areas are proposed to be used as reference sites for rehabilitation via revegetation, with the intended PMLU of low intensity grazing land. These seven areas (outlined in **Appendix H)** include RA8 and RA9 which pertain to open-woodland reference site, and RA1, RA2. RA4, RA5 and RA7 which pertain to grassland reference sites.

The site attributes and benchmarks intended for assessment of RA8 and RA9 revegetation works are provided in **Table 37**, while the site attributes and benchmarks intended for assessment of RA1, RA2, RA4, RA5 and RA7 revegetation works are provided in **Table 38**.

Table 37. Open woodland site attributes benchmarks

Site attribute	Reference site benchmark	BioCondition scoring[1]		Revegetation target
		Description	Score	
Canopy tree height (m)	14.5	<25%	0	≥10.2
		≥25% to 70%	3	
		≥70%	5	
Canopy tree recruitment (%)	100	<20%	0	≥75%
		≥20-75%	3	
		≥75%	5	
Canopy tree cover (%)	15.5	<10%	0	7.8-31%
		≥10% and <50%	2	
		≥50% or ≤200%	5	
		>200%	3	
Tree species richness	2	<25%	0	≥2
		≥25% to 90%	2.5	
		≥90%	5	
Shrub cover (%)	7.3	<10%	0	3.7-14.6%
		≥10% and <50% or >200%	3	
		≥50% or ≤200%	5	
Shrub species richness	8	<25%	0	≥8
		≥25% to 90%	2.5	
		≥90%	5	
Grass species richness	8	<25%	0	≥8
		≥25% to 90%	2.5	
		≥90%	5	
Other species richness	9	<25%	0	≥9
		≥25% to 90%	2.5	
		≥90%	5	
Non-native plant cover (%)	0	>50%	0	<5%
		≥25% to 50%	3	
		≥5% to 25%	5	
		<5%	10	
Perennial grass cover (%)	40.4	<10%	0	≥36.4%
		≥10% to 50%	1	
		≥50% to 90%	3	
		≥90%	5	
Organic litter cover (%)	19	<10%	0	9.5-38%
		≥10% to <50% or >200%	3	
		≥50% or ≤200%	5	

Table 38. Grassland site attribute benchmarks

Site attribute	Reference site benchmark	BioCondition scoring[1]		Revegetation target
		Description	Score	
Grass species richness	5	<25%	0	≥5
		≥25% to 90%	2.5	
		≥90%	5	
Other species richness	2	<25%	0	≥2
		≥25% to 90%	2.5	
		≥90%	5	
Non-native plant cover (%)	0	>50%	0	<5%
		≥25% to 50%	3	
		≥5% to 25%	5	
		<5%	10	
Perennial grass cover (%)	75	<10%	0	≥67.5%
		≥10% to 50%	1	
		≥50% to 90%	3	
		≥90%	5	
Organic litter cover (%)	10	<10%	0	5-20%
		≥10% to <50% or >200%	3	
		≥50% or ≤200%	5	

7.8.3. Rehabilitation Milestones

To track the progress of the revegetation works and identify any limitation to success, expected milestone have been suggested and are provided in **Table 39**. A landform is considered stable when it can sustain the intended PMLU (DES 2021).

Table 39. Rehabilitation milestones for revegetation areas

Milestone	Description
1. Landform development and reshaping / reprofiling of other areas	• Areas to be revegetated will have water shedding landforms with slopes not exceeding 12% (RA1, RA2, RA4, RA5, RA7, RA8, RA9) • Grazing RAs (RA1, RA2, RA4, RA5, RA7, RA8, RA9) assessed as stable and non-polluting by a suitably qualified person • Final landform (other than RA3 Pit 2 and RA6 Pit 3-4) does not contain any low points that may pond water for more than 1 month • Eastern and western levees (RA10) are certified as geotechnically stable by a suitably qualified geotechnical engineer
2. Surface preparation (grazing PMLU)	Areas to be revegetated should be ripped to a depth of 500 mm at 500-800 mm spacings An assessment of stockpiled soil quality and suitability for rehabilitation has been completed by an AQP prior to seeding to confirm available topsoil is suitable for the establishment and maintenance of the nominated post-mine land use Topsoil placed to an average depth of 200 mm to all RAs where required Application of ameliorants on topsoil if required, as per recommendations from the soil quality and suitability assessment All bores decommissioned in consultation with the Queensland Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development Development according with the preferred practices nominated in the Minimum Construction Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee 2020)
3. Revegetation (grazing)	• Initial revegetation campaign to seed target species per Table 2 and Table 3, including planting in rehabilitated sediment ponds (RA8) and topsoil stockpile areas (RA9)

Milestone	Description
	• Timing of seeding (sowing) determined based on target species • Cleared areas (RA1), silt dump (RA2), infrastructure and laydown areas (RA4), Southern WRD (RA5), and spoil pile areas (RA7) to be seeded with native grasses • Firebreak maintained along edge of mining lease until rehabilitation complete • Install temporary exclusion stock fencing if needed to prevent access to revegetation areas until established, or as advised by an AQP
4. Rehabilitation monitoring and maintenance	Rehabilitation monitoring reference sites for grazing PMLU have been selected in unmined pasture areas within the lease area (excluding RA3, RA6 and RA10), as per reference (survey) sites in Figure 13 of Revegetation Plan Annual rehabilitation monitoring for low intensity grazing pasture PMLU is undertaken annually for a period of at least five years from when rehabilitation commenced, in accordance with Revegetation Plan Annual monitoring shows that the mean projective cover of invasive plants listed as a restricted biosecurity matter will account for no more than 5% ground cover in rehabilitated areas with grazing pasture PMLU or exceed the groundcover recorded in reference pasture areas (whichever is greater) Native or introduced desirable palatable and productive species in rehabilitated areas trending towards at least 50% of the vegetative ground cover Bare ground % is equivalent to at least a “fair” condition as defined by Future Beef (https://futurebeef.com.au/resources/land-condition/). Vegetation maintenance and or additional soil amelioration has been undertaken as soon as is practicable where monitoring has shown that groundcover or pasture composition does not meet the milestone criteria within the nominated timeframe The ground cover in rehabilitated areas with low intensity grazing pasture PMLU will, on average, be dominated by native grasses identified in the Revegetation Plan that are recognised as pasture species or known to be palatable and provide forage for livestock No active gully erosion (i.e., >0.3 m deep) is present in the rehabilitated areas with grazing pasture PMLU during the rehabilitation monitoring period of at least 5 years from when rehabilitation first commenced If active gully erosion (>0.3 m deep) is identified during rehabilitation monitoring, repair works have been undertaken as soon as is practicable Annual visual monitoring of the void slopes (RA3 and RA6) demonstrates that they have remained stable for a period of ten years from when rehabilitation commenced Where unacceptable instability is recorded, advice has been sought from a suitably qualified person and remediation works have been undertaken as soon as is practicable
5. Achievement of post-mining land use to stable condition (grazing)	• Revegetation criteria per RM9 have been met on at least three consecutive annual monitoring events • Certification from a suitably qualified person that RA5 southern waste rock dump is functional and no migration of contaminants to groundwater has or will occur • Certification from a suitably qualified person that the area has achieved a stable condition

7.8.4. Revegetation Limitations

A variety of factors can result in insufficient revegetation of the Project area. The following limitations have been identified as factors that could result in unsuccessful rehabilitation:

- **Poor seed establishment** – caused by unfavourable conditions being encountered on the site
- **Damage to revegetation area** – trampled juvenile plants and/or herbivory from browsing animals
- **Erosion** – loss of topsoil and scouring of land
- **Fire** – natural fires resulting in loss of planted stock
- **Weeds** – proliferation of weeds out competing native species

Mitigation measures for these limitations include:

- Ongoing monitoring of revegetation as per **Section 10**
- Implementation of exclusion fencing if damage to revegetation from animals is observed (refer **Appendix H)**
- Implementation of management measures per Erosion and Sediment Control Plan (ESCP), provided in **Appendix L**
- Implementation of preventative risk measures as outlined in the Environmental Management Plan (EMP)
- Weed and pest issues will be managed in accordance with Weed and Pest Management Plan provided in **Appendix K**

7.8.5. Weed Management

It is important to implement an annual plan of action for the management of weeds. Areas of weed infestations will be mapped onto the site plan, and the desired goals will be established in line with the existing Weed and Pest Management Plan (refer **Appendix K**). This maximises the efficient use of resources and enables weed control to be undertaken at the most effective time, particularly prior to revegetation and seeding activities. It is also important to review the success of weed control undertaken during the previous year, and make the necessary adjustments to improve success, if necessary.

Control of weeds can be achieved through mechanical or chemical methods. In general, chemical methods are preferred as they achieve greatest success per unit effort. Mechanical methods are only preferred when infestations are small, located in waterways and/or located among sensitive native species for which collateral impacts of sprays are unacceptable.

7.9. Tailing Storage Facility

There are no TSF included in the Project.

7.10. Voids

A geotechnical assessment was undertaken by Rocktest Consulting (2026) for the PRC Plan to consider safety measures, stability, and rehabilitation recommendations for the design of the residual void at EOML. The assessment concluded that the proposed landforms can support the nominated PMLUs and achieving acceptable long-term geotechnical performance, provided the recommended design specifications, monitoring requirements and risk management measures are implemented. The geotechnical assessment including the stability analysis for the final design is provided in **Appendix B**. Additional to final landform design considerations identified in **Section 7.6**, the geotechnical assessment provided in **Appendix B** also includes discussion on void closure including:

- Geotechnical assessment of all final landforms including consideration of stability, erosion, weathering, and hydrological events
- Final slope angles, abandonment bund design and offset requirements, and design specifications for final voids and the Southern WRD.
- Geotechnical stability mechanisms, including void filling, reshaping, and void configuration through earthworks.

7.10.1. Final Landform Specifications and Stability

Nominal angles and specifications of the final Pit 3-4 and Pit 2 landforms from the Geotechnical Assessment provided in **Appendix B** are summarised in **Table 40** and **Table**

41 respectively. Consistent with Pit 2, a hard rock perimeter abandonment bund will be constructed with a minimum setback from the top of the slopes to prevent access. Engineering design has been completed for the proposed abandonment bunds, with dimensions outlined in Table 2 of the Geotechnical Assessment provided in **Appendix B**. This is consistent with the requirements of the '*Safety Bund around Abandoned Open Pit Mines Guideline*' (DIR 1997).

Table 40. Final design specifications of Pit 3-4 at EOML

Dimension Value	Value
Trend of major axis	178°
Length of major axis at crest	1,550 m
Average length of minor axis at crest	584 m
Maximum heights of walls	110 m
Heights of benches	12 m
Maximum number of benches	9
Width of berms	10 m
Height of edge bund on berms	1 m
Batter angles in unweathered rocks	65°
Batter angles in weathered rocks	18°
Inter-ramp angles	38°
Maximum overall slope angles (north/south/east/west)	32°
Ramp type / Minimum width	Linear / 30 m

Source: Rocktest 2026

Table 41. Final design specifications of Pit 2 at EOML

Dimension Value	Value
Trend of major axis	168°
Length of major axis at crest	418 m
Average length of minor axis at crest	200 m
Maximum heights of walls	34 m
Heights of benches	None
Maximum number of benches	1
Width of berms	n/a
Height of edge bund on berms	n/a
Batter angles in unweathered rocks	n/a
Batter angles in weathered rocks	n/a
Inter-ramp angles	n/a
Maximum overall slope angles (north/south/east/west)	34°
Ramp type / Minimum width	Linear / 17 m

Source: Rocktest 2026

The relief of the final voids is shown in **Plate 30** in the context of the surrounding landform. The final landform with the full pit lake filling is shown in **Plate 31**.

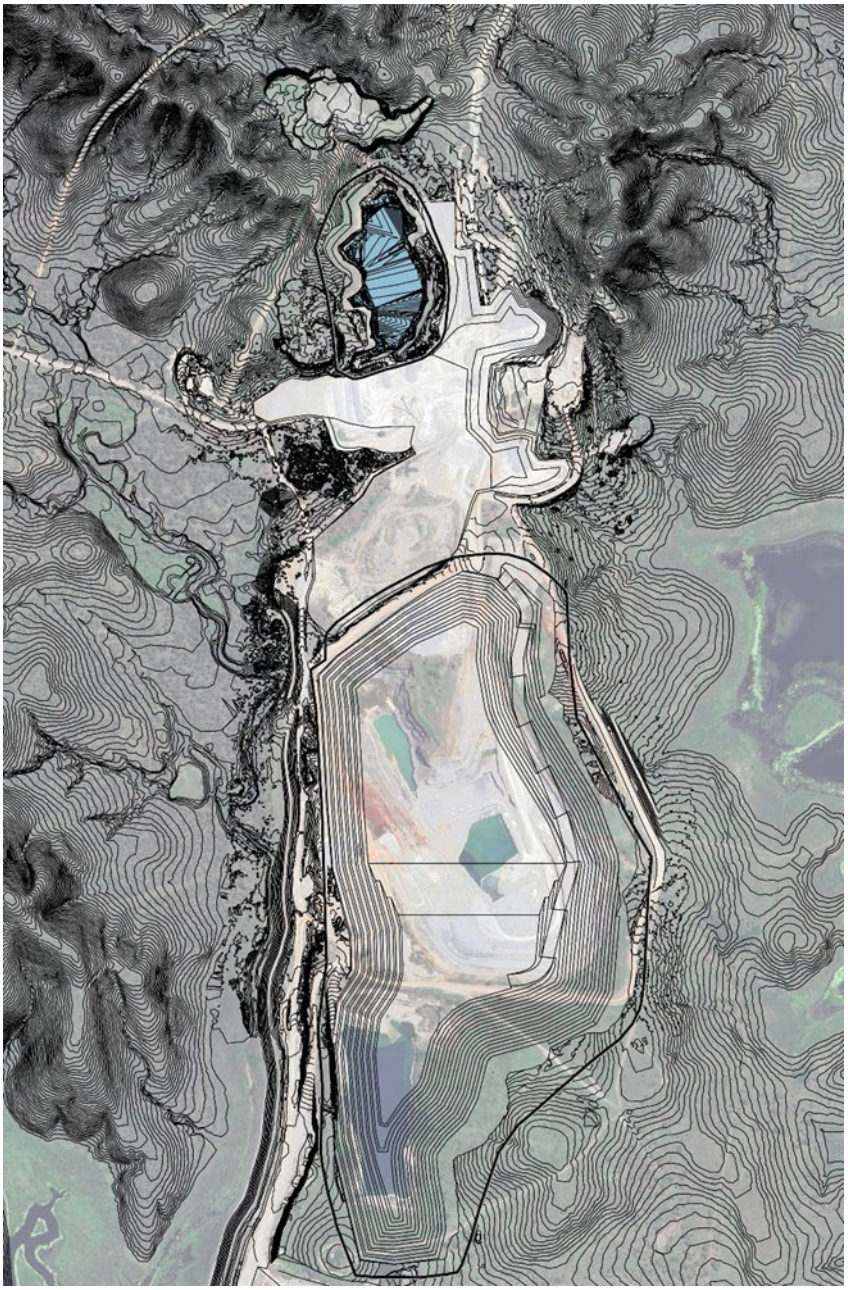


Plate 30. Final void landform relief
Source: Graymont 2026b

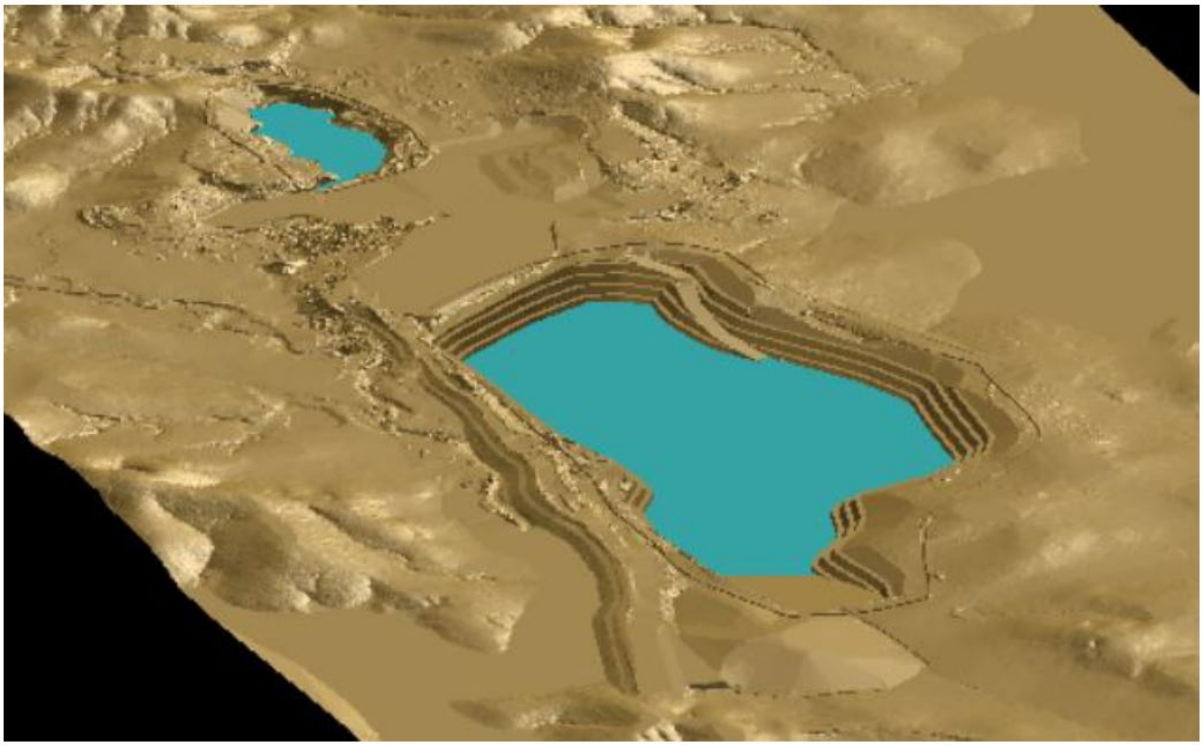


Plate 31. Final landform showing pit lakes in Pit 2 and Pit 3/4
Source: Graymont 2026b, Appendix M

Bench, inter-ramp, and wall scale stabilities are described in the Geotechnical Assessment provided in **Appendix B**. The assessment concluded overall scale instabilities are unlikely, consistent with the performance of Pit walls to date. Water within either Pit 2 and Pit 3-4 slightly increases the stabilities of the walls and will increase more if the level increases above RL40 during flood conditions. Each berm is likely to have sufficient retention capacity to control the volume of rocks involved in almost all bench scale instabilities and prevent the rocks from traversing beyond the berms (Rocktest 2026). The assessment indicates that the proposed Pit 2 and Pit 3-4 landforms are capable of achieving acceptable long-term geotechnical stability and supporting the proposed water storage PMLU.

Rockfalls and Bench Scale Stabilities

Final berms in Pit 3-4 will be 10 m wide and contain 1 m high edge bunds. The widths exceed the minimum 7 m width recommended by Ryan and Prior (2000) for retention of individual rocks that fall from 12 m high benches. A series of rockfall simulations were undertaken to confirm this theory and to inform an understanding of the trajectories of rocks that release from, and traverse down, a batter and the likelihoods for these rocks to traverse over the crest of a berm (refer Appendix 5 of **Appendix B**). These simulations indicated that rocks are unlikely to traverse beyond the edge bund and support the conclusion that the proposed berm configuration is capable of controlling falling rocks (Rocktest 2026).

It is noted that the largest wedge that could develop in the specified bench has a volume and a length along the crest of approximately 265 m^3 and 13 m respectively (Ryan and Prior 2000). Historically a wedge of this volume has never occurred on any bench within any of the three existing pits. Therefore, based on the considerations listed in Gibson et al (2006) on the optimisation of bench face angle and berm width for open pit mines it is expected that a 10 m

wide berm is likely to prevent almost all rocks spilling on to a lower berm if this wedge mobilises.

On this basis, and based on experience within Pit 4, the specified berms are likely to have sufficient retention capacities to control and retain falling rocks involved in an event up to bench scale. In addition, as access into the pit will be restricted, the pit floor will be a lake and access on to a berm will not be possible, the likelihood of a person being below a rock that detaches at the time it detaches is extremely low. For these reasons, together with the proposed abandonment bunds and restricted access controls, the residual rockfall risk is considered acceptable for the proposed water storage PMLU (Rocktest 2026).

7.10.1.1. Management of Flood Events

Historical evidence indicates the eastern and western levees and natural contour highs north and east of the site prevent the pit walls being overtopped by flood water during most flood events originating from Awooga Dam and its tributaries, however, a rare Peak Maximum Flood event could result in some sections of some walls being overtopped (Rocktest 2026). Experience in Pit 4 provides evidence that an event does not cause significant instabilities of rocks exposed in the batters. However, soil within karst exposed in a section of an upper bench will erode, resulting in the section retreating due to gully erosion (Rocktest 2026). Preventing this occurrence during the PMLU requires, prior to EOML, creating shallow rock lined drains in areas of soil filled karst (refer Section 4.6 and Figure 20 of **Appendix B**) i.e.:

- Reduce, to less than 18 degrees, the batter angle in each section of an upper bench that comprises soil
- Grade the base of the excavation to create a shallow V-structure to cause water to migrate down the centreline of the excavation
- Sheeting the soil with a minimum 0.5 m thickness of well graded durable rocks of +0.25 mm size
- Spray the rocks with a cementitious binder of sufficient strength and quality to reduce the likelihood of the rocks that form the bed of the drain from detaching during flows
- Inspect drains and, if necessary, repair damage after flood events (Rocktest 2026)

7.10.2. Abandonment Bunds

The final landform will include an abandonment bund behind the crest of each wall surrounding both Pits 2 and 3-4. The abandonment bunds are required to:

- Prevent inadvertent access to the crests by vehicles and restrict access by motorbikes and persons on foot
- Provide areas between the crests and the bunds that are sufficiently clear and flat to enable evidence of crest retreat to be observed during inspections to enable access by equipment for remediation

In lieu of Queensland's specific guidelines on abandonment bunds, the recommendations in the Western Australian Guideline (1997) will be to be applied. The intentions within this guideline are for a bund to:

- Be installed behind the crest of each wall beyond potential failure zones
- Encircle the pits with no gaps other than where locked gates provide restricted access through the bund

- Be obvious
- Have sufficient height to restrict access
- Have sufficient longevity to remain functional for the long-term

The characteristics and specifications of the bunds are indicated in **Plate 32**. The bund will contain 1 m high core of compacted clayey soil. The bund will also be sheeted in unweathered crushed limestone to a height of 2 m sourced from site and will remain unvegetated to maintain visibility, facilitate inspections and discourage access to the crest areas. Their nominal specification is outlined in **Table 42.**

Table 42. Abandonment bund specifications

Element	Specification
Total Height	2 m
Footing Width	5.4 m
Slope Angles	1.3H:1V (i.e. 38^{O})
Sheeting	Well-graded coarse unweathered limestone of +25 mm
Core	Compacted clayey soil

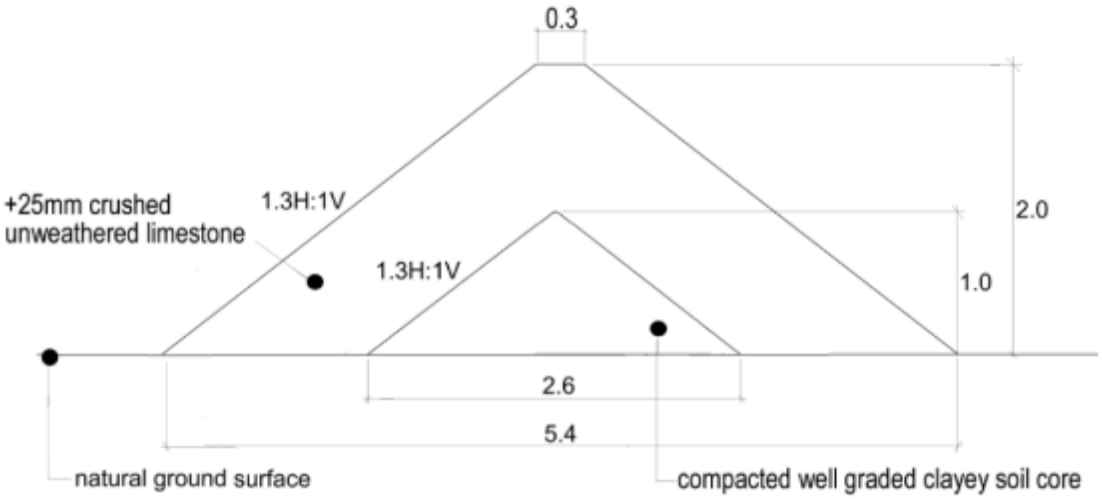


Plate 32. Nominal specifications of the abandonment bunds to encircle Pit 2 and Pit 3 – 4

Source: Rocktest 2026

7.10.2.1. Offsets from pit crests

The Guideline recommends bunds be offset a minimum of 10 m behind the point at which a construction line from the toe of a wall intersects the natural ground surface behind the wall. The line is to be orientated at 45^{o} in unweathered rocks and 25^{o} in weathered rocks. On this basis, the minimum offsets are those listed in both **Table 43** and **Table 44**.

Stability analysis (refer Section 6.3 of **Appendix B**) indicates that overall (wall) scale surfaces having the lowest capacities daylight up to 50 m behind the crest of the north wall of Pit 3-4 and 30 m for the other walls. However, the analyses indicate the scarp of an instability is unlikely to develop as far back as these distance, more likely no more than a few metres behind a crest.

This understanding is consistent with the historical performances of the walls in Pits 2 and 3 – 4. On this basis, the offsets in the table should be considered to be minimum distances; the bunds being placed as far as practical beyond them. The actual distances, to be established

prior to the EOML, should be informed by the results of the stability analyses and be within the lease boundaries.

Table 43. Minimum abandonment bund offsets from the crests of the walls of Pit 2

Wall	Height of Wall (m)	Overall Slope Angle	Weathering Depth (m)	Minimum Offset
North	31	36°	31	34
South	16	38°	16	24
East	21	35°	21	25
West	37	36°	37	38

Table 44. Minimum abandonment bund offsets from the crests of the walls of Pit 3-4

Wall	Height of Wall (m)	Overall Slope Angle	Weathering Depth (m)	Minimum Offset
North	105	38°	20	10
South	107	30°	20	10
East	105	26°	20	10
West	116	38°	20	10

The abandonment bund will be constructed based on minimum offsets required from the top of the pit crest, creating an exclusion zone to the abandonment bund. As described in **Section 2.4.3.5** and **Section 2.4.3.6**, no rehabilitation will occur within the exclusion zone to the abandonment bund as these areas are undisturbed or naturally regrown, too steep, or unsafe to access for rehabilitation. These areas are therefore not considered a revegetation area and have no applicable milestone criteria associated with them. The abandonment bunds will remain unvegetated to aid their inaccessibility.

7.10.3. Potential for Environmental Harm

An assessment of environmental values and water quality objectives is provided in **Appendix F.** Water seeps from the eastern and western walls of Pit 3 and Pit 4 from the locations identified in **Appendix B** and **Appendix F**. Over time, it is likely the base and walls of the void will develop a silty seal, and this will reduce the effect of seepage in or out of the void (Graymont 2026a, refer **Appendix F**).

The potential impact mechanism on Lake Awoonga water supply is via overland flow in a flooding scenario or by slow seepage through the bedrock once the Pit 3-4 void water levels are elevated. The latter mechanism is very low probability given the long-term void water levels are expected to be slightly lower than the Lake Awoonga water levels, hence the groundwater gradient will be shallow toward the void (Graymont 2026a).

Overland flooding of the future Pit 3-4 is also unlikely because the lowest topographic point for the final landform design surrounding the mining void is 40 m RL and this lies inside the proposed abandonment bund. The bund will provide a further 8 m height buffer preventing direct overland flow. The long-term void water level for Pit 3-4 is expected to be around 32 m RL, however, in extreme wet climate periods, the risk of overtopping the void perimeter into the pit may increase. Therefore, the risk of water quality impacts from interaction of void water to Lake Awoonga water supply are low to negligible (Graymont 2026a).

The analytical assessment of the expected groundwater impact zone from mining related depressurisation may extend to 2 km. The closest water bore is 3.8 km north of the mining operation. There are currently no existing groundwater supply bores within the expected zone

groundwater drawdown zone, therefore the current risk to other groundwater users is negligeable (Graymont 2026a).

The quality of the water stored within the void does not pose a threat to the local groundwater resources and there is no indication that local water quality has been affected by seepage through the void. The Project has an ESCP (provided in **Appendix L**) for operations that will be updated as required to reflect recommended design standards in the Best Practice Erosion and Sediment Control (BPESC) guideline so it can be implemented at the EOML (e.g. IECA 2008).

7.11. Underground Mining

The quarry is operated by open cut mining methods. No underground workings have been developed nor are any planned for the LOM.

7.12. Built Infrastructure

All built infrastructure will be decommissioned, demolished and/or disposed of upon closure of the site, with exception to the access tracks and eastern and western levees which are to be retained under an approved landholder agreement (refer **Appendix E**). Built infrastructure comprises all above and below ground infrastructure, including offices, amenities, workshop facilities, fixed and mobile plant, service pits and trenches and product conveyance.

7.12.1. Decommissioning of Built Infrastructure

Decommissioning of all buildings not intended to be retained following closure will involve the onsite demolition and removal of all buildings and related infrastructure (i.e. footings, stairwells, and handrails etc).

Prior to closure a detailed review of the dangerous goods and hazardous substances onsite will be undertaken to assist in the identification of suitable options for reuse, recycling, or disposal. This review will also determine the requirement for any specific management required during decommissioning, including management and removal of identified asbestos or silica containing materials.

Where feasible mobile and/or temporary amenities, including all prefabricated buildings, will be relocated to alternative sites prior to, and during closure as relevant, with general consideration given to general condition and potential for contamination of the asset prior to being demobilised from site.

It is understood onsite built infrastructure may change prior to closure of the site as operations upscale, downscale, or as building maintenance or improvement works are undertaken.

At the time of writing the following buildings are considered demountable and/or relocatable:

- Weighbridge office
- Administration offices
- Amenities block
- Crib / break room
- All fuel and water storage infrastructure

The following buildings are considered permanent in nature:

- Former homestead (to be retained under landholder agreement)

- Weighbridges and weighbridge huts
- Boiler maker shed
- Workshop and workshop office

Permanent buildings that are not to be retained will be demolished upon closure. Demolition is to be undertaken in a controlled manner with consideration given to the materials from which they were constructed. Where practicable, efforts will be made to segregate construction materials with the view of maximising the reuse or recycling of waste material.

Proposed demolition strategy is outlined in **Table 45**.

Table 45. Demolition method (built infrastructure)

Item	Method	Disposal / Reuse
Concrete (slabs, footings etc)	All slabs and footings will be broken up on-site by excavator with rock-breaker attachment	• Crushed for re-use during rehabilitation. • Processed through licenced facility (concrete recycler)
Timber (treated)	To be selectively picked by excavator with grab attachment	To be transported offsite for disposal at a licenced facility.
Timber (untreated)		• To be mulched onsite to facilitate rehabilitation
Steel and metals (including roofing iron, bracing, formwork)		To be processed at an approved metal recycler
Plumbing (including PVC pipes, copper, and brass fittings)		• To be recycled/processed at an approved facility
Miscellaneous building materials (plasterboard, insulation, trace plastics)		To be transported offsite for disposal
Hazardous materials (e.g.: asbestos/silica containing materials)	To be removed by licenced subcontractor.	• To be transported offsite for disposal at a licenced facility.
Groundwater bores	Bore decommissioned in consultation with the Queensland Department of Resources according to the preferred practices nominated in the Minimum Construction Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee 2020) The bore casing will be cut off at least 0.5 m below the surface and decommissioned by fully grouting from the bottom of the bore to the surface.	To be transported offsite for disposal at a licenced facility.

7.12.2. Access Tracks

A number of access tracks are to be retained onsite following closure will be retained under approved landholder agreement (**Appendix E**), as depicted in **Figure 3.** Access tracks that aren't retained will be decommissioned through removal of gravel, where present, for offsite disposal. Non-gravel roads will be ripped to facilitate direct planting.

7.12.3. Fixed and Mobile Plant

All mobile plant will be relocated to alternative operational sites upon closure of the site in 2100, or completion of rehabilitation (where relevant). It is anticipated plant will commence being available for removal progressively during closure, including:

- Excavators: required onsite to enact rehabilitation, to be demobilised once rehabilitation is complete
- Bulldozers: required onsite to enact rehabilitation, to be demobilised once rehabilitation is complete
- Crusher: will be removed upon conclusion of processing operations
- Mobile/fixed screen: will be removed upon conclusion of processing operations
- Trommel: will be removed upon conclusion of processing operations
- Articulated dump trucks: required onsite to enact rehabilitation, to be demobilised once rehabilitation is complete
- Rigid dump trucks: will be removed upon conclusion of processing operations
- Stacker: will be removed upon conclusion of processing operations.

7.12.4. Remediation of Infrastructure Area

Following removal of all equipment from the infrastructure areas, Graymont will implement a suitable remediation program that will comprise of:

- A contaminated land site investigation undertaken in accordance with Schedule B2 (Guideline on Site Characterisation) of the *National Environmental Protection (Assessment of Site Contamination)*
- Preparation of a remediation action plan (RAP) (if required)
- A validation program to confirm suitable remediation actions have been adequately implemented and the site is suitable for the final land use.

Once the remediation works have been validated as appropriate, the infrastructure areas will be assessed to determine if final land use outcomes have been achieved.

7.12.5. Site Rehabilitation

All disturbed areas of the site will be rehabilitated to achieve the final land-use. Rehabilitation will be progressively undertaken as the final landform is reached in each area.

8. Risk Assessment

In accordance with section 126C(1)(f) of the EP Act, the RPP of the PRC Plan must identify the risks of a stable condition for land described as a post-mining land use not being achieved, and how the applicant intends to manage or minimise the risks.

A risk assessment was undertaken in accordance with AS/NZS ISO 31000:2018 *Risk Management – guidelines* and *HB203:2006 Environmental risk management principles and processes*. The criteria adopted for assessing risk levels of identified hazards is shown in **Table 46**. Analysis of the likelihood and consequence was conducted to determine the risk rating given against each hazard (refer **Table 47** and **Table 48**).

The risk assessment matrix in **Table 49** provides a summary of the hazard analysis and risk assessment as it relates to the PRC Plan. The risk assessment also identifies the risk of a stable condition for land not being achieved and includes mitigation measures outlining how this risk will be managed. The identified mitigation measures have been incorporated into the rehabilitation and closure planning outlined in the PRC Plan.

Table 46. Risk assessment criteria

Likelihood	Consequence				
	Extreme 5	Major 4	Moderate 3	Minor 2	Insignificant 1
Almost Certain 5	Extreme (25)	Extreme (20)	Extreme (15)	High (10)	Moderate (5)
Likely 4	Extreme (20)	Extreme (16)	High (12)	Moderate (8)	Low (4)
Possible 3	Extreme (15)	High (12)	Moderate (9)	Moderate (6)	Low (3)
Unlikely 2	High (10)	Moderate (8)	Moderate (6)	Low (4)	Low (2)
Rare 1	Moderate (5)	Low (4)	Low (3)	Low (2)	Very low (1)

Table 47. Consequence scale

Level	Descriptor	Definition
1	Insignificant	• Very low environmental and health impacts confined to a small area within the site • Prompt (typically within a shift) clean-up • Negligible loss of human, social, financial, or built capital/wellbeing • Negligible media coverage
2	Minor	• Low environmental and health impacts confined within the site • Short-term (typically within a week) clean-up • Small but noticeable loss of human, social, financial, or built capital/wellbeing, can be easily rehabilitated • Regulation breaches without fine or litigation • Negative local media coverage • Complaint from community
3	Moderate	• Reversible off-site environmental health impacts, requiring short-term clean-up (weeks)

Level	Descriptor	Definition
		• Onsite medium term (months) clean-up • Moderate, noticeable loss of financial or built capital/wellbeing • Regulation breaches resulting in fine or prosecution. • Negative media coverage at local/regional level over more than one day
4	Major	• Major, off-site, environmental and health impacts requiring medium-term clean-up (months) • Onsite impact requiring significant clean-up effort (years) • Substantial loss of financial or built capital/wellbeing, will attract public concern • Major litigation at operation level • Negative national media cover age;
5	Extreme	• Prolonged or severe, off-site, or regional environmental and health impacts requiring long-term clean-up (years) with irreversible residual damage • Extreme permanent loss of, financial or built capital/ wellbeing, with anticipated major public outrage • Major litigation or prosecution at parent company level • Loss of environmental licence

Table 48. Likelihood scale

Level	Descriptor	Definition
1	Rare	Unlikely to occur during a lifetime or very unlikely to occur
2	Unlikely	Could occur about once during a lifetime or more likely not to occur than to occur
3	Possible	Could occur more than once during site lifetime and more likely not to occur than to occur
4	Likely	Will probably occur in most circumstances
5	Almost Certain	Is expected to occur in most circumstances

Table 49. Qualitative risk assessment – PRC Plan

Disturbance Type	PMLU	Risk Statement	Risk Rating	Mitigation Measures	Residual Risk Rating
Southern WRD	Low intensity grazing	Southern WRD is on ongoing source of acid and metalliferous drainage impacting groundwater and surface water quality	**Moderate (6)**	• Surface water and groundwater monitoring undertaken at the release points including a range of variables specified in the EA. A design response will be undertaken in the event that monitoring identifies potential for environmental harm • Waste characterisation is proposed to demonstrate low potential for acid and metalliferous drainage • Waste characterisation undertaken which demonstrate low concentrations of heavy metals and minimal environmental risk of acid mine drainage or dispersion presented by overburden dumps. • Additional contaminant assessment of pit water and groundwater undertaken.	**Low (4)**
		Rehabilitation efforts do not result in self-sustaining land suitable for low intensity grazing	**High (12)**	• Adaptive management of rehabilitation and re-seeding to bolster natural seed stocks • Regular monitoring with early intervention of rehabilitation failure • Revegetation works informed by ecological investigations at the site	**Moderate (9)**
		Southern WRD becomes unstable and results in erosion and sedimentation impacting surface water quality, groundwater quality and land degradation	**High (12)**	• Waste rock dump slope angles designed and certified by an appropriately qualified and experienced geotechnical consultant • Waste dump geotechnical inspection and stability modelling undertaken by an AQP • Installation of edge bunds behind the crests of the WRD • Landform development and final landform slopes meet final design specifications • Certification from an appropriately qualified person verifying design intent has been achieved and installed with appropriate QA/QC measures • Ongoing erosion modelling assessments to reaffirm achievement of relevant criteria and target vegetation covers	**Moderate (9)**
		Flood events undermine the toe of the Southern WRD resulting in erosion and sedimentation and instability impacting surface water	**Moderate (8)**	• Southern WRD redesign has mitigated risks of pooling around the toe of the dump • A drain will be installed to direct mine-affected water towards Pit 3-4	**Low (4)**

Disturbance Type	PMLU	Risk Statement	Risk Rating	Mitigation Measures	Residual Risk Rating
		quality, groundwater quality and land degradation		• Hydrology modelling is proposed to assess the risk of susceptibility of the site to flooding and determine if specific geotechnical considerations are required • Specific geotechnical protections will be designed and constructed within the toe of the Southern WRD if required	
Topsoil Stockpiles	Low Intensity Grazing	Topsoil is mismanaged, affecting rehabilitation success.	**Moderate (9)**	• Topsoil will be selectively sourced from onsite sources, supplemented by additional imported topsoil as needed • Amelioration will be undertaken as required to ensure vegetation establishment • Topsoil in stockpiles to be used for rehabilitation has been assessed and results reviewed by a Certified Professional Soil Scientist for this PRC Plan • Topsoil will be sourced from stockpiles on-site where possible, and a topsoil material balance will be updated as required	**Moderate (6)**
		Stable condition for land described as a PMLU not being achieved.	**High (12)**	• Ongoing assessment and monitoring of the stability of landscape in accordance with reference milestones • Areas outside operations are undisturbed and are not considered likely to become destabilised • Design and construction of any additional works will be undertaken with consideration of achieving long-term geotechnical stability	**Moderate (6)**
		Stability of landscape not being achieved, meaning the PMLU cannot be achieved.	**Moderate (9)**	• All drainage features will be reinstated • All exposed areas will be rehabilitated to achieve a suitable level of ground cover to minimise the potential for scouring	**Low (4)**
		Weeds are not adequately controlled during rehabilitation.	**Moderate (9)**	• Weeds will be managed in accordance with the strategies outlined in the Revegetation Plan (**Appendix H**) and Weed and Pest Management Plan (**Appendix K**)	**Low (4)**
		Poor seed establishment, stock damage, erosion, fire and/or weeds.	**High (12)**	• Early detection of poor performance. Successful germination of grasses can be assessed at 6-18 months to determine viability • Provision of sufficient water • Correct management of topsoil	**Moderate (6)**

Disturbance Type	PMLU	Risk Statement	Risk Rating	Mitigation Measures	Residual Risk Rating
				• Exclusion of stock in active rehabilitation area/s until completion criteria met • Exclusion of stock from discrete areas (>9°) to prevent soil disturbance • Once completion criteria met, grazing intensity limited for first few years • Construction of silt traps or drainage sumps for erosion control • Exclusion of fire from rehabilitation areas during LOM by maintaining a firebreak around mining lease • Implementation of weed control and management comparable to reference sites and baseline survey results through a weed monitoring program.	
		Rehabilitation does not result in successful attainment of completion criteria.	**High (12)**	• Adaptive implementation of PRC Plan and regular monitoring with early intervention of rehabilitation failure	**Low (4)**
Open pits (voids) Pit 2 – Residual Void	Water Storage	Stability of landscape not being achieved, meaning the PMLU cannot be achieved.	**Moderate (6)**	• The Southern WRD and residual void will be stabilised to ensure structural integrity • All drainage features will be reinstated • All exposed areas will be rehabilitated to achieve a suitable level of ground cover to minimise the potential for scouring	**Low (4)**
Pit 3-4 - Residual Void		Residual voids become geotechnically unstable which results in land degradation	**Moderate (6)**	• Geotechnical assessments have been conducted to assess the current stability and to inform the rehabilitation strategy for the residual void • Annual visual monitoring of batters during operations to demonstrate that they have remained stable • Batter slopes meet final design specifications • Certification from an AQP verifying design intent has been achieved • Abandonment bunds and residual void slopes have been assessed by an AQP as sufficient to maintain slope stability and protect from erosion for a minimum of five years after completion of rehabilitation	**Low (4)**
		Residual voids become unstable due to erosion of slope batters which results in land degradation	**Moderate (6)**	• Drainage controls will be retained at closure and will be physically stable in the long term • Perimeter abandonment bund and safety signage installed around the top of residual voids	**Low (4)**

Disturbance Type	PMLU	Risk Statement	Risk Rating	Mitigation Measures	Residual Risk Rating
				• Certification from an AQP verifying design intent has been achieved • Abandonment bunds and residual void slopes have been assessed by an AQP as sufficient to maintain slope stability and protect from erosion for a minimum of five years after completion of rehabilitation	
		Water quality of the voids is not suitable for stock watering and impacts the ability to achieve and sustain the nominated PMLU	**Moderate (6)**	• Previous groundwater and void water quality samples have been taken which demonstrate that the results achieve the required standards to support the PMLU • Surface water and groundwater quality complies with the site-specific water quality objectives detailed in the environmental authority	**Low (4)**
		Water quality of the void impacts surface water and groundwater quality.	**Moderate (6)**	• Previous groundwater and void water quality samples have been taken which demonstrate results achieve the required standards to support the PMLU	**Low (4)**
		Retained pits and/or infrastructure pose a physical safety threat to humans or wildlife	**High (12)**	• Restricted site access via construction of the abandonment bund • Maintenance of fencing • Maintenance of adequate signage	**Moderate (8)**
Access tracks, infrastructure	Low intensity grazing	Retained infrastructure poses a physical safety threat to humans or animals.	**High (12)**	• Perimeter abandonment bund and safety signage installed around the top of residual voids • Abandonment bunds and residual void slopes have been assessed by an appropriately qualified person as sufficient to maintain slope stability and protect from erosion for a minimum of five years after completion of rehabilitation • The rehabilitation strategy is to remove all mine assets and infrastructure, unless otherwise agreed through a Landholder Statement • All buildings and associated infrastructure including tanks and plant equipment to be demolished, and removed offsite to an appropriately licenced waste facility • Machinery not required for rehabilitation removed off-site	**Moderate (9)**
		Infrastructure decommissioning results in contamination.	**High (12)**	• Site investigation and remediation as required e.g.:	**Moderate (6)**

Disturbance Type	PMLU	Risk Statement	Risk Rating	Mitigation Measures	Residual Risk Rating
				• Contaminated land site investigation undertaken in accordance with Schedule B2 (Guideline on Site Characterisation) of the National Environmental Protection (Assessment of Site Contamination) • Preparation of a Remediation Action Plan (RAP) – if required • A validation program to confirm suitable remediation actions have been adequately implemented and the site is suitable for the final land-use	
		Retained infrastructure poses a physical safety threat to humans or animals.	**High (12)**	• The rehabilitation strategy is to remove all mine assets and infrastructure, unless otherwise agreed through a Landholder Statement • All buildings and associated infrastructure including tanks and plant equipment to be demolished, and removed offsite to an appropriately licenced waste facility • Machinery not required for rehabilitation removed off-site.	**Moderate (9)**
All areas with grazing PMLU	Low intensity grazing	Insufficient topsoil quantity and quality results in the inability to achieve and sustain the nominated PMLU	**High (12)**	• Topsoil material balance to be regularly updated • Soil assessment to be completed • Topsoil in stockpiles to be used for rehabilitation has been assessed and results reviewed by a Certified Professional Soil Scientist • Rehabilitation undertaken in accordance with the Revegetation Plan **(Appendix H)** • Rehabilitation trials will be undertaken if required	**Moderate (9)**
		Inadequate water supply or drought results in poor rehabilitation performance and results in the inability to achieve and sustain the nominated PMLU	**High (12)**	• Site water storages can be used as a water source for irrigation during periods of drought • Water within pits can be used to support rehabilitation onsite	**Moderate (9)**
		Site decommissioning results in contamination and the inability to achieve and sustain the nominated PMLU.	**Moderate (6)**	• Contaminated land site investigation undertaken in accordance with Schedule B2 (Guideline on Site Characterisation) of the National Environmental Protection (Assessment of Site Contamination) • Preparation of a Remediation Action Plan (RAP) – if required	**Low (4)**

Disturbance Type	PMLU	Risk Statement	Risk Rating	Mitigation Measures	Residual Risk Rating
				• A validation program to confirm suitable remediation actions have been adequately implemented and the site is suitable for the final land-use – if required	
		Open woodland structure and grassed areas not achieved or sustained due to failure in vegetation establishment, dieback, insufficient soil types or insufficient seed mixes.	**Moderate (6)**	• The plant species selected are tolerant of a wide range of soil conditions and drought • Revegetation strategy considered optimum timing for planning to maximise potential for follow up rains • Vegetation and land condition monitoring program developed • Seeding mix selected is suited to the available soil resources and site conditions • Monitoring rehabilitation areas on a regular basis will ensure that original objectives set out in the PRC Plan are achieved • In the circumstances that rehabilitation activities in RA8 and RA9 do not achieve the desired outcomes in the PRC Plan, procedures will be reviewed and adapted to achieve compliance • Progressive rehabilitation using endemic species	**Low (4)**
Climate Change-Progressive Rehabilitation	All	• Progressive rehabilitation success may be compromised during the site life through the loss of vegetation and increased erosion • The expected increase in average annual temperatures during the construction and operation phase of the site life is not expected to compromise the success of progressive rehabilitation • Changes in drought patterns, leading to reduced rainfall may inhibit plant growth • Damage from strong winds may result in unsuccessful rehabilitation planting	**Moderate (6)**	• Monitoring rehabilitated areas on a regular basis will ensure that original objectives set out in the PRC Plan are achieved. In the circumstance that rehabilitation activities do not achieve the desired outcomes in the PRC Plan, procedures will be reviewed and adapted to achieve compliance; and • Graymont will monitor changes to the climate over the life of the site and update rehabilitation strategies based on climate projections from BoM and CSIRO and expert advice from appropriately qualified personnel, such as ecologists and soil scientists. This will maximise the probability of progressive and final rehabilitation success.	**Low (4)**

Disturbance Type	PMLU	Risk Statement	Risk Rating	Mitigation Measures	Residual Risk Rating
		• Changes in rainfall patterns, can result in major flooding • Rehabilitation failure due to bushfires, and harsher and more extreme fire weather • Unsuccessful rehabilitation planting resulting from climate change impacts may result in setbacks to the long-term closure planning program • Increased average temperature projections for year 2050 onward may have more influence on final rehabilitation depending on actual temperatures increases.			
Insufficient Monitoring and Maintenance Program	All	• Inability to provide sufficient evidence that closure and rehabilitation activities have been carried out in accordance with the approved PRC Plan • Potential for re-work that has not been provisioned for, resulting in financial loss • Delay in surrendering the EA	**High (12)**	• Ongoing review of Monitoring and Maintenance Program • Utilise historic monitoring reports/results for continual improvement and to identify areas which may require further work in order to achieve subsequent rehabilitation milestones • Adaptive management of rehabilitation during the LOM as needed • Amendments to the PRC Plan prior to closure to ensure it still reflects mine operations and rehabilitation plans	**Moderate (6)**

8.1. Rehabilitation Trials

No rehabilitation trials are planned. The revegetation required is considered standard and does not require specific research.

Lessons learned from rehabilitation monitoring outcomes for RA1 will be considered and the rehabilitation strategy outlined in the PRC Plan will be updated if required.

9. Rehabilitation Milestones and Completion Criteria

This section of the PRC Plan outlines the rehabilitation milestones and completion criteria developed for the Project. In developing the milestone criteria, a review was undertaken to consider the EA conditions related to rehabilitation which are largely captured in Table 9 of the EA.This review ensures consistency with proposed PMLUs, rehabilitation indicators, and outcomes. SMART principles have been implemented to develop the milestone criteria for each of the nominated PMLUs (refer **Table 50**).

The rehabilitation outcomes to be achieved for the rehabilitation are aligned with the section 111A of the EP Act and include:

- Creating a landform that is safe for humans and wildlife into the foreseeable future
- Creating a structurally stable landform
- Ensuring there is no environmental harm being caused by anything on or in the land
- Establishing land that can sustain the PMLU

The PRCP Schedule is being negotiated with the DETSI as a separate standalone document, and any references to Tables within **Table 50** relate to tables within this document.

Table 50. Rehabilitation milestones, criteria, justification and outcomes

Rehabilitation Milestone	Applicable Rehabilitation Area/s	Completion / Milestone Criteria	Justification for Criteria	Rehabilitation Indicator/s and Frequency
RM1- Infrastructure decommissioning and removal	2, 4, 7	1. With the exception of any infrastructure to remain as part of the post-mining land use (PMLU), the following criteria are completed. 2. All services disconnected	All services must be disconnected prior to infrastructure being decommissioned and removed	One visual inspection following completion of each decommissioning and removal criteria
		3. All buildings and associated infrastructure including tanks and plant equipment to be demolished, and removed offsite to an appropriately licenced waste or recycling facility	No landholder agreements are in place for this Project for the buildings and associated infrastructure, therefore no buildings and associated infrastructure are to remain as part of the PMLU.	
		4. Machinery not required for rehabilitation removed off-site	Machinery that is not required for rehabilitation should be removed to eliminate any potential safety risks	
		5. All concrete slabs and footings have been broken up and removed to an appropriately licenced waste facility.	No concrete slabs and footings to remain as part of the PMLU	
		6. An independent AQP has certified the achievement of RM1.1 to RM1.5.	Certification must be provided by an appropriately qualified person that the infrastructure has been completely decommissioned and there are no residual hazards.	
RM2- Contaminated land assessment and remediation	4, 8	1. Contaminated water and sediment removed from dams.	As required, it will be necessary to: either remove or treat onsite contaminated water to ensure appropriate remediation and a safe, non-polluting site remove and dispose of contaminated materials to ensure a safe and non-polluting site onsite remediation of contaminated soils will be undertaken to ensure a safe and non-polluting site	Contaminated land investigation completed by a suitably qualified person as required Certification from a suitably qualified person that remediation is completed as required
		2. An appropriately qualified person (AQP) undertakes a Preliminary Site Investigation and prepares a site investigation report that includes a review of previous activities to assess whether contamination has the potential to exist in a mine domain and whether further investigation is needed to be completed by an SQP. The SQP either: i. Certifies that no contamination unsuitable for the PMLU remains or is occurring; or ii. Specifies that a Contaminated Land Investigation Document must be completed in accordance with the *Environmental Protection Act 1994*	A contaminated land investigation completed by a suitably qualified person (as defined under the EP Act) is necessary to ensure that risks to human health and the environment have been appropriately managed. The site investigation / remediation may include (as required): • contaminated land site investigation undertaken in accordance with Schedule B2 (Guideline on Site Characterisation) of the National Environmental Protection (Assessment of Site Contamination) • preparation of a Remediation Action Plan (RAP) • a validation program to confirm suitable remediation actions have been adequately implemented and the site is suitable for the final PMLU	
		In the event that RM2.1ii is determined by an AQP 3. A Contaminated land investigation will be completed (investigation, remediation and validation) in accordance with the EP Act, including a site investigation report, and where required, a validation report and/or a draft Site Management Plan.		
		4. A Contaminated Land Auditor certifies that no contamination unsuitable for the PMLU remains or is occurring. Validation sampling and analysis conducted to confirm that contaminated water, soils or other materials have been removed or remediated	Once any contaminated soils have been removed and/or remediated, it is necessary to undertake validation testing. This can be included as part of the contaminated land investigation if needed and will ensure a safe, non-polluting PMLU	
RM3- Landform development and reshaping / re-profiling of residual void	3, 6	1. All major earthworks (including reshaping, pushing/trimming) are completed in accordance with the design specification provided by an AQP.	Landform development and reshaping / re-profiling involves major earthworks (i.e. removal, adding and/or moving large quantities of soil and/or overburden from one area to another). No active rill, gully or sheet erosion should be visible five years after rehabilitation activities commenced. Drainage should follow appropriate drainage paths. For the purposes of this criteria, these types of erosion have been defined as: Rill: an individual eroded channel in the soil that is less than 300 mm deep (Catchments & Creeks 2012)	One visual inspection by an AQP following completion of major earthworks required for landform development / re-profiling of waste rock dump Visual inspection (as required during operation and decommissioning) by an appropriately qualified person to confirm there is no active rill, gully, or sheet erosion present on final landform

Rehabilitation Milestone	Applicable Rehabilitation Area/s	Completion / Milestone Criteria	Justification for Criteria	Rehabilitation Indicator/s and Frequency
			Gully: widespread soil erosion caused by flowing surface water. It consists of open, unstable channels that have been cut more than 300 mm deep into the ground (Queensland Government 2020) Sheet: the removal of an even layer of surface soil through the actions of raindrop impact and stormwater runoff (Catchments & Creeks 2012) Erosion management to be undertaken in accordance with the ESCP for the Project area, in accordance with the BPESC guideline (IECA 2008)	After completion of milestone criteria, certification provided by a geotechnical engineer that the final waste rock dump landform and armour rock bund are geotechnically stable Provision of the completed flood assessment to the DETSI prior to closure.
		2. A flood impact assessment must be undertaken by an AQP to confirm interactions between flood waters and final landforms. The assessment must consider: a) all landform interfaces where flood velocities are a risk to erosional stability; and b) the mitigation measures that will be implemented to ensure stability of the landform.	To assess potential flood impacts prior to closure and construction of the final landform, and consideration of any mitigation measures requiring implementation.	
		3. Mitigation measures for reducing flood velocities installed to landform, as recommended in the flood impact assessment in RM3.2.		
		4. An AQP has confirmed that geotechnical stability of the residual void walls (i.e., a factor of safety value of ≥1.5) has been achieved.	Landform development and reshaping / re-profiling involves major earthworks (i.e. removal, adding and/or moving large quantities of soil and/or overburden from one area to another) and achieves design specifications	One visual inspection by an appropriately qualified person following completion of major earthworks required for landform development / re-profiling of mine pits and stable
		5. Pit 3-4 (RA6) batter slopes meet final design specifications (18° in weathered rock, 65° in unweathered rock)		
		6. Pit 2 (RA3) maximum overall slope angle meets final design specifications (34°)	To establish a stable condition for land, the final site design specifications must be met to demonstrate final landform stability	Certification provided by a geotechnical engineer that the final landform batter slopes meet the site design specifications after completion of milestone criteria
		7. Perimeter abandonment bund and safety signage installed offset, as specified by an AQP, from the crest of the voids (RA3 and RA6)	To meet the national guideline requirements for safe closure of mine pits (DIR 1997), and establish exclusion zone for safety	
		8. Safety signage (design in accordance with Australian standard) is erected at 100m intervals along the fence.		
		9. Locked gates and signage installed at access points to the residual voids to prevent unauthorised access (RA3 and RA6)		
		10. An AQP certifies that void final landform design intent has been achieved	Certification must be provided by an appropriately qualified geotechnical engineer that the final landform is geotechnically stable post reshaping / re-profiling of landform	
		11. 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.		
		12. Independent AQP has surveyed the final landform and certified that RM3.1 to RM3.9 have been achieved.		
RM4- Landform development and reshaping / re-profiling of waste rock dump	5	1. A flood impact assessment must be undertaken by an AQP to confirm interactions between flood waters and final landforms. The assessment must consider: a) all landform interfaces where flood velocities are a risk to erosional stability; and b) the mitigation measures that will be implemented to ensure stability of the landform.	To assess potential flood impacts prior to closure and construction of the final landform, and consideration of any mitigation measures requiring implementation.	One visual inspection by an AQP following completion of major earthworks required for landform development / re-profiling of waste rock dump Visual inspection (as required during operation and decommissioning) by an appropriately qualified person to confirm there is no active rill, gully, or sheet erosion present on final landform
		2. Mitigation measures for reducing flood velocities installed to landform, as recommended in the flood impact assessment in RM4.2.		
		3. Erosion modelling confirms that the Southern Waste Rock Dump design can achieve average rates of erosion below 10 t/ha/yr	To ensure long term stability and non-polluting nature of the landform	
		4. Major earthworks completed and landform constructed in accordance with final engineering and design plans (maximum 12° slopes) provided by an AQP	Landform development and reshaping / re-profiling involves major earthworks (i.e. removal, adding and/or moving large quantities of soil and/or overburden from one area to another). No active rill, gully or sheet erosion should be visible five years after rehabilitation activities commenced. Drainage should follow appropriate drainage paths. For the purposes of this criteria, these types of erosion have been defined as:	After completion of milestone criteria, certification provided by a geotechnical engineer that the final waste rock dump landform and armour rock bund are geotechnically stable Provision of the completed flood assessment to the DETSI prior to closure.

Rehabilitation Milestone	Applicable Rehabilitation Area/s	Completion / Milestone Criteria	Justification for Criteria	Rehabilitation Indicator/s and Frequency
			• Rill: an individual eroded channel in the soil that is less than 300 mm deep (Catchments & Creeks 2012) • Gully: widespread soil erosion caused by flowing surface water. It consists of open, unstable channels that have been cut more than 300 mm deep into the ground (Queensland Government 2020) • Sheet: the removal of an even layer of surface soil through the actions of raindrop impact and stormwater runoff (Catchments & Creeks 2012) Erosion management to be undertaken in accordance with the ESCP for the Project area, in accordance with the BPESC guideline (IECA 2008)	
		5. As built inspection by an AQP confirms that the final landform design intent has been achieved, and average batter slopes do not exceed 12%	Certification must be provided by an appropriately qualified geotechnical engineer that the final landform is geotechnically stable post reshaping / re-profiling of landform	
		6. Constructed landform achieves a geotechnical stability with a Factor of Safety ≥1.5, which includes consideration of flood stress.		
		7. 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.		
		8. Independent AQP has surveyed the final landform and certified that RM4.1 to RM4.7 have been achieved.		
RM5- Landform development and reshaping / re-profiling of other areas	1, 2, 4, 7, 8, 9, 10	1. All major earthworks (including reshaping, pushing/trimming) are completed in accordance with the design specification provided by an AQP.	Landform development and reshaping / re-profiling involves major earthworks (i.e. removal, adding and/or moving large quantities of soil and/or overburden from one area to another). No active rill, gully or sheet erosion should be visible five years after rehabilitation activities commenced. Drainage should follow appropriate drainage paths. For the purposes of this criteria, these types of erosion have been defined as: Rill: an individual eroded channel in the soil that is less than 300 mm deep (Catchments & Creeks 2012) Gully: widespread soil erosion caused by flowing surface water. It consists of open, unstable channels that have been cut more than 300 mm deep into the ground (Queensland Government 2020) Sheet: the removal of an even layer of surface soil through the actions of raindrop impact and stormwater runoff (Catchments & Creeks 2012) Erosion management to be undertaken in accordance with the ESCP for the Project area, in accordance with the BPESC guideline (IECA 2008)	Visual inspection by an appropriately qualified person following completion of major earthworks required for landform development / re-profiling of other areas Certification from an appropriately qualified engineer that water drainage lines have been adequately reinstated post landform reshaping / re-profiling, and sediment pond is geotechnically stable
		2. Areas to be revegetated will have water shedding landforms with slopes not exceeding 12% (RA1, RA2, RA4, RA5, RA7, RA8, RA9)	Visual inspection by an AQP following completion of major earthworks required for landform development / re-profiling of other areas	
		3. Grazing RAs (RA1, RA2, RA4, RA5, RA7, RA8, RA9) assessed as stable and non-polluting by a AQP	Certification must be provided by an appropriately qualified geotechnical engineer that the final landform is geotechnically stable post reshaping / re-profiling of landform	
		4. All rehabilitated areas (other than RA3 Pit 2 and RA6 Pit 3-4) does not contain any low points that may pond water for more than one month	Certification must be provided by an appropriately qualified geotechnical engineer that the final landform and features are geotechnically stable post reshaping / re-profiling of landform	
		5. Eastern and western levees (RA10) are certified as geotechnically stable by a suitably qualified geotechnical engineer		
		6. 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.		
		7. Independent AQP has surveyed the final landform and certified that RM5.1 to RM5.6 have been achieved.		
RM6- Surface preparation (grazing)	1, 2, 4, 5, 7, 8, 9	1. Areas to be revegetated should be ripped to a depth of 500 mm at 500-800 mm spacings	To encourage water infiltration and grass root development to a depth that is sufficient for adequately stabilising surface soils	Visual inspection by an appropriately qualified person during and after completion of ripping activities

Rehabilitation Milestone	Applicable Rehabilitation Area/s	Completion / Milestone Criteria	Justification for Criteria	Rehabilitation Indicator/s and Frequency
		2. Stockpiled topsoil has been assessed for quality, physical properties, amelioration requirements and suitability for rehabilitation and a plan for treatment developed by an AQP prior to seeding to confirm available topsoil is suitable for the establishment and maintenance of the nominated post-mine land use	Outcomes implemented as result of the soil health and suitability assessment/s competed by an appropriately qualified person	Outcomes implemented as result of the soil health and suitability assessment/s competed by an appropriately qualified person
		3. Topsoil placed to an average depth of 200 mm to all RAs where required	A mixture of topsoil and subsoil will be placed with a minimum thickness of 200 mm to provide sufficient depth for vegetation growth. This is a standardised depth and has been successfully applied to rehabilitated mine sites in Queensland	One visual inspection by an appropriately qualified person after topsoil placement completed
		4. Application of ameliorants on topsoil if required, as per recommendations from the soil quality and suitability assessment in RM6.2.	Ameliorants may be required to improve cohesion with the subsoil / topsoil and to sustain nutrient levels for plant growth. Ameliorants will be applied in accordance with the recommendations included in the soil health and suitability assessment.	Outcomes implemented as result of the soil health and suitability assessment/s completed by an appropriately qualified person
		5. Following the amelioration as per RM6.2 and RM6.4 , representative soil testing of growth media confirms: a) pH in the range of 6 – 8.5; b) Electrical Conductivity (saturated extract) (dS/m) ≤2 (2,000 µS/cm); c) Exchangeable sodium percentage (ESP) (%) <6; and d) Emerson aggregate class ≥4.		
		6. All bores decommissioned in consultation with the Queensland Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development according with the preferred practices nominated in the Minimum Construction Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee 2020)	Industry standard for bore decommissioning, consistent with Graymont's Murgon Operations (PRCP schedule)	One visual inspection by an AQP after bores decommissioned
		7. Surface and ground water monitoring is underway (at least one year of sampling undertaken).	Certification must be provided by an appropriately qualified person that water monitoring and topsoil placement has been completed appropriately	One visual inspection upon completion of topsoil placement and review of monitoring data when available
		8. Independent AQP has certified the plan in RM6.2 and the achievement of RM 6.1 to 6.7		
RM7- Surface preparation (other areas)	3, 6, 10	1. Undertake ripping on ramps from the surface to the floors of the Pit 2 (RA3) and Pit 3-4 (RA6) to prevent access	To encourage water infiltration and grass root development to a depth that is sufficient for adequately stabilising surface soils	Visual inspection (as required during operation and decommissioning) by an appropriately qualified person to confirm there is no active rill, gully, or sheet erosion present on final landform
		2. Localised erosion areas identified and repaired	No active rill, gully or sheet erosion should be visible five years after rehabilitation activities commenced. Drainage should follow appropriate drainage paths.	
		3. Access tracks (RA10) are clear of debris and graded to conform with the surrounding landforms	Suitable requirement that is compatible with landholder statement with the GAWB, who will continue to use the tracks post-closure.	
		4. An independent AQP has certified the achievement of RM7.1 to 7.3	Certification must be provided by an appropriately qualified person that tracks have been ripped and graded appropriately	One visual inspection upon completion of relevant milestone criteria for ramp ripping and grading
RM8- Revegetation (grazing)	1, 2, 4, 5, 7, 8, 9	1. Initial revegetation campaign to seed target species per Table 2 and Table 3, including planting in rehabilitated sediment ponds (RA8) and topsoil stockpile areas (RA9)	To prepare the topsoil for seeding at appropriate widths and depths. This will enhance the probability of seed germination by protecting the seed from rapid desiccation and predation from birds and other animals	Visual inspections (weekly, then as required) by an appropriately qualified person during and after seeding works
		2. Timing of seeding (sowing) determined based on target species, as in Table 3	Sowing in the wet season will improve the probability of seed germination.	
		3. Cleared areas (RA1), silt dump (RA2), infrastructure and laydown areas (RA4), Southern WRD (RA5), and spoil pile areas (RA7) to be seeded with native grasses per Table 1 and Table 3	Grasses have been found to be the most successful rehabilitation approach applied to rehabilitated mine sites in Queensland, including Graymont's Murgon Operations (PRCP schedule: PRCP-EPML00352613-V1-1)	
		4. Firebreak maintained along edge of mining lease until rehabilitation complete	Site is within a medium to high intensity bushfire area, reduces risk of extreme fires that could kill established vegetation and grasses and reduce vegetation cover	
		5. Install temporary exclusion stock fencing if needed to prevent access to revegetation areas until established, or as advised by an AQP	Additional rehabilitation effort during the vegetation establishment period to improve rehabilitation success.	
		6. An independent AQP has certified the achievement of RM8.1 to 8.5	Certification must be provided by an appropriately qualified person that revegetation and stock fencing installation has been undertaken appropriately	One visual inspection upon completion of relevant milestone criteria for revegetation and fencing installation
RM9- Rehabilitation monitoring	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	1. Rehabilitation monitoring reference sites for grazing PMLU have been selected in unmined pasture areas within the lease area (excluding RA3, RA6 and RA10), as per reference (survey) sites in Figure 3 of Revegetation Plan	Reference sites will be used to benchmark rehabilitation progress.	Annual rehabilitation monitoring program will be undertaken by an AQP for 10 years from

Rehabilitation Milestone	Applicable Rehabilitation Area/s	Completion / Milestone Criteria	Justification for Criteria	Rehabilitation Indicator/s and Frequency
and maintenance		2. Species used in rehabilitation remain present and show evidence of natural recruitment. Evidence of flora recruitment from rehabilitation monitoring data.	Monitor the germination or regrowth of weed species annually. Introduced flora and fauna species can compromise revegetation and the success of the PMLU. Weeds should be in densities no greater than 5% ground cover.	commencement of rehabilitation. The program will include: • Survey certifying weeds / pests are in densities no greater than 5% ground cover to be undertaken by an appropriately qualified person • Visual inspection (monthly during earthworks, then annually) by an appropriately qualified person to confirm there is no active rill, gully, or sheet erosion present on final landform • Annual monitoring of groundcover densities and soil depths • Annual visual monitoring of void slopes to ensure long-term stability and if required, recommendations and implementation of remediation works • An annual audit of geotechnical risk issues will be undertaken by an independent geotechnical consultant
		3. Weed presence less than 5% of total vegetative cover.	Weeds are a major source of failure of rehabilitation efforts. It is imperative that new weed infestations are prevented and/or controlled at the earliest possible opportunity. Weed control and management is an important component of successful rehabilitation. Graymont is obliged under the *Biosecurity Act 2014* to prevent the spread of declared weeds, and some non-declared weeds can also severely impair the successful development of rehabilitation. It is therefore important to prioritise weed species of concern and identify their management requirements. Priority is awarded to species that have the highest risk of severely impairing the success of rehabilitation, and for which eradication is a possibility. Priorities should be reviewed annually, by monitoring the spread of low and medium- priority species	
		4. Annual rehabilitation monitoring for low intensity grazing pasture PMLU is undertaken annually for a period of at least five years from when rehabilitation commenced, in accordance with Revegetation Plan	Monitoring and benchmarking to ensure rehabilitation success and effective weed management.	
		5. A BioConditioning assessment is completed by an AQP using the methodology outlined in the latest version of the Queensland Herbarium's "Bio-condition Assessment Manual".		
		6. The Bio-condition assessment completed under RM9.5 indicates that the ecosystems comply with the PRCP benchmark for the PMLU, as Per Table 9 and 10– Bio Conditioning milestone benchmarks.		
		7. Annual monitoring shows that the mean projective cover of invasive plants listed as a restricted biosecurity matter will account for no more than 5% ground cover in rehabilitated areas with grazing pasture PMLU or exceed the groundcover recorded in reference pasture areas (whichever is greater)	Monitor the germination or regrowth of weed species annually. Introduced flora and fauna species can compromise revegetation and the success of the PMLU. Weeds should be in densities no greater than 5% ground cover. Suitable for controlling the spread of weeds per the general biosecurity obligation in the Biosecurity Act.	
		8. Native or introduced desirable palatable and productive species in rehabilitated areas trending towards at least 50% of the vegetative ground cover.	Seeds of local provenance (Gladstone region) and representative of the Brigalow Belt bioregion will be primarily used for rehabilitation	
		9. Bare ground % is equivalent to at least a "fair" condition as defined by Future Beef (https://futurebeef.com.au/resources/land-condition/).	Consistent with approach in Graymont's Murgon Operations (PRCP schedule)	
		10. Vegetation maintenance and or additional soil amelioration has been undertaken as soon as is practicable where monitoring has shown that groundcover or pasture composition does not meet the milestone criteria within the nominated timeframe	Vegetation maintenance in accordance with the Revegetation Plan and Soil Analysis and Quality Plans (SAQP) of the PRC Plan	
		11. The ground cover in rehabilitated areas with low intensity grazing pasture PMLU will, on average, be dominated by native grasses identified in the Revegetation Plan that are recognised as pasture species or known to be palatable and provide forage for livestock	Regional floristic patterns are subject to seasonal fluctuations in response to numerous factors including rainfall, disturbance, and climate	
		12. With respect to erosion: a) No evidence of erosion classified as 'moderate' or 'severe' as defined by Table 4- Erosion classification framework; b) Any erosion present will not compromise the achievement of the PMLU to a stable condition; and c) Erosion requiring intervention has been remediated and does not impact achieving the PMLU.	Rehabilitation monitoring has shown no active rill, gully or sheet erosion have developed five years after rehabilitation activities commenced.	
		13. Surface water runoff has been collected across representative areas of rehabilitation when surface flows occur and is safe to do so.	Surface water quality at monitoring locations is to remain within site specific water quality criteria outlined in the conditions of the EA, once established by DETSI. These limits will be revised and any amendments relating to rehabilitation will be provided to the Administering Authority prior to commencement of rehabilitation activities	
		14. Surface water runoff complies with Table 5 – Surface water quality limits.		

Rehabilitation Milestone	Applicable Rehabilitation Area/s	Completion / Milestone Criteria	Justification for Criteria	Rehabilitation Indicator/s and Frequency
		15. Annual visual monitoring of the void slopes (RA3 and RA6) demonstrates that they have remained stable for a period of ten years from when rehabilitation commenced.	Visual inspection of the walls and pits will be undertaken weekly, then as required, by an AQP. Strategies for managing any possible increase in risk during the long term will be implemented.	
		16. Where unacceptable instability is recorded, advice has been sought from a suitably qualified person and remediation works have been undertaken as soon as is practicable.	Data collected will be compared to data collected previously for the landforms, and if different, advice will be sought. The data will be used to input to kinematic analyses to ascertain whether the specifications of the final walls are still appropriate or require modification.	
		17. 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	To ensure suitable soil health for supporting rehabilitated outcome.	
		18. Independent AQP certifies achievement of RM9.1 to 9.17.	Certification must be provided by an appropriately qualified person that topsoil and revegetation requirements have been undertaken appropriately	
RM10- Achievement of post-mining land use to stable condition (water storage)	3, 6	1. The final landform is geotechnical stable with a factor of safety ≥1.5.	Ensures design specifications are achieved into perpetuity	After rehabilitation monitoring program is completed, certification from an AQP that all completion criteria identified in the geotechnical assessment (**Appendix B**) are achieved.
		2. Abandonment bunds and residual void slopes have been assessed by a suitably qualified person as sufficient to maintain slope stability and protect from erosion	Certification from an AQP must be provided to ensure that the final landform is in a stable condition. In accordance with Section 111A of the EP Act: Land is in a stable condition if 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.	
		3. Water in water storages monitored quarterly, must be of a suitable quality for native wildlife and/or livestock ingestion and must not exceed the stock water guidelines (ANZEEC 2000), for a minimum of 5 consecutive years.	Consistent with requirements under relevant water quality guidelines to ensure safe ingestions for stock animals.	After completion of the rehabilitation monitoring program, certification by an AQP that surface water quality objectives are achieved.
		4. Independent AQP certifies achievement of RM10.1 to 10.3.	Certification must be provided by an appropriately qualified person that water quality and geotechnical stability criteria have been achieved.	
RM11- Achievement of post-mining land use to stable condition (grazing)	1, 2, 4, 5, 7, 8, 9	1. Safety hazards in rehabilitation areas are not significantly different to surrounding unmined landscapes subject to the same land use.	To manage residual risk from unnatural hazards within the mined area.	After completion of the rehabilitation monitoring program, certification by an AQP that revegetation and safety objectives are achieved.
		2. Weed presence is a maximum of 5% total vegetative cover confirmed by an AQP in annual monitoring.	Suitable for controlling the spread of weeds per the general biosecurity obligation in the Biosecurity Act.	
		3. Absence of ecosystem altering weeds.		
		4. A BioConditioning assessment is completed by an AQP using the methodology outlined in the latest version of the Queensland Herbarium's "BioConditioning Assessment Manual".	Monitoring and benchmarking to ensure rehabilitation success based on site-specific data.	
		5. The BioConditioning assessment completed under RM11.4 indicates that the ecosystems comply with the PRCP benchmark for the PMLU, as per Table 9 and 10 – BioConditioning milestone benchmarks.		
		6. Notwithstanding RM11.5, landform contains greater than 50% groundcover (vegetation (living and dead) and biological crusts) at 30 September each calendar year.		
		7. With respect to erosion: a) No evidence of erosion as classified as 'moderate' or 'severe' as defined by Table 4 – Erosion classification framework; b) All other erosion requiring intervention has been remediated and does not impact achieving the PMLU; and c) Any erosion present will not compromise the achievement of a PMLU to a stable condition.	Rehabilitation monitoring has shown no active rill, gully or sheet erosion have developed five years after rehabilitation activities commenced.	
		8. Surface water runoff complies with Table 5 – Surface water quality limits.	Surface water and groundwater quality at monitoring locations is to remain within site specific water quality criteria outlined in the conditions of the EA, once established by DETSI. These limits will be revised and any amendments relating to rehabilitation will be provided to the Administering Authority prior to commencement of rehabilitation activities	
		9. Surface water quality monitored monthly during flow at, but not limited to, downstream locations specified in Table 6 – Surface water monitoring locations, must not exceed the limits in Table 5 – Surface water quality limits for a minimum of 5 consecutive years.		

Rehabilitation Milestone	Applicable Rehabilitation Area/s	Completion / Milestone Criteria	Justification for Criteria	Rehabilitation Indicator/s and Frequency
		10. For a minimum of 5 consecutive years ground water quality must be monitored quarterly at, but not limited to, compliance bores/locations specified in Table 8 – Ground water monitoring locations for all quality characteristics listed in Table 7 – Ground water quality limits.		
		11. Ground water quality must not exceed the limits in Table 7 – Ground water quality limits, for 3 consecutive results.		
		12. Certification from a SQP that RA5 southern waste rock dump is functional and no migration of contaminants to groundwater has or will occur.		
		13. Certification from a SQP that the area has achieved an erosionally and geotechnically stable condition and achieved a factor of safety ≥1.5.	Certification must be provided by an appropriately qualified person that water quality, erosion, and geotechnical stability criteria have been achieved, and the post mining land use is achieved.	
		14. Independent AQP certifies the achievement of RM11.1 to RM11.13.		Certification from an AQP stating the land is in a stable condition and PMLU has been achieved.
RM12- Achievement of post-mining land use to stable condition (access tracks)	10	1. With respect to erosion: a) No evidence of erosion as classified as 'moderate' or 'severe' as defined by Table 4 – Erosion classification framework; b) All other erosion requiring intervention has been remediated and does not impact achieving the PMLU; and c) Any erosion present will not compromise the achievement of a PMLU to a stable condition.	To minimise the potential for erosion.	Visual inspection (after completion of rehabilitation monitoring program) by an AQP to confirm there is no active rill, gully, or sheet erosion present on final landform
		2. Access tracks (RA10) are stabilised and graded to facilitate runoff and access for maintenance activities, fire management, etc.	To ensure ongoing access and retention of fire breaks and stormwater infrastructure in accordance with landholder statement with GAWB.	Final certification from an AQP stating the land is in a stable condition and suitable for transition to landholder.
		3. Infrastructure to be transitioned to a future landholder is deemed fit for purpose (verified by an AQP) and accepted, by signed agreement, with the future landholder.	Suitable requirement that is compatible with landholder statement with the GAWB, who will continue to use the tracks post-closure.	
		4. An AQP certifies that all infrastructure to be retained onsite is safe, stable and will not cause environmental harm.	Certification must be provided by an appropriately qualified person that water quality, erosion, and geotechnical stability criteria have been achieved, and the post mining land use is achieved.	
		5. Independent AQP certifies the achievement of RM12.1 to RM12.4		

[1] For pH, the quality result measured at the downstream location must be within the prescribed range. However, where pH at the downstream location is greater-than (>) the highest limit in the range, the pH at the applicable upstream location must be greater-than or equal-to (≥) the downstream location. Conversely, where pH at the downstream location is less than (<) the lowest limit in the range, the upstream pH at the applicable upstream location must be less-than or equal-to (≤) the downstream location.

[2]Active as defined in the Australian Soil and Land Survey Field Handbook (3rd Edition), The National Committee on Soil and Terrain published by CSIRO Publishing 2009.

10. Monitoring and Maintenance

10.1. Monitoring and Maintenance Program

A monitoring and maintenance program has been developed for the Project in accordance with Section 3.8 of the PRC Plan Guideline and Section 126C(1)(j) of the EP Act. The program identifies and describes the monitoring systems that will be carried out to demonstrate how the rehabilitation milestones will be achieved. Each rehabilitation milestone will have a robust monitoring and/or assessment program, as outlined below.

10.1.1. Low Intensity Grazing

The monitoring program developed for RA1 Cleared areas, RA2 Silt dump, RA4 Infrastructure and laydown areas, RA5 Southern WRD, RA7 spoil pile areas, RA8 sediment ponds, and RA9 topsoil areas and silt dump is outlined in **Table 51**.

Table 51. Monitoring program – low-intensity grazing land

Item	Description
Applicable Rehabilitation Milestones	• RM1- infrastructure decommissioning and removal • RM2- contaminated land assessment and remediation • RM4-5-landform development and reshaping / re-profiling of waste rock dump, and other areas • RM6- surface preparation (grazing) • RM8 – revegetation (grazing) • RM9- rehabilitation monitoring and maintenance • RM11- achievement of PMLU to stable condition (grazing)
Indicator	**Stability, Safety and Erosion:** No residual contamination is present in the Project area All infrastructure and plant are successfully decommissioned and / or removed Southern WRD slopes have been profiled for long-term stabilities of the slopes as evidenced by a survey of the Southern WRD at the EOML Perimeter rock wall around southern WRD is in the correct locations and structurally sound Course rock cover system is installed on the Southern WRD Visual evidence that the stabilities of the Southern WRD slopes have remained constant or increased as rehabilitation is established **Revegetation and Soil:** Site prepared, weed removal completed, topsoil/ subsoil spread where required, grass seed sown, commenced maintenance and irrigation Fertilisers and ameliorants applied to soil as required, desired depths for seeding achieved Tree and shrub planted (RA8 and RA9 only), commence weed surveys, end irrigation, broad-scale non-residual herbicide applied End maintenance (weeding control and supplementary planting) Start cattle grazing Final weed survey undertaken and PMLU achieved **Water Management:** No ponding is occurring on the surface of the Southern WRD If required, the Southern WRD slope toes are protected from inflows associated with floods (Rocktest 2026) Monitoring of groundwater and surface water locations as per the EA to identify any potential contaminant leaching from the Southern WRD Monitoring of water in sediment pond (RA8) prior to dewatering, including analysis of total metals/metalloids (As, Cd, Cr, Cu, Ni, Pb, Se, Zn) and hydrocarbons. Results will be compared to ARMCANZ & ANZECC (2000) guidelines for stock water (cattle).

Item	Description
Schedule and frequency	• One visual inspection following completion of each decommissioning and removal criteria • One visual inspection after completion of ripping activities and soil placement • Inspection after rock armour bund installed • Contaminated land investigation completed by a suitably qualified person as required • Visual inspections (weekly, then as required) by an AQP during and after seeding works • Weekly inspections during earthworks, then annually • Inspection following completion of major earthworks required for landform development / re-profiling of waste rock dump • Ongoing quarterly surface and groundwater monitoring until all PMLUs achieved • Monitoring of sediment pond (RA8) prior to dewatering • Annual rehabilitation monitoring program undertaken including reporting and inspections for a period of 10 years from when rehabilitation commenced • Final inspection and certification after completion of all milestone criteria and monitoring program, including compaction of Southern WRD
Guidelines	**Stability, Safety and Erosion:** Hawley, M. and Cunning, J. (2017) Chapter 8: Stability Analysis. *Guidelines for Mine Waste Dump and Stockpile Design.* CSIRO Publications. IECA 2008, Best Practice Erosion and Sediment Control Manual, International Erosion Control Association (Australasia), Picton NSW *Workplace Health and Safety Act 2011* Minimum Construction Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee 2020) **Revegetation:** Eyre TJ, Kelly AL and Neldner VJ 2017, Method for the Establishment and Survey of Reference Sites for BioCondition. Version 3. Queensland Herbarium, Department of Science, Information Technology and Innovation, Brisbane Neldner V & M Ngugi 2014, Application of the BioCondition assessment framework to mine vegetation Rehabilitation. In: Ecological Management and Restoration, 15(2): 158-161. Eyre, T.J., Kelly, A.L, Neldner, V.J., Wilson, B.A., Ferguson, D.J., Laidlaw, M.J. and Franks, A.J. 2015, BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual. Version 2.2. Queensland Herbarium, Department of Science, Information Technology, Innovation and Arts, Brisbane **Soils:** Department of Resources (DoR) (2021), Queensland Soil and Land Resource Survey Information Guideline, VEG/2018/4460, Version 2.00 DSITI & DNRM (2013), Regional Land Suitability Frameworks for Queensland, Queensland Government (Department of Science, Information Technology and Innovation and Department of Natural Resources and Mines), Brisbane, Queensland Forster 2011, Draft for Discussion – Soil Survey Methodology along Linear Features Isbell RF & NCST (2021), The Australian Soil Classification, Third Edition, CSIRO Publishing, Collingwood VIC Land Resources Branch Staff (1990), Guidelines for agricultural land evaluation in Queensland, Queensland Department of Primary Industries, QI9005 McKenzie NJ, Grundy MJ, Webster R, Ringrose-Voase AJ (2008), Guidelines for Surveying Soils and Land Resources, Second Edition, CSIRO Publishing **Water:** Environment Protection (Water) Policy 2009 Monitoring and Sampling Manual (DES 2018) Using monitoring data to assess groundwater quality and potential environmental impacts guideline (DES 2021) ARMCANZ & ANZECC (2000) guidelines for stock water (cattle)

Item	Description
Method	An annual rehabilitation monitoring program for at least five years will be undertaken by AQP/s, comprised of visual inspections and audits. Visual revegetation inspections include: • Survey certifying weeds / pests are in densities no greater than 5% ground cover to be undertaken by an appropriately qualified person • Annual monitoring of groundcover densities and soil depths • Monitoring of pasture establishment, ground cover, vegetation composition and biomass • Identification of any active rill, gully, or sheet erosion present on final landform Visual geotechnical inspections and audits include: • Monitoring of the performance of the of the slopes of the WRD and the surrounding landforms • An audit of geotechnical risk issues • Visual inspection (monthly during earthworks, then annually) by an AQP to confirm there is no active rill, gully, or sheet erosion present on final landform • If required, recommendations and implementation of remediation works After the rehabilitation monitoring program is completed, certification from an AQP that all remediation and milestone criteria are completed and the PMLU is achieved. Certification provided by a geotechnical engineer that: • The final landform batter slopes meet the site design specifications after completion of milestone criteria • Material on the Southern WRD has been compacted in accordance with the requirement for 500 mm lifts, watering, and multiple passes by a compactor • The final waste rock dump landform and armour rock bund are geotechnically stable • Water drainage lines have been adequately reinstated post landform reshaping / re-profiling, and sediment pond is geotechnically stable • No migration of contaminants to groundwater has / will occur • Erosion measures have been implemented • Sediment pond is appropriately backfilled Certification by an AQP that: • Outcomes have been implemented as result of the soil health and suitability assessment/s • Topsoil/ subsoil placement is in accordance with SAQP, or corrective actions have been implemented • Grassing and vegetation growth (in RA9 topsoil areas and RA8 sediment ponds) has achieved milestone criteria in accordance with the Revegetation Plan • Water monitoring is compliant with contaminant triggers in the EA • Sediment pond (RA8) results are suitable under ARMCANZ & ANZECC (2000) guidelines for stock water (cattle)
QA	Certification by an AQP
Review	Secondary review by Graymont and GAWB
Corrective Actions	**Stability, Safety and Erosion:** Remediate hazards associated with the southern WRD that may increase the risks applicable to persons and/or animals Undertake remediation as required prior to rehabilitation if contaminated land is identified Install erosion control measures prior to the commencement of soil stripping and rehabilitation activities Coir logs should be placed in rows to control erosion where slope is >10° (excluding Southern WRD) **Revegetation and Soils:** Targeted herbicide application and spot spray restricted and environmental weeds Restricted weeds are to be stockpiled separately and disposed of at an appropriate waste disposal facility Vehicle/machinery hygiene measures (i.e. valid weed and seed free certificate) to be implemented to prevent the introduction and/or further spread of weeds on and off the site

Item	Description
	Undertake weed removal to treat germinated or regrown weed species, in accordance with **Appendix K** Adjust fertiliser / soil ameliorant inputs and reseed during appropriate seasonal conditions Increase irrigation frequency if rainfall is inadequate Undertake additional soil sampling / seek input from an AQP if required **Water:** If there is an exceedance in surface water or groundwater quality criteria, undertake follow up monitoring within three months of the initial monitoring event Ensure mine affected water is directed into the Pits
Reporting	• Geotechnical audit to confirm design intent and monitoring outcomes have been achieved and identify any geotechnical risks or corrective actions required • An Infrastructure decommissioning and removal checklist is to be completed and retained to document works undertaken and acceptance of site by relevant personnel • Water quality data compiled into a consolidated spreadsheet including assessment against contaminant triggers • Active erosion features, slumping and ponded areas will be photographed and logged with a GPS for repairs as required • Drone footage of the slopes of the Southern WRD will be collected with supporting data as required • Photographic records, taken at the same photographic point location in each RA, will be kept for each monitoring occasion as a permanent visual record of rehabilitation progress • Final certification from an AQP stating the land is in a stable condition, and vegetated asset has achieved criteria in accordance with the Revegetation Plan

10.1.2. Access Tracks

The monitoring program developed for RA10 Access tracks is outlined in **Table 52**.

Table 52. Monitoring program – access tracks

Item	Description
Applicable Rehabilitation Milestones	• RM5 - landform development and reshaping / re-profiling of other areas • RM7- surface preparation (other areas) • RM9- rehabilitation monitoring and maintenance • RM12- achievement of PMLU to stable condition (access tracks)
Indicator	**Stability, Safety and Erosion:** Signs are installed Site access is restricted to the general public (Rocktest 2026) Access tracks and eastern and western levees facilitate runoff Visual evidence that the stabilities of the access tracks have remained constant and no additional erosion has occurred Erosion control measures are installed as required No ponding is occurring on access tracks Certification from an AQP that PMLU has been achieved and landholder agreements with GAWB have been actioned
Schedule and Frequency	• Inspection after erosion control measures installed, as required • Annual rehabilitation monitoring program undertaken including reporting and inspections for a period of two years from when rehabilitation commenced • Final inspection and certification after completion of milestone criteria
Guidelines / Agreements	**Erosion:** IECA 2008, *Best Practice Erosion and Sediment Control Manual, International Erosion Control Association* (Australasia), Picton NSW **Agreement:**

Item	Description
	Landholder agreement with GAWB
Method	An annual rehabilitation monitoring program will be undertaken by an AQP/s, comprised of visual inspections and audits, which includes: • Visual inspection (monthly during earthworks, then annually) by an AQP to confirm there is no active rill, gully, or sheet erosion present on final landform • Visual monitoring of access tracks to ensure long-term stability and if required, recommendations and implementation of remediation works • Certification from an AQP that all completion criteria are completed and the PMLU is achieved.
QA	Certification by an AQP
Review	Secondary review by Graymont and GAWB
Corrective Actions	**Stability, Safety and Erosion:** Stabilise haul roads as soon as practical Install additional erosion control measures prior to commencement of monitoring program, and as required
Reporting	Active erosion features, slumping and ponded areas will be photographed and logged with a GPS for repairs as required.

10.1.3. Water Storage

The monitoring program developed for RA 3 Pit 2 and RA6 Pit 3-4 is outlined in **Table 53**.

Table 53. Monitoring program – water storage

Item	Description
Applicable Rehabilitation Milestones	• RM3- landform development and reshaping / re-profiling of residual void • RM7 – surface preparation (other areas) • RM9- rehabilitation monitoring and maintenance • RM11- achievement of PMLU to stable condition (water storage)
Indicator	**Stability, Safety and Erosion:** Signs are installed Site access is restricted to the public Walls of the pits profiled for long-term stabilities as evidenced by surveys of the walls at the EOML Visual evidence that the stabilities of the walls have remained constant or increased as rehabilitation is established Erosion control measures are installed as required Perimeters are measured, in the correct locations, and structurally sound (Rocktest 2026) Certification provided by a geotechnical engineer that the PMLU has been achieved No residual contamination is present in the Project area **Revegetation and Soil:** Undisturbed areas and areas of natural regrowth will remain **Water:** Evidence that water in the pits is contained with no overflows as predicted by modelling If required, the pit walls are protected from possible inflows associated with floods Surface water and groundwater monitoring shows compliance with contaminant triggers as per the EA Water storage PMLU achieved
Schedule and Frequency	• Weekly inspections during earthworks • Inspection following completion of major earthworks required for landform development / re-profiling of residual void • Inspection after abandonment bund installed • Inspection after erosion control measures installed, or corrective actions implemented, as required • Ongoing quarterly surface and groundwater monitoring until all PMLUs achieved

Item	Description
	• Annual rehabilitation monitoring program undertaken including reporting and inspections for a period of 10 years from when rehabilitation commenced • Final inspection and certification after completion of all milestone criteria and monitoring program
Guidelines	**Stability and Erosion:** Government of Western Australia Department of Industry and Resources (1997) *Safety Bund Walls Around Open Pit Mines: Guideline*. MOSHAB Approved. Document No. ZMA048HA. Read, J. and Stacey, P. (2009) Chapter 9: Acceptance Criteria. Guidelines for Open Pit Slope Design. CSIRO Publications. IECA 2008, Best Practice Erosion and Sediment Control Manual, International Erosion Control Association (Australasia), Picton NSW. **Water:** National Health and Medical Research Council 2011, *Australian Drinking Water Guidelines 6*, Version 3.8, Australian Government Monitoring and Sampling Manual: Environmental Protection (Water) Policy (DES 2018)
Method	An annual rehabilitation monitoring program will be undertaken by an AQP/s, comprised of visual inspections and audits, which includes: • Visual inspection (monthly during earthworks, then annually) to confirm there is no active rill, gully, or sheet erosion present on final landform • Visual monitoring of void slopes to ensure long-term stability and if required, recommendations and implementation of remediation work • Water monitoring undertaken and data is assessed against contaminant triggers in the EA • Visual geotechnical inspections, including monitoring of the performance of the walls of the pits and slopes of the surrounding landforms • An audit of geotechnical risk issues After the rehabilitation monitoring program is completed, certification from an AQP that surface water quality objectives and all milestone criteria are completed and the PMLU is achieved. Certification provided by a geotechnical engineer that the final landform batter slopes meet the site design specifications after completion of milestone criteria
QA	Certification by an AQP
Review	Secondary review by Graymont and GAWB
Corrective Actions	**Stability, Safety and Erosion:** Remediate hazards associated with the residual voids that are causing potential environmental harm Reshape sections of the batters of the upper benches of Pit 2 and Pit 3-4 to their final landform so they can be progressively rehabilitated **Water:** If there is an exceedance in surface water or groundwater quality criteria, undertake follow up monitoring within three months of the initial monitoring event Ensure mine affected water is directed into the Pits
Reporting	• Geotechnical audit to confirm design intent and monitoring outcomes have been achieved and identify any geotechnical risks or corrective actions required • Active erosion features, slumping and ponded areas will be photographed and logged with a GPS for repairs as required • Drone footage of the walls of the pits will be collected with supporting data as required • Water quality data compiled into a consolidated spreadsheet including assessment against contaminant triggers

10.1.4. PRC Plan and Schedule Review and Update

The PRC Plan and Schedule are based on the current understanding of the reserve and LOM. Graymont will continue to refine mine planning for the LOM and if refinements will impact on

the PRC Plan or Schedule, Graymont will prepare an amendment application in accordance with sections 224 to 226 of the EP Act.

11. Limitations and Disclaimer

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Appendix A PRC Plan Schedule

DRAFT FOR PRCP schedule

Environmental Protection Act 1994

DRAFT PRCP schedule P-PRCP-100905310_V1

This is the approved form for a PRCP schedule issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.

PRCP schedule: P-PRCP-100905310_V1

PRCP schedule holder(s)

Name(s)	Registered address
Graymont (Calliope) Pty Ltd	Level 9, 118 Mount Street, NORTH SYDNEY, NSW 2060

Location details

Location(s)
Mining Lease (ML) 3594, ML3595, ML3596, ML3597, ML3598, ML3599, ML3600, ML3602, ML3603, ML3604, ML3605, ML3606, ML3608, ML3609, ML80036, ML80189, ML80190, ML80191, ML80192.

Take effect

In accordance with section 202B of the *Environmental Protection Act 1994* (EP Act), the PRCP schedule has effect on the day the environmental authority for carrying out relevant activities on land to which the schedule relates takes effect. Pursuant to section 202C of the EP Act, a PRCP schedule continues in force until the environmental authority for the relevant activities to which the PRCP schedule relates is cancelled or surrendered, even if the resource tenure expires or is cancelled and even if the relevant environmental authority is suspended under Chapter 5, part 11 or 11A of the EP Act.

Signature	Date

Department of the Environment, Tourism, Science and Innovation

Delegate of the administering authority

Environmental Protection Act 1994

Enquiries:

Mineral Business Centre

Po Box 7230, Cairns QLD 4870

Phone: (07) 4222 5468

Email: ESCairns@detsi.qld.gov.au

Queensland Government

Obligations under the *Environmental Protection Act 1994*

Pursuant to section 202E of the EP Act, if there is an inconsistency between an environmental authority and a PRCP schedule, the environmental authority prevails to the extent of the inconsistency.

Pursuant to section 285 of the EP Act:

- the holder of a PRCP schedule must commission an audit of the schedule by a rehabilitation auditor for the following periods (each an audit period) —

  (a) the 3-year period starting on the day the schedule takes effect

  (b) each 3-year period starting on the day after the previous audit period ended.

- the holder must, within 4 months after the end of each audit period, give the administering authority -

  (a) the rehabilitation auditor's report (an audit report) about the audit that complies with section 286 of the EP Act, and

  (b) a declaration for the audit report that complies with section 285 of the EP Act.

In addition to the requirements found in the conditions of this PRCP schedule, the holder must also meet their obligations under the environmental authority, the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the EP Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443).

PRCP schedule

The PRCP schedule incorporates the following sections:

- Section A - Conditions of PRCP schedule
- Section B – Definitions
- Section C - Final site design and reference maps
- Section D - Post mining land uses

Section A - Conditions of PRCP schedule

Pursuant to section 206A of the EP Act:

- it is a condition of this PRCP schedule that, in carrying out a relevant activity under the schedule, the holder must comply with a requirement stated in the environmental authority relevant to carrying out the activity.
- it is a condition of this PRCP schedule that the holder must comply with the following matters stated in the schedule -

  (a) each rehabilitation milestone and management milestone

  (b) when each rehabilitation milestone and management milestone is to be achieved

General conditions

PRCP1 All mining disturbance authorised under environmental authority (EA) EPML00969013 must have an associated rehabilitation outcome provided in this PRCP Schedule.

PRCP2 The holder must for each rehabilitation area achieve the corresponding rehabilitation milestone criterion (milestone reference):

(a) for the cumulative area available specified in this schedule; and

(b) by the milestone completion date specified in this schedule.

PRCP3 Where land becomes 'available for rehabilitation' earlier than the date nominated in this schedule, the holder must:

(a) notify the administering authority in writing within 30 days of the land becoming 'available for rehabilitation'; and

(b) Unless otherwise agreed to by the administering authority in writing, within 90 business days of the land becoming 'available for rehabilitation', apply to the administering authority to amend this schedule in a way that maximises the progressive rehabilitation of the land to a stable condition, including bring forward achievement of relevant milestones and criteria.

Notes:

1. Reference to "earlier than the nominated date in the schedule" means a date that is greater than 1 year prior to the date nominated in the schedule.
2. The written notification must include precise details of the relevant land area and the date when that land became 'available for rehabilitation'
3. Assessment of land becoming available is undertaken on a nominally annual basis.
4. Rehabilitation of land size must be practicable and economical.
5. The dates by which milestones are to be completed is brought forward, to the extent it is reasonably practicable to do so, by the same amount of time as the commencement was brought forward.

PRCP4 Where an area achieves a rehabilitation or management milestone, the holder must continue to achieve the milestone criteria until a surrender is approved.

PRCP5 The holder must maintain a risk register that identifies the risks to not achieving:

(a) a stable condition for post-mining land uses (PMLU), and

(b) how the risks are being managed or minimised.

PRCP6 The risk register (PRCP5) must be reviewed annually and include consideration of the outcomes of PRCP monitoring data.

PRCP7 The holder must carry out monitoring in accordance with:

(a) the monitoring and maintenance program described in the rehabilitation planning part for the activity version 2; and

(b) any requirement under this schedule; and

(c) as necessary to demonstrate achievement of each rehabilitation milestone or management milestone criteria.

Note: Where there is any inconsistency between this schedule and the rehabilitation planning part, the schedule criteria prevail to the extent of the inconsistency.

PRCP8 The holder must make and keep up to date records on:

(a) Achievement and maintenance of each rehabilitation milestone criteria of this schedule;

(b) Rehabilitation activities and the results of those activities (including but not limited to, actions taken, date, location, methods, data collected, quality assurance and quality control, photos, waste tracking and disposal records, appropriately qualified person details and assumptions);

(c) Maintenance of rehabilitation and the results of maintenance activities;

(d) Monitoring of rehabilitation and the results of monitoring;

(e) Details and results of rehabilitation trials;

(f) Designs, drawings, specifications and any similar documents developed in accordance with good professional practice in relation to rehabilitation milestones or milestone criteria;

(g) All documents in relation to the requirements of this 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;

(h) Landholder agreements; and

(i) Details of community consultation in the community consultation register relating to rehabilitation and closure activities.

PRCP9 Records made under PRCP8 must be kept until the relevant environmental authority has been surrendered.

PRCP10 Records made under PRCP8 must be provided to the administering authority in the specified format within 10 business days of a written request.

PRCP11 All appropriately qualified person (AQP) designs, specifications, certifications, assessments and any similar documents, must:

(a) include documented consideration of any relevant (and published at the time of the AQP deliverable) guideline or publication material, including material published by the administering authority.

(b) detail the boundary conditions (of any model);

(c) detail any assumptions made, limitations and areas of uncertainty; and

(d) contain sufficient detail to allow for independent peer review and substantiation.

PRCP12 Surface water quality must be monitored monthly during flow, but not limited to, the locations specified in Table 6 and Figure 3– Surface Water Monitoring Locations.

PRCP13 With respect to surface water and subject to PRCP12 the following must be demonstrated prior to surrender:

(a) Surface water quality must not exceed the limits specified in Table 5 – Surface Water Quality

Limits within the five-year period immediately prior to surrender;

(b) If the surface water quality exceeds criteria a), 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 site.

PRCP14 Where the surface water quality at the downstream site exceeds the upstream site result (PRCP13(b), an independent AQP must complete an assessment of the cause and risk of rehabilitation not achieving a stable condition within the schedule timeframe and:

(a) Where there is a low risk to achieving a stable condition from the rehabilitation areas then no further action is to be taken; or

(b) Where there is a risk greater than low to achieve a stable condition, then an assessment of potential environment harm and any changes or rectification actions to rehabilitation activities must be determined and implemented.

PRCP15 The assessment/s under PRCP14 must be completed and provided to the administering authority within 3 months of receiving the relevant sampling results.

PRCP16 The holder must prepare an erosion stability assessment for the Southern Waste Rock Dump, undertaken by an AQP during the detailed design phase.

(a) The assessment must demonstrate, using appropriate modelling and supporting technical analyses, that the proposed final landform is expected to achieve long-term erosional stability under the relevant performance criteria and post-closure conditions.

(b) Where the assessment identifies that the proposed final landform does not meet the specified performance criteria, the holder must revise the final landform design and repeat the assessment until the revised design demonstrates compliance with those criteria and specifications.

(c) Where the modelling identifies that amendments to the final landform are necessary to achieve the specified performance criteria for long-term erosional stability, the holder must amend the final landform design to incorporate those changes.

PRCP17 By 30 June 2035, the holder must submit RPEQ-certified design for drains, overflow pathways and scour protection work.

PRCP18 By 30 June 2036, the holder must, submit to the administering authority contemporary long term post-mining prediction numerical modelling for drawdown and groundwater level elevations.

The predictive groundwater modelling as per the Australian Groundwater Modelling Guidelines (*list (current version*, and any subsequent version), confirms:

(a) The residual voids will not cause environmental harm through the release of contaminants from the void lakes beyond the tenure boundaries post-closure; and

(b) Groundwater drawdown will not negatively impact groundwater dependent ecosystems (GDEs) on or surrounding the site.

END OF CONDITIONS

Section B – Definitions

Activity (EP Regulation)	includes that part, if any, of an activity relating to the following— (a) preparing a place for the activity before carrying out the activity; (b) rehabilitating a place after it has been used for carrying out the activity.
Appropriately qualified person (AQP)	means a person who has professional qualifications, training, skills and experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods or literature.
BioCondition	refers to the *BioCondition Assessment Manual* (Eyre, T.J., Kelly, A.L, Neldner, V.J., Wilson, B.A., Ferguson, D.J., Laidlaw, M.J. and Franks, A.J. (2015)) and *BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual. Version 2.2* (Queensland Herbarium, Department of Science, Information Technology, Innovation and Arts, Brisbane) or later versions thereof.
Contaminants	can be a gas, liquid or solid; or an odour; or an organism (whether alive or dead), including a virus; or energy, including noise, heat, radioactivity and electromagnetic radiation; or a combination of contaminants.
Contaminated Land Auditor	A contaminated land auditor is responsible for auditing the work of the suitably qualified person (SQP) by evaluating and certifying site investigation and validation reports and drafting the site management plans that are submitted for a decision on a land contamination matter.
Flood stress	is the pressure on structures from rapid water rise, erosion, and saturation during extreme floods, risking instability.
Growth media	is defined as all soil and soil-like material that will support the final vegetation cover. This includes the topsoil and subsoil where these materials are applied independently. Where the topsoil is incorporated into the underlying subsoil/spoil, topsoil refers to the depth of incorporation and the remaining depth is regarded as subsoil. The total depth of growth media is nominally considered to be the effective plant root zone
Gully	A gully is a channel excavated by water, more than 0.3 m deep.
Independent AQP	is an AQP who is a third party, being independent of the PRCP schedule holder, and has not previously provided advice on the matter the subject of the review.
Independently peer reviewed	means a peer reviewer who is a third-party to the PRCP schedule holder and the AQP whose report is being reviewed and substantiated. The peer reviewer shall also be an AQP and documentation provided must contain sufficient detail to allow for independent technical review and substantiation and provide and justify site-specific landform performance (SMART) criteria.
Potentially acid forming (PAF)	means material with either a Net Acid Producing Potential of greater than 5 kg of H_2SO_4/tonne or a Net Acid Generation oxidation pH of less than 4.5 (pH unit).
Rehabilitation activity	means any activity that the holder is required to carry out in relation to this PRCP schedule.
Relevant material	includes: i. Final landform design report, ii. Durability assessment/ report, iii. “As Constructed” report;

	iv. All monitoring data v. Assessment of monitoring data, vi. All maintenance records; and vii. Modelling and technical assessments.
Relevant structure	To be defined during the assessment and listed here. Typically includes TSF and higher risk structures, including WRDs.
Rill	A rill is a channel excavated by water, less than 0.3 m deep.
RPEQ	Registered Professional Engineer of Queensland, a legally recognized certification that confirms an engineer's qualifications, competency, and ability to perform professional engineering services in Queensland
Stable	in relation to land, means landform dimensions are or will be stable within tolerable limits now and in the foreseeable future. Stability includes consideration of environmental context, geotechnical stability, settlement and consolidation allowances, bearing capacity (trafficability), erosion resistance and geochemical stability with respect to seepage, leachate and related contaminant generation.
Stabilised	means one or both of the following conditions apply: no evidence of sediment movement; sides and/or floors of erosion form are revegetated (Australian Soil and Land Survey Field Handbook Third Edition).
Stable condition	see section 111A of the *Environmental Protection Act 1994*.
Suitably qualified and experienced person (SQP)	for performing a regulatory function under chapter 7, part 8 (Contaminated Land) of the EP Act or another function prescribed under a regulation, means a person who— (a) has qualifications and experience relevant to performing the function; and (b) if a regulation prescribes an organisation for this paragraph—is a member of the organisation.
Vegetative groundcover	Means plants, plant litter, tree leaf litter, twigs and woody debris capable of protecting the soil surface from erosion.
Weed	Non-native plant that are: • Category 3 restricted invasive plant species, defined by the Biosecurity Act 2014; and • Weeds of National Significance, defined by Invasive Plants and Animals Committee 2016, Australian Weeds Strategy 2017 to 2027, Australian Government Department of Agriculture and Water Resources, Canberra.

Section C - Final site design and reference maps

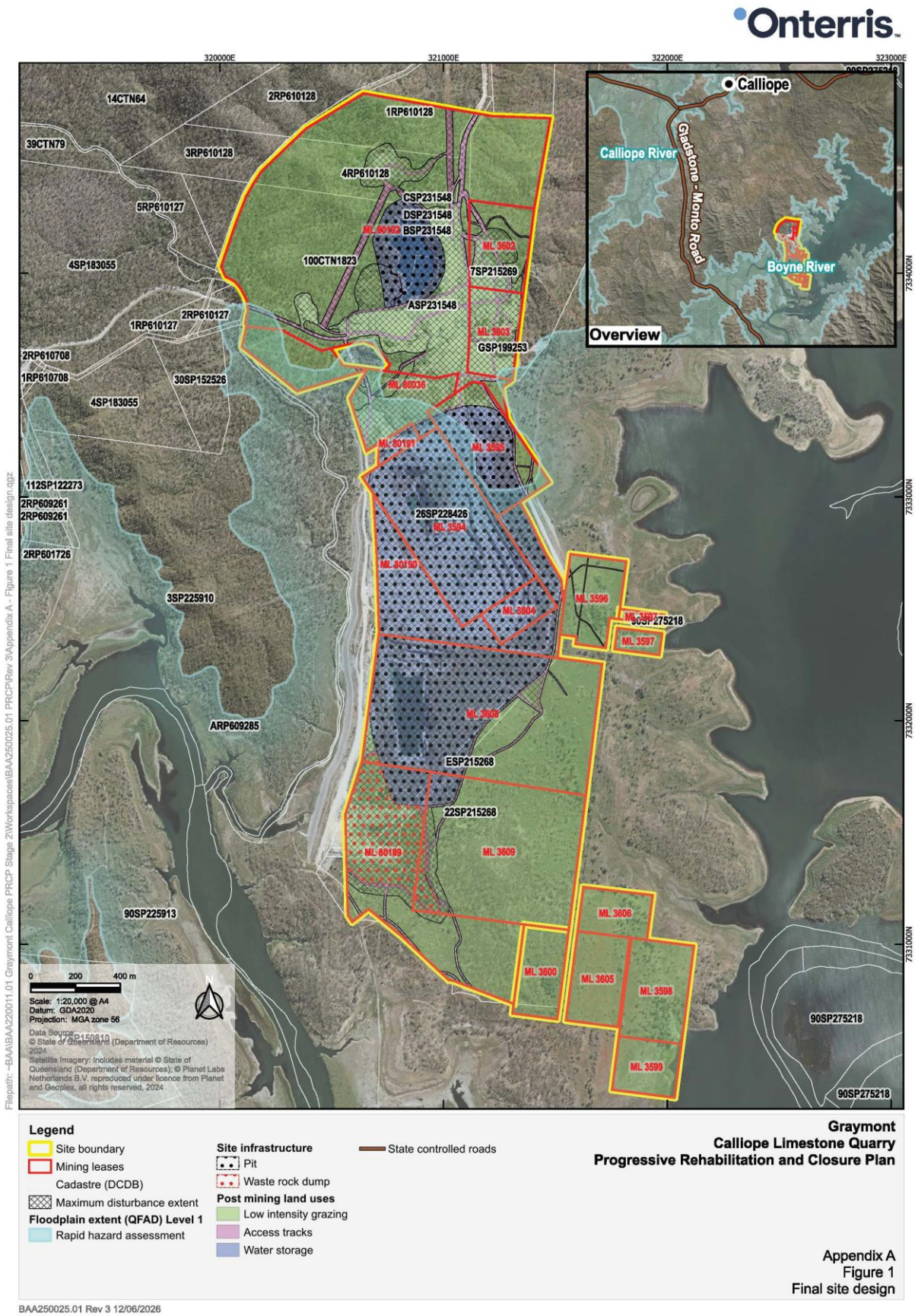


Figure 1 – Final site design

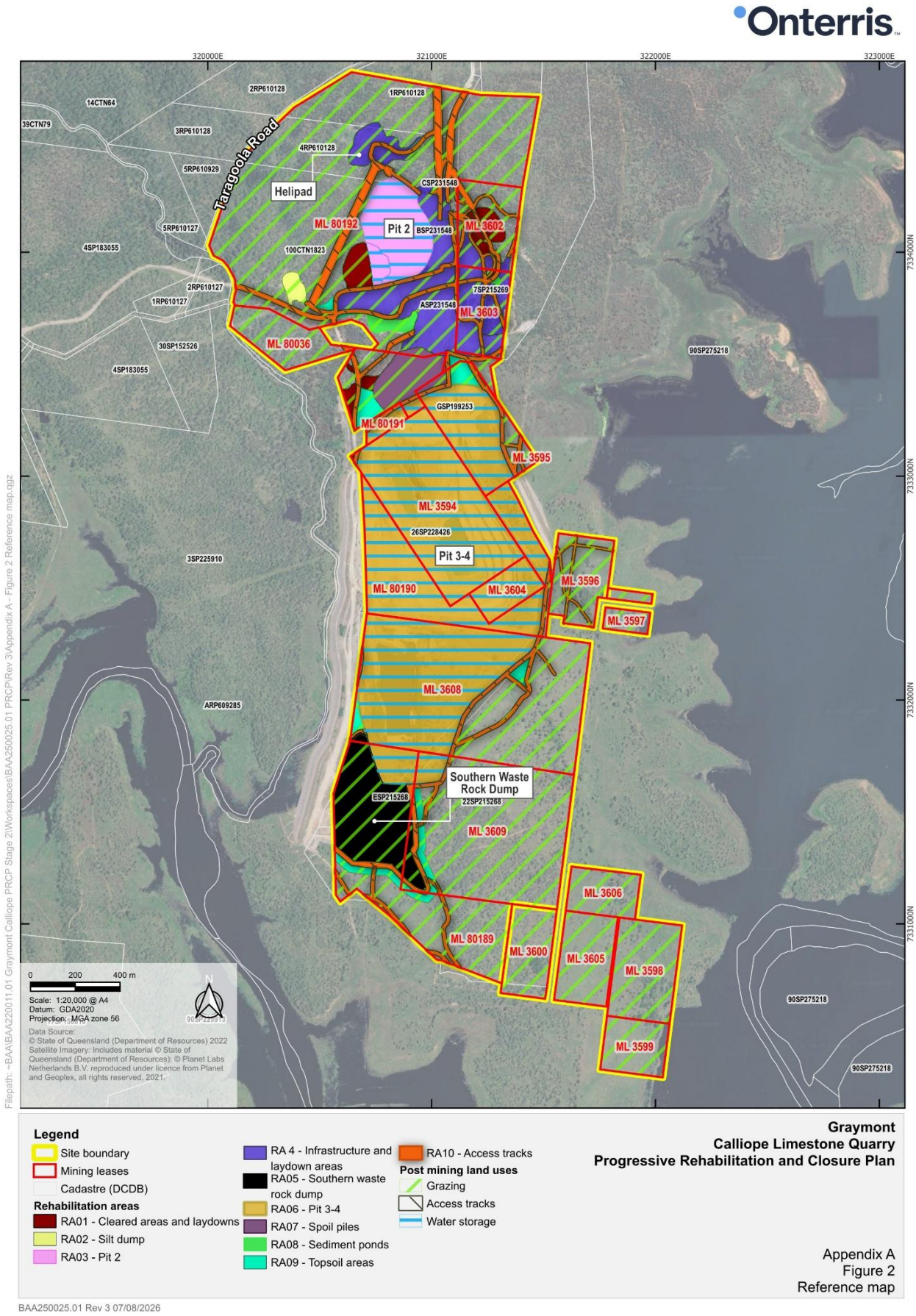


Figure 2 – Rehabilitation Areas

Section D – Post mining land uses

Milestone reference	Rehabilitation milestone	Rehabilitation Area									
		RA1	RA2	RA3	RA4	RA5	RA6	RA7	RA8	RA9	RA10
		Cleared Areas and Laydowns	Silt Dump	Pit 2	Infrastructure and ROM Pad	Southern Waste Rock Dump	Pit 3-4	Spoil Pile Areas	Sediment Ponds	Topsoil Stockpile areas	Access Tracks
RM1	Infrastructure decommissioning and removal										
RM2	Contaminated land assessment and remediation										
RM3	Landform development and reshaping / re-profiling of residual void										
RM4	Landform development and reshaping / re-profiling of waste rock dump										
RM5	Landform development and reshaping / re-profiling of other areas										
RM6	Surface preparation (grazing PMLU)										
RM7	Surface preparation (other areas)										
RM8	Revegetation (grazing)										
RM9	Achievement of surface requirement										
RM10	Achievement of post-mining land use to stable condition (water storage)										
RM11	Achievement of post-mining land use to stable condition (grazing)										
RM12	Achievement of post-mining land use to stable condition (access tracks)										
RM13	Achievement of groundwater quality										

(RA1) Rehabilitation area 1

Post-mining land uses (PMLU)							
Rehabilitation area	RA1						
Relevant activities	Cleared Areas and Laydowns						
Total rehabilitation area size (ha)	5.72						
Commencement of first milestone: RM5	10/12/2045						
PMLU	Low Intensity Grazing						
Date area is available	10/12/2045	10/12/2046	10/12/2047	10/12/2096	10/12/2097	10/12/2106	10/12/2117
Cumulative area available (ha)	2.14	2.14	2.14	5.72	5.72	5.72	5.72
Milestone completed by	10/12/2046	10/12/2047	10/12/2048	10/12/2097	10/12/2098	10/12/2107	10/12/2124
Milestone Reference	**Cumulative area achieved (ha)**						
RM5	2.14			5.72			
RM6	2.14			5.72			
RM8	2.14			5.72			
RM9		2.14			5.72		
RM11			2.14			5.72	
RA13							5.72

(RA2) Rehabilitation area 2

Post-mining land uses (PMLU)					
Rehabilitation area	RA2				
Relevant activities	Silt Dump				
Total rehabilitation area size (ha)	1.11				
Commencement of first milestone: RM2	10/12/2096				
PMLU	Low Intensity Grazing				
Date area is available	10/12/2096	11/12/2097	11/12/2098	11/12/2107	10/12/2117
Cumulative area available (ha)	1.11	1.11	1.11	1.11	1.11
Milestone completed by	11/12/2097	11/12/2098	11/12/2099	11/12/2108	10/12/2124
Milestone Reference	**Cumulative area achieved (ha)**				
RM2	1.11				
RM5	1.11				
RM6	1.11				
RM8		1.11			
RM9			1.11		
RM11				1.11	
RM13					1.11

(RA3) Rehabilitation area 3

Post-mining land uses (PMLU)				
Rehabilitation area	RA3			
Relevant activities	Pit 2			
Total rehabilitation area size (ha)	11.46			
Commencement of first milestone: RM3	10/12/2100			
PMLU	Water Storage			
Date area is available	10/12/2100	10/12/2101	10/12/2109	10/12/2117
Cumulative area available (ha)	11.46	11.46	11.46	11.46
Milestone completed by	10/12/2101	11/12/2102	17/12/2110	10/12/2124
Milestone Reference	**Cumulative area achieved (ha)**			
RM3	11.46			
RM7	11.46			
RM9		11.46		
RM10			11.46	
RA13				11.46

(RA4) Rehabilitation area 4

Post-mining land uses (PMLU)						
Rehabilitation area	RA4					
Relevant activities	Infrastructure and ROM Pad					
Total rehabilitation area size (ha)	27.34					
Commencement of first milestone: RM1	10/12/2100					
PMLU	Low Intensity Grazing					
Date area is available	10/12/2100	10/12/2101	10/12/2102	10/12/2103	10/12/2104	10/12/2117
Cumulative area available (ha)	27.34	27.34	27.34	27.34	27.34	27.34
Milestone completed by	10/12/2101	10/12/2102	10/12/2103	10/12/2104	10/12/2113	10/12/2124
Milestone Reference	**Cumulative area achieved (ha)**					
RM1	27.34					
RM2		27.34				
RM5		27.34				
RM6			27.34			
RM8			27.34			
RM9				27.34		
RM11					27.34	
RM13						27.34

(RA5) Rehabilitation area 5

Post-mining land uses (PMLU)				
Rehabilitation area	RA5			
Relevant activities	Southern Waste Rock Dump			
Total rehabilitation area size (ha)	15.83			
Commencement of first milestone: RM4	10/12/2101			
PMLU	Low Intensity Grazing			
Date area is available	10/12/2101	10/12/2102	10/12/2111	10/12/2117
Cumulative area available (ha)	15.83	15.83	15.83	15.83
Milestone completed by	10/12/2102	11/12/2103	12/12/2112	10/12/2124
Milestone Reference	**Cumulative area achieved (ha)**			
RM4	15.83			
RM6	15.83			
RM8		15.83		
RM9		15.83		
RM11			15.83	
RM13				15.83

(RA6) Rehabilitation area 6

Post-mining land uses (PMLU)				
Rehabilitation area	RA6			
Relevant activities	Pit 3-4			
Total rehabilitation area size (ha)	109.72			
Commencement of first milestone: RM3	10/12/2102			
PMLU	Water storage			
Date area is available	10/12/2102	10/12/2103	10/12/2112	10/12/2117
Cumulative area available (ha)	109.72	109.72	109.72	109.72
Milestone completed by	10/12/2103	10/12/2104	10/12/2113	10/12/2124
Milestone Reference	**Cumulative area achieved (ha)**			
RM3	109.72			
RM7	109.72			
RM9		109.72		
RM10			109.72	
RM13				109.72

(RA7) Rehabilitation area 7

Post-mining land uses (PMLU)					
Rehabilitation area	RA7				
Relevant activities	Spoil Pile Areas				
Total rehabilitation area size (ha)	6.03				
Commencement of first milestone: RM1	10/12/2103				
PMLU	Low Intensity Grazing				
Date area is available	10/12/2103	10/12/2104	10/12/2105	10/12/2114	10/12/2117
Cumulative area available (ha)	6.03	6.03	6.03	6.03	6.03
Milestone completed by	10/12/2104	10/12/2105	10/12/2106	10/12/2115	10/12/2124
Milestone Reference	**Cumulative area achieved (ha)**				
RM1	6.03				
RM5	6.03				
RM6	6.03				
RM8		6.03			
RM9			6.03		
RM11				6.03	
RM13					6.03

(RA8) Rehabilitation area 8

Post-mining land uses (PMLU)					
Rehabilitation area	RA8				
Relevant activities	Sediment Ponds				
Total rehabilitation area size (ha)	1.46				
Commencement of first milestone: RM2	10/12/2104				
PMLU	Low Intensity Grazing				
Date area is available	10/12/2104	10/12/2105	10/12/2106	10/12/2115	10/12/2117
Cumulative area available (ha)	1.46	1.46	1.46	1.46	1.46
Milestone completed by	10/12/2105	10/12/2106	10/12/2107	10/12/2116	10/12/2124
Milestone Reference	**Cumulative area achieved (ha)**				
RM2	1.46				
RM5	1.46				
RM6	1.46				
RM8		1.46			
RM9			1.46		
RM11				1.46	
RM13					1.46

(RA9) Rehabilitation area 9

Post-mining land uses (PMLU)					
Rehabilitation area	RA9				
Relevant activities	Topsoil Stockpile Areas				
Total rehabilitation area size (ha)	7.84				
Commencement of first milestone: RM5	10/12/2105				
PMLU	Low Intensity Grazing				
Date area is available	10/12/2105	11/12/2106	12/12/2107	18/12/2116	10/12/2117
Cumulative area available (ha)	7.84	7.84	7.84	7.84	7.84
Milestone completed by	11/12/2106	12/12/2107	13/12/2108	13/12/2117	10/12/2124
Milestone Reference	**Cumulative area achieved (ha)**				
RM5	7.84				
RM6	7.84				
RM8		7.84			
RM9			7.84		
RM11				7.84	
RM13					7.84

(RA10) Rehabilitation area 10

Post-mining land uses (PMLU)			
Rehabilitation area	RA10		
Relevant activities	Access Tracks		
Total rehabilitation area size (ha)	17.95		
Commencement of first milestone: RM5	10/12/2100		
PMLU	Access Tracks		
Date area is available	10/12/2100	10/12/2109	10/12/2117
Cumulative area available (ha)	17.95	17.95	17.95
Milestone completed by	10/12/2101	10/12/2110	10/12/2124
Milestone Reference	**Cumulative area achieved (ha)**		
RM5	17.95		
RM7	17.95		
RM9	17.95		
RM12		17.95	
RM13			17.95

Rehabilitation area milestones

Milestone reference	Rehabilitation milestone	Milestone criteria
RM1	Infrastructure decommissioning and removal	1.1 With the exception of any infrastructure to remain as part of the post-mining land use (PMLU), the following criteria are completed. (a) All services disconnected. (b) All buildings and associated infrastructure including tanks and plant equipment to be demolished, and removed offsite to an appropriately licenced waste or recycling facility. (c) Machinery and equipment not required for rehabilitation removed off-site. (d) All concrete slabs and footings have been broken up and removed to an appropriately licenced waste facility. 1.2 An independent AQP has certified the achievement of RM1.1 to RM1.2.
RM2	Contaminated land assessment and remediation	2.1 Contaminated water and sediment removed from dams. 2.2 An appropriately qualified person (AQP) undertakes a Preliminary Site Investigation and prepares a site investigation report that includes a review of previous activities to assess whether contamination has the potential to exist in a mine domain and whether further investigation is needed to be completed by an SQP. The SQP either: (a) Certifies that no contamination unsuitable for the PMLU remains or is occurring; or (b) Specifies that a Contaminated Land Investigation Document must be completed in accordance with the *Environmental Protection Act 1994* 2.3 In the event that RM2.2(b) is determined by an AQP, a Contaminated land investigation will be completed (investigation, remediation and validation) in accordance with the EP Act, including a site investigation report, and where required, a validation report and/or a draft Site Management Plan. 2.4 A Contaminated Land Auditor certifies that no contamination unsuitable for the PMLU remains or is occurring. Validation sampling and analysis conducted to confirm that contaminated water, soils or other materials have been removed or remediated.
RM3	Landform development and reshaping /reprofiling of residual void	3.1 All major earthworks (including reshaping, pushing/trimming) are completed in accordance with the design specification provided by an AQP. 3.2 A flood impact assessment must be undertaken by an AQP to confirm interactions between flood waters and final landforms. The assessment must consider: (a) all landform interfaces where flood velocities are a risk to erosional stability; and

		(b) the mitigation measures that will be implemented to ensure stability of the landform. 3.3 Mitigation measures for reducing flood velocities installed to landform, as recommended in the flood impact assessment in RM3.2. 3.4 An AQP has confirmed that geotechnical stability of the residual void walls (i.e., a factor of safety value of ≥1.5) has been achieved. 3.5 Pit 3-4 (RA6) batter slopes meet final design specifications (18° in weathered rock, 65° in unweathered rock). 3.6 Pit 2 (RA3) maximum overall slope angle meets final design specifications (34°). 3.7 Perimeter abandonment bund and safety signage installed offset, as specified by an AQP, from the crest of the voids (RA3 and RA6). 3.8 Safety signage (design in accordance with Australian standard) is erected at 100m intervals along the fence. 3.9 Locked gates and signage installed at access points to the residual voids to prevent unauthorised access (RA3 and RA6). 3.10 An AQP certifies that void final landform design intent has been achieved. 3.11 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. 3.12 Independent AQP has surveyed the final landform and certified that RM3.1 to RM3.11 have been achieved.
RM4	Landform development and reshaping /reprofiling of waste rock dump	4.1 A flood impact assessment must be undertaken by an AQP to confirm interactions between flood waters and final landforms. The assessment must consider: (a) all landform interfaces where flood velocities are a risk to erosional stability; and (b) the mitigation measures that will be implemented to ensure stability of the landform. 4.2 Mitigation measures for reducing flood velocities installed to landform, as recommended in the flood impact assessment in RM4.2. 4.3 Erosion modelling confirms that the Southern Waste Rock Dump design can achieve average rates of erosion below 10 t/ha/yr. 4.4 Major earthworks completed and landform constructed in accordance with final engineering and design specifications (maximum 12% slopes) provided by an AQP. 4.5 As built inspection by an AQP confirms that the final landform design intent has been achieved, and average batter slopes do not exceed 12%. 4.6 Constructed landform achieves a geotechnical stability with a Factor of Safety ≥1.5, which includes consideration of flood stress.

		4.7	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.
		4.8	Independent AQP has surveyed the final landform and certified that RM4.1 to RM4.7 have been achieved.
RM5	Landform development and reshaping /reprofiling of other areas	5.1	All major earthworks (including reshaping, pushing/trimming) are completed in accordance with the design specification provided by an AQP.
		5.2	Areas to be revegetated will have water shedding landforms with slopes not exceeding 12%.
		5.3	Grazing PMLU rehabilitation areas assessed as stable and non-polluting by an AQP.
		5.4	An “As-Constructed Report” prepared by an AQP which details and justifies all variations to the design required under PRCP18, including a certification that such variations will not affect the design performance.
		5.5	Independent AQP has surveyed the final landform and certified that RM5.1 to RM5.5 have been achieved.
RM6	Surface preparation (grazing PMLU)	6.1	Areas to be revegetated should be ripped to a depth of 500 mm at 500-800 mm spacings.
		6.2	Stockpiled topsoil has been assessed for quality, physical properties, amelioration requirements and suitability for rehabilitation and a plan for treatment developed by an AQP prior to seeding to confirm available topsoil is suitable for the establishment and maintenance of the nominated post-mine land use.
		6.3	Topsoil placed to an average depth of 200 mm to all RAs where required.
		6.4	Application of ameliorants on topsoil if required, as per recommendations from the soil quality and suitability assessment in RM6.2.
		6.5	Following the amelioration as per RM6.2 and RM6.4, growth media health and suitability is assessed and documented by an AQP as suitable for the PMLU and target vegetation establishment.
		6.6	Surface and ground water monitoring is underway (at least one year of sampling undertaken).
		6.7	Independent AQP has certified the plan in RM6.2 and the achievement of RM 6.1 to 6.7.
RM7	Surface preparation (other areas)	7.1	Localised erosion areas identified and repaired.
		7.2	Access tracks (RA10) are clear of debris and graded to conform with the surrounding landforms.
		7.3	An independent AQP has certified the achievement of RM7.1 to 7.2
RM8	Revegetation (grazing)	8.1	Initial revegetation campaign to seed target species per **Table 2 and Table 3**, including planting in rehabilitated sediment ponds (RA8) and topsoil stockpile areas (RA9).
		8.2	Timing of seeding (sowing) determined based on target species, as in **Table 3**.
		8.3	Cleared areas (RA1), silt dump (RA2), infrastructure and laydown areas (RA4), Southern WRD (RA5), and spoil pile areas (RA7) to be seeded with native grasses per **Table 1 and Table 3**.
		8.4	Firebreak maintained along edge of mining lease until rehabilitation complete.

		8.5 Install temporary exclusion stock fencing if needed to prevent access to revegetation areas until established, or as advised by an AQP. 8.6 Independent AQP has certified the achievement of RM 8.1 to 8.5.
RM9	Achievement of surface requirement	9.1 Rehabilitation monitoring reference sites for grazing PMLU have been selected in unmined pasture areas within the lease area (excluding RA3, RA6 and RA10), as per reference (survey) sites in **Figure 5.** and **Table 11. Reference sites..** 9.2 Species used in rehabilitation remain present and show evidence of natural recruitment. Evidence of flora recruitment from rehabilitation monitoring data. 9.3 A BioCondition assessment is completed by an AQP in accordance with the latest version of the Queensland Herbarium's ''BioCondition Assessment Manual' determines that the PMLU has reached a BioCondition score of 20/60 as per T**able 9. Open woodland BioCondition milestone benchmarks and Figure 6 Rehabilitation area vegetation structure for RA8 and RA9**– BioCondition Benchmark Criteria. 9.4 A BioCondition assessment is completed by an AQP in accordance with the latest version of the Queensland Herbarium's ''BioCondition Assessment Manual' determines that the PMLU has reached a BioCondition score of 10/30 as per **Table 10. Grassland BioCondition milestone benchmarks and Figure 6 Rehabilitation area vegetation structure for RA1, RA2, RA4, RA5 and RA7** 9.5 Weed presence less than 5% of total vegetative cover. 9.6 Native desirable palatable and productive species in rehabilitated areas trending towards at least 50% of the vegetative ground cover. 9.7 Vegetation maintenance and or additional soil amelioration has been undertaken as soon as is practicable where monitoring has shown that groundcover or pasture composition does not meet the milestone criteria within the nominated timeframe. 9.8 The ground cover in rehabilitated areas with low intensity grazing pasture PMLU will, on average, be dominated by native grasses identified in the revegetation plan that are recognised as pasture species or known to be palatable and provide forage for livestock. 9.9 No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 4- Erosion classification framework**. 9.10 No evidence of scouring, overtopping, sedimentation or destabilisation in or associated with erosion and sediment control and engineered drainage structures. 9.11 Erosion requiring intervention has been remediated and does not impact achieving the PMLU. 9.12 Surface water runoff has been collected across representative areas of rehabilitation when surface flows occur and is safe to do so. 9.13 Surface water runoff is on trajectory to complying with **Table 5 – Surface water quality limits**.

		9.14 Annual visual monitoring of the void slopes (RA3 and RA6) demonstrates that they have remained stable for a period of ten years from when rehabilitation commenced. 9.15 Where unacceptable instability is recorded, advice has been sought from an AQP and remediation works have been undertaken as soon as is practicable. 9.16 Independent AQP certifies achievement of RM9.1 to 9.16.
RM10	Achievement of post-mining land use to stable condition (water storage)	10.1 The final landform is geotechnical stable with a factor of safety ≥1.5. 10.2 Abandonment bunds and residual void slopes have been assessed by an AQP as sufficient to maintain slope stability and protect from erosion. 10.3 Water in water storages monitored quarterly, must be of a suitable quality for native wildlife and/or livestock ingestion and must not exceed the stock water guidelines (ANZECC 2000), for a minimum of 5 consecutive years. 10.4 Independent AQP certifies the achievement of RM10.1 to RM10.3
RM11	Achievement of post-mining land use to stable condition (grazing)	11.1 Safety hazards in rehabilitation areas are not significantly different to surrounding unmined landscapes subject to the same land use. 11.2 Weed presence is a maximum of 5% total vegetative cover confirmed by an AQP in annual monitoring. 11.3 A BioCondition assessment is completed by an AQP in accordance with the latest version of the Queensland Herbarium's ''BioCondition Assessment Manual' determines that the PMLU has reached a BioCondition score of 40/60 as per T**able 9. Open woodland BioCondition milestone benchmarks and Figure 6 Rehabilitation area vegetation structure) for RA8 and RA9**– BioCondition Benchmark Criteria. 11.4 A BioCondition assessment is completed by an AQP in accordance with the latest version of the Queensland Herbarium's ''BioCondition Assessment Manual' determines that the PMLU has reached a BioCondition score of 20/30 as per **Table 10. Grassland BioCondition milestone benchmarks and Figure 6 Rehabilitation area vegetation structure for RA1, RA2, RA4, RA5 and RA7** 11.5 Landform contains greater than 50% groundcover (vegetation (living and dead) and biological crusts) at 30 September each calendar year. 11.6 No evidence of erosion as classified as 'moderate' or 'severe' as defined by **Table 4 – Erosion classification framework.** 11.7 Any erosion present will not compromise the achievement of a PMLU to a stable condition. 11.8 Surface water runoff complies with **Table 5 – Surface water quality limits**. 11.9 Certification from a AQP that RA5 southern waste rock dump is functional and no migration of contaminants to groundwater has or will occur. 11.10 Certification from a AQP that the area has achieved an erosionally and geotechnically stable condition and achieved a factor of safety ≥1.5.

		11.11 Independent AQP certifies the achievement of RM11.1 to RM11.10.
RM12	Achievement of post-mining land use to stable condition (access tracks)	12.1 No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 4- Erosion classification framework.** 12.2 Any erosion present will not compromise the achievement of the PMLU to a stable condition. 12.3 Access tracks (RA10) are stabilised and graded to facilitate runoff and access for maintenance activities, fire management, etc. 12.4 Infrastructure to be transitioned to a future landholder is deemed fit for purpose (verified by an AQP) and accepted, by signed agreement, with the future landholder. 12.5 An AQP certifies that all infrastructure to be retained onsite is safe, stable and will not cause environmental harm. 12.6 Independent AQP certifies the achievement of RM12.1 to RM12.5
RM13	Achievement of groundwater requirements	13.1 Groundwater quality must be monitored quarterly at, but not limited to, bores specified in **Table 7 and Figure 4 – Groundwater monitoring locations** for all quality characteristics listed in **Table 8 – Groundwater quality limits.** 13.2 Groundwater quality must not exceed the limits in **Table 8 – Groundwater quality limits**, for 3 consecutive results, for a minimum of five consecutive years immediately prior to the milestone completion date. 13.3 All bores decommissioned in consultation with the Queensland Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development according with the preferred practices nominated in the Minimum Construction Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee 2020).

[1] For pH, the quality result measured at the downstream location must be within the prescribed range. However, where pH at the downstream location is greater-than (>) the highest limit in the range, the pH at the applicable upstream location must be greater-than or equal-to (≥) the downstream location. Conversely, where pH at the downstream location is less than (<) the lowest limit in the range, the upstream pH at the applicable upstream location must be less-than or equal-to (≤) the downstream location.

[2]Active as defined in the Australian Soil and Land Survey Field Handbook (3rd Edition), The National Committee on Soil and Terrain published by CSIRO Publishing 2009.

Table 1. Native grass and forbs seeds species and quantities

Common name	Species name	Seed mix %
Slender Bamboo Grass	*Austrostipa verticillata*	50
Black Speargrass	*Heteropogon contortus*	10
Kangaroo Grass	*Themeda triandra*	10
Pitted Bluegrass	*Bothriochloa decipiens*	10
Hairy Panic	*Panicum effusum*	10
Barbed-wire Grass	*Cymbopogan queenslandicus*	10
	Enneapogon lindeyanus	
	Eustrephus latifolius	
	Rhyncosia minima	
	Cyanthillium cinereum	
	Glycine tomentella	
	Phyllanthus virgatus	

Table 2. Tree and shrub species planting mix

Common name	Species name	Planting density (plants/100m2)
Trees		
Narrow-leaved Ironbark	*Eucalyptus crebra*	2
Red Bloodwood	*Corymbia erythrophloia*	1
Silver-leaved ironbark	*Eucalyptus melanophloia*	2
Shrubs		
Pretty Wattle	*Acacia decora*	4
Corky Apple	*Planchonia careya*	1
Wild Orange	*Capparis canecens*	1
Currant Bush	*Carissa ovata*	1

Table 3. Planting and maintenance schedule

Year	Season			
	Summer	**Autumn**	**Winter**	**Spring**
1	Site preparation Targeted weed removal Spread soil	Sow native grass seeds Herbicide spot spray Commence maintenance and irrigation		Broad-scale non-residual herbicide application
2	Weeds survey	Plant tree and shrub tubestock (RA8 and RA9 only) Herbicide spot spray	End irrigation	Broad-scale non-residual herbicide application
3	Weeds survey	Herbicide spot spray		
4	Weeds survey	Herbicide spot spray End maintenance (weeding control and supplementary planting)		
5	Weeds survey	Start cattle grazing		
6	Weeds survey			
7	Weeds survey			
8	Weeds survey			
9	Weeds survey			
10	Final weed survey	PMLU achieved		

Table 4. Erosion classification framework

Erosion classification	Minor	Moderate	Severe
Sheet erosion[1]	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*	<15 rills/100m	15-30 rills/100m	>30 rills/100m
Gully erosion	Absent	Absent	Present
Tunnel erosion[2]	Absent	Absent	Present
Mass movement[3]	Absent	Absent	Present

[1]Erosion from definitions: NCST (2024) *Australian Soil and Land Survey Field Handbook, 4th edition*. The National Committee on Soil and Terrain. CSIRO Publishing, Collingwood, Australia.

* Rill frequency assessed on the contour over entirety of rehabilitation area (not only features that intersect a monitoring transect).

[2] Tunnel erosion - This is the removal of subsoil by water while the surface soil remains relatively intact

[3] Mass movement - A generic term for any process or sediments (mass movement deposit) resulting from the dislodgment and downslope transport of soil and rock material as a unit under direct gravitational stress. The process includes slow displacements such as creep and solifluction, and rapid movements such as landslides, rock slides and falls, earthflows, debris flows and avalanches

Table 5. Surface water quality limits

Quality characteristic (units)	Limit	Comment on limit
pH	6.5-8.0	WQO
Electrical Conductivity (µS/cm)	920	Boyne WQO - Diglum Creek lowland fresh
Sulfate (mg/L)	21	Boyne WQO - Diglum Creek lowland fresh
Turbidity (NTU)	10	Boyne WQO - Diglum Creek lowland fresh
Arsenic – Dissolved (µg/L)	13	ANZG2018
Cadmium – Dissolved (µg/L)	0.2	ANZG2018
Chromium – Dissolved (µg/L)	1	ANZG2018
Cobalt – Dissolved (µg/L)	1.4	ANZG2018
Copper – Dissolved (µg/L)	1.4	ANZG2018
Lead – Dissolved (µg/L)	3.4	ANZG2018
Mercury – Dissolved (µg/L)	0.06	ANZG2018
Nickel – Dissolved (µg/L)	11	ANZG2018
Selenium – Dissolved (µg/L)	5	ANZG2018
Uranium – Dissolved (µg/L)	0.5	ANZG2018
Zinc – Dissolved (µg/L)	8	ANZG2018
Total recoverable hydrocarbons (C6-C9) (µg/L)	20	
Total recoverable hydrocarbons (C10-C36) (µg/L)	100	
Major ions (mg/L) Calcium, chloride, potassium, magnesium, sodium, bicarbonate, carbonate	For interpretation purposes	
Hardness (mg/L)	For interpretation purposes	

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)
- ANZG (2018) To account for the bioaccumulating nature of selenium, it is recommended that the 99% species protection level DGV is used for slightly to moderately disturbed systems.
- WQO - https://environment.des.qld.gov.au/__data/assets/pdf_file/0034/87775/boyne-calliope-curtis-evs-wqos.pdf (Curtis Island, Calliope River and Boyne River Basin Environmental Values and Water Quality Objectives)

Table 6. Surface water monitoring locations

Monitoring Locations	Receiving waters location description	Easting (GDA2020 / MGA zone 56)	Northing (GDA2020 / MGA zone 56)
Upstream monitoring locations			
US1	Upstream tributary to Raggote Creek	320328.5	7334828
US2	Upstream tributary to Raggote Creek	320144.8	7334740
US3	Upstream Raggote Creek	319837.7	7334044
Downstream monitoring locations			
DS1	Downstream Raggote Creek (exit from ML in the northwest)	320062.3	7333792
DS2	Downstream Raggote Creek (exit from ML in the southwest)	320157.3	7331482
DS3	Downstream tributary to New Zealand Gully	321173.8	7334729
DS4	Downstream tributary into Lake Awonga	321547.3	7334039
DS5	Downstream tributary into Lake Awonga	321409.1	7333890
DS6	Downstream tributary into Lake Awonga	321348.1	7333439

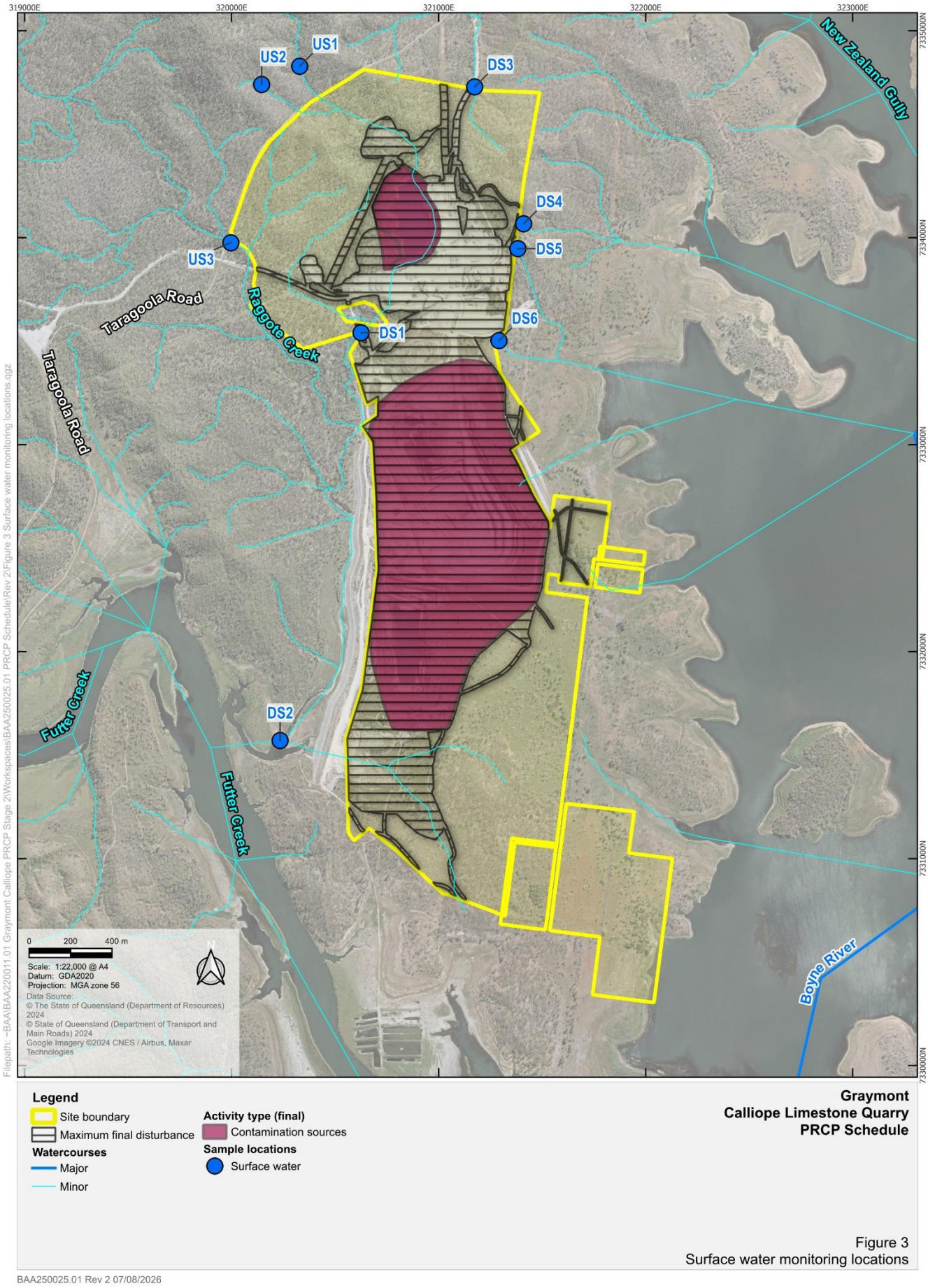


Figure 3. Surface water monitoring locations

Table 7. Groundwater monitoring Bore locations

Monitoring bore	Hydrogeological Unit	Location	
		Easting (GDA2020 / MGA zone 56)	Northing (GDA2020 / MGA zone 56)
FM5	**Limestone Aquifer**	321430.6541	7332651.421
FM5b	**Andesite Aquifer**	321432.0776	7332658.128
FM6	**Andesite Aquifer**	321080.6545	7334350.421
FM7	**Limestone Aquifer**	321133.7934	7333730.139
FM8	**Volcanic**	321546.5801	7332636.828
FM9	**Volcanic**	320721.6894	7332516.483
FM10	**Volcanic**	320542.8698	7333666.417
FM11	**Volcanic**	320703.8191	7332099.299
FM12	**Volcanic**	320459.3772	7331326.934
FM13	**Volcanic**	321526.2118	7331832.704

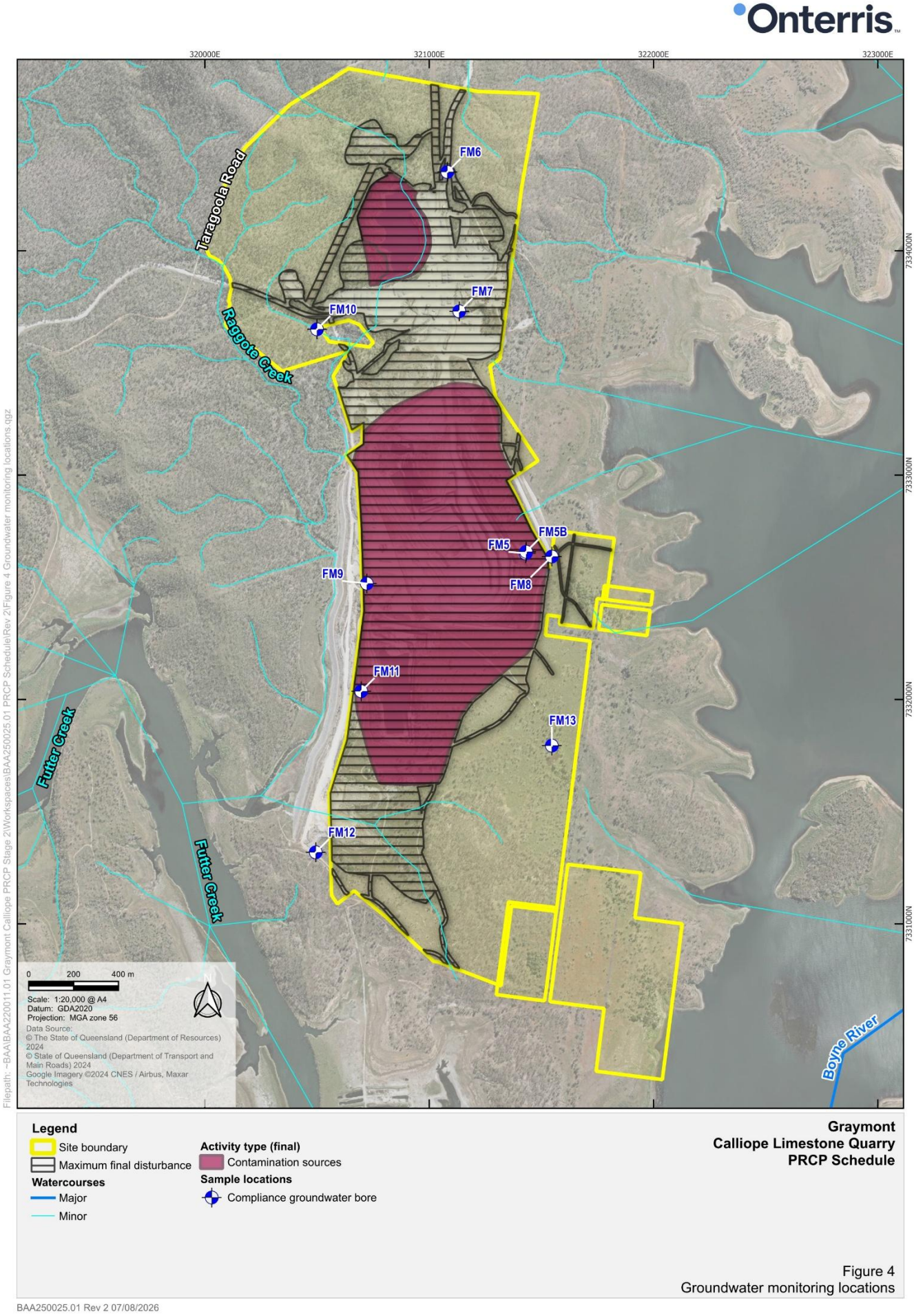


Figure 4. Groundwater monitoring locations.

Table 8. Groundwater quality Limits

Quality characteristic (units)	Limit	Comment on limit
pH	6.5-8.0	Boyne WQO groundwater Zone 10 moderate depth
Electrical Conductivity (µS/cm)	1,225	Boyne WQO groundwater Zone 10 moderate depth
Sulfate (mg/L)	38	Boyne WQO groundwater Zone 10 moderate depth
Arsenic – Dissolved (µg/L)	13	ANZG2018
Cadmium – Dissolved (µg/L)	0.2	ANZG2018
Chromium – Dissolved (µg/L)	1	ANZG2018
Cobalt (µg/L) – Dissolved (µg/L)	1.4	ANZG2018
Copper – Dissolved (µg/L)	1.4	ANZG2018
Lead – Dissolved (µg/L)	3.4	ANZG2018
Mercury (µg/L) – Dissolved (µg/L)	0.06	ANZG2018
Nickel (µg/L) – Dissolved (µg/L)	11	ANZG2018
Selenium (µg/L) – Dissolved (µg/L)	5	ANZG2018
Uranium (µg/L) – Dissolved (µg/L)	0.5	ANZG2018
Zinc – Dissolved (µg/L)	8	ANZG2018
Total recoverable hydrocarbons (C6-C9) (µg/L)	20	
Total recoverable hydrocarbons (C10-C36) (µg/L)	100	
Major ions (mg/L) Calcium, chloride, potassium, magnesium, sodium, bicarbonate, carbonate	For interpretation purposes	
Hardness (mg/L)	For interpretation purposes	
Water Level (mAHD)	For interpretation purposes	

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)
- ANZG (2018) To account for the bioaccumulating nature of selenium, it is recommended that the 99% species protection level DGV is used for slightly to moderately disturbed systems.
- WQO - https://environment.des.qld.gov.au/__data/assets/pdf_file/0034/87775/boyne-calliope-curtis-evs-wqos.pdf (Curtis Island, Calliope River and Boyne River Basin Environmental Values and Water Quality Objectives)

Table 9. Open woodland BioCondition milestone benchmarks) for RA8 and RA9

Bio-Condition Assessable Attributes	BioCondition Assessable Attribute Weighting	Reference site benchmark for Open Woodland	Modified benchmark for RM9	Modified benchmark for RM11
Tree canopy height (m)	**5**	18m	4.5m ≥70% of benchmark height	≥10.2 m9m
Recruitment of canopy species (% of trees)	**5**	100	100 ≥75% of benchmark canopy species recruitment	100 ≥75% of dominant canopy species recruiting
Tree canopy cover (%)	**5**	35%	10% 50-200% of benchmark tree canopy cover	17% 7.8-21% canopy cover
Shrub canopy cover (%)	**5**	3%	1% 50-200%	2% 3.7-14.6% shrub canopy cover
Tree (native) species richness	**5**	4 species	3 species≥90% of benchmark tree (native) species richness	3 species ≥2 tree (native) species richness
Shrub (native) species richness	**5**	3 species	1 species ≥90% benchmark of shrub (native) species richness	1 species ≥8
Grass (native) species richness*	**5**	7 species	4 species ≥90% benchmark of grass (native) species richness	4 species ≥8
Forb/other (native) species richness*	**5**	12 species	5 species ≥90% benchmark of forb/other (native) species richness	5 species ≥9
Non-native plant cover (%)	**10**	0	<5% non-native plant cover	<5%
Native perennial grass cover (%)	**5**	445%	10% ≥90% benchmark of native perennial grass cover (%)	22% ≥36.4
Organic litter cover (%)	5	123%	5% 50-200% of benchmark tree canopy cover	10%
Total	**60**		**20/60**	**40/60**

Table 10. Grassland BioCondition milestone benchmarks for RA1, RA2, RA4, RA5 and RA7

Bio-Condition Assessable Attributes	BioCondition Assessable Attribute Weighting	Reference site benchmark	Modified benchmark for RM9	Modified benchmark for RM11
Grass (native) species richness	5	5	5 ≥90% benchmark of grass (native) species richness	5 ≥5
Forb/other (native) species richness	5	2	4 ≥90% benchmark of grass (native) species richness	4 ≥2
Non-native plant cover (%)	10	0	<5% non-native plant cover	<5%
Native perennial grass cover (%)	5	75	≥90% benchmark of native perennial grass cover (%)	≥67.5%
Organic Litter Cover (%)	5	10	50-200% of benchmark tree canopy cover	5-20%
Total	30		10/30	20/30

Table 11. Reference sites

Reference site	Ecosystem	Location	
		Easting (GDA2020 / MGA zone 56)	Northing (GDA2020 / MGA zone 56)
R1	**Open Woodland**	**320394.1765**	**7334528.709**
R2	**Grassland**	**321186.4762**	**7331779.676**

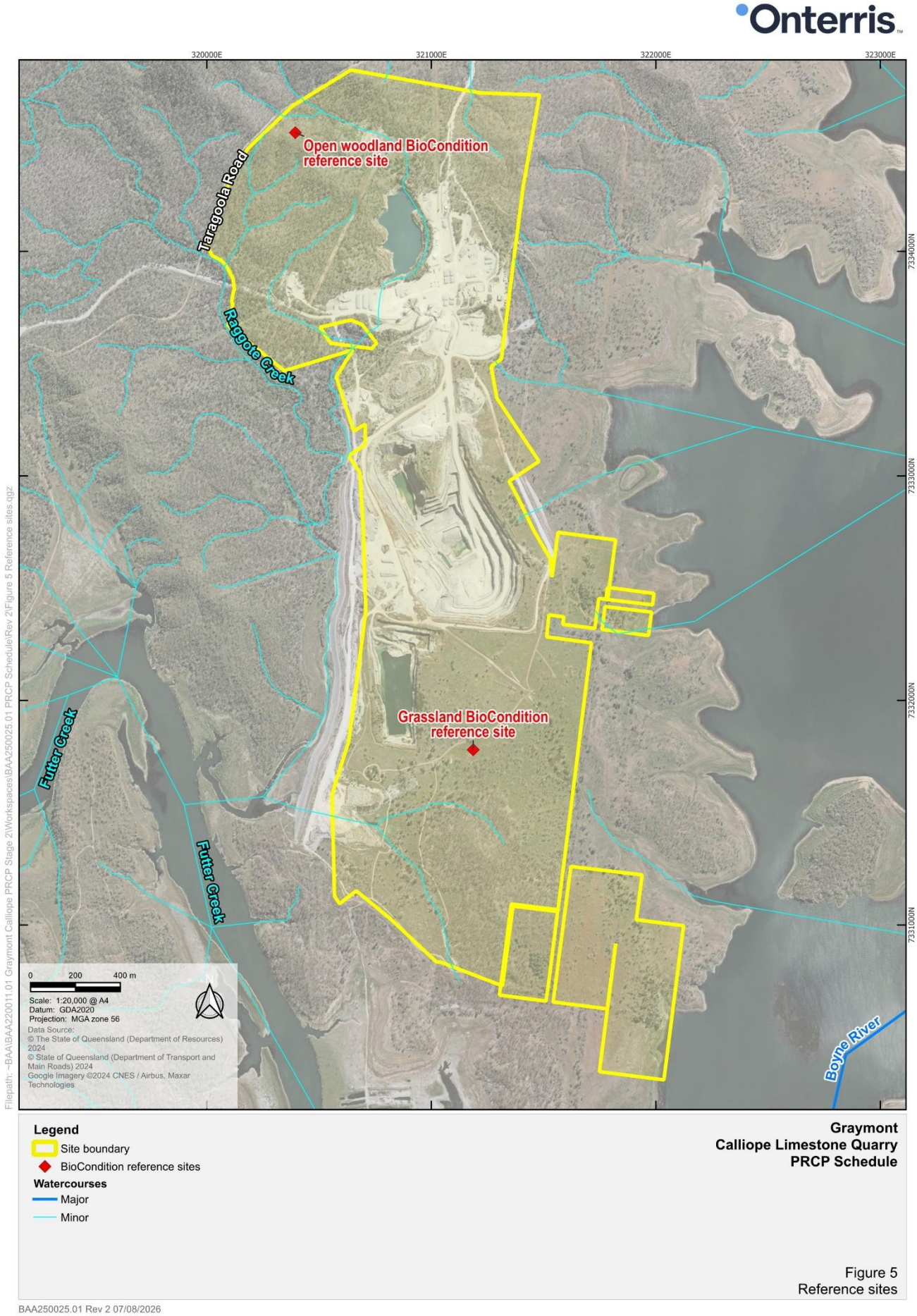


Figure 5. Reference sites

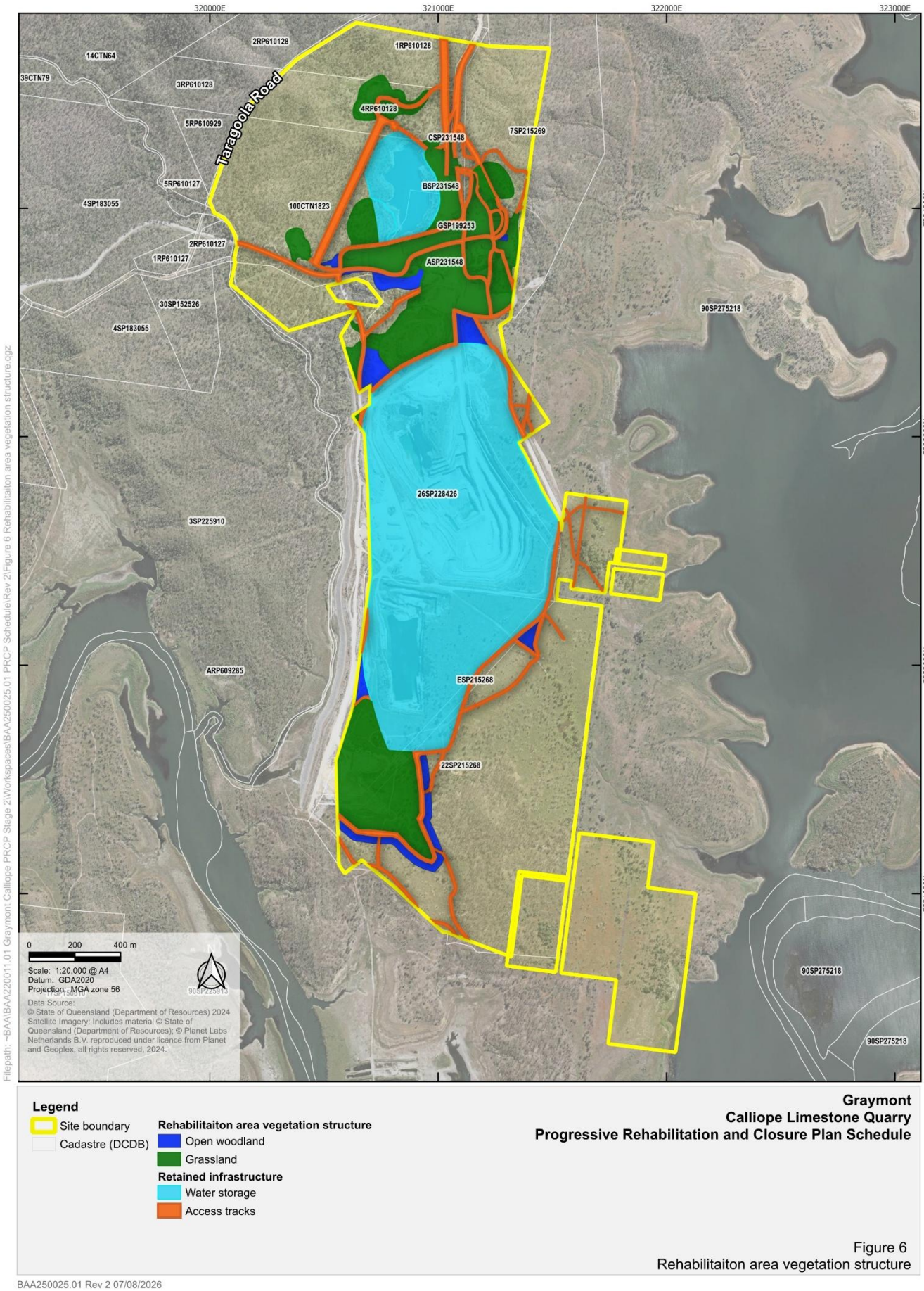


Figure 6. Rehabilitation area vegetation structure

END OF PRCP SCHEDULE

Appendix B Geotechnical Assessment

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18 May 2026

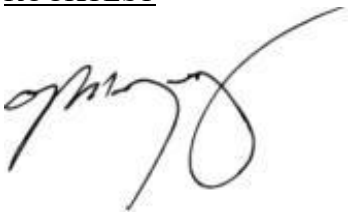
Maxime Descôteaux
HSE & Corporate Affairs Manager
Graymont Australia Pty Ltd
Level 9, 118 Mount Street
North Sydney, NSW, Australia 2060

Dear Maxime,

Calliope Progressive Rehabilitation and Closure Plan (PRCP) - Pits and WRD: Geotechnical

The attached report addresses geotechnical issues relevant to the PRCP for the Calliope Mine. I trust it provides the information you require. Please contact this office if you wish to discuss any aspect of it or require further assistance.

For and on behalf of
ROCKTEST



Tony Meyers
BE (Mining) PhD (Rock Mechanics), MAusIMM (CP Mining Geotech), MIEAust (CPEng), RPEQ (Mining)
Principal Rock Mechanics Engineer

CALLIOPE MINE PRCP PITS AND WRD: GEOTECHNICAL V2.0

for

GRAYMONT

DOCUMENT CONTROL

Project	Calliope Mine PRCP
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DOCUMENT APPROVAL

Signature 

Approval Tony Meyers

Position Principal Rock Mechanics Engineer

Date 18 May 2026

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ACRONYMS

AQP	Appropriately Qualified Person (e.g., qualified geotechnical consultant)
BGL	Below Ground Level
FoS	Factor of Safety
EOML	End of Mine Life
GCMP	Ground Control Management Plan
GLE	General Limit Equilibrium method of slope stability analysis
PGA	Peak Ground Acceleration
PoF and P_f	Probability of Failure
PRCP	Progressive Rehabilitation and Closure Plan
RL	Relative Level
SWL	Standing Water Level
WRD	Waste Rock Dump

1 INTRODUCTION

1.1 Background

This report considers geotechnical issues[1] applicable to the Progressive Rehabilitation and Closure Plan (PRCP) for the final landforms at the Calliope Mine. The landforms considered are two open-cut pits, Pit 2 and Pit 3-4 and the southern waste rock dump[2], referred to in this report as the WRD. The requirements of the PRCP, as outlined by the Guideline prepared by the QLD Department of Environment and Science[3], are that it details the strategies that will ensure the stabilities of the landforms will be acceptable during the post mining land use.

The project was undertaken by Rocktest at the request[4] of Graymont Australia Pty Ltd (Graymont).

1.2 Requirements in the PRCP

Consistent with the requirements of the PRCP in regard to the pits, this document discusses the:

- locations and specifications i.e., depths, lengths, widths, overall slope angles, bench specifications,
- methods of construction, with 3D design plans,
- soil/rock characteristics,
- geotechnical conditions (i.e., soil/rock characteristics),
- geotechnical stabilities of the walls, considering the effects of long-term erosion and weathering and the effects of significant hydrological events,
- rehabilitation strategies.

Consistent with the requirements of the PRCP in regard to the WRD, this document discusses the:

- location and specification i.e., height, length, width, overall slope angles, bench specifications,
- method of construction with 3D design plans,
- soil/rock characteristics,
- geotechnical stabilities of the slopes,
- settling and subsidence over time,
- rehabilitation strategy.

1.3 Terminology

Time periods referred to in this report are:

- Short-term: < Five years
- Medium-term: Five years to EOML
- Long-term: Post mining land use

---

[1] This report considers geotechnical issues only. Surface and subsurface hydrology issues and environmental issues are considered only where relevant.

[2] Two WRDs are on site at the current date, a northern and a southern dump. The northern dump will be removed during the medium to long term, prior to the EOML. Hence, at the EOML, only the southern dump will be a component of the final landform. As this report considers the landforms at the EOML, the terms WRD and dump refer to the southern dump only.

[3] Guideline – Progressive rehabilitation and closure plans (PRC plans) ESR/2019/4964, Version 2.00, Last reviewed: 17 March 2021.

[4] Phone call to T. Meyers of Rocktest from E. Ashong of Graymont, 28 February 2022.

2 LOCATION AND GENERAL LANDFORM CHARACTERISTICS

The landforms at the Calliope mine at the EOML will comprise two pits and a waste rock dump (WRD). Figure 1 shows their final footprints. Pit 2 is the small northernmost pit, which will not be mined between the current date and the EOML. The large pit, Pit 3-4, will be mined prior to then. This pit will comprise an amalgamation of the current Pits 3 and 4.

The landforms are on a low north-south trending ridge separating Awoonga Dam on the Boyne River to the east from its tributary, Futter Creek, to the southwest, and its tributary Ragotte Creek to the west (Figures 2 and 3). Ragotte Creek is ephemeral. Futter Creek has permanent water. Its maximum depth, and that of the water in the lake, is controlled primarily[5] by the height (i.e., 40 mRL) of the spillway of the Awoonga Dam.

Pit 2 is within a natural contour high that prevents it from being inundated during floods.

The likelihood for Pit 3-4 to flood is reduced by two levees, the Western and Eastern levees (Figures 4 and 5), and by natural contour highs to the north and east of the pit. The lowest point on the upper surfaces of the levees is at 52 mRL, which is significantly higher than the spillway.

3 GEOLOGY

3.1 General Characteristics

The Taragoola limestone deposit occur within the Early Devonian age (419-Ma) Calliope Beds. The Beds occupy a north-northwest striking belt about 40 km long and 3 to 4 km wide. They comprise predominantly volcanic rocks with relatively minor inter-bedded sedimentary rocks, including limestone. The rocks have been subjected to folding and faulting.

Overburden consists of a shallow cover of soil. Boulders and cobbles of limestone and volcanics occur in much of this layer.

Predominantly limestone underlies the overburden in the area that includes the mine. Discontinuities within the limestone are clay filled to a depth up to approximately 15 mBGL. Karst features are prevalent to approximately this depth. Below this depth, karst and infill becomes less prevalent and the apertures of the discontinuities become tight.

Bedding surfaces within the limestone generally dip very steep towards the west, a characteristic consistent with the regional structure. The major axes of the pits are parallel to the strikes of the beds.

The volcanics exposed in the walls of the pits include predominantly basic basalt and intermediate olive green andesite (Figure 6).

- The basalt occurs as lava flows. It is exposed primarily in the upper benches of the east and south walls of Pit 4. It is dark grey, has high to very high strength and is slightly weathered.
- The andesite generally occurs as steep dipping dykes that follow vertical to sub-vertical bedding and joints within the limestone. The two dominant systems of the dykes strike north-north-west and east. The widths of the dykes range from stringers to a few metres. Reduced vertical stresses at shallower depths

[5] The width of the spillway is also relevant under flood conditions.

have allowed the andesite to also extrude along shallow dipping joints. The andesite has high to very high strength and is moderately to slightly weathered.

The volcanics comprise less than 5% of the total rockmass below the second bench (i.e., <27 mRL). Combined with their high strengths, and discontinuity characteristics no less favourable to wall stabilities than those within the limestone, the volcanics have insignificant influence on the stabilities of the walls. Their influence is not therefore considered specifically in this report.

3.2 Soil

3.2.1 Characteristics

The thickness of the soil overlying the limestone generally ranges between 1 m and 4 m (Figure 7).

- The upper horizon is ≈0.2 m thick. It comprises red to red-brown, Terra-Rosa, clay loam, medium plasticity, moist, soft, medium dense, and weakly cemented. It contains some to many smooth to angular gravels to boulder sized rocks. The rocks comprise weathered limestone and volcanics from 10 mm to 100 mm sizes. This horizon is ignored in the stability analyses in Sections 6 and 7 as it is thin, hence has no significant influence on the stabilities of the upper benches of the pit. And it is stripped from below the footing of the waste rock dump and stockpiled.
- The lower horizon comprises light to medium, yellowish brown, silty clay, low plasticity, dry, firm to stiff, medium dense, and weakly to moderately cemented. It contains many angular gravels to boulder sized rocks. The rocks comprise weathered limestone and volcanics from 10 mm to 300 mm sizes. The average shear strength of the material is defined[6] in the stability analyses in Sections 6 and 7 in terms of a conservative friction angle of 25^{o} and a cohesion of 50 kPa.

3.2.2 Soil Management

The depth of in-situ soil is generally shallow (<2 m). Hence, soil stripping and handling prior to the EOML requires:

- retaining the depth of soil where possible,
- minimising the total area from which soil is stripped,
- stockpiling all soil stripped.

The stability of the stockpiled soil is to be maintained by:

- maximising the height of the stockpile to below 3 m,
- maintaining the slopes of the stockpile at less than 3H:1V,
- vegetating the slopes,
- installing sediment fences and/or up contour diversion bunds,
- re-using the soil as soon as practical.

[6] The shear strength of the soil is estimated, based on the characteristics of the materials.

3.3 Limestone

3.3.1 Intact Rock Characteristics

The intact limestone is fine grained and recrystallised due to regional metamorphism. It is light to dark grey but can be various colours (e.g., pink, red, pale brown). It can be vitreous or mottled. It is even textured. It can have occasional ferruginous bands. It can be iron stained on discontinuities.

At depths exceeding ≈15 mBGL, the limestone is moderately-weathered to fresh with high to very high strength (ave. 65 MPa) and an average density of 25.8 t/m^3 (refer Appendix 1). At shallower depths, and adjacent to faults and karst structures, the surfaces of individual rocks tend to be highly weathered. However, their cores may be only slightly weathered, hence their strengths can be similar to those of the unweathered[7] rocks. The strengths progressively decrease as the depths of weathering into the cores increase. During the long term, the rocks become extremely weathered gravels of medium to high strength, then become residual sands and silts. The shear strength of the sediments is defined in the stability analyses in terms of a conservative friction angle of 34^{o}[8].

Most of the weathered[9], and all of the unweathered, limestone has sufficient strength and durability for it to be suitable for use as erosion control cover. Only the extremely weathered rocks are not suitable for use as cover, although these rocks are non-typical.

3.3.2 Discontinuities

The surfaces of the discontinuities (i.e., joints, bedding) are generally smooth. At depths exceeding ≈20 mBGL, they are tight, clean, and unfilled. At shallower depths in the upper benches, they can be dilated due to stress relaxation, karst, and weathering. When dilated, they are generally filled with either lava or hard clay. The clay can influence the stabilities of the upper benches. Maintaining their stabilities over the long-term will require reducing the batter angles of the applicable sections of the benches.

Analysis of data obtained from discontinuity mapping (Figure 8) indicates that most discontinuities can be assigned to one of 6 sets[10] (Table 1). Set 1 contains bedding-parallel cleavage, which is the dominant fabric. Sets 2 to 6 contain joints. Based on the mean orientations of each set, discontinuities within:

- Set 1 dip very steep[11] generally towards the west but can be overturned and dip east,
- Set 2 dip very steep generally towards the southeast but can be overturned and dip northwest,
- Set 3 dip very steep generally towards the south but can be overturned and dip north,
- Set 4 dip moderate towards the southwest,
- Set 5 dip shallow to moderate towards the northeast and east,
- Set 6 dip very steep generally towards the southwest but can be overturned and dip northeast,
- Set 0 are random discontinuities having no preferential orientations.

---

[7] "Unweathered" rocks that shows little of no change in strength from fresh rocks. The term includes fresh rocks and rocks that are moderately weathered and slightly weathered.

[8] The friction angle of the sediments is based on the angle of repose of fines and gravels in the WRD.

[9] "Weathered" rocks have strengths that are significantly reduced from what they were when the rocks were unweathered. The term includes the weathering grades of highly weathered and extremely weathered.

[10] Characteristics based on the orientations of 726 discontinuities within fresh limestone.

[11] Dip terms: Very shallow 0-20^{o}; Shallow 20-40^{o}; Moderate 40-60^{o}; Steep 60-75^{o}; Very steep 75-90^{o}.

The average of the Fisher's constant[12] values (i.e., F_{ave} = 35) applicable to the six sets is moderate. This characteristic is generally indicative of a rockmass not having been significantly deformed. However, the high proportion of random discontinuities[13] (i.e., R_p = 28%) is typically indicative of a rockmass having been significantly deformed, which is consistent with the tectonic history of the rockmass. Understanding the tectonic history that resulted in this inconsistency[14] is beyond the scope or requirement of this PRCP.

The mean and maximum trace lengths[15] of the discontinuities within each set are listed in Table 1. Based on these values, the persistences[16] of the discontinuities are generally medium[17] although a small proportion have high persistences. These characteristics have contributed to all instabilities on all walls in Pit 4 having been of bench scale or smaller (e.g., Figures 9, 10 and 11).

The shear strength characteristics of the discontinuities is described in terms of a conservative average peak friction angle of 32° for unweathered limestone, reducing to 18° over the long-term (Appendix 1.4).

Table 1. Characteristics of the sets of discontinuities in the limestone.

Set	*Dip*	*Dip Direction*	*Fisher's constant, F*	*Weighted # logged (% of total)*	*Min/Mean/Max spacing (m)*	*Mean/Max trace lengths (m)*
1 (cleavage)	89	269	25	438 (25)	0.01/0.31/10.3	1.8/10
2	82	146	51	243 (14)	0.01/0.43/3.0	1.6/8
3	85	175	48	151 (9)	0.01/0.58/2.1	1.4/10
4	44	247	42	128 (7)	0.01/0.25/1.1	0.8/3
5	14	031	19	107 (6)	0.03/0.90/5.4	4.5/10
6	85	222	28	178 (10)	0.01/0.69/4.3	1.5/10
0		n/a	0	486 (28)	0.01/0.35/3.9	1.2/10
			Total	1731 (100)		

3.3.3 Karst

Karst is exposed extensively in the batters of the upper benches of all walls of both pits. The most obvious features are clay filled solution widened discontinuities and caverns (e.g., Figure 12). The widths of these features are generally less than 2 m. Unfilled features are rare. The features are most prevalent to 10 mBGL, although they can extend to 20 mBGL. They have not influenced the strengths of the lower benches in either pit.

Prior to the EOML, the batter angles of sections of the upper benches that contain karst will be reduced to <18°. Soil exposed within karst will be covered with broken limestone to reduce the rate the soil erodes.

[12] Fisher's constant defines how tightly the orientation data within a group are clustered around the mean orientation of that group. Values near o imply parallelism. Values less than 20 imply a highly deviated set of data.

[13] Random discontinuities are those that have no preferential orientation and hence are not assigned to a set. They are sometimes referred to as the isotropic component.

[14] The inconsistency between F_{ave} and R_p may be due to insufficient data having been sampled. The data set is however sufficiently large to characterize the orientation and spacing characteristics of the discontinuities for the purpose of this study.

[15] When the 2D surface of a discontinuity intersects a batter, the line of intersection on the batter is referred to as the trace of the discontinuity.

[16] The persistence is the two-dimensional areal extent of a discontinuity.

[17] Persistence classification: 1-m ≤ Low ≤ 3-m ≤ Medium ≤ 10-m ≤ High ≤ 20 m, Very high >20 m.

3.4 Earthquakes

Geoscience Australia (2018)[18] places Calliope in a zone of low earthquake hazard. The estimated peak ground acceleration (PGA) having a 10% probability of being exceeded in a 50-year period is 0.005g (0.05 m/s^2). The probability corresponds to a 1 in 500 annual return period. There is therefore a 10% probability that an acceleration (A_e) of 0.001g (100/500^{ths} of 0.005g) will be exceeded during a 100-year period.

Several studies have reported on PGA values of 0.2g being required to generate falls of individual rocks from pit walls[19] in low stress conditions as apply at this site. On this basis, PGA values of 0.001g are unlikely to generate many, if any, rockfalls. On this basis, a 100-year event is unlikely to significantly increase the risk to persons within or upon the crest of a wall when an earthquake of this intensity occurs.

Wall scale instabilities being triggered by earthquakes within any pit are rare. Although they are unlikely to do so at this site, the influence of earthquake loading on the stabilities of the walls is considered in the stability analyses in Sections 6.3 and 7.

4 PIT CHARACTERISTICS AND RISK MANAGEMENT

4.1 Background

4.1.1 Pit 1

Pit 1 (Figure 13) was mined prior to 1960. Its final floor was at 46 mRL, which was 6 m above the spillway of the dam. Hence, the floor did not saturate with groundwater.

In 2024, the pit was backfilled to surface with well-graded[20] blasted rock. The material was placed in thin layers (i.e., <30 cm), moisture conditioned then well-compacted prior to placing the next layer. Due to this procedure, the maximum consolidation at the EOML will unlikely exceed 0.1 m[21]. The surface will be used as a laydown crushing area prior to then. Any excess consolidation during the period will be filled back to the level of the natural surface. At the EOML, the surface will be ripped to encourage natural revegetation. The rate of consolidation during the long-term will be insignificantly low and the area will be safe and stable.

4.1.2 Pit 2

Pit 2 (Figure 14) was mined from the mid-1960s until the mid-1970s. It is currently used for water storage. It will continue to be used for this purpose after the EOML.

4.1.3 Pits 3 and 4

Pit 3 was mined from the mid-1960s until the mid-1970s. Pit 4 was begun in 1976 and has been mined since then. The two pits will be combined into a single pit, Pit 3-4, prior to 2030. This pit will be mined until the EOML. As currently occurs in Pit 4, ore-grade limestone will be hauled to the ROM pad north of the pit from where it will be transported off site. Low-grade limestone and limestone contaminated with clay or volcanics will be hauled to the WRD south of Pit 3 (Section 5).

---

[18] Geoscience Australia (2018) The 2018 National Seismic Hazard Assessment for Australia. (Editor. Allen, T.) Page 10.

[19] Rockfalls have been reported for PGA values of 0.16g in pits where discontinuities contain significant joint pressures.

[20] The sizing of the backfill material ranges from sand to boulder sized rocks up to 30cm.

[21] Consolidation is estimated using the method of Kermani, M. and Konrad, J.M. (2018) *In-situ short-term and long-term rockfill compressibility as a function of void ratio and strength of parent rock*. Jnl. Geotechnical and Geoenvironmental Engineering, April.

4.2 Specifications

4.2.1 Pit 2

Figure 15 shows cross sections through the highest section of each wall of Pit 2. Their specifications are listed in Tables 2 and 3. The pit is shallow, the walls being less than 37 m high. Their stabilities are considered in Section 6.3.

4.2.2 Pit 3-4

Figures 2 and 3 show the elevations of Pit 3-4 at the EOML. It will have an approximately rectangular circumference with a major axis trending north-south. Figure 16 shows cross-sections through the highest section of each wall. Their specifications are listed in Tables 2 and 3.

Water seeps sporadically from the western and eastern walls of Pits 3 and 4 respectively. The locations of seepage are highlighted in Figures 19 and 20, and are listed in Table 4. Seepage is expected to continue to occur from these locations in Pit 3-4. A hydrogeological study[22] concluded that the seeping water originates in Awoonga Dam and its tributaries. The flows likely occur within permeable sediments between the sources and the walls and within karst voids. They may also occur along east-west striking joints with solution widened apertures. The rates of seepage are functions of the heights of water in the sources (Table 5). No evidence has been observed to indicate the flows have contributed to hydrostatic pressures sufficiently large to reduce the stabilities of the respective sections of either wall. Nonetheless, the influence of groundwater on the stabilities of the walls is considered in stability analyses in Section 6.3.

Table 2. Specifications of the pits at the EOML.

Dimension	*Pit 2*	*Pit 3-4*
Trend of major axis	168°	178°
Length of major axis at crest	435 m	1700 m
Average length of minor axis at crest	235 m	650 m
Maximum heights of walls	37 m	117 m
Heights of benches	none	12 m
Maximum number of benches	1	9
Widths of berms	n/a	10 m
Height of edge bund on berms	n/a	1 m
Batter angles in unweathered rocks	75°	65°
Batter angles in weathered rocks	≤18°	≤18°
Overall slope angles	≤34°	≤38°

[22] Graymont Mining Services (2021) Calliope: Hydrogeological Investigation of Excess Water in Pit 3 2018-2020. 27 pages.

Table 3. Dip directions of the walls of the pits at the EOML.

Pit	*North (South dip)*	*South (North dip)*	*East (West dip)*	*West (East dip)*
2	139°	303°	243°	086°
3-4	151°	306° to 355°	240° to 295°	082°

Table 4. Locations of water seeps in Pit 3-4.

Wall	*Easting*	*Northing*	*RL*
West	320785	7331969	32-35
East	321284	7332811	28-40

Table 5. Likelihood of seepage for various RLs of water in Awoonga Dam.

Dam Level (mRL)	*West Wall*	*East Wall*
<40	negligible	none
40 to 42.5	low	none
>42.5	progressively increasing	

Prior to the EOML, the pit will be partially backfilled with waste material generated from mining, processing, removal of the northern WRD, and reprofiling of the southern WRD. The backfill will be spread over the largest area of the floor practical, abutting the adjacent toes of the walls. As such, it will provide minor support to these sections of the walls. The backfill will not be required to be engineered as the stabilities of the sections of the walls are not dependent on support, the backfill will be confined, it will not be required to support significant applied vertical loads, and it will form the floor of a pit lake.

4.3 Risk Management Strategies for the Pits at EOML

After the EOML, the key geotechnical related considerations required to be managed will be:

- Pit wall stability, particularly failure of multiple benches or an overall slope, actions which could result in retreat of a crest.
- Erosion of a crest of a pit wall due to typical surface flows or flows due to an extreme flood event.
- Public access to and around the pits.

Strategies to be implemented to achieve these outcomes are:

- Install abandonment bunds with warning signs behind the crests of the pits. Offset the bunds the appropriate distances behind the crests (Section 4.4).
- Reduce to <18° the batter angles of sections of the upper benches that comprise extremely weathered rocks and soil filled karst. Cover the stripped ground with broken rocks to reduce the rate of erosion.
- Restrict public access to and around the pits by ripping all unrequired access routes around the site and to the pits and the ramps within the pits.
- Adhere to the requirements of the completion criteria (refer Section 8).

- Visually monitor the performances of the walls of the pits prior to the EOML (refer Section 9). Be prepared to modify their designs if their performances do not comply with the completion criteria.

4.4 Abandonment Bund

4.4.1 General Requirements

The final landform will include an abandonment bund (Figure 17) behind the crest of each wall of each pit to:

- prevent inadvertent access to the crests by vehicles, and restrict access by motorbikes and persons on foot,
- provide areas between the crests and the bunds that are sufficiently clear and flat to enable evidence of crest retreat to be observed during inspections and to enable access by equipment for remediation.

In lieu of Queensland specific guidelines on abandonment bunds, the recommendations in the Western Australian Guideline (1997)[23] will be applied. Their intentions are for a bund to:

- be installed behind the crest of each wall beyond potential failure zones,
- encircle the pits with no gaps other than where locked gates provide restricted access through a bund,
- be obvious,
- have sufficient height to restrict access,
- have sufficient longevity to remain functional for the long-term[24].

The specifications of the bunds are indicated in Figure 18. They will have a 1 m high core of compacted clayey soil. They will be sheeted in unweathered crushed limestone to a minimum height of 2 m. They will not be vegetated to aid their inaccessibility. Their specifications are to be:

- Total height: 2 m (minimum)
- Footing width: 4.3 m (minimum)
- Slope angles: Cover: 1.1H:1V (45^{o}) Core: 1.3H:1V (38^{o})
- Cover: Well-graded coarse unweathered limestone of +25 mm
- Core: Well-compacted, well graded, clayey sand and/or sandy clay.

4.4.2 Offsets from the Crests

The Guideline recommends bunds be offset a minimum of 10 m behind the point at which a construction line from the toe of a wall intersects the natural ground surface behind the wall. The line is to be orientated at 45^{o} in unweathered rocks and 25^{o} in weathered rocks. On this basis, the minimum offsets are those listed in Tables 6 and 7.

Stability analyses (Section 6.3) indicate that the scarp of a large scale instability is unlikely to develop more than a few metres behind the crest of any of the walls. This understanding is consistent with the historical performances of the walls in Pits 2, 3 and 4. On this basis, the offsets in the table are the minimum distances the bunds are to be placed behind the crests. Their actual locations will be established prior to the EOML, informed by the performances of the walls prior to then and the locations of the lease boundaries.

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[23] Government of Western Australia Department of Industry and Resources (1997) *Safety Bund Walls Around Abandoned Open Pit Mines: Guideline*. MOSHAB Approved. Document No: ZMA048HA. 14 pages.

[24] A bund remains in place for the long-term with negligible maintenance whereas a fence can deteriorate within 10 to 15 years if not maintained.

4.4.3 Construction

The cores of the bunds are to be constructed by placing the specified material in a thin layer (i.e., <30 cm), moisture conditioning the material, then well-compacting the layer prior to placing the next layer. The process is to be repeated until a height of approximtely 1 m is achieved. Doing so will aim to achieve the maximum practical compaction. The crushed rock sheeting will be end dumped or placed over the core to achieve an approximate total height of 2m.

Table 6. Minimum abandonment bund offsets from the crests of the walls of Pit 2.

Wall	*Height of Wall (m)*	*Overall Slope Angle*	*Weathering Depth (m)*	*Minimum Offset (m)*
North	31	36°	31	34
South	16	38°	16	24
East	21	35°	21	25
West	37	36°	37	38

Table 7. Minimum abandonment bund offsets from the crests of the walls of Pit 3-4.

Wall	*Height of Wall (m)*	*Overall Slope Angle*	*Weathering Depth (m)*	*Minimum Offset (m)*
North	105	38°	20	10
South	107	30°	20	10
East	105	26°	20	10
West	116	38°	20	10

4.5 Pit Water Management During Typical Conditions

Under typical conditions, inflows to Pit 3-4 will comprise predominantly runoff from the walls, groundwater inflows, and direct impact by rainfall.

After the EOML, inflows will no longer be pumped out of the pit. The pit is a passive hydraulic sink, hence the level of water within it will subsequently increase progressively to form a pit lake. The upper surface of the lake will stabilise at an elevation at which the surface area of the lake is sufficiently large for losses due to evaporation and other outflows to equate to inflows. This elevation will be similar to those of the water in Awoonga Dam and its tributaries, although there will be time lags for the levels to equate.

The lake will be contained within predominantly unweathered limestone exposed on the lower batters of the pit walls. These rocks are durable[25], hence repeated cycles of wetting and drying will not significantly reduce their strengths. Hence, significant progressive loss of the support these rocks provide to the toes of the walls is unlikely to occur during the long term.

Stability analyses discussed in Section 6.3 indicate that the water in the pit will not reduce the stabilities of the walls. The water will negate any deleterious effects[26] of excess hydrostatic pressures on these stabilities due to flows of water through the walls into the pit. The exception could be if the level of the water is

[25] Slake durability tests indicate the limestone has a 2nd stage durability index exceeding 95%.

[26] No deleterious effects have been observed, and none are expected after the EOML.

reduced (i.e., drawn down) rapidly. The resulting pressure differentials either side of rocks that were below the original level of the water could result in some rocks displacing towards the pit. However, this action is unlikely as there is no conceivable method by which a rapid draw-down will occur.

4.6 Overland Flows Around the Pits

The areas around the pits between the two levees and the natural contour highs to the north and east of the pits are relatively flat. Most water that falls during heavy intensity and/or long duration rainfall events pools in contour lows on the surfaces. A very small proportion of the water flows down ramps into the pits. After the EOML, the abandonment bunds around the pits (refer Section 4.4) will modify the rates and directions of these flows. So too will ripping the areas between the bunds and the crests of the walls and ripping the surfaces of the ramps. The result of these actions will be a significant reduction in the proportion of the total volume of water that falls during rainfall events flowing into the pits.

4.7 Management of Flood Events

Historical evidence indicates that the eastern and western levees, and natural contour highs north and east of the site, prevent the walls of the pits being overtopped by flood water during most flood events that originate from Awooga Dam and its tributaries. However, a rare Peak Maximum Flood (PMF) event could result in some sections of some walls being overtopped (Figure 21). Experience in Pit 4 provides evidence that these events do not cause significant instabilities of rocks exposed in those batters over which water flows. However, soil within karst exposed in the upper batters can erode, which could result in gully erosion to the depth of the karst. The strategies required prior to the EOML to prevent these occurrence in areas of soil and soil filled karst are:

1. Reduce, to less than 18^{o} , the batter angle in sections of the upper benches that comprising soil.
2. Create a shallow V-drain in areas of extensive and/or deep soil filled karst to channel water down the centreline of the karst (Figure 22).
3. Sheet soil with a minimum 0.5 m thickness of well graded durable rocks of +0.25 mm size. Spray the rocks with a cementitious binder of sufficient strength and quality to reduce the likelihood of those rocks that form the bed of the drain from detaching during flows.
4. Inspect drains and, if necessary, repair damage after flood events.

Additional flood modelling prior to the EOML will ascertain whether additional strategies may be required to further reduce the likelihood of water overtopping of the walls.

As flood water subsides, the levels of water in the pits will reduce as water evaporates and/or dissipates into the surrounding strata. The level in Pit 3-4 will eventually stabilise at the level of water in Awoonga dam and its tributaries.

5 SOUTHERN WASTE ROCK DUMP (WRD)

5.1 Background

The southern WRD is of the sidehill fill type. The materials within it comprises low-grade limestone, limestone contaminated with clay, basic volcanics, and crusher fines.

The dump was constructed on a natural slope that dips shallow (57H:1V) towards the west. Prior to placing waste material, the thin layer of clay loam topsoil was stripped from the natural surface to achieve a relatively flat footing comprising bouldery silty clay. The clay has a shear strength greater than that of the topsoil.

Lifts of the dump have traditional used a top down method. Trucks have end dumped material near the crests. A dozer has spread and compacted some of the material on the upper surface and pushed the remainder of the material over crests where they were compacted. The slopes were advanced in the same directions as the topography. Ongoing construction will involve a bottom up method required to achieve good compaction.

The dump will be temporarily constructed to a height up to 100 m and with steeper than final slopes due to limited capacity in the dump. The dump will be regraded at the end-of-mine life to achieve final slopes of 12% (6.8^{o}) and a maximum height of 25 m. Excess material will be pushed into the southern end of Pit 3-4.

No significant drainage paths will be blocked by the final footprint of the dump. A drain will be constructed along the toes of the south and east slopes to mitigate ponding. The drain is required to intercept water flows from the footing of the dump and overland flows from the east and south and convey them to the north into Pit 3-4.

5.2 Specifications

Figure 2 shows the proposed final elevation of the dump at the EOML. It will be approximately rectangular, with the specifications listed in Table 8 and highlighted in Figure 25.

Table 8. Specifications of the WRD at the EOML.

Dimension	*Value*
Trend of major axis	North-south
Length of major axis along footing	560 m
Length of minor axis along footing	345 m
Maximum height of dump	25 m
Maximum overall slope angles	12% (6.8^{o})
Minimum distance of the toe of a slope from a pit crest	10 m
Concave grade on upper levels for drainage	2^{o}

5.3 Managing and Assessing the WRD Slopes at the EOML

After the EOML, the key geotechnical related considerations to be managed will be:

- Geotechnical stability, particularly slumping of a slope potentially resulting in loss of material to the surrounding area (Section 7).
- Erosion, due possibly to failure of vegetation to establish and/or ineffective management of surface flows.

- Undercutting of a toe of a slope due to water pooling at its toe and/or ineffective drainage of water away from the toe.
- Settlement of the upper surface (Section 5.4).
- Public access to and around the dump.

Strategies to be implemented to achieve these outcomes are:

- Construct the cores of the outer slopes in a series of lifts from the bottom up to achieve the maximum practical compaction of the material, thereby providing it with its greatest achievable strength and lowest permeability:
  1. Strip topsoil and vegetation from the natural surface.
  2. Dump waste material in a pile.
  3. Spread the material in a near horizontal layer as thin as practical.
  4. Moisture condition (i.e., damp) the material.
  5. Use repeated passes of equipment to compact the material until no further compaction occurs with additional passes.
  6. Repeat stages 2 to 5 for subsequent lifts.
- Prior to the EOML, regrade the slopes to 12% (6.8^{o}). Begin the work from the upper level. Recompact the material.
- Place a low bund of unweathered rock approximately 2 m behind the crests of the slopes to provide an additional barrier to prevent water shedding over the crests.
- Place a low bund on the western levee to reduce the volume of water that flows off it on to the western slope of the dump.
- Grade the upper surface at approximately 3.5% (2^{o}) to direct water away from the slopes and towards the centre of the dump. Some of this water will evaporate. Some will be retained within voids and pores in the near surface materials from where it will eventually evaporate. Some will migrate into and be retained within the body of the dump. The small proportion of water that subsequently migrates to the footing of the dump will seep from the toes of the eastern and southern slopes.
- Construct a shallow drain, 1 m to 2 m out from the toes of the south and east slopes to intercept seeping water and overland flows. The drain is to be a minimum 2 m wide and 0.5 m deep and have 35^{o} slopes. It will have a shallow gradient ensuring water is conveyed to the north. Line the drain with well graded unweathered rocks.
- Visually monitor the performances of the slopes prior to the EOML (Sections 8 and 9) to ascertain whether they are performing acceptably. Be prepared to modify their specifications and/or undertake earthworks if their performances do not comply with the completion criteria.
- Rip all unrequired access routes to the dump.

5.4 Settlement of the WRD

Settlement of the upper surface of the dump will occur during the long-term as the materials within the dump spatially rearrange to minimise the inter-granular void spaces. This action will be exacerbated by the weight of the materials, by water infiltrating through the dump and by water causing rocks to degrade. Crushing of grains is unlikely to occur at the low vertical pressures that will apply within this relatively low dump (i.e., <25 m).

Settlement will occur slowly as >90% of the materials are high strength and durable; a moderate proportion of which are oversize. Based on a relationship by Kermani (2018)[27], the maximum settlement ΔH during the long-term will be relatively small (i.e., 21 mm ≤ ΔH ≤ 42 mm). This range is insignificant, particularly because no infrastructure will be constructed on any surface of the dump. The associated increases in the bulk densities of the materials due to consolidation will reduce their permeabilities and enhance the stabilities of the slopes. Both actions will reduce the rates of subsequent settlement.

6 STABILITIES OF THE WALLS OF THE PITS

6.1 Rockfalls and Bench Scale Stabilities

The final berms in Pit 3-4 will be 10 m wide, which is sufficient to contain 1 m high edge bunds (

Table 2). The widths exceed the minimum 7 m width recommended by Ryan and Prior (2000[28]) for retention of individual rocks that fall from 12 m high benches. Nonetheless, a series of rockfall simulations[29] (Appendix 5) were undertaken to confirm this understanding. The simulations also highlighted the trajectories of rocks that will detach from the batters during the long term. They confirmed (Figure 23) that these rocks are unlikely to traverse beyond the edge bunds.

Theoretically[30], the largest wedge[31] that could develop in a bench will have a volume and a length along the crest of approximately 265 m^3 and 13 m respectively (Figure 24). Based on relationships of Gibson et. al. (2006[32]), a 10 m wide berm is likely to be sufficient to prevent almost all rocks in a wedge of this volume from traversing beyond the edge bund[33]. Those rocks that do so will be retained on the berm below.

On the bases of empirical evidence, the results of the rockfall simulations and observations of rockfalls in Pits 2, 3 and 4, the final berms are likely to have sufficient retention capacities to control and retain individual rocks and masses of rocks up to bench scale.

The likelihood of a person being below a rock that detaches at the time it detaches is extremely low as access to and into the pits will be restricted, their floors will be lakes and access on to a berm will not possible. For these reasons, the risk applicable to rockfall hazards will be acceptable.

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[27] Kermani, M., and Konrad, J.M. (2018) In-situ short-term and long-term rockfill compressibility as a function of void ratio and strength of parent rock. In *Jnl. Geotechnical and Geoenvironmental Engineering*, April. Figure 3.

[28] Ryan TM and Pryor PR (2000). Designing catch benches and interramp slopes. In *Slope Stability in Surface Mining* (eds WA Hustrulid, MK McCarter & DJA Van Zyl), pp. 27-38. SME. Colorado.

[29] The simulations used the software Rocfall2.

[30] Historically, a wedge of the indicated volume has never formed on any bench in any of the three pits.

[31] A large wedge could comprise many individual rocks.

[32] Gibson, W, de Bruyn, I A and Walker, D J H, 2006. Considerations in the optimisation of bench face angle and berm width geometries for open pit mines, in *Proc. South African IMM Int Symp on Stability of Rock Slopes*, Symp. Series S44 Stability of rock slopes in open pit mining and civil engineering situations, pp. 557 – 579.

[33] The berm width is based on two equations for calculating the required berm width from the wedge failure volumes, which depend on the geometry of the failed material on the berm (conical vs pyramid shape). Assumed is a swell volume of 1.2, volume of wedge of 265 m^3, wedge width along crest of 13 m and 38° angle of repose of the failed rock.

6.2 Inter-ramp Scale Stabilities

No inter-ramp (IR) scale instability has occurred in any of the pits since mining commenced. None is expected to occur after the EOML as the IR angle of the final walls will be less than it is for the current walls . Nonetheless, a series of analyses (Appendix 2) were undertaken for Pit 3-4 to confirm this understanding. An analysis was not undertaken for Pit 2 as this pit is not benched. The analyses indicate:

- Toppling will be the most likely mode of instability in unweathered rocks on all walls (e.g., Figure 11). The mode will involve masses of rocks toppling from discontinuities that dip steeply into the walls. This result is consistent with occurrences in Pit 4.
- Instabilities involving masses of rocks sliding along underlying discontinuities (i.e., planar sliding) or pairs of intersecting discontinuities (i.e., wedge failure) will be less prevalent.

Over the long-term, as weathering reduces the shear strengths of the discontinuities, toppling may become less prevalent and wedge sliding (e.g., Figure 10) may become increasingly more prevalent. These modes will be most apparent in the upper benches within which will be the most weathered discontinuities. They will be less frequent on the lower benches where discontinuities will be less weathered. The relationships between weathering and the modes of instability are consistent with occurrences in Pit 4.

The results of the analyses are listed in Tables A2.1 and A2.2 in terms of likelihood for instability (P_f)[34]. The acceptabilities of these values are assessed by comparing them to values typically considered acceptable in the mining industry. Read and Stacey (2009)[35] recommend maximum P_f values of 20% as a general guide for inter-ramp scale instabilities where the consequence of instability could be “low” to “medium”. These classifications are appropriate due to access into hazardous area by persons during the long-term being significantly restricted, interramp scale breakback at a crest being within the area bounded by the abandonment bunds and no inter-ramp scale instability having occurred in any pit since mining commenced even though the inter-ramp angles have exceeded those that will be applicable after the EOML.

The results from the analyses indicates that the P_f values are approximately 20% or less, hence are within the range of acceptability. On this basis, the proposed bench specifications are likely to be acceptable.

6.3 Wall Scale Stabilities

No instability of wall scale (i.e., wall crest to toe) has occurred in Pits 2, 3 or 4 since mining commenced. Nonetheless, if such an instability was to occur during the long-term it would likely result in a section of the crest of a wall retreating. A series of analyses were therefore undertaken to quantify the likelihood of such an event, and to highlight the likely maximum offsets from the crests of potential surfaces of instability. These offsets inform the area that should be inspected during the long-term for evidence of instability. They also inform the abandonment bund set back to ensure a section of a bund is not subsumed by crest retreat.

[34] The likelihood of sliding quantifies the probability that a particular location on a wall will experience a sliding instability.

[35] Acceptance criteria are listed in Read, J. and Stacey, P. (2009) Chapter 9: Acceptance Criteria. *Guidelines for Open Pit Slope Design*. CSIRO Publications.

Details of the analyses are discussed in Appendix 3. The results indicate:

- A wall scale instability is unlikely to occur during the long-term. This result is consistent with the performances of the walls to date.
- The largest surfaces likely to develop have toes that daylights within weathered limestone in the upper two benches. If a large instability was to occur, it would likely have a toe within, and be limited to, these benches with crest retreat of less than 3 m. Retreat is unlikely to extend to an abandonment bund.
- Water within a pit does not have a significant influence on the stabilities of its walls.

The results of the analyses (Figures A3.4 to A3.8) are quantified in terms of Factor of Safety (FoS)[36] values. Read and Stacey (2009) recommend a minimum FoS of 1.3 under static loading conditions and 1.05 under dynamic (earthquake) loading conditions where the consequence of instability could be "medium". This classification is appropriate for the reasons noted in Section 6.2. The results from the analyses indicate that no wall scale surface in either pit has a FoS value less than 1.5 for both loading states. Hence, the wall specifications are deemed to be acceptable.

7 STABILITIES OF THE SLOPES OF THE WRD

The current slopes of the WRD dip at approximately 33°. No significant instability has occurred within these slopes to date. At the EOML, the slope angles will be reduced to 7°. The likelihood of an instability developing at these angles is significantly less than it is currently. Nonetheless, a series of analyses were undertaken to quantify the stabilities of the highest of the proposed final slopes during the long-term when the rocks within the dump have weathered. The analyses also highlight the likely offsets of the lowest strength surfaces within the slopes. These offsets inform the extents of the areas behind the crests that should be inspected for evidence of instability. Details of the analyses are discussed in Appendix 4.

The results of the analyses are quantified in terms of Factor of Safety (FoS) values for each of hundreds of surfaces within each slope. The surfaces with the lowest capacities are highlighted in Figures A4.1 and A4.2. The results indicate that no slope scale surface has a FoS value less than 4.1 during dynamic loading. The stabilities are greater under static loading.

The acceptability of the stabilities is considered by comparing them to values typically considered acceptable in the mining industry. Subsummation within flowing rocks at the toe of a slope or within a collapsing crest are high consequence events. However, these events are unlikely to occur due to the risk mitigation strategies that will be implemented prior to the EOML (Section 5.3). They are therefore medium risk events[37]. Hawley and Cunning (2017)[38] recommend a minimum FoS criterion of 1.5 under static loading and 1.15 under dynamic loading be considered for these events. The results significantly exceed these criteria; hence the slopes are likely to be acceptably stable during the long-term.

During the long-term, weathering of intact rocks within the dump will create additional fines that will increase the bulk densities of volumes of the materials. Weathering will also reduce the permeabilities of

[36] The Factor of Safety (FoS) is the ratio of the average shear strength of a surface to the average shear stress applied to the surface. A FoS value of less than unity (i.e., 1.0) indicates a 50% or greater likelihood for the surface to be unstable.

[37] Risk classification terms are consistent with AS/NZS ISO 31000-2009 Risk management— Principles and guidelines. Standards Australia

[38] Acceptance criteria are listed in Hawley, M. and Cunning, J. (2017) Chapter 8: Acceptance Criteria. *Guidelines for Mine Waste Dump and Stockpile Design*. CSIRO Publications.

these volumes, which could enable pore water pressures to develop within them. These actions may result in the angles of the slopes reducing progressively during the period. As they do, the slopes will become more stable. Extension of any toe will be negligible due to the design angle being very low; hence will not result in any significant additional geotechnical hazard. Drains and bunds, which will be placed beyond the toes of the slopes, will control individual rocks that could, albeit unlikely, run out due to slope movement.

8 COMPLETION CRITERIA

Table 9 lists the general objectives relevant to geotechnical aspects of the pits and the WRD during the short- to long-terms. Milestone criteria relevant to these aspects are listed in Table 10. The respective landforms will be considered suitable for relinquishment when these objectives and criteria have been met.

Table 9. General Objectives Relevant to Geotechnical Aspects of the Landform

Short-term	*Medium to Long-term*
• Minimise the areas disturbed by limiting clearing to the minimum area required for the operation and by progressively rehabilitating areas as they become available. • Install erosion control measures prior to the commencement of soil stripping and rehabilitation activities. • Strip soil from areas of disturbance only as, when, and where required to reduce the potential for erosion and to minimise the volumes of soil stockpiled and the period of storage. • In preference to stockpiling soil, replace stripped soil directly on to completed sections of the final landform where practical. • Reshape sections of the batters of the upper benches to their final landform as soon as practical so they can be progressively rehabilitated. • Stabilise haulroads, batters of the upper benches of the pits and the slopes of the WRD as soon as practical. • Visually monitor the performances of the walls of the pits and the slopes of the WRD and the surrounding landforms.	• Provide self-maintaining, geotechnically stable and safe landforms that complement the surrounding landforms in terms of slopes, geomorphological characteristics, and postmining land use. • Remediate hazards associated with the pits and the WRD that may increase the risks applicable to persons and/or animals. • Construct the upper surfaces on the WRD to ensure rainfall runoff drains away from the crests of the slopes towards the centres of the surfaces. • Minimise the catchment areas applicable to the pits and the toes of the WRD with up contour bunds and abandonment bunds.

Table 10. Proposed Geotechnical Rehabilitation Milestone Criteria for the Residual Voids and WRD.

Landform	*Rehabilitation milestone reference*	*Rehabilitation milestone*	*Milestone criteria*
Residual voids (Pit 2 and Pit 3-4)	RM3	Landform development and reshaping / re-profiling of residual void	• An AQP[39] has confirmed that geotechnical stability of the residual void walls has been achieved. An AQP confirms that the final landform design intent has been achieved and the walls of the pits conform to the design specifications listed in • Table 2. • Perimeter abandonment bund and safety signage installed and offset from the crests of the pits as specified by an AQP. • Locked gates and signage installed at access points to the residual voids to prevent unauthorised access • AQP certifies that void final landform design intent has been achieved
	RM10	Achievement of post-mining land use to stable condition (water storage)	• Visual inspection by an AQP provides evidence that the stabilities of the residual void crests and walls have remained constant or increased following cessation of mining and rehabilitation activities
WRD	RM4	Landform development and reshaping / re-profiling of waste rock dump.	• As built inspection by an AQP confirms that the final landform design intent has been achieved, and the slopes conform to the design specifications listed in Table 8.
	RM11	Achievement of post-mining land use to stable condition (grazing)	• Visual inspection by an AQP provides evidence that the geotechnical stability of the WRD has remained constant or increased following completion of rehabilitation activities

[39] AQP = Appropriately qualified person (such as a qualified geotechnical consultant)

9 GEOTECHNICAL MONITORING

Calliope's Ground Control Management Plan (GCMP) requires the following geotechnical monitoring and management strategies be implemented until the EOML:

- Profiles of the walls of the pits and the slopes of the WRD will be collected annually using drone based photogrammetry. Surfaces will be created from the point clouds. The surfaces will be compared to previous surfaces to highlight changes. Excessive deformations will require strategies to be implemented to ensure the deformation mechanisms are understood and, if necessary, to ensure the risk to persons and the operation remain acceptable.
- Data quantifying the orientations of the discontinuities most recently exposed in Pit 3- 4 will be collected using discontinuity mapping techniques if changes to the geology occurs. The data will be compared to data collected elsewhere to highlight whether the characteristics of the discontinuities are consistent with those recorded previously. If different, the data will be used as input to kinematic analyses to ascertain whether the specifications of the final walls are still appropriate or require modification.
- Visual inspections of the walls of the pits and the slopes of the WRD will be undertaken weekly. Hazards and strategies for managing any increase in risk will be recorded in the daily log.
- An audit of geotechnical risk issues will be undertaken by an independent geotechnical consultant every 18 months.

A programme for visually monitoring and auditing the walls, slopes, and the landforms after the EOML will be established prior to then.

10 SUMMARY

10.1 Conclusions

- The proposed landforms satisfy the geotechnical related requirements of the PRCP Guideline.
- The long term stabilities of the walls of Pit 2 and Pit 3-4 and the slopes of the southern WRD will be within the ranges typically considered acceptable in the mining industry.
- After the EOML, the water level in Pit 3-4 will increase forming a pit lake. The final level of the lake will be controlled by the heights of water in Awoonga Dam and its tributaries. The water will not significantly reduce the performances of the pit walls unless rapid drawdown occurs, which is unlikely.

10.2 Risk Management Strategies

Prior to the EOML, the principal strategies to be implemented reduce the risks applicable to the walls of the pits and the slopes of the WRD will be:

- Restrict public access to the site.
- Rip access routes within and into the pits and to the upper surfaces and toes of the WRD.
- Install abandonment bunds behind the crests of the pits. The offsets of the bunds are to be specified in Section 4.4.2,
- Visually monitor the performances of the walls of the pits and the slopes of the WRD.
- Routinely inspect the areas behind the crests of the pit walls and the slopes of the WRD for evidence that may be indicative of large scale instabilities developing (e.g., cracking, subsidence etc.).

- Adhere to the requirements of the completion criteria (Section 8).
- Prior to the EOML, be prepared to modify specifications and/or undertake earthworks if any landform deviates significant from the proposed design and/or its performance does not comply with the completion criteria.

10.3 Limitations in the Stability Analyses

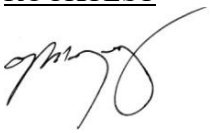
The stability analyses for the walls of the pits and the slopes of the WRD and the risk assessment process are based on limited data. For example, no information is available on the locations, extents, or characteristics of any very persistent structures (e.g., faults, shear zones etc.) that may occur behind a pit wall prior to the EOML and how these structures may influence the performance of the wall during the long-term. The implications of these limitations are:

- The geotechnical model will require updating if information becomes available that could influence the conclusions and recommendations in this study.
- The strategies required to ensure the risks to persons and the post-closure landform remain acceptable.

11 CLOSURE

This report addresses the geotechnical related issues required in a PRCP as listed in Section 1. I trust that it provides the information you require. Please contact the undersigned if you have any queries on any matter discussed within it or wish to discuss any aspect of the report in more detail.

For and on behalf of
ROCKTEST



Tony Meyers
Principal Rock Mechanics Engineer

FIGURES

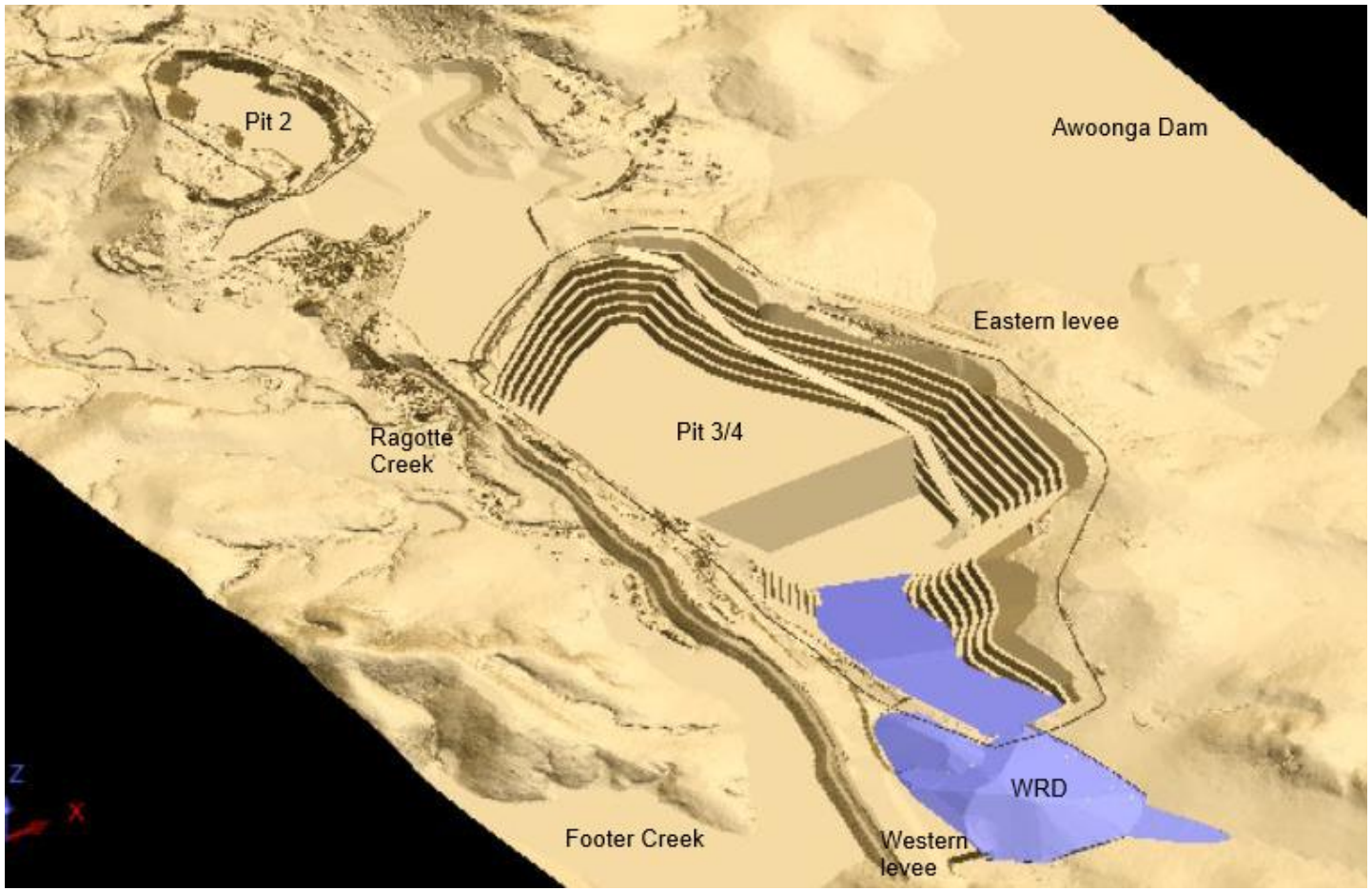


Figure 1. View of the site in 2026 highlighting the approximate footprints of the final landforms of Pit 2, Pit 3-4 and the WRD.

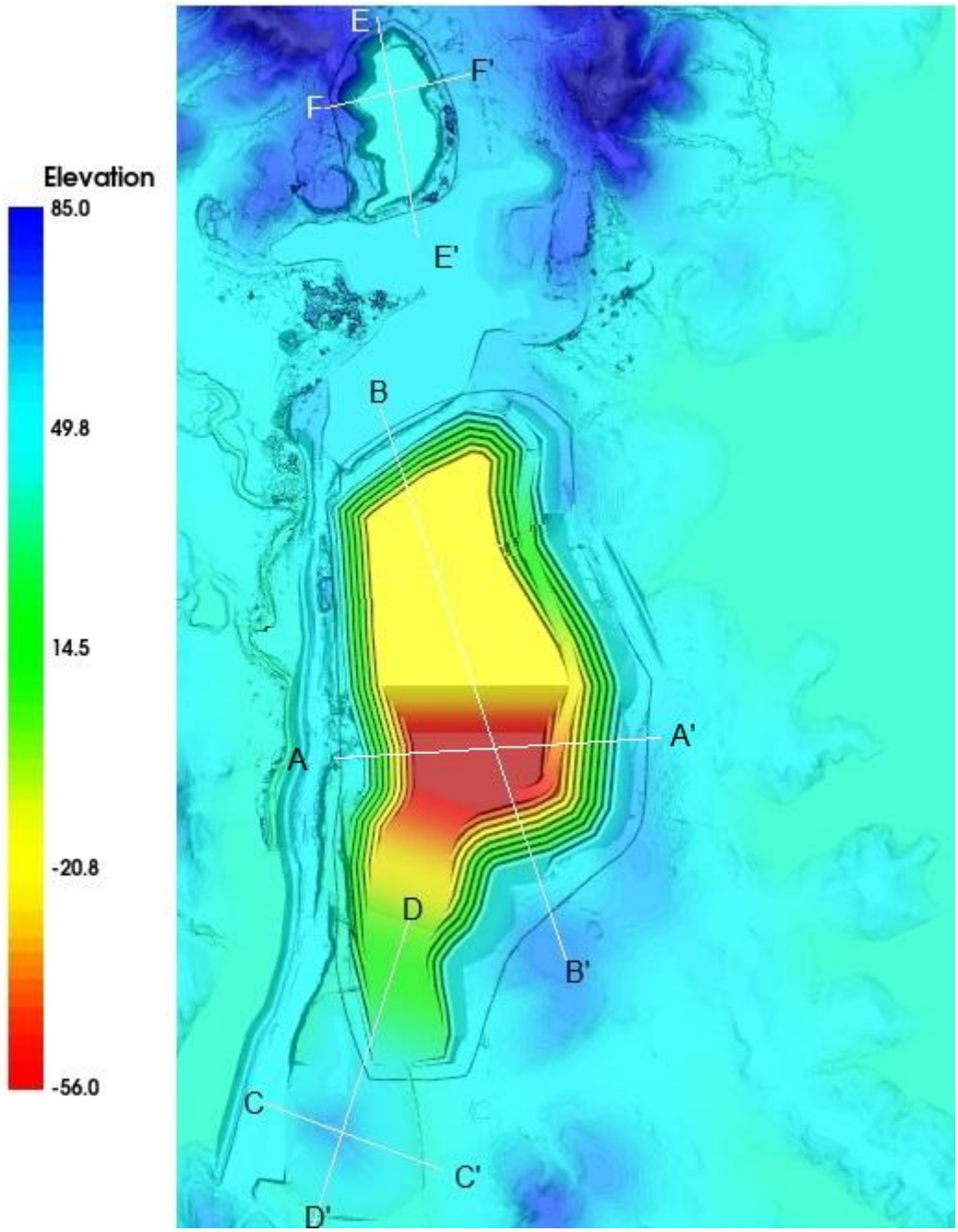


Figure 2. Elevations of landforms around Pit 3-4 and the WRD and locations of the cross sections.

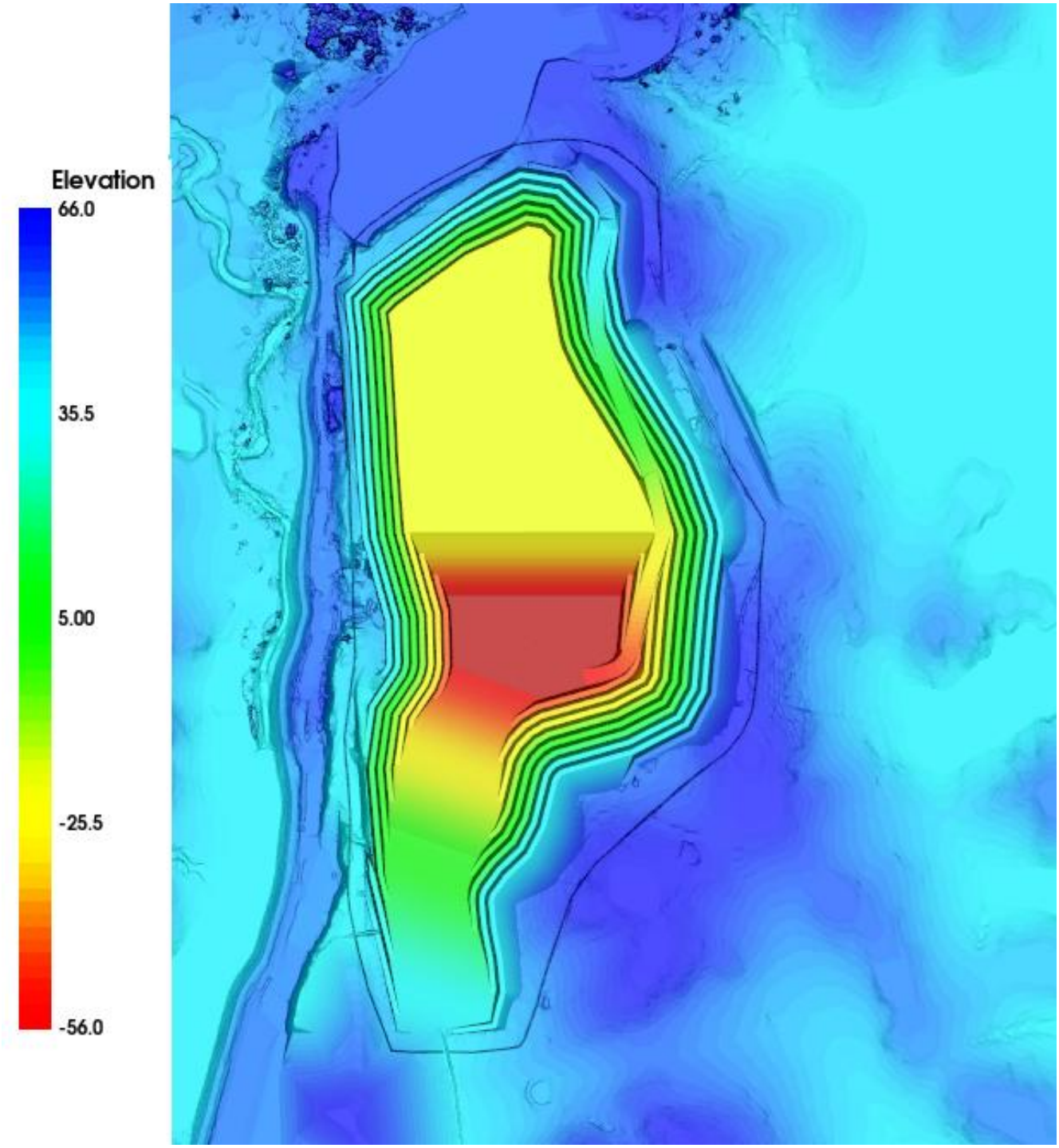


Figure 3. Elevations of landforms around Pit 3-4 highlighting the RLs of the eastern and western levees.



Figure 4. Eastern levee looking south. Awoonga Dam is to the left and Pit 4 is to the right.



Figure 5. Western levee looking north. Ragotte Creek is to the left and Pit 4 is to the right.



(a)



(b)

Figure 6. Basalt lava flows exposed in the upper benches of the east wall of Pit 4 and andesite dykes daylighting within the (a) floor and (b) south wall.



(a)



Figure 7. Bouldery clay overlying limestone on the (a) east wall and (b) north wall of Pit 4.

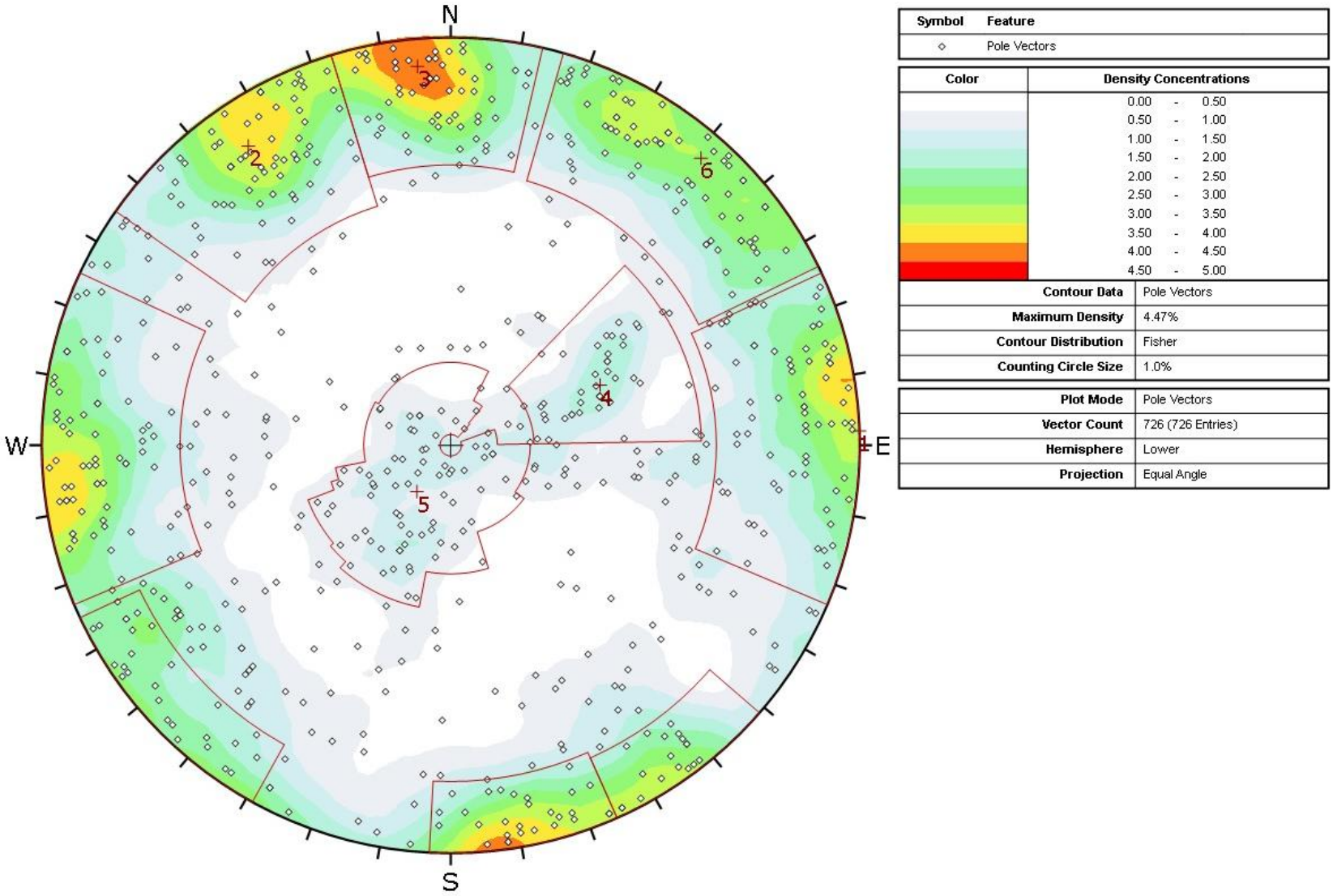


Figure 8. Stereonet highlighting the orientations of poles to 726 discontinuities within the fresh limestone, the boundaries of the 6 sets into which the discontinuities have been assigned and the mean orientations of the sets.



Figure 9. Examples of planar sliding on the west wall of Pit 4 involving bench scale masses of rocks sliding along bedding/cleavage from Set 1 and joints from Set 5.

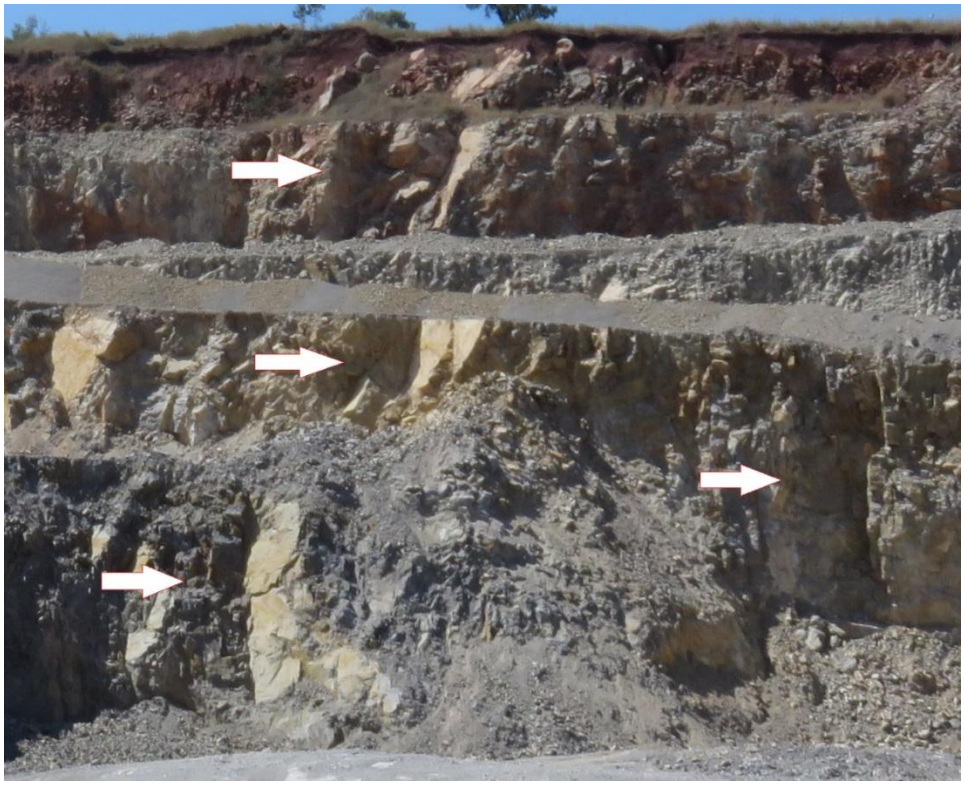


Figure 10. Examples of wedge sliding on the east wall of Pit 4 involving bench scale masses of limestone sliding along steep dipping joints from Sets 3 and 4 having medium to high persistences.



Figure 11. Example of toppling on the north wall of Pit 4 involving bench scale masses of rocks bounded to the rear by steep dipping joints from Set 3 having high persistences..



(a) Apertures within discontinuities daylighting in the north wall of Pit 4.



(b) Cavern on the south wall.

Figure 12. Examples of clay filled karst structures within the upper benches of Pit 4.



Figure 13. Pit 1 (upper) was fully backfilled in 2024 (lower) with well compacted blasted rocks and fines.



Figure 14. Pit 2 has not been mined since the 1970s and will not be mined prior to the EOML.

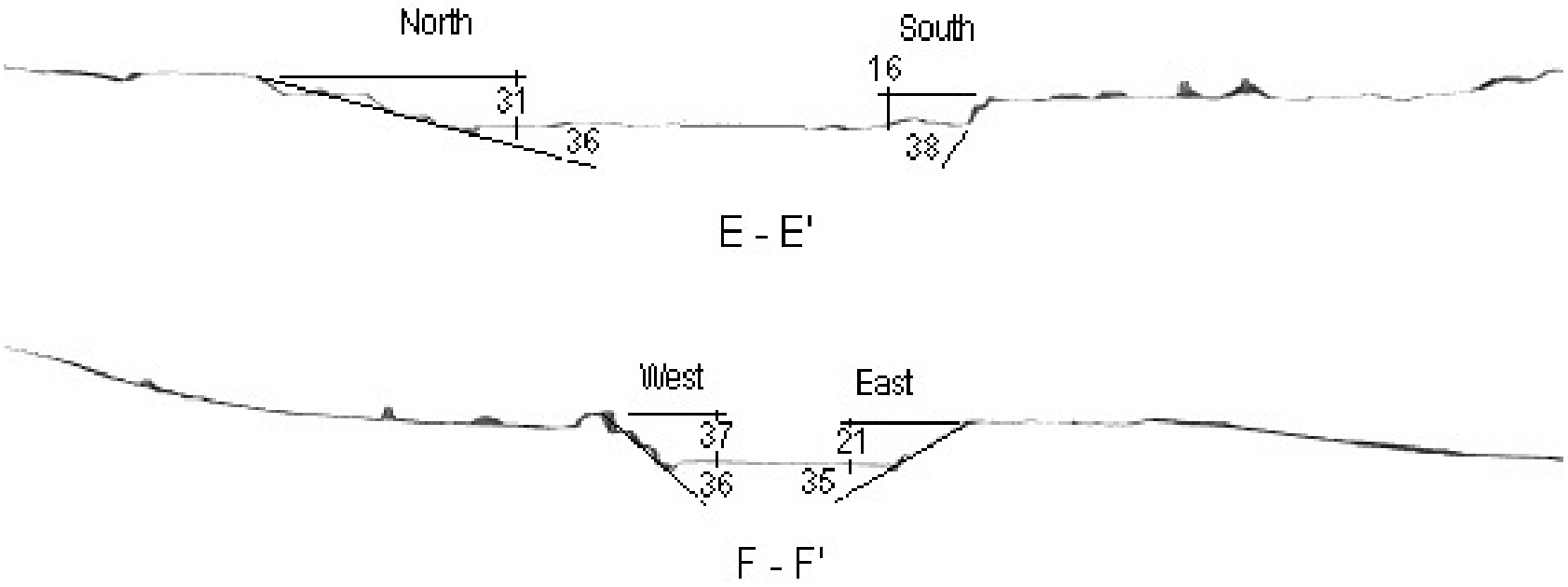


Figure 15. Cross-sections through the walls of Pit 2 at the EOML. Refer Figure 2 for locations.

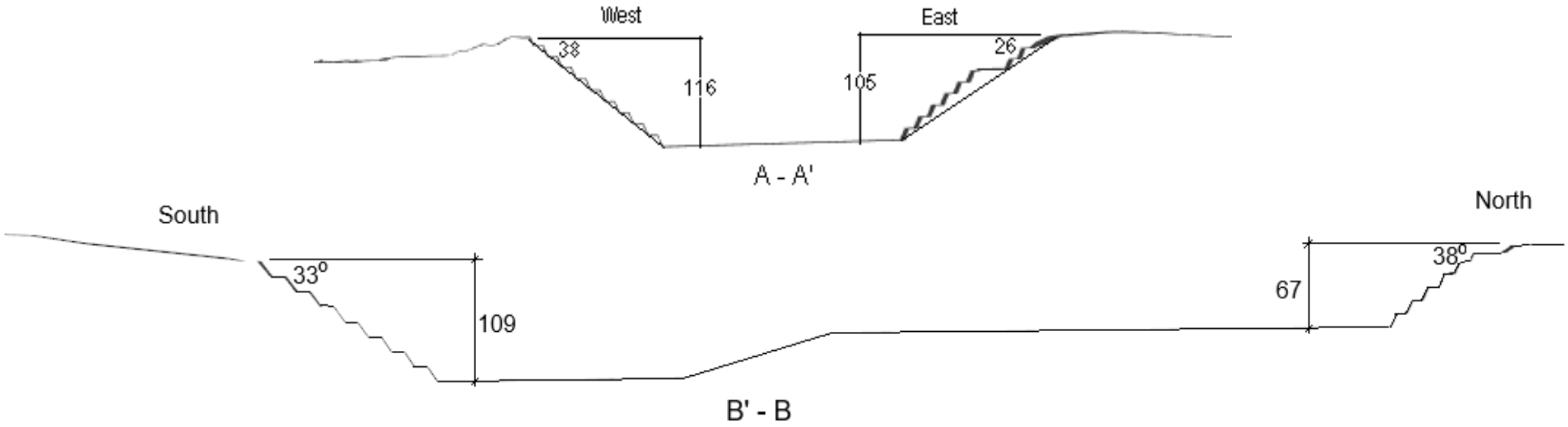


Figure 16. Cross-sections through the walls of Pit 3-4 at the EOML. Refer Figure 2 for locations.



Figure 17. Example of an abandonment bund similar to those to be placed around Pits 2 and 3-4.

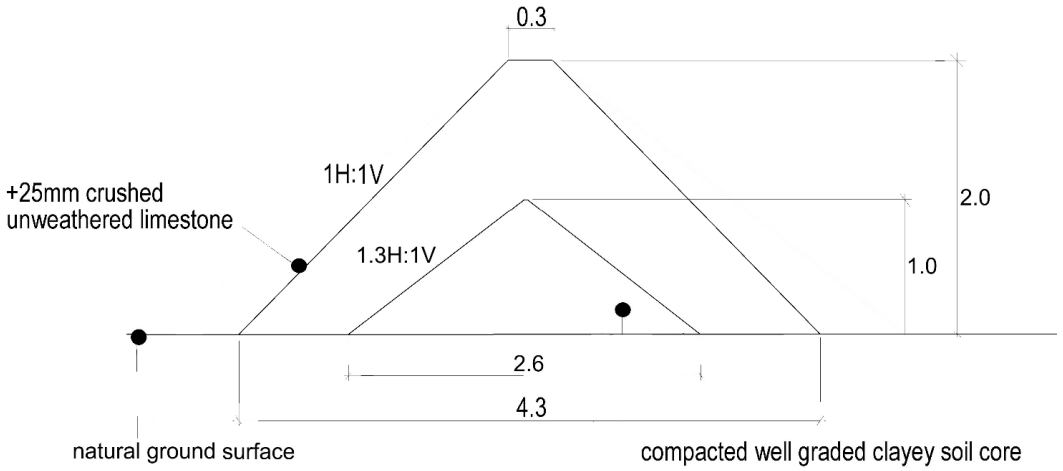


Figure 18. Nominal specifications of the abandonment bunds to encircle Pits 2 and 3-4.



Figure 19. Water can seep from the batter of the upper bench on the east wall of Pit 4 when the level of water in Awoonga Dam exceeds ≈40 mRL.

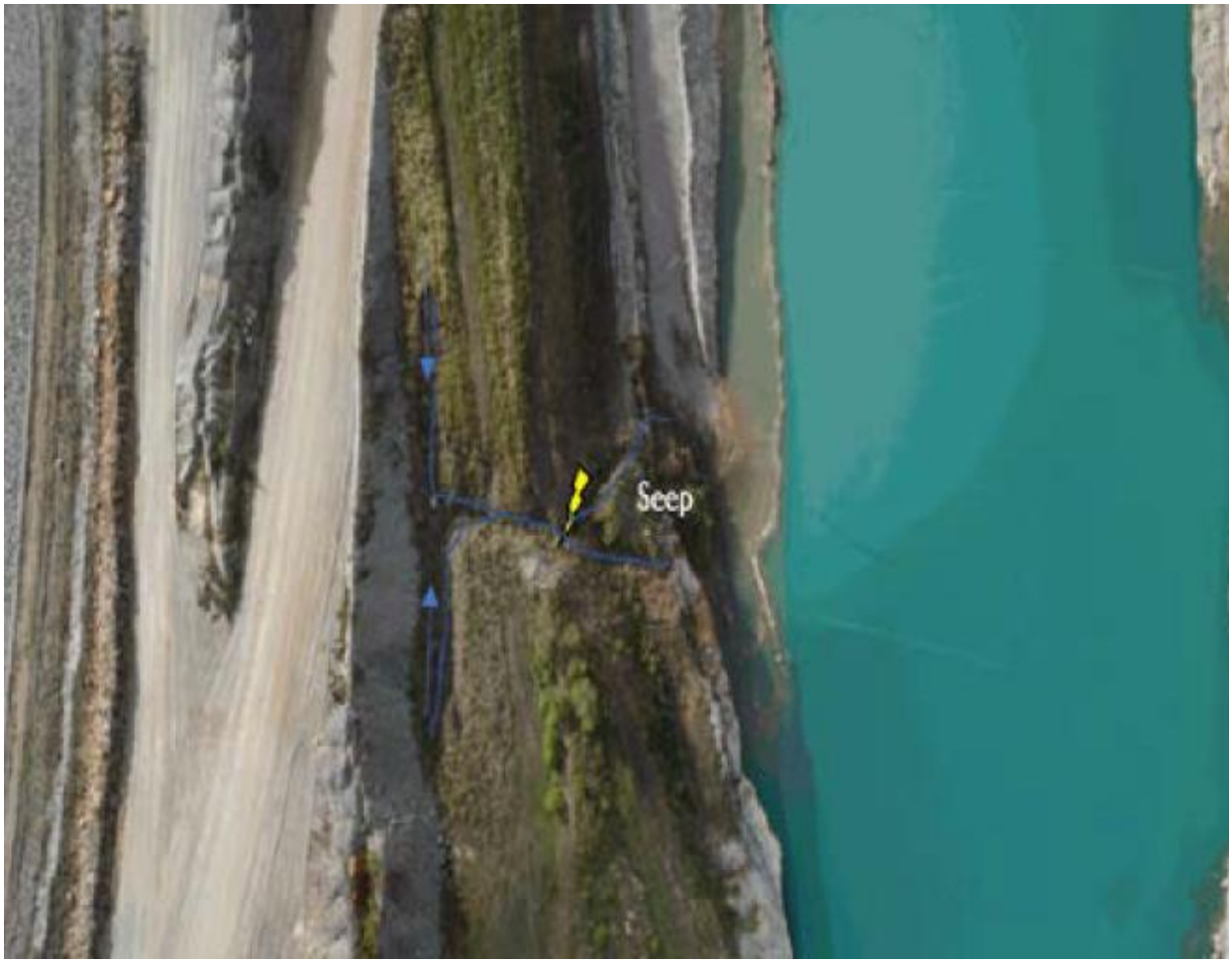


Figure 20. Water can seep from the upper batter on the west wall of Pit 3 when the level of water in Awoonga Dam exceeds ≈40 mRL.

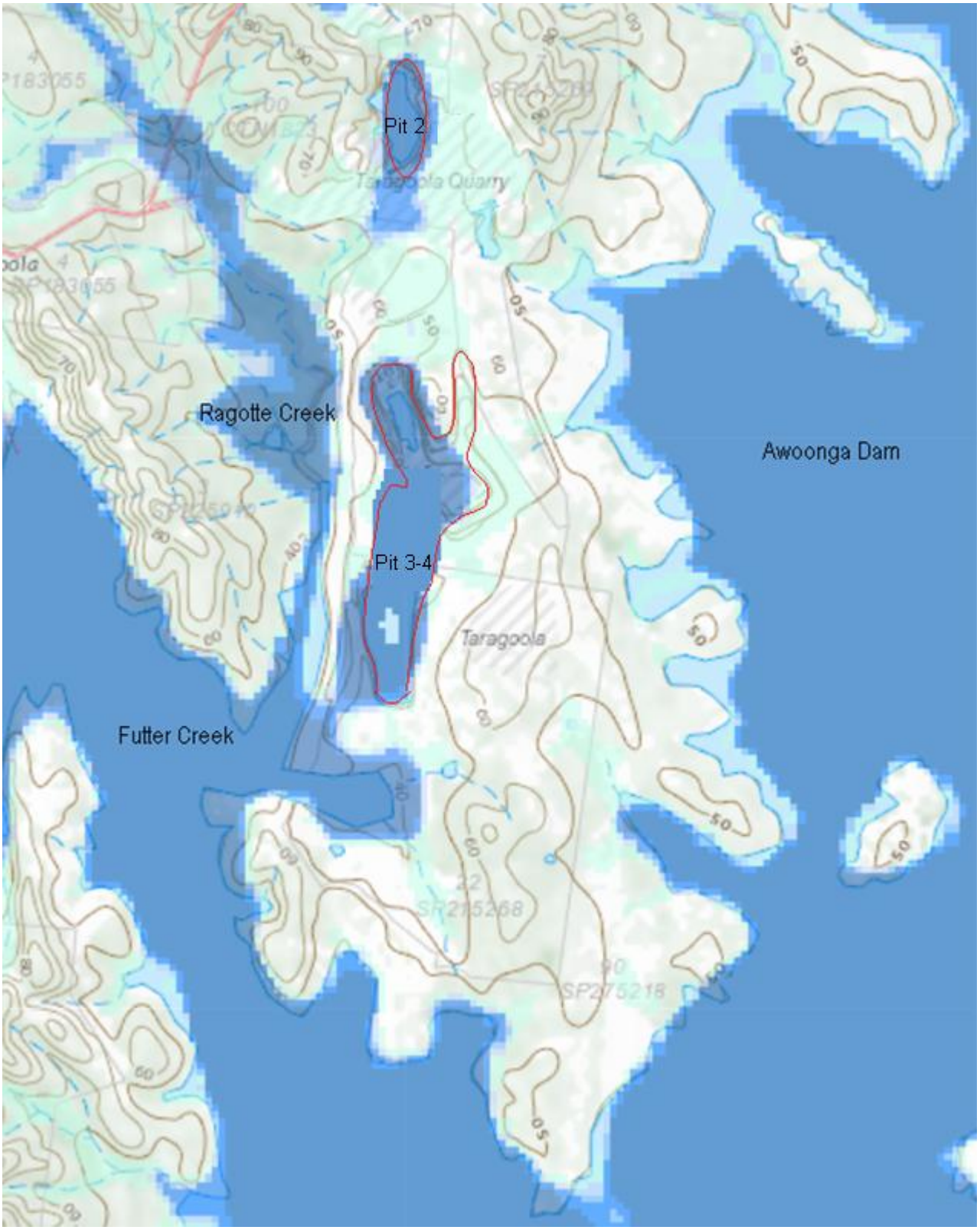


Figure 21. Estimated water level for an extreme flood event.
(Source: https://floodcheck.information.qld.gov.au).



Figure 22. Example of a shallow rock lined v-drain constructed down a slope comprising erodible soil to prevent gully erosion. Similar drains will be required in sections of final upper benches comprising soil filled karst.

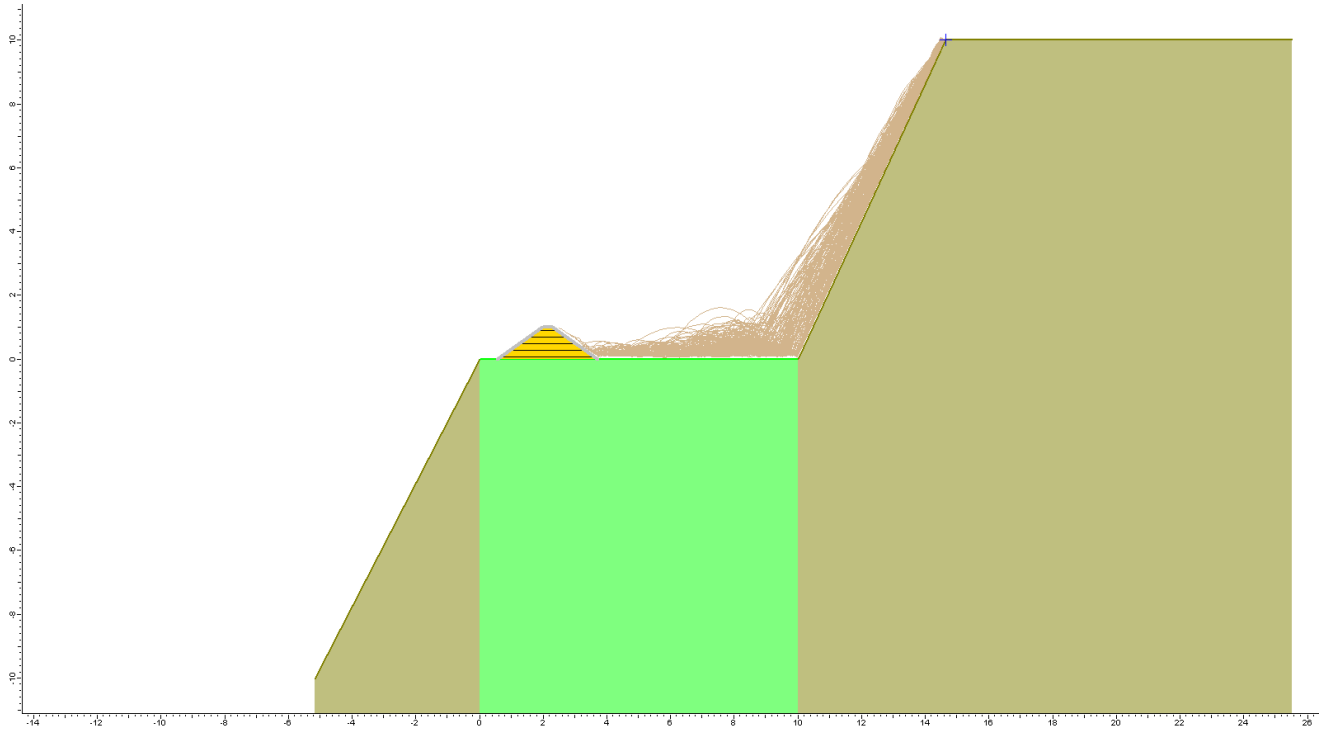


Figure 23. Rockfall simulations of 1000 rocks detaching from the crest of a batter indicate that no rocks are likely to traverse beyond the edge bund.

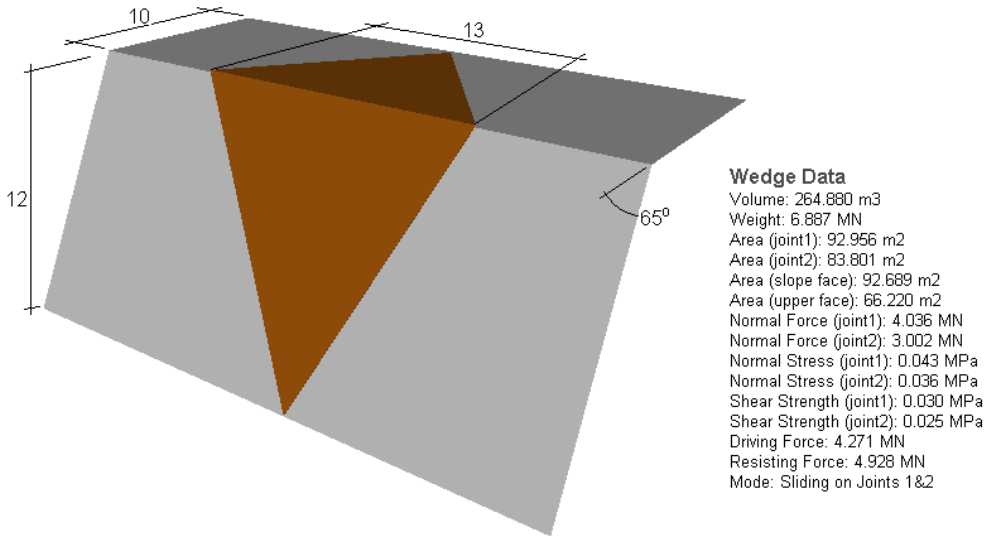


Figure 24. Largest wedge that could develop within a bench. Spill volume analyses indicate that almost all rocks will be retained on the specified 10 m wide berms.

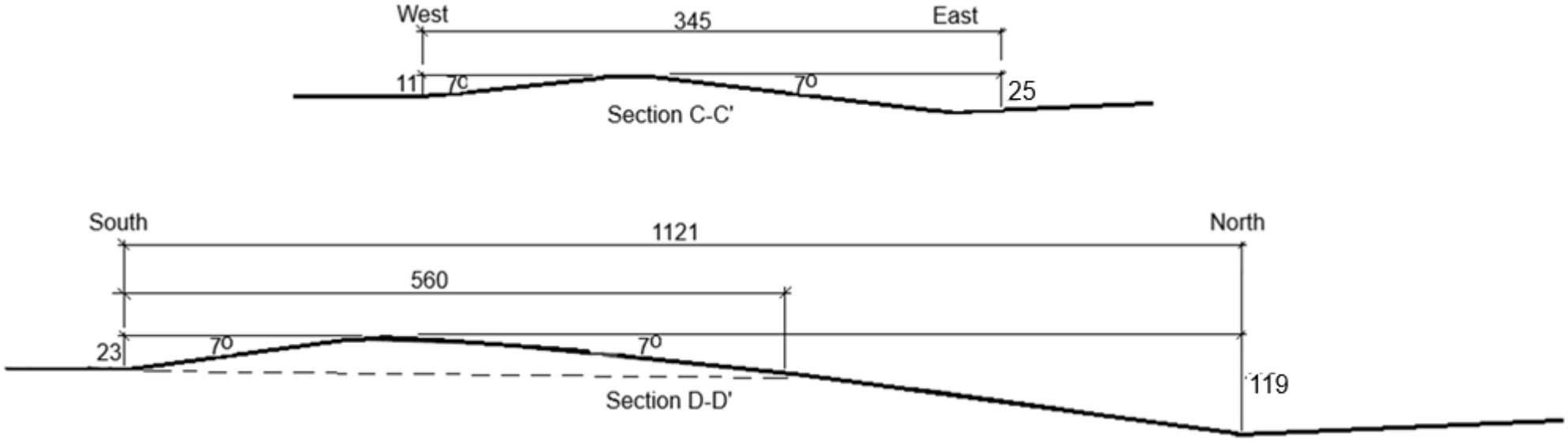


Figure 25. Cross-sections through the steepest slopes of the WRD at the EOML. Refer Figure 2 for locations of cross sections.

ADDITIONAL INFORMATION

- The recommendations in this report have been based on certain assumptions and very few observations. It would be very rare if the conditions at the site did not vary from those observed even if exhaustive investigations had been undertaken. Hence, it is unlikely that the conditions observed will represent the extremes of conditions that exist. As such, even though the aim of this report is to address issues influencing geotechnical related risks applicable to the landforms at the Calliope mine during the long-term, it is possible for events to occur or conditions to exist that were not planned for and as such should not be unexpected.
- The report was prepared on completion of the field work and is based on conditions encountered and reviewed at the time of preparation. Natural developments in, and changes to, or surrounding a volume of geomaterials over time, which are out of the control of the Rocktest Engineer ("Engineer"), will change the stresses that act through the geomaterials and their engineering characteristics. Changes in these conditions may significantly alter the way in which the ground conditions behave. As such, the conclusions reached in this report will be less applicable over time and may not be applicable or relevant at a later point in time. Rocktest disclaims responsibility for any changes that might have occurred or the implication of these changes on the assessments or recommendations in this report.
- This report was prepared specifically for Graymont Australia Pty Ltd ("Client") and for a specific purpose. It was not prepared for the use by any party other than the client and its respective consulting advisers.
- It is not possible to make a proper assessment of the report without a clear understanding of the terms of engagement upon which it was prepared, including the scope of instructions, directions and information provided by the client to those who prepared the report and the assumptions made in the report. The report may not address issues that would need to be addressed if the intention, environment, circumstances, time requirements and brief were different from those for which the report was prepared. Only the Engineer has a true understanding of the effects that these limitations and the assumptions made in the report may have on the conclusion reached within the report. As such, no party other than the Client should use the data, contents of the report or the techniques used in it for application to conditions different from those for which the report was intended without an independent and detailed review being carried out as to its suitability, relevance, and accuracy.
- This report must be read in full. No responsibility is accepted for use of any part of the report in any other context or for any other purpose other than that for which it was prepared.
- Where engineering advice, recommendations and/or designs are provided, all elements/components of the advice, recommendations and/or designs are intended to function in combination. The Engineer accepts no liability arising out of their partial application.
- The Engineer will not accept any responsibility for negligence, nor any loss or damage suffered by the Client due to the occurrence of events or the existence of any factors which are out of the Engineer's control. The Engineer will indemnify the Client for claims or loss arising from a breach of professional duty in the provision of the professional services. The liability of the Engineer is reduced to the extent that the Client or other person(s) caused or contributed to the loss or occurrence which gave rise to the claim.
- This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

The above clauses do not in any way attempt to absolve the Engineer from any professional responsibilities in relation to the diligent and careful performance of duties in providing this report. Rather, they are intended to be a guide as to where the Engineer's responsibilities end, and where forces of nature assume responsibility for the composition of a volume of geomaterials and its performance.

APPENDIX 1
ROCKMASS CHARACTERISTICS

A1.1 Compressive Strengths

The compressive strengths of weathered and unweathered limestone were defined in terms of Point-Load Strength Indices, $I_{s(50)}$.

Samples of limestone were collected at random locations within the pit and from areas nearby. No preparation of the rocks was required. They were tested at their moisture content at the time of testing.

The tests were carried out in accordance with ISRM (1985[40]) and AS 4133.4.1 9 (1993[41]).

1. A rock was inserted into an ELE point-load test apparatus. The rock was aligned perpendicular to the dominant fabric.
2. The platens were closed to contact the smallest dimension and away from the edges.
3. The load was steadily and slowly increased until failure. Tests for which the failure plane did not fully intersect the rock were rejected. The pressure at failure was recorded.
4. The distance between the platens at failure and the width of the failure plane were recorded with a Vernier calliper. The width was calculated as (W1+W2)/2[42] if opposite sides of the failure plane were not parallel.

The results are summarised in Table A1.1.

Table A1.1. Summary of point load strength indices $I_{s(50)}$ for limestone.

Grade	*Number of tests*	*Minimum (MPa)*	*Mean (MPa)*	*Maximum (MPa)*
weathered	4	1.5	2.0	2.6
unweathered	11	2.1	3.6	6.3

A1.2 Specific Gravities

The densities of weathered and unweathered limestone were estimated as functions of their specific gravities.

1. The mass (M_d) of a dry rock was measured with a Nuweigh KK5000 electronic balance.
2. The rock was suspended in water and its saturated mass (M_s) was measured.
3. The rock was removed from the water and its wet mass (M_w) was measured.
4. The density of the rock was estimated from the following equation.

The results are summarised in Table A1.2.

$$\text{Density} = \frac{1000\, M_d}{M_w - M_s}$$

[40] ISRM (1985) International Society for Rock Mechanics Commission on Testing Methods. Suggested Methods for Determining Point Load Strength, Int. Jnl. Rock Mech., Min. Sci. & Geomech. Abstr. Vol. 22 No. 2 pp.51-60

[41] AS 4133.4.1 (1993) Australian Standard Methods of Testing Rocks for Engineering Purposes. Method 4.1 Rock Strength tests – Determination of Point Load Strength Index.

[42] ISRM (1985) and AS4133.4.1 suggest that the dimension W should be the minimum dimension of the sample perpendicular to the loading direction prior to testing due to the simplicity of obtaining this dimension. However, researchers and the German Standards argue in favour of measuring W as the minimum dimension of the failure surface after testing although obtaining this dimension is more time consuming than the former method. Rocktest adopts the latter method.

Table A1.2. Summary of density values for limestone.

Grade	*Number of tests*	*Minimum (kg/m³)*	*Mean (kg/m³)*	*Maximum (kg/m³)*
weathered	8	2511	2576	2617
unweathered	10	2575	2631	2679

A1.3 Basic Friction Angles

The basic friction angles[43] (ϕ_b) of discontinuities within unweathered and weathered limestone were estimated were estimated using the procedure:

1. A diamond tipped saw blade was used to cut through the sample. The smooth cut surfaces were manually abraded to remove all roughness features. The halves were then reassembled.
2. The lower half of the sample was tilted slowly until the top half begun to slide. The tilting was stopped.
3. The tilt angle was recorded with a digital M&D "SmartTool" level.
4. The halves were realigned and the test repeated a minimum of 12 times.

Table A1.3. summarises the results from the tests. Pitting of the surfaces contributes to the values for the weathered rocks being higher than those for the unweathered rocks.

Table A1.3. Summary of basic friction angles test data.

Grade	*Number of tilts*	*Minimum*	*Mean*	*Maximum*
weathered	50	23°	25°	27°
unweathered	54	16°	21°	24°

A1.4 Discontinuity Shear Strengths

Bench scale instabilities within the pits are dominated by gravity driven sliding and toppling of rocks. Displacements occurs when the driving forces applied to individual rocks and masses of rocks exceed the shear strengths of the underlying discontinuities[44]. In this study, these strengths are quantified in terms of minimum and mean peak friction angles[45]. The discontinuities are assumed to have negligible cohesive strengths as:

- the rocks within the benches have been vibrated during blasting,
- most discontinuities have undergone some shear displacements during tectonic deformations and creep which destroyed cementation,
- relatively low stresses are applied to the discontinuities within the benches.

[43] The basic friction angle quantifies the inter-granular friction after all roughness asperities have been abraded from opposing surfaces of a discontinuity.

[44] Assuming rocks are free to move out from a bench.

[45] Any movement along a discontinuity destroys any cohesive bonds leaving a surface that is purely frictional.

The "shape" of the shear strength/normal stress curve is described by the non-linear Barton-Bandis (BB) shear strength criterion[46]. The criterion is defined in terms of the following parameters. Their assumed values are listed in Table A1.4:

- Joint Wall Compressive Strength (JCS) is assumed to be equivalent to the compressive strengths of the intact rocks. These strengths were quantified as functions of the point load strength indices listed in Table A1.1. A conservative multiplication factor K (i.e., UCS = K x I_{s50}) of 18 was assumed.
- Normal stress (σ_n) acting perpendicular to a discontinuity. This stress is a function of the unit weight of the overlying rocks. This value was quantified using the data obtained from the specific gravity tests listed in Table A1.2.
- Residual friction angle (ϕ_r) of the discontinuities was quantified as a function of the basic friction angles obtained from the tilt tests listed in Table A1.3.
- Joint Roughness Coefficients[47] (JRC) was quantified by comparing the surfaces of in-situ discontinuities to standard roughness profiles. The values are listed in Table A1.5.

The estimated peak friction angles are listed in Table A1.6. The range of values is typical for limestone. The values for the unweathered limestone are lower than those for the weather limestone as a pitted surface due to weathering increases the shear strength of the surface. The lowest value, 18°, is used in stability analyses as a lower bound shear strength.

Table A1.5. Summary of Joint Roughness Coefficient (JRC) values.

Number of observations	*Minimum*	*Mean*	*Maximum*
532	1	4	10

Table A1.6. Summary of peak friction angles for limestone based on B-B model.

Grade	*Minimum*	*Mean*
weathered	25°	35°
unweathered	18°	32°

[46] Barton, N. and Bandis, S (1990) Review of predictive capabilities of JRC-JCS model in engineering practice. In *Proc. Rock Joints*. Balkema pp.803-810.

[47] The Joint Roughness Coefficient (JRC) quantifies the roughness of the surface of a discontinuity. It is estimated by comparing the surface of a discontinuity with standard roughness profiles. The roughness is scaled from one for a very smooth (slickensided) surface to 20 for a very rough stepped surface.

A1.5 Rock Mass Strengths

The shear strength of the limestone rockmass was estimated using the Generalised Hoek-Brown Rock Mass Strength criterion[48]. The criterion is defined in terms of the parameters listed in Table A1.8.

- The Hoek-Brown intact rock constant m_i for limestone.
- The disturbance factor (D) which depends upon the degree of disturbance to which the rock mass at the depth of a potential surface of instability has been subjected by blast vibration and stress relaxation[49]. A value of 0.5 is applied as controlled blasting is not used and hence benches undergo some disturbance.
- The Geological Strength Index (GSI)[50] is a quantitative value that defines the quality of the rockmass in terms of the parameters[51]:
  - Rock volume (Table A1.7) is a function of the set spacing values listed in Table 1. Characteristics of the sets of discontinuities in the limestone. Only the minimum and mean values are calculated. A maximum value of 1 m^3 is based on observation of oversize rocks[52].

Table A1.7. Summary of block volumes (m^3).

Minimum	*Mean*	*Maximum*
3 x 10^{-14}cc	4.2 x 10^{3}cc	1.0 x 10^{6}cc

  - Joint Condition Factor (J_c) is the ratio of the following qualitative parameters from the Q[53] rock mass classification system:
    - Joint Roughness number (J_r) is a function of the surface of the discontinuities. Most surfaces are smooth planar resulting in a value of 1.0/
    - Joint Alteration number (J_a) ranges from 2 to 3 for the weathered limestone and 0.75 to 1.0 for the unweathered limestone.

Figure A1.1 shows the likely ranges in the GSI values based on the data described above. The average values decrease from 43 to 24 as the limestone weathers. These values are low, reflecting the highly discontinuous nature of the rock mass. Although the values are not definitive, they still provide an indication of the decrease in the quality of the limestone as the degree of weathering increases during the long-term.

[48] Hoek, E. Carranza-Torres, C. & Corkum, B. (2002) Hoek-Brown failure criterion, 2002 edn. In *Mining and Tunnelling Innovation and Opportunity*. *Proc. 5th North American Rock Mech. Symp*. Toronto, vol. 1 pp.267-273 Uni. Toronto Press, Toronto.

[49] D varies from 0 for undisturbed rockmasses to 1 for very disturbed rockmasses.

[50] The geological strength index (GSI) produces quantitative values used to calculate the strength properties of a rockmass.

[51] Cai, M., Kaiser, P.K., Uno, H., Tasaka, Y., Minami, M. 2004. Estimation of rock mass deformation modulus and strength of jointed hard rock masses using the GSI system. *Int. J. Rock Mech. & Min. Sci*. 41:3–19

[52] A maximum value is not calculated as a lack of wide spacing value data produces erroneous results.

[53] Barton and Choubey (1977) The shear strength of rock joints in theory and practice. *Rock Mechanics* **6** 183-236.

Table A1.8. Rock mass shear strength parameters for limestone.

Characteristic		*Grade*	*Minimum*	*Mean*
Intact rock constant, m_i.		all	9	12
Unit weight, (kN/m^3)		weathered	24.6	25.3
		unweathered	25.3	25.8
Disturbance factor, D.		all	0.5	
Uniaxial compressive strength, UCS (MPa)		weathered	27	36
		unweathered	38	65
Rock volume (cm^3)		weathered	100	2000
		unweathered	1000	4200
Joint condition factor, $J_c = J_r/J_a$		weathered	0.3	0.5
		unweathered	1.0	1.3
Geological Strength Index, GSI. (Figure A1.1)		weathered	24	33
		unweathered	38	43
Rock mass shear strength	friction angle	weathered	29^o	35^o
	cohesion (MPa)		0.29	0.60
	friction angle	unweathered	29^o	37^o
	cohesion (MPa)		0.41	1.31

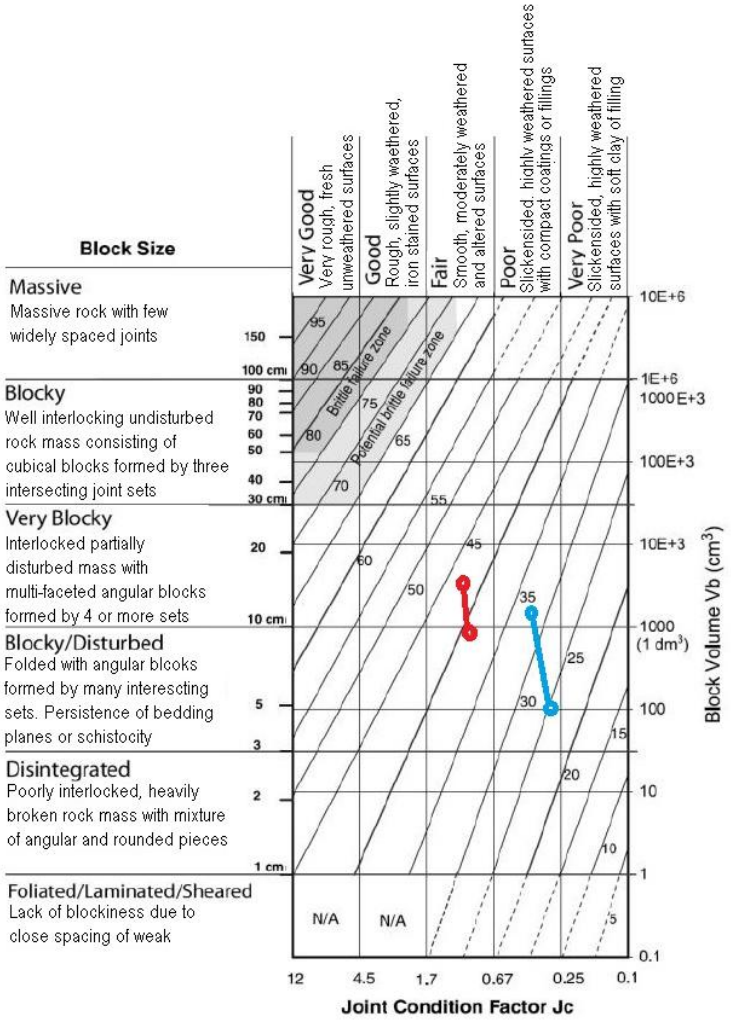


Figure A1.1. Ranges of GSI values for (red) unweathered and (blue) weathered limestone.

A1.6 Rockfill Shear Strength

Table A1.9 list the range of angles of repose of the materials exposed in the slopes of the WRD. The rocks within the dump are in various stages of decomposition.

The shear strength of the materials within the dump can be defined in terms of a friction angle. This angle is typically a few degrees higher than the angle of repose. Based on the values in Table A1.9, the friction angle likely ranges from approximately 34^{o} to 40^{o}. As the rocks in the WRD are generally free-draining, the values when saturated will differ little from these values when dry.

Table A1.9. Observed angle of repose and estimated friction angles of weathered rocks in the WRD.

Parameter	*minimum*	*average*	*maximum*
Angle of repose	32^{o}	35^{o}	37^{o}
Estimated friction angle	34^{o}	37^{o}	40^{o}

The friction angle of the materials within the dump can also be estimated by applying a non-linear function proposed by Barton (2008)[54]. The function is defined in terms of the parameters listed in Table A1.10. The values listed in the table are lower bound values. The estimated friction angles listed in the table are similar to the values in Table A1.9. On this basis, a lower bound value of 31^{o} is assumed for the long-term friction angle of the materials.

Table A1.10. Estimated parameters for the weathered waste rock.

Parameter	*Source*	*Value*
Basic friction angle, ϕ_b	A1.2	23^{o}
Compressive strength of intact rock, UCS	A1.1	27MPa
Mean size of rocks, D_{50}		100mm
Compacted porosity, n	typical	29%
Density of materials in WRD, d	estimated	$1.9t/m^2$
Size dependent equivalent strength, S = *f*[UCS, D50] (MPa)	chart	6.8MPa
Equivalent roughness, R = *f*[n]	chart	7.3
Friction angle = *f*[S, R, ϕ_b]	calculated	31^{o} to 39^{o}

[54] Shear Strength of Rockfill, Interfaces and Rock Joints, and their Points of Contact in Rock Dump Design. N.R. Barton. Rock Dump 2008, Perth, Australia 15 pages

APPENDIX 2 PIT INTER-RAMP SCALE STABILITY

Stability analyses were undertaken to quantify the likelihoods[55] for discontinuity controlled modes of instabilities at inter-ramp scales[56] in Pit 3-4. The analyses used the stereographic method, implemented in the software Dips[57], to assess whether the kinematics[58] applicable to the benches are conducive to instabilities. The method calculates the proportions of the logged discontinuities that are conducive to masses of rocks:

- sliding from the walls along underling single (planar) or multiple (wedge) discontinuities
- or toppling from the walls bounded to the rear by single discontinuities.

Although significant limitations in the analysis method limit the veracities of the results, they are of a standard suitable for highlighting the possible dominant modes of instabilities and the relative likelihood for the modes to occur.

The assessments assumed the following:

- The six sets of discontinuities have the orientation characteristics listed in Table 1.
- An average inter-ramp angle of 38^o.
- The slopes dip towards the medians of the ranges of directions listed in Table 3.
- The shear strengths of the discontinuities transition from a friction angle $\phi = 32^o$ to $\phi = 18^o$ over the long-term as listed in Table A1.5.

The percentage of discontinuities having orientations conducive to sliding is defined as:

- For planar sliding and flexural and direct toppling, the percentage (P_{fp}) of the total number of poles[59] to discontinuities that are within "critical zones[60]".
- For wedge sliding and oblique toppling, the percentage (P_{fw}) of the total number of intersections between pairs of discontinuities that are within "critical zones".

The total percentage of discontinuities having orientations conducive to sliding or toppling (P_u) is a function of P_{fp} and P_{fw} based on decision tree theory.

The likelihood for failure (P_f) is defined as P_u x P_l where P_l is the proportion of discontinuities sufficiently persistent to underlie or bound to the rear an inter-ramp scale instability.

As discussed in Section 3.3.2, discontinuities are likely to generally have medium persistences. A conservative value for P_l of 0.7 is assumed to characterise this feature i.e., 70% of discontinuities may have sufficient persistences to influence inter-ramp scale instabilities.

Figures A2.1 to A2.4 shows example of the stereonets applicable to planar and wedge sliding. The results of the analyses are listed in Tables A2.1 and A2.2 and discussed in Section 5.1.

---

[55] The likelihood (P_f) is not equivalent to the probability of failure (PoF). A stereonet method cannot provide a definitive assessment of PoF due to fundamental limitations in the analysis method.

[56] After the EOML, loss of one or more benches is a significant hazard. Loss of width from an individual berm is not a significant hazard.

[57] The kinematic analysis software, Dips, is produced by Rocscience Inc, Toronto.

[58] Kinematics describes the motion of rocks without considering their masses nor the forces that may cause the motion. It is primarily concerned with the orientations of discontinuities bounding rocks with respect to the orientations of slopes from which rocks may move.

[59] In a stereonet analysis, a discontinuity is assumed to be a planar feature represented on a stereonet as a "great circle". The "pole" to a discontinuity is a downward directed line orientated perpendicular to the plane. It is represented on a stereonet as a point.

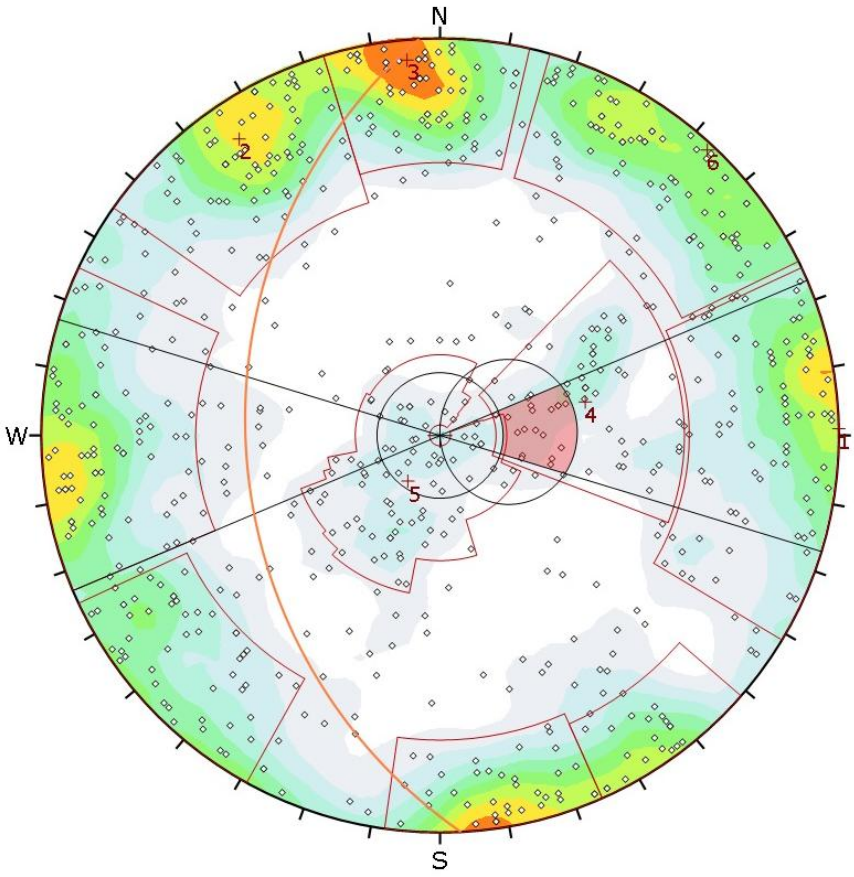
[60] "Critical zones" are areas on a stereonet within which a pole is deemed to have the orientation characteristics conducive to sliding.

Table A2.1. Results of analyses in unweathered limestone ($\phi = 32^{o}$).

	Wall (dip direction)			
	North (151°)	South (330°)	East (267°)	West (082°)
Failure Mode	Percentage of poles in critical area/s (%)			
Planar sliding, P_{fp}	0.0	0.0	0.3	0.1
Wedge sliding, P_{fw}	0.2	0.2	0.3	0.3
Flexural toppling, P_{ff}	1.9	2.2	1.5	1.5
Direct toppling, P_{fd}	3.2	6.4	5.4	5.9
Oblique toppling, P_{fo}	14.3	19.2	17.0	15.4
Total, $P_u = f(P_{fp}, P_{fw}, P_{ff}, P_{fd}, P_{fo})$	18.8	26.2	23.1	21.9
Likelihood for failure, $P_f = P_u \times P_i$	13.1	18.4	16.2	15.3

Table A2.2. Results of analyses in weathered limestone ($\phi = 18^{o}$)

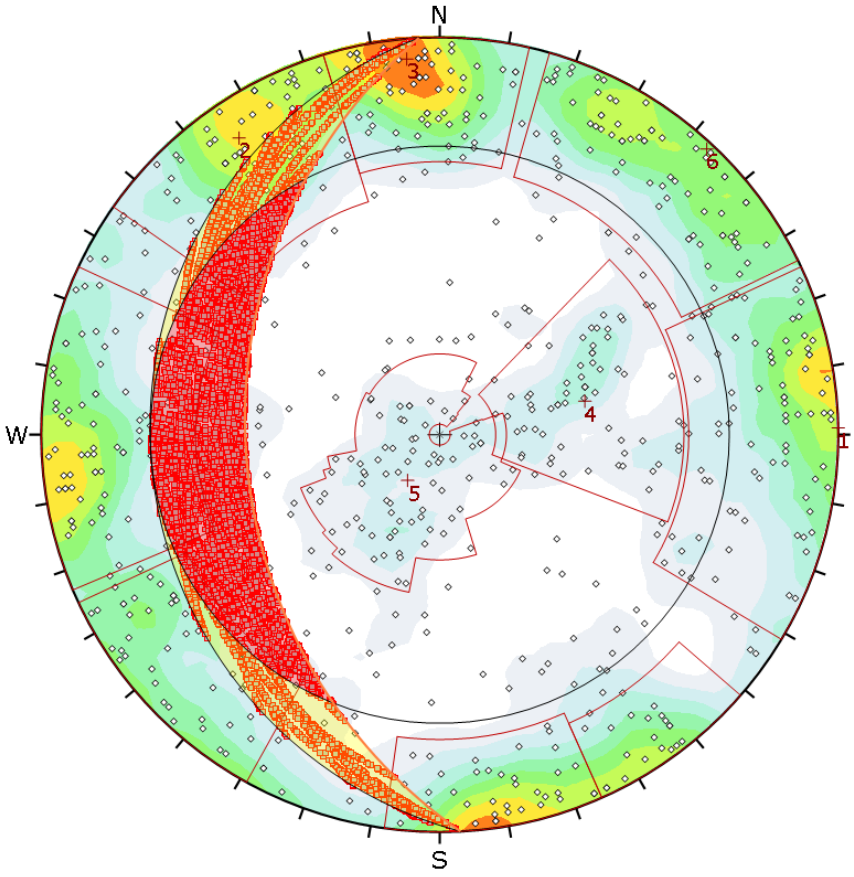
	Wall (dip direction)			
	North (151°)	South (330°)	East (267°)	West (082°)
Failure Mode	Percentage of poles in critical area/s (%)			
Planar sliding, P_{fp}	0.6	0.3	2.3	1.0
Wedge sliding, P_{fw}	4.6	6.0	6.5	4.9
Flexural toppling, P_{ff}	6.1	9.8	8.0	7.6
Direct toppling, P_{fd}	3.2	6.4	5.4	5.9
Oblique toppling, P_{fo}	7.4	10.6	9.5	8.3
Total, $P_u = f(P_{fp}, P_{fw}, P_{ff}, P_{fd}, P_{fo})$	20.1	29.3	28.1	24.9
Likelihood for failure, $P_f = P_u \times P_i$	14.1	20.5	19.7	17.4



Kinematic Analysis	Planar Sliding		
Slope Dip	38		
Slope Dip Direction	267		
Friction Angle	18°		
Lateral Limits	20°		
	Critical	Total	%
Planar Sliding (All)	17	726	2.34%
Planar Sliding (Set 30: 4)	17	64	26.56%

Plot Mode	Pole Vectors
Vector Count	726 (726 Entries)
Hemisphere	Lower
Projection	Equal Angle

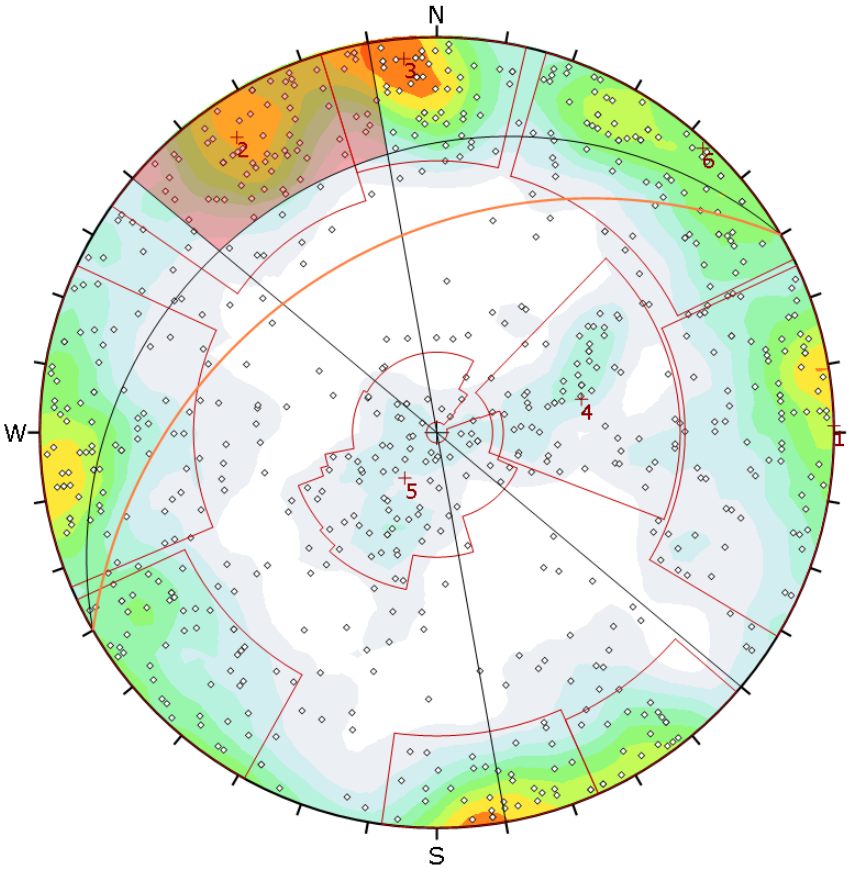
Figure A2.1. Stereonet applicable to planar sliding on the east wall during the long-term.



Kinematic Analysis	Wedge Sliding		
Slope Dip	38		
Slope Dip Direction	267		
Friction Angle	18°		
	Critical	Total	%
Wedge Sliding	17119	263124	6.51%

Plot Mode	Pole Vectors
Vector Count	726 (726 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	263124
Hemisphere	Lower
Projection	Equal Angle

Figure A2.2. Stereonet applicable to wedge sliding on the east wall during the long-term.

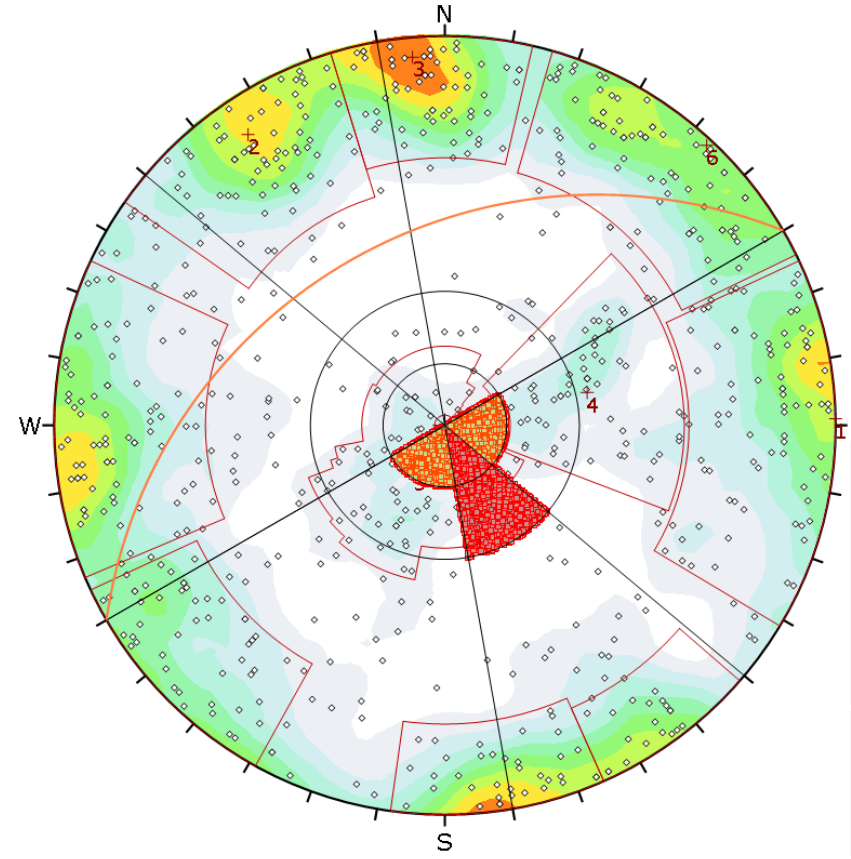


Kinematic Analysis	Flexural Toppling
Slope Dip	38
Slope Dip Direction	330
Friction Angle	18°
Lateral Limits	20°

	Critical	Total	%
Flexural Toppling (All)	71	726	9.78%
Flexural Toppling (Set 27: 2)	61	89	68.54%
Flexural Toppling (Set 31: 3)	10	98	10.20%

Plot Mode	Pole Vectors
Vector Count	726 (726 Entries)
Hemisphere	Lower
Projection	Equal Angle

Figure A2.3. Stereonet applicable to flexural toppling on the south wall during the long-term.



Kinematic Analysis	Direct Toppling
Slope Dip	38
Slope Dip Direction	330
Friction Angle	18°
Lateral Limits	20°

	Critical	Total	%
Direct Toppling (Intersection)	16844	263124	6.40%
Oblique Toppling (Intersection)	27938	263124	10.62%
Base Plane (All)	21	726	2.89%
Base Plane (Set 30: 4)	1	64	1.56%
Base Plane (Set 32: 5)	20	77	25.97%

Plot Mode	Pole Vectors
Vector Count	726 (726 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	263124
Hemisphere	Lower
Projection	Equal Angle

Figure A2.4. Stereonet applicable to direct and oblique block toppling on the south wall during the long-term.

APPENDIX 3 PIT WALL SCALE STABILITY

The stabilities of wall scale surfaces through the highest and steepest walls in Pit 2 and Pit 3-4 prior to backfilling were assessed using a limit-state equilibrium method implemented in the software *Slide2*[61]. The two-dimensional analysis code is applicable for these walls as they are wide relative to their heights and they are relatively straight.

The following characteristics were assumed:

The walls have the specifications listed in

- Table 2. Figures A3.1 to A3.3 show the specifications. In both pits weathered limestone is underlain by less weathered limestone.
- The shear strength characteristics of the limestone rockmass is described by Generalised Hoek-Brown shear strength models discussed in Appendix A1.5. Lower bound values are assumed as these values become progressively more applicable over the long-term.
- An anisotropic model is applied to allow for cleavage in the limestone. The shear strength characteristics of the cleavage are applied to sections of potential sliding surfaces that dip at $90^{o} \pm 20^{o}$. This strength is described by the Barton-Bandis (B-B) discontinuity shear strength criterion defined in terms of the parameters listed in Table A1.4. Conservative values applicable to weathered limestone are assumed (i.e., $\phi = 18^{o}$).
- A PGA of 0.001g, discussed in Section 3.4, is represented as a pseudo-static horizontal force directed out of the wall.
- Two groundwater scenarios are considered for both pits: no water and water at 40 mRL, the level of the spillway on the dam wall.

The results of the analyses are quantified in terms of Factor of Safety (FoS) values for each of hundreds of surfaces assessed within the walls. The surfaces with the lowest capacities are highlighted in Figures A3.3 to A3.7. The results of the analyses are discussed in Section 6.3.

[61] *Slide2 Ver 9.02* is developed by RocScience Inc. Toronto, Ontario.

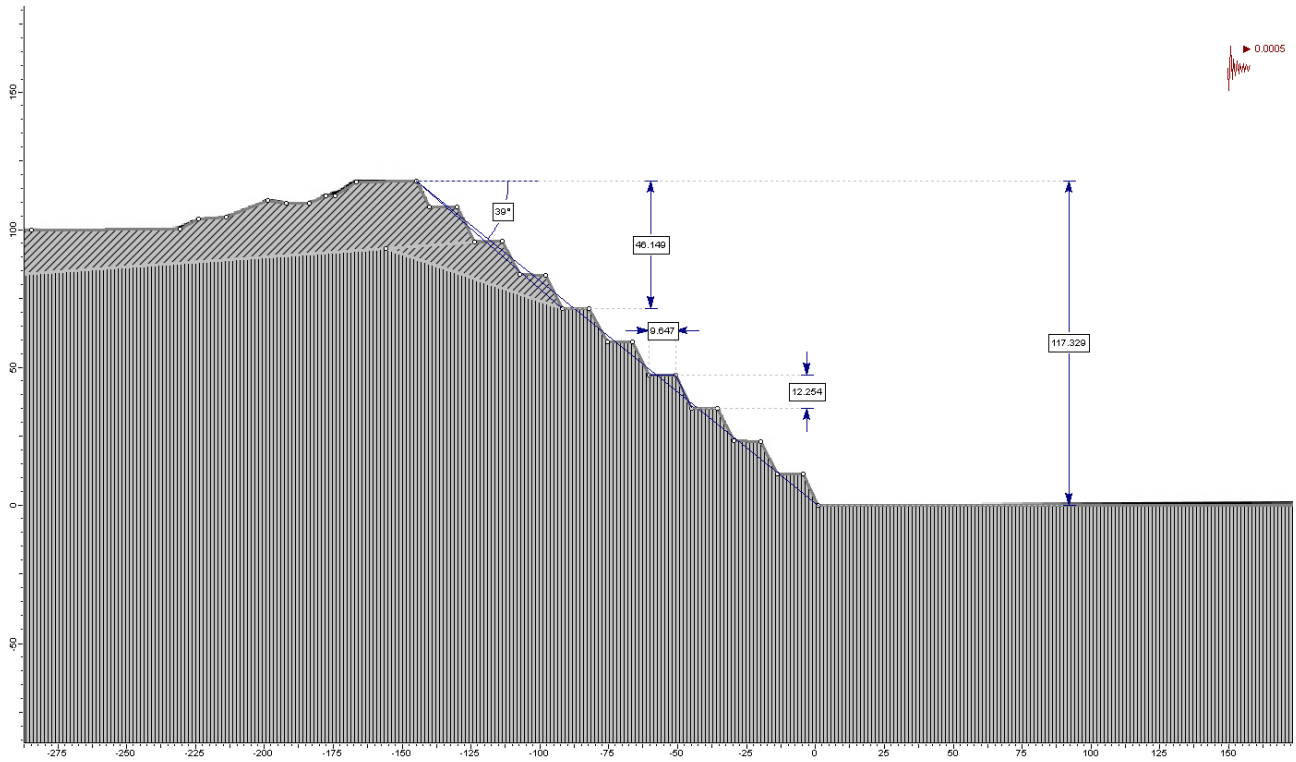


Figure A3.1. Cross-section through the west wall of Pit 3-4.

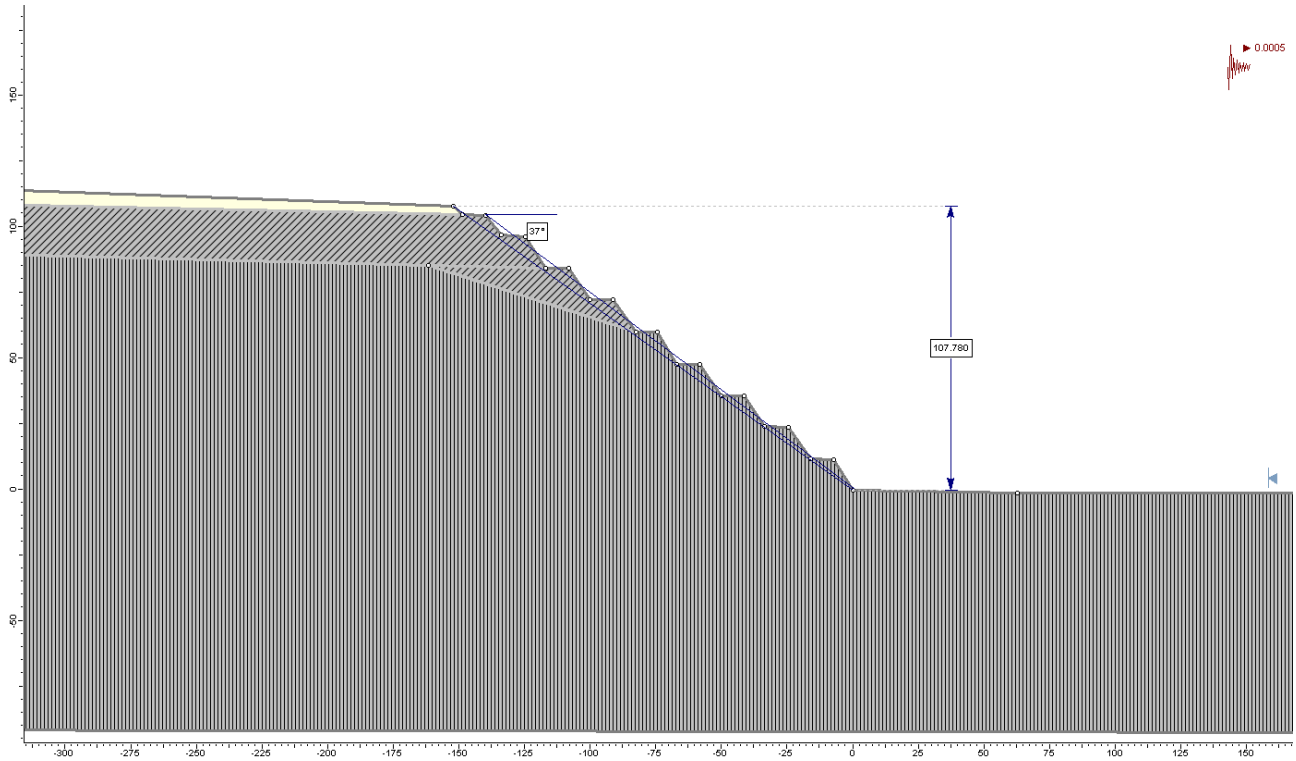


Figure A3.2. Cross-section through the north wall of Pit 3-4 prior to backfilling.

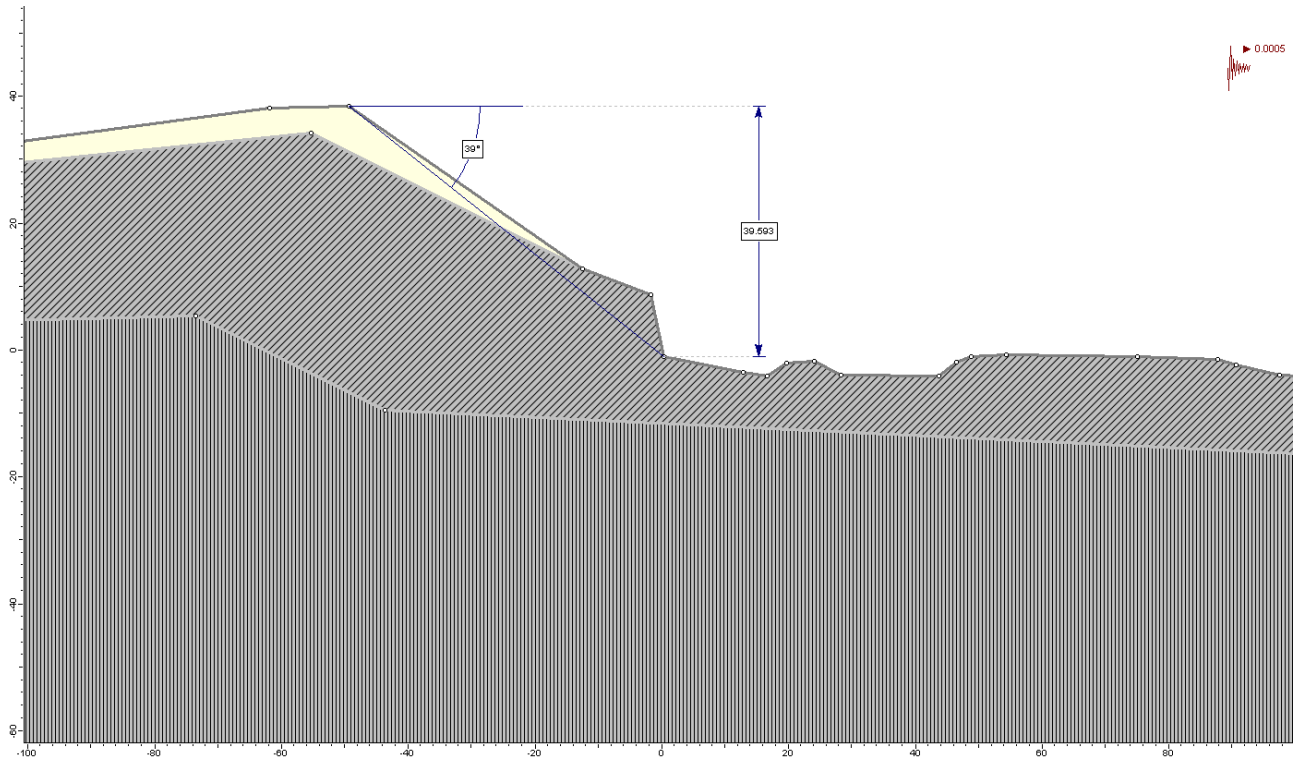


Figure A3.3. Cross section through the west wall of Pit 2.

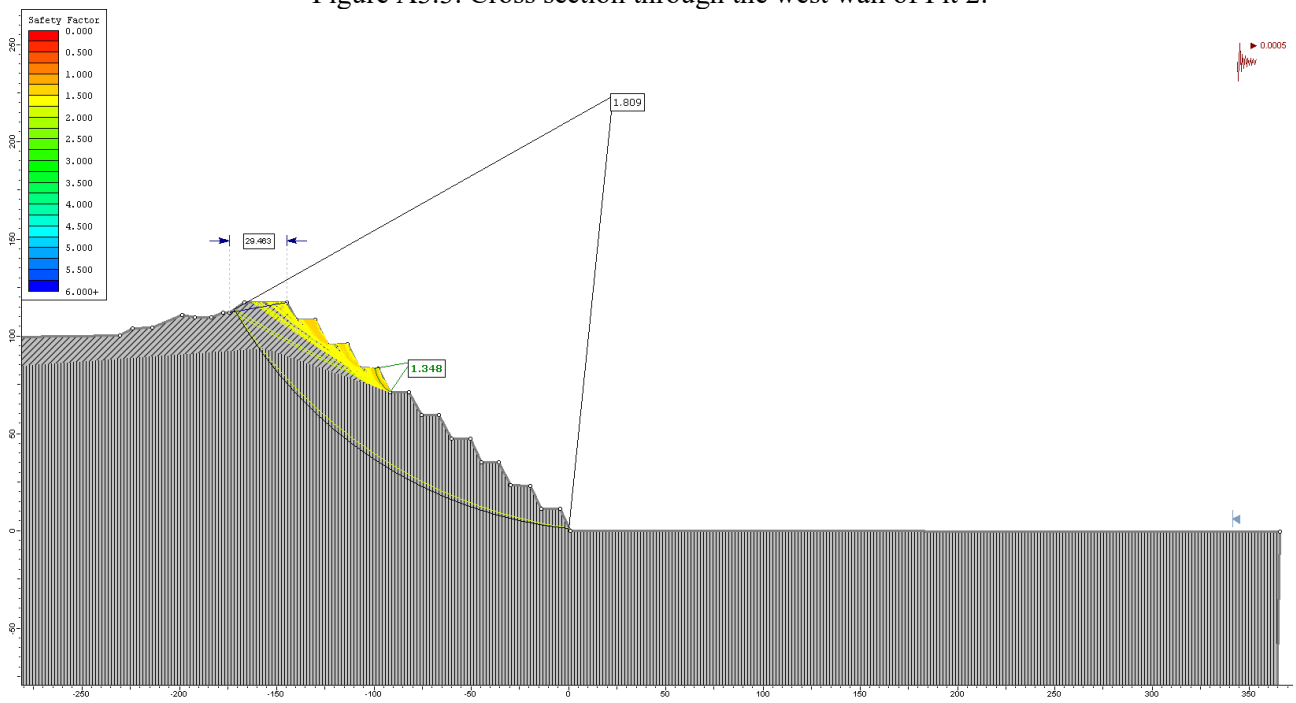


Figure A3.4. Highlighted are surfaces within the west wall of Pit 3-4 that have FoS values less than 1.8.

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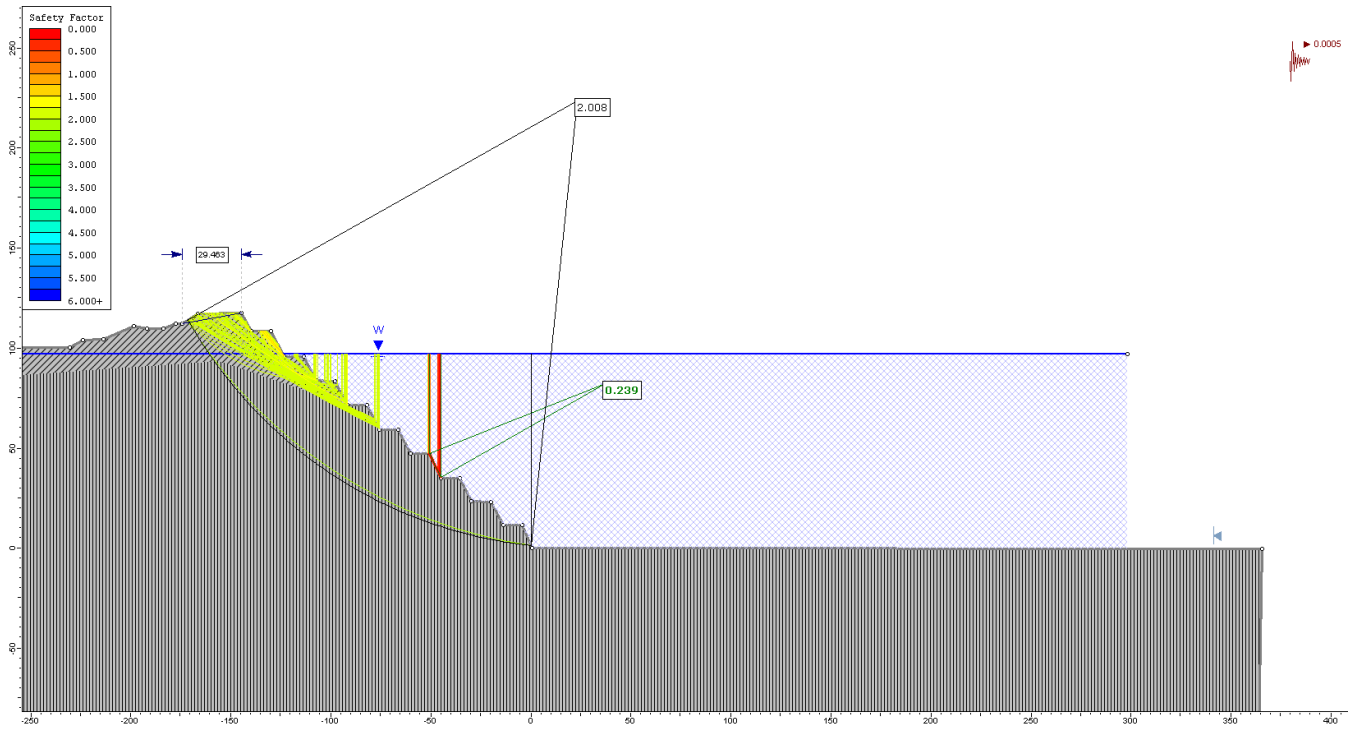


Figure A3.5. Highlighted are surfaces within the west wall of Pit 3-4 as a lake having FoS values less than 2.0.

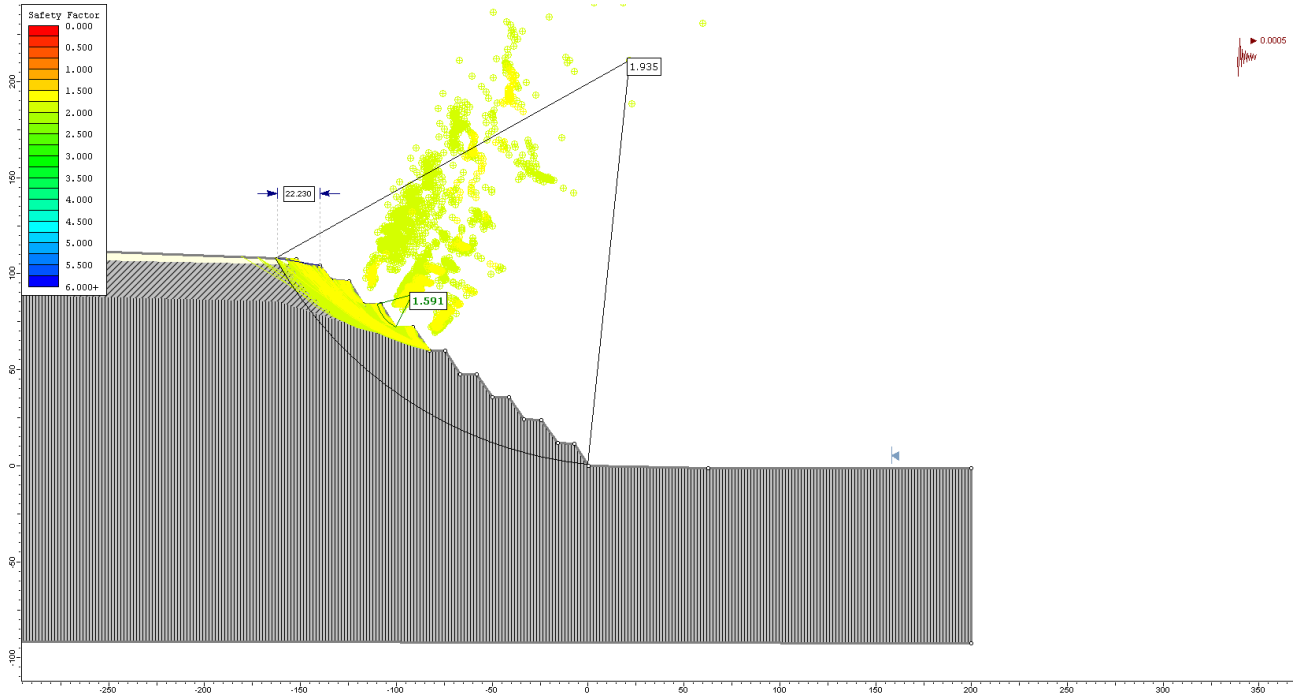


Figure A3.6. Highlighted are surfaces within the north wall of Pit 3-4 having FoS values less than 1.9.

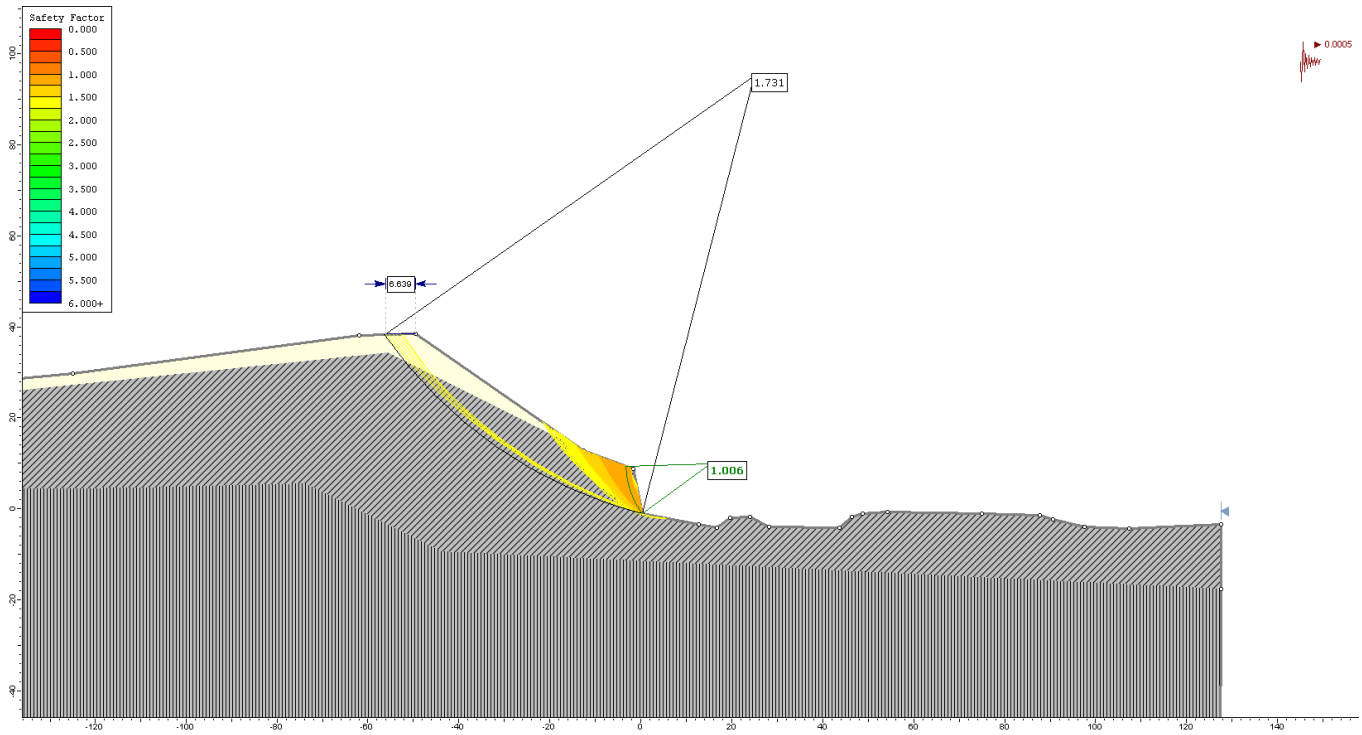


Figure 3.7. Highlighted are surfaces within the west wall of Pit 2 that have FoS values less than 1.7.

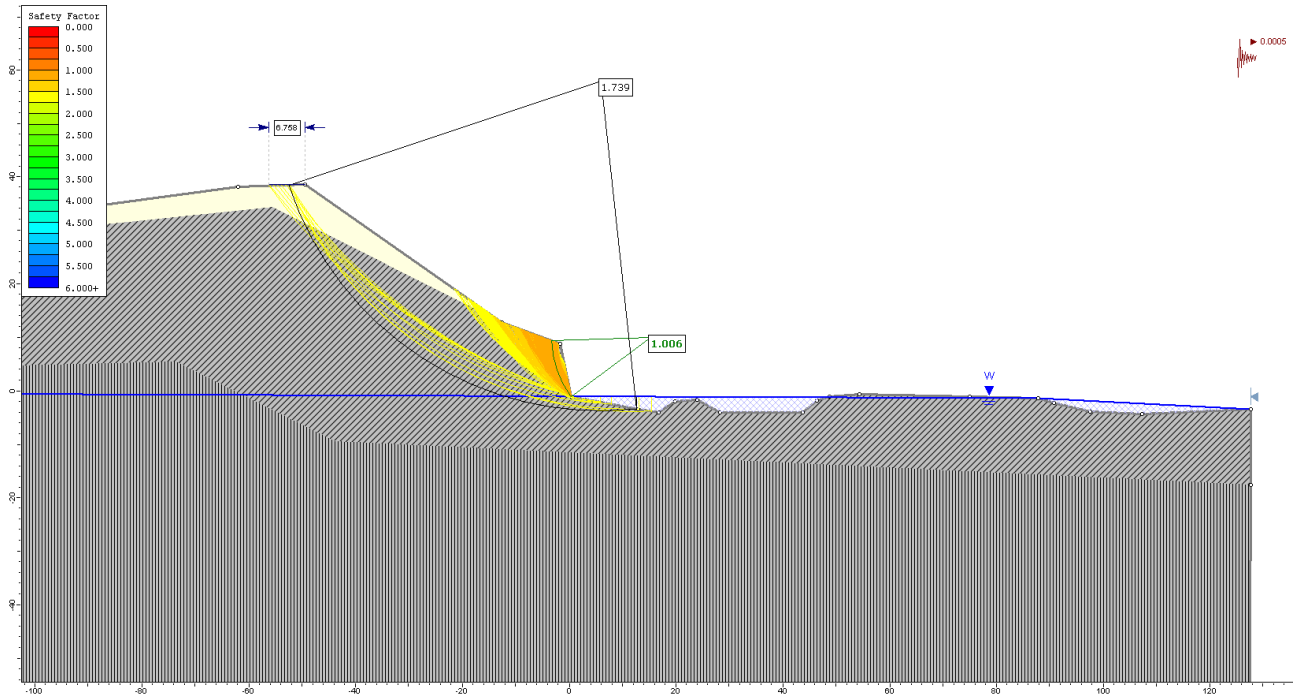


Figure A3.8. Highlighted are surfaces within the west wall of Pit 3-4 with water at floor level having FoS values less than 1.74.

APPENDIX 4 WRD SLOPE STABILITY

The stabilities of surfaces through the two slopes of the WRD highlighted in Figure 25 were assessed using the limit-state equilibrium method implemented in *Slide2.*

The following characteristics were assumed:

- The slopes, shown in Figures A4.1 and A4.2, have the dimensions listed in Table 8.
- The shear strength characteristics of the materials are described using linear Mohr-Coulomb models defined in terms of friction angles and cohesions:
  - The footings comprise clayey silt defined in terms of a friction angle of 25^{o} and a cohesion of 50 kPa, as discussed in Section 3.2.1.
  - The materials within the dump are defined in terms of a conservative 31^{o} friction angle, as discussed in Appendix A1.6.
- As evidenced by observation, the materials within the dump are assumed to be permeable. Water that infiltrates the surfaces and does not subsequently evaporate, seeps from the down contour toe. Excess hydrostatic pressures do not develop within the materials.
- A PGA of 0.001g, discussed in Section 3.4, is represented as a pseudo-static horizontal force directed out of the wall.

The results of the analyses are quantified in terms of Factor of Safety (FoS) values for each of hundreds of surfaces assessed within each slope. The surfaces having the lowest capacities are highlighted in Figures A4.1 and A4.2. The results of the analyses are discussed in Section 7.

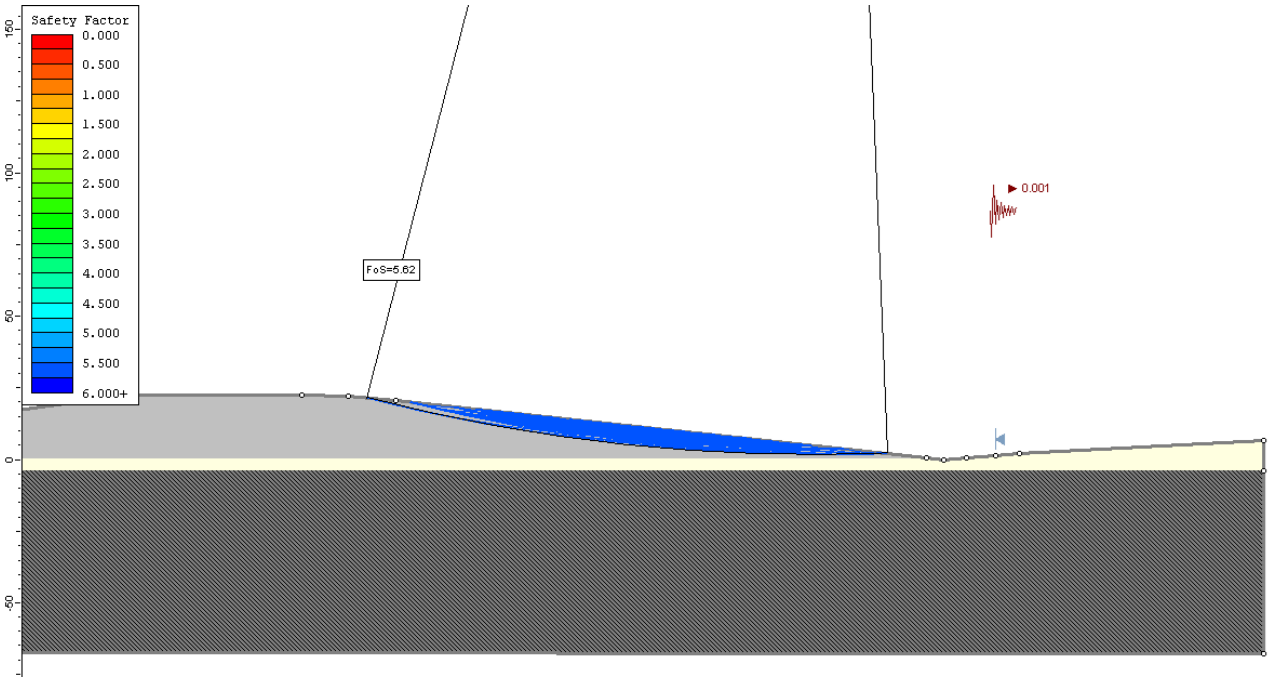


Figure A4.1. Highlighted are surfaces within cross section C-C' through the WRD that have the lowest FoS values. Dynamic loading is assumed. All values exceed 5.6.

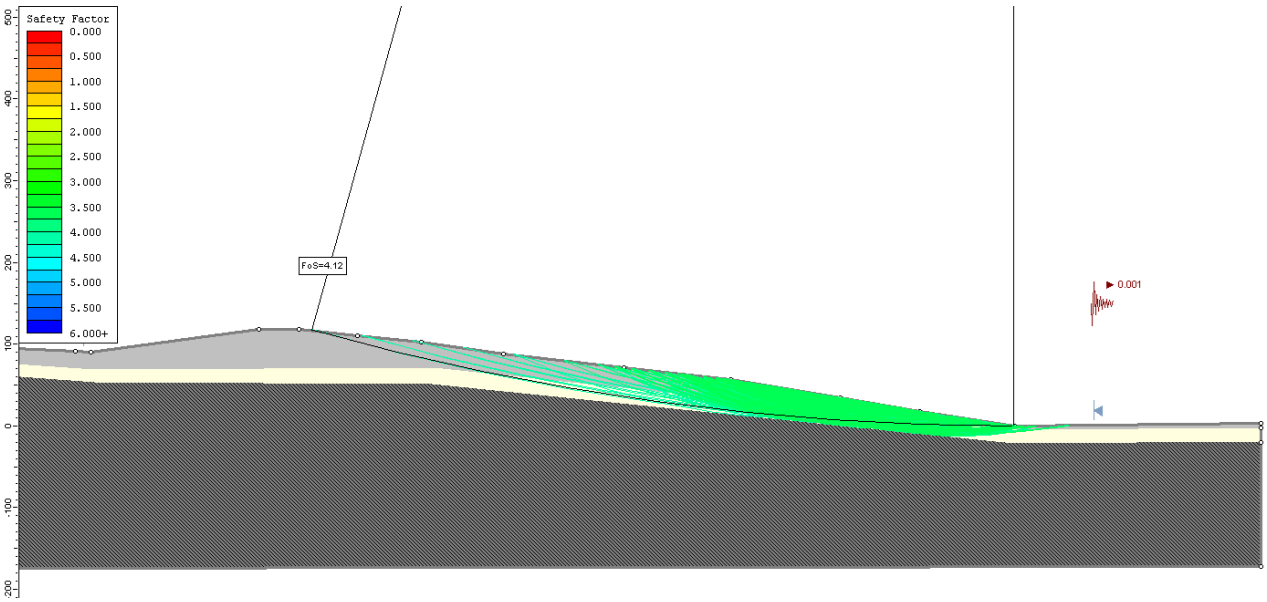


Figure A4.2. Highlighted are surfaces within cross section D-D' through the WRD that have the lowest FoS values. Dynamic loading is assumed. All values exceed 4.1.

APPENDIX 5 BENCH SCALE ROCKFALL ANALYSES

A series of rockfall simulations[62] were undertaken to inform an understanding of the trajectories of rocks that release from and traverse down a final batters in Pit 3-4 and the likelihoods for these rocks to traverse over the crest of the berm. The simulations used the rigid block method as implemented in the software *Rocfall2*[63]. This two-dimensional analysis code is applicable as no evidence has been observed indicating that falling rocks traverse significant distances in the third dimension i.e. along strike of a batter.

Figure 23 is the cross section of the bench. It is 12 m high with a 65° batter angle. The berm is 10 m wide and contains a 1 m high edge bund. These values are consistent with the values listed in

- Table 2.
- Table A5.1 lists the values of the parameters assumed for the rebound characteristics of the batter and the berm[64]. The batter is assumed to comprise exposed rocks; the berm to comprise fines and rockfall debris.
- Tables A5.2 and A5.3 summarise the sizes and shapes assumed for the rocks based on observation (Figure A5.1). The shapes are typically rounded and non-rounded blocks (i.e., uniform side lengths) and rounded and non-rounded rectangles (i.e., non-uniform side lengths).

The source for the rocks is assumed to be the crest; rockfalls being triggered by overland flows. This assumption is conservative as rocks typically fall from anywhere on a batter. A simulation involved generating a thousand rocks.

Figure 23 shows the trajectories of 1000 rocks generated. None of the rocks traverses beyond the edge bund. The combination of a 10 m wide berm and 1 m high edge bund is likely to be sufficient to terminate the trajectories of rocks that detach from the adjacent batters.

Table A5.1. Normal distribution parameters assumed for the batter.

Parameter	*Normal restitution*	*Tangential restitution*	*Dynamic friction*	*Rolling friction*
Mean	0.45	0.85	0.75	0.40
Standard deviation	0.04	0.04	0.04	0.04
Relative minimum	0.12	0.12	0.12	0.12
Relative maximum	0.12	0.12	0.12	0.12

[62] The simulations used the software Rocfall2.

[63] The proprietary software Rockfall 2 Version 8.024 is developed by Rocscience.

[64] Some values of the parameters listed in Table A5.1 are different to the default values suggested by Rocscience. The four mean values "suggested" by Rocscience for the normal and tangential coefficients of restitution (0.35 and 0.85) and the coefficients of dynamic and rolling friction (0.75 and 0.40) are default values. Some, or all, values rarely reflect the actual values at any site as the geology, surface characteristics and profile and weathering characteristics differ between sites. Rocscience provides tables of values that have been used by other practitioners. In these tables, the ranges of coefficients and the mean value assumed in the report are approximately those as follows: normal restitution: 0.25 to 0.60 (0.45), tangential restitution: 0.55 to 0.95 (0.85), dynamic friction: 0.5-inadequate data (0.75) and rolling friction: 0.4 to 0.9 (0.4). The values used in the current study are within the ranges applied by other practitioners. The upper bound value for dynamic friction seeks to quantify the significant braking effect the roughness of the weathered surface and rocks have on sliding. The values assumed in this study are deemed appropriate based on observations of the trajectories of rocks that have fallen within the pits at this site. The end locations of the rocks in the simulations are acceptably similar to the actual end locations of the rocks that have ended up on the berms, ramps and pit floors, which provides evidence that the values assumed for the parameters are "in the ballpark".

Table A5.2. Normal distribution parameters assumed for the berm.

Parameter	*Normal restitution*	*Tangential restitution*	*Dynamic friction*	*Rolling friction*
Mean	0.32	0.80	0.50	0.30
Standard deviation	0.04	0.04	0.04	0.04
Relative minimum	0.12	0.12	0.12	0.12
Relative maximum	0.12	0.12	0.12	0.12

Table A5.2. Parameters assumed for the rocks.

Parameter	*Edge length (m)*	*Volume (cc)*	*Mass (kg)*	*Density (kg/m^3)*
Mean	0.20	7,990	21.1	2,650
Standard deviation	0.05	3,560	9.4	50
Relative minimum	0.19	7,391	19.5	200
Relative maximum	0.80	22,230	56.7	50

Table A5.3. Shapes assumed for the rocks.

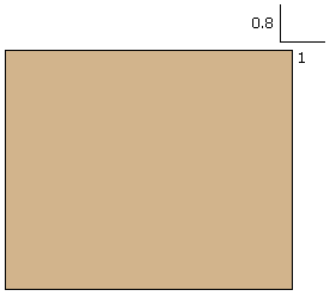
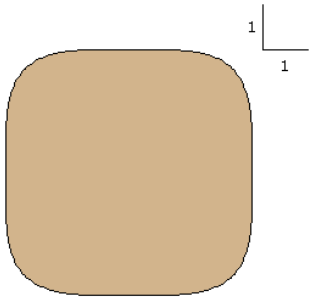
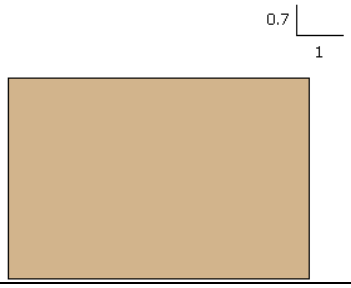
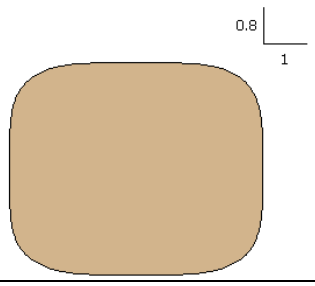
Blocks	*Rounded blocks*
	
	



Figure A5.1. Typical muckpile highlighting the range of rock shapes and sizes generally exposed on the benches. The sizes and shapes generated in the simulation are consistent with these observations.

Appendix C Soil and Land Suitability Assessment



A Montrose Environmental Company

Calliope Limestone Quarry Soil and Land Suitability Assessment

Graymont (Calliope) Pty Ltd
Calliope Limestone Quarry Soil and Land Suitability Assessment
Calliope Limestone Quarry
BCL230021.01
30 June 2025

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1 INTRODUCTION

Epic Environmental (Epic) was commissioned by Graymont (Calliope) Pty Ltd (Graymont) to conduct a soil and land suitability (SALS) assessment and to provide advice on soil stripping, soil stockpiling and suitability of the recovered soil resources for use in the proposed rehabilitation of the site post-mining. This work will support the preparation of the Progressive Rehabilitation and Closure Plan (PRCP) requirements for the Calliope Limestone Quarry (the site). Graymont has approval for mining activity granted under Environmental Authority (EA) EPML00969013. This applies to the following Mining Leases (ML): ML3594, ML3595, ML3596, ML3597, ML3598, ML3599, ML3600, ML3602, ML3603, ML3604, ML3605, ML3606, ML3608, ML3609, ML80036, ML80189, ML80190, ML80191, ML80192 (the MLs).

The site is located approximately 11 km south of the township of Calliope and 30 km south of Gladstone in Central Queensland. It lies within the Gladstone Regional Local Government Area (LGA) (**Figure F1**)**.**

The investigation area (56.35 ha) covers part of the southern portion of the site that is largely unaffected by mining activities, but which may be disturbed during the planned life of the mine (**Figure F1**).

1.1 Objectives

The SALS assessment will determine the suitability of land to be disturbed by mining for agricultural uses in the investigation area. The soil survey and analytical data will also be used to provide advice on soil stripping, soil stockpiling and the suitability of the recovered soil resources for use in the proposed rehabilitation of the site to a nominated post-mine land use (PMLU). This work will support the development of an appropriate rehabilitation strategy for the site that will be incorporated into the PRCP.

1.2 Scope of Works

To achieve the objective, a soil and land survey, and soil sampling was undertaken between 24th June 2023 to 30th June 2023. The fieldworks program included the following elements:

- Soil and land survey
  - Advancement of 11 test pits across the investigation area to a maximum depth of 2.0 metres below ground level (mbgl)
  - Advancement of eight shallow (0.3 mbgl) hand excavations across the investigation area
  - Surface observations at seven locations across the investigation area
- Submission of soil samples to a National Association of Testing Authority (NATA) accredited laboratory and/or a laboratory certified by the Australasian Soil and Plant Analysis Council (ASPAC) for selected analysis
- Interpretation of field and laboratory data and the preparation of this SALS report

1.3 Technical Framework

The soil survey was conducted with consideration of the following sources and guidance material:

- Australian Soil and Land Survey: Field Handbook (NCST 2009)
- Guidelines for Surveying Soil and Land Resources (McKenzie et al. 2008)
- The Australian Soil Classification (Isbell and NCST 2021)
- Technical Guidelines for Environmental Management of Exploration and Mining in Queensland – Land suitability assessment techniques (DME 1995)
- Guidelines for Agricultural Land Evaluation in Queensland (Second Edition) (DSITI & DNRM 2015)
- Regional Land Suitability Frameworks for Queensland (DNRM 2013)
- Queensland Soil and Land Resource Survey Information Guideline, VEG/2018/4460, v2.00 (DoR 2021)

2 SITE DESCRIPTION AND SETTING

2.1 Site Description

The site is wholly located within the Gladstone Regional LGA, at Taragoola, near the Central Queensland coast (**Figure F1**). It lies 11 km south of the township of Calliope, approximately 30 km south south-west of Gladstone.

The south, east and west of the site is surrounded by Lake Awoonga which is operated by the Gladstone Area Water Board (GAWB). The primary access route to the site is via Taragoola Road which adjoins Nuggety Road to the west of the Site. To the north, Charters Crossing Road intersects the site and acts as an alternative access route. An unnamed road, managed by GAWB, borders the west, south-west boundary and the closest residential area is approximately 4 km north of the site's northern boundary. Surrounding land is primarily State land, managed by the GAWB. The land use is classified as grazing on native vegetation (i.e., unimproved pasture).

A summary of the site details is summarised in **Table 1.**

Table 1. Site and investigation area details

Category	Details
Address	Taragoola Rd, Taragoola QLD 4680 Site entrance coordinates: -24.093083, 151.239753
Legal property description	The site covers the following land parcels: 100CTN1823, 1RP610128, 22SP215268, 26SP228426, 4RP610128, 7SP215269, 90SP275218, ASP231548, BSP231548, CSP231548, DSP231548, ESP215268 & GSP199253
Site operator	Graymont (Calliope) Pty Ltd
Site access	From Taragoola Rd
Local Government Area	Gladstone Regional Local Government Area
Current land use	Mining and grazing on native vegetation
Investigation area	The investigation area covers currently unmined land which is anticipated to be disturbed by future expansion of the mining operations during the life of mine (Figure F2). The total investigation area is approximately 56.35 ha.

2.2 Topography

The local topography is characterised by undulating to rolling low hills with elevations ranging from 40 to 100 metres Australian Height Datum (mAHD), as shown in **Figure F2**. Topography falls to the east, south, and west to Lake Awoonga.

The Eastern bund wall and Western bund wall were constructed to protect the site and operations from inundation from Lake Awoonga flood waters, The Eastern bund wall, adjacent to Raggote Creek, is 1.9 km long and was constructed of earth and rock. The Western bund wall, adjacent to Lake Awoonga, is of a similar construction, but smaller. Both bund walls are also used as access tracks with the crest of these walls are approximately 52 mAHD. The construction of the bud walls was completed as part of a cooperative agreement between the previous owners of the site and the GAWB.

2.3 Climate

The site is located within Queensland's sub-tropical climatic zone which is characterised by high summer temperatures, warm dry winters, and distinct wet and dry seasons (Bureau of Meteorology 2020).The Gladstone Radar Weather Station (station no. 39123) is the closest weather station to the site, located approximately 27 km from the site. The weather station is located closer to the coast at a lower elevation and may represent a slightly different climate than that experienced at the site. Climate data was available from 1957 to present from the Gladstone Radar Weather Station. The region experiences an annual mean maximum temperature of 31.4 degrees Celsius (°C) and mean minimum temperature of 23.0°C. The long-term mean temperature is presented in **Figure 1.**

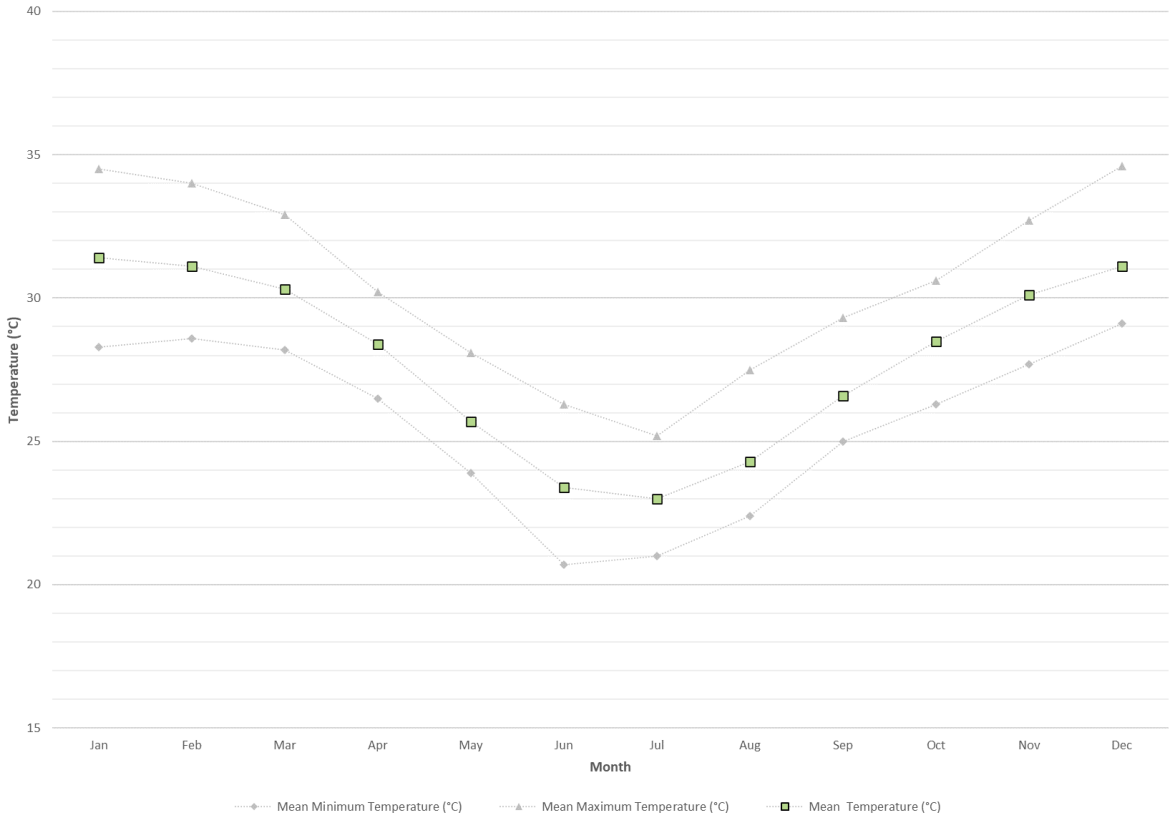


Figure 1. Mean monthly temperature data (BOM weather station 39123)

The rainfall data recorded at Gladstone Radar Weather Station shows distinct wet and dry seasons, with high rainfall from December to March and low rainfall from April to November, with a mean total annual rainfall of 882.8 mm. The long-term mean rainfall pattern is presented on **Figure 2.**

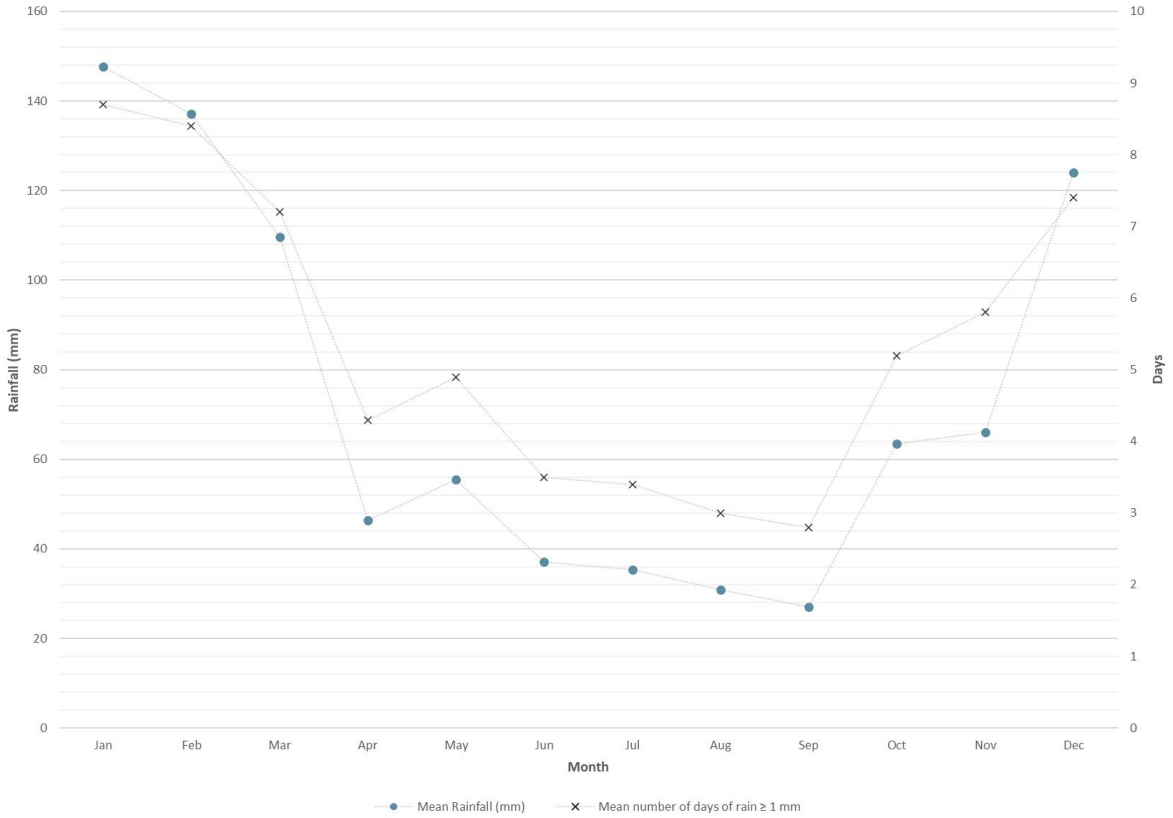


Figure 2. Mean monthly rainfall data (BOM weather station 39123)

2.4 Geological Setting

The site is underlain by five geological formations[1], which include the Calliope beds, Calliope beds limestone, Mount Alma Formation, Quaternary alluvium and Rockhampton Group (**Figure F3**) described below:

- Calliope Beds (SDa/l): Fossiliferous limestone and marble
- Calliope Beds (SDa): Basaltic to andesitic (rarely dacitic and rhyolitic) volcaniclastic sandstone and conglomerate, limestone, siltstone and andesite
- Rockhampton Group (Cr): Dark grey mudstone, siltstone, felsic volcaniclastic sandstone, polymictic conglomerate, ooid-bearing sandstone and conglomerate with mudstone rip-up clasts; oolitic and pisolitic limestone, minor skeletal limestone and rare rhyolitic ignimbrite
- Mount Alma Formation (DCa): Thinly interbedded fine-grained sandstone and siltstone and thick beds of conglomerate with andesitic to dacitic clasts and siltstone rip-up-clasts
- Quaternary alluvium-QLD (Qa-QLD): Clay, silt, sand and gravel; flood-plain alluvium. Note that this geological formation does not cover the investigation area.

The investigation area does not include areas underlain by Quaternary alluvium-QLD (Qa-QLD).

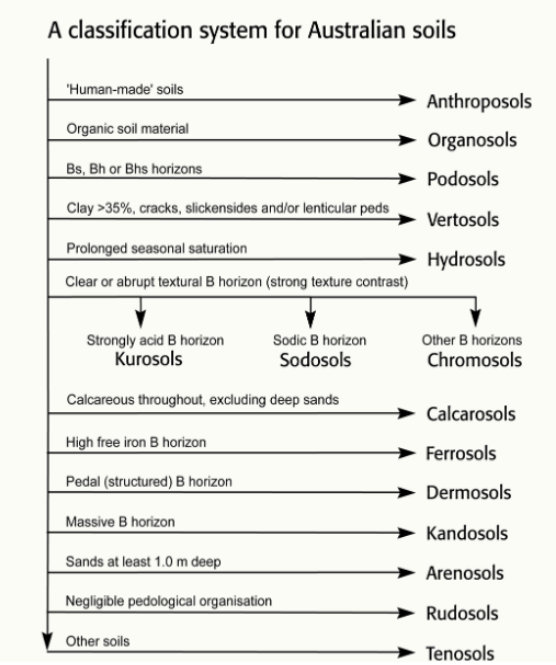
[1] Detailed Surface Geology - Queensland, available through Queensland Spatial Catalogue (Q Spatial) Online resource at https://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={0CEA14DE-D170-4CA2-9FC9-20ED49143B4B}

2.5 Review of Existing Soil Mapping and Land Evaluation Resources

2.5.1 Digital Atlas of Australian Soils

The Digital Atlas of Australian Soils (1:2 000 000 scale) (BRS 2009) indicates the investigation area is contains colluvial and alluvial soils typified by hard pedal mottled-yellow duplex (texture contrast) soils (most likely equivalent to Chromosols in the Australia Soil Classification [ASC] of Isbell and NCST 2021). A summary of the ASC is provided in Figure 3

Figure 3. Simplified key to the ASC Orders (Isbell and NCST 2021)



2.5.2 Land Systems of the Capricornia Coast

A search on the Queensland Government's Soils Data Portal (accessed 8 March 2023) identified the area lies within the boundaries of Map 3 of the Land Systems of the Capricornia Coast (scale 1:250 000) prepared by the Queensland Department of Primary Industries (1995). The map is provided in **Appendix B** and shows that the investigation area lies within the Clifton (Cf) land system. The landform and major soils of the Clifton land system are described in **Table 2**.

Table 2. Description of the Clifton land system (Queensland Department of Primary Industries 1995)

Map code	Land system	Landform and geology	Major soils	Native vegetation
Cf	Clifton	Steep to rolling hills on steeply dipping sedimentary rocks with minor volcanic intrusions	Shallow, stony brown and black. massive loams and clay loams; bleached sandy and loamy surface, brown and grey, alkaline sodic duplex soils	Eucalypt woodland (lemon-scented gum, narrow- leaved ironbark, pink bloodwood, Queensland peppermint) with mixed understory

2.5.3 Soil Mapping Sites

A search of Queensland Soil and Land Information (SALI) site listings (soil descriptions logged for previous government sponsored land resource surveys accessed through Queensland Globe[2]) identified four soil mapping sites (archived profile descriptions collected during previous soil and land surveys) within the site. None of the soil mapping sites were located within the investigation area (**Figure F3**). Details of each soil site are summarised in **Table 3** and full soil and landform information reports are provided in **Appendix A.**

Table 3. Soil and mapping site details

ID	ASC and description		Soil code	Substrate lithology	Slope (%)	Landform	Disturbances
CCL187	Chromosol	Sodic, Eutrophic, Brown Chromosol; medium, non-gravelly, clay loamy, clayey, moderate	Bo (Bondoola)	Colluvium	6	Low hills	Limited clearing
CCL236	Dermosol	Haplic, Eutrophic, Red Dermosol; medium, non-gravelly, clayey, moderate	Cm (Cammoo)	Limestone	Not recorded	Hillslope	Extensive clearing
CCL237	Dermosol	Haplic, Eutrophic, Red Dermosol; medium, non-gravelly, clayey, very deep	Cm (Cammoo)	Limestone	5	Hillslope	Extensive clearing
CCL238	Vertosol	Endo-calcareous, Self-mulching, Black Vertosol; non-gravelly, fine, very fine, very deep	Cw (Cardowan)	Limestone	3	Alluvial Plain	Not recorded

2.5.4 Agricultural Land Class

The Agricultural Land Audit (DAFF 2013) identifies land currently used for agriculture and land with the potential to be used for agriculture using the Agricultural Land Class (ALC) scheme (DSITI & DNRM 2015). The standard definitions for each class are:

- **Class A:** Crop land that is suitable for a wide range of current and potential crops with nil to moderate limitations to production
  - **A1**: Suitable for a wide range of current and potential broadacre and horticultural crops
  - **A2**: Only suitable for a wide range of current and horticultural crops
- **Class B:** Limited crop land that is suitable for a narrow range of current and potential crops due to severe limitations, but is highly suitable for pastures. Land may be suitable for cropping with engineering or agronomic improvements
- **Class C:** Pasture land that is suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production. Some areas may tolerate a short period of ground disturbance for pasture establishment
  - **C1**: Suitable for grazing sown pastures that require ground disturbance for establishment or native pastures on higher fertility soils
  - **C2**: Suitable for grazing on native pastures, with or without the introduction of pasture and with lower fertility soils than C1
  - **C3**: Light grazing of native pastures only suitable in accessible areas. Also includes steep land more suited to forestry or catchment protection

[2] Queensland Globe, *Layer - Soil sites*, accessed 08 March 2024,metadata available at https://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={0B7EB39F-73C8-4079-9CEE-27C43A11821C}

- **Class D:** Non-agricultural land and land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant conservation or catchment values, land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop, poor drainage, salinity, acidic drainage, or is an urbanised area

The investigation area is mapped as Class C2 under the ALC scheme[3]. This is consistent with the current land use.

2.5.5 Strategic Cropping Land

The investigation area is not mapped as Strategic cropping land (SCL) (accessed through Queensland Globe, 29 August 2023[4]). A review of the Queensland Globe layer '*Regional Planning Interests Act* 2014' indicated no Priority Agricultural Areas (PAAs), Priority Living Areas (PLAs), Strategic Environmental Areas (SEAs) or Strategic Cropping Areas (SCAs) within the investigation area (accessed through Queensland Globe, 3 June 2024[5]).

2.6 Land Use

The land uses mapped in areas surrounding the investigation include reservoir/dam, mining and grazing on native vegetation. The land uses mapped within the investigation area include grazing on native vegetation and mining (**Figure F5**).

2.7 Hydrology

The site is largely surrounded by Lake Awoonga which is a drinking water supply dam managed by the GAWB (**Figure F1**).

The site is not within the flood warning area, and it is not located within a floodplain or flood hazard area under the Gladstone Regional Council (GRC) Planning Scheme (GRC 2017). The site is located adjacent to areas that can be affected by major floods but is protected by two bunds that prevent inundation from rising waters in Lake Awoonga during periods of high rainfall.

One section of the investigation area, adjacent to the southern waste rock dump, is affected by to periodic waterlogging and standing water. This is caused by the presence of the southern waste rock dump which restricts the flow in two ephemeral drainage lines (**Figure F1**).

[3] Queensland Globe, *Layer - Agricultural land class A, B, C and D*, accessed 04 June 2024, metadata available at https://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={405BEB64-9216-4502-839B-A94DD67EA961}

[4] Queensland Globe, *Layer – Strategic Cropping Land*, accessed 29 August 2023, metadata available at https://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={72D1DD11-F6F4-40A2-A625-D7F00819FE09}

[5] Queensland Globe, *Layer - Regional planning interests - Strategic environmental area*, accessed 03 June 2024, metadata available at https://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={54709F43-F94B-4707-A006-D5DE1E538ED5}

3 SOIL PRELIMINARY MAPPING AND PROPOSED SAMPLING DENSITY

3.1 Preliminary Mapping Units (PMUs)

The drafting of Preliminary Mapping Units (PMUs) for the study area was based upon a review of existing information as provided in **Section 2**. The available soils, geology, topography, land systems, hydrology and vegetation data were analysed using geographical information systems (GIS) to identify tracts of land (PMUs) expected to share similar attributes such as soils, geology landform and vegetation that could be separated from neighbouring tracts of land with different attributes. The PMUs were used to direct the field survey and identify possible observation locations for the soil survey.

After the completion of fieldwork these PMUs were reviewed together with information obtained from ground observations and laboratory results to determine the final soil mapping units (SMUs) for the investigation area. A summary of the PMU used for the field survey is provided in **Table 4.**

Table 4. Preliminary mapping units

PMU ID	Geological unit	Land system	Area (hectares)
Sda – Cf	Calliope beds	Clifton	40
Dca – Cf	Mount Alma Formation	Clifton	6
Cr – Cf	Rockhampton Group	Clifton	1
SDa/I – Cf	Calliope beds/I	Clifton	9
		Total	**56**

3.2 Sampling Density

The proposed sampling density required to characterise the investigation area was determined in accordance with *Guidelines for Surveying Soil and Land Resources* (McKenzie et al. 2008). The sampling density was based on a target map scale of 1:10,000. This requires a minimum sampling density of one observation per four hectares or a minimum of 14 observations for the investigation area. Details of the proposed sampling frequency are provided in **Table 5**.

Table 5. Proposed sample density

Observation type and recommended proportion of sites				Proposed density and proportion
Site type	Detailed Sites	Soil description with laboratory analysis (1-5%)		4 (15%)
		Soil description only (10-30%)		7 (25%)
	Observation Sites	Semi-detailed	(Combined 60-88%)	8 (30%)
		Observation		8 (30%)
Total				**27**

4 METHODOLOGY

4.1 Survey Location Selection Rationale

The soil survey locations were selected based on:

- The desktop review of background information (**Section 2**)
- The PMUs (**Section 3**)
- The required sampling density to meet the survey requirements (**Section 3.2**)
- Field observations of the relationship between landscape position and soils

The sample locations follow a stratified systematic sampling pattern. However, adjustments were made to planned observation locations in the field. Details of the methods employed are provided in the following sections. The survey density and scale achieved are provided in **Section 5.1**.

4.2 Soil and Land Survey

4.2.1 Detailed Sites – Soil Description with Laboratory Analysis

Detailed description and soil sampling locations were advanced using an excavator supplied by Graymont down to a maximum depth of 2.0 mbgl to include full extent of B horizon development (refer to **Figure F7**). A range of soil profile morphological attributes were described as per the *Australian Soil and Land Survey Field Handbook* (NCST 2009) including:

- Location (GDA2020) and type of soil observation (e.g., erosion exposed by cutting or hand auger)
- Vegetation description
- Landform type, position of the site and slope gradient
- Surface condition (e.g. presence of cracks, surface crust, rocks, stones and cobbles, erosion status, microrelief)
- Types and vertical extent of soil horizons
- Colour (Munsell Soil Colour Charts [2009]) and mottling of each horizon
- Field texture
- Field pH, Observations of presence and abundance of segregations, coarse fragments, structure, consistency and pedality, and moisture content for each horizon
- Presence of organic matter, roots and prevalence of biological activity
- Presence of gleyed horizons, iron staining, jarosite presence
- Photographs of the soil profile and surrounding landscape

In addition to describing the soil profile, soil samples were generally collected from 0-0.1 m, 0.1-0.2 m, 0.3-0.5 m, 0.6-0.8 m, and 0.8-1.0 m, or at least one sample per horizon with a depth of >0.2 m. The soil samples were collected as outlined below:

- Soil samples were collected from test pit wall (where safe to do so) or the excavator bucket at the nominated depths
- The samples were handled by hand using disposable nitrile gloves
- A clean pair of nitrile gloves was worn between each sample depth and location
- The soil samples were immediately transferred into labelled laboratory supplied labelled jars/bags
- Sample containers were sealed as soon as practicable and transferred immediately to a storage container
- A complete Chain of Custody was filled out prior to sending samples to the laboratory

Field duplicates (intra-laboratory) and triplicates (inter-laboratory duplicates) were also collected in the field by collecting soil samples from the same location as a primary sample. The soil samples were mixed and homogenised during collection. However, no splitting of soil samples occurred (i.e., through the use of a riffle splitter).

4.2.2 Detailed Sites – Soil Description Only

Sample locations were advanced and described using the methods in **Section 4.2.1**. However, no soil samples were collected for detailed sites with soil descriptions only. The sample locations are provided in **Figure F7**.

4.2.3 Semi-Detailed Sites

Observational sites with morphological data were described as per NCST (2009) (refer to **Figure F7**). Soils were examined through shallow hand digging or hand augering The major information recorded for these sites included:

- Location (GDA2020) and type of soil observation (e.g., erosion exposed by cutting or hand auger)
- Major vegetation types
- Landform type, position of the site and slope gradient
- Surface condition (e.g., presence of cracks, surface crust, rocks, stones and cobbles, erosion status, microrelief)
- Horizon depth
- Colour (Munsell Soil Colour Charts, 2009) and mottling
- Observations of field texture, pH, coarse fragments, structure, consistency and moisture content
- Photographs of the surface soil and surrounding landscape

4.2.4 Observation Sites

Observation sites were used to identify changes in soil types or soil boundaries. This involved collection of data on basic diagnostic soil attributes and detail surface conditions including rock, slope percentage, landform type and position, dominant vegetation and land condition. The sample locations are provided in **Figure F7**.

4.3 Sample Naming Convention

All soil samples were labelled using the general rules outlined in **Table 6**.

Table 6. Sample naming convention

Sample Type	Sample ID	Sample ID Breakdown
Test pit samples	TP01_0.1, TP01_0.5, etc	TP: Test pit 01: location ID 0.1: 0.1 m depth
Field duplicate	QC100, QC101, etc	QC: Quality Control 100: blind duplicate number ID
Interlaboratory duplicate	QC200, QC201, etc	QC: Quality Control 200: split duplicate number ID

4.4 Laboratory Analysis

Laboratory analysis was completed by the Department of Environment and Science (now Department of Science and Innovation) Chemistry Centre (primary laboratory) and the Southern Cross University Environmental Analysis Laboratory (EAL) (secondary laboratory for inter-laboratory QC samples). These laboratories are either National Association of Testing Authorities (NATA) accredited or Australasian Soil and Plant Analysis Council (ASPAC) certified for the analytical methods used. A summary of the soil analytical schedule is provided below in **Table 7**.

Table 7. Laboratory analytical schedule

Analytical Suite	Full Suite[1]	Limited Suite[2]
Investigation Area		
TP01	2	3
TP03	2	1
TP04	2	2
TP05	2	3
QA/QC Samples		
Inter-laboratory duplicates	2	0
Intra-laboratory duplicates	2	0
Totals	**12**	**9**

Notes:

[1.] Full suite: pH, EC (1:5), total N, nitrate-N, bicarbonate extractable P, organic matter, exchangeable cations (Ca, Mg, K, Na), CEC, Ca/Mg ratio, ESP, DTPA extractable metals, sulfur, chloride, particle size distribution, dispersion,
[2] Limited suite: pH, EC (1:5), exchangeable cations (Ca, Mg, K, Na), CEC, Ca/Mg ratio, ESP, chloride, particle size distribution, dispersion.

4.5 Agricultural Land Evaluation

Land evaluation involves determining the potential for land to be used for a range of possible land uses through the identification of land and soil limitations that may affect sustainable use. *The Regional Land Suitability Framework* (DSITIA and DNRM 2013) provides a land suitability framework that can be applied to different agricultural regions within Queensland.

Given the apparent poor quality of the land according to the ALC mapping (C2 Pasture Land see **Section 2.5.4**) and the investigation area is constrained by surrounding land uses (mining) and waterways or lakes which would limit development for cropping, the land evaluation has focussed on rainfed grazing /pasture land uses. The *Regional Land Suitability Frameworks for Queensland* (DSITIA and DNRM 2013) for the Central Queensland Coast region does not contain limitations and limitation classes for a rainfed beef grazing land use. In the absence of suitable regional limitation classes, the land suitability assessment will reference the limitation classes for rainfed beef grazing presented in the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME 1995).

The soil and land attributes recorded for each SMU have been compared to the limitation classes in DME (1995). Land suitability is ranked according to five classes as described in *Queensland Guidelines for Agricultural Land Evaluation* (DSITI & DNRM 2015) and presented in **Table 8**. The overall land suitability for each SMU is based on the most limiting attribute score obtained.

Table 8. Land suitability classes used in Queensland

Land Suitability Class	Description	Definition
1	Suitable land with negligible limitations	This is highly productive land requiring only simple management practices to maintain economic production.
2	Suitable land with minor limitations	Either reduce production or require more than the simple management practices of class 1 land to maintain economic production.
3	Suitable land with moderate limitations	Either further lower production or require more than those management practices of class 2 land to maintain economic production.
4	Unsuitable land with severe limitations (also referred to as marginal land)	Presently considered unsuitable due to severe limitations. The long-term significance of these limitations on the proposed land use is unknown or not quantified. The use of this land is dependent upon undertaking additional studies to determine whether the effect of the limitation(s) can be reduced to achieve sustained economic production.
5	Unsuitable land with extreme limitations	Extreme limitations that preclude its use.

Note: the colours represent the standard colour palette used for land suitability class mapping in Queensland

5 RESULTS

5.1 Final Survey Density

The overall number of investigation sites resulted in a survey density to achieve the recommended mapping scale equivalent to a 1:10,000 as presented in **Table 9.**

Table 9. Survey sample density compared to requirements to achieve 1:10,000 mapping scale

Survey parameter	Total	Detailed sites	Analysed sites	Semi-detailed (morphological features)	Observation sites
Recommended number of observations	14-56	2-17	1-3	8-49	
Recommended proportion of observations	-	10-30%	1-5%	60-88%	
Survey observation numbers	26	11*	4	7	8
Survey proportion of observations	-	42%*	15%	58%	

*Includes analysed sites

5.2 Soil Mapping Units

SMUs were identified within the investigation area according to data collected during the soil and land survey, desktop review information, and laboratory analysis of selected soil samples. The individual SMUs have been classified in accordance with the ASC (Isbell and NCST 2021). The soil landscapes and SMUs are presented in **Table 10** and further details of each provided in summary sheets that follow. The extent of each SMU and the locations of the survey points are provided on **Figure F7**. Field sheets are presented in **Appendix C**.

Table 10. Summary of soil landscape and SMUs

SMU	Soil landscape description	Dominant broad vegetation	Survey locations (analysed sites in bold)	Surface area (ha)	% of study area
Landscape A: Limestone and marble of the Calliope Beds (SDa/l)					
A1	Very deep, gradational, pale brown to brown moderate structured clay loam to clay surface soil over moderate to well-structured dark brown clay subsoil with very few (<2%) subangular, fine gravels (2-6mm) at the surface. (ASC: Brown Dermosols)	*Eucalyptus crebra* woodland to open woodland (mapped as RE 11.11.15a)	TP10, TP11, OB08 OB04	9.5	16.8
Landscape B: Arenite-mudrock of the Mount Alma Formation (DCa)					
B1	Shallow, gradational, brown to black, moderately structured light clay over dark yellowish brown, weakly to moderately structured very stony clayey sand to medium clay with very few (2%) fine to coarse (2-60 mm) subangular/subrounded gravel fragments at the surface. (ASC: Leptic Rudosol)	*Eucalyptus crebra* woodland to open woodland (mapped as RE 11.11.15a)	TP07, TP08, MO02, MO01	5.5	9.8

SMU	Soil landscape description	Dominant broad vegetation	Survey locations (analysed sites in bold)	Surface area (ha)	% of study area
B2	Deep, uniform, dark grey, very slightly mottled weakly structured medium clay over black, increasingly mottled moderately to well-structured medium clay grading to moderately gravelly mottled yellow medium clay at depth with few (2-10%) fine to medium (2-20mm) subrounded/rounded gravels at the surface. (ASC: Redoxic Hydrosol)	*Eucalyptus crebra* woodland to open woodland (mapped as RE 11.11.15a)	**TP01** OB02	1.5	2.7
Landscape C: Made ground / disturbed largely on limestone substrate					
C1	Deep, disturbed mixed regolith reddish brown; clay loam sandy to light clay; moderate to extremely abundant (20-90%) fine gravels to boulders (2-2000 mm) at the surface. (ASC: Spolic Anthroposol)	Largely cleared - some *Eucalyptus crebra* woodland to open woodland (mapped as RE 11.11.15a)	TP02, MO05, MO03	4.4	7.8
Landscape D: Sedimentary rocks of the Rockhampton Group (Cr)					
D1	Shallow, gradational, moderately to well-structured slightly to very stony dark grey; light clay over extremely stony, mottled weathered parent material with very few (<2%) fine to medium gravels (2-20mm) at the surface. (ASC: Leptic Rudosol)	*Eucalyptus crebra* woodland to open woodland (mapped as RE 11.11.15a)	**TP03,** TP09	1.5	2.6
Landscape E: Mixed sedimentary and mafic rocks of the Calliope Beds (SDa)					
E1	Deep, texture contrast, brown to yellowish brown weakly structured, moderately stony sandy clay loam to clay loam sandy surface soil over strong brown well-structured, moderately stony heavy clay with very few to few (2-10%) fine to medium gravels (2-20mm) at the surface. (ASC: Brown Chromosol)	*Eucalyptus crebra* woodland to open woodland (mapped as RE 11.11.15a / RE 11.11.4))	**TP04,** MO06, MO04	19.3	34.3
E1(s)	E1 shallow phase Moderately deep, texture contrast, dark yellowish brown, weakly structured, stony sandy clay loam over moderately structured, reddish brown, moderately stony medium clay with few (2-10%) fine gravels (2-6 mm) at the surface. (ASC: Brown Chromosol)	Cleared native pasture	TP06	2.2	3.9
E2	Deep, gradational, very dark brown very slightly stony, massive clay loam sandy over brown, increasingly stony, massive clay loam sandy with very slightly to moderate (<2-50%) fine to medium (2-20mm) angular/subangular gravels at the surface. (ASC: Brown Kandosol)	*Eucalyptus crebra* woodland to open woodland (mapped as RE 11.11.15a)	**TP05,** MO07	12.4	22.0

Soil Mapping Unit A1	
Geological landscape:	Fossiliferous limestone and marble on Calliope Beds (SDa/l)
Landform:	Very gently inclined to moderately inclined slopes
Soil concept:	Very deep firm to hard setting brown to dark reddish brown; clayey to clay loamy surface soil over clayey subsoil; very few to few fine gravel at the surface
Australian Soil Classification:	Brown Dermosol
Runoff, permeability, drainage:	Slow to moderately rapid runoff, slowly to moderately permeable, moderately well to imperfectly drained
Erosion:	Minor to moderate sheet erosion
Surface features:	Firm to hard setting
Dominant vegetation:	*Eucalyptus crebra* woodland to open woodland with tussock grass ground cover
Investigation area:	Total area mapped: 9.5 ha No. of field sites: 4 Analysed sites: nil

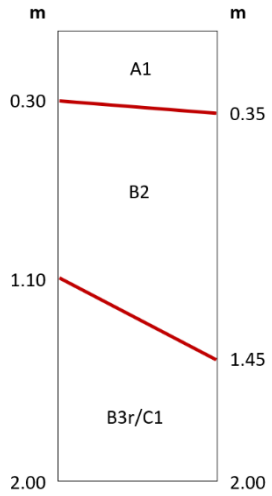


Eucalyptus crebra woodland to open woodland dominated by tussock grass ground cover (TP11)



Firm surface soil with exposed boulder and gravel inclusions (TP10)





The surface soil (A1) very pale brown (10YR 8/2) to brown (7.5YR 5/2) clay loam sandy to light clay with moderate to strong structure; very few (<2%) to few (2-10%) fine gravel (2-6 mm); no segregations; few to common very fine to fine roots; field pH 8-8.5. Gradual change.

The upper subsoil (B21) dark reddish brown (2.5 YR 3/3) to dark brown (7.5YR 3/4) medium to heavy clay with moderate to strong structure; very few (<2%) fine gravel (2-6mm); occasionally few segregations of medium (2-6 mm) ferruginous nodules; few very fine roots; field pH 6.5-8.5.

Lower subsoil (B3r/C1) present in places with soft weathered limestone in massive strong brown clay loam matrix with prominent rusty red mottles; field pH 8.

Est PAWC: 125-150 mm

Soil Mapping Unit B1	
Geological landscape:	Mount Alma Formation (DCa)
Landform:	Very gently to gently inclined slope
Soil concept:	Shallow black to dark yellowish brown; light clay over clayey sand to medium clay; very few to few fine to coarse gravel fragments at the surface.
Australian Soil Classification:	Leptic Rudosol
Runoff, permeability, drainage:	Slow to moderate runoff, slowly to moderately permeable and moderately well to imperfectly drained.
Erosion:	Minor sheet erosion
Surface features:	Soft to hard setting
Dominant vegetation:	*Eucalyptus crebra* woodland to open woodland with tussock grass ground cover
Investigation area:	Total area mapped: 5.5 ha No. of field sites: 4 Analysed sites: nil

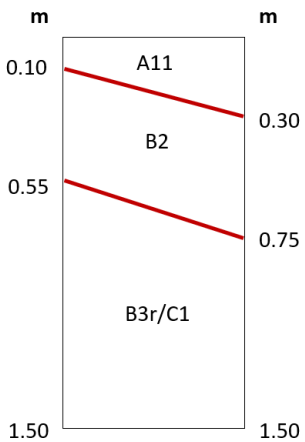


Eucalyptus crebra woodland to open woodland dominated by tussock grass ground cover (TP07)



Hard setting surface (MO02)





The surface soil (A1) dark brown (7.5YR 3/3) to black (7.5YR 2.5/1) light clay with moderate structure; very few (<2%) to common (10-20%) fine to coarse gravel (2-60 mm); few to common very fine to coarse roots; field pH 6-7.5.

The subsoil (B2) is dark yellowish brown (10YR 4/4) clayey sand to medium heavy clay to with weak to moderate structure; extremely abundant (>90%) medium to coarse gravel (6-60 mm) and cobbles to stones (60-600 mm); many red, yellow and orange mottles associated with weathered parent material; many, very fine (<1 mm diameter) roots; field pH 6.

The substrate (B3r/C1) is massive, yellowish brown (10YR 5/4) with little fine material; extremely abundant (>90%) medium to coarse (6-60mm) angular gravel, cobbles (60-200mm) and stones (200-600mm); few very fine to coarse roots, many orange mottles associated with weathered parent material; very fine to coarse (<1->5mm) roots; field pH 6-7.5.

Est PAWC: 75-100 mm

Soil Mapping Unit B2	
Geological landscape:	Mount Alma Formation (DCa)
Landform:	Seasonally shallow inundation
Soil concept:	Deep dark grey to yellow; medium clay; fine to medium gravel fragments at the surface.
Australian Soil Classification:	Redoxic Hydrosol
Runoff, permeability, drainage:	No runoff, slowly permeable and very poorly to imperfectly drained.
Erosion:	Stabilised
Surface features:	Some parts currently flooded and evidence of vegetation dieback
Dominant vegetation:	*Eucalyptus crebra* woodland to open woodland dominated by grasses
Investigation area:	Total area mapped: 1.5 ha No. of field sites: 2 Analysed sites: 1 (TP01)

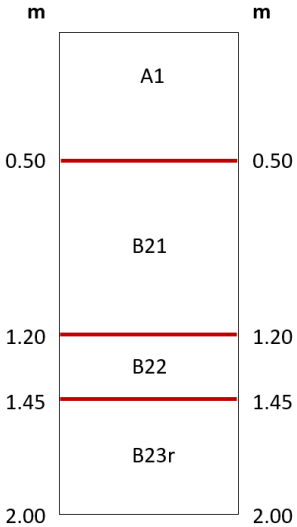


E. crebra woodland (note stags due to waterlogging)



Stabilised surface with grass ground cover (TP01)





The surface soil (A1) variable is hue 5YR 4/1 (dark grey) medium clay with weak structure; slightly or few (2-10%) fine to medium gravel (2-20 mm); many clear dark orange mottles; very few ferromanganiferous nodules; common very fine to fine roots (<1-2 mm diameter); field pH 7.

The subsoil (B2) is a 5YR 2.5/1 (black) medium clay with moderate structure; very few (2-10%) fine to medium subrounded/rounded gravel (2-20 mm); few very fine (<1 mm diameter) roots; field pH 8.5.

The subsoil (B22) is a 5YR 2.5/1 (black) medium clay with strong structure; few (2-10%) fine to coarse (2-60mm) subangular/rounded gravels; many dark diffuse orange mottles; no roots; field pH 8.5.

The subsoil (B23r) is a 10YR 8/8 (yellow) medium clay with moderate structure; many (20-50%) medium to coarse (6-60mm) gravels and cobbles (60-200mm) of angular/subangular shape; many rusty diffuse red mottles; no roots; field pH 8.5.

Est PAWC: 125-150 mm

Analytical data from analysed site TP01

Depth (m)	OC (%)	Total N (%)	Colwell P (mg/kg)	Sulfate S (mg/kg)	Extr. Micronutrients (mg/kg)			
					Cu	Zn	Mn	Fe
0-0.10	2.97	0.27	35	37	3.2	<0.1	24.4	8.8

Depth (m)	Coarse Sand (%)	Fine Sand (%)	Silt (%)	Clay (%)	CEC:clay ratio
0-0.10	6.1	12.1	41.4	40.4	0.59
0.10-0.20	5.8	12.6	41.5	43.9	0.43
0.80-1.00	4.9	10.8	24.7	63.3	0.51
1.25-1.45	10.7	10.6	17.6	63.8	0.47
1.60-1.80	34.9	21.3	15.6	33.1	0.57

Depth (m)	$pH_{1:5}$ H_2O	$EC_{1:5}$ (dS/m)	$Cl_{1:5}$ (mg/kg)	Exch. cations ($cmol^+/kg$)				CEC ($cmol^+/kg$)	ESP %	Ca:Mg Ratio	R1 Disp. Ratio
				Ca	Mg	K	Na				
0-0.1	8.1	0.20	<20	22.6	2.93	0.41	0.19	24	0.79	7.71	0.61
0.10-0.20	8.3	0.19	<20	11.2	7.5	0.16	0.87	19	4.6	1.49	0.72
0.80-1.00	9.0	0.36	<20	13.3	16.3	0.13	4.92	32	15.2	0.82	0.88
1.25-1.45	9.3	0.49	154	10.1	15.9	0.1	6.54	30	22.1	0.64	0.99
1.60-1.80	9.3	0.32	86	10.5	8.4	0.06	3.24	19	17.4	1.25	0.83

Soil Mapping Unit C1	
Geological landscape:	Fossiliferous limestone and marble on Calliope Beds (SDa/l)
Landform:	Very gently to gently inclined slope to crest
Soil concept:	Moderately deep disturbed mixed regolith reddish brown; clay loam sandy to light clay; moderate to extremely abundant fine gravel to boulders (2-2000 mm) at the surface
Australian Soil Classification:	Spolic Anthroposol
Runoff, permeability, drainage:	Very slow to rapid runoff, highly permeable, well drained
Erosion:	Moderate sheet erosion
Surface features:	Loose to soft overburden fill
Dominant vegetation:	*Eucalyptus crebra* woodland to open woodland dominated by tussock grass ground cover
Investigation area:	Total area mapped: 4.4 ha No. of field sites: 3 Analysed sites: nil



Eucalyptus crebra woodland to open woodland dominated by tussock grass ground cover (TP02)



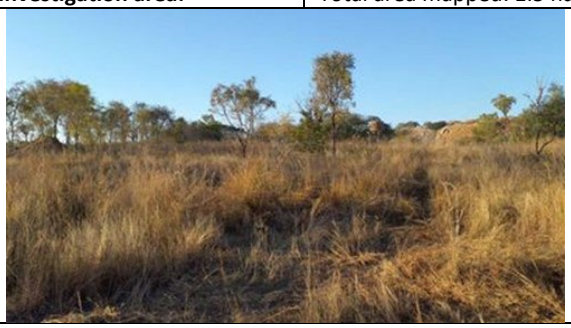
Loose surface containing abundant fine to boulder coarse fragments (MO05)



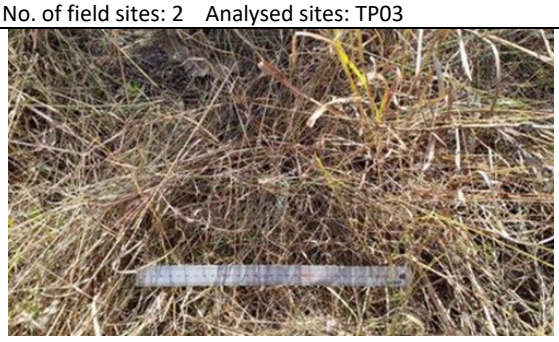
Disturbed and mixed material with distinguishable horizons
No profile diagram shown

Mixed soil and overburden with no distinct horizonation. Colour variable ranging from hues of 5YR (reddish yellow browns) to 10YR (browns to yellowish browns) with massive structure; very abundant (50-90%) fine gravel (2-6mm) to boulders (600-2000 mm); no segregations; common very fine to medium roots; field pH 8-8.5.

Soil Mapping Unit D1	
Geological landscape:	Dark grey mudstone, siltstone, felsic volcaniclastic sandstone, polymictic conglomerate, ooid-bearing sandstone and conglomerate with mudstone rip-up clasts; oolitic & pisolitic limestone, minor skeletal limestone and rhyolitic ignimbrite in Rockhampton Group (Cr)
Landform:	Gently inclined slope
Soil concept:	Shallow dark grey; light to medium clay; very few (<2%) fine to medium gravel (2-20mm) at the surface
Australian Soil Classification:	Leptic Rudosol
Runoff, permeability, drainage:	Slow to moderately rapid runoff, slowly to moderately permeable, moderately to imperfectly drained
Erosion:	Minor sheet erosion
Surface features:	Hard setting
Dominant vegetation:	*Eucalyptus crebra* woodland to open woodland with tussock grasses
Investigation area:	Total area mapped: 1.5 ha No. of field sites: 2 Analysed sites: TP03

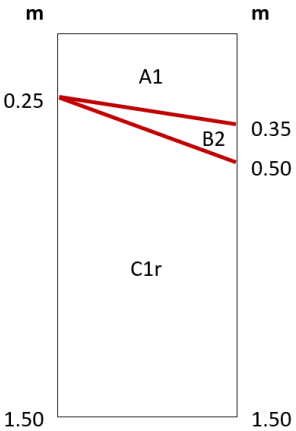


E. crebra woodland with tussock grass ground cover (TP09)



Hard setting surface, very few fine to medium gravel (TP03)





The surface soil (A1) 2.5Y 4/1 (dark grey) to 2.5 YR 2.5/1 (reddish black) light clay with moderate to strong structure; few (2-10%) to abundant (50-90%) fine gravel to cobbles (2-200 mm); no segregations; common to very abundant very fine to coarse roots; field pH 5.5.

The subsoil (B2) where present 2.5YR 4/6 (red) medium clay with moderate structure; common (10-20%) coarse gravel to stones (20-600 mm); dark yellow and grey mottles; few, coarse (>5 mm diameter) roots; field pH 5.5.

The substrate (C1r) 10YR 2/2 (very dark brown), very abundant (>90%) medium pebbles (6-20mm) to stones (200-600mm), dark orange and yellow mottles, field pH 6.0

Est PAWC: 50-75 mm

Analytical data from analysed site TP03

Depth (m)	OC (%)	Total N (%)	Colwell P (mg/kg)	Sulfate S (mg/kg)	Extr. Micronutrients (mg/kg)			
					Cu	Zn	Mn	Fe
0-0.10	3.44	0.241	10	5	0.6	1.6	33.8	51

Depth (m)	Coarse Sand (%)	Fine Sand (%)	Silt (%)	Clay (%)	CEC:clay ratio
0-0.10	25	30.1	20	29.4	0.50
0.10-0.20	26.7	28.1	21.4	29.1	0.31
0.40-0.50	3.9	11.3	15.4	73.8	0.26

Depth (m)	$pH_{1:5}$ H_2O	$EC_{1:5}$ (dS/m)	$Cl_{1:5}$ (mg/kg)	Exch. cations ($cmol^+/kg$)				CEC ($cmol^+/kg$)	ESP %	Ca:Mg Ratio	R1 Disp. Ratio
				Ca	Mg	K	Na				
0-0.10	6.9	0.15	23	10.7	3.13	0.87	<0.08	14.7	<0.54	3.4	0.62
0.10-0.20	6.1	0.05	<20	4.99	3.33	0.62	0.20	9.1	2.2	1.5	0.65
0.40-0.50	6.6	0.11	71	4.88	11.2	0.20	2.59	18.9	13.7	0.4	0.82

Soil Mapping Unit E1	
Geological landscape:	Basaltic to andesitic (rarely dacitic and rhyolitic) volcaniclastic sandstone and conglomerate, limestone, siltstone and andesite on Calliope Beds (SDa)
Landform:	Very gently to gently inclined slope
Soil concept:	Deep dark brown to reddish black; sandy clay loam to heavy clay; very few to few (2-10%) fine to medium gravel (2-20mm) at the surface
Australian Soil Classification:	Brown Chromosol
Runoff, permeability, drainage:	Slow to moderately rapid runoff, very slow to slowly permeable, well to imperfectly drained
Erosion:	Minor sheet erosion
Surface features:	Firm to hard setting
Dominant vegetation:	Tussock grassland with sparsely populated *Eucalyptus crebra*
Investigation area:	Total area mapped: 19.3 ha No. of field sites: 3 Analysed sites: **TP04**

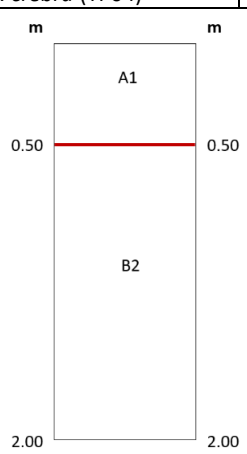


Tussock grassland with sparse *E. crebra* (TP04)



Firm surface containing few fine to medium gravel (MO06)





The surface soil (A1) variable ranges from hue 10YR (browns to yellowish browns) to 7.5 YR (grey to reddish yellow brown) sandy clay loam to clay loamy sand with weak structure; moderate (20-50%) fine gravel (2-6 mm); common (10-20%) ferruginous iron nodules of medium size (2-6 mm); common very fine to fine roots (1-2 mm); field pH 5.5-6.

The subsoil (B2) is a 7.5YR 4/6 (strong brown) heavy clay with strong structure; moderate (20-50%) fine gravel (2-6 mm); very few ferruginous fine to coarse nodules; many, very fine (<1 mm diameter) roots; field pH 6.

Est PAWC: 125-150 mm

Analytical data from analysed site TP04

Depth (m)	OC (%)	Total N (%)	Colwell P (mg/kg)	Sulfate S (mg/kg)	Extr. Micronutrients (mg/kg)			
					Cu	Zn	Mn	Fe
0-0.10	2.93	0.216	15	4	11.9	1.8	62.5	42.9

Depth (m)	Coarse Sand (%)	Fine Sand (%)	Silt (%)	Clay (%)	CEC:clay ratio
0-0.10	31.3	20.5	18.7	33.5	0.55
0.10-0.20	47.9	14.5	10.1	32.8	0.32
0.40-0.50	13.7	10.0	6.9	73.6	0.28
1.85-1.95	9.8	10.2	10.2	74.5	0.35

Depth (m)	$pH_{1:5}$ H_2O	$EC_{1:5}$ (dS/m)	$Cl_{1:5}$ (mg/kg)	Exch. cations ($cmol^+/kg$)				CEC ($cmol^+/kg$)	ESP %	Ca:Mg Ratio	R1 Disp. Ratio
				Ca	Mg	K	Na				
0-0.10	6.7	0.06	<20	14.5	3.45	0.50	<0.08	18.5	<0.54	4.2	0.40
0.10-0.20	6.7	0.02	<20	7.49	2.84	0.16	0.15	10.6	1.40	2.6	0.58
0.40-0.50	7.0	0.04	26	11.9	7.30	0.18	1.1	20.6	5.46	1.6	0.61
1.85-1.95	7.6	0.10	86	14.2	7.16	0.14	1.7	26.0	6.69	2.0	0.79

Soil Mapping Unit E1(s)	
Geological landscape:	Basaltic to andesitic (rarely dacitic and rhyolitic) volcaniclastic sandstone and conglomerate, limestone, siltstone, and andesite on Calliope Beds (SDa)
Landform:	Moderately inclined slope
Soil concept:	Shallow yellowish to dark brown; sandy clay loam to medium clay; few (2-10%) fine gravel (2-6 mm) at the surface
Australian Soil Classification:	Brown Chromosol
Runoff, permeability, drainage:	Slow runoff, slow to moderately permeable, well to imperfectly drained
Erosion:	Minor sheet erosion
Surface features:	Hard setting
Dominant vegetation:	Tussock grassland with sparsely populated *Eucalyptus crebra*
Investigation area:	Total area mapped: 2.2 ha No. of field sites: 1 Analysed sites: nil

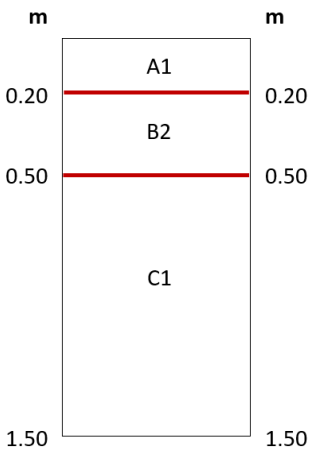


Tussock grassland with sparsely populated *E. crebra* (TP06)



Hard setting surface containing few fine gravel fragments, covered with tussock grass (TP06)





The surface soil (A1) 10YR 3/4 (dark yellowish-brown) sandy clay loam with weak structure; common (10-20%) fine to medium gravel (2-20 mm); very few (<2%) ferruginous iron nodules of medium size (2-6 mm); common very fine to fine roots (1-2 mm); field pH 5.5-6.

The subsoil (B2) 7.5YR 5/4 (reddish brown) medium clay with moderate structure, moderate (20-50%) fine gravel (2-6 mm); very few ferruginous fine to coarse nodules; common, very fine to fine (<1-2 mm diameter) roots; field pH 6.5.

The substrate (C1) 7.5YR 3/3 (dark brown) clayey sand with massive structure; abundant (50-90%) fine to coarse gravel (2-60 mm) and cobbles (60-200 mm); common (10-30%) calcareous and ferruginous nodules; no roots; field pH 6.

Est PAWC: 75-100 mm

Soil Mapping Unit E2	
Geological landscape:	Basaltic to andesitic (rarely dacitic and rhyolitic) volcaniclastic sandstone and conglomerate, limestone, siltstone and andesite on Calliope Beds (SDa)
Landform:	Gently inclined slopes
Soil concept:	Moderately deep hard setting brown; clay loamy sand; very slightly to moderate fine to medium gravels at the surface
Australian Soil Classification:	Brown Kandosol
Runoff, permeability, drainage:	Slow runoff, slowly to moderately permeable, moderately well to imperfectly drained
Erosion:	Minor to no sheet erosion
Surface features:	Loose to hard setting
Dominant vegetation:	*Eucalyptus crebra* woodland to open woodland with tussock grass ground cover
Investigation area:	Total area mapped: 12.4 ha No. of field sites: 2 Analysed sites: **TP05**

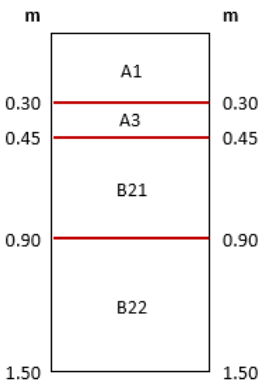


E. crebra woodland to open woodland with tussock grass ground cover (TP05)



Hard setting surface containing very few fine to medium gravels and dense vegetation cover (TP05)





The surface soil (A1) 10YR 2/2 (very dark brown) clay loam, sandy with massive structure; few (2-10%) fine gravel (2-6 mm) to cobbles (60-200 mm); no segregations; common very fine to medium roots (1-5 mm); field pH 6-7.5.

The transition (A3) 10YR 3/3 (dark brown) clay loam, sandy with massive structure; few (2-10%) fine to medium (2-20mm) gravels; common fine to medium (1-5 mm diameter) roots; field pH 6.

The subsoil (B21) 7.5YR 4/4 (brown) clay loam, sandy with massive structure; common (10-20%) fine to medium (2-20mm) gravels; no segregations; few very fine to fine (<1-2 mm diameter) roots; field pH 6.

The subsoil (B22) is a 7.5YR 4/6 (strong brown) medium clay; common (10-20%) fine to medium gravel (2-20 mm); medium earthy segregations; few fine (1-2 mm diameter) roots; field pH 9.5.

Est PAWC: 125-150 mm

Analytical data from analysed site TP05

Depth (m)	OC (%)	Total N (%)	Colwell P (mg/kg)	Sulfate S (mg/kg)	Extr. Micronutrients (mg/kg)			
					Cu	Zn	Mn	Fe
0-0.10	2.99	0.199	9	5	0.9	2.1	105	70

Depth (m)	Coarse Sand (%)	Fine Sand (%)	Silt (%)	Clay (%)	CEC:clay ratio
0-0.10	31.4	31.8	15.2	27.4	0.48
0.10-0.20	36.2	34.1	13.3	27.1	0.35
0.40-0.50	38.9	22.0	10.0	32.5	0.43
0.70-0.80	33.3	26.6	9.9	36.1	0.43
1.50-1.60	32.7	23.9	11.6	34.3	0.41

Depth (m)	$pH_{1:5}$ H_2O	$EC_{1:5}$ (dS/m)	$Cl_{1:5}$ (mg/kg)	Exch. cations ($cmol^+/kg$)				CEC ($cmol^+/kg$)	ESP %	Ca:Mg Ratio	R1 Disp. Ratio
				Ca	Mg	K	Na				
0-0.10	6.21	0.05	<20	8.73	3.84	0.58	<0.08	13.15	<0.54	2.27	0.58
0.10-0.20	6.34	0.03	<20	5.27	3.80	0.11	0.23	9.41	2.46	1.39	0.60
0.40-0.50	6.56	0.03	<20	7.47	5.90	0.10	0.39	13.85	2.79	1.27	0.65
0.70-0.80	6.66	0.04	<20	8.33	6.74	0.09	0.50	15.67	3.22	1.24	0.67
1.50-1.60	6.08	0.21	293	6.81	6.29	0.07	1.79	14.96	6.84	1.08	0.59

5.3 Laboratory Analytical Results

A summary of the soil analytical results and corresponding laboratory transcripts are provided in **Appendix D**.

5.3.1 Quality Assurance

The reproducibility of most intra- and inter-laboratory duplicate samples was within acceptable reproducibility limits (relative percent difference – RPD) based on the limits of reporting[6]. Intra-laboratory samples for EC, exchangeable sodium and extractable sulfur were marginally outside the RPD. A review of the relevant analytes and results indicated that this would not have affected data interpretation.

A summary of the RPD compared to the quality assurance criteria is provided in **Appendix E**.

[6] Note the laboratories chosen for inter laboratory comparisons conducted PSD according to different methods and this data has been excluded for the QA assessment.

6 AGRICULTURAL LAND EVALUATION

The Agricultural Land Audit (DAFF 2013) determined that the investigation area was ALC Class C2 or suitable for grazing on native pastures. Therefore, the SALS assessment land evaluation assessment has considered grazing land uses only.

6.1 Land Suitability Assessment

The aim of the assessment was to evaluate the suitability of the land within the investigation area for rainfed beef grazing in accordance with the methodologies described in **Section 4.5**. The SMU C1 (Spolic Anthroposol) has not been included in the assessment as it has previously been disturbed. The five land suitability classes used for assessing the land are defined in **Section 114.5**, **Table 8**.

The results of the desktop assessment, field survey and laboratory analysis have been reviewed and compared against the limitation classes for rainfed beef cattle grazing presented in DME (1995) Table 2.2. The limitations assessed include:

- Water availability
- Nutrient deficiency
- Soil physical factors
- Salinity
- Rockiness
- Micro relief
- pH
- Exchangeable Sodium Percentage (ESP)
- Wetness
- Topography
- Water erosion
- Flooding
- Vegetation regrowth

6.1.1 Water Availability

Plant available water capacity (PAWC) has been estimated from soil profile properties and the PAWC classes described in Table 2.3 in DME (1995). The PAWC for each SMU was compared to the limitation classes in Table 2.2 in DME (1995). The land suitability limitations for the water availability for each SMU are provided in **Table 11**.

Table 11. Assessment of water availability (PAWC) for rainfed beef grazing (Source DME 1995)

Limitation	Basis for decision rule	Data set used	SMU	Value	Limitation class
Water Availability (PAWC)	PAWC (as estimated from DME 1995)	Soils type/texture & depth to limiting horizon (depth to weathered rock, pH trend, chloride concentration and ESP)	A1	125-150 mm	1
			B1	75-100 mm	3
			B2	125-150 mm	1
			D1	50-75 mm	4
			E1	125-150 mm	1
			E1(s)	75-100 mm	3
			E2	125-150 mm	1

6.1.2 Nutrient Deficiency

The nutrient status of samples analysed was assessed against the limitation classes in Table 2.2 of DME (1995). The land suitability limitations for the nutrient status for each SMU are provided in **Table 12.**

Table 12. Assessment of nutrient deficiency for rainfed beef grazing (Source DME 1995)

Limitation	Basis for decision rule	Data set used	SMU	Value	Limitation class
Nutrient Deficiency	Colwell P and vegetation	Vegetation type, soil texture and depth, Colwell P (10 cm)	A1	Other soils with P 5-10 ppm (P 8 mg/kg)*	3
			B1	Other soils with P 5-10 ppm (P 10 mg/kg)[1]	3
			B2	Eucalypt vegetation with P > 10 ppm (P 35 mg/kg)	2
			D1	Other soils with P 5-10 ppm (P 10 mg/kg)	3
			E1	Eucalypt vegetation with P > 10 ppm (P 15 mg/kg)	2
			E1(s)	Eucalypt vegetation with P > 10 ppm (P 15 mg/kg)[2]	2
			E2	Other soils with P 5-10 ppm (P 9 mg/kg)	3

* No data available for SMU A1. The value for soil chemistry data from CCL Site 237 from the same soil type was used for assessment

[1] No data available for SMU B1, however due to soil similarities with SMU D1 , data from that soil was used for assessment

[2] No data available for SMU E1(s); however, it shares similar soil properties with SMU E1, data from that soil was used for assessment

6.1.3 Soil Physical Factors

Field-described physical factors were assessed against the limitation classes in Table 2.2 in DME (1995) to determine the land suitability class of the SMUs. The land suitability limitations for the soil physical factors of each SMU are provided in **Table 13.**

Table 13. Assessment of soil physical factors for rainfed beef grazing (Source DME 1995)

Limitation	Basis for decision rule	Data set used	SMU	Value	Limitation class
Soil Physical Factors	Surface condition and presence or absence of cracking clay soils	Surface condition	A1	Rigid soils with a hard setting surface when dry	2
			B1	Rigid soils with a hard setting surface when dry	2
			B2	Rigid soils with a firm surface when dry	1
			D1	Rigid soils with a firm surface when dry	1
			E1	Rigid soils with a firm surface when dry	1
			E1(s)	Rigid soils with a hard setting surface when dry	2
			E2	Rigid soils with a hard setting surface when dry	2

6.1.4 Salinity

The laboratory data was assessed against the limitation classes in Table 2.2 of the DME (1995) to determine the land suitability class of the SMUs. The land suitability limitations for salinity of each SMU are provided in **Table 14.**

Table 14. Assessment of salinity for rainfed beef grazing (Source DME 1995)

Limitation	Basis for decision rule	Data set used	SMU	Value (chloride mg/kg)	Limitation class
Salinity	Rootzone chloride concentration	Rootzone chloride concentration (maximum value to 1.5 m)	A1	38 [1]	1
			B1	71 [2]	1
			B2	154	1
			D1	71	1
			E1	26	1
			E1(s)	26 [3]	1
			E2	29	1

1 No data available for SMU A1. The soil chemistry data value from CCL Site 237 from the same soil type was used for assessment
2 No data available for SMU B1. However, due to soil similarities with SMU D1 and data from that soil was used for assessment
3 No data available for SMU E1(s). However, it is a shallow phase of SMU E1 and data from that soil was used for assessment.

6.1.5 Rockiness

Field data on rockiness was assessed against the limitation classes in Table 2.2 in DME (1995). A summary of the land suitability limitations for rockiness for each SMU is provided in **Table 15**.

Table 15. Assessment of rockiness for rainfed beef grazing (Source DME 1995)

Limitation	Basis for decision rule	Data set used	SMU	Value	Limitation class
Rockiness	Cover of coarse gravels or cobbles (>60 mm) and rock outcrop	Surface coarse fragments abundance and occurrence of rock outcrops	A1	Slightly rocky (10-20%) bedrock exposed	1
			B1	Very few to few (<2-10%) fragments	1
			B2	No coarse fragments	1
			D1	Very few to few (<2-10%) fragments	1
			E1	Very few (<2%) fragments	1
			E1(s)	Few (2-10%) fragments	1
			E2	Very few (<2%) fragments	1

6.1.6 Microrelief

Field data on microrelief was assessed against the limitation classes in Table 2.2 in DME (1995) . A summary of the microrelief limitations for each SMU is provided in **Table 16**.

Table 16. Assessment of microrelief for rainfed beef grazing (Source DME 1995)

Limitation	Basis for decision rule	Data set used	SMU	Value	Limitation class
Microrelief	Cover % and depth of Melonhole Gilgai	Microrelief (presence of gilgai)	A1	No gilgai	1
			B1	No gilgai	1
			B2	No gilgai	1
			D1	No gilgai	1
			E1	No gilgai	1
			E1(s)	No gilgai	1
			E2	No gilgai	1

6.1.7 Soil pH

Laboratory and field data on surface soil pH was assessed against the limitation classes in Table 2.2 in DME (1995). The land suitability limitations for the pH of each SMU are provided in **Table 17**.

Table 17. Assessment of pH for rainfed beef grazing (Source DME 1995)

Limitation	Basis for decision rule	Data set used	SMU	Value (pH)	Limitation class
pH (1:5)	Laboratory reported pH (1:5 aqueous) or field assessed pH (indicator)	pH (1:5 aqueous) (0-0.1 m) or field pH (surface horizon)	A1	8.0*	2
			B1	6.0*	1
			B2	8.1	3
			D1	6.9	2
			E1	6.7	2
			E1(s)	6.5*	1
			E2	6.2	1

* Field pH value used

6.1.8 Exchangeable Sodium Percentage (ESP)

Laboratory data was assessed against the limitation classes in Table 2.2 in DME (1995). The land suitability limitations for the ESP of each SMU are provided in **Table 18**.

Table 18: Assessment of ESP % for rainfed beef grazing (Source DME 1995)

Limitation	Basis for decision rule	Data set used	SMU	Value (ESP%)	Limitation class
ESP % (10 cm)	ESP % at 10 cm	Laboratory derived ESP	A1	0.2[1]	1
			B1	2.2[2]	1
			B2	4.6	1
			D1	2.2	1
			E1	1.4	1
			E1(s)	1.4[3]	1
			E2	2.5	1

[1] No data available for SMU A1. The soil chemistry data value from CCL Site 237 from the same soil type was used for assessment
[2] No data available for SMU B1. However, due to soil similarities with SMU D1 and data from that soil was used for assessment
[3] No data available for SMU E1(s). However, it is a shallow phase of SMU E1 and data from that soil was used for assessment

6.1.9 Wetness

Field data and supporting laboratory data were assessed against the limitation classes in Table 2.2 in DME (1995). A summary of the land suitability limitations for the wetness of each SMU is provided in **Table 19**.

Table 19. Assessment of wetness for rainfed beef grazing (Source DME 1995)

Limitation	Basis for decision rule	Data set used	SMU	Value	Limitation class
Wetness	Landform and soils type	Field observations of landform and soil type (supported by laboratory sodicity analysis)	A1	Undulating terrain	1
			B1	Undulating terrain	1
			B2	Shallow seasonal inundation	3
			D1	Undulating terrain	1
			E1	Undulating terrain	1
			E1(s)	Undulating terrain	1
			E2	Undulating terrain	1

6.1.9.1 Topography

Field data was assessed against the limitation classes in Table 2.2 in DME (1995). A summary of the land suitability limitations for the topography of each SMU is provided in **Table 20**.

Table 20. Assessment of topography for rainfed beef grazing (Source DME 1995)

Limitation	Basis for decision rule	Data set used	SMU	Value	Limitation class
Topography	Presences of gullies or steep dissected terrain and slope class %,	Landform pattern (gullying) and slope class %	A1	Slope <15%, not strongly dissected	1
			B1	Slope <15%, not strongly dissected	1
			B2	Slope <15%, not strongly dissected	1
			D1	Slope <15%, not strongly dissected	1
			E1	Slope <15%, not strongly dissected	1
			E1(s)	Slope <15%, not strongly dissected	1
			E2	Slope <15%, not strongly dissected	1

6.1.10 Water Erosion

Laboratory and field data were assessed against the limitation classes in Table 2.2 in DME (1995). A summary of the land suitability limitations for the water erosion of each SMU is provided in **Table 21.**

Table 21. Assessment of water erosion for rainfed beef grazing (Source DME 1995)

Limitation	Basis of decision rule	Data set used	SMU	Value	Limitation class
Water Erosion	Slope % , ESP and soil type	Slope class, surface ESP% and soil type	A1	Gentle slopes (3-12%) on rigid (non-sodic)[1] non-cracking soils	2
			B1	Gentle slopes (3-12%) on rigid (non-sodic)[2] non-cracking soils	2
			B2	Level (<1%) rigid (non-sodic) non-cracking soils	1
			D1	Gentle slopes (3-12%) on rigid (non-sodic) non-cracking soils	2
			E1	Very gentle (1-3%) on rigid (non-sodic) non-cracking soils	1
			E1(s)	Moderate slope (3-12%) on rigid (non-sodic)[3] non-cracking soils	2
			E2	Gentle slopes (3-12%) on rigid (non-sodic) non-cracking soils	2

1 No data available for SMU A1. The soil chemistry data value from CCL Site 237 from the same soil type was used for assessment
2 No data available for SMU B1. However, due to soil similarities with SMU D1 and data from that soil was used for assessment
3 No data available for SMU E1(s). However, it is a shallow phase of SMU E1 and data from that soil was used for assessment.

6.1.11 Flooding

Field data and other sources were assessed against the limitation classes in Table 2.2 in DME (1995). The construction of bunds on the site and the damming of neighbouring Lake Awoonga have protected the site from basin level flood events as summarised in Graymont's *Water Management Plan: Calliope Limestone Operation* (2023). A summary of the limitations for each SMU is provided in **Table 22**.

Table 22. Assessment of flooding for rainfed beef grazing (Source DME 1995)

Limitation	Basis of decision rule	Data set used	SMU	Value	Limitation class
Flooding	Frequency of flooding events	Field observations and site Water Management Plan	A1	No flooding	1
			B1	No flooding	1
			B2	Periodic inundation	2
			D1	No flooding	1
			E1	No flooding	1
			E1(s)	No flooding	1
			E2	No flooding	1

6.1.12 Vegetation Regrowth

Field data was assessed against the limitation classes in Table 2.2 in DME (1995). For this assessment, it was assumed that extensively cleared areas carried Eucalypt woodland similar to that in remnant or partially cleared vegetation. A summary of the limitations for each SMU is provided in **Table 23**.

Table 23. Assessment of vegetation regrowth for rainfed beef grazing (Source DME 1995)

Limitation	Basis for decision rule	Data set used	SMU	Value	Limitation class
Vegetation regrowth (management limitation)	Vegetation observed and RE mapping	Vegetation community	A1	Ironbark woodlands without wattle understorey	2
			B1	Ironbark woodlands without wattle understorey	2
			B2	Former Ironbark woodlands without wattle understorey	2
			D1	Ironbark woodlands without wattle understorey	2
			E1	Ironbark woodlands without wattle understorey	2
			E1(s)	Former Ironbark woodlands without wattle understorey	2
			E2	Ironbark woodlands without wattle understorey	2

6.1.13 Overall Land Suitability Summary

The results of the assessment of individual limitations for rainfed beef grazing have been summarised in **Table 24** for each SMU. A map showing the distribution of Land suitability class for rainfed beef grazing is presented in **Figure F8**. Only land associated with SMU D1 is considered unsuitable for rainfed beef grazing and is limited by low water availability.

Table 24. Overall Land Suitability Class for rainfed beef grazing

Limitation	Limitation class for each SMU						
	A1	B1	B2	D1	E1	E1(s)	E2
Water availability (PAWC)	1	3	1	4	1	3	1
Nutrient deficiency	3	3	2	3	2	2	3
Soil physical factors	2	2	1	1	1	2	2
Salinity	1	1	1	1	1	1	1
Rockiness	1	1	1	1	1	1	1
Microrelief	1	1	1	1	1	1	1
pH	2	1	3	2	2	1	1
ESP	1	1	1	1	1	1	1
Wetness	1	1	3	1	1	1	1
Topography	1	1	1	1	1	1	1
Water erosion	2	2	1	2	1	2	2
Flooding	1	1	2	1	1	1	1
Vegetation regrowth	2	2	2	2	2	2	2
Overall land suitability class	**3**	**3**	**3**	**4**	**2**	**3**	**3**

7 ASSESSMENT OF SOIL QUALITY AND SUITABILITY FOR REHABILITATION

The following provides an assessment of soil quality against a range of important soil quality indicators. General remarks are provided about limitations to stripping depth and a summary of limitations and available soil resources is provided in **Section 8.2**.

7.1.1 Soil Salinity

Elevated salinity can limit the range of potential native species that can be used in rehabilitation. It can therefore affect the selection of PMLUs. None of the root zone electrical conductivity (EC) or chloride results was notably elevated with EC values generally below 0.3 dS/m and chloride concentrations all below 300 mg/kg. EC was slightly elevated in the subsoil of SMU B2 (below 0.5 m), but would not prevent it being used for profile reconstruction for the intended PMLU or for rehabilitation to native vegetation.

The results indicate that there is no limitation to the recovery of topsoils and subsoil materials to a depth of up to 1.0 m where other factors allow. The results indicate that there is no limitation to the use of recovered soils for a PMLU of either grazing or native vegetation.

7.1.2 Soil Sodicity and Dispersion

High sodicity, as measured by ESP%, can cause clay dispersion which makes soils susceptible surface sealing and crusting or, if present in the subsoil, gully and tunnel erosion. Sodic material can also have poor internal drainage properties leading to water logging or poor infiltration that promotes run-off. Therefore, the stripping and/or exposure of sodic materials at the surface should be avoided.

None of the topsoils has ESP values greater than 6% and all would be classed as non-sodic. Sodic soil material (ESP 6-15%) was identified below 0.3 m in SMU D1 (and is expected to occur in SMU B1), below 1.75 m in SMU E1 and below 1.4 m in SMU E2. Strong sodicity (ESP >15%) was identified in the weathered parent material below 0.8 m in SMU B2.

In the sodic or strongly sodic soils from B2, D1 and E1, the elevated ESP values were coupled with relatively high R1 dispersion values (>0.6), low Ca:Mg ratios and a high clay content; indicating the potential for clay dispersion. These materials will be prone to surface sealing and accelerated soil erosion if exposed at the surface. This property will limit the suitability of subsoil material for recovery and reuse and stripping should be limited to the recommended depths in **Table 26**.

7.1.3 Soil pH

Soil pH affects nutrient supply. Extremes of pH may cause deficiencies (such as zinc and iron at high pH) or increase in the availability of elements potentially toxic to plants (such as aluminium which is more readily available at pH below 5.5). Plants vary in their tolerance to pH, and it is not appropriate to use a single desirable pH range for assessing soil quality in terms of its rehabilitation potential. Most native vegetation has a wide pH tolerance (Metcalf and Bui 2016) and species that occur locally would be tolerant to the range of conditions found on site. Similarly native grass species, that may be used for pasture establishment, will be well adapted to local conditions.

Topsoil pH values generally ranged from 6.0 – 8.4 or slightly acid to moderately alkaline and are well within the range pH values measured in natural soils (de Caritat et al. 2011). Soil pH was relatively uniform with depth in SMU D1, E1 and E2, but showed a marked alkaline trend in B2 with pH values up to 9.3 (associated with the strongly sodic conditions described above). This limits the value of subsoil material from SMU B2.

The results indicate that there is no limitation to the recovery of topsoils from any of the SMUs. Subsoil materials (with the exception of subsoils from SMU B2) would be suitable for stripping to a depth of up to 1.0 m where other factors allow. The results indicate that there is no limitation to the use of recovered soils for a PMLU of either grazing or native vegetation.

7.1.4 Nutrient Availability and Nutrient Retention Capacity

The cation exchange capacity (CEC) provides an indication of a soils ability to retain nutrients and make them available for plant use. The SMUs had CEC values of between 9.1 to 32 $cmol^+/kg$ which is rated low to high (Landon 1991). The CEC generally reflects soil clay content with the highest CEC recorded in soils with high clay content (such as SMUs B2 and E1) and lower is soils with lower clay content (such as SMUs D1 and E2). There was also some variability associated with clay mineralogy with SMUs B2 and E1 having a higher proportion of higher activity smectite clays (CEC to clay ratios approaching or exceeding 0.55 mol^+/kg as presented in **Section 5.2**).

The relatively low CEC of topsoils from SMU D1 and E2 will need to be considered in terms of post-rehabilitation soil and fertiliser management. Smaller repeat applications of fertiliser during vegetation re-establishment would be more beneficial than a single initial fertiliser application.

All soils had adequate supplies of exchangeable calcium and magnesium. Although Ca:Mg ratios were low in subsoils, they would not be expected to trigger Ca deficiency in topsoils.

All surface topsoil samples (0-0.1 m) generally had adequate exchangeable potassium levels. However, exchangeable potassium was lower in deeper topsoils (<0.4 $cmol^+/kg$) in all soils except SMU D1 and a response to fertiliser (in terms of productivity) would be expected in affected soils. This would not be a limitation for rehabilitation to native vegetation but will need to be addressed during pasture establishment where grazing is chosen as the PMLU.

The Colwell P (available P) was low (<15 mg/kg) to moderate (up to 35 mg/kg for SMU B2) in surface topsoils (0-0.1 m). Based on site observations, the concentrations are clearly adequate for the maintenance of current grass ground cover or native vegetation. However, a response to fertiliser (in terms of pasture productivity) would be expected for most topsoils and amelioration would be required during pasture establishment where grazing is chosen as the PMLU.

All topsoils were high in organic carbon (all > 1.8 %) and moderate to high in total nitrogen (all >0.15%). Although high organic matter provides benefits for soil structure maintenance, nutrient retention and water holding capacity and organic nitrogen provides a pool of nitrogen that can be released to plants through mineralisation, these properties are not considered when assessing soil quality for a particular end land use For example, they are not considered as limitations in DME (1995), DISITA and DNRM (2013) or Short (2023) and the values obtained do not constitute a significant limitation for rehabilitation. However, maximising the potential of the organic matter (and seed) reserves in surface soils surface soils should be considered through selective stripping of surface soils. Despite the high total nitrogen content, nitrogen should be included in the fertiliser regime for pasture establishment if grazing is chosen as the PMLU.

Of the micronutrients analysed, only the DTPA extractable zinc was low in surface soils from SMU B2. This should be considered when selecting an appropriate fertiliser regime for pasture establishment if grazing is chosen as the PMLU.

7.1.5 Soil Physical Properties and Erosion Risk

Most soils had hard setting surfaces (except SMU B2 and C1) and most has weak or massive structure. However, there was little evidence of crust formation that can restrict germination in soils used for rehabilitation. Only minor sheet erosion was observed during the survey and the topsoils should be resistant to erosion except when placed on steeper slopes (>12%) and where good ground cover is not established.

The sodicity and dispersion risk of subsoils from B2, D1 and E1, means these materials will be prone to surface sealing and accelerated soil erosion if exposed at the surface. This property will limit the suitability of subsoil material recovery and reuse from these soils.

The shallow soils (SMUs B1 and D1) have very high course fragment content in the subsoil or grade to weathered parent material below the topsoil. Subsoil material from these soils would not be suitable for recovery or re-use. Similarly, the Anthroposol (SMU C1) has a high content of coarse fragments throughout. However, this material is loose and could be considered for recovery and reuse where required. The subsoils from the remaining SMUs (A1, B2, E1, E1(s) and E2) have low to moderate course fragment contents and would be suitable for recovery and re-use.

The wetness and the high clay content of SMU B1 mean that there will be few times when the soil is dry enough to allow stripping without causing significant damage to its physical properties and compromising its suitability for rehabilitation. Stripping and recovery of this SMU would not be recommended.

8 CONCLUSION AND RECOMMENDATIONS

8.1 Land Suitability

The outcomes of the land suitability assessment for beef cattle grazing are summarised in **Table 25**.

Table 25. Summary of Land Suitability for beef cattle grazing

Outcome- Overall land suitability class SMU	Land Use – Rainfed beef grazing	Major limiting factors (class 4 and 5)
A1	3	Not applicable
B1	3	Not applicable
B2	3	Not applicable
D1	4	Water availability (PAWC)
E1	2	Not applicable
E1(s)	3	Not applicable
E2	3	Not applicable

The suitability classes of the SMUs mean that:

- SMU E1 is suitable land for beef cattle grazing with minor limitations
- SMUs A1, B1, B2, E2 and E1(s) are suitable land for beef cattle grazing with moderate limitations
- SMUs D1 is unsuitable land for beef cattle grazing with severe limitations

8.2 Soil Stripping

8.2.1 Available Resources

With careful soil stripping and management, the soil resources recovered from most of the SMUs mapped within the investigation area are suitable for reuse in rehabilitation and would be able to support a rainfed beef cattle grazing or native ecosystem PMLU outcome.

Table 26 provides a summary of available soil resources for use in rehabilitation assuming the whole investigation area is disturbed. Subsoils (to 1.0 m) from some of the SMUs would be considered suitable for stripping and can be used as subsurface material in the re-creation of complete soil profiles on rehabilitation areas. This would be most beneficial where natural subsoil material is not present such as on rock dumps tops and areas where excavations to more than 0.3 m below ground level have exposed weathered parent material.

8.2.2 Stripping Management

It is recommended that soils be stripped when moist and friable where practicable. Stripping should be avoided after heavy rain and when soils are powdery (non-cohesive). Vegetation should be removed (including stumps) ahead of stripping and stockpiled for use in rehabilitation either through mulching and use in topsoil soil erosion protection or used as habitat for native wildlife.

Table 26. Summary of stripping depth recommendations and available soil resources

SMU	Topsoil stripping depth (mbgl)	Subsoil stripping depth (mbgl)	Limitations and management recommendations	Area (ha)	Available topsoil (m^3)[1]	Available subsoil (m^3)[1]
A1	0 to 0.3	0.3 to 1.0	There are no significant limitations to topsoil re-use, although it has an elevated pH. However, the elevated pH will not restrict rehabilitation to a PMLU of cattle grazing or native vegetation. Subsoils also suitable for stripping and reuse and a subsoil material. For pasture establishment on re-instated topsoil, an application for a broad based NPK fertiliser will be required. The rate of application should be determined by soil analysis of stockpiled material prior to removal and application.	9.5	28,500	66,500
B1	0 to 0.2	Not recommended	There are no limitations to topsoil re-use. Subsoils are not suitable for stripping and reuse due to high coarse fragment content and potential sodicity issues. For pasture establishment on re-instated topsoil, an application for a broad based NPK fertiliser will be required. The rate of application should be determined by soil analysis of stockpiled material prior to removal and application.	5.5	11,000	0
B2	Not recommended	Not recommended	Waterlogging and high clay content mean that it will be difficult to strip and store topsoils from this SMU without causing serious damage that could affect their quality and suitability for rehabilitation. Therefore, stripping and recovery is not recommended. Subsoils are strongly sodic and prone to dispersion and are not suitable for reuse.	1.5	0	0
C1	Nil	0 to 1.0	Due to the disturbed nature and high coarse fragment content of this SMU, it is only recommended for reuse as a subsoil material.	4.4	0	44,000
D1	0 to 0.3	Not recommended	There are no limitations to topsoil re-use. Subsoils are not suitable for stripping and reuse due to high coarse fragment content and potential sodicity issues. For pasture establishment on re-instated topsoil, an application for a broad based NPK fertiliser will be required. The rate of application should be determined by soil analysis of stockpiled material prior to removal and application.	1.5	4,500	0
E1	0 to 0.3	0.3 to 1.0	There are no limitations to topsoil re-use. Subsoils also suitable for stripping and reuse and a subsoil material. For pasture establishment on re-instated topsoil, an application for a broad based NPK fertiliser will be required. The rate of application should be determined by soil analysis of stockpiled material prior to removal and application.	19.3	57,900	135,100

SMU	Topsoil stripping depth (mbgl)	Subsoil stripping depth (mbgl)	Limitations and management recommendations	Area (ha)	Available topsoil (m^3)[1]	Available subsoil (m^3)[1]
E1(s)	0 to 0.2	0.2 to 0.5	There are no limitations to topsoil re-use where slopes allow safe operation of machinery. Although subsoils have a moderate course fragment content, they would be suitable for stripping to the depth of the weathered parent material for reuse and a subsoil material. For pasture establishment on re-instated topsoil, an application for a broad based NPK fertiliser will be required. The rate of application should be determined by soil analysis of stockpiled material prior to removal and application.	2.2	4,400	6,600
E2	0 to 0.3	0.3 to 1.0	There are no limitations to topsoil re-use. Subsoils also suitable for stripping and reuse and a subsoil material. For pasture establishment on re-instated topsoil, an application for a broad based NPK fertiliser will be required. The rate of application should be determined by soil analysis of stockpiled material prior to removal and application.	12.4	37,200	86,800

1 Volumes do not include bulking up factor.

8.3 Stockpile Management

The following recommendations should be considered for managing stockpiles to maintain soil quality and function:

- Stockpile locations be placed in areas outside of any planned mining activities to prevent double handling. Stockpiles be stored as close as possible to its origin
- Stockpiles be located away from drainage lines
- Any overland flow or upslope drainage be diverted away from stockpile areas
- Where practicable, soils from each SMU be stripped and stockpiled separately
- Topsoil and subsoil materials be stockpiled separately with records maintained of the origin of materials and characteristics
- Where possible, stockpile location be placed against existing vegetation areas. This will improve recruitment of native species of local origin into the stockpiled soils and help retain natural seedbanks and biological activity
- Ideally stockpiles be constructed to a preferred height of 2.0 m or to a maximum of 3.0 m. As the soils may be prone to erosion, a low wide stockpile profile is preferred
- Stockpiles that are to be in storage for more than 3 months should be seeded with native perennial grasses similar to the range of species found locally or those to be used for the establishment of the PMLU. A cover crop (sterile millet or equivalent) should also be included to provide erosion protection during groundcover establishment. A fertiliser application of CK55 or similar at a rate of 100 kg/ha will aid establishment (a higher rate may be needed for subsoils). The use of vegetation will help to retain soil biological activity and function and minimise the effect of stockpiling
- Stockpiles be protected from damage by mine vehicles through use of signage or fencing to minimise unauthorised disturbance
- Sediment control devices be placed downslope of the stockpiles.
- Regular inspection be conducted after initial establishment (particularly after rainfall events >20 mm). The frequency may be reduced once vegetation is established, and stability has been achieved

8.4 Reinstatement

The following recommended management measures should be considered for the reinstatement of soil resources:

- Topsoil materials be tested (through the entire depth of the stockpiles) prior to removal and reinstatement to allow for appropriate amelioration rates to be determined. Areas receiving topsoil derived from areas of SMU E2 may require follow up fertiliser applications as nutrient retention capacity is limited
- Subsoil resources be placed prior to the application of topsoils
- Ideally soils be reinstated in similar locations or landscape positions (slopes) to their origin
- During removal from the stockpile every effort should be made to mix soils from the surface and the subsurface of the stockpile to ensure that biologically active soils with a retained seedbank are included in every truckload
- Topsoil depths will depend on the nature of the reformed landform and the PMLU. DME (1995) states that depths of between 0.1-0.3 m are acceptable. The depth may be governed by the nature of the final landforms and the final materials balance
- Ideally cultivation and soil disturbance should be minimised. All ripping, seed bed preparation, seeding and ameliorant application should be carried out with the minimum of passes

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10 ACRONYMS

Acronym	Description
°C	Degrees Celsius
EA	Environmental Authority
ALC	Agricultural Land Class
ASC	Australian Soil Classification
ASPAC	Australian Soil and Plant Analysis Council
BoM	Bureau of Meteorology
CEC	Cation Exchange Capacity
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Department of Agriculture, Fisheries and Forestry
DME	Department of Minerals and Energy
DNRM	Department of Natural Resources and Mines
DoR	Department of Resources
DSITI	Department of Science, Information Technology and Innovation
DSITIA	Department of Science, Information Technology, Innovation, and the Arts
EAL	Southern Cross University Environmental Analysis Laboratory
EC	Electrical conductivity
ESP	Exchangeable Sodium Percentage
ha	hectares
km	kilometres
LGA	Local Government Area
m	metres
mAHD	Meters Australian Height Datum
mbgl	Metres below ground level
ML	Mining lease
mm	millimetres
NATA	National Association of Testing Authority
NCST	National Committee on Soil and Terrain
PAWC	Plant available water capacity
PMLU	Post-mine land use
PMU	Preliminary Mapping Unit
PRCP	Progressive Rehabilitation and Closure Plan
QA	Quality assurance sample
QC	Quality control sample
QLD	Queensland
RE	Regional ecosystem
SALI	Soil and Land Information
SALS	Soil and Land Suitability
SCL	Strategic cropping Land
SMU	Soil Mapping Unit

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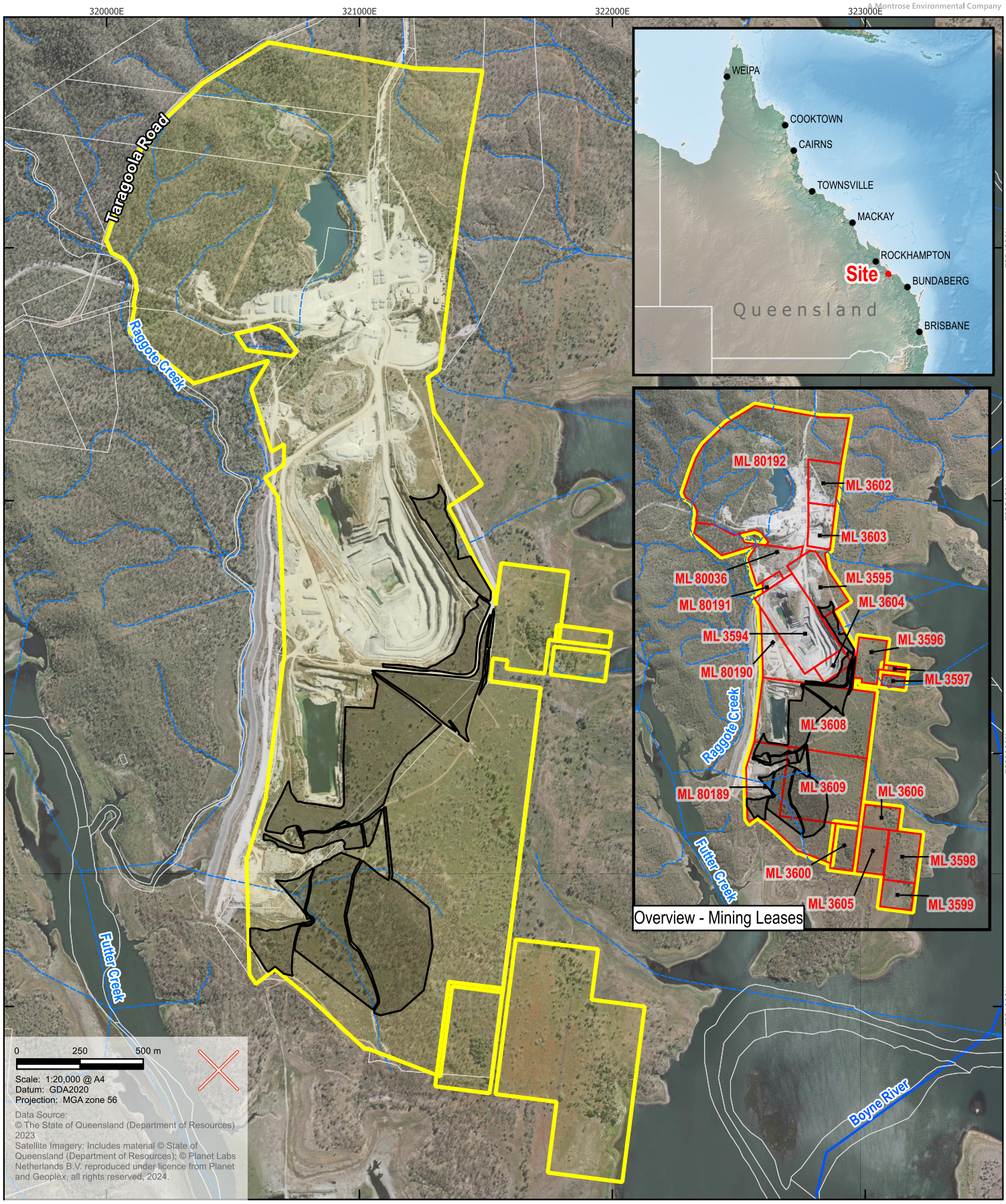
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FIGURES

Figure F1. Regional Location and Area of Investigation
Figure F2. Site Topography
Figure F3. Geological Setting
Figure F4. Soil Mapping Sites
Figure F5. Land Use
Figure F6. Land Systems of the Capricornia Coast – Map 3
Figure F7. Soil Mapping Units
Figure F8. Land Suitability Classes – Rainfed Beef Grazing



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BCL230021.01 Soil and Land Suitability Assessment\Rev 2\Figure F1 Regional location and area of investigation.qgz

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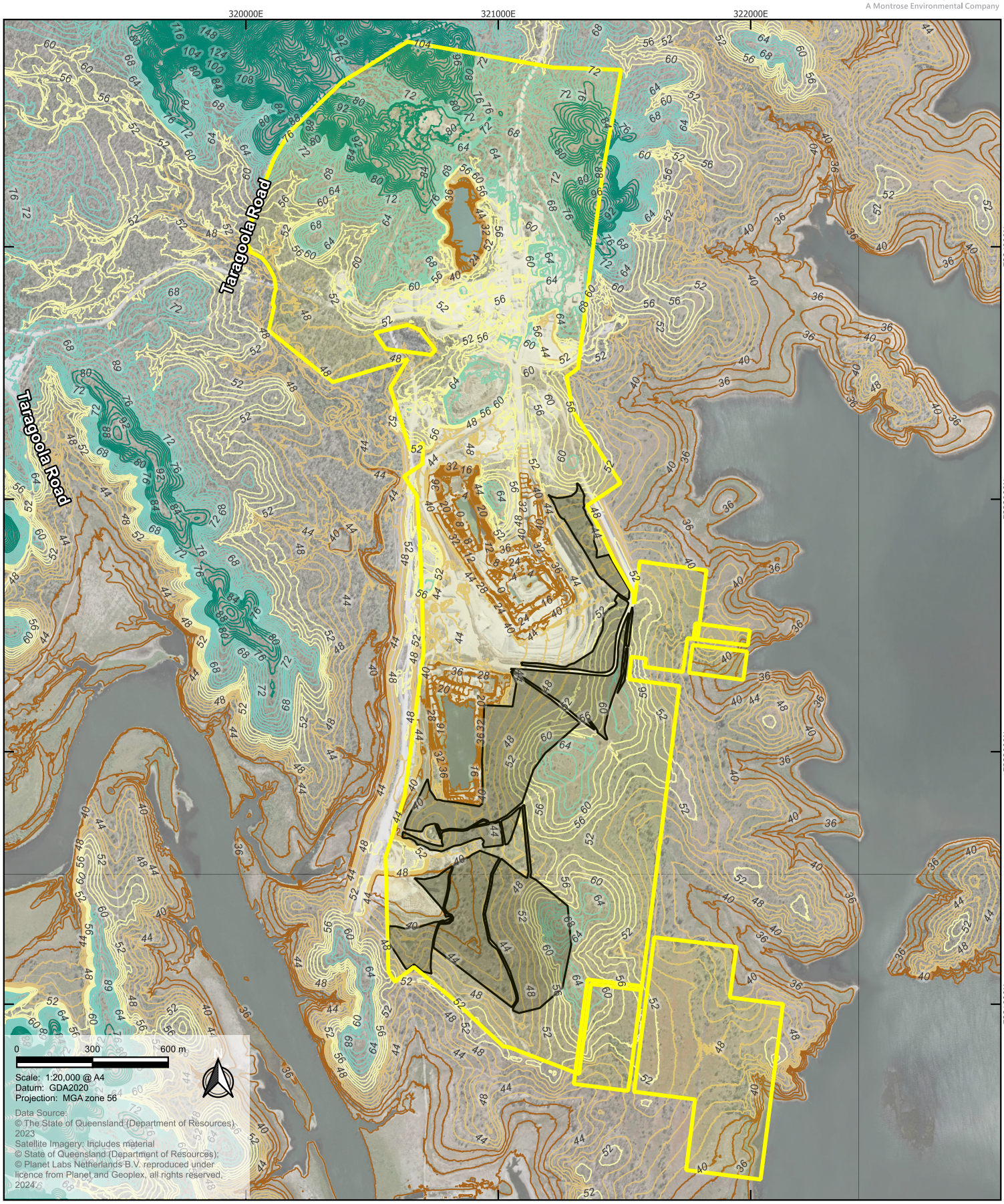
- Site boundary
- Mining Leases
- Investigation area
- Cadastre (DCDB)

Watercourses

- Major
- Minor

Graymont (Calliope) Pty Ltd
Calliope Limestone Quarry
Soil and Land Suitability Assessment

Figure F1
Regional location and area of investigation



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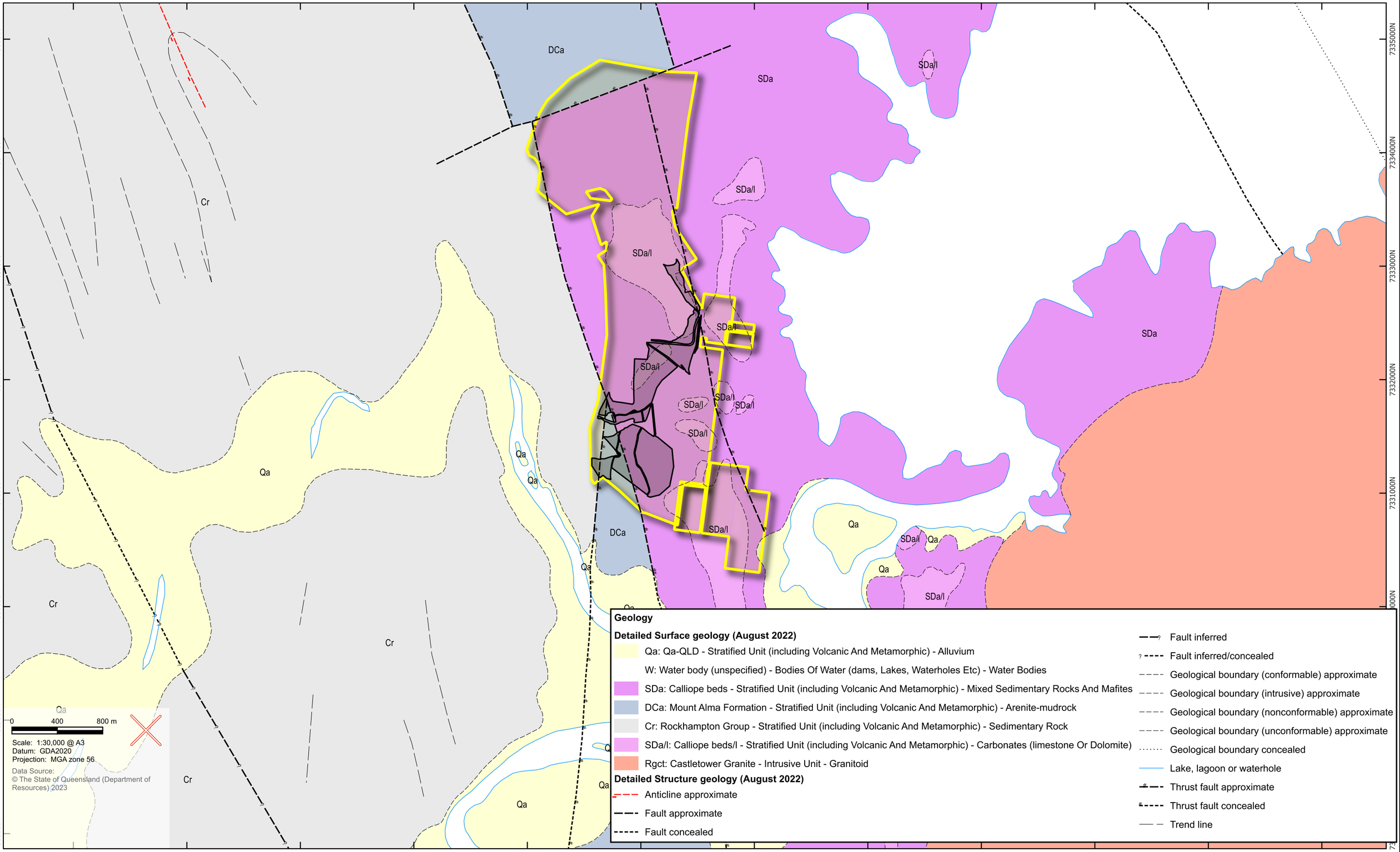
- Site boundary
- Investigation area

Elevation contours (mAHD)

- -4 - 40
- 40 - 50
- 50 - 60
- 60 - 76
- 76 - 438

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Calliope Limestone Quarry
Soil and Land Suitability Assessment

Figure F2
Site topography



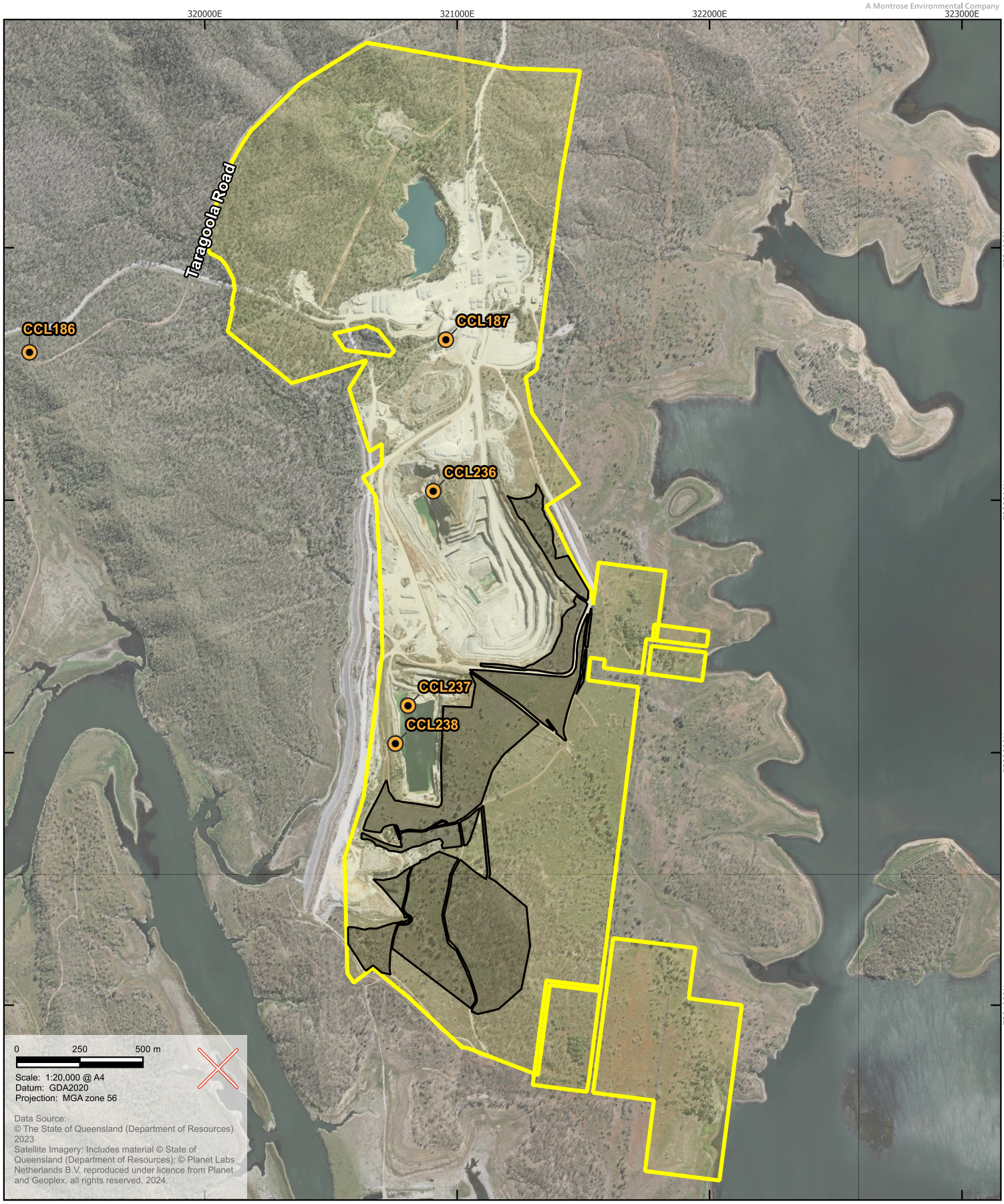
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- Site boundary
- Investigation area

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Soil and Land Suitability Assessment

Figure F3
Geological setting



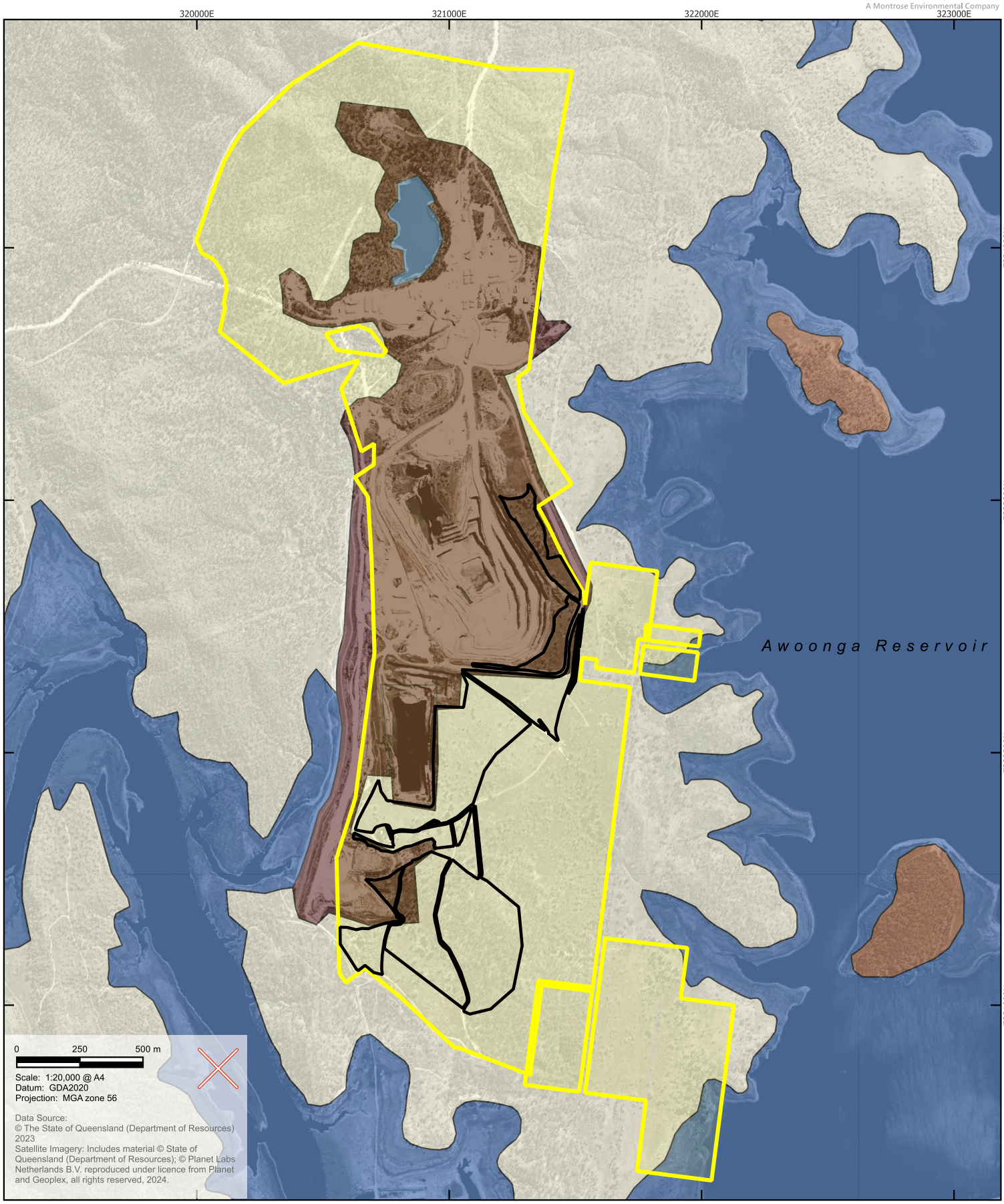
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Legend

- Site boundary
- Investigation area
- Queensland soil survey sites (SALI database)

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Calliope Limestone Quarry
Soil and Land Suitability Assessment

Figure F4
Soil mapping sites



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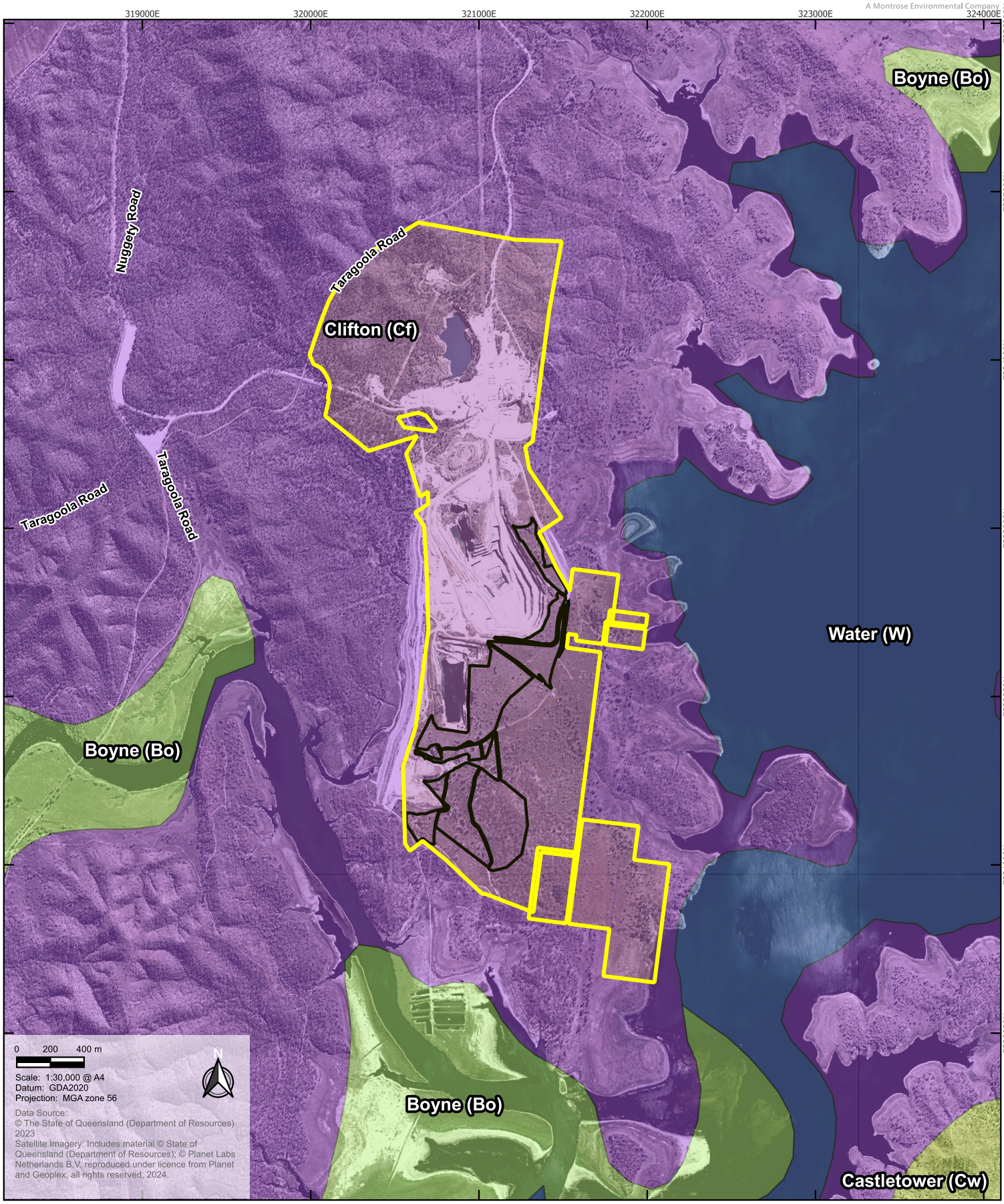
- Site boundary
- Investigation area

QLD Land use mapping (secondary)

- Other minimal use
- Grazing native vegetation
- Mining
- Reservoir/dam

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Calliope Limestone Quarry
Soil and Land Suitability Assessment

Figure F5
Land uses



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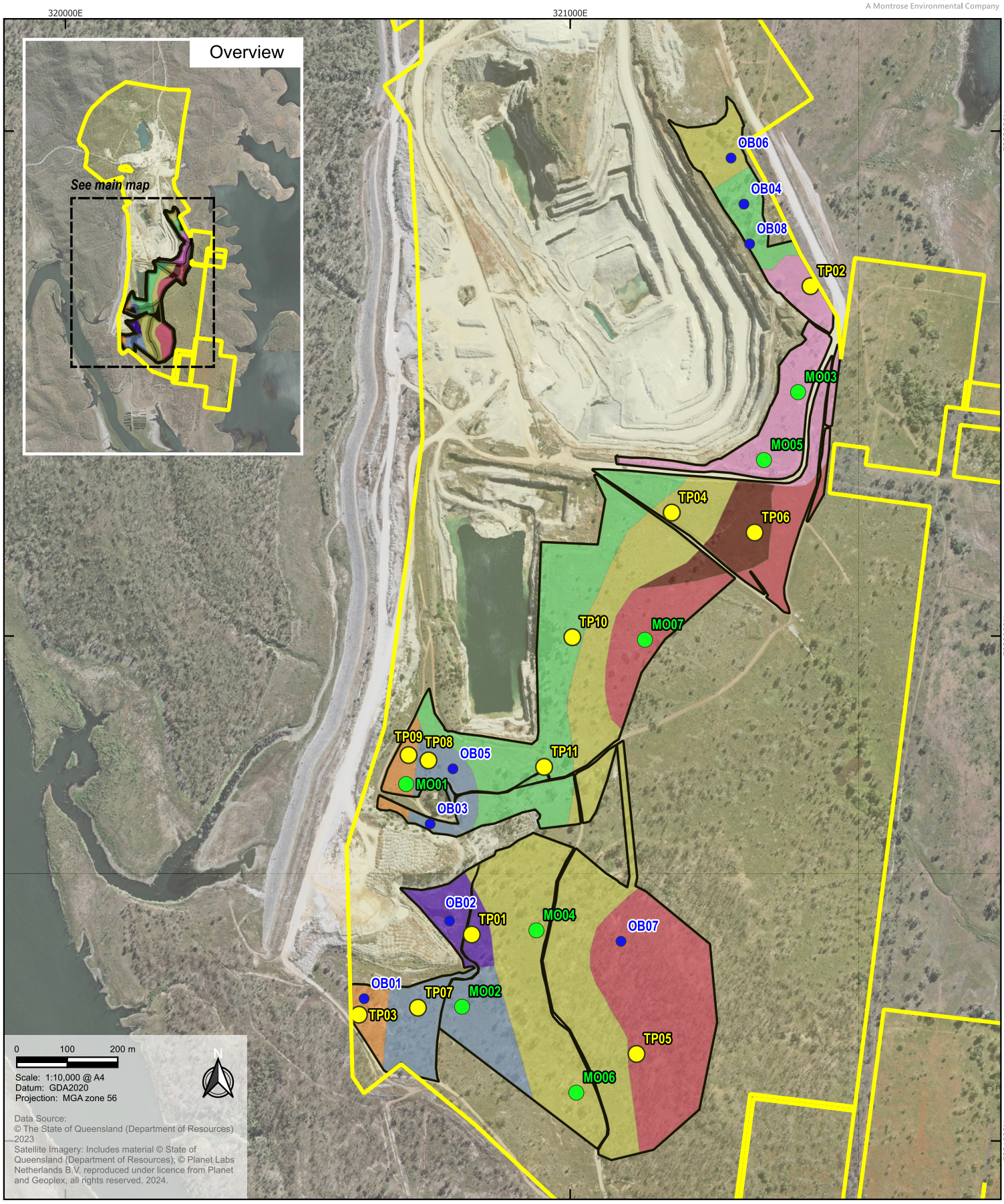
- Site boundary
- Investigation area

Land systems of the Capricornia coast (CCL3)

- Boyne (Bo)
- Castletower (Cw)
- Clifton (Cf)
- Water (W)

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Calliope Limestone Quarry
Soil and Land Suitability Assessment

Figure F6
Land systems of the Capricornia Coast



Filepath: --BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BCL230021.01 Soil and Land Suitability Assessment\Rev 2\Figure F7 Soil mapping units.qgz

Legend

- Site boundary
- Investigation area

SMU and ASC classification

- A1 Brown Dermosol
- B1 Leptic Rudosol
- B2 Redoxic Hydrosol
- C1 Spolic Anthroposol
- D1 Leptic Rudosol
- E1 Brown Chromosol
- E1(s) Brown Chromosol
- E2 Brown Kandosol

Soil survey sites

- Detailed site
- Observation site
- Semi-detailed site

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Calliope Limestone Quarry
Soil and Land Suitability Assessment

Figure F7
Soil mapping units

APPENDIX A SALI SOIL MAPPING SITES REPORTS

Project description

Project name:	Land Resources and Evaluation of the Capricornia Coastal Lands, Broadsound Shire, QLD
Project status:	Data is from an active project and may be subject to change through additions/updates or further quality assessment processes
Location:	Capricornia Coastal Lands - Broadsound, Central Queensland St Lawrence, Marlborough, Yeppoon, Rockhampton, Calliope,Gladstone, Boyne Valley

Site characteristics

Date described:	9/11/1990	Observation type:	Not recorded (historical)
Site Type:	Free survey site	Observation class:	Class I (detailed soil profile description)

Slope (%):	3	Morphological type:	Flat
Slope type	Abney level or clinometer and tape	Landform element:	Plain
Geology:	Calliope Beds: Intermediate and basic lava, tuff, andesitic agglomerate, limestone, conglomerate, li	Landform pattern:	Alluvial plain

Soil Name:	Cardowan (Cw)	Substrate lithology:	Limestone
Runoff:	Slow	Depth to free water:	Not recorded
Permeability:	Slowly permeable (5-50 mm/day)	Erosion:	Not recorded
Drainage:	Moderately well drained	Microrelief type:	Not recorded
Disturbance:	Not recorded	Proportion gilgai:	N/A
Rock outcrop:	Not recorded	Vertical interval (m):	N/A
Surface condition:	Periodic cracking; Self-mulching	Horizontal interval (m):	N/A
Surface coarse fragments:	Not recorded	Microrelief component sampled:	N/A

Site location

Datum	Latitude (dd)	Longitude (dd)	Zone	Easting (m)	Northing (m)	Location accuracy (m)	Location measurement method
GDA 94	-24.11391	151.23633	56	320754	7332034	Not recorded	Topographic map
GDA 2020	-24.11390	151.23634	56	320755	7332036		

Soil classification

Australian Soil Classification (ASC)	Confidence	ASC Technical Reference	Buried	GSG	PPF
Endocalcareous, Self-mulching, Black Vertosol; non-gravelly, fine, very fine, very deep, —.	No analytical data are available but confidence is fair.	Isbell (1996) The Australian Soil Classification (First Edition)	N/A	Black earth	Ug5.15

Profile morphology

No	Name	Upper depth (m)	Lower depth (m)	Colour	Mottles	Textures	Structures	Coarse fragments	Segregations	Strengths	Bounds
1	A1	0	0.25	Black (10YR 2/1) moist		Light medium clay	Strong Subangular blocky structure;				clear
2	B21	0.25	0.6	Black (10YR 2/1) moist		Medium heavy clay	Strong Lenticular structure;		Very few (<2%) Fine (<2mm) Calcareous Nodules;		gradual
3	B22	0.6	1.2	Black (10YR 2/1) moist		Medium heavy clay	Strong Lenticular structure;		Few (2-10%) Medium (2-6 mm) Calcareous Nodules;		sharp
4	D1kc	1.2	1.6	Yellowish brown (10YR 5/4) moist		Medium heavy clay	Strong Lenticular structure;		Common (10-20%) Medium (2-6 mm) Calcareous Nodules; Very few (<2%) Fine (<2mm) Manganiferous Concretions;		

Notes

Note level	Horizon name	Horizon no	Note
Site			BE LIMESTONE PIT

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Location:	Capricornia Coastal Lands - Broadsound, Central Queensland St Lawrence, Marlborough, Yeppoon, Rockhampton, Calliope,Gladstone, Boyne Valley

Site characteristics

Date described:	9/11/1990	Observation type:	Not recorded (historical)
Site Type:	Free survey site	Observation class:	Class I (detailed soil profile description)

Slope (%):	Not recorded	Morphological type:	Upper slope
Slope type	Not recorded	Landform element:	Hillslope
Geology:	Calliope Beds: Intermediate and basic lava, tuff, andesitic agglomerate, limestone, conglomerate, li	Landform pattern:	Rises

Soil Name:	Cammoo (CCL)(v1) (Cm)	Substrate lithology:	Limestone
Runoff:	Moderately rapid	Depth to free water:	Not recorded
Permeability:	Moderately permeable (50-500 mm/day)	Erosion:	Not recorded
Drainage:	Well drained	Microrelief type:	Not recorded
Disturbance:	Extensive clearing	Proportion gilgai:	N/A
Rock outcrop:	Slightly rocky 2-10% bedrock exposed,limestone	Vertical interval (m):	N/A
Surface condition:	Firm	Horizontal interval (m):	N/A
Surface coarse fragments:	Few (2-10%), limestone	Microrelief component sampled:	N/A

Site location

Datum	Latitude (dd)	Longitude (dd)	Zone	Easting (m)	Northing (m)	Location accuracy (m)	Location measurement method
GDA 94	-24.10490	151.23793	56	320904	7333034	Not recorded	Topographic map
GDA 2020	-24.10489	151.23793	56	320905	7333036		

Soil classification

Australian Soil Classification (ASC)	Confidence	ASC Technical Reference	Buried	GSG	PPF
Haplic, Eutrophic, Red Dermosol; medium, non-gravelly, clayey, clayey, moderate.	No analytical data are available but confidence is fair.	Isbell (1996) The Australian Soil Classification (First Edition)	N/A	Prairie soil	Uf6.31

Vegetation

Community name	Tall woodland, Corymbia erythrophloia	
Stratum	Species	Common name
Tallest 12.01-20 m	*Corymbia erythrophloia*	gum-topped bloodwood, variable-barked bloodwood
	Eucalyptus melanophloia	silver-leaved ironbark, silver ironbark
	Corymbia tessellaris	carbeen, Moreton Bay ash
Mid	*Alyxia ruscifolia*	chainfruit
Lowest	*Heteropogon contortus*	black speargrass

Profile morphology

No	Name	Upper depth (m)	Lower depth (m)	Colour	Mottles	Textures	Structures	Coarse fragments	Segregations	Strengths	Bounds
1	A11	0	0.15	Dark brown (7.5YR 3/2) moist		Light clay	Moderate Granular structure;	few (2-10%) shale;			
2	A12	0.15	0.25	Dark reddish brown (5YR 3/4) moist		Light clay	Strong Polyhedral structure;	few (2-10%) shale;			
3	B2	0.25	0.6	Red (2.5YR 4/6) moist		Medium clay	Strong Polyhedral structure;	common (10-20%) shale;			
4	C	0.6	0.61								

Field test

pH by Raupach and Tucker method

Depth (m)	Value
0.02	7
0.3	7
0.6	7

Notes

Note level	Horizon name	Horizon no	Note
Site			SHAL E TOP LIMESTONEPIT

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Project CCL Site 187 Observation 1

SALI4320

Project description

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Location:	Capricornia Coastal Lands - Broadsound, Central Queensland St Lawrence, Marlborough, Yeppoon, Rockhampton, Calliope,Gladstone, Boyne Valley

Site characteristics

Date described:	25/10/1990	Observation type:	Not recorded (historical)
Site Type:	Free survey site	Observation class:	Class I (detailed soil profile description)

Slope (%):	6	Morphological type:	Lower slope
Slope type	Abney level or clinometer and tape	Landform element:	Footslope
Geology:	Calliope Beds: Intermediate and basic lava, tuff, andesitic agglomerate, limestone, conglomerate, li	Landform pattern:	Low hills

Soil Name:	Bondoola (Bo)	Substrate lithology:	Colluvium
Runoff:	Moderately rapid	Depth to free water:	Not recorded
Permeability:	Slowly permeable (5-50 mm/day)	Erosion:	Not recorded
Drainage:	Moderately well drained	Microrelief type:	Not recorded
Disturbance:	Limited clearing	Proportion gilgai:	N/A
Rock outcrop:	Not recorded	Vertical interval (m):	N/A
Surface condition:	Firm	Horizontal interval (m):	N/A
Surface coarse fragments:	Not recorded	Microrelief component sampled:	N/A

Site location

Datum	Latitude (dd)	Longitude (dd)	Zone	Easting (m)	Northing (m)	Location accuracy (m)	Location measurement method
GDA 94	-24.09949	151.23849	56	320954	7333634	Not recorded	Topographic map
GDA 2020	-24.09948	151.23850	56	320955	7333636		

Soil classification

Australian Soil Classification (ASC)	Confidence	ASC Technical Reference	Buried	GSG	PPF
Sodic, Eutrophic, Brown Chromosol; medium, non-gravelly, clay loamy, clayey, moderate.	No analytical data and little or no knowledge of this soil.	Isbell (1996) The Australian Soil Classification (First Edition)	N/A	Non-calcic brown soil	Db3.12

Vegetation

Community name	Tall open forest, Eucalyptus moluccana	
Stratum	Species	Common name
Tallest 12.01-20 m	*Eucalyptus moluccana*	gum-topped box, grey box
Mid	*Acacia leiocalyx*	black wattle, Brisbane black wattle, curracabah
	Acacia decora	pretty wattle

Profile morphology

No	Name	Upper depth (m)	Lower depth (m)	Colour	Mottles	Textures	Structures	Coarse fragments	Segregations	Strengths	Bounds
1	A	0	0.22	Dark brown (10YR 3/3) moist		Clay loam	Weak Polyhedral structure;				abrupt
2	B21	0.22	0.55	Brown (7.5YR 4/4) moist		Medium clay	Strong Angular blocky structure;				gradual
3	B22	0.55	0.56	Reddish brown (5YR 4/4) moist		Medium heavy clay					

Field test

pH by Raupach and Tucker method

Depth (m)	Value
0.02	8
0.3	7
0.56	8

Notes

Note level	Horizon name	Horizon no	Note
Site			GTB ON NKB

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Project description

Project name:	Land Resources and Evaluation of the Capricornia Coastal Lands, Broadsound Shire, QLD
Project status:	Data is from an active project and may be subject to change through additions/updates or further quality assessment processes
Location:	Capricornia Coastal Lands - Broadsound, Central Queensland St Lawrence, Marlborough, Yeppoon, Rockhampton, Calliope,Gladstone, Boyne Valley

Site characteristics

Date described:	9/11/1990	Observation type:	Not recorded (historical)
Site Type:	Free survey site	Observation class:	Class IIIb (core analytical suite)

Slope (%):	5	Morphological type:	Lower slope
Slope type	Abney level or clinometer and tape	Landform element:	Hillslope
Geology:	Calliope Beds: Intermediate and basic lava, tuff, andesitic agglomerate, limestone, conglomerate, li	Landform pattern:	Rises

Soil Name:	Cammoo (CCL)(v1) (Cm)	Substrate lithology:	Limestone
Runoff:	Moderately rapid	Depth to free water:	Not recorded
Permeability:	Moderately permeable (50-500 mm/day)	Erosion:	Not recorded
Drainage:	Well drained	Microrelief type:	Not recorded
Disturbance:	Extensive clearing	Proportion gilgai:	N/A
Rock outcrop:	Very slightly rocky <2% bedrock exposed,limestone	Vertical interval (m):	N/A
Surface condition:	Not recorded	Horizontal interval (m):	N/A
Surface coarse fragments:	Not recorded	Microrelief component sampled:	N/A

Site location

Datum	Latitude (dd)	Longitude (dd)	Zone	Easting (m)	Northing (m)	Location accuracy (m)	Location measurement method
GDA 94	-24.11257	151.23684	56	320804	7332184	Not recorded	Topographic map
GDA 2020	-24.11255	151.23685	56	320805	7332186		

Soil classification

Australian Soil Classification (ASC)	Confidence	ASC Technical Reference	Buried	GSG	PPF
Haplic, Eutrophic, Red Dermosol; medium, non-gravelly, clayey, clayey, very deep.	All necessary analytical data is available	Isbell (1996) The Australian Soil Classification (First Edition)	N/A	Euchrozem	Uf6.31

Vegetation

Community name	Tall woodland, Eucalyptus tereticornis	
Stratum	Species	Common name
Tallest 12.01-20 m	*Eucalyptus tereticornis*	blue gum, forest red gum
	Corymbia erythrophloia	gum-topped bloodwood, variable-barked bloodwood
	Corymbia tessellaris	carbeen, Moreton Bay ash
Lowest	*Hyparrhenia rufa*	thatch grass

Profile morphology

No	Name	Upper depth (m)	Lower depth (m)	Colour	Mottles	Textures	Structures	Coarse fragments	Segregations	Strengths	Bounds
1	A1	0	0.2	Dark brown (7.5YR 3/2) moist		Light clay	Moderate 2-5 mm Polyhedral structure;				gradual
2	B21	0.2	0.35	Dark reddish brown (5YR 3/4) moist		Light medium clay	Moderate Polyhedral structure;				clear
3	B22	0.35	0.8	Strong brown (7.5YR 4/6) moist		Light clay	Moderate Polyhedral structure;	very few (<2%) angular limestone medium pebbles (6-20 mm);	Very few (<2%) Fine (<2mm) Ferromanganiferous Concretions;		gradual
4	B23	0.8	1.2	Dark red (2.5YR 3/6) moist		Light clay	Weak Polyhedral structure;		Few (2-10%) Fine (<2mm) Ferromanganiferous Concretions;		gradual
5	B3	1.2	1.5	Dark red (2.5YR 3/6) moist		Clay loam	Massive structure;		Very few (<2%) Fine (<2mm) Ferromanganiferous Concretions;		

Field test	
pH by Raupach and Tucker method	
Depth (m)	Value
0.02	6
0.3	6.5
0.6	7
0.9	7
1.2	7
1.5	7

Notes			
Note level	Horizon name	Horizon no	Note
Site			DEEP E LIMESTONEPIT

Laboratory test results

				Sample	1	2	3	4	5	6	7
				Upper depth (m)	0	0	0.2	0.5	0.8	1.1	1.4
				Lower depth (m)	0.1	0.1	0.3	0.6	0.9	1.2	1.5
Group	Method	Code	Units	Bulked Sample	Y	N	N	N	N	N	N
Profile General	pH - 1:5 water	4A1			6.3	6.1	6.4	6.9	6.9	6.8	6.9
	pH - 1:5 0.01M CaCl2	4B1			5.4	5.2	5.6	6.3	6.3	6	6.2
	EC - 1:5 water	3A1	dS/m		0.03	0.06	0.05	0.02	0.02	0.03	0.04
	Cl - 1:5 water - automated	5A2	mg/kg		<20	31	20	<20	<20	38	45
	Water sol NO3 - automated	7B1	mg/kg		2	12	18	2	2	2	2
	OC - Walkley/Black	6A1	%		2.1						
	Total N - Kjeldahl, automated	7A2a			0.16						
	Coarse sand	2Z2_CS	%			15	17	9	13	10	
	Fine sand	2Z2_FS	%			17	16	10	10	10	
	Silt	2Z2_Silt	%			11	9	7	9	7	
	Clay	2Z2_Clay	%			55	56	74	69	73	
	PSA sum	2Z2_sum				98	98	100	101	100	
	Moisture content - air-dry	2A1	%			3.1	2.9	3.1	3.0	3.0	
	Moisture content - 15 bar	2E1	%			20.0	21.0	25.0	25.0		
	Silt+Clay/Total Silt+Clay (R1)	2Z1_R1				0.54	0.62	0.46	0.47		
	Total S XRF	10A1	%			0.04	0.02	0.01	0.005	0.01	
	Total P XRF	9A1	%			0.08	0.05	0.03	0.03	0.03	
	Total K XRF	17A1	%			0.330	0.240	0.280	0.310	0.250	
	Citrate/dithionite Extr Fe	13C1_Fe	%				3.5		3.5		
Alcoholic Cations	Exch Ca - Alch NH4Cl, pH8.5, prewash	15C1_Ca	cmol_c/kg			16.40	23.80	14.70	15.20	17.00	
	Exch Mg - Alch NH4Cl, pH8.5, prewash	15C1_Mg	cmol_c/kg			3.90	3.20	2.00	1.70	1.40	
	Exch Na - Alch NH4Cl, pH8.5, prewash	15C1_Na	cmol_c/kg			0.07	0.07	0.09	0.13	0.22	
	Exch K - Alch NH4Cl, pH8.5, prewash	15C1_K	cmol_c/kg			0.57	0.12	0.08	0.09	0.10	
	CEC - Alch NH4Cl pH8.5 pre wash	15C1_CEC	cmol_c/kg			32	28	22	21	22	
Other Bulk	DTPA Extr Cu	12A1_Cu	mg/kg		17.8						
	DTPA Extr Fe	12A1_Fe	mg/kg		48.0						
	DTPA Extr Mn	12A1_Mn	mg/kg		106.0						
	DTPA Extr Zn	12A1_Zn	mg/kg		1.2						
	Extr K - HCl	18B1	mg/kg		0.4						
	P (BiCarb Extr)- automated	9B2	mg/kg		8						

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APPENDIX B LAND SYSTEMS OF THE CAPRICORNIA COAST – MAP 3

LAND SYSTEMS OF THE CAPRICORNIA COAST
MAP 3 CALLIOPE AREA

SCALE 1:250 000

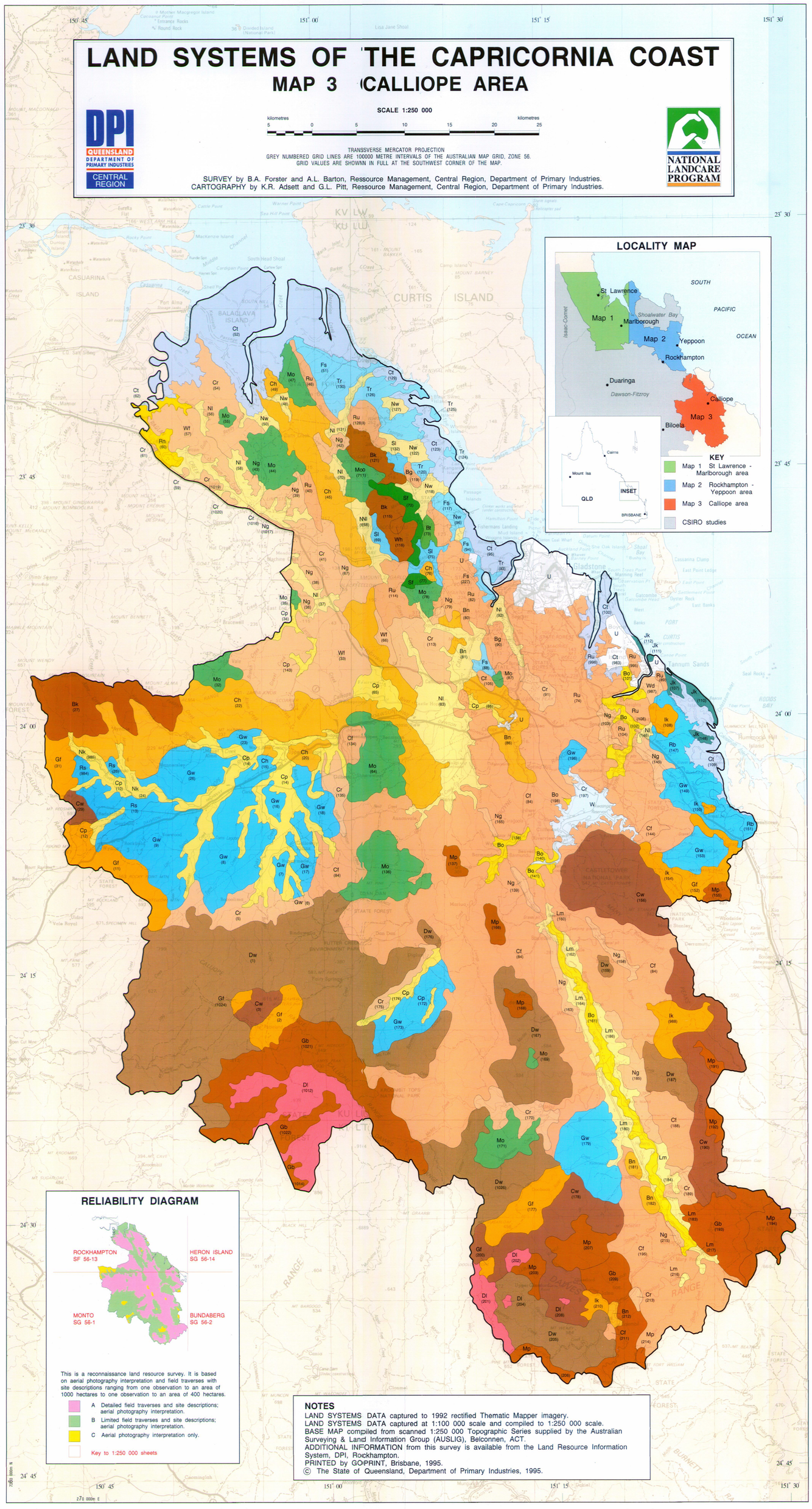
kilometres 5 0 5 10 15 20 kilometres 25

TRANSVERSE MERCATOR PROJECTION
GREY NUMBERED GRID LINES ARE 100000 METRE INTERVALS OF THE AUSTRALIAN MAP GRID, ZONE 56.
GRID VALUES ARE SHOWNN IN FULL AT THE SOUTHWEST CORNER OF THE MAP.

SURVEY by B.A. Forster and A.L. Barton, Ressource Management, Central Region, Department of Primary Industries.
CARTOGRAPHY by K.R. Adsett and G.L. Pitt, Ressource Management, Central Region, Department of Primary Industries.

DPI QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES CENTRAL REGION

NATIONAL LANDCARE PROGRAM



LOCALITY MAP

RELIABILITY DIAGRAM

This is a reconnaissance land resource survey. It is based on aerial photography interpretation and field traverses with site descriptions ranging from one observation to an area of 1000 hectares to one observation to an area of 400 hectares.

- A Detailed field traverses and site descriptions; aerial photography interpretation.
- B Limited field traverses and site descriptions; aerial photography interpretation.
- C Aerial photography interpretation only.

Key to 1:250 000 sheets

NOTES

LAND SYSTEMS DATA captured to 1992 rectified Thematic Mapper imagery.
LAND SYSTEMS DATA captured at 1:100 000 scale and compiled to 1:250 000 scale.
BASE MAP compiled from scanned 1:250 000 Topographic Series supplied by the Australian Surveying & Land Information Group (AUSLIG), Belconnen, ACT.
ADDITIONAL INFORMATION from this survey is available from the Land Resource Information System, DPI, Rockhampton.
PRINTED by GOPRINT, Brisbane, 1995.
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REFERENCE

MAP CODE	LAND SYSTEM	LANDFORM AND GEOLOGY	MAJOR SOILS	REMNANT NATIVE VEGETATION
MOUNTAINS				
Granitic Rocks				
Cw	Castletower	Steep to precipitous mountains on granitic rocks.	Shallow, stony brown and black massive coarse sands and loams; shallow bleached sands.	Eucalypt woodland (white mahogany, narrow-leaved ironbark, brown bloodwood); montane heath; vine forest.
Volcanic Rocks				
Wh	Wheeler	Steep to precipitous volcanic plugs on trachyte.	Shallow, stony brown massive loams; shallow, stony bleached, massive loams.	Eucalypt woodland (white mahogany, pink bloodwood); vine forest.
Bk	Berserker	Steep mountains and very steep escarpments on acid and intermediate volcanic rocks and minor intrusions.	Shallow, stony brown and black massive loams and clay loams; shalldow, stony, black and brown, structured uniform clays and gradational clay loams.	Eucalypt woodland (lemon-scented gum, white mahogany); vine forest.
Mp	Many Peaks	Steep mountains on intermediate and basic volcanic rocks, with narrow summit surfaces on deeply weathered basalt.	Shallow, stony black, structured uniform clays and gradational clay loams; deep red, structured uniform clays and gradational clay loams.	Vine forest with hoop pine emergents.
Gb	Golembil	Steep mountains on intermediate and basic volcanic rocks.	Shallow, stony black and brown, structured uniform clays and gradational clay loams.	Eucalypt woodland (lemon-scented gum, narrow-leaved ironbark, pink bloodwood).
Sedimentary Rocks				
Dw	Dawes	Steep mountains on steeply dipping sedimentary rocks.	Shallow, stony brown and black massive loams and clay loams.	Eucalypt woodland (lemon-scented gum, white mahogany, narrow-leaved ironbark, pink bloodwood, supplejack).
PLATEAUS				
Sedimentary Rocks				
Dl	Dooloo	Undulating, high level plateaus on sandstone.	Brown and yellow, massive gradational loams and clay loams; bleached massive sands and loams.	Eucalypt tall open forest (New England peppermint, grey gum, white mahogany).
HILLS				
Eucalypt Open Forest and Woodland				
Granitic Rocks				
Gf	Glassford	Steep to rolling hills and escarpments on granitic rocks.	Sandy and loamy surface, red and brown duplex soils; brown, red and yellow, massive gradational loams and clay loams.	Eucalypt woodland (narrow-leaved ironbark, pink bloodwood or silver-leaved ironbark, gum-topped bloodwood).
Ik	Inkerman	Rolling low hills on granitic rocks.	Bleached coarse sands with silica hardpans; brown, red and yellow, massive coarse sands and loams.	Eucalypt woodland (narrow-leaved ironbark, lemon-scented gum) with shrub understory.
Volcanic Rocks				
Ch	Chalmers	Rolling to steep hills on acid and intermediate volcanic rocks and steeply dipping sedimentary rocks.	Bleached massive sands and loams; shallow, stony brown and black structured uniform clays and gradational clay loams.	Eucalypt woodland (narrow-leaved ironbark, lemon-scented gum, pink bloodwood, ghost gum).
Bn	Balnagowan	Rolling low hills and rises on intermediate and basic volcanic rocks.	Shallow to deep, black and brown, structured uniform clays and gradational clay loams.	Eucalypt woodland (silver-leaved ironbark, gum-topped bloodwood or narrow-leaved ironbark, pink bloodwood).
Sedimentary Rocks				
Cf	Clifton	Steep to rolling hills on steeply dipping sedimentary rocks with minor volcanic intrusions.	Shallow, stony brown and black massive loams and clay loams; bleached sandy and loamy surface, brown and grey, alkaline sodic duplex soils.	Eucalypt woodland (lemon-scented gum, narrow-leaved ironbark, pink bloodwood).
Ru	Rundle	Steep to rolling hills on steeply dipping sedimentary rocks.	Shallow, stony brown and black massive loams and clay loams.	Eucalypt open forest (lemon-scented gum, narrow-leaved ironbark, pink bloodwood, Queensland peppermint) with mixed understory.
Bg	Bungundarra	Steep to rolling hills with long footslopes on steeply dipping sedimentary rocks.	Red, structured gradational clay loams and uniform clays.	Eucalypt open forest (lemon-scented gum, narrow-leaved ironbark, pink bloodwood) with mixed understory; vine forest.
Wd	Wandilla	Undulating to rolling low hills, rises and fans on sedimentary rocks.	Bleached sandy annd loamy surface, grey and brown, acid sodic duplex soils.	Eucalypt open forest (lemon-scented gum, narrow-leaved ironbark, Queensland peppermint) with mixed understory; gum-topped box woodland.
Cr	Carrara	Undulating to rolling low hills and rises on sedimentary rocks.	Shallow brown annd black massive loams and clay loams; bleached sandy and loamy surface, brown and grey, alkaline sodic duplex soils.	Eucalypt woodland (narrow-leaved ironbark, gum-topped bloodwood, pink bloodwood).
Wf	Wycheproof	Undulating to rolling low hills and rises on sedimentary rocks and greenstone; saline outbreaks on lower slopes and drainage flats.	Shallow, stony, brown and black massive loams and clay loams; shallow, red and brown, structured gradational clay loams.	Eucalypt woodland (narrow-leaved ironbark, gum-topped bloodwood and Moreton Bay ash).
Ng	Nagoorin	Undulating to rolling low hills and fans on fine grained sedimentary rocks and unconsolidated sediments.	Bleached clay loamy and silty surface, brown and grey, alkaline sodic duplex soils.	Gum-topped box woodland.
Vine Forest				
Granitic Rocks				
Sf	Sugarloaf	Steep hills and escarpments and valley flats on granitic and intermediate volcanic rocks.	Brown, red and yellow, massive gradational loams and clay loams.	Vine forest; eucalypt woodland (narrow-leaved ironbark, pink bloodwood).
Volcanic Rocks				
Bt	Belmont	Steep hills and rolling low hills on intermediate and basic volcanic rocks.	Shallow, stony reed, brown and black structured uniform clays and gradational clay loams.	Vine forest.
Sedimentary Rocks				
Mo	Moore	Steep to rolling hills and rises on sedimentary rocks.	Shallow, stony brown, red and dark, structured gradational clay loams and uniform clays.	Vine forest.
UNDULATING RISES AND PLAINS				
Eucalypt Woodland				
Granitic Rocks				
Gw	Galloway	Gently undulating rises and plains on granitic rocks; isolated low hills.	Sandy and loamy surface, brown and black duplex soils; bleached sandy and loamy surface, brown and grey, alkaline sodic duplex soils.	Eucalypt woodland (silver-leaved ironbark, gum-topped bloodwood); poplar box woodland.
Rs	Redshirt	Undulating rises on granitic rocks.	Loamy surface, reed duplex soils.	Eucalypt woodland (silver-leaved ironbark, gum-topped bloodwood).
Rb	Rodds Bay	Gently undulating plains and rises on granitic rocks and unconsolidated sediments.	Bleached coarse sands with silica hardpans; bleached sandy surface, brown and grey, alkaline sodic duplex soils.	Eucalypt woodland (pink bloodwood, long-fruited bloodwood, narrow-leaved ironbark) with mixed shrub understory; bull oak, broad-leaved teatree low open forest.
Volcanic Rocks				
Sl	Sleipner	Undulating footslopes and rises, and gently undulating fans below hills on intermediate and acid volcanic rocks, and small areas of granitic rocks.	Bleached loamy annd clay loamy surface, brown and grey, alkaline sodic duplex soils.	Eucalypt woodland (blue gum, narrow-leaved ironbark).
Sedimentary Rocks				
Fs	Fanside	Undulating footslopes and rises on sedimentary rocks, and gently undulating fans below rolling hills.	Red, structured gradational clay loams and uniform clays; shallow, bleached sandy and loamy surface, red duplex soil.	Eucalypt woodland (pink bloodwood, blue gum, swamp mahogany, poplar gum) with mixed shrub understory.
Tr	Terise	Gently undulating rises and plains on sedimentary rocks.	Red, structured gradational clay loams and uniform clays; bleached loamy surface, grey and brown, acid sodic duplex soils.	Eucalypt open forest (narrow-leaved ironbark, blue gum, gum-topped bloodwood); eucalypt woodland (Queensland peppermint, narrow-leaved ironbark).
OLD ALLUVIAL PLAINS AND ALLUVIAL FANS				
Duplex Soils				
Lm	Littlemere	Narrow, level, terraced alluvial plains above active floodplains.	Clay loamy surface, brown, red and black duplex soils; bleached loamy and clay loamy surface, brown and grey, alkaline sodic duplex soils.	Eucalypt woodland (blue gum, Moreton Bay ash, silver-leaved ironbark, pink bloodwood, swamp mahogany); gum-topped box woodland.
Nl	Nulgi	Broad, level to gently undulating alluvial plains on silty and fine textured alluvium.	Bleached silty surface, brown and grey, alkaline sodic duplex soils.	Gum-topped box woodland.
Nw	Narrows	Alluvial fans and lower colluvial slopes of the coastal hills.	Bleached silty surface, brown and grey, alkaline sodic duplex soils.	Eucalypt woodland (blue gum, narrow-leaved ironbark, swamp mahogany) with teatree understory.
FLOODPLAINS AND LOCAL ALLUVIAL PLAINS				
Cracking Clays				
Rn	Raglan	Narrow to broad floodplains with meander channels; saline marine plains in lower sections flanking tidal streams.	Black and grey, mottled cracking clays.	Blue gum woodland; swampy grassland; marine couch grassland.
Gradational Soils				
Bo	Boyne	Narrow floodplains and alluvial terraces along the Boyne River and tributaries.	Black structured gradational clay loams and uniform clays; black and brown, massive sands and loams.	Eucalypt woodland (blue gum and Moreton Bay ash); vine forest.
Duplex Soils				
Cp	Calliope	Broad, level alluvial plains along the Calliope River and tributaries.	Clay loamy surface, black and brown duplex soils; black and grey, alkaline cracking clays with moderate melonhole.	Eucalypt woodland (Moreton Bay ash, blue gum, narrow-leaved ironbark).
Nk	Nankin	Narrow valley flats associated with steep volcanic mountains.	Clay loamy surface, brown and red duplex soils; brown and red, structured gradational clay loams.	Eucalypt woodland (blue gum, Moreton Bay ash, pink bloodwood, narrow-leaved ironbark).
COASTAL DUNES AND SAND PLAINS				
Jk	Joskeleigh	Gently undulating beach ridge plains and swamps along the coast.	Yellow and red sands; brown shelly sands.	Eucalypt woodland (pink bloodwood, white mahogany, Moreton Bay ash, swamp mahogany, coast banksia); vine thicket.
MARINE PLAINS				
Ct	Carpentaria	Marine plains, with extensive bare tidal flats inundated by tidal waters and dissected by tidal channels.	Crusting surface, grey mottled, saline cracking clays; saline muds and sands.	Mangrove low closed forest; marine couch grassland; samphire.
MISCELLANEOUS				
U	Urban			
W	Water			

(148) Unique Map Area (UMA) number.

BASE MAP LEGEND

- Built-up area; National route marker
- Principal road and highway; Road Bridge
- Secondary road; Distance in kilometres
- Minor road
- Vehicular track
- Railway, multiple track; Station; Railway bridge
- Railway, single track; Railway tunnel
- Light railway or tramway
- Aerodrome; Landing Ground
- Power transmission line; Fence
- Mine; Quarry
- Building/s; Homestead in sparsely settled area
- Drive-in theatre; Yard
- Trig station; Spot elevation

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LAND SYSTEMS OF THE CAPRICORNIA COAST
MAP 3 CALLIOPE AREA
LAND SYSTEMS
DPI.REF.No. 95-CCL-R-AO-3411

APPENDIX C EPIC SOIL AND LAND SURVEY FIELD SHEETS

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	MO01
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MP) - Brief mapping observation with some soil morphological data
Date:	28/6/2023 11:54	**Observation Method**	(S) - Shallow surface disturbance (<0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Cr) - Rockhampton Group
Lat / Long:	-24.11686,151.23551	**Preliminary Mapping Unit:**	Cr - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(RU) – Rudosols
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(4) - Complete clearing; pasture, native or imporved, but never cultivated	Surface Coarse Fragments Abundance	(3) - No qualifier or common (10-20%)
State of Erosion - Water	(S) - Stabilised	Fragment Size	(2) - Medium gravelly or medium pebbles (6-20mm), (3) - Coarse gravelly or large pebbles (20-60mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(A) - Angular, (S) - Subangular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(S) - Soft
State of Erosion - Wind	(S) - Stabilised	Runoff	(3) - Slow
Type of Erosion - Wind	(W0) - no wind erosion	Vegetation	Native tussock grasses
Other Erosion			
LANDFORM			
Location Type	(T) - Top landform element	Slope Element	
Slope Class	(VG) - Very gentle (1-3%)	Geomorphological Activity	(ER) - Eroded
Morphological Type	(S) - Simple Slop	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

SURFACE SOIL DESCRIPTION			
Soil moisture	(D) - Dry	Dry colour	10YR32
pH Field	6		very dark greyish brown
Field texture	(CLS) - Clay loam, sandy	Moisture colour	10YR21
Soil strength	(2) - Weak		black
Comment	Soil similar to TP09, A1 0-0.05 mbgl		

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	MO02
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MP) - Brief mapping observation with some soil morphological data
Date:	28/6/2023 11:15	**Observation Method**	(S) - Shallow surface disturbance (<0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Dca) - Mount Alma Formation
Lat / Long:	-24.12086,151.23654	**Preliminary Mapping Unit:**	Dca - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(RU) – Rudosols
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(3) - Extensive clearing (e.g. poisoning, ringbarking)	Surface Coarse Fragments Abundance	(2) - Slightly or few (2-10%)
State of Erosion - Water	(S) - Stabilised	Fragment Size	(2) - Medium gravelly or medium pebbles (6-20mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(A) - Angular, (S) - Subangular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(H) - Hard setting
State of Erosion - Wind	(S) - Stabilised	Runoff	(4) - Moderately rapid
Type of Erosion - Wind	(W0) - no wind erosion	Vegetation	Native tussock grasses and eucalyptus trees
Other Erosion			
LANDFORM			
Location Type	(M) - Middle landform element	Slope Element	
Slope Class	(VG) - Very gentle (1-3%)	Geomorphological Activity	(EA) - Eroded or aggraded
Morphological Type	(S) - Simple Slop	Landform Pattern	(LOW) - Low Hills

PHOTOS



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

SURFACE SOIL DESCRIPTION			
Soil moisture	(D) - Dry	Dry colour	2.5YR52
pH Field	6		weak red
Field texture	(CLS) - Clay loam, sandy	Moisture colour	10YR32
Soil strength	(3) - Firm		very dark greyish brown
Comment	Surface soil similar to TP07, A1 0.0 - 0.15 mbgl		

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	MO03
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MP) - Brief mapping observation with some soil morphological data
Date:	29/6/2023 08:52	**Observation Method**	(S) - Shallow surface disturbance (<0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda/I) - Calliope beds/l
Lat / Long:	-24.10994,151.24324	**Preliminary Mapping Unit:**	Sda/I - Cf
Horizontal accuracy (m):	3	**Australian Soil Classification:**	(AN) – Anthroposols
SITE SURFACE			
Weather	Overcast	Microrelief	(N) - Animal, (M) - Man, (U) - Mound/depression, Other
Land Use	Intensive Uses	Gully Size	
Disturbance	(8) - Highly disturbed (e.g. quarrying, road works, mining, landfill, urban)	Surface Coarse Fragments Abundance	(4) - Moderate or many (20-50%)
State of Erosion - Water	(P) - Partly Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm), (3) - Coarse gravelly or large pebbles (20-60mm), (4) - Cobbly or cobbles (60-200mm)
Type of Erosion - Water	(S2) - sheet erosion moderate	Fragment Shape	(A) - Angular, (S) - Subangular, (AT) - Angular tabular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(S) - Soft
State of Erosion - Wind	(S) - Stabilised	Runoff	(5) - Rapid
Type of Erosion - Wind	(W0) - no wind erosion	Vegetation	Exotic species and tussock grasses
Other Erosion			
LANDFORM			
Location Type	(T) - Top landform element	Slope Element	
Slope Class	(VG) - Very gentle (1-3%)	Geomorphological Activity	(BU) - Built up
Morphological Type	(C) - Crest	Landform Pattern	(MAD) - Made Land
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

SURFACE SOIL DESCRIPTION			
Soil moisture	(D) - Dry	Dry colour	10YR43
pH Field	8		brown
Field texture	(SCL) - Sandy clay loam	Moisture colour	10YR33
Soil strength	(2) - Weak		dark brown
Comment			

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	MO04
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MP) - Brief mapping observation with some soil morphological data
Date:	28/6/2023 13:13	**Observation Method**	(S) - Shallow surface disturbance (<0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda) - Calliope beds
Lat / Long:	-24.11951,151.23801	**Preliminary Mapping Unit:**	Sda - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(CH) – Chromosols
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(3) - Extensive clearing (e.g. poisoning, ringbarking)	Surface Coarse Fragments Abundance	(1) - Very slightly or very few (<2%)
State of Erosion - Water	(S) - Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(S) - Subangular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(L) - Loose
State of Erosion - Wind	(S) - Stabilised	Runoff	(4) - Moderately rapid
Type of Erosion - Wind	(W0) - no wind erosion	Vegetation	Native tussock grasses and ecalytpus trees
Other Erosion			
LANDFORM			
Location Type	(B) - Bottom landform element	Slope Element	(A) - Maximal
Slope Class	(GE) - Gentle (3-10%)	Geomorphological Activity	(EA) - Eroded or aggraded
Morphological Type	(L) - Lower Slope	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

SURFACE SOIL DESCRIPTION			
Soil moisture	(D) - Dry	Dry colour	5YR31
pH Field	5.5		very dark grey
Field texture	(SCL) - Sandy clay loam	Moisture colour	2.5YR2.5 1
Soil strength	(2) - Weak		reddish black
Comment	A1 0.0 - 0.2 mbgl		

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	MO05
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MP) - Brief mapping observation with some soil morphological data
Date:	29/6/2023 09:13	**Observation Method**	(S) - Shallow surface disturbance (<0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda) - Calliope beds
Lat / Long:	-24.11115,151.24256	**Preliminary Mapping Unit:**	Sda - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(AN) - Anthroposol
SITE SURFACE			
Weather	Overcast	Microrelief	(M) - Man, (V) - Vegetation, Other
Land Use	Intensive Uses	Gully Size	
Disturbance	(8) - Highly disturbed (e.g. quarrying, road works, mining, landfill, urban)	Surface Coarse Fragments Abundance	(5) - Very or abundant (50-90%)
State of Erosion - Water	(P) - Partly Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm), (3) - Coarse gravelly or large pebbles (20-60mm), (4) - Cobbly or cobbles (60-200mm), (5) - Stony or stones (200-600mm), (6) - Bouldery or boulders (600-2000mm)
Type of Erosion - Water	(S2) - sheet erosion moderate	Fragment Shape	(A) - Angular, (S) - Subangular, (AT) - Angular tabular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(L) - Loose
State of Erosion - Wind	(S) - Stabilised	Runoff	(5) - Rapid
Type of Erosion - Wind	(WX) - not apparent	Vegetation	Tussock grasses and iron bark
Other Erosion			
LANDFORM			
Location Type	(T) - Top landform element	Slope Element	
Slope Class	(GE) - Gentle (3-10%)	Geomorphological Activity	(BU) - Built up
Morphological Type	(C) - Crest	Landform Pattern	(MAD) - Made Land

PHOTOS



Photo1: Landscape

Tp02



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

SURFACE SOIL DESCRIPTION			
Soil moisture	(D) - Dry	Dry colour	7.5YR33
pH Field	8		dark brown
Field texture	(LC) - Light clay	Moisture colour	5YR2.5 2
Soil strength	(2) - Weak		dark reddish brown
Comment	Built up		

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	MO06
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MP) - Brief mapping observation with some soil morphological data
Date:	28/6/2023 12:10	**Observation Method**	(S) - Shallow surface disturbance (<0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda) - Calliope beds
Lat / Long:	-24.12242,151.23875	**Preliminary Mapping Unit:**	Sda - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(CH) – Chromosols
SITE SURFACE			
Weather	Sunny	Microrelief	(V) - Vegetation
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(3) - Extensive clearing (e.g. poisoning, ringbarking)	Surface Coarse Fragments Abundance	(2) - Slightly or few (2-10%)
State of Erosion - Water	(P) - Partly Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(S) - Subangular, (U) - Subrounded
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(F) - Firm
State of Erosion - Wind	(S) - Stabilised	Runoff	(4) - Moderately rapid
Type of Erosion - Wind	(W0) - no wind erosion	Vegetation	Tussock grasses, ironbark and eucalypt
Other Erosion			
LANDFORM			
Location Type	(B) - Bottom landform element	Slope Element	
Slope Class	(VG) - Very gentle (1-3%)	Geomorphological Activity	(AG) - Aggraded
Morphological Type	(V) - Open Depression	Landform Pattern	Other(DDE) - Drainage Depression
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

SURFACE SOIL DESCRIPTION			
Soil moisture	(D) - Dry	Dry colour	2.5Y53
pH Field	5.5		light olive brown
Field texture	(CLS) - Clay loam, sandy	Moisture colour	10YR33
Soil strength	(3) - Firm		dark brown
Comment	A1 0.0 - 0.25		

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	MO07
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MP) - Brief mapping observation with some soil morphological data
Date:	27/6/2023 14:31	**Observation Method**	(Y) - Surface observation only
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda/I) - Calliope beds/I
Lat / Long:	-24.11434,151.2402	**Preliminary Mapping Unit:**	Sda/I - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(KA) – Kandosols
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(3) - Extensive clearing (e.g. poisoning, ringbarking)	Surface Coarse Fragments Abundance	(4) - Moderate or many (20-50%)
State of Erosion - Water	(S) - Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(S) - Subangular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(1) - Very slightly rocky (<2% bedrock exposed)
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(L) - Loose
State of Erosion - Wind	(S) - Stabilised	Runoff	(4) - Moderately rapid
Type of Erosion - Wind	(W0) - no wind erosion	Vegetation	Native tussock grasses and ecalyptus trees
Other Erosion			
LANDFORM			
Location Type	(T) - Top landform element	Slope Element	(X) - Waxing
Slope Class	(GE) - Gentle (3-10%)	Geomorphological Activity	(ER) - Eroded
Morphological Type	(U) - Upper Slope	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

SURFACE SOIL DESCRIPTION			
Soil moisture	(D) - Dry	Dry colour	5YR42
pH Field	7.5		dark reddish grey
Field texture	(CS) - Clayey sand	Moisture colour	5YR33
Soil strength	(2) - Weak		dark reddish brown
Comment	A1 0.0 - 0.2		

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	OB01
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MP) - Brief mapping observation with some soil morphological data
Date:	26/6/2023 15:38	**Observation Method**	(Y) - Surface observation only
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Cr) - Rockhampton Group
Lat / Long:	-24.12069,151.23464	**Preliminary Mapping Unit:**	Cr - Cf
Horizontal accuracy (m):	2	**Australian Soil Classification:**	
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(3) - Extensive clearing (e.g. poisoning, ringbarking)	Surface Coarse Fragments Abundance	(0) - No coarse fragments
State of Erosion - Water	(S) - Stabilised	Fragment Size	
Type of Erosion - Water		Fragment Shape	
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(F) - Firm
State of Erosion - Wind	(S) - Stabilised	Runoff	(4) - Moderately rapid
Type of Erosion - Wind	(WX) - not apparent	Vegetation	Native grasses, ecalytpus
Other Erosion	No water erosion		
LANDFORM			
Location Type	(B) - Bottom landform element	Slope Element	(I) - Minimal
Slope Class	(VG) - Very gentle (1-3%)	Geomorphological Activity	(EA) - Eroded or aggraded
Morphological Type	(L) - Lower Slope	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

SURFACE SOIL DESCRIPTION			
Soil moisture	(D) - Dry		
pH Field	5.5		
Field texture	(LC) - Light clay		
Soil strength	(5) - Strong		
Comment			

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	OB02
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MO) - Brief mapping observation with no soil morphological data
Date:	26/6/2023 16:02	**Observation Method**	(Y) - Surface observation only
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Dca) - Mount Alma Formation
Lat / Long:	-24.11932,151.23632	**Preliminary Mapping Unit:**	Dca - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(HY) – Hydrosols
SITE SURFACE			
Weather	Sunny	Microrelief	(N) - Animal, (V) - Vegetation
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(4) - Complete clearing; pasture, native or imporved, but never cultivated	Surface Coarse Fragments Abundance	(0) - No coarse fragments
State of Erosion - Water	(S) - Stabilised	Fragment Size	
Type of Erosion - Water		Fragment Shape	
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(S) - Soft
State of Erosion - Wind	(S) - Stabilised	Runoff	(4) - Moderately rapid
Type of Erosion - Wind	(WX) - not apparent	Vegetation	Couch grass and weeds (cobbless pegs, caster oil),no trees
Other Erosion	No water erosion		
LANDFORM			
Location Type	(B) - Bottom landform element	Slope Element	
Slope Class	(LE) - Level (<1%)	Geomorphological Activity	(AG) - Aggraded
Morphological Type	(F) - Flat	Landform Pattern	Other(SWP) Swamp

PHOTOS



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

SURFACE SOIL DESCRIPTION			
Soil moisture	(W) - Wet		
pH Field	8.5		
Field texture	(MC) - Medium clay		
Soil strength	(1) - Very weak		
Comment			

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	OB03
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MO) - Brief mapping observation with no soil morphological data
Date:	26/6/2023 16:15	**Observation Method**	(Y) - Surface observation only
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Dca) - Mount Alma Formation
Lat / Long:	-24.11758,151.23597	**Preliminary Mapping Unit:**	Dca - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(4) - Complete clearing; pasture, native or imporved, but never cultivated	Surface Coarse Fragments Abundance	(1) - Very slightly or very few (<2%)
State of Erosion - Water	(S) - Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm)
Type of Erosion - Water		Fragment Shape	(S) - Subangular, (U) - Subrounded
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(F) - Firm
State of Erosion - Wind	(S) - Stabilised	Runoff	(3) - Slow
Type of Erosion - Wind	(WX) - not apparent	Vegetation	Renament regrowth, native grasses and sparse weeds (luceana and lantenna)
Other Erosion			
LANDFORM			
Location Type	(T) - Top landform element	Slope Element	
Slope Class	(VG) - Very gentle (1-3%)	Geomorphological Activity	(ER) - Eroded
Morphological Type	(C) - Crest	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

SURFACE SOIL DESCRIPTION			
Soil moisture	(D) - Dry		
pH Field	6		
Field texture	(SCL) - Sandy clay loam		
Soil strength	(3) - Firm		
Comment			

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	OB04
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MO) - Brief mapping observation with no soil morphological data
Date:	29/6/2023 07:59	**Observation Method**	(S) - Shallow surface disturbance (<0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda) - Calliope beds
Lat / Long:	-24.10657,151.24223	**Preliminary Mapping Unit:**	Sda - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(DE) – Dermosols
SITE SURFACE			
Weather	Overcast	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(2) - Limited clearing (e.g. selective logging)	Surface Coarse Fragments Abundance	(1) - Very slightly or very few (<2%)
State of Erosion - Water	(P) - Partly Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(S) - Subangular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(G) - Cracking
State of Erosion - Wind	(S) - Stabilised	Runoff	(2) - Very slow
Type of Erosion - Wind	(WX) - not apparent	Vegetation	Tussock grasses and eucalypt
Other Erosion			
LANDFORM			
Location Type	(B) - Bottom landform element	Slope Element	
Slope Class	(LE) - Level (<1%)	Geomorphological Activity	(AG) - Aggraded
Morphological Type	(V) - Open Depression	Landform Pattern	Other(DDE) Drainage Depression
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	OB05
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MO) - Brief mapping observation with no soil morphological data
Date:	27/6/2023 13:43	**Observation Method**	(Y) - Surface observation only
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda) - Calliope beds
Lat / Long:	-24.1166,151.23642	**Preliminary Mapping Unit:**	Sda - Cf
Horizontal accuracy (m):	2	**Australian Soil Classification:**	
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Relatively Natural Environments	Gully Size	
Disturbance	(3) - Extensive clearing (e.g. poisoning, ringbarking)	Surface Coarse Fragments Abundance	(2) - Slightly or few (2-10%)
State of Erosion - Water	(S) - Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm)
Type of Erosion - Water	(SX) - sheet erosion not apparent	Fragment Shape	(S) - Subangular, (U) - Subrounded
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(S) - Soft
State of Erosion - Wind	(S) - Stabilised	Runoff	(3) - Slow
Type of Erosion - Wind	(W0) - no wind erosion	Vegetation	Tussock grasses
Other Erosion			
LANDFORM			
Location Type	(T) - Top landform element	Slope Element	
Slope Class	(VG) - Very gentle (1-3%)	Geomorphological Activity	(EA) - Eroded or aggraded
Morphological Type	(S) - Simple Slop	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

SURFACE SOIL DESCRIPTION			
Soil moisture	(D) - Dry		
pH Field	6.5		
Field texture	(CL) - Clay loam		
Soil strength	(2) - Weak		
Comment			

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	OB06
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MO) - Brief mapping observation with no soil morphological data
Date:	29/6/2023 07:39	**Observation Method**	(Y) - Surface observation only
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda/l) - Calliope beds/l
Lat / Long:	-24.10574,151.24199	**Preliminary Mapping Unit:**	Sda/l - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	
SITE SURFACE			
Weather	Overcast	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(3) - Extensive clearing (e.g. poisoning, ringbarking)	Surface Coarse Fragments Abundance	(1) - Very slightly or very few (<2%)
State of Erosion - Water	(P) - Partly Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(S) - Subangular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(L) - Loose
State of Erosion - Wind	(S) - Stabilised	Runoff	(2) - Very slow
Type of Erosion - Wind	(WX) - not apparent	Vegetation	Tussock grasses
Other Erosion			
LANDFORM			
Location Type	(B) - Bottom landform element	Slope Element	
Slope Class	(LE) - Level (<1%)	Geomorphological Activity	(AG) - Aggraded
Morphological Type	(V) - Open Depression	Landform Pattern	Other(DDE) Drainage Depression
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

SURFACE SOIL DESCRIPTION			
Soil moisture	(D) - Dry		
pH Field	6.5		
Field texture	(CL) - Clay loam		
Soil strength	(2) - Weak		
Comment			

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	OB07
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MO) - Brief mapping observation with no soil morphological data
Date:	28/6/2023 13:40	**Observation Method**	(Y) - Surface observation only
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda) - Calliope beds
Lat / Long:	-24.11972,151.23966	**Preliminary Mapping Unit:**	Sda - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(2) - Limited clearing (e.g. selective logging)	Surface Coarse Fragments Abundance	(4) - Moderate or many (20-50%)
State of Erosion - Water	(S) - Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm), (3) - Coarse gravelly or large pebbles (20-60mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(A) - Angular, (S) - Subangular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(1) - Very slightly rocky (<2% bedrock exposed)
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(L) - Loose
State of Erosion - Wind	(S) - Stabilised	Runoff	(5) - Rapid
Type of Erosion - Wind	(W0) - no wind erosion	Vegetation	Native tussock grasses, ecalytpus and regrowth
Other Erosion			
LANDFORM			
Location Type	(T) - Top landform element	Slope Element	(A) - Maximal
Slope Class	(MO) - Moderate (10-23%)	Geomorphological Activity	(ER) - Eroded
Morphological Type	(U) - Upper Slope	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

SURFACE SOIL DESCRIPTION			
Soil moisture	(D) - Dry		
pH Field	5.5		
Field texture	(LC) - Light clay		
Soil strength	(2) - Weak		
Comment			

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	OB08
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(MO) - Brief mapping observation with no soil morphological data
Date:	29/6/2023 09:34	**Observation Method**	(Y) - Surface observation only
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda/l) - Calliope beds/l
Lat / Long:	-24.10728,151.24233	**Preliminary Mapping Unit:**	Sda/l - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(DE) – Dermosols
SITE SURFACE			
Weather	Overcast	Microrelief	
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(2) - Limited clearing (e.g. selective logging)	Surface Coarse Fragments Abundance	(1) - Very slightly or very few (<2%)
State of Erosion - Water	(P) - Partly Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(S) - Subangular, (U) - Subrounded
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(F) - Firm
State of Erosion - Wind	(S) - Stabilised	Runoff	(2) - Very slow
Type of Erosion - Wind	(WX) - not apparent	Vegetation	Tussock grasses
Other Erosion			
LANDFORM			
Location Type	(B) - Bottom landform element	Slope Element	
Slope Class	(LE) - Level (<1%)	Geomorphological Activity	(AG) - Aggraded
Morphological Type	(V) - Open Depression	Landform Pattern	Other(DDE) Drainage Depression
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

SURFACE SOIL DESCRIPTION			
Soil moisture	(D) - Dry		
pH Field	8.5		
Field texture	(LC) - Light clay		
Soil strength	(2) - Weak		
Comment			

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	TP01
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(PD) - Detailed profile description with no laboratory analysis
Date:	26/6/2023 11:31	**Observation Method**	(P) - Soil pit (>0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Dca) - Mount Alma Formation
Lat / Long:	-24.11957,151.23675	**Preliminary Mapping Unit:**	Dca - Cf
Horizontal accuracy (m):	12	**Australian Soil Classification:**	(HY) – Hydrosols
SITE SURFACE			
Weather	Sunny, Humid	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(3) - Extensive clearing (e.g. poisoning, ringbarking)	Surface Coarse Fragments Abundance	(0) - No coarse fragments
State of Erosion - Water	(S) - Stabilised	Fragment Size	
Type of Erosion - Water	(SX) - sheet erosion not apparent	Fragment Shape	
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	
State of Erosion - Wind	(S) - Stabilised	Runoff	(1) - No runoff
Type of Erosion - Wind	(WX) - not apparent	Vegetation	Couch
Other Erosion			
LANDFORM			
Location Type	(B) - Bottom landform element	Slope Element	
Slope Class	(LE) - Level (<1%)	Geomorphological Activity	(AG) - Aggraded
Morphological Type	(D) - Closed Depression	Landform Pattern	Other(SWP) Swamp
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

DETAILED SOIL DESCRIPTION

Type of Soil Observation

Horizon	Soil			Mottle		Root	Fragments	Pedality	Cutans	Segregations		Pan	Soil Water Regime		
• Horizon • From-To • Horizon Boundary • Boundary Shape	• Moisture • pH	Dry Colour	Moisture Colour	• Type • Abundance • Size	• Contrast • Colour • Boundaries	• Abundance • Size	• Field texture • Surface coarse fragments abundance • Size • Shape	• Grade • Size • Type • Smooth-ped fabric	• Type • Abundance • Distinctness	• Abundance • Nature • Form • Size • Strength	• Magnetic Attributes • Soil strength • Depth to R horizon	• Type • Cementation • Continuity • Structure	• Permeability • Drainage	Depth to free water	Sample ID + Depth
A1 0 - 0.50 (G) - Gradual (50-100mm) (I) - Irregular	(M) - Moist 7	5Y41 dark grey	5Y41 dark grey	(M) - Mottles (4) - Many (20-50%) (2) - Medium (5-15mm)	(P) - Prominent (DO) - Dark orange (C) - Clear	(2) - Common (10-25 p/m^2) (1) - Very fine (<1mm diameter), (2) - Fine (1-2mm diameter)	(MC) - Medium clay (2) - Slightly or few (2-10%) (1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm) (U) - Subrounded, (R) - Rounded	(W) - Weak (4) - 10-20mm, (5) - 20-50mm (4) - 10-20mm, (5) - 20-50mm (R) - Rough-ped	(M) - Mangans (1) - Few (<10%) (D) - Distinct	(1) - Very few (<2%) (N) - Ferromanganiferous (iron-manganese)(N) - Ferromanganiferous (iron-manganese) (N) - Nodules, (R) - Root linings (1) - Fine (<2mm)	(N) - Non-magnetic (3) - Firm	(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (2) - Poorly drained	No Free water	No Free water No Free water
B21 0.50 - 1.20 (G) - Gradual (50-100mm) (I) - Irregular	(M) - Moist 8.5	5YR31 very dark grey	5YR2.5 1 black	(0) - No mottles or colour patterns		(1) - Few (1-10 p/m^2) (1) - Very fine (<1mm diameter)	(MC) - Medium clay (1) - Very slightly or very few (<2%) (1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm) (U) - Subrounded, (R) - Rounded	(M) - Moderate (3) - 5-10mm, (4) - 10-20mm (3) - 5-10mm, (4) - 10-20mm (R) - Rough-ped	(0) - No cutans	(0) - No segregations		(Z) - Zero or no pan	(1) - Very slowly permeable, Ks range: <5 mm/day, drainage time: months (3) - Imperfectly drained	No free water	No free water No free water
B22 1.20 - 1.45 (G) - Gradual (50-100mm) (W) - Wavy	(W) - Wet 8.5	5YR31 very dark grey	5YR2.5 1 black	(M) - Mottles (4) - Many (20-50%) (2) - Medium (5-15mm)	(D) - Distinct (DO) - Dark orange (D) - Diffuse	(0) - No roots	(MC) - Medium clay (2) - Slightly or few (2-10%) (1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm), (3) - Coarse gravelly or large pebbles (20-60mm) (S) - Subangular, (R) - Rounded	(S) - Strong (3) - 5-10mm, (4) - 10-20mm (3) - 5-10mm, (4) - 10-20mm (S) - Smooth-ped	(0) - No cutans	(1) - Very few (<2%) (H) - Organic (humified, well-decomposed organic matter)(H) - Organic (humified, well-decomposed organic matter) (R) - Root linings (1) - Fine (<2mm) (1) - Weak	(N) - Non-magnetic (3) - Firm	(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (1) - Very poorly drained	No free water	No free water No free water
B23r 1.45 - 2.00 (D) - Diffuse (>100mm) (S) - Smooth	(D) - Dry 8.5	5YR58 yellowish red	10YR88 yellow	(M) - Mottles (4) - Many (20-50%) (2) - Medium (5-15mm)	(D) - Distinct (RR) - rusty red (D) - Diffuse	(0) - No roots	(MC) - Medium clay (4) - Moderate or many (20-50%) (2) - Medium gravelly or medium pebbles (6-20mm), (3) - Coarse gravelly or large pebbles (20-60mm), (4) - Cobbly or cobbles (60-200mm) (A) - Angular, (S) - Subangular	(M) - Moderate (3) - 5-10mm (3) - 5-10mm (R) - Rough-ped	(0) - No cutans	(0) - No segregations		(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (3) - Imperfectly drained	No Free Water	No Free Water No Free Water

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Photo – Soil Profile	

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

OTHER PHOTOS (IF TAKEN)	
TP01_BOLLUS	

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	TP02
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(PD) - Detailed profile description with no laboratory analysis
Date:	29/6/2023 08:15	**Observation Method**	(P) - Soil pit (>0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda) - Calliope beds
Lat / Long:	-24.10805,151.24351	**Preliminary Mapping Unit:**	Sda - Cf
Horizontal accuracy (m):	3	**Australian Soil Classification:**	(AN) - Anthroposol
SITE SURFACE			
Weather	Overcast	Microrelief	(M) - Man, (U) - Mound/depression
Land Use	Intensive Uses	Gully Size	
Disturbance	(8) - Highly disturbed (e.g. quarrying, road works, mining, landfill, urban)	Surface Coarse Fragments Abundance	(6) - Extremely or very abundant (>90%)
State of Erosion - Water	(P) - Partly Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm), (3) - Coarse gravelly or large pebbles (20-60mm), (4) - Cobbly or cobbles (60-200mm), (5) - Stony or stones (200-600mm), (6) - Bouldery or boulders (600-2000mm), (7) - Large boulders (>2000mm)
Type of Erosion - Water	(S2) - sheet erosion moderate	Fragment Shape	(A) - Angular, (S) - Subangular, (U) - Subrounded, (AT) - Angular tabular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	Other: Overburden fill
State of Erosion - Wind	(S) - Stabilised	Runoff	(2) - Very slow
Type of Erosion - Wind	(WX) - not apparent	Vegetation	Tussock grasses
Other Erosion			
LANDFORM			
Location Type	(T) - Top landform element	Slope Element	
Slope Class	(VG) - Very gentle (1-3%)	Geomorphological Activity	(BU) - Built up
Morphological Type	(C) - Crest	Landform Pattern	(MAD) - Made Land
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

DETAILED SOIL DESCRIPTION																
Type of Soil Observation				(P) - Soil pit												
Horizon	**Soil**			**Mottle**		**Root**	**Fragments**	**Pedality**	**Cutans**	**Segregations**		**Pan**	**Soil Water Regime**			
• Horizon • From-To • Horizon Boundary • Boundary Shape	• Moisture • pH	Dry Colour	Moisture Colour	• Type • Abundance • Size	• Contrast • Colour • Boundaries	• Abundance • Size	• Field texture • Surface coarse fragments abundance • Size • Shape	• Grade • Size • Type • Smooth-ped fabric	• Type • Abundance • Distinctness	• Abundance • Nature • Form • Size • Strength	• Magnetic Attributes • Soil strength • Depth to R horizon	• Type • Cementation • Continuity • Structure	• Permeability • Drainage	Depth to free water	Sample ID + Depth
No distinct horizonation	(D) - Dry, (SM) - Slightly moist 8.5	10YR54 weak red	10YR43 weak red	(0) - No mottles or colour patterns		(2) - Common (10-25 p/m^2) (1) - Very fine (<1mm diameter), (3) - Medium (2-5mm diameter)	(CLS) - Clay loam, sandy (5) - Very or abundant (50-90%) (1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm), (3) - Coarse gravelly or large pebbles (20-60mm), (4) - Cobbly or cobbles (60-200mm), (5) - Stony or stones (200-600mm), (6) - Bouldery or boulders (600-2000mm) (A) - Angular, (S) - Subangular, (AT) - Angular tabular	(V) - Massive (R) - Rough-ped	(0) - No cutans	(0) - No segregations		(Z) - Zero or no pan	(4) - Highly permeable, Ks range: >500 mm/day, drainage time: hours (5) - Well-drained	No	No No

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Photo – Soil Profile			

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

OTHER PHOTOS (IF TAKEN)	
A1_Horizon	

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	TP03
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes and Michael Kowalczyk	**Observation Class:**	(SM) - Profile with standard analytical suite
Date:	26/6/2023 14:04	**Observation Method**	(P) - Soil pit (>0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Cr) - Rockhampton Group
Lat / Long:	-24.12098,151.23453	**Preliminary Mapping Unit:**	Cr - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(RU) – Rudosols
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(2) - Limited clearing (e.g. selective logging)	Surface Coarse Fragments Abundance	(1) - Very slightly or very few (<2%)
State of Erosion - Water	(P) - Partly Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(S) - Subangular, (U) - Subrounded
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(H) - Hard setting
State of Erosion - Wind	(S) - Stabilised	Runoff	(3) - Slow
Type of Erosion - Wind	(WX) - not apparent	Vegetation	Iron bark and grasses
Other Erosion			
LANDFORM			
Location Type	(M) - Middle landform element	Slope Element	(N) - Waning
Slope Class	(GE) - Gentle (3-10%)	Geomorphological Activity	(EA) - Eroded or aggraded
Morphological Type	(S) - Simple Slop	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

DETAILED SOIL DESCRIPTION															
Type of Soil Observation				(P) - Soil pit											
Horizon	**Soil**			**Mottle**		**Root**	**Fragments**	**Pedality**	**Cutans**	**Segregations**		**Pan**	**Soil Water Regime**		
• Horizon • From-To • Horizon Boundary • Boundary Shape	• Moisture • pH	Dry Colour	Moisture Colour	• Type • Abundance • Size	• Contrast • Colour • Boundaries	• Abundance • Size	• Field texture • Surface coarse fragments abundance • Size • Shape	• Grade • Size • Type • Smooth-ped fabric	• Type • Abundance • Distinctness	• Abundance • Nature • Form • Size • Strength	• Magentic Attributes • Soil strength • Depth to R horizon	• Type • Cementation • Continuity • Structure	• Permeability • Drainage	Depth to free water	Sample ID + Depth
A1 0.25 - 0.35	(D) - Dry 5.5	2.5YR4 1 dark reddish grey	2.5Y41 dark grey	(0) - No mottles or colour patterns		(2) - Common (10-25 p/m^2) (1) - Very fine (<1mm diameter), (2) - Fine (1-2mm diameter), (3) - Medium (2-5mm diameter), (4) - Coarse (>5mm diameter)	(LC) - Light clay (2) - Slightly or few (2-10%) (1) - Fine gravelly or small pebbles (2-6mm), (3) - Coarse gravelly or large pebbles (20-60mm) (S) - Subangular, (U) - Subrounded	(M) - Moderate (2) - 2-5mm, (3) - 5-10mm, (4) - 10-20mm (2) - 2-5mm, (3) - 5-10mm, (4) - 10-20mm (R) - Rough-ped	(0) - No cutans	(0) - No segregations		(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (4) - Moderatley well-drained	No free water	No free water No free water
B 2 0.25-0.5 (D) - Diffuse (>100mm) (S) - Smooth	(SM) - Slightly moist 5.5	2.5YR4 3 reddish brown	2.5YR46 red	(Z) - Colour patterns due to inclsuions of weathered substrate (3) - Common (10-20%) (1) - Fine (<5mm)	(P) - Prominent (DY) - Dark yellow, (DG) - Dark grey (D) - Diffuse	(1) - Few (1-10 p/m^2) (4) - Coarse (>5mm diameter)	(MC) - Medium clay (3) - No qualifier or common (10-20%) (3) - Coarse gravelly or large pebbles (20-60mm), (4) - Cobbly or cobbles (60-200mm) (A) - Angular, (U) - Subrounded	(M) - Moderate (4) - 10-20mm, (5) - 20-50mm (4) - 10-20mm, (5) - 20-50mm (R) - Rough-ped	(M) - Mangans (1) - Few (<10%) (D) - Distinct	(0) - No segregations		(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (3) - Imperfectly drained	No free water	No free water No free water

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Photo – Soil Profile	

DETAILED SUBSTRATE			
Type	(P) - Soil pit	Dry colour	10YR76
Depth	0.5		yellow
pH Field	5.5	Moisture colour	10YR56
Lithology Type	Blocky Siltstone		yellowish brown
Comment			

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	TP04
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(SM) - Profile with standard analytical suite
Date:	27/6/2023 07:38	**Observation Method**	(P) - Soil pit (>0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda/I) - Calliope beds/l
Lat / Long:	-24.11207,151.24075	**Preliminary Mapping Unit:**	Sda/I - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(CH) – Chromosols
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(4) - Complete clearing; pasture, native or imporved, but never cultivated	Surface Coarse Fragments Abundance	(1) - Very slightly or very few (<2%)
State of Erosion - Water	(S) - Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(U) - Subrounded, (R) - Rounded
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(F) - Firm
State of Erosion - Wind	(S) - Stabilised	Runoff	(3) - Slow
Type of Erosion - Wind	(WX) - not apparent	Vegetation	Tussock Grass
Other Erosion	No water erosion		
LANDFORM			
Location Type	(B) - Bottom landform element	Slope Element	(I) - Minimal
Slope Class	(VG) - Very gentle (1-3%)	Geomorphological Activity	(ER) - Eroded
Morphological Type	(M) - Mid-Slope	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

DETAILED SOIL DESCRIPTION

Type of Soil Observation

Horizon	Soil			Mottle		Root	Fragments	Pedality	Cutans	Segregations		Pan	Soil Water Regime		
• Horizon • From-To • Horizon Boundary • Boundary Shape	• Moisture • pH	Dry Colour	Moisture Colour	• Type • Abundance • Size	• Contrast • Colour • Boundaries	• Abundance • Size	• Field texture • Surface coarse fragments abundance • Size • Shape	• Grade • Size • Type • Smooth-ped fabric	• Type • Abundance • Distinctness	• Abundance • Nature • Form • Size • Strength	• Magentic Attributes • Soil strength • Depth to R horizon	• Type • Cementation • Continuity • Structure	• Permeability • Drainage	Depth to free water	Sample ID + Depth
A1 0-0.5	(D) - Dry 6	7.5YR3 2 dark brown	7.5YR2.5 2 very dark brown	(0) - No mottles or colour patterns		(2) - Common (10-25 p/m^2) (1) - Very fine (<1mm diameter), (2) - Fine (1-2mm diameter)	(CLS) - Clay loam, sandy (4) - Moderate or many (20-50%) (1) - Fine gravelly or small pebbles (2-6mm) (R) - Rounded	(W) - Weak (1) - <2mm, (2) - 2-5mm, (3) - 5-10mm (1) - <2mm, (2) - 2-5mm, (3) - 5-10mm (E) - Earthy	(0) - No cutans	(3) - Common (10-20%) (F) - Ferruginous (iron)(F) - Ferruginous (iron) (N) - Nodules (2) - Medium (2-6mm) (2) - Strong	(N) - Non-magnetic (4) - Very firm	(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (5) - Well-drained		
B2 0.5-2.00 (A) - Abrupt (5-20mm) (W) - Wavy	(M) - Moist 6	7.5YR4 4 brown	7.5YR46 strong brown	(0) - No mottles or colour patterns		(3) - Many (25-200 p/m^2) (1) - Very fine (<1mm diameter)	(HC) - Heavy clay (4) - Moderate or many (20-50%) (1) - Fine gravelly or small pebbles (2-6mm) (U) - Subrounded, (R) - Rounded	(S) - Strong (5) - 20-50mm, (7) - 100-200mm (5) - 20-50mm, (7) - 100-200mm (S) - Smooth-ped	(0) - No cutans	(1) - Very few (<2%) (F) - Ferruginous (iron)(F) - Ferruginous (iron) (N) - Nodules (1) - Fine (<2mm), (2) - Medium (2-6mm), (3) - Coarse (6-20mm)		(Z) - Zero or no pan	(1) - Very slowly permeable, Ks range: <5 mm/day, drainage time: months (3) - Imperfectly drained		

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Photo – Soil Profile		

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	TP05
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes and Michael Kowalczyk	**Observation Class:**	(SM) - Profile with standard analytical suite
Date:	26/6/2023 07:43	**Observation Method**	(P) - Soil pit (>0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda/I) - Calliope beds/l
Lat / Long:	-24.12174,151.23993	**Preliminary Mapping Unit:**	Sda/I - Cf
Horizontal accuracy (m):	2.82	**Australian Soil Classification:**	(KA) – Kandosols
SITE SURFACE			
Weather	Foggy	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Relatively Natural Environments	Gully Size	
Disturbance	(2) - Limited clearing (e.g. selective logging)	Surface Coarse Fragments Abundance	(1) - Very slightly or very few (<2%)
State of Erosion - Water	(S) - Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm)
Type of Erosion - Water	(SX) - sheet erosion not apparent	Fragment Shape	(A) - Angular, (S) - Subangular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(H) - Hard setting
State of Erosion - Wind	(S) - Stabilised	Runoff	(3) - Slow
Type of Erosion - Wind	(WX) - not apparent	Vegetation	Remnant Eucalyptus crebra woodland and native tussock grasses and herbs, and weed species were sparse
Other Erosion	No water erosion		
LANDFORM			
Location Type	(M) - Middle landform element	Slope Element	(N) - Waning
Slope Class	(GE) - Gentle (3-10%)	Geomorphological Activity	(EA) - Eroded or aggraded
Morphological Type	(S) - Simple Slop	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

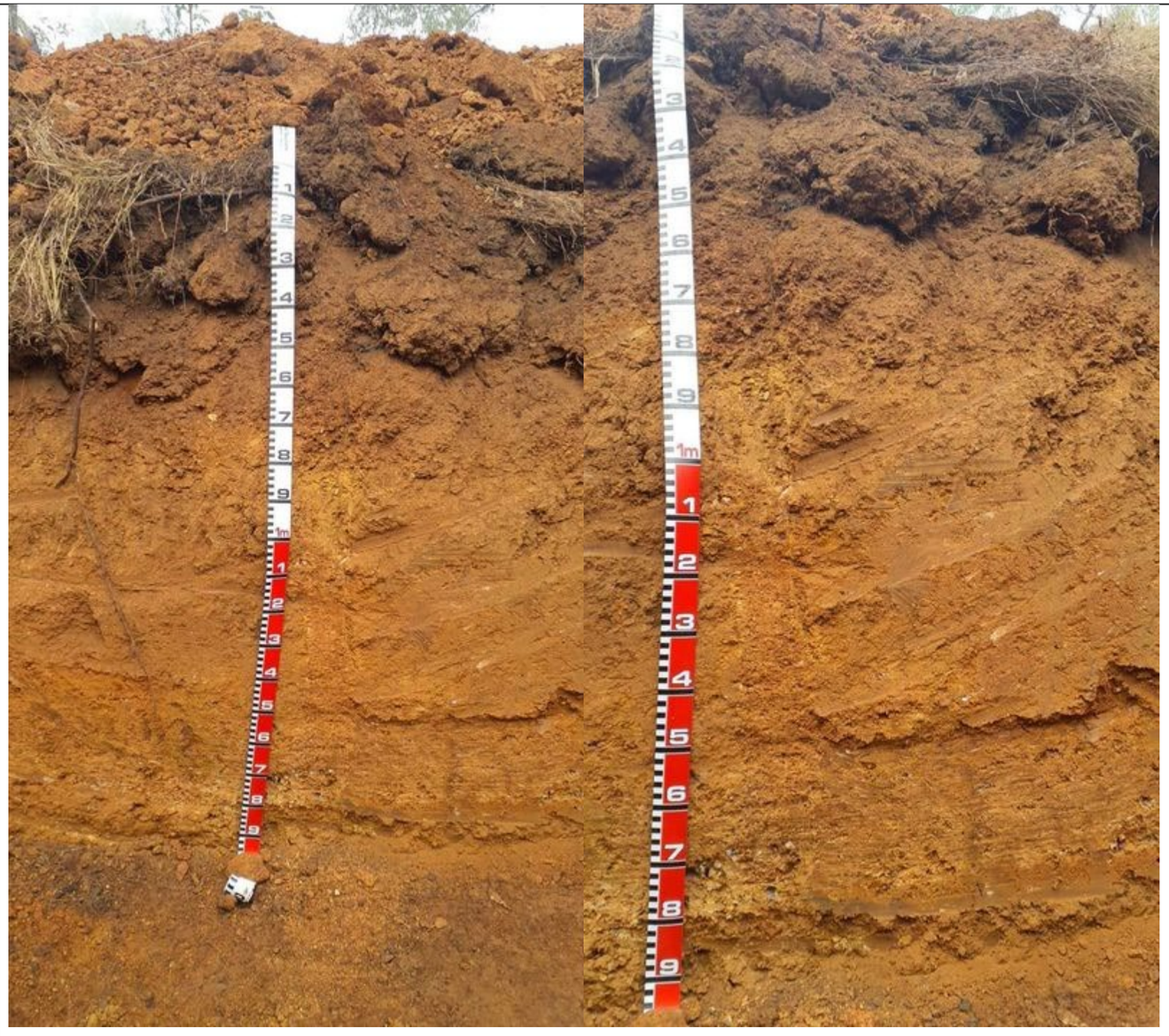
Survey type: Surface Soil Description

DETAILED SOIL DESCRIPTION															
Type of Soil Observation				(P) - Soil pit											
Horizon	**Soil**			**Mottle**		**Root**	**Fragments**	**Pedality**	**Cutans**	**Segregations**		**Pan**	**Soil Water Regime**		
• Horizon • From-To • Horizon Boundary • Boundary Shape	• Moisture • pH	Dry Colour	Moisture Colour	• Type • Abundance • Size	• Contrast • Colour • Boundaries	• Abundance • Size	• Field texture • Surface coarse fragments abundance • Size • Shape	• Grade • Size • Type • Smooth-ped fabric	• Type • Abundance • Distinctness	• Abundance • Nature • Form • Size • Strength	• Magentic Attributes • Soil strength • Depth to R horizon	• Type • Cementation • Continuity • Structure	• Permeability • Drainage	Depth to free water	Sample ID + Depth
A1 0 - 0.30	(D) - Dry 6	10YR43 brown	10YR22 very dark brown	(0) - No mottles or colour patterns		(2) - Common (10-25 p/m^2) (1) - Very fine (<1mm diameter), (3) - Medium (2-5mm diameter)	(CLS) - Clay loam, sandy (2) - Slightly or few (2-10%) (2) - Medium gravelly or medium pebbles (6-20mm), (4) - Cobbly or cobbles (60-200mm) (A) - Angular, (U) - Subrounded	(V) - Massive (2) - 2-5mm, (3) - 5-10mm (2) - 2-5mm, (3) - 5-10mm (R) - Rough-ped	(0) - No cutans	(0) - No segregations		(Z) - Zero or no pan	(3) - Moderately permeable, Ks range: 50-500 mm/day, drainage time: days (4) - Moderately well-drained	No free water	No free water No free water
A 3 0.30 - 0.45 (A) - Abrupt (5-20mm) (W) - Wavy	(D) - Dry 6	10YR36 dark yellowish brown	10YR33 dark brown	(0) - No mottles or colour patterns		(2) - Common (10-25 p/m^2) (2) - Fine (1-2mm diameter), (3) - Medium (2-5mm diameter)	(CLS) - Clay loam, sandy (2) - Slightly or few (2-10%) (1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm) (S) - Subangular, (U) - Subrounded	(V) - Massive (1) - <2mm, (3) - 5-10mm (1) - <2mm, (3) - 5-10mm (R) - Rough-ped	(0) - No cutans	(1) - Very few (<2%) (H) - Organic (humified, well-decomposed organic matter)(H) - Organic (humified, well-decomposed organic matter) (S) - Soft segregations (3) - Coarse (6-20mm) (1) - Weak	(N) - Non-magnetic (4) - Very firm	(Z) - Zero or no pan	(3) - Moderately permeable, Ks range: 50-500 mm/day, drainage time: days (4) - Moderately well-drained	No water encountered	No water encountered No water encountered
B21 0.45 - 0.90 (C) - Clear (20-50mm) (W) – Wavy	(D) - Dry 6	7.5YR46 strong brown	7.5YR44 brown	(M) - Mottles (1) - Very few (<2%) (1) - Fine (<5mm)	(F) - Faint (DR) - Dark red (D) - Diffuse	(1) - Few (1-10 p/m^2) (1) - Very fine (<1mm diameter), (2) - Fine (1-2mm diameter)	(CLS) - Clay loam, sandy (3) - No qualifier or common (10-20%) (1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm) (A) - Angular, (U) - Subrounded	(V) - Massive (2) - 2-5mm, (3) - 5-10mm (2) - 2-5mm, (3) - 5-10mm (R) - Rough-ped	(0) - No cutans	(0) - No segregations		(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (3) - Imperfectly drained	No free water	No free water No free water
B22 0.90 – 1.50 (D) - Diffuse (>100mm) (W) - Wavy	(D) - Dry 9.5	5YR56 yellowish red	7.5YR46 strong brown	(Z) - Colour patterns due to inclsuions of weathered substrate (2) - Few (2-10%) (2) - Medium (5-15mm)	(D) - Distinct (DRR) - Dark rusty red (D) - Diffuse	(1) - Few (1-10 p/m^2) (2) - Fine (1-2mm diameter)	(MC) - Medium clay (3) - No qualifier or common (10-20%) (1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm) (A) - Angular, (U) - Subrounded, (R) - Rounded	(V) - Massive (2) - 2-5mm, (3) - 5-10mm (2) - 2-5mm, (3) - 5-10mm (R) - Rough-ped	(0) - No cutans	(E) - Earthy (dominantly non-clayey)(E) - Earthy (dominantly non-clayey) (F) - Fragments (2) - Medium (2-6mm) (2) - Strong	(6) - Very strong	(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (3) - Imperfectly drained	No free water	No free water No free water

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

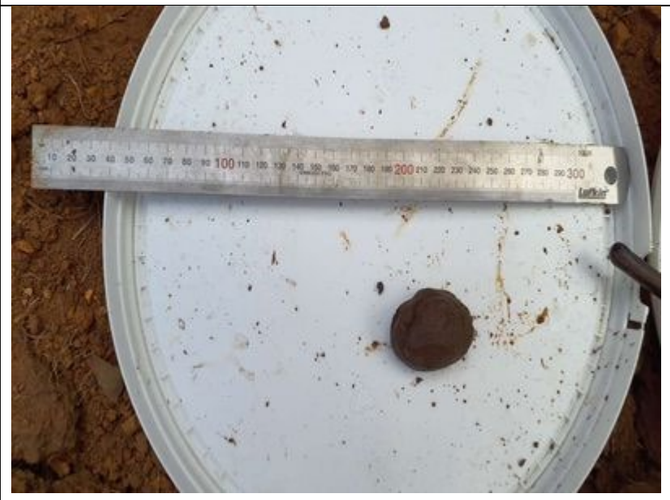
Photo – Soil Profile





SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

OTHER PHOTOS (IF TAKEN)	
Surface_coarse_fragments	
A1_Bollus	
TP05_bollus	

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	TP06
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(PD) - Detailed profile description with no laboratory analysis
Date:	27/6/2023 09:32	**Observation Method**	(P) - Soil pit (>0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda) - Calliope beds
Lat / Long:	-24.11244,151.24236	**Preliminary Mapping Unit:**	Sda - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(CH) - Chromosols
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(4) - Complete clearing; pasture, native or imporved, but never cultivated	Surface Coarse Fragments Abundance	(2) - Slightly or few (2-10%)
State of Erosion - Water	(S) - Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(A) - Angular, (S) - Subangular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(H) - Hard setting
State of Erosion - Wind	(S) - Stabilised	Runoff	(3) - Slow
Type of Erosion - Wind	(W0) - no wind erosion	Vegetation	Tussock grasses
Other Erosion			
LANDFORM			
Location Type	(T) - Top landform element	Slope Element	(A) - Maximal
Slope Class	(MO) - Moderate (10-23%)	Geomorphological Activity	(ER) - Eroded
Morphological Type	(U) - Upper Slope	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

DETAILED SOIL DESCRIPTION

Type of Soil Observation				(P) - Soil pit												
Horizon	**Soil**			**Mottle**		**Root**	**Fragments**	**Pedality**	**Cutans**	**Segregations**		**Pan**	**Soil Water Regime**			
• Horizon • From-To • Horizon Boundary • Boundary Shape	• Moisture • pH	Dry Colour	Moisture Colour	• Type • Abundance • Size	• Contrast • Colour • Boundaries	• Abundance • Size	• Field texture • Surface coarse fragments abundance • Size • Shape	• Grade • Size • Type • Smooth-ped fabric	• Type • Abundance • Distinctness	• Abundance • Nature • Form • Size • Strength	• Magnetic Attributes • Soil strength • Depth to R horizon	• Type • Cementation • Continuity • Structure	• Permeability • Drainage	Depth to free water	Sample ID + Depth
A 1 0 -0.2	(D) - Dry 6.5	10YR44 dark yellowish brown	10YR34 dark yellowish brown	(0) - No mottles or colour patterns		(2) - Common (10-25 p/m^2) (1) - Very fine (<1mm diameter), (2) - Fine (1-2mm diameter)	(SCL) - Sandy clay loam (3) - No qualifier or common (10-20%) (1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm) (A) - Angular, (R) - Rounded	(W) - Weak (2) - 2-5mm, (3) - 5-10mm (2) - 2-5mm, (3) - 5-10mm (R) - Rough-ped	(0) - No cutans	(1) - Very few (<2%) (F) - Ferruginous (iron)(F) - Ferruginous (iron) (N) - Nodules (2) - Medium (2-6mm) (1) - Weak	(N) - Non-magnetic (2) - Weak	(Z) - Zero or no pan	(3) - Moderately permeable, Ks range: 50-500 mm/day, drainage time: days (5) - Well-drained	No water encountered	No water encountered No water encountered
B2 0.2 - 0.5 (S) - Sharp (<5mm) (S) - Smooth	(D) - Dry 6	5YR44 reddish brown	5YR54 reddish brown	(0) - No mottles or colour patterns		(1) - Few (1-10 p/m^2) (1) - Very fine (<1mm diameter)	(MC) - Medium clay (2) - Slightly or few (2-10%) (1) - Fine gravelly or small pebbles (2-6mm) (A) - Angular	(M) - Moderate (5) - 20-50mm, (6) - 50-100mm (5) - 20-50mm, (6) - 50-100mm (R) - Rough-ped	(0) - No cutans	(1) - Very few (<2%) (F) - Ferruginous (iron)(F) - Ferruginous (iron) (N) - Nodules (1) - Fine (<2mm) (1) - Weak	(N) - Non-magnetic (3) - Firm	(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (4) - Moderately well-drained		
C1 0.5 -1.50 (D) - Diffuse (>100mm) (I) - Irregular	(D) - Dry 6	7.5YR44 brown	7.5YR33 dark brown	(Z) - Colour patterns due to inclusions of weathered substrate (2) - Few (2-10%) (2) - Medium (5-15mm), (3) - Coarse (15-30mm)	(P) - Prominent (RR) - rusty red, (Y) - Yellow (D) - Diffuse		(CS) - Clayey sand (5) - Very or abundant (50-90%) (1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm), (3) - Coarse gravelly or large pebbles (20-60mm), (4) - Cobbly or cobbles (60-200mm) (A) - Angular	(V) - Massive (5) - 20-50mm (5) - 20-50mm (R) - Rough-ped	(0) - No cutans	(3) - Common (10-20%) (K) - Calcareous (carbonate), (F) - Ferruginous (iron)(K) - Calcareous (carbonate), (F) - Ferruginous (iron) (N) - Nodules, (L) - Laminae		(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (3) - Imperfectly drained		

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Photo – Soil Profile		

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

OTHER PHOTOS (IF TAKEN)	
Weathered_rock	

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	TP07
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(PD) - Detailed profile description with no laboratory analysis
Date:	26/6/2023 14:04	**Observation Method**	(P) - Soil pit (>0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Dca) - Mount Alma Formation
Lat / Long:	-24.12086,151.23568	**Preliminary Mapping Unit:**	Dca - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(RU) - Rudosols
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(2) - Limited clearing (e.g. selective logging)	Surface Coarse Fragments Abundance	(1) - Very slightly or very few (<2%)
State of Erosion - Water	(P) - Partly Stabilised	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(A) - Angular, (S) - Subangular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(H) - Hard setting
State of Erosion - Wind	(S) - Stabilised	Runoff	(3) - Slow
Type of Erosion - Wind	(WX) - not apparent	Vegetation	Iron bark and grasses
Other Erosion			
LANDFORM			
Location Type	(M) - Middle landform element	Slope Element	(N) - Waning
Slope Class	(GE) - Gentle (3-10%)	Geomorphological Activity	(ER) - Eroded
Morphological Type	(S) - Simple Slop	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

DETAILED SOIL DESCRIPTION

Type of Soil Observation				(P) - Soil pit												
Horizon	**Soil**			**Mottle**		**Root**	**Fragments**	**Pedality**	**Cutans**	**Segregations**		**Pan**	**Soil Water Regime**			
• Horizon • From-To • Horizon Boundary • Boundary Shape	• Moisture • pH	Dry Colour	Moisture Colour	• Type • Abundance • Size	• Contrast • Colour • Boundaries	• Abundance • Size	• Field texture • Surface coarse fragments abundance • Size • Shape	• Grade • Size • Type • Smooth-ped fabric	• Type • Abundance • Distinctness	• Abundance • Nature • Form • Size • Strength	• Magnetic Attributes • Soil strength • Depth to R horizon	• Type • Cementation • Continuity • Structure	• Permeability • Drainage	Depth to free water	Sample ID + Depth
A11 0.10 - 0.30 (D) - Diffuse (>100mm)	(D) - Dry 6	10YR53 brown	7.5YR33 dark brown	(0) - No mottles or colour patterns		(2) - Common (10-25 p/m^2) (1) - Very fine (<1mm diameter), (2) - Fine (1-2mm diameter), (4) - Coarse (>5mm diameter)	(LC) - Light clay (3) - No qualifier or common (10-20%) (1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm) (A) - Angular, (S) - Subangular	(M) - Moderate (2) - 2-5mm, (3) - 5-10mm, (4) - 10-20mm (2) - 2-5mm, (3) - 5-10mm, (4) - 10-20mm (R) - Rough-ped	(0) - No cutans	(0) - No segregations		(Z) - Zero or no pan	(3) - Moderately permeable, Ks range: 50-500 mm/day, drainage time: days (4) - Moderately well-drained	No free water	No free water No free water
B2 0.55-0.75 (D) - Diffuse (>100mm) (I) - Irregular	(D) - Dry 6	10YR64 light yellowish brown	10YR44 dark yellowish brown	(Z) - Colour patterns due to inclusions of weathered substrate (4) - Many (20-50%) (4) - Very coarse (>30mm)	(D) - Distinct (O) - Orange, (Y) - Yellow (D) - Diffuse	(2) - Common (10-25 p/m^2) (1) - Very fine (<1mm diameter)	(CS) - Clayey sand (6) - Extremely or very abundant (>90%) (4) - Cobbly or cobbles (60-200mm), (5) - Stony or stones (200-600mm) (A) - Angular	(V) - Massive (1) - <2mm, (2) - 2-5mm (1) - <2mm, (2) - 2-5mm (R) - Rough-ped	(M) - Mangans (1) - Few (<10%) (D) - Distinct	(0) - No segregations		(Z) - Zero or no pan	(3) - Moderately permeable, Ks range: 50-500 mm/day, drainage time: days (4) - Moderately well-drained	No free water	No free water No free water
B3r/C1 0.75 -1.50 (D) - Diffuse (>100mm) (T) - Tongued	(D) - Dry 6	10YR54 yellowish brown	10YR33 dark brown	(Z) - Colour patterns due to inclusions of weathered substrate (4) - Many (20-50%) (4) - Very coarse (>30mm)	(P) - Prominent (D) - Diffuse	(1) - Few (1-10 p/m^2) (4) - Coarse (>5mm diameter)	(6) - Extremely or very abundant (>90%) (2) - Medium gravelly or medium pebbles (6-20mm), (3) - Coarse gravelly or large pebbles (20-60mm), (4) - Cobbly or cobbles (60-200mm), (5) - Stony or stones (200-600mm) (A) - Angular	(V) - Massive (1) - <2mm (1) - <2mm (R) - Rough-ped	(M) - Mangans (D) - Distinct	(0) - No segregations		(Z) - Zero or no pan	(3) - Moderately permeable, Ks range: 50-500 mm/day, drainage time: days (4) - Moderately well-drained	No	No No

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Photo – Soil Profile	

DETAILED SUBSTRATE			
Type	(P) - Soil pit	Dry colour	10YR76
Depth	0.5		yellow
pH Field	5.5	Moisture colour	10YR56
Lithology Type	Blocky Siltstone		yellowish brown
Comment			

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

OTHER PHOTOS (IF TAKEN)	
A1_horizon	
C_Horizon	

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	TP08
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(PD) - Detailed profile description with no laboratory analysis
Date:	27/6/2023 12:10	**Observation Method**	(P) - Soil pit (>0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Dca) - Mount Alma Formation
Lat / Long:	-24.11644,151.23595	**Preliminary Mapping Unit:**	Dca - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(RU) – Rudosols
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(3) - Extensive clearing (e.g. poisoning, ringbarking)	Surface Coarse Fragments Abundance	(2) - Slightly or few (2-10%)
State of Erosion - Water	(S) - Stabilised	Fragment Size	(2) - Medium gravelly or medium pebbles (6-20mm), (3) - Coarse gravelly or large pebbles (20-60mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(S) - Subangular, (U) - Subrounded
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(S) - Soft
State of Erosion - Wind	(S) - Stabilised	Runoff	(3) - Slow
Type of Erosion - Wind	(W0) - no wind erosion	Vegetation	Grasses and jacaranda
Other Erosion			
LANDFORM			
Location Type	(T) - Top landform element	Slope Element	
Slope Class	(VG) - Very gentle (1-3%)	Geomorphological Activity	(ER) - Eroded
Morphological Type	(S) - Simple Slop	Landform Pattern	(LOW) - Low Hills
PHOTOS			
Photo1: Landscape		**Photo 2: Surface of soil**	

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

DETAILED SOIL DESCRIPTION

Type of Soil Observation				(P) - Soil pit												
Horizon	**Soil**			**Mottle**		**Root**	**Fragments**	**Pedality**	**Cutans**	**Segregations**		**Pan**	**Soil Water Regime**			
• Horizon • From-To • Horizon Boundary • Boundary Shape	• Moisture • pH	Dry Colour	Moisture Colour	• Type • Abundance • Size	• Contrast • Colour • Boundaries	• Abundance • Size	• Field texture • Surface coarse fragments abundance • Size • Shape	• Grade • Size • Type • Smooth-ped fabric	• Type • Abundance • Distinctness	• Abundance • Nature • Form • Size • Strength	• Magnetic Attributes • Soil strength • Depth to R horizon	• Type • Cementation • Continuity • Structure	• Permeability • Drainage	Depth to free water	Sample ID + Depth
A11 0.10-0.30	(D) - Dry 6	2.5YR5 1 dark reddish grey	7.5YR2.5 1 black	(0) - No mottles or colour patterns		(2) - Common (10-25 p/m^2) (1) - Very fine (<1mm diameter), (3) - Medium (2-5mm diameter)	(LC) - Light clay (3) - No qualifier or common (10-20%) (1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm) (A) - Angular, (S) - Subangular	(M) - Moderate (2) - 2-5mm, (3) - 5-10mm (2) - 2-5mm, (3) - 5-10mm (R) - Rough-ped	(0) - No cutans	(0) - No segregations		(Z) - Zero or no pan	(4) - Highly permeable, Ks range: >500 mm/day, drainage time: hours (4) - Moderately well-drained	No	No No
B2 0.55-0.75 (S) - Sharp (<5mm) (S) - Smooth	(D) - Dry 6	2.5Y42 weak red	10YR44 dark yellowish brown	(Z) - Colour patterns due to inclusions of weathered substrate (4) - Many (20-50%) (3) - Coarse (15-30mm), (4) - Very coarse (>30mm)	(D) - Distinct (DR) - Dark red, (O) - Orange (D) - Diffuse	(3) - Many (25-200 p/m^2) (1) - Very fine (<1mm diameter)	(MHC) - Medium heavy clay (6) - Extremely or very abundant (>90%) (2) - Medium gravelly or medium pebbles (6-20mm), (3) - Coarse gravelly or large pebbles (20-60mm), (4) - Cobbly or cobbles (60-200mm), (5) - Stony or stones (200-600mm) (A) - Angular	(M) - Moderate (4) - 10-20mm, (5) - 20-50mm (4) - 10-20mm, (5) - 20-50mm (R) - Rough-ped	(0) - No cutans	(2) - Few (2-10%) (H) - Organic (humified, well-decomposed organic matter)(H) - Organic (humified, well-decomposed organic matter) (R) - Root linings (2) - Medium (2-6mm) (1) - Weak	(N) - Non-magnetic (3) - Firm	(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (3) - Imperfectly drained	No	No No
B3r/C1 1.50 (D) - Diffuse (>100mm) (I) - Irregular	(D) - Dry 7.5	7.5YR5 6 strong brown	10YR54 yellowish brown	(Z) - Colour patterns due to inclusions of weathered substrate (4) - Many (20-50%) (4) - Very coarse (>30mm)	(P) - Prominent (PO) - Pale orange, (PG) - Pale grey (D) - Diffuse	(1) - Few (1-10 p/m^2) (1) - Very fine (<1mm diameter), (2) - Fine (1-2mm diameter)	(6) - Extremely or very abundant (>90%) (3) - Coarse gravelly or large pebbles (20-60mm), (4) - Cobbly or cobbles (60-200mm), (5) - Stony or stones (200-600mm) (A) - Angular	(V) - Massive	(0) - No cutans	(1) - Very few (<2%) (L) - Argillaceous (clayey)(L) - Argillaceous (clayey) (V) - Veins (2) - Medium (2-6mm) (1) - Weak	(N) - Non-magnetic (2) - Weak	(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (3) - Imperfectly drained	No	No No

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Photo – Soil Profile	

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

OTHER PHOTOS (IF TAKEN)	
Roots_segredations	
C_Horizon	

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	TP09
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(PD) - Detailed profile description with no laboratory analysis
Date:	28/6/2023 07:37	**Observation Method**	(P) - Soil pit (>0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Cr) - Rockhampton Group
Lat / Long:	-24.11634,151.23556	**Preliminary Mapping Unit:**	Cr - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(RU) – Rudosols
SITE SURFACE			
Weather	Showers	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(4) - Complete clearing; pasture, native or imporved, but never cultivated	Surface Coarse Fragments Abundance	(2) - Slightly or few (2-10%)
State of Erosion - Water	(S) - Stabilised	Fragment Size	(2) - Medium gravelly or medium pebbles (6-20mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(A) - Angular, (S) - Subangular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(F) - Firm
State of Erosion - Wind	(S) - Stabilised	Runoff	(4) - Moderately rapid
Type of Erosion - Wind	(W0) - no wind erosion	Vegetation	Tusdock grasses
Other Erosion			
LANDFORM			
Location Type	(T) - Top landform element	Slope Element	
Slope Class	(GE) - Gentle (3-10%)	Geomorphological Activity	(EA) - Eroded or aggraded
Morphological Type	(S) - Simple Slop	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

DETAILED SOIL DESCRIPTION																
Type of Soil Observation				(P) - Soil pit												
Horizon	**Soil**			**Mottle**		**Root**	**Fragments**	**Pedality**	**Cutans**	**Segregations**		**Pan**	**Soil Water Regime**			
• Horizon • From-To • Horizon Boundary • Boundary Shape	• Moisture • pH	Dry Colour	Moisture Colour	• Type • Abundance • Size	• Contrast • Colour • Boundaries	• Abundance • Size	• Field texture • Surface coarse fragments abundance • Size • Shape	• Grade • Size • Type • Smooth-ped fabric	• Type • Abundance • Distinctness	• Abundance • Nature • Form • Size • Strength	• Magentic Attributes • Soil strength • Depth to R horizon	• Type • Cementation • Continuity • Structure	• Permeability • Drainage	Depth to free water	Sample ID + Depth
A1 0.25-0.35 (S) - Sharp (<5mm)	(D) - Dry 5.5	10YR42 dark greyish brown	2.5YR2.5 1 reddish black	(0) - No mottles or colour patterns		(3) - Many (25-200 p/m^2) (1) - Very fine (<1mm diameter), (2) - Fine (1-2mm diameter), (3) - Medium (2-5mm diameter)	(LC) - Light clay (5) - Very or abundant (50-90%) (1) - Fine gravelly or small pebbles (2-6mm), (2) - Medium gravelly or medium pebbles (6-20mm), (3) - Coarse gravelly or large pebbles (20-60mm), (4) - Cobbly or cobbles (60-200mm) (A) - Angular	(S) - Strong (2) - 2-5mm (2) - 2-5mm (R) - Rough-ped	(0) - No cutans	(0) - No segregations		(Z) - Zero or no pan	(3) - Moderately permeable, Ks range: 50-500 mm/day, drainage time: days (4) - Moderately well-drained	No	No No
C1r 0.25-0.50 (S) - Sharp (<5mm)	(D) - Dry 6	10YR22 very dark brown	10YR22 very dark brown	(Z) - Colour patterns due to inclusions of weathered substrate (4) - Many (20-50%) (2) - Medium (5-15mm), (3) - Coarse (15-30mm), (4) - Very coarse (>30mm)	(P) - Prominent (DO) - Dark orange, (Y) - Yellow, OtherWhite (D) - Diffuse	(1) - Few (1-10 p/m^2) (1) - Very fine (<1mm diameter), (2) - Fine (1-2mm diameter), (3) - Medium (2-5mm diameter)	(6) - Extremely or very abundant (>90%) (2) - Medium gravelly or medium pebbles (6-20mm), (3) - Coarse gravelly or large pebbles (20-60mm), (4) - Cobbly or cobbles (60-200mm), (5) - Stony or stones (200-600mm) (A) - Angular	(V) - Massive	(M) - Mangans (2) - Common (10-50%) (D) - Distinct	(4) - Many (20-50%) (K) - Calcareous (carbonate)(K) - Calcareous (carbonate) (S) - Soft segregations, (V) - Veins, (L) - Laminae (1) - Fine (<2mm), (2) - Medium (2-6mm), (3) - Coarse (6-20mm) (1) - Weak	(N) - Non-magnetic (2) - Weak	(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (3) - Imperfectly drained	No	No No

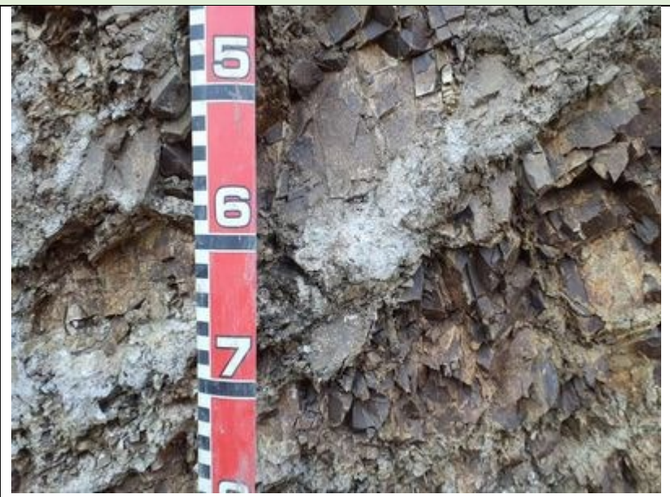
SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Photo – Soil Profile			

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

OTHER PHOTOS (IF TAKEN)	
Carbonate_seggration	
Weathered_rock_dip	

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	TP10
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(PD) - Detailed profile description with no laboratory analysis
Date:	28/6/2023 08:47	**Observation Method**	(P) - Soil pit (>0.3 m deep)
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda/I) - Calliope beds/l
Lat / Long:	-24.11427,151.23878	**Preliminary Mapping Unit:**	Sda/I - Cf
Horizontal accuracy (m):	8	**Australian Soil Classification:**	(DE) – Dermosols
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(3) - Extensive clearing (e.g. poisoning, ringbarking)	Surface Coarse Fragments Abundance	(2) - Slightly or few (2-10%)
State of Erosion - Water	(P) - Partly Stabilised	Fragment Size	(6) - Bouldery or boulders (600-2000mm), (7) - Large boulders (>2000mm)
Type of Erosion - Water	(S1) - sheet erosion minor	Fragment Shape	(R) - Rounded
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(2) - Slightly rocky (2-10% bedrock exposed)
Type of Erosion - Scald	(C0) - no scalding	Surface Condition	(F) - Firm
State of Erosion - Wind	(S) - Stabilised	Runoff	(4) - Moderately rapid
Type of Erosion - Wind	(W0) - no wind erosion	Vegetation	Tussock grasses
Other Erosion			
LANDFORM			
Location Type	(M) - Middle landform element	Slope Element	(I) - Minimal
Slope Class	(MO) - Moderate (10-23%)	Geomorphological Activity	(EA) - Eroded or aggraded
Morphological Type	(M) - Mid-Slope	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

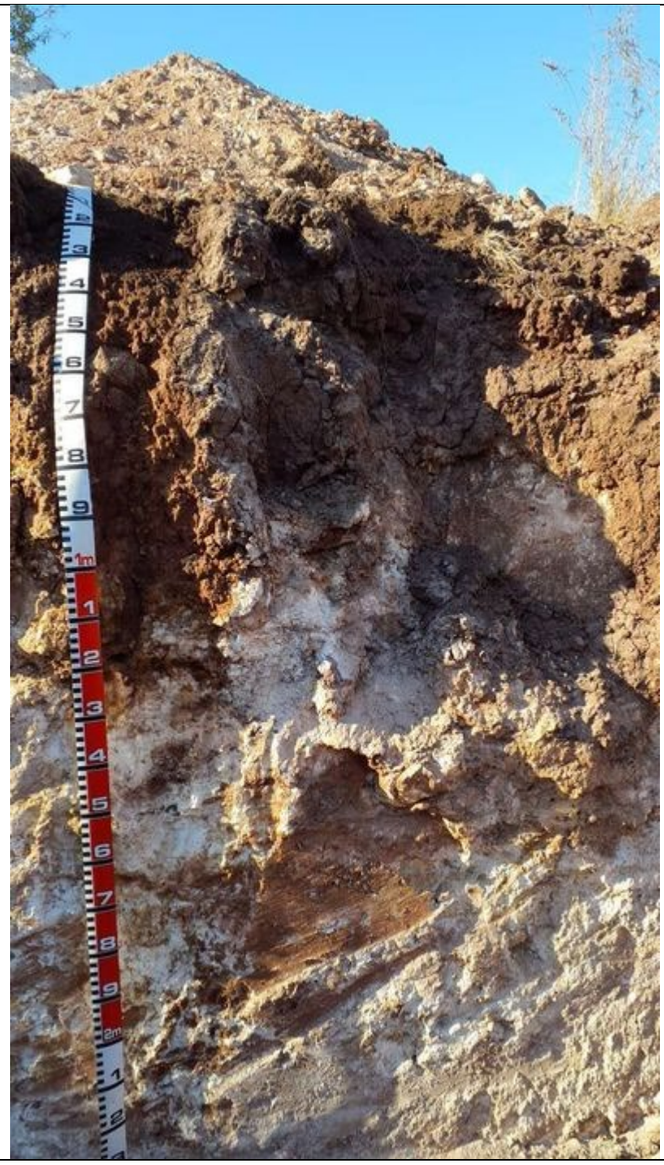
DETAILED SOIL DESCRIPTION

Type of Soil Observation

Horizon	Soil			Mottle		Root	Fragments	Pedality	Cutans	Segregations		Pan	Soil Water Regime		
• Horizon • From-To • Horizon Boundary • Boundary Shape	• Moisture • pH	Dry Colour	Moisture Colour	• Type • Abundance • Size	• Contrast • Colour • Boundaries	• Abundance • Size	• Field texture • Surface coarse fragments abundance • Size • Shape	• Grade • Size • Type • Smooth-ped fabric	• Type • Abundance • Distinctness	• Abundance • Nature • Form • Size • Strength	• Magentic Attributes • Soil strength • Depth to R horizon	• Type • Cementation • Continuity • Structure	• Permeability • Drainage	Depth to free water	Sample ID + Depth
A 1 0.30 - 0.35	(D) - Dry 8	10YR31 very dark grey	10YR82 very pale brown	(0) - No mottles or colour patterns		(2) - Common (10-25 p/m^2) (1) - Very fine (<1mm diameter), (2) - Fine (1-2mm diameter)	(LC) - Light clay (1) - Very slightly or very few (<2%) (1) - Fine gravelly or small pebbles (2-6mm) (A) - Angular	(M) - Moderate (2) - 2-5mm, (3) - 5-10mm, (4) - 10-20mm (2) - 2-5mm, (3) - 5-10mm, (4) - 10-20mm (R) - Rough-ped	(0) - No cutans	(0) - No segregations		(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (4) - Moderatley well-drained	No	No No
B 1 1.10 - 1.45 (W) - Wavy	(D) - Dry 8.5	2.5YR2.5 3 dark reddish brown	2.5YR33 dark reddish brown	(0) - No mottles or colour patterns		(1) - Few (1-10 p/m^2) (1) - Very fine (<1mm diameter)	(MHC) - Medium heavy clay (1) - Very slightly or very few (<2%) (1) - Fine gravelly or small pebbles (2-6mm) (S) - Subangular, (U) - Subrounded	(S) - Strong (4) - 10-20mm, (5) - 20-50mm (4) - 10-20mm, (5) - 20-50mm (S) - Smooth-ped	(K) - Slickensides (2) - Common (10-50%) (D) - Distinct	(0) - No segregations		(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (3) - Imperfectly drained	No	No No
B3r/C1 1.45-2.00 (G) - Gradual (50-100mm) (T) - Tongued	(D) - Dry 8	7.5YR 1	7.5YR 1	(Z) - Colour patterns due to inclsuions of weathered substrate (3) - Common (10-20%) (3) - Coarse (15-30mm)	(P) - Prominent (RR) - rusty red (D) - Diffuse	(0) - No roots	(CL) - Clay loam (0) - No coarse fragments	(V) - Massive (1) - <2mm (1) - <2mm	(0) - No cutans	(0) - No segregations		(Z) - Zero or no pan	(1) - Very slowly permeable, Ks range: <5 mm/day, drainage time: months (3) - Imperfectly drained	No	No No

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Photo – Soil Profile		

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Project Name:	Calliope Soil survey	**Site ID:**	TP11
Job No:	BCL230021.01	**Site Type:**	(F) - Free survey site
Described By:	Andrew Hughes & Michael Kowalczyk	**Observation Class:**	(PD) - Detailed profile description with no laboratory analysis
Date:	28/6/2023 10:14	**Observation Method**	
Coordinate System:	World Geodetic System 1984	**Regional Geology:**	(Sda) - Calliope beds
Lat / Long:	-24.11659,151.2382	**Preliminary Mapping Unit:**	Sda - Cf
Horizontal accuracy (m):	4	**Australian Soil Classification:**	(DE) – Dermosols
SITE SURFACE			
Weather	Sunny	Microrelief	(Z) - Zero or no microrelief
Land Use	Production from Dryland Agriculture and Plantations	Gully Size	
Disturbance	(3) - Extensive clearing (e.g. poisoning, ringbarking)	Surface Coarse Fragments Abundance	(1) - Very slightly or very few (<2%)
State of Erosion - Water	(A) - Active	Fragment Size	(1) - Fine gravelly or small pebbles (2-6mm)
Type of Erosion - Water	(S2) - sheet erosion moderate	Fragment Shape	(S) - Subangular
State of Erosion - Scald	(S) - Stabilised	Rock Outcrop	(0) - No rock outcrop
Type of Erosion - Scald		Surface Condition	(H) - Hard setting
State of Erosion - Wind	(S) - Stabilised	Runoff	(4) - Moderately rapid
Type of Erosion - Wind		Vegetation	Tussock grassesvamd eucalypt
Other Erosion			
LANDFORM			
Location Type	(B) - Bottom landform element	Slope Element	(N) - Waning
Slope Class	(VG) - Very gentle (1-3%)	Geomorphological Activity	(EA) - Eroded or aggraded
Morphological Type	(L) - Lower Slope	Landform Pattern	(LOW) - Low Hills
PHOTOS			



Photo1: Landscape



Photo 2: Surface of soil

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

DETAILED SOIL DESCRIPTION

Type of Soil Observation				(P) - Soil pit												
Horizon	**Soil**			**Mottle**		**Root**	**Fragments**	**Pedality**	**Cutans**	**Segregations**		**Pan**	**Soil Water Regime**			
• Horizon • From-To • Horizon Boundary • Boundary Shape	• Moisture • pH	Dry Colour	Moisture Colour	• Type • Abundance • Size	• Contrast • Colour • Boundaries	• Abundance • Size	• Field texture • Surface coarse fragments abundance • Size • Shape	• Grade • Size • Type • Smooth-ped fabric	• Type • Abundance • Distinctness	• Abundance • Nature • Form • Size • Strength	• Magentic Attributes • Soil strength • Depth to R horizon	• Type • Cementation • Continuity • Structure	• Permeability • Drainage	Depth to free water	Sample ID + Depth
A1 0.30-0.35 (A) - Abrupt (5-20mm) (S) - Smooth	(D) - Dry 8	7.5YR5 2 brown	10YR22	(0) - No mottles or colour patterns		(1) - Few (1-10 p/m^2) (1) - Very fine (<1mm diameter), (2) - Fine (1-2mm diameter)	(CLS) - Clay loam, sandy (1) - Very slightly or very few (<2%) (1) - Fine gravelly or small pebbles (2-6mm) (A) - Angular, (S) - Subangular	(S) - Strong (1) - <2mm, (2) - 2-5mm (1) - <2mm, (2) - 2-5mm (R) - Rough-ped	(0) - No cutans	(0) - No segregations		(Z) - Zero or no pan	(3) - Moderatly permebale, Ks range: 50-500 mm/day, drainage time: days (4) - Moderatley well-drained	No	No No
B1 1.10 - 1.45 (S) - Sharp (<5mm) (S) - Smooth	(D) - Dry 6.5	7.5YR4 3 brown	7.5YR34	(0) - No mottles or colour patterns		(1) - Few (1-10 p/m^2) (1) - Very fine (<1mm diameter)	(MC) - Medium clay (1) - Very slightly or very few (<2%) (1) - Fine gravelly or small pebbles (2-6mm) (U) - Subrounded	(M) - Moderate (5) - 20-50mm, (6) - 50-100mm (5) - 20-50mm, (6) - 50-100mm (S) - Smooth-ped	(K) - Slickensides (2) - Common (10-50%) (D) - Distinct	(2) - Few (2-10%) (N) - Ferromanganiferous (iron-manganese), (F) - Ferruginous (iron)(N) - Ferromanganiferous (iron-manganese), (F) - Ferruginous (iron) (N) - Nodules (2) - Medium (2-6mm) (2) - Strong	(N) - Non-magnetic (5) - Strong	(Z) - Zero or no pan	(2) - Slowly permeable, Ks range: 5-50 mm/day, drainage time: weeks (4) - Moderatley well-drained	No	No No
B3r/C1 1.45-2.00 (D) - Diffuse (>100mm) (I) - Irregular	(SM) - Slightly moist 8	5YR46 yellowi sh red	5YR46 yellowish red	(Z) - Colour patterns due to inclsuions of weathered substrate (4) - Many (20-50%) (2) - Medium (5-15mm)	(D) - Distinct (Y) - Yellow, (PG) - Pale grey (D) - Diffuse	(0) - No roots	(6) - Extremely or very abundant (>90%) (1) - Fine gravelly or small pebbles (2-6mm), (4) - Cobbly or cobbles (60-200mm), (6) - Bouldery or boulders (600-2000mm) (U) - Subrounded	(V) - Massive (1) - <2mm, (2) - 2-5mm (1) - <2mm, (2) - 2-5mm (R) - Rough-ped	(M) - Mangans (2) - Common (10-50%) (P) - Prominent	(0) - No segregations		(Z) - Zero or no pan	(3) - Moderatly permebale, Ks range: 50-500 mm/day, drainage time: days (2) - Poorly drained	No	No No

SOIL SURVEY FIELD SHEET

Survey type: Surface Soil Description

Photo – Soil Profile	

APPENDIX D LABORATORY TRANSCRIPTS

Project Name: Graymont Calliope
Job Number: BCL230021.01
Client: Graymont
Sumary of Laboratory Results

			Soil Cl & NO_3 (Aqueous 1:5)		Soil pH & EC (Aqueous 1:5)		Exchangeable Cations				Exchangeable Cation Calculations			Nutrients		Diethylenetriaminepentaacetic Acid (DTPA) Extraction				Carbon	Total Nitrogen and Phosphorus		Soil Particle Size Analysis (PSA)				Dispersion Ratio	
			Chloride	Nitrate (NO_3)	Electrical Conductivity (EC)	pH	Calcium (Ca)	Potassium (K)	Magnesium (Mg)	Sodium (Na)	Ca:Mg	Exchangeable Sodium Percentage (ESP)	Cation Exchange Capacity (CEC)	Phosphorus (P) - Colwell	Sulphur (S) - Extractable	Copper (Cu)	Iron (Fe)	Manganese (Mn)	Zinc (Zn)	Total Organic Carbon (TOC)	Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl Phosphorus (TKP)	Clay	Coarse sand	Fine sand	Silt	R1	R2
Soil Type	Sample Location	Sample Depth (m)	mg/kg	mg/kg	dS/m	-	cmol_c/kg	cmol_c/kg	cmol_c/kg	cmol_c/kg	-	%	cmol/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%	%	%	%	-	-
SMU B2	TP01	0-0.1	<20	11	0.20	8.10	22.6	0.414	2.93	0.189	7.71	0.79	24	35	37	3.2	29.1	24.4	<0.1	2.97	0.266	0.02	40.4	6.1	12.1	41.4	0.61	0.26
SMU B2	TP01	0.1-0.2	<20	1	0.19	8.25	11.2	0.157	7.5	0.874	1.49	4.60	19	5	16	2.3	8.8	6.6	<0.1	0.48	0.042	<0.013	43.9	5.8	12.6	41.5	0.72	0.4
SMU B2	TP01	0.8-1.0	<20	<1	0.36	9.01	13.3	0.13	16.3	4.92	0.82	15.38	32	3	62					0.57	0.033	<0.013	63.3	4.9	10.8	24.7	0.88	0.55
SMU B2	TP01	1.25-1.45	154	<1	0.49	9.34	10.1	0.095	15.9	6.54	0.64	21.80	30	<2	51					0.31	0.022	<0.013	63.8	10.7	10.6	17.6	0.99	0.78
SMU B2	TP01	1.6-1.8	86	<1	0.32	9.27	10.5	0.061	8.4	3.24	1.25	17.05	19	<2	33					0.55	0.014	0.014	33.1	34.9	21.3	15.6	0.83	0.44
SMU D1	TP03	0-0.1	23	2	0.15	6.88	10.7	0.874	3.13	<0.08	3.42	<0.54	14.7	10	5	0.6	51	33.8	1.6	3.44	0.241	0.024	29.4	25	30.1	20	0.62	0.35
SMU D1	TP03	0.1-0.2	<20	2	0.05	6.08	4.99	0.615	3.33	0.201	1.50	2.20	9.1	7	6	0.6	72.8	24.4	1.2	2.12	0.136	0.02	29.1	26.7	28.1	21.4	0.65	0.38
SMU D1	TP03	0.3-0.5	71	<1	0.11	6.63	4.88	0.196	11.2	2.59	0.44	13.73	18.9	<2	14					0.88	0.069	<0.013	73.8	3.9	11.8	15.4	0.82	0.58
SMU E1	TP04	0-0.1	<20	<1	0.06	6.74	14.5	0.501	3.45	<0.080	4.20	<0.54	18.5	15	4	11.9	42.9	62.5	1.8	2.93	0.216	0.054	33.5	31.3	20.5	18.7	0.4	0.18
SMU E1	TP04	0.1-0.2	<20	<1	0.02	6.69	7.49	0.164	2.84	0.149	2.64	1.40	10.6	7	3	11	41	61.7	0.1	1.08	0.067	0.051	32.8	47.9	14.5	10.1	0.58	0.25
SMU E1	TP04	0.75-0.95	26	<1	0.04	6.96	11.9	0.176	7.3	1.12	1.63	5.46	20.5	<2	4					0.34	0.035	0.013	73.6	13.7	10	6.9	0.61	0.29
SMU E1	TP04	1.75-1.95	86	<1	0.10	7.61	14.2	0.143	7.16	1.74	1.98	6.69	26	2	<1					0.25	0.033	0.014	74.5	9.8	11.3	10.2	0.79	0.39
SMU E2	TP05	0-0.1	<20	1	0.05	6.21	8.73	0.578	3.84	<0.080	2.27	<0.54	13.1	9	5	0.9	70	105	2.1	2.99	0.199	0.028	27.4	31.4	31.8	15.2	0.58	0.22
SMU E2	TP05	0.1-0.2	<20	<1	0.03	6.34	5.27	0.108	3.8	0.231	1.39	2.46	9.4	3	6	1.3	38.5	69.9	0.2	0.75	0.056	0.015	27.1	36.2	34.1	13.3	0.6	0.3
SMU E2	TP05	0.3-0.5	<20	<1	0.03	6.56	7.47	0.098	5.9	0.386	1.27	2.79	13.9	<2	8					0.27	0.029	<0.013	32.5	38.9	22	10	0.65	0.31
SMU E2	TP05	0.6-0.8	<20	<1	0.04	6.66	8.33	0.092	6.74	0.504	1.24	3.22	15.7	<2	10					0.25	0.024	<0.013	36.1	33.3	26.6	9.9	0.67	0.28
SMU E2	TP05	1.4-1.6	293	<1	0.21	6.08	6.81	0.074	6.29	0.967	1.08	6.84	14.1	<2	1					0.14	0.015	<0.013	34.3	32.7	23.9	11.6	0.59	0.24

Queensland Government

Department of Environment and Science - Chemistry Centre

Soil Analysis Report

Job No: 23-0451

Report ID: 23-0451-F-V1

				Method	S_ADM_105	S_AQ4_AA		S_AQ4_EL		S_CAT_ALC				S_CAT_ALCC								* S_CEC	S_COLWELL	S_DT1_ICP				S_DUM_TOC
				Component	ADMC	Cl	NO3-N	EC	pH	Ca	K	Mg	Na	Base sat	Ca:CEC	Ca:Mg	CEC:Clay	ESP	K:CEC	Mg:Ca	Mg:CEC	Mg:K	Na:K	CEC	P	Cu	Fe	Mn	Zn	OC
				Units	%	mg/kg	mg/kg	dS/m	-	cmol_c/kg	cmol_c/kg	cmol_c/kg	cmol_c/kg	%				%						cmol/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%
Sample No	Customer's ID	Project Id	Description	Depth (m)																										
23-0451-0001	SP01_01	BCL23003101	Stockpile Sample - Soil	0.00-4.00	4.2	<20	11	0.15	8.18	12	0.078	0.228	<0.070	108	1.05	52.6	-	0	0.00687	0.019	0.0199	2.9	0.893	11	7	0.5	2.2	5.1	<0.1	0.716
23-0451-0002	SP01_02	BCL23003101	Stockpile Sample - Soil	0.00-4.00	2.5	<20	5	0.15	8.18	12	0.098	<0.070	0.101	100	0.978	171	-	0.8	0.00802	0.00585	0.00572	0.714	1.03	12	6	0.4	5.7	11.8	<0.1	0.424
23-0451-0003	SP01_03	BCL23003101	Stockpile Sample - Soil	0.00-4.00	5.7	<20	4	0.13	8.25	11.4	0.059	<0.070	<0.070	108	1.07	163	-	0	0.0055	0.00613	0.00654	1.19	1.19	11	6	0.5	3.3	6.5	0.1	1.49
23-0451-0004	SP01_04	BCL23003101	Stockpile Sample - Soil	0.00-4.00	4.2	<20	11	0.16	8.22	10.1	0.053	0.076	<0.070	100	0.981	132	-	0	0.00521	0.0076	0.00746	1.43	1.31	10	5	0.4	3	7.3	<0.1	1.46
23-0451-0005	SP01_05	BCL23003101	Stockpile Sample - Soil	0.00-4.00	2.8	<20	3	0.16	8.19	11.8	<0.050	0.101	<0.070	93	0.912	117	-	0	0.00386	0.00854	0.00779	2.02	1.4	13	5	0.5	4.1	9.9	<0.1	0.791
23-0451-0006	SP01_06	BCL23003101	Stockpile Sample - Soil	0.00-4.00	2.4	<20	8	0.15	8.16	12	0.098	0.208	0.085	109	1.06	57.5	-	0.8	0.00864	0.0174	0.0184	2.13	0.868	11	6	0.4	2.1	4.8	<0.1	0.561
23-0451-0007	SP01_07	BCL23003101	Stockpile Sample - Soil	0.00-4.00	3.8	<20	8	0.15	8.23	11.1	0.052	0.9	0.074	119	1.09	12.4	-	0.7	0.00513	0.0808	0.0882	17.2	1.4	10	7	0.4	3.9	5.2	0.3	1.04
23-0451-0008	SP01_08	BCL23003101	Stockpile Sample - Soil	0.00-4.00	9.1	<20	4	0.14	8.22	12	<0.050	0.862	0.093	120	1.11	13.9	-	0.9	0.00462	0.0718	0.0797	17.2	1.86	11	5	0.3	3.2	2.4	<0.1	0.325
23-0451-0009	SP01_09	BCL23003101	Stockpile Sample - Soil	0.00-4.00	6.9	<20	9	0.16	8.21	10.7	0.182	0.177	<0.070	105	1.01	60.3	-	0	0.0173	0.0166	0.0168	0.971	0.385	11	5	0.3	<2.0	4.2	<0.1	0.829
23-0451-0010	SP01_10	BCL23003101	Stockpile Sample - Soil	0.00-4.00	6.4	<20	7	0.19	8.22	12.2	0.066	3.75	0.243	133	0.996	3.26	-	2	0.00538	0.307	0.306	56.8	3.68	12	7	0.5	70	35.9	0.3	1.92
23-0451-0011	SP01_11	BCL23003101	Stockpile Sample - Soil	0.00-4.00	4	<20	6	0.19	8.28	11.7	<0.050	3.29	0.252	124	0.951	3.55	-	2.1	0.00407	0.282	0.268	65.8	5.04	12	4	0.3	20.5	8.2	0.1	2.22
23-0451-0012	SP01_12	BCL23003101	Stockpile Sample - Soil	0.00-4.00	3.2	<20	8	0.18	8.23	11	<0.050	0.931	0.108	105	0.954	11.9	-	0.9	0.00432	0.0843	0.0804	18.6	2.15	12	4	0.3	3.3	5.9	<0.1	0.592
23-0451-0013	SP01_13	BCL23003101	Stockpile Sample - Soil	0.00-4.00	3.3	48	24	0.22	8.16	11.3	<0.050	0.273	0.208	97	0.928	41.4	-	1.7	0.00411	0.0241	0.0224	5.45	4.17	12	4	0.3	<2.0	2.8	<0.1	0.318
23-0451-0014	SP01_14	BCL23003101	Stockpile Sample - Soil	0.00-4.00	9.5	<20	6	0.14	8.09	10.1	<0.050	0.072	<0.070	95	0.94	141	-	0	0.00463	0.00711	0.00668	1.44	1.4	11	6	0.4	<2.0	<2.0	<0.1	0.292
23-0451-0015	SP02_01	BCL23003101	Stockpile Sample - Soil	0.00-4.00	9.1	<20	5	0.13	8.32	32.4	0.081	5.15	0.171	132	1.13	6.3	-	0.6	0.00281	0.159	0.179	63.7	2.11	29	7	1	5.9	10.9	0.2	1.02
23-0451-0016	SP03_01	BCL23003101	Stockpile Sample - Soil	0.00-4.00	2.4	<20	11	0.17	8.06	12.6	0.078	0.224	<0.070	92	0.893	56.2	-	0	0.0055	0.0178	0.0159	2.89	0.903	14	6	0.6	3.6	9.6	<0.1	0.477
23-0451-0017	SP04_01	BCL23003101	Stockpile Sample - Soil	0.00-4.00	<1.5	323	24	0.46	8.52	3.17	<0.050	0.936	0.34	173	1.22	3.39	-	13.1	0.0193	0.295	0.362	18.7	6.81	3	3	0.2	5.3	6.3	0.3	3.6
23-0451-0018	SP04_02	BCL23003101	Stockpile Sample - Soil	0.00-4.00	<1.5	<20	17	0.14	8.54	8.86	<0.050	1.68	0.11	130	1.08	5.26	-	1.3	0.00608	0.19	0.205	33.7	2.21	8	5	0.2	9.1	7.4	0.2	2.56
23-0451-0019	SP05_01	BCL23003101	Stockpile Sample - Soil	0.00-4.00	<1.5	<20	12	0.13	8.62	7.98	0.065	0.691	0.076	121	1.1	11.6	-	1	0.0089	0.0866	0.0952	10.7	1.18	7	<2	0.3	8.6	4.9	0.4	3.71
23-0451-0020	SP05_02	BCL23003101	Stockpile Sample - Soil	0.00-4.00	2.5	<20	10	0.22	8.66	13.7	<0.050	5.81	1.12	145	0.962	2.35	-	7.9	0.00352	0.425	0.409	116	22.5	14	5	0.2	21.1	9	<0.1	0.909
23-0451-0021	SP05_03	BCL23003101	Stockpile Sample - Soil	0.00-4.00	5.3	<20	5	0.16	8.51	20.9	<0.050	6.19	0.63	145	1.1	3.38	-	3.3	0.00262	0.296	0.324	124	12.6	19	5	0.2	31	11.4	0.2	0.368
23-0451-0022	SP05_04	BCL23003101	Stockpile Sample - Soil	0.00-4.00	3.4	<20	5	0.15	8.55	19.3	<0.050	5.45	0.604	140	1.06	3.54	-	3.3	0.00275	0.282	0.3	109	12.1	18	5	0.2	28.9	10.3	0.1	0.297
23-0451-0023	SP05_05	BCL23003101	Stockpile Sample - Soil	0.00-4.00	3.4	<20	3	0.15	8.57	21	<0.050	5.91	0.613	143	1.09	3.55	-	3.2	0.00259	0.281	0.306	118	12.3	19	6	0.5	2.5	5.8	<0.1	0.568
23-0451-0024	QC100	BCL23003101	Field Duplicate Sample	0.00-4.00	4.1	<20	12	0.15	8.29	11	0.065	0.169	<0.070	105	1.03	65.2	-	0	0.00604	0.0153	0.0157	2.61	1.08	11	7	3.7	64.4	26	0.6	1.12
23-0451-0025	TP01_0.0	BCL23003101	Testpit Sample - Soil	0.00-0.00	4.7	<20	11	0.2	8.1	22.6	0.414	2.93	0.189	111	0.956	7.71	-	0.8	0.0175	0.13	0.124	7.07	0.455	24	35	3.2	29.1	24.4	<0.1	2.97
23-0451-0026	TP01_0.1	BCL23003101	Testpit Sample - Soil	0.00-0.20	4.6	<20	1	0.19	8.25	11.2	0.157	7.5	0.874	105	0.595	1.49	-	4.6	0.00837	0.671	0.399	47.7	5.55	19	5	2.3	8.8	6.6	<0.1	0.48
23-0451-0027	TP01_0.9	BCL23003101	Testpit Sample - Soil	0.80-1.00	8.1	<20	<1	0.36	9.01	13.3	0.13	16.3	4.92	107	0.409	0.814	-	15.2	0.004	1.23	0.503	126	37.9	32	3	-	-	-	-	0.57
23-0451-0028	TP01_1.35	BCL23003101	Testpit Sample - Soil	1.25-1.45	8.9	154	<1	0.49	9.34	10.1	0.095	15.9	6.54	110	0.341	0.635	-	22.1	0.00322	1.57	0.537	167	68.7	30	<2	-	-	-	-	0.306
23-0451-0029	TP01_1.70	BCL23003101	Testpit Sample - Soil	1.60-1.80	4.5	86	<1	0.32	9.27	10.5	0.061	8.4	3.24	119	0.565	1.25	-	17.4	0.00326	0.799	0.452	138	53.4	19	<2	-	-	-	-	0.55
23-0451-0030	TP03_0.0	BCL23003101	Testpit Sample - Soil	0.00-0.00	2.6	23	2	0.15	6.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	0.6	51	33.8	1.6	3.44
23-0451-0031	TP03_0.1	BCL23003101	Testpit Sample - Soil	0.00-0.20	<1.5	<20	2	0.05	6.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	0.6	72.8	24.4	1.2	2.12
23-0451-0032	TP03_0.4	BCL23003101	Testpit Sample - Soil	0.30-0.50	5.1	71	<1	0.11	6.63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	0.881
23-0451-0033	TP04_0.0	BCL23003101	Testpit Sample - Soil	0.00-0.00	4.7	<20	<1	0.06	6.74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	11.9	42.9	62.5	1.8	2.93
23-0451-0034	TP04_0.1	BCL23003101	Testpit Sample - Soil	0.00-0.20	3.1	<20	<1	0.02	6.69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	11	41	61.7	0.1	1.08
23-0451-0035	TP04_0.85	BCL23003101	Testpit Sample - Soil	0.75-0.95	7.7	26	<1	0.04	6.96	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	0.344
23-0451-0036	TP04_1.85	BCL23003101	Testpit Sample - Soil	1.75-1.95	3.9	86	<1	0.1	7.61	14.2	0.143	7.16	1.74	88	0.539	1.99	-	6.6	0.0054	0.503	0.271	50.2	12.2	26	2	-	-	-	-	0.246
23-0451-0037	TP05_0.0	BCL23003101	Testpit Sample - Soil	0.00-0.00	2.6	<20	1	0.05	6.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	0.9	70	105	2.1	2.99
23-0451-0038	TP05_0.1	BCL23003101	Testpit Sample - Soil	0.00-0.20	1.7	<20	<1	0.03	6.34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1.3	38.5	69.9	0.2	0.745
23-0451-0039	TP05_0.4	BCL23003101	Testpit Sample - Soil	0.30-0.50	2.2	<20	<1	0.03	6.56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	0.27
23-0451-0040	TP05_0.7	BCL23003101	Testpit Sample - Soil	0.60-0.80	2.6	<20	<1	0.04	6.66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	0.245
23-0451-0041	TP05_1.5	BCL23003101	Testpit Sample - Soil	1.40-1.60	2.6	293	<1	0.21	6.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	0.141
23-0451-0042	QC101	BCL23003101	Field Duplicate Sample	0.00-0.20	6.5	<20	<1	0.1	7.83	15.1	0.231	5.58	0.399	102	0.722	2.71	-	1.9	0.011	0.369	0.267	24.2	1.73	21	5	3.4	28.4	23.1	<0.1	0.578

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Queensland Government

Department of Environment and Science - Chemistry Centre

Soil Analysis Report

Job No: 23-0451

Report ID: 23-0451-F-V1

* S_KJ_AA		S_PSA					* S_PSD										* S_PSD_MECD															
TKN	TKP	Clay	Coarse sand	Fine sand	Silt	Total	<2µm	>2000µm	10µm to 63um	2µm to 10µm	2µm to 20um	20µm to 200um	200µm to 2000µm	63µm to 200um	d(0.9)	Obscuration	<0.24µm	<62.5µm	0.5µm to 0.24µm	1µm to 0.5µm	1000µm to 500µm	125µm to 62µm	16µm to 8um	2µm to 1um	2000µm to 1000µm	250µm to 125um	31µm to 16um	4µm to 2um	500µm to 250um	62µm to 31um	8µm to 4um	d(0.9)	Obscuration
%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	µm	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	µm	%
0.041	0.02	67.9	14.2	10.6	13.1	105.9	48	<1.0	17	25	32	17	2	7.2	56.4	11.3	32.2	93.6	6	2.1	<1.0	2.8	7.9	8.1	<1.0	1.8	6.7	13.7	1.6	4.9	12.1	36.4	11.6
0.028	0.026	66.8	13.9	18.2	9.4	108.4	-	-	-	-	-	-	-	-	96	14.4	26.5	84.9	6.1	2.8	<1.0	5.2	7.8	6.7	<1.0	5.2	7.9	10.3	4.5	7.1	9.6	125	14.5
0.043	0.017	58.2	19.2	18.7	15.1	111.2	-	-	-	-	-	-	-	-	85.8	12.4	15.9	92.1	5.5	2.9	<1.0	5.7	13.1	7.3	<1.0	2.3	11.5	13.1	<1.0	8.4	14.5	50.6	12.4
0.037	0.016	57.5	20.1	13.9	16.5	108	-	-	-	-	-	-	-	-	88.8	8.4	16.1	89.5	5.3	2.8	<1.0	7	11.7	7.2	<1.0	3.5	11.4	12.4	<1.0	9.4	13.1	65.4	8.3
0.045	0.018	61.9	15.8	12.5	14.6	104.8	-	-	-	-	-	-	-	-	108	9.3	18.4	88.6	5.5	2.7	<1.0	6	10.9	7	<1.0	3.5	10.3	12.2	2	8.8	12.7	71.7	9.1
0.035	0.018	70.2	11.9	14.3	12.8	109.2	-	-	-	-	-	-	-	-	-	-	33.8	94.2	5.9	2.3	<1.0	3.4	7.9	8.1	<1.0	2.2	7.1	12.7	<1.0	5.3	11.1	35	11.4
0.036	0.02	57.3	22.5	13.5	13	106.4	-	-	-	-	-	-	-	-	-	-	28.4	93.3	6.3	2.8	<1.0	3.6	9.5	7.8	<1.0	2.3	8.6	12.2	<1.0	6.1	11.6	40.6	9.6
0.027	0.02	67.6	13.2	11.5	10.1	102.4	-	-	-	-	-	-	-	-	-	-	37.7	97	8.3	3.7	<1.0	2.4	7.6	7.7	<1.0	<1.0	6.9	10.4	<1.0	4.9	9.8	25.4	5.9
0.036	0.017	69.9	13.6	11.2	9.7	104.4	-	-	-	-	-	-	-	-	-	-	34.6	91.5	6.7	2.8	<1.0	4.5	8	6.8	<1.0	3.1	7.2	10	<1.0	5.5	9.9	49.7	10.1
0.046	0.019	34.1	29.9	22.6	16.7	103.2	-	-	-	-	-	-	-	-	-	-	2.5	85.6	3.4	2.6	<1.0	8	15.6	6.4	<1.0	4.7	14.1	13.2	1.8	11.4	16.2	88.8	7.4
0.026	0.019	40.2	30.1	22.4	12.9	105.7	-	-	-	-	-	-	-	-	-	-	7.7	85	4.7	2.7	<1.0	6.6	14.4	5.9	<1.0	5.2	13.1	11.7	3.1	10.3	14.5	103	9.1
0.033	0.017	67.3	15.2	14.9	9.5	107	-	-	-	-	-	-	-	-	-	-	40.8	95.6	7.2	2.3	<1.0	2.1	6.9	7.4	<1.0	1.3	5.1	11.9	<1.0	3.2	10.8	22.4	10.5
0.036	0.017	72.4	5.8	8.5	1	87.8	-	-	-	-	-	-	-	-	-	-	48.8	100	7.1	1.7	<1.0	<1.0	6.6	7.4	<1.0	<1.0	4.2	12.7	<1.0	<1.0	11.1	8.9	13
0.032	0.02	73.1	5.7	9.3	15.7	103.8	-	-	-	-	-	-	-	-	-	-	31.6	96.8	5.6	1.8	<1.0	1.5	10.6	7.7	<1.0	<1.0	7.8	13.8	<1.0	4.1	13.7	24	15.6
0.066	0.015	45.6	24.6	19.7	13.8	103.7	-	-	-	-	-	-	-	-	-	-	11.7	89.2	4	1.9	<1.0	4.7	15.1	6.2	<1.0	3.1	12.4	13.4	2.5	8	16.6	68.7	12
0.041	0.021	66.7	9.6	11.9	14.7	102.8	-	-	-	-	-	-	-	-	-	-	27.2	94.7	5	2.2	<1.0	2.3	10.8	8.4	<1.0	1.4	7.5	15	1.2	4.1	14.6	28.9	13.7
<0.013	0.014	18.7	19.9	39.9	23	101.6	-	-	-	-	-	-	-	-	-	-	<1.0	74.1	<1.0	2.5	<1.0	11.5	16.8	4.1	<1.0	9.7	16.2	7.8	4.8	13.7	12.3	170	15.7
0.021	0.017	22.1	18.4	34	29.8	104.3	-	-	-	-	-	-	-	-	-	-	<1.0	82	1.2	3	<1.0	8.8	18.5	5.4	<1.0	6.4	16	10.7	2.9	11.7	15.5	117	12.4
0.013	<0.013	22.1	47	21.5	13	103.6	-	-	-	-	-	-	-	-	-	-	7	75.3	4.4	2.6	<1.0	7.3	13.6	4	<1.0	8.7	13.2	7.7	8.7	11.3	11.2	233	8.9
0.025	0.024	25.8	34.2	28.4	16.4	104.7	-	-	-	-	-	-	-	-	-	-	<1.0	74	2.8	2.3	1.7	8.4	14	4.5	<1.0	7.1	14.2	9.7	8.9	12.5	13	263	10.2
0.024	0.034	22.9	35.7	30.3	13.3	102.3	-	-	-	-	-	-	-	-	-	-	<1.0	71.2	2	1.9	1.8	10.5	13.6	4	<1.0	8.4	14.3	9.1	8.4	13.4	12.3	253	12.5
0.017	0.042	22.5	40.1	29.1	13.1	104.9	-	-	-	-	-	-	-	-	-	-	<1.0	82.2	2.5	2.3	<1.0	8.3	16.1	5.3	<1.0	6.8	15.5	11.6	2.8	12.7	15.4	120	15.6
0.019	0.042	22.6	36.2	30	16.8	105.6	-	-	-	-	-	-	-	-	-	-	<1.0	81.4	2.5	2.3	<1.0	8.6	15.7	5.2	<1.0	5.8	15.1	11.6	4.2	12.9	15.2	127	15.7
0.035	0.019	62.7	17.2	12	11.7	103.6	-	-	-	-	-	-	-	-	-	-	31.8	96.9	6.2	2.3	<1.0	2.1	8.2	8.9	<1.0	<1.0	6.1	15.7	<1.0	3.9	13.8	22.1	13.3
0.266	0.02	40.4	6.1	12.1	41.4	100	-	-	-	-	-	-	-	-	-	-	<1.0	78.7	<1.0	1.5	1.6	9.2	18.5	4.2	<1.0	6.1	15.9	10.2	4.6	12	16.2	156	15.9
0.042	<0.013	43.9	5.8	12.6	41.5	103.8	-	-	-	-	-	-	-	-	-	-	<1.0	94.3	<1.0	3	<1.0	3.3	22.3	7	<1.0	1.3	17.1	14.4	1.1	9.1	20.7	41.5	16.8
0.033	<0.013	63.3	4.9	10.8	24.7	103.8	-	-	-	-	-	-	-	-	-	-	2.4	94.1	4.7	5.4	<1.0	2.5	18.4	9.7	<1.0	1.5	13.4	15.1	1.6	6.5	18.5	37.2	15.4
0.022	<0.013	63.8	10.7	10.6	17.6	102.7	-	-	-	-	-	-	-	-	-	-	8.6	94.4	6.6	4.8	<1.0	3.3	17.7	8.1	<1.0	1.9	12.1	13.1	<1.0	6.1	17.3	35.7	12.1
0.014	0.014	33.1	34.9	21.3	15.6	104.9	-	-	-	-	-	-	-	-	-	-	<1.0	80.6	3.2	3.2	<1.0	5.9	17	4.5	4.4	3.6	18.6	8.3	<1.0	12.9	12.1	249	10.5
0.241	0.024	29.4	25	30.1	20	104.6	-	-	-	-	-	-	-	-	-	-	<1.0	65.7	<1.0	1	2	12.8	13.7	3.2	<1.0	10.9	13.7	8.3	8.7	13.2	12.5	262	11.2
0.136	0.02	29.1	26.7	28.1	21.4	105.3	-	-	-	-	-	-	-	-	-	-	<1.0	68.2	<1.0	1.7	3.5	9.8	13.9	4.3	<1.0	8.5	12.9	9.9	10.1	11.5	13.6	321	13.3
0.069	<0.013	73.8	3.9	11.8	15.4	104.8	-	-	-	-	-	-	-	-	-	-	4.7	85.7	5.5	3.4	<1.0	6.5	15.1	5.4	<1.0	4.2	14.3	11.6	3	10.4	15.1	97.6	14.4
0.216	0.054	33.5	31.3	20.5	18.7	104	-	-	-	-	-	-	-	-	-	-	<1.0	74.8	<1.0	<1.0	<1.0	10.4	18.1	2.9	<1.0	8.7	14.8	10	5.7	11.6	17.1	181	10.4
0.067	0.051	32.8	47.9	14.5	10.1	105.3	-	-	-	-	-	-	-	-	-	-	3.4	83.3	2.4	1.5	1.2	6	17.8	4.7	<1.0	4.7	14.4	11.9	4.9	9.7	17.5	140	11.9
0.035	0.013	73.6	13.7	10	6.9	104.2	-	-	-	-	-	-	-	-	-	-	28.8	88.6	8.7	3.2	<1.0	5	9.7	4.7	<1.0	4	8.7	8.3	2.4	6.6	10	75.6	11.5
0.033	0.014	74.5	9.8	11.3	10.2	105.8	-	-	-	-	-	-	-	-	-	-	40	95.7	9.2	4	<1.0	2.1	7.9	6.1	<1.0	1.1	6.7	8.5	1	4.3	9.1	26.7	14.1
0.199	0.028	27.4	31.4	31.8	15.2	105.7	-	-	-	-	-	-	-	-	-	-	<1.0	71	<1.0	<1.0	1.3	10.7	16.2	3	<1.0	8.9	14.8	8.9	8.3	12.7	14.4	242	10.9
0.056	0.015	27.1	36.2	34.1	13.3	110.8	-	-	-	-	-	-	-	-	-	-	1.4	79.1	2.3	1.7	<1.0	9.8	15.5	4.9	<1.0	7	13.6	11.8	4	11.8	16	138	10.6
0.029	<0.013	32.5	38.9	22	10	103.4	-	-	-	-	-	-	-	-	-	-	9.2	81.2	5.2	3.2	<1.0	6.5	12.5	5.7	<1.0	5.8	11.4	10.8	6.4	9.9	13.1	176	13.3
0.024	<0.013	36.1	33.3	26.6	9.9	106	-	-	-	-	-	-	-	-	-	-	8.5	76.6	4.8	2.8	<1.0	8.7	11.5	5	<1.0	8.8	11.5	9.6	5.9	11	11.7	186	12.9
0.015	<0.013	34.3	32.7	23.9	11.6	102.6	-	-	-	-	-	-	-	-	-	-	5	73.8	4	2.8	1.6	9.2	10.9	6.1	<1.0	7.5	10.7	11.1	8	10.8	12.3	242	15.4
0.046	<0.013	34	2.8	14.5	54.7	105.9	-	-	-	-	-	-	-	-	-	-	<1.0	90.5	1.3	3.4	<1.0	4.8	20.3	7.1	<1.0	2.7	15.9	13.8	1.9	9.7	19.1	59.3	15.7

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Queensland Government

Department of Environment and Science - Chemistry Centre

Soil Analysis Report

Job No: 23-0451

Report ID: 23-0451-F-V1

* S_PSD_PRED																	* S_PSD_ULTD															
<0.24µm	<62.5µm	0.5µm to 0.24µm	1µm to 0.5µm	1000µm to 500µm	125µm to 62µm	16µm to 8µm	2µm to 1µm	2000µm to 1000µm	250µm to 125µm	31µm to 16µm	4µm to 2µm	500µm to 250µm	62µm to 31µm	8µm to 4µm	d(0.9)	Obscuration	<0.24µm	<62.5µm	0.5µm to 0.24µm	1µm to 0.5µm	1000µm to 500µm	125µm to 62µm	16µm to 8µm	2µm to 1µm	2000µm to 1000µm	250µm to 125µm	31µm to 16µm	4µm to 2µm	500µm to 250µm	62µm to 31µm	8µm to 4µm	d(0.9)	Obscuration
%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	µm	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	µm	%
32	93.5	5.9	2	<1.0	2.7	7.9	8.1	<1.0	1.6	6.7	13.7	1.4	5	12.1	37.1	11.5	32.9	90.7	6.1	2.1	<1.0	4.8	7.6	7.2	<1.0	3.4	6.9	11.8	1.2	5.4	10.7	56.4	11.3
26.8	85.7	6.1	2.8	<1.0	5.1	7.9	6.8	<1.0	4.7	8	10.4	4	7	9.8	113	14.4	28.3	86.4	6.3	2.8	<1.0	5.7	7.9	6.4	<1.0	5.1	8	9.8	2.9	7.5	9.4	96	14.4
15.8	91.8	5.4	2.8	<1.0	5.2	13.1	7.3	<1.0	2.9	11.5	13.1	<1.0	8.3	14.5	52	12.3	17.3	87	5.4	2.7	<1.0	6.4	11.8	6.7	<1.0	3.9	10.5	11.6	2.2	8.1	12.9	85.8	12.4
15.7	87.5	5.1	2.6	<1.0	6.6	11.5	7	<1.0	4.8	11.2	12.2	1.3	9.3	12.8	80.1	8.3	17.1	86.2	5.3	2.7	<1.0	7.5	11	6.6	<1.0	5.6	11	11.2	<1.0	9.3	11.9	88.8	8.4
18.2	87.2	5.3	2.6	<1.0	6.1	10.7	6.9	<1.0	4.5	10.1	12	2.3	8.6	12.6	84.3	9	19.5	84.6	5.3	2.5	<1.0	6.7	10.1	6.4	<1.0	5	9.9	10.8	3.3	8.7	11.4	108	9.3
33.8	94.4	5.9	2.2	<1.0	3.6	7.9	8.1	<1.0	2	7.1	12.8	<1.0	5.5	11.2	34.8	11.4	34.8	92.1	5.9	2.3	1.8	3.6	7.6	7.5	<1.0	1.8	6.9	11.5	<1.0	5.3	10.2	45.6	11.5
28.4	93.8	6.3	2.8	<1.0	4	9.5	7.8	<1.0	2.1	8.6	12.3	<1.0	6.2	11.8	39.2	9.5	28.8	90	6.2	2.6	<1.0	4.9	8.9	7	<1.0	3.5	8.3	10.9	1.4	6.5	10.6	62.3	9.6
37.8	96.4	8.2	3.6	<1.0	2.7	7.6	7.7	<1.0	<1.0	6.9	10.4	<1.0	4.7	9.7	26.1	5.9	28.7	73.8	6.2	2.5	9.5	4.6	5.6	5.4	<1.0	3.5	5.6	7.3	8.6	5.4	7	490	5.9
34.9	91.9	6.7	2.8	<1.0	3.9	8	6.9	<1.0	2.8	7.2	10.1	1.3	5.5	9.9	47.2	10.1	32.9	82.8	6.2	2.4	1.3	4.8	6.9	5.6	5.3	3	6.4	8.3	<1.0	5.7	8.4	199	9.9
2.6	87.3	3.4	2.6	<1.0	7.7	16.1	6.6	<1.0	4.6	14.4	13.6	<1.0	11.1	16.7	78.1	7.4	2.6	76	3.1	2.3	<1.0	10.4	13.5	5.4	<1.0	8.8	12.8	11.1	4.9	11.4	13.7	165	7.5
7.7	85.9	4.7	2.7	<1.0	7	14.7	6	<1.0	4.4	13.3	11.9	2.7	10.3	14.7	91.3	9	8.2	83.6	4.7	2.6	<1.0	8.2	13.8	5.6	<1.0	5.2	12.9	11	3	11	13.7	106	9
38.2	89.6	6.7	2.1	2.5	2	6.5	6.9	2.6	1.2	4.8	11.2	1.2	3.1	10.1	71.1	10.4	39.3	89.3	6.8	2.1	<1.0	4.2	6.3	6.3	<1.0	3.1	5	9.9	2.9	4.3	9.2	69.9	10.3
48.7	100	7	1.7	<1.0	<1.0	6.7	7.4	<1.0	<1.0	4.2	12.8	<1.0	<1.0	11.2	8.9	13	51.7	100	7.3	1.8	<1.0	<1.0	6.1	6.7	<1.0	<1.0	4	11	<1.0	1.4	10.1	9.2	12.6
32.1	97.8	5.6	1.8	<1.0	<1.0	10.8	7.8	<1.0	<1.0	7.8	14	<1.0	4	13.9	21.9	15.6	33.5	95.1	5.7	1.8	<1.0	2.4	10.2	7.2	<1.0	1.3	7.3	12.6	<1.0	3.9	12.9	27.2	15.5
11.7	90.3	4	1.9	<1.0	5	15.2	6.3	<1.0	3.3	12.4	13.5	1.4	8.4	16.8	60.1	12	12.8	88.1	4.3	2	1.1	5.7	14.3	6	<1.0	3.3	11.9	12.7	1.9	8.3	15.7	77.4	11.9
27.2	94.9	5	2.1	1.1	1.8	10.8	8.5	<1.0	<1.0	7.6	15	1.5	4.1	14.7	28.6	13.7	30.2	94.2	5.3	2.2	<1.0	3.6	10.3	7.8	<1.0	2.1	7.1	13.6	<1.0	4.2	13.5	31	13.4
<1.0	73.5	<1.0	2.5	<1.0	11.5	16.7	4	<1.0	10.6	16	7.7	4.6	13.6	12.2	174	15.7	<1.0	73.6	<1.0	2.5	<1.0	11.6	16.6	4	<1.0	9.9	16.1	7.6	5.1	13.7	12.1	175	15.9
<1.0	78.9	1.1	2.9	<1.0	8.4	17.9	5.2	<1.0	6.9	15.5	10.3	5.3	11.1	14.9	163	12.4	<1.0	78.3	1.2	2.9	1.8	9.4	17.5	5.1	<1.0	6.2	15.4	10	4.5	11.6	14.5	157	12.5
6.5	71.4	4.2	2.5	2.4	7.5	12.9	3.8	<1.0	7.9	12.7	7.3	10.9	10.8	10.7	307	8.9	6.8	71.6	4.2	2.5	1.6	8.8	12.7	3.7	<1.0	8	12.7	7	10.1	11.6	10.3	280	9.1
<1.0	71.9	2.7	2.3	2.4	8.2	13.7	4.3	<1.0	7.3	13.9	9.4	10.3	12.1	12.6	300	10.2	1	74.8	2.9	2.3	<1.0	9	14	4.4	<1.0	7.9	14.6	9.4	8	13.3	12.7	224	10.4
<1.0	71.1	2	1.9	1.2	10.8	13.6	4.1	<1.0	8.7	14.3	9.1	8.4	13.3	12.3	242	12.5	<1.0	75.8	2.2	2.1	<1.0	10.6	14.4	4.3	<1.0	7.8	15.4	9.6	5.7	14.5	12.9	173	12.9
<1.0	79.7	2.4	2.2	<1.0	8.2	15.7	5.1	<1.0	6.7	15	11.3	5.3	12.5	14.8	157	15.6	<1.0	86.7	2.7	2.5	<1.0	7.5	17.1	5.5	<1.0	4.4	16.5	12.2	1.5	13.3	16.1	81	16
<1.0	78.7	2.5	2.2	<1.0	9.1	15.1	5	<1.0	6.5	14.6	11.2	5.3	12.6	14.6	158	15.7	<1.0	85.9	2.8	2.4	<1.0	8.3	16.6	5.5	<1.0	4.5	16.1	12.2	1.5	13.2	16	84.9	16.1
31.2	94.4	5.9	2.2	<1.0	2.2	8	8.6	<1.0	1.3	5.9	15.2	1.5	4	13.4	29.6	13.2	33.3	96.2	6.4	2.4	<1.0	2.1	8.1	8.5	<1.0	1.1	6.1	14.5	<1.0	4	13	24.1	13.2
<1.0	78.6	<1.0	1.5	1.6	9	18.5	4.2	<1.0	5.3	15.8	10.2	5.7	12	16.2	168	15.9	<1.0	82.9	<1.0	1.7	<1.0	8.4	19.2	4.7	<1.0	4.4	16.3	11.2	3.6	12.1	17.3	111	16.3
<1.0	92.6	<1.0	2.9	<1.0	3.4	21.9	6.8	<1.0	1.8	16.8	14.1	1.9	9	20.3	47.5	16.8	<1.0	95.1	<1.0	3.1	<1.0	3.1	22.4	7.2	<1.0	1	17.2	14.5	<1.0	9.1	20.8	39.1	16.9
2.3	95.7	4.8	5.5	<1.0	2.6	18.8	9.8	<1.0	1.3	13.7	15.4	<1.0	6.5	18.9	32.9	15.3	2.3	93.9	4.9	5.5	<1.0	3.1	18.3	9.5	<1.0	1.7	13.7	14.7	1.3	7	18.1	39	15.4
8.6	93.6	6.5	4.8	<1.0	3.2	17.5	8	<1.0	1.9	12	13	1.3	6	17.1	38.7	12	8.6	95	6.7	4.9	<1.0	3.3	17.7	8.1	<1.0	1.5	12.3	13	<1.0	6.3	17.2	34.5	12.1
<1.0	65.3	<1.0	1	3.9	12.7	13.6	3.1	<1.0	10	13.6	8.2	8.2	13.2	12.3	297	11.2	<1.0	70.6	<1.0	1.3	2.3	13.1	14	3.6	<1.0	7.8	14.9	8.7	6.4	15.2	12.6	216	11.7
<1.0	61.2	<1.0	1.5	10.6	9.3	12.4	3.9	1.6	7.9	11.6	8.8	9.6	10.4	12.2	568	13.3	<1.0	68.1	<1.0	1.8	7.1	10.4	13.3	4.5	<1.0	6.9	12.9	9.7	7.3	12.2	13	408	14
4.6	85.5	5.4	3.3	<1.0	6.8	15.1	5.4	<1.0	4.5	14.3	11.5	2.8	10.5	15.1	97.9	14.4	6.1	89.9	6.1	3.7	<1.0	5.4	15.7	6	<1.0	3.3	14.3	12.4	1.3	9.6	16	62.9	14.5
<1.0	72.3	<1.0	<1.0	<1.0	9.5	17.5	2.8	<1.0	9.3	14.3	9.7	8.3	11.1	16.5	234	10.3	<1.0	80	<1.0	<1.0	<1.0	11.4	18.8	3.2	<1.0	8	16.1	10.6	<1.0	13.1	17.7	115	10.9
3.4	81.4	2.3	1.4	1.4	6	17.3	4.6	<1.0	4.9	14.1	11.6	6.5	9.7	17	189	11.9	4.5	80.3	2.5	1.5	2.8	5.6	16.3	4.7	4.9	3.1	13.5	11.5	1.4	9.4	16.4	442	12
28.6	87.4	8.5	3.1	<1.0	5	9.5	4.7	<1.0	3.9	8.6	8.1	3	6.5	9.8	88.6	11.5	30	87.9	8.5	3	<1.0	4.7	9.2	4.7	<1.0	3.2	8.4	8.1	3.3	6.4	9.6	83.9	11.7
40.3	96	9.2	3.9	<1.0	2	7.9	6	<1.0	<1.0	6.8	8.5	<1.0	4.4	9.1	26.2	14	40.3	96.4	9.3	4	<1.0	2.2	7.9	6.1	<1.0	<1.0	6.8	8.5	<1.0	4.4	9	25.2	14.2
<1.0	67.3	<1.0	<1.0	3.9	10.5	15.3	2.8	<1.0	9.1	14	8.4	9.4	12.1	13.6	318	10.9	<1.0	74.6	<1.0	<1.0	1.6	11.1	16.7	3.2	<1.0	7.5	15.6	9.3	5.4	13.5	15	180	11.2
1.4	76.9	2.2	1.7	<1.0	10.2	15	4.7	<1.0	7.2	13.3	11.4	5	11.5	15.6	161	10.6	2.1	80.3	2.5	1.8	<1.0	9.2	15.3	5.1	<1.0	7.4	13.7	12	3.1	11.6	16	131	10.8
9.1	81.4	5.2	3.2	<1.0	7.5	12.7	5.7	<1.0	6.4	11.5	10.9	4.7	10	13.2	142	13.3	10.8	85.2	5.5	3.3	<1.0	8.1	12.7	6	<1.0	5.7	12.1	11	1.2	10.5	13.1	93.5	13.7
8.3	74.7	4.6	2.7	<1.0	8.8	11.2	4.9	<1.0	10.1	11.3	9.4	6.5	10.8	11.4	199	12.9	9.2	75.1	4.7	2.7	<1.0	9.3	10.9	4.8	<1.0	10	11.4	9	5.8	11.4	10.9	189	13.3
4.9	71.6	3.9	2.7	2.1	8.6	10.6	6	<1.0	7.8	10.4	10.8	10.1	10.3	12	289	15.3	5.3	68.9	3.7	2.5	3.7	9.5	10.1	5.4	<1.0	8.1	10.2	9.9	9.9	10.7	11	324	15.7
<1.0	91.1	1.3	3.4	<1.0	4.7	20.4	7.2	<1.0	2.3	16.1	13.9	1.6	9.7	19.2	56	15.7	<1.0	91.2	1.4	3.4	<1.0	5.2	20.3	7.2	<1.0	2.5	15.9	13.9	1.2	9.9	19.2	55.8	15.8

Name: Dan Yousaf

Title: Soil & Plant team leader

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Queensland Government

Department of Environment and Science - Chemistry Centre

Soil Analysis Report

Job No: 23-0451

Report ID: 23-0451-F-V1

* S_PSD_W	* S_R1-R2		* S_SCP_IC	S_WALKLEY	S_CAT_EQ				
PSD	R1	R2	S	OC	Ca	K	Mg	Na	Na corr
			mg/kg	%	cmol_c/kg	cmol_c/kg	cmol_c/kg	cmol_c/kg	cmol_c/kg
-	0.33	<0.10	21	0.41	-	-	-	-	-
-	0.45	<0.10	16	0.24	-	-	-	-	-
-	0.41	0.11	11	0.52	-	-	-	-	-
-	0.39	<0.10	22	0.4	-	-	-	-	-
-	0.39	<0.10	33	0.45	-	-	-	-	-
-	0.34	<0.10	25	0.29	-	-	-	-	-
-	0.4	<0.10	18	0.37	-	-	-	-	-
-	0.48	<0.10	20	0.3	-	-	-	-	-
-	0.37	<0.10	27	0.44	-	-	-	-	-
-	0.75	0.28	29	0.68	-	-	-	-	-
-	0.67	0.16	18	0.38	-	-	-	-	-
-	0.43	<0.10	27	0.32	-	-	-	-	-
-	0.48	<0.10	29	0.32	-	-	-	-	-
-	0.32	<0.10	14	0.31	-	-	-	-	-
-	0.55	0.26	2	0.94	-	-	-	-	-
-	0.31	<0.10	23	0.39	-	-	-	-	-
-	0.93	0.21	115	0.18	-	-	-	-	-
-	0.82	0.37	18	0.31	-	-	-	-	-
-	0.92	0.37	3	0.2	-	-	-	-	-
-	0.88	0.4	13	0.35	-	-	-	-	-
-	0.81	0.36	8	0.31	-	-	-	-	-
-	0.81	0.32	6	0.21	-	-	-	-	-
-	0.73	0.36	2	0.35	-	-	-	-	-
-	0.36	<0.10	18	0.35	-	-	-	-	-
-	0.61	0.26	37	2.58	-	-	-	-	-
-	0.72	0.4	16	0.49	-	-	-	-	-
-	0.88	0.55	62	0.52	-	-	-	-	-
-	0.99	0.78	51	0.2	-	-	-	-	-
-	0.83	0.44	33	0.11	-	-	-	-	-
-	0.62	0.35	5	3	10.7	0.874	3.13	0.106	<0.080
-	0.65	0.38	6	1.92	4.99	0.615	3.33	0.201	0.201
-	0.82	0.58	14	0.74	4.88	0.196	11.2	2.79	2.59
-	0.4	0.18	4	2.69	14.5	0.501	3.45	<0.080	<0.080
-	0.58	0.25	3	0.92	7.49	0.164	2.84	0.149	0.149
-	0.61	0.29	4	0.39	11.9	0.176	7.3	1.2	1.12
-	0.79	0.39	<1	0.25	-	-	-	-	-
-	0.58	0.22	5	2.6	8.73	0.578	3.84	<0.080	<0.080
-	0.6	0.3	6	0.75	5.27	0.108	3.8	0.231	0.231
-	0.65	0.31	8	0.24	7.47	0.098	5.9	0.386	0.386
-	0.67	0.28	10	0.22	8.33	0.092	6.74	0.504	0.504
-	0.59	0.24	1	0.11	6.81	0.074	6.29	1.79	0.967
-	0.56	0.63	9	0.51	-	-	-	-	-

Name: Dan Yousaf

Title: Soil & Plant team leader

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AGRICULTURAL SOIL ANALYSIS REPORT

2 samples supplied by Epic Environmental Pty Ltd on 04/07/2023. Lab Job No.P2646

Analysis requested by Andrew Hughes. Your Job: BCL230021.01

Level 17 BRISBANE QLD 4000

			Sample 1	Sample 2	*Heavy Soil*	*Medium Soil*	*Light Soil*	*Sandy Soil*
		Sample ID:	QC101	QC200				
		Crop:	Soil	Soil				
		Client:	Calliope Soil Survey	Calliope Soil Survey	*Clay*	*Clay Loam*	*Loam*	*Loamy Sand*
	Parameter		Method reference	P2646/1	P2646/2	Indicative guidelines - refer to Notes 6 and 8			
	Phosphorus (mg/kg P)		**Rayment & Lyons 2011 - 9B2 (Colwell)	6.1	7.2	*80*	*50*	*45*	*35*
	Nitrate Nitrogen (mg/kg N)		**Inhouse S37 (KCl)	1.2	12	*15*	*13*	*10*	*10*
	Ammonium Nitrogen (mg/kg N)			1.9	1.3	*20*	*18*	*15*	*12*
	Sulfur (mg/kg S)			16	25	*10.0*	*8.0*	*8.0*	*7.0*
	pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)	8.21	8.43	*6.5*	*6.5*	*6.3*	*6.3*
	Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.144	0.154	*0.200*	*0.150*	*0.120*	*0.100*
	Estimated Organic Matter (% OM)		**Calculation: Total Carbon x 1.75	1.4	2.1	*> 5.5*	*>4 .5*	*> 3.5*	*> 2.5*
	Exchangeable Calcium	(cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	15	26	*15.6*	*10.8*	*5.0*	*1.9*
		(kg/ha)		6,916	11,615	*7000*	*4816*	*2240*	*840*
		(mg/kg)		3,087	5,185	*3125*	*2150*	*1000*	*375*
	Exchangeable Magnesium	(cmol+/kg)		8.2	0.93	*2.4*	*1.7*	*1.2*	*0.60*
		(kg/ha)		2,228	253	*650*	*448*	*325*	*168*
		(mg/kg)		995	113	*290*	*200*	*145*	*75*
	Exchangeable Potassium	(cmol+/kg)		0.30	<0.12	*0.60*	*0.50*	*0.40*	*0.30*
		(kg/ha)		265	<112	*526*	*426*	*336*	*224*
		(mg/kg)		118	<50	*235*	*190*	*150*	*100*
	Exchangeable Sodium	(cmol+/kg)		0.83	0.08	*0.3*	*0.26*	*0.22*	*0.11*
		(kg/ha)		430	44	*155*	*134*	*113*	*57*
		(mg/kg)		192	19	*69*	*60*	*51*	*25*
	Exchangeable Aluminium	(cmol+/kg)	**Inhouse S37 (KCl)	0.04	0.03	*0.6*	*0.5*	*0.4*	*0.2*
		(kg/ha)		7.3	6.7	*121*	*101*	*73*	*30*
		(mg/kg)		3.3	3.0	*54*	*45*	*32*	*14*
	Exchangeable Hydrogen	(cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	*0.6*	*0.5*	*0.4*	*0.2*
		(kg/ha)		<1	<1	*13*	*11*	*8*	*3*
		(mg/kg)		<1	<1	*6*	*5*	*4*	*2*
	Effective Cation Exchange Capacity (ECEC) (cmol+/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	25	27	*20.1*	*14.3*	*7.8*	*3.3*
	Calcium (%)		**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	62	96	*77.6*	*75.7*	*65.6*	*57.4*
	Magnesium (%)			33	3.4	*11.9*	*11.9*	*15.7*	*18.1*
	Potassium (%)			1.2	0.22	*3.0*	*3.5*	*5.2*	*9.1*
	Sodium - ESP (%)			3.4	0.31	*1.5*	*1.8*	*2.9*	*3.3*
	Aluminium (%)			0.15	0.12	*6.0*	*7.1*	*10.5*	*12.1*
	Hydrogen (%)			0.00	0.00				
	Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol+/kg)	1.9	28	*6.5*	*6.4*	*4.2*	*3.2*

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AGRICULTURAL SOIL ANALYSIS REPORT

2 samples supplied by Epic Environmental Pty Ltd on 04/07/2023. Lab Job No.P2646

Analysis requested by Andrew Hughes. Your Job: BCL230021.01

Level 17 BRISBANE QLD 4000

			Sample 1	Sample 2	*Heavy Soil*	*Medium Soil*	*Light Soil*	*Sandy Soil*
		Sample ID:	**QC101**	**QC200**				
		Crop:	**Soil**	**Soil**				
		Client:	**Calliope Soil Survey**	**Calliope Soil Survey**	*Clay*	*Clay Loam*	*Loam*	*Loamy Sand*
	Parameter	**Method reference**	**P2646/1**	**P2646/2**	**Indicative guidelines - refer to Notes 6 and 8**			
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	<0.5	<0.5	*6.0*	*5.0*	*4.0*	*3.0*
	Manganese (mg/kg)		41	6.9	*25*	*22*	*18*	*15*
	Iron (mg/kg)		44	4.7	*25*	*22*	*18*	*15*
	Copper (mg/kg)		3.8	0.54	*2.4*	*2.0*	*1.6*	*1.2*
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.36	0.17	*2.0*	*1.7*	*1.4*	*1.0*
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	44	5.3	*50*	*45*	*40*	*35*
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	0.77	1.2	*> 3.1*	*> 2.6*	*> 2.0*	*> 1.4*
	Total Nitrogen (%)		0.08	0.07	*> 0.30*	*> 0.25*	*> 0.20*	*> 0.15*
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	9.8	18	*10–12*	*10–12*	*10–12*	*10–12*
	Basic Texture	**Inhouse S65	Clay	Clay	..	..	..	..
	Basic Colour		Brownish	Red	..	..	..	..
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	92	99	..	..	..	..
	Chloride (mg/kg)	**Rayment & Lyons 2011 - 5A3a	21	16	..			
	pH	**Rayment & Lyons 2011 - 4B4 ($CaCl_2$)	7.4	7.8	..			

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
10. Conversions for 1 cmol+/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
13. ** NATA accreditation does not cover the performance of this service.
14. Analysis conducted between sample arrival date and reporting date.
15. This report is not to be reproduced except in full. Results only relate to the item tested.
16. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer SCU.edu.au/eal/t&cs).
17. This report was issued on 19/07/2023.

Quality Checked: Kris Saville
Agricultural Co-Ordinator

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GRAIN SIZE ANALYSIS (hydrometer techniques)

2 soil samples supplied by Epic Environmental Pty Ltd on 4th July, 2023 - Lab Job No. P2646
Analysis requested by Andrew Hughes. Job Ref: BCL230021.01
Level 17, 95 North Quay BRISBANE QLD 4000

SAMPLE ID	Lab Code	TEXTURE USDA classification	TEXTURE ISSS classification	MOISTURE CONTENT (105 °C) (% Moisture)	GRAVEL > 2 mm (%)	SAND > 50 µm USDA (< 2 mm fraction)	SAND > 20 µm ISSS (< 2 mm fraction)	SILT 2–50 µm USDA (< 2 mm fraction)	SILT 2–20 µm ISSS (< 2 mm fraction)	CLAY < 2 µm (< 2 mm fraction)	R1 DISPERSION	R2 DISPERSION
QC101	P2646/1	Silty clay	Silty Clay	18.2%	0.4%	11.0%	22.0%	47.6%	36.7%	41.3%	0.53	0.20
QC200	P2646/2	Clay	Clay	9.9%	19.1%	19.9%	25.1%	19.3%	14.1%	60.8%	0.16	0.04

Note:

1. The Hydrometer Analysis method was used to determine the percentage sand, silt and clay,
modified from SOP meth004 (California Dept of Pesticide Regulation), using method of Gee & Bauder (1986)," &
in Methods of Soil Analysis. Part 1 Agron. Monogr. 9 (2nd Ed). Klute, A., American Soc. of Agronomy Inc., Soil Sci. Soc. America Inc., Madison WI: 383-411.
2. The texture classification was based on the hydrometer results and the appropriate texture triangle.
3. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (see EAL website: scu.edu.au/eal).
4. This report is not to be reproduced except in full.
5. This report was issued on 02/08/2023.

checked: .....
Graham Lancaster (Nata signatory)
Laboratory Manager

APPENDIX E QUALITY ASSURANCE

Project Name: Graymont Calliope
Job Number: BCL230021.01
Client: Graymont
Sumary of QA/QC Results

		Electrical Conductivity (1:5 water)	pH (1:5 water)	Total Nitrogen	Total Organic Carbon	Calcium (Ca)	Potassium (K)	Magnesium (Mg)	Sodium (Na)	Cation Exchange Capacity (CEC)	Chloride (1:5 water)	Sulfur (S) - Extractable	Phosphorus (P) - Colwell	Iron (Fe)	Copper (Cu)	Manganese (Mn)	Zinc (Zn)	R1	R2
	LOR	0.01	0.1	0.02	0.05	0.6	0.05	0.07	0.7	2	20	1	2	2	0.1	2	0.5	0.1	0.1
	5 x LOR	0.05	0.5	0.1	0.25	3	0.25	0.35	0.35	10	100	5	10	10	0.5	10	2.5	0.5	0.5
	10 x LOR	0.1	1	0.2	0.5	6	0.5	0.7	0.7	20	200	10	20	20	1	20	5	1	1
Field ID	Sample Type																		
TP01_0.1	Sample	0.19	8.25	0.042	0.48	11.2	0.157	7.5	0.874	19	<20	16	5	8.8	2.3	6.6	<0.1	0.72	0.4
TP01_0.1 (QC101)	Field duplicate (DES)	0.10	7.83	0.046	0.578	15.1	0.231	5.58	0.399	21	<20	9	5	28.4	3.4	23.1	<0.1	0.56	0.63
TP01_0.1 (QC200)	Inter-laboratory duplicate (EAL)	0.154	8.21	0.08	0.77	15	0.3	8.2	0.83	25	21	16	6.1	44	3.8	41	<0.5	Not tested	Not tested
		62%	5%	9%	19%	30%	38%	29%	75%	10%	N/C	56%	0%	105%	39%	111%	N/C	25%	45%
		21%	0%	62%	46%	29%	63%	9%	5%	27%	N/C	0%	20%	133%	49%	145%	N/C	N/C	N/C
		<50%	**<50%**	No Limit	No Limit	**<50%**	No Limit	**<50%**	**<50%**	No Limit	N/C	**<50%**	No Limit	No Limit	**<50%**	No Limit	N/C	No Limit	No Limit

Legend	
ND	Not determined
N/C	Criteria not calculated (result <LOR or no duplicate)
No limit	No limit (result <10 x LOR)
<50%	Criterion where calculated
	RPD > criteria
	RPD < criteria

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Appendix D Stockpile Topsoil Report



Calliope Quarry Stockpile Soil Suitability

Graymont
Calliope Quarry Stockpile Soil Suitability
Taragoola Rd, Taragoola Queensland
BCL230021.01
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1 INTRODUCTION

Epic Environmental (Epic) was commissioned by Graymont Limited (Graymont) to complete a topsoil characterisation assessment across five existing stockpiles to form part of the progressive rehabilitation closure plan (PRCP) requirements for the Calliope Limestone Quarry (the site). The quarry has approval under Environmental Authority (EA) EPML00969013 which covers the following the Mining Leases (ML): ML3594, ML3595, ML3596, ML3597, ML3598, ML3599, ML3600, ML3602, ML3603, ML3604, ML3605, ML3606, ML3608, ML3609, ML80036, ML80189, ML80190, ML80191, ML80192.

The site is located approximately 11 kilometres (km) south of the township of Calliope and 30 km south of Gladstone in Central Queensland within the Gladstone Local Government Area (LGA) (see **Figure F1**) with the site layout presented in **Figure F2.**

Epic understands that Graymont requires characterisation of stockpiled material prior to reuse onsite. The stockpiled material is currently stored in five separate stockpiles referred to as Stockpile SP01, Stockpile SP02, Stockpile SP03, Stockpile SP04 and Stockpile SP05 (**Figure F3**). The stockpiled material has been sourced from the site during establishment and striping.

This memorandum does not detail the results of the soil and land suitability assessment which will be detailed in the final soils report currently being prepared for the PRCP requirements.

1.1 Objectives

The objective of this memorandum was to summarise the suitability of the stockpiled material in SP01 to SP05 for the proposed cattle grazing post mining land use and recommend amelioration (if required).

1.2 Scope of Works

To achieve the objective, the scope of works for this stockpile sampling program included the:

- Development of a sampling plan
- Development of Safe Work Methods Statement (SWMS) and Health Safety and Environment Plan (HSEP)
- Stockpile sampling of:
  - Stockpile SP01 with samples collected at 14 locations approximately 1.0 to 2.0 m below surface level (mbsl)
  - Stockpile SP02 with one sample collected 0.5 mbsl into the northern face of the stockpile
  - Stockpile SP03 with one sample collected 0.5 mbsl into the northern face of the stockpile
  - Stockpile SP04 with two samples collected 0.5 mbsl into the eastern face of the stockpile
  - Stockpile SP05 with samples collected at five locations across the top of the stockpile, down to a maximum depth of 3.0 mbsl
- Logging of soils including the details of field texturing, pH, moisture, Munsell colour, consistency, and plasticity
- Submission of samples to a National Association of Testing Authority (NATA) accredited laboratory and/or a laboratory certified by the Australasian Soil and Plant Analysis Council (ASPAC) for selected analysis
- Preparation of this memorandum

2 SITE DESCRIPTION AND SETTING

2.1 Site Identification

The site is located within the Gladstone LGA, in Taragoola, near the Central Queensland coast (**Figure F1**). The site area and surrounds are zoned as rural under the Gladstone Regional Council Planning Scheme 2017.

The south, east and west of the site is surrounded by Lake Awoonga created by the Awoonga Dam. The Gladstone Area Water Board (GAWB) owns and operates Awoonga Dam on the Boyne River along with a network of delivery pipelines, water treatment plants and other bulk water distribution infrastructure in the Gladstone region in Central Queensland. The primary access route to the site is via Taragoola Road which adjoins Nuggety Road to the west of the Site. To the north, Charters Crossing Road intersects the site and acts as an alternative access route. An unnamed road managed by GAWB borders the west, south-west boundary and the closest residential area is approximately 4 km north of the site's northern boundary. Surrounding land is primarily State land, managed by the GAWB and classified as grazing native vegetation.

A summary of the site details is summarised in **Table 1.**

Table 1. Site Description Summary

Category	Details
Address	Taragoola Rd, Taragoola QLD 4680 Site entrance coordinates: -24.093083, 151.239753
Legal Property Description	The site covers the following land parcels: 100CTN1823, 1RP610128, 22SP215268, 26SP228426, 4RP610128, 7SP215269, 90SP275218, ASP231548, BSP231548, CSP231548, DSP231548, ESP215268 & GSP199253
Site Owner	Graymont Pty Ltd
Site Access	From Taragoola Rd
Local Government Area	Gladstone Local Government Area
Current Use	Mining and grazing native vegetation
Site Features & Infrastructure	• Site features include the mine pits, topsoil stockpiles, spoil stockpiles, waste rock dump, silt dump, infrastructure areas, roads and tracks, sediment basins (refer to **Figure F1**) • Five topsoil stockpiles are located on site which require characterisation. The topsoil stockpile approximate locations are provided on **Figure F3.**

3 METHODOLOGY

Samples were collected from five stockpiles at the site with sample locations shown on **Figure F3**. The stockpile samples were collected using the following methodology:

- Soil samples were collected from the test pit walls (when less than 1.0 mbsl) or from the excavator bucket at the nominated depths
  - Samples were collected from SP01 and SP05 using an excavator from a depth range of 1.0 to 3.0 mbsl
  - Samples were collected from Stockpile SP02, SP03 and SP04 using a shovel and mattock at 0.5 mbsl
  - Field duplicates (intra-laboratory) and triplicates (inter-laboratory duplicates) were collected in the field by collecting soil samples from the same location as a primary sample
  - The soil texture, pH (using a Inoculo Raupach testing kit), moisture, Munsell colour, consistency, plasticity, and other notable characteristics of the material were also recorded in the field during sample collection
- The soil samples were immediately transferred into labelled ziplock bags, sealed as soon as practicable and transferred immediately to a storage container
- A complete Chain of Custody was filled out prior to sending samples to the laboratory

The stockpiles material present onsite was sampled at a minimum frequency of 1:1,500 m^3 with the sampling density for each stockpile provided in **Table 2,** this was in accordance with the sampling plan**.** Stockpile volume was initially estimated using geospatial data and confirmed in the field by pacing out the length, width and height of each stockpile and estimating is geometric shape.

Table 2. Sample Density – stockpile material

Stockpile ID	Approximate Volume (m^3)	Number of Samples
SP01	20,000	14
SP02	120	1
SP03	90	1
SP04	3,000	2
SP05	6,300	5

3.1 Laboratory Analysis

Laboratory analysis was completed by the Department of Environment and Science (DES) Chemistry Centre and Southern Cross University Environmental Analysis Laboratory (EAL). These laboratories are either National Association of Testing Authorities (NATA) accredited or Australasian Soil and Plant Analysis Council (ASPAC) certified for the analytical methods used. A summary of the soil analytical schedule is provided in **Table 3.**

Table 3. Laboratory Analytical Schedule

Analytical Suite	Full Suite[1]
Stockpile 01	14
Stockpile 02	1
Stockpile 03	1
Stockpile 04	2
Stockpile 05	5
Inter-laboratory duplicates	1
Intra-laboratory duplicates	1
Totals	25

Notes:

[1.] Full suite includes: pH, EC (1:5), Total N, nitrates, Bicarbonate Extractable P, Organic Matter, Major exchangeable cations (Ca, Mg, K, Na), CEC, Ca/Mg Ratio, ESP, Metals, Sulfur, Chloride, PSD (particle size distribution with a laser diffraction and dry sieving), Dispersion, Emerson aggregate test, Moisture content, Atterberg limits

3.2 Topsoil Evaluation Criteria

Field data and laboratory analytical results were evaluated against the relevant cattle grazing land use suitability criteria sourced from technical guidelines as listed in **Section 7** and summarised in the following sections. Soils were not assessed against the cropping (irrigated or dryland) criteria as this is not proposed as a post mining land use.

3.2.1 Soil pH (1:5 soil/water)

The pH ratings were used to interpret pH data as described by Bruce and Rayment (1982) which are presented in **Table 4.**

Table 4. pH 1:5 Soil/Water Ratings

Rating	pH
Strongly acidic	<5.5
Acidic	5.6–6.5
Neutral	6.6–7.5
Alkaline	7.6–8.5
Strongly alkaline	>8.5

3.2.2 Electrical Conductivity

The EC 1:5 salinity ratings were used to assess the significance of laboratory measured EC 1:5 data in consideration of the known clay content. A summary of these criteria are presented in **Table 5** (Shaw 1988).

Table 5. Electrical Conductivity Ratings

Rating	EC 1:5 (dS/m)			
	10–20% clay	20–40% clay	40–60% clay	60–80% clay
Very low	<0.05	<0.08	<0.12	<0.18
Low	0.05–0.10	0.08–0.17	0.12–0.25	0.18–0.37
Moderate	0.10–0.25	0.17–0.40	0.25–0.58	0.37–0.85
High	0.25–0.45	0.40–0.67	0.58–1.00	0.85–1.5
Very high	0.45–0.70	0.67–1.05	1.00–1.58	1.5–2.4
Extreme	>0.70	>1.05	>1.58	>2.4

3.2.3 Cation Exchange Capacity (CEC)

CEC was evaluated against the relevant criteria for the surface soils to provide a preliminary indication of the overall fertility status. These criteria as per Landon (1991) are presented in **Table 6.**

Table 6. Cation Exchange Capacity Ratings

Rating	CEC/ECEC (milliequivalent [meq]/100 grams [g] of soil)
Very low	<5
Low	5–15
Moderate	15–25
High	25–40
Very high	>40

3.2.4 Cation Dominance – Exchangeable Sodium Percentage (ESP)

Sodicity was evaluated against the criteria presented by Baker and Eldershaw (1993) using exchangeable sodium percentages (ESP) as presented in **Table 7.**

Table 7. ESP Ratings

Rating	ESP (%)
Non-sodic (low)	<6
Sodic (moderate)	6–15
Strongly sodic (high)	15–20
Extremely sodic (very high)	>20

3.2.5 Calcium/Magnesium Ratio (Ca/Mg)

The ratings used to interpret Ca/Mg ratios (Baker and Eldershaw 1993) are presented in **Table 8.** Soils that disperse readily but have low ESP levels; often have high levels of Mg relative to the other cations. To account for this deviation from ESP, a ratio of Ca to Mg is used to provide a guide to the relative abundance of the two major cations.

Table 8. Ca:Mg Ratio Ratings

Rating	Ca/Mg Ratio	Comments
Very low	<0.10	Mg is >10 times more dominant than Ca
Low	0.10–0.50	Mg is 5–10 times more dominant than Ca
Moderate	0.51–1.0	Ca and Mg becoming co-dominant
High	1.1–2	Ca more dominant than Mg
Very high	>2	Ca >2 times more dominant than Mg

3.2.6 Available Phosphorus (P)

The criteria used to assess bicarbonate extractable phosphorus categories are based upon Ahern et al. (1994) and are presented in **Table 9.**

Table 9. Available Phosphorus

Rating	Bicarb extractable Phosphorus
Very low	<5
Low	6-9
Moderate	10-15
High	16-40
Very high	>40

3.2.7 Dispersion Tests

Dispersion testing was based on the Emerson Aggregate Test (EAT), derived from the Department of Sustainable Natural Resources. The purpose of the EAT is to assess the coherence of the soil aggregates when immersed into water. The coherence of the soil is determined by the slaking and dispersion behaviour of the soil. The EAT can be divided into the following classes as described in **Table 10** and **Table 11**.

Table 10. Emerson Aggregate Class

Emerson Aggregate Class	Dispersibility
Classes 1 and 2(3)	Very high
Class 2(2)	High
Class 2 (1)	High to moderate
Classes 3(4) and 3(3)	Moderate
Classes 3(2), 3(1) and 5	Slight
Classes 4, 6, 7 and 8	Negligible/ aggregated

Dispersion subclasses (shown in brackets): 1 – slight milkiness, 2 – obvious milkiness, less than 50% of the aggregate affected, 3 – obvious milkiness, greater than 50% of the aggregate affected, and 4 – total dispersion leaving only sand grains

Table 11. Emerson Aggregate Class Interpretation

Class	Slaking	Definition
Class 1	Slakes	Air dried crumbs of soil show a strong dispersion reaction. A colloidal cloud covers nearly the whole bottom of the beaker, usually in a very thin layer. The reaction should be evident within 10 minutes. In extreme cases all the water in the beaker becomes cloudy, leaving only a coarse residue in a cloud of clay.
Class 2		Air dried crumbs of soil show a moderate to slight reaction. A moderate reaction consists of an easily recognizable cloud of colloids in suspension, usually spreading in thin streaks on the bottom of the beaker. A slight reaction consists of the bare hint of cloud in water at the surface of the crumbs.
Class 3		The soil remoulded at the plastic limit disperses in water.
Class 4		The remoulded soil does not disperse in water. Calcium carbonate (calcite) or calcium sulfate (gypsum) is present.
Class 5		The remoulded soil does not disperse in water and the 1:5 soil/water suspension remains dispersed after 5 minutes.
Class 6		The remoulded soil does not disperse in water and the 1:5 soil/water suspension begins to flocculate after 5 minutes.
Class 7	Does not slake	The air dried crumbs of soil remain coherent in water and swells.
Class 8		The air dried crumbs of soil remain coherent in water and do not swell.

3.2.8 SAR Calculation for Saline and Sodic Soils

The sodium absorption ration (SAR) is commonly used as a measure of the activity of sodium ions relative to calcium and magnesium ions (Pam Hazelton & Brian Murphy 2016). SAR values greater than 3 can cause dispersion in soil of low electrolyte concentration. The SAR and ESP can be used in conjunction which each other to indicate dispersive tendencies of the soil is whether it is prone to soil compaction, crusting and/or hard setting of surfaces.

4 RESULTS

4.1 Field Observations

A total of 23 sample locations were advanced using an excavator or hand tools to a maximum depth of 3.0 mbsl. Details of the material encountered at each location is summarised in **Table 12.** A photographic log of the stockpiles are presented in **Plate P1** to **Plate P5.**

Table 12. Field Logging Summary

Location	Sample Location / ID	Soil pH (field)[1]	Ribbon length (cm)	Moisture	Consistency	Colour	Description
Stockpile 01	SP01_01 (QC100 and QC101)	8.5	8.5 - 9.5	Dry to slightly moist below 0.5 mbsl	Stockpile was excavator bucket compacted, bolus was soft to very soft	5YR 3/4 Dark Reddish Brown	Coarse grained sandy medium CLAY, slightly plastic, with coarse subangular fine to coarse gravel (10%), limestone boulders (1%) and cobbles (10%).
	SP01_01	8.5	6.0 – 7.5			5YR 3/3 Dark Reddish Brown	Coarse grained sandy light medium CLAY, slightly plastic, with coarse subangular fine to coarse gravel (20%) and cobbles (10%).
	SP01_02	8.5	6.0 – 7.5			5YR 3/3 Dark Reddish Brown	Coarse grained sandy light medium CLAY, slightly plastic, with coarse subangular fine to coarse gravel (20%) and cobbles (10%).
	SP01_03	8.5	8.5 - 9.5			5YR 3/4 Dark Reddish Brown	Coarse grained sandy medium CLAY, slightly plastic, with coarse subangular fine to coarse gravel (10%), limestone boulders (1%) and cobbles (10%).
	SP01_04	8.5	6.0 – 7.5			5YR 3/3 Dark Reddish Brown	Coarse grained sandy light medium CLAY, slightly plastic, with coarse subangular fine to coarse gravel (20%) and cobbles (10%).
	SP01_05	8.5	8.5 - 9.5			5YR 3/4 Dark Reddish Brown	Coarse grained sandy medium CLAY, slightly plastic, with coarse subangular fine to coarse gravel (10%), limestone boulders (1%) and cobbles (10%).
	SP01_06	8.5	8.5 - 9.5			5YR 3/4 Dark Reddish Brown	Coarse grained sandy medium CLAY, slightly plastic, with coarse subangular fine to coarse gravel (10%), limestone boulders (1%) and cobbles (10%).
	SP01_07	8.5	8.5 - 9.5			5YR 3/4 Dark Reddish Brown	Coarse grained sandy medium CLAY, slightly plastic, with coarse subangular fine to coarse gravel (10%), limestone boulders (1%) and cobbles (10%).
	SP01_08	8.5	8.5 - 9.5			5YR 3/4 Dark Reddish Brown	Coarse grained sandy medium CLAY, slightly plastic, with coarse subangular fine to coarse gravel (10%), limestone boulders (1%) and cobbles (10%).
	SP01_09	8.5	8.5 - 9.5			5YR 3/4 Dark Reddish Brown	Coarse grained sandy medium CLAY, slightly plastic, with coarse subangular fine to coarse gravel (10%), limestone boulders (1%) and cobbles (10%).
	SP01_10	8.5	9.5 – 10.0			10YR 5/3 Brown	Coarse grained sandy light CLAY, non-plastic, with coarse subangular fine to coarse gravel (20%).
	SP01_11	8.5	9.5 – 10.0			10YR 5/3 Brown	Coarse grained sandy light CLAY, non-plastic, with coarse subangular fine to coarse gravel (20%).

	SP01_12	8.5	9.5 – 10.0			10YR 5/3 Brown	Coarse grained sandy light CLAY, non-plastic, with coarse subangular fine to coarse gravel (20%).
	SP01_13	8.5	8.5 - 9.5			10YR 5/3 Brown	Coarse grained sandy medium CLAY, slightly plastic, with coarse subangular fine to coarse gravel (10%), limestone boulders (1%) and cobbles (10%).
	SP01_14	8.5	6.0 – 7.5			5YR 3/3 Dark Reddish Brown	Coarse grained sandy light medium CLAY, slightly plastic, with coarse subangular fine to coarse gravel (20%) and cobbles (10%).
Stockpile 02	SP02_01	8.5	8.5 - 9.5	Dry	Firm	5YR 3/4 Dark Reddish Brown	Coarse grained sandy medium CLAY, slightly plastic, with coarse subangular fine to coarse gravel (10%), limestone boulders (1%) and cobbles (10%).
Stockpile 03	SP03_01	8.5	8.5 - 9.5	Dry	Very weak	5YR 3/4 Dark Reddish Brown	Coarse grained sandy medium CLAY, slightly plastic, with coarse subangular limestone boulders (10%) and cobbles (20%).
Stockpile 04	SP04_01	8.5	2.0 – 2.5	Dry	Loose	7.5YR 5/6 Strong Brown	Coarse grained sandy LOAM, non-plastic, with coarse subangular coarse gravel (20%).
	SP04_01	8.5	2.0 – 2.5				
Stockpile 05	SP05_01	8.5	1.0 – 2.0	Dry to slightly moist below 0.5 mbsl	Stockpile was excavator bucket compacted, bolus was soft to very soft	7.5YR 5/4 Brown	Coarse grained sandy LOAM, non-plastic, with coarse subangular coarse gravel (20%) and cobbles (10%).
	SP05_02	8.5	1.0 – 2.0				Coarse grained sandy LOAM, non-plastic, with coarse subangular coarse gravel (20%) and cobbles (10%).
	SP05_03	8.5	1.0 – 2.0				Coarse grained sandy LOAM, non-plastic, with coarse subangular coarse gravel (20%)
	SP05_04	8.5	1.0 – 2.0				Coarse grained sandy LOAM, non-plastic, with coarse subangular coarse gravel (20%) and cobbles (10%).
	SP05_05	8.5	1.0 – 2.0				Coarse grained sandy LOAM, non-plastic, with coarse subangular coarse gravel (20%) and cobbles (10%).

4.2 Laboratory Analytical Results

The laboratory results were compared against the criteria presented in **Section 3.2** for each stockpile and are summarised in the following sections. Laboratory transcripts are provided in **Appendix A** and tabulated results presented in **Table T1**.

Stockpile 01

From the 14 samples collected from stockpile SP01:

- The pH ranged from 8.09 (SP01_14) to 8.28 (SP01_11) which are classified as alkaline soils.
- Soil EC ranged from 0.13 dS/m (SP01_03) to 0.22 dS/m (SP01_13), with an average of 0.16 dS/m. This soil is classified as having low to very low salinity.
- Soil CEC ranged from 10.00 cmol/kg (SP01_04) to 13.00 cmol/kg (SP01_05), averaging 11.36 cmol/kg. The soil are classified as having low CEC
- The Ca:Mg ratios ranged from 3.26 (SP01_10) to 171.00 (SP01_02), with an average ratio of 70.06. The ratios are very high, indicating that Ca concentrations in the soil are much higher than Mg
- The level of extractable phosphorus ranged from 4.00 mg/kg (SP01_11) to 7.00 mg/kg (SP01_01), with an average concentration of 5.50 mg/kg. The concentration of extractable phosphorus is classified as very low to low
- Soil ESP ranged from 0.6 % (calculated for SP01_01) to 2.10 % (SP01_11), with an average ESP of 0.71 %. The soil are classified as a non-sodic soil based on the ESP levels
- Emerson aggregate test ranged from class 2 to 4. Dispersion classes indicate that the material is possibly dispersive material

Stockpile 02

From the one sample collected from stockpile SP02:

- The pH observed was 8.32 which are classified as an alkaline soil
- Soil EC was 0.13 dS/m thus this soil is classified as having low salinity
- Soil CEC was 29.00 cmol/kg and are classified as having high CEC
- The Ca:Mg ratio was 6.30, indicating that the ratio is very high indicating that Ca concentrations in the soil are much higher than Mg
- The level of extractable phosphorus was 7.00 mg/kg. The concentration of extractable phosphorus is classified as low
- Soil ESP was 0.60 % therefore the soil are classified as a non-sodic soil based on the ESP levels

Stockpile 03

From the one sample collected from stockpile SP03:

- The pH observed was 8.06 which are classified as an alkaline soil
- Soil EC was 0.17 dS/m, and thus this soil is classified as having very low salinity
- Soil CEC was 14.00 cmol/kg therefore soil are classified as having low CEC
- The Ca:Mg ratio was 56.20 indicating that the ratio is very high
- The level of extractable phosphorus was 6.00 mg/kg, which is classified as low
- Soil ESP was 0.50 % indicating that the soil is non-sodic based on the ESP levels

Stockpile 04

From the two samples collected from stockpile SP04:

- The pH ranged from 8.52 (SP04_01) to 8.54 (SP04_02) which are classified as alkaline soils.
- Soil EC ranged from 0.14 dS/m (SP04_02) to 0.46 dS/m (SP04_01), with an average of 0.30 dS/m for all Stockpile 04 samples. This soil is classified as having low to very high salinity

- Soil CEC ranged from 3.00 cmol/kg (SP04_01) to 8.00 cmol/kg (SP04_02), averaging 5.50 cmol/kg. The soil are classified as having very low to low CEC
- The Ca:Mg ratios ranged from 3.39 (SP04_01) to 5.26 (SP04_02), with an average ratio of 4.33. The ratios are very high, indicating that Ca concentrations in the soil are much higher than Mg
- The level of extractable phosphorus ranged from 3.00 mg/kg (SP04_01) to 5.00 mg/kg (SP04_02), with an average concentration of 4.00 mg/kg. The concentration of extractable phosphorus is classified as very low
- Soil ESP ranged from 1.30 % (SP04_02) to 13.10 % (SP04_01), with an average ESP of 7.20 %. The soil are classified as a non-sodic to sodic soil based on the ESP levels

Stockpile 05

From the five samples collected from stockpile SP05:

- The pH ranged from 8.51 (SP05_03) to 8.66 (SP05_02) which are classified as alkaline to strongly alkaline soils.
- Soil EC ranged from 0.13 dS/m (SP05_03) to 0.22 dS/m (SP05_02), with an average of 0.16 dS/m for all Stockpile 05 samples. This soil is classified as having low to moderate salinity
- Soil CEC ranged from 7.00 cmol/kg (SP05_01) to 19.00 cmol/kg (SP05_03), averaging 15.40 cmol/kg. The soil are classified as having low to moderate CEC
- The Ca:Mg ratios ranged from 2.35 (SP05_02) to 11.60 (SP05_01), with an average ratio of 4.88. The ratios are very high, indicating that Ca concentrations in the soil are much higher than Mg
- The level of extractable phosphorus ranged from <2 mg/kg (SP05_01) to 6.00 mg/kg (SP05_05), with an average concentration of 5.25 mg/kg. The concentration of extractable phosphorus is classified as very low to low
- Soil ESP ranged from 1.00 % (SP05_01) to 7.90 % (SP05_02), with an average ESP of 3.74 %. The soil are classified as a non-sodic to sodic soil based on the ESP levels

5 LAND SUITABILITY

The aim of the assessment was to evaluate the suitability of the soil in Stockpiles SP01 to SP05 for re-use on site for a cattle grazing post mining land use. The investigation was carried out on excavated material stockpiled and not representative of material in-situ. Therefore, some methodologies in the guideline documents were not applicable. These included the assessment of the micro-relief, water availability, rockiness, wetness, topography, water erosion, vegetation regrowth and flooding.

The five land suitability classes used for assessing land are presented in **Table 13**, with the suitability decreasing as the class increases. The land suitability classes are adopted to identity the level of suitability of the soil and landscape for a pre-determined land use scenario. When soils are evaluated against the relevant evaluation criteria, soils may be determined to be unsuitable for the proposed land use. The soil property that is considered unsuitable is considered a limitation, and land is considered more unsuitable as the severity of these limitations increase. An increase in limitation severity increase may reflect:

- Reduced potential for production
- Increased inputs to achieve and acceptable level of production
- Increased inputs to prepare the land for successful production
- Increased inputs required to prevent land degradation

Stockpiled soil determined to be Class 1 to 3 is considered suitable for a particular land use, as the long-term benefits obtained from that land use typically outweigh the inputs required to initiate and maintain production.

Class 4 land is considered temporarily unsuitable for the specified land use due to the severity of one or several limitations. However, this land may be improved to a more suitable class with the implementation of soil improvement measures.

Class 5 land is considered entirely unsuitable for the specified land use as the limitation(s) are so severe that the inputs required to initiate and maintain the specified land use are not considered to be practical or sustainable.

A visual representation of data is provided on **Figure F4** and **Figure F5** for stockpiles with more than 3 samples (SP01 and SP05), showing individual sample results and the geometric mean. The full assessment of stockpile material is presented in **Section 5.1**.

Table 13. Land Suitability Classes

Class	Agricultural Definition	Conservation Definition
1	Suitable land with negligible limitations – land which is well suited to its proposed use.	Areas well suited for conservation uses must possess significant conservation benefits in the pre-mining environment and capable of being returned to that use post-mining.
2	Suitable land with minor limitations – land which is suited to a proposed use but which may require minor changes in management to sustain the use.	These areas are suited to conservation use in that a significant component of the pre-mining conservation values can be restored post-mining. There will however be some loss in conservation where soil terrain or hydrological post-mining conditions may inhibit the full replication of the pre-mining values.
3	Suitable land with moderate limitations – land which is moderately suited to a proposed use but which require significant inputs to ensure sustainable use.	These lands contain significant conservation values pre-mining; however restoration of all of these values may not be feasible. These areas could, however, be restored to a form of conservation use which provides alternative conservation benefits.
4	Marginally suitable land – land which is marginally suited for proposed use and would require major inputs to ensure sustainability. These inputs may not be justified by the benefits to be obtained in using the land for the particular purpose and is hence considered to be presently unsuited.	These lands contain limited conservation value pre-mining and/ or are incapable of being effectively restored post-mining to any alternative conservation use which provides similar benefits. The area could, however, be restored to provide a stable form of use which does not impact on surrounding conservation values.

5	Unsuitable land with extreme limitations – land which is unsuited and cannot be sustainably used for proposed use.	These lands contain no significant conservation values.

Limitations for the assessment of grazing land suitability on improved pastures as outlined in the Land Suitability Assessment Technique (DME 1995) Guidelines (Table 2.2 and 2.3) are:

- Water availability (not assessed for stockpiled material)
- Nutrient deficiency
- Soil physical factors
- Salinity
- Rockiness (not assessed for stockpiled material)
- Micro relief (not assessed for stockpiled material)
- pH
- ESP
- Wetness (not assessed for stockpiled material)
- Topography (not assessed for stockpiled material)
- Flooding (not assessed for stockpiled material)
- Vegetation (not assessed for stockpiled material)

5.1 Summary of Land suitability for Cattle Grazing

The suitability of the stockpiled material for reuse onsite for cattle grazing land use has been summarised in **Table 14**. The sample locations associated with stockpiled material are on **Figure F3**.

Table 14. Summary of Land Suitability for Cattle Grazing – stockpiled material

Limitations	Stockpile 01	Stockpile 02	Stockpile 03	Stockpile 04	Stockpile 05
Water Availability	*Not accessed*				
Nutrient Deficiency	3	3	3	4	3
Soil Physical Factors	1	1	1	2	1
Salinity	2	1	2	2	2
Rockiness	*Not accessed*				
Microrelief	*Not accessed*				
pH	3	3	3	3	3
ESP (0-10cm)	1	1	1	2	1
Wetness	*Not accessed*				
Flooding	*Not accessed*				
Vegetation Regrowth	*Not accessed*				
Topography	*Not accessed*				
Overall Suitability Rating	3	3	3	4	3

Notes:

Red = unsuitable

Yellow = marginally suitable

Green = suitable

Light grey = not accessed due to the stockpiled nature of soils

A discussion on the derivation of these land suitability classes is discussed further in following sections.

Nutrient Deficiency

The nutrient status of samples analysed were assessed against Table 2.2 of the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques (DME 1995); Colwell P data was considered rather than Bicarbonate as Colwell P is a measurement of plant available P. The land suitability classes for the nutrient status in Stockpile SP01 and Stockpile SP05 are provided on **Figure F4** and **Figure F5**, respectively. A summary is provided in **Table 15.** It is noted that the two samples from stockpile SP04 were still within range of samples collected from other stockpiled material.

Table 15. Summary of Land Suitability Classes for Cattle Grazing based on Nutrient Status

Stockpile	Limiting Feature	Land Suitability Class
SP01	Colwell P 5 – 10 mg/kg	3
SP02	Colwell P 5 – 10 mg/kg	3
SP03	Colwell P 5 – 10 mg/kg	3
SP04	Colwell P ≤4 mg/kg	4
SP05	Colwell P 5 – 10 mg/kg	3

Soil Physical Factors

Table 2.2 of the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques (DME 1995) has been used to assess the physical factors for the stockpile material. The physical condition of soils plays a direct role with seed germination and emergence. Adverse conditions such as hard setting or crusting of surface soils reduces plant establishment through creating a barrier, reducing seed soil contact. The soil peds determined in the field could be mis-leading as the assessment was undertaken on a stockpile and not an in-situ test pit / borehole. The land suitability classes for the soil physical factors in Stockpile SP01 and Stockpile SP05 are provided on **Figure F4** and **Figure F5**, respectively. A summary is provided in **Table 16.**

Table 16. Summary of Land Suitability Classes for Cattle Grazing based on Soil Physical Features

Stockpile	Limiting Feature	Land Suitability Class
SP01	Rigid soils with a loose, soft or firm surface when dry	1
SP02	Rigid soils with a loose, soft or firm surface when dry	1
SP03	Rigid soils with a loose, soft or firm surface when dry	1
SP04	Rigid soils with a hard setting surface when dry	2
SP05	Rigid soils with a loose, soft or firm surface when dry	1

Salinity

Table 2.2 of the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques (DME 1995) has been used to determine the land suitability class against salinity parameters. The land suitability classes for salinity in Stockpile SP01 and Stockpile SP05 are provided on **Figure F4** and **Figure F5**, respectively. A summary is provided in **Table 17.**

Table 17. Summary of Land Suitability Classes for Cattle Grazing based on Salinity

Stockpile	Limiting Feature	Land Suitability Class
SP01	EC 0.15 – 0.3 mS/cm or CL 300 – 600 ppm	2
SP02	EC <0.15 mS/cm or CL <300 ppm	1
SP03	EC 0.15 – 0.3 mS/cm or CL 300 – 600 ppm	2
SP04	EC 0.15 – 0.3 mS/cm or CL 300 – 600 ppm	2
SP05	EC 0.15 – 0.3 mS/cm or CL 300 – 600 ppm	2

pH

The land suitability class for pH was assessed against Table 2.2 of the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques (DME 1995). Soil pH determines the availability of nutrients for plant uptake, with the following limitations occurring:

- Where the soil is strongly acidic, problems with aluminium and manganese toxicity may occur which limit root growth and plant productivity. Strongly acidic soils may require input of lime or dolomite to increase soil pH.
- Strongly alkaline soils might require the input of sulphur, aluminium sulphate or sulfuric acid to lower the pH level of the soil. Strongly alkaline soils will restrict the availability of some elements (Fe, Cu, Zn) and may be an indicator of sodicity.

Ameliorates may be added to the soil to correct pH and increase nutrient availability. The land suitability classes for the pH in Stockpile SP01 and Stockpile SP05 are provided on **Figure F4** and **Figure F5**, respectively. A summary is provided in **Table 18.**

Table 18. Summary of Land Suitability Classes for Cattle Grazing based on pH

Stockpile	Limiting Feature	Land Suitability Class
SP01	8.0 – 9.0	3
SP02	8.0 – 9.0	3
SP03	8.0 – 9.0	3
SP04	8.0 – 9.0	3
SP05	8.0 – 9.0	3

Exchangeable Sodium Percentage (ESP)

The ESP of each stockpile was assessed against Table 2.2 of the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques (DME 1995). ESP is used to determine the erosion potential of soils. The land suitability classes for the ESP in Stockpile SP01 and Stockpile SP05 are provided on **Figure F4** and **Figure F5**, respectively. A summary is provided in **Table 19.**

Table 19. Summary of Land Suitability Classes for Cattle Grazing based on ESP

Stockpile	Limiting Feature	Land Suitability Class
SP01	<5.0 %	1
SP02	<5.0 %	1
SP03	<5.0 %	1
SP04	<5.0 %	2
SP05	<5.0 %	1

6 CONCLUSION AND RECOMMENDATIONS

The following recommendations are based upon the chemical analysis of the samples from SP01 to SP05 collected at the sampling density of 1:1500m^3. The investigation was carried out on excavated material stockpiled and not representative of material in-situ. Therefore, some methodologies in the guideline documents were not applicable. These included the assessment of the micro-relief, water availability, rockiness, wetness, topography, water erosion, vegetation regrowth and flooding. As such these recommendations should be reviewed with consideration to the final landform which will include the slope, coarse fragments, and soil depth.

Based upon the assessment of stockpile material suitability (discussed in **Section 5**), SP04 was identified with a low phosphorus content which should be considered for amelioration. There is no requirement to ameliorate soil within SP01, SP02, SP03 and SP05. A summary of the suitability of the topsoil for cattle grazing is summarised in **Section 5.1**. Based upon these, the following is recommended:

- Stockpiles SP01, SP02, SP03 and SP05 are suitable for use as cattle grazing with a suitability class of 3. It is noted that the pH of these stockpiled were just outside of the range of 6.0 to 8.0 which is considered most suitable for plant establishment via the accessibility of nutrients, but within the tolerable range for cattle grazing land use
- Stockpile SP04 is considered marginally suitable to support the post mining land use of cattle grazing. As such, the following is recommended:
  - As the suitability classification of SP04 was based upon two samples to characterise 3,000m^3, additional sampling is recommended as this may improve understanding of nutrients available in the soil
  - Alternatively, amelioration of the stockpile can be considered as the nutrients (phosphorus) of the soil are a limitation present as they are low. It is also noted that the pH of SP04 was just outside (average of 8.53) of the range of 6.0 to 8.0 which is considered most suitable for plant establishment via the accessibility of nutrients, but within the tolerable range for cattle grazing land use
- It is recommended that the boulders and cobbles be separated out where practical and reused separate to the soil fractions (sand, silt and clay) of the stockpile

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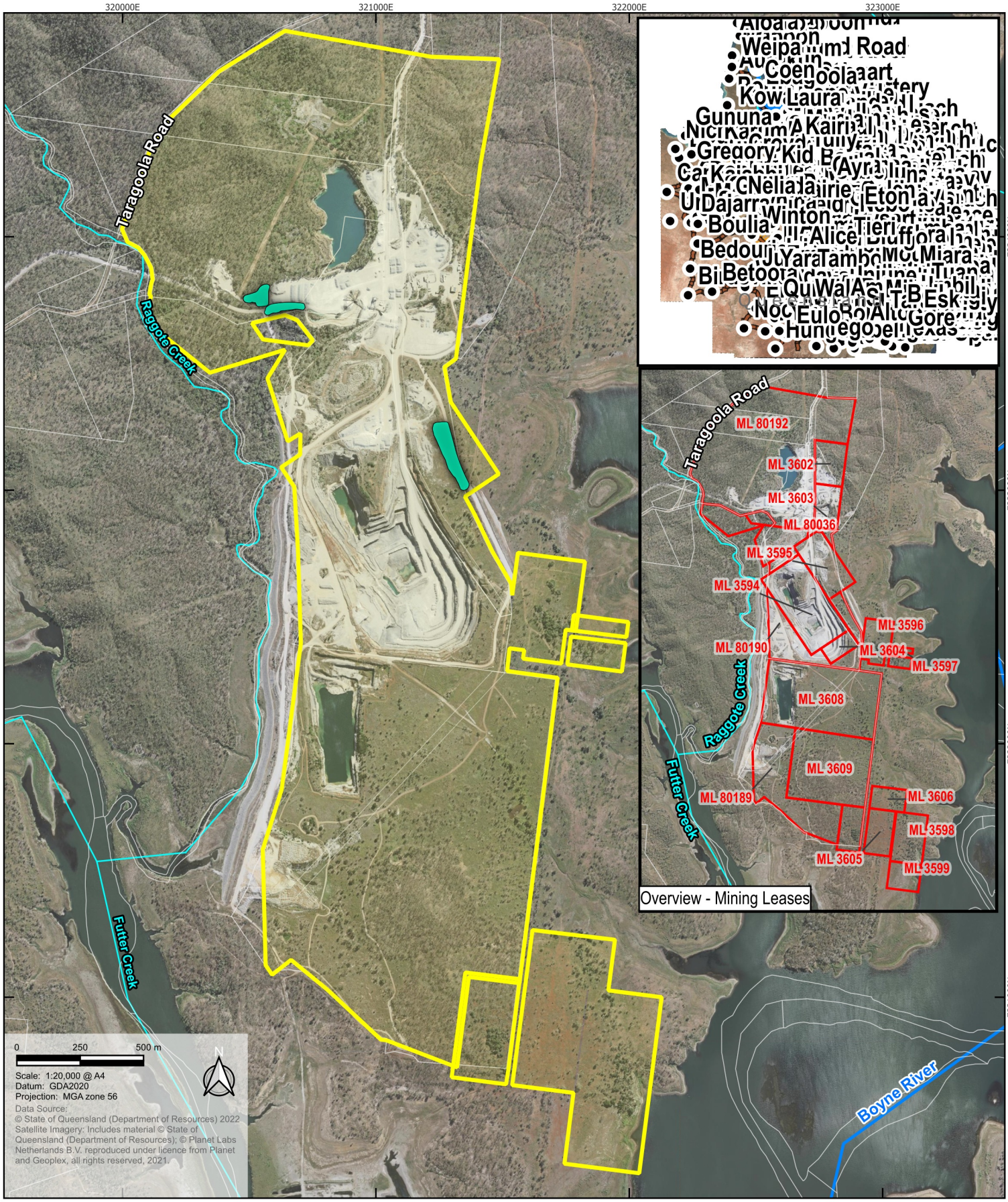
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FIGURES

Figure F1. Regional Location



Filepath: ~GIS\Projects\2022\BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BCL230021.01 Stockpile Soil Suitability\Rev 1\Figure F1 Regional location.qgz

Legend

- Site boundary
- Mining leases
- Topsoil stockpile
- Cadastre (DCDB)

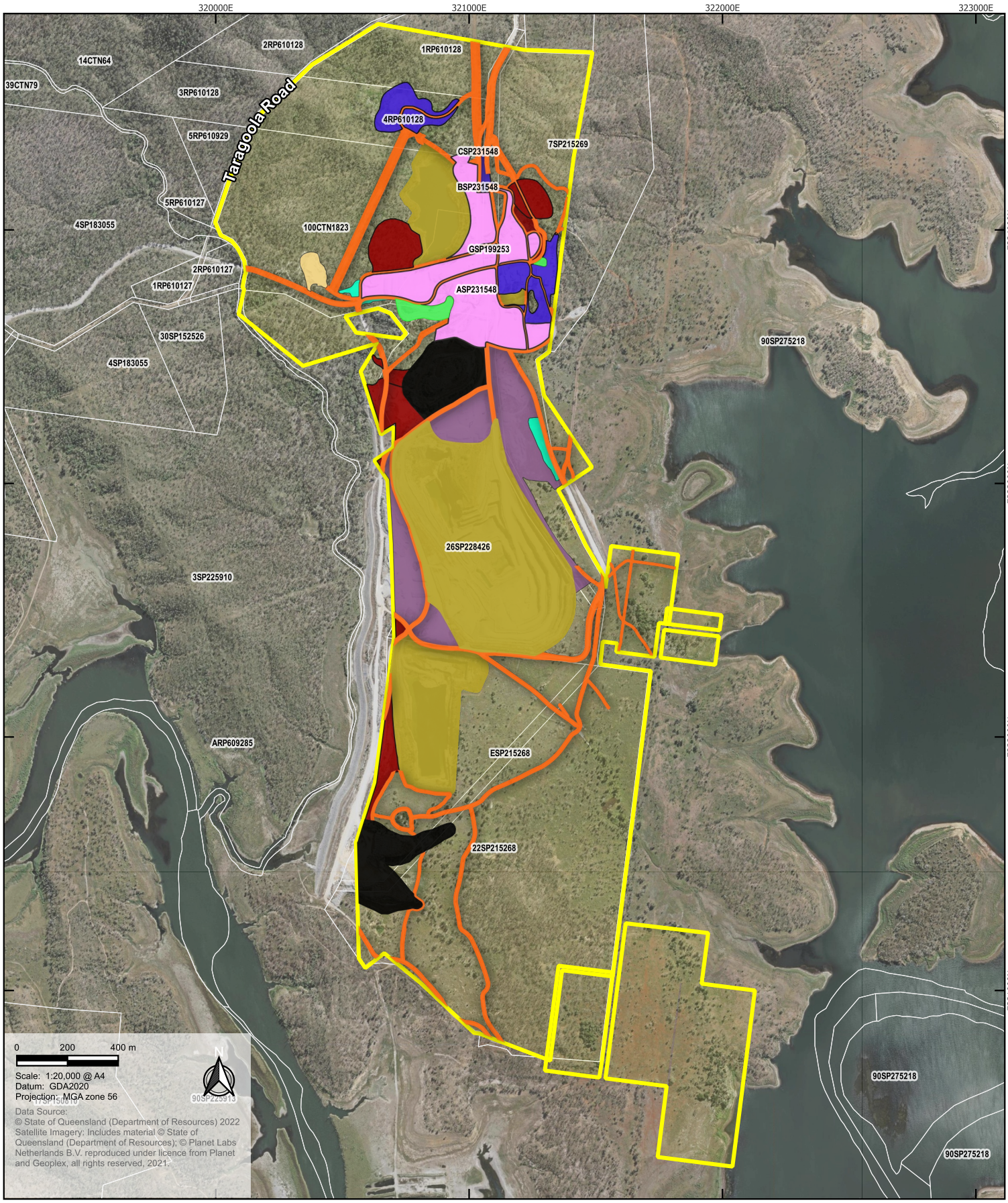
Watercourses

- Major
- Minor

Graymont
Calliope Limestone Quarry
Stockpile Soil Suitability

Figure F1
Regional location

Figure F2. Site Layout and Features



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BCL230021.01 Stockpile Soil Suitability\Rev 1\Figure F2 Site layout and features.qgz

Legend

- Site boundary
- Cadastre (DCDB)

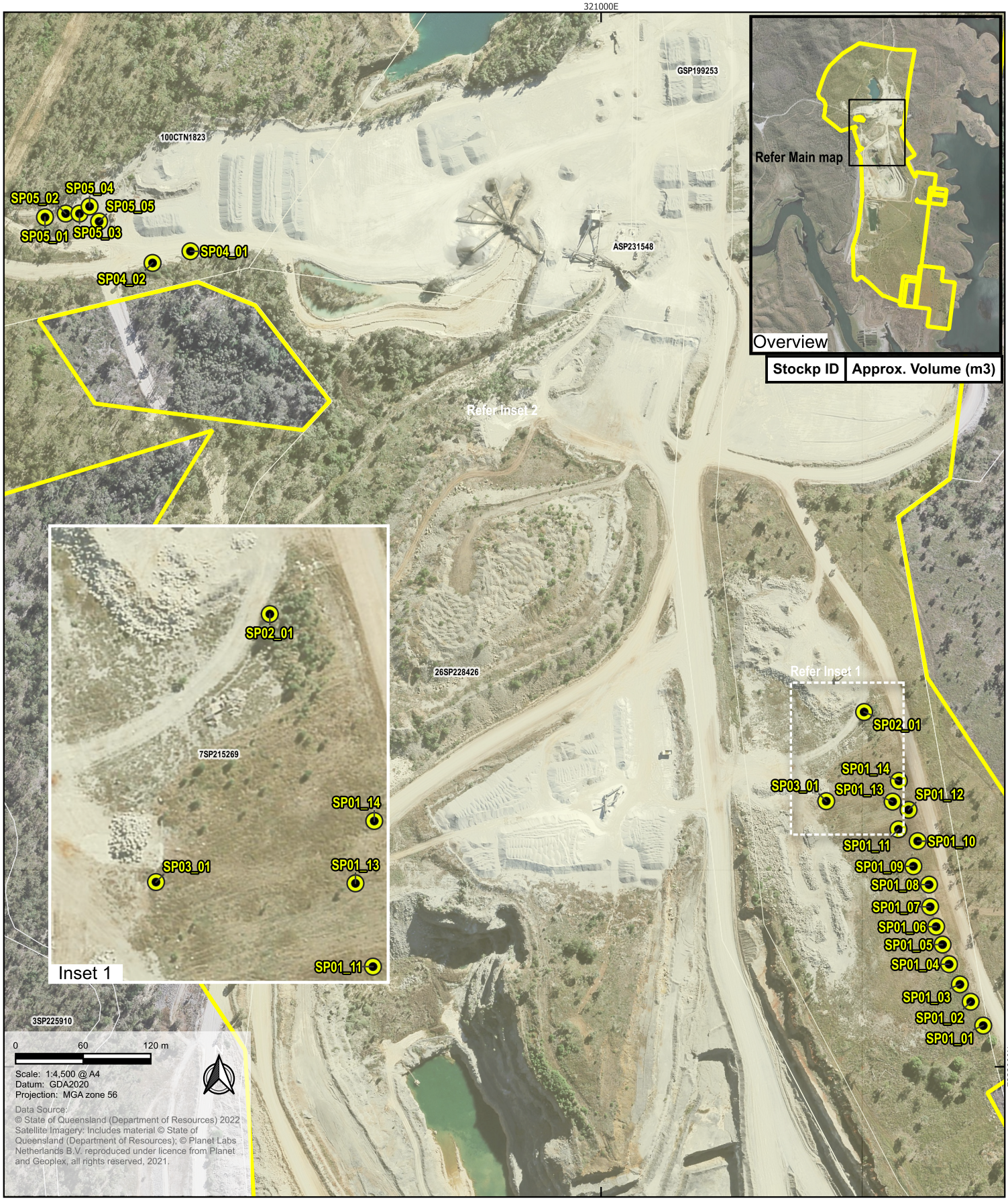
Current Disturnance

- Access tracks
- Cleared areas and laydowns
- Infrastructure and plant
- Sediment pond
- Pit
- ROM processing area
- Silt dump
- Temporary spoil storage area
- Topsoil stockpile
- Waste rock dump

Graymont
Calliope Limestone Quarry
Stockpile Soil Suitability

Figure F2
Site layout and features

Figure F3. Topsoil Stockpiles



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BCL230021.01 Stockpile Soil Suitability\Rev 1\Figure F3 Topsoil stockpile volumes and sample locations.qgz

Legend

- Site boundary
- Cadastre (DCDB)
- Stockpile Sample Location

Graymont
Calliope Limestone Quarry
Stockpile Soil Suitability

Figure F3
Topsoil stockpile volumes and sample locations

Figure F4. Suitability Classes – Cattle Grazing – Stockpile 01

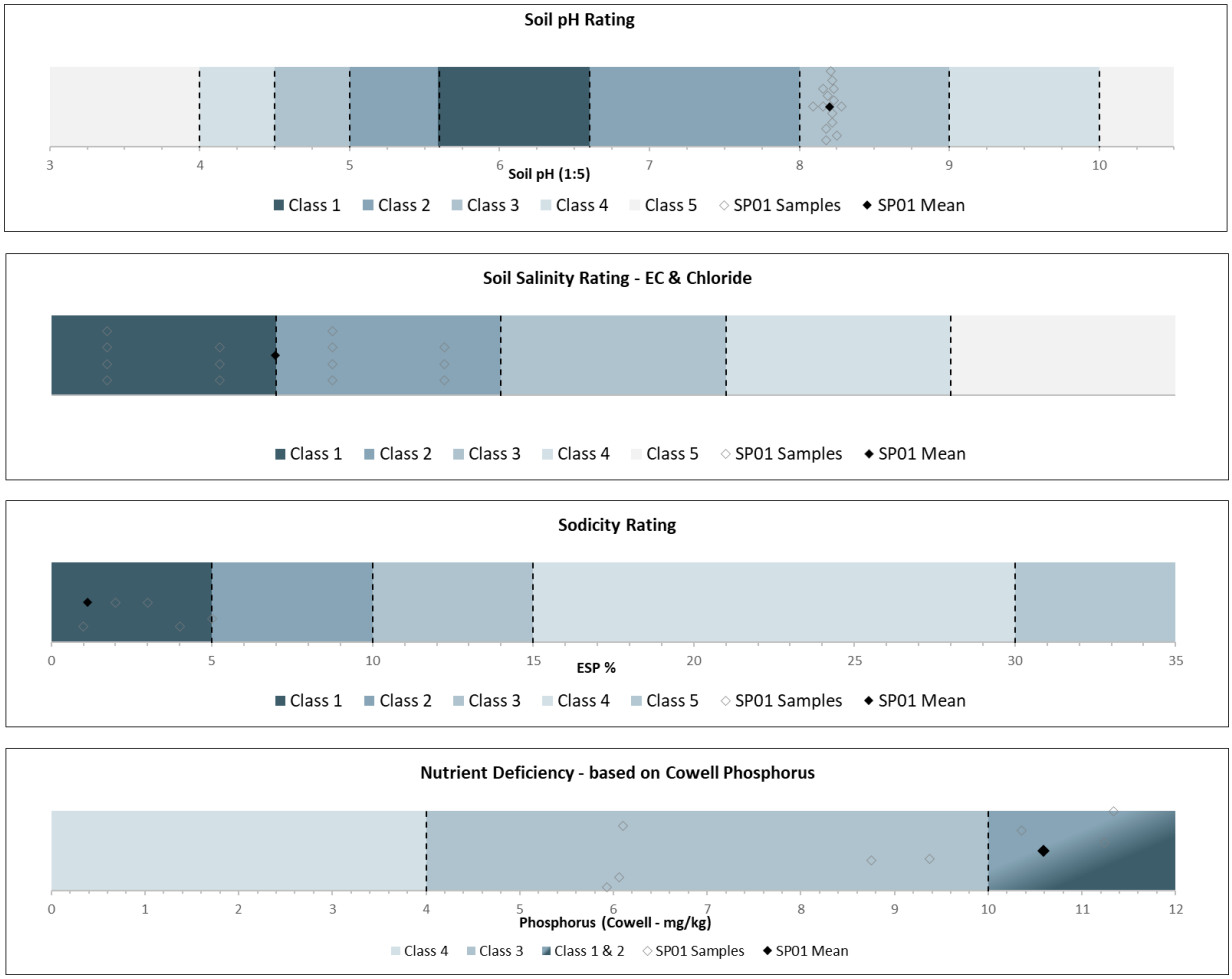
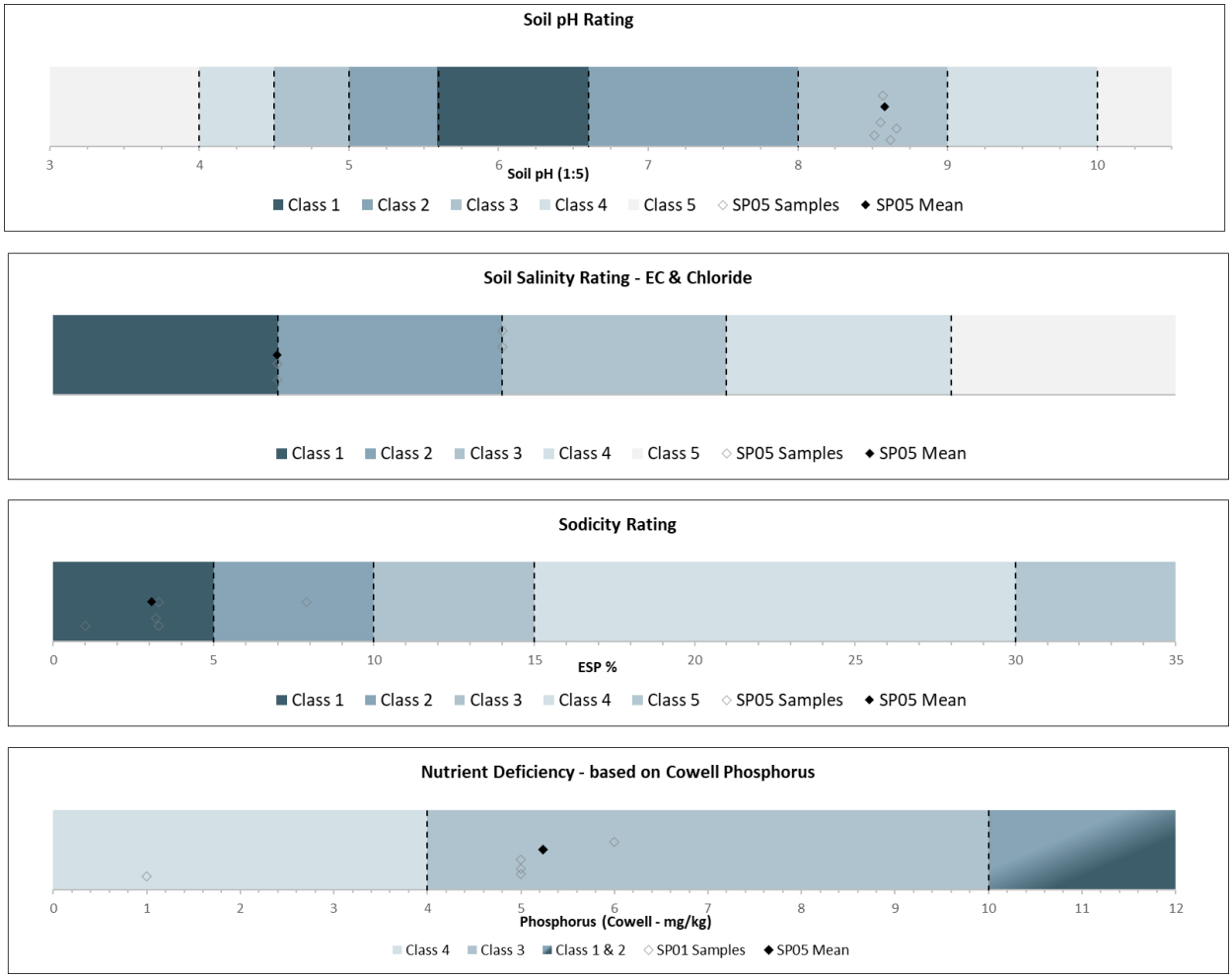


Figure F5. Suitability Classes – Cattle Grazing – Stockpile 05



PLATES



Plate P1. Stockpile SP01 Looking North



Plate P2. Stockpile SP02 Looking East



Plate P3. Stockpile SP03 Looking East



Plate P4. Stockpile SP04 Looking Southeast



Plate P5. Stockpile SP05 Looking East

TABLES

Table T1. Soil Analytical Results

APPENDIX A LABORATORY TRANSCRIPTS

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Department of Environment and Science - Chemistry Centre
Eco Sciences Precinct
Level 3, Block A, 41 Boggo Rd
Dutton Park Qld 4102
Telephone: 07 3170 5696
Facsimile: 07 3170 5801

Analysis Report

Job Number : 23-0451

Epic Environmental Pty Ltd
Epic Environmental Pty Ltd
L17, 95 North Quay,

Brisbane QLD 4000
Attn : Andrew Hughes
ahughes@epicenvironmental.com.au

Date Sampled:	25-Mar-2023 to 25-Mar-2023
Date Received:	07-Jul-2023 to 07-Jul-2023
Date Tested:	14-Jul-2023 to 14-Jul-2023
Date Reported:	04-Sep-2023

Final Report

Report ID: 23-0451-F-V1

BCL23003101 , Calliope Soil Survey

Calliope Soil Survey

The Chemistry Centre is always trying to improve our services. Please provide any feedback via chemistry.centre@des.qld.gov.au Thank you.

NOTE: Results pertain to samples as received by this laboratory and relate to the items tested
NOTE: Chemistry Centre is not responsible for sample collection

Additional Notes

Queensland Government

Department of Environment and Science - Chemistry Centre

Sample Details

Job No: **23-0451**

Report ID: **23-0451-F-V1**

Soil							
Sample No	**Customer's ID**	**Description**	**Date Sampled**	**Site**	**Obs**	**SNo**	**Depth (m)**
23-0451-0001	SP01_01	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0002	SP01_02	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0003	SP01_03	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0004	SP01_04	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0005	SP01_05	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0006	SP01_06	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0007	SP01_07	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0008	SP01_08	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0009	SP01_09	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0010	SP01_10	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0011	SP01_11	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0012	SP01_12	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0013	SP01_13	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0014	SP01_14	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0015	SP02_01	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0016	SP03_01	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0017	SP04_01	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0018	SP04_02	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0019	SP05_01	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0020	SP05_02	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0021	SP05_03	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0022	SP05_04	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0023	SP05_05	Stockpile Sample - Soil	25/06/2023		0	0	0.00-4.00
23-0451-0024	QC100	Field Duplicate Sample	25/06/2023		0	0	0.00-4.00
23-0451-0025	TP01_0.0	Testpit Sample - Soil	26/06/2023		0	0	0.00-0.00
23-0451-0026	TP01_0.1	Testpit Sample - Soil	26/06/2023		0	0	0.00-0.20
23-0451-0027	TP01_0.9	Testpit Sample - Soil	26/06/2023		0	0	0.80-1.00
23-0451-0028	TP01_1.35	Testpit Sample - Soil	26/06/2023		0	0	1.25-1.45
23-0451-0029	TP01_1.70	Testpit Sample - Soil	26/06/2023		0	0	1.60-1.80
23-0451-0030	TP03_0.0	Testpit Sample - Soil	26/06/2023		0	0	0.00-0.00
23-0451-0031	TP03_0.1	Testpit Sample - Soil	26/06/2023		0	0	0.00-0.20
23-0451-0032	TP03_0.4	Testpit Sample - Soil	26/06/2023		0	0	0.30-0.50
23-0451-0033	TP04_0.0	Testpit Sample - Soil	26/06/2023		0	0	0.00-0.00
23-0451-0034	TP04_0.1	Testpit Sample - Soil	26/06/2023		0	0	0.00-0.20
23-0451-0035	TP04_0.85	Testpit Sample - Soil	26/06/2023		0	0	0.75-0.95
23-0451-0036	TP04_1.85	Testpit Sample - Soil	26/06/2023		0	0	1.75-1.95
23-0451-0037	TP05_0.0	Testpit Sample - Soil	26/06/2023		0	0	0.00-0.00
23-0451-0038	TP05_0.1	Testpit Sample - Soil	26/06/2023		0	0	0.00-0.20
23-0451-0039	TP05_0.4	Testpit Sample - Soil	26/06/2023		0	0	0.30-0.50

23-0451-0040	TP05_0.7	Testpit Sample - Soil	26/06/2023		0	0	0.60-0.80
23-0451-0041	TP05_1.5	Testpit Sample - Soil	26/06/2023		0	0	1.40-1.60
23-0451-0042	QC101	Field Duplicate Sample	26/06/2023		0	0	0.00-0.20

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Department of Environment and Science - Chemistry Centre

Soil Analysis Report

Job No: 23-0451

Report ID: 23-0451-F-V1

				Method	S_ADM_105	S_AQ4_AA		S_AQ4_EL		S_CAT_ALC				S_CAT_ALCC									* S_CEC	S_COLWELL	S_DT	
				Component	ADMC	Cl	NO3-N	EC	pH	Ca	K	Mg	Na	Base sat	Ca:CEC	Ca:Mg	CEC:Clay	ESP	K:CEC	Mg:Ca	Mg:CEC	Mg:K	Na:K	CEC	P	Cu	Fe
				Units	%	mg/kg	mg/kg	dS/m	-	cmol_c/kg	cmol_c/kg	cmol_c/kg	cmol_c/kg	%				%						cmol/kg	mg/kg	mg/kg	mg/kg
Sample No	Customer's ID	Project Id	Description	Depth (m)																							
23-0451-0001	SP01_01	BCL23003101	Stockpile Sample - Soil	0.00-4.00	4.2	<20	11	0.15	8.18	12	0.078	0.228	<0.070	108	1.05	52.6	-	0	0.00687	0.019	0.0199	2.9	0.893	11	7	0.5	2.2
23-0451-0002	SP01_02	BCL23003101	Stockpile Sample - Soil	0.00-4.00	2.5	<20	5	0.15	8.18	12	0.098	<0.070	0.101	100	0.978	171	-	0.8	0.00802	0.00585	0.00572	0.714	1.03	12	6	0.4	5.7
23-0451-0003	SP01_03	BCL23003101	Stockpile Sample - Soil	0.00-4.00	5.7	<20	4	0.13	8.25	11.4	0.059	<0.070	<0.070	108	1.07	163	-	0	0.0055	0.00613	0.00654	1.19	1.19	11	6	0.5	3.3
23-0451-0004	SP01_04	BCL23003101	Stockpile Sample - Soil	0.00-4.00	4.2	<20	11	0.16	8.22	10.1	0.053	0.076	<0.070	100	0.981	132	-	0	0.00521	0.0076	0.00746	1.43	1.31	10	5	0.4	3
23-0451-0005	SP01_05	BCL23003101	Stockpile Sample - Soil	0.00-4.00	2.8	<20	3	0.16	8.19	11.8	<0.050	0.101	<0.070	93	0.912	117	-	0	0.00386	0.00854	0.00779	2.02	1.4	13	5	0.5	4.1
23-0451-0006	SP01_06	BCL23003101	Stockpile Sample - Soil	0.00-4.00	2.4	<20	8	0.15	8.16	12	0.098	0.208	0.085	109	1.06	57.5	-	0.8	0.00864	0.0174	0.0184	2.13	0.868	11	6	0.4	2.1
23-0451-0007	SP01_07	BCL23003101	Stockpile Sample - Soil	0.00-4.00	3.8	<20	8	0.15	8.23	11.1	0.052	0.9	0.074	119	1.09	12.4	-	0.7	0.00513	0.0808	0.0882	17.2	1.4	10	7	0.4	3.9
23-0451-0008	SP01_08	BCL23003101	Stockpile Sample - Soil	0.00-4.00	9.1	<20	4	0.14	8.22	12	<0.050	0.862	0.093	120	1.11	13.9	-	0.9	0.00462	0.0718	0.0797	17.2	1.86	11	5	0.3	3.2
23-0451-0009	SP01_09	BCL23003101	Stockpile Sample - Soil	0.00-4.00	6.9	<20	9	0.16	8.21	10.7	0.182	0.177	<0.070	105	1.01	60.3	-	0	0.0173	0.0166	0.0168	0.971	0.385	11	5	0.3	<2.0
23-0451-0010	SP01_10	BCL23003101	Stockpile Sample - Soil	0.00-4.00	6.4	<20	7	0.19	8.22	12.2	0.066	3.75	0.243	133	0.996	3.26	-	2	0.00538	0.307	0.306	56.8	3.68	12	7	0.5	70
23-0451-0011	SP01_11	BCL23003101	Stockpile Sample - Soil	0.00-4.00	4	<20	6	0.19	8.28	11.7	<0.050	3.29	0.252	124	0.951	3.55	-	2.1	0.00407	0.282	0.268	65.8	5.04	12	4	0.3	20.5
23-0451-0012	SP01_12	BCL23003101	Stockpile Sample - Soil	0.00-4.00	3.2	<20	8	0.18	8.23	11	<0.050	0.931	0.108	105	0.954	11.9	-	0.9	0.00432	0.0843	0.0804	18.6	2.15	12	4	0.3	3.3
23-0451-0013	SP01_13	BCL23003101	Stockpile Sample - Soil	0.00-4.00	3.3	48	24	0.22	8.16	11.3	<0.050	0.273	0.208	97	0.928	41.4	-	1.7	0.00411	0.0241	0.0224	5.45	4.17	12	4	0.3	<2.0
23-0451-0014	SP01_14	BCL23003101	Stockpile Sample - Soil	0.00-4.00	9.5	<20	6	0.14	8.09	10.1	<0.050	0.072	<0.070	95	0.94	141	-	0	0.00463	0.00711	0.00668	1.44	1.4	11	6	0.4	<2.0
23-0451-0015	SP02_01	BCL23003101	Stockpile Sample - Soil	0.00-4.00	9.1	<20	5	0.13	8.32	32.4	0.081	5.15	0.171	132	1.13	6.3	-	0.6	0.00281	0.159	0.179	63.7	2.11	29	7	1	5.9
23-0451-0016	SP03_01	BCL23003101	Stockpile Sample - Soil	0.00-4.00	2.4	<20	11	0.17	8.06	12.6	0.078	0.224	<0.070	92	0.893	56.2	-	0	0.0055	0.0178	0.0159	2.89	0.903	14	6	0.6	3.6
23-0451-0017	SP04_01	BCL23003101	Stockpile Sample - Soil	0.00-4.00	<1.5	323	24	0.46	8.52	3.17	<0.050	0.936	0.34	173	1.22	3.39	-	13.1	0.0193	0.295	0.362	18.7	6.81	3	3	0.2	5.3
23-0451-0018	SP04_02	BCL23003101	Stockpile Sample - Soil	0.00-4.00	<1.5	<20	17	0.14	8.54	8.86	<0.050	1.68	0.11	130	1.08	5.26	-	1.3	0.00608	0.19	0.205	33.7	2.21	8	5	0.2	9.1
23-0451-0019	SP05_01	BCL23003101	Stockpile Sample - Soil	0.00-4.00	<1.5	<20	12	0.13	8.62	7.98	0.065	0.691	0.076	121	1.1	11.6	-	1	0.0089	0.0866	0.0952	10.7	1.18	7	<2	0.3	8.6
23-0451-0020	SP05_02	BCL23003101	Stockpile Sample - Soil	0.00-4.00	2.5	<20	10	0.22	8.66	13.7	<0.050	5.81	1.12	145	0.962	2.35	-	7.9	0.00352	0.425	0.409	116	22.5	14	5	0.2	21.1
23-0451-0021	SP05_03	BCL23003101	Stockpile Sample - Soil	0.00-4.00	5.3	<20	5	0.16	8.51	20.9	<0.050	6.19	0.63	145	1.1	3.38	-	3.3	0.00262	0.296	0.324	124	12.6	19	5	0.2	31
23-0451-0022	SP05_04	BCL23003101	Stockpile Sample - Soil	0.00-4.00	3.4	<20	5	0.15	8.55	19.3	<0.050	5.45	0.604	140	1.06	3.54	-	3.3	0.00275	0.282	0.3	109	12.1	18	5	0.2	28.9
23-0451-0023	SP05_05	BCL23003101	Stockpile Sample - Soil	0.00-4.00	3.4	<20	3	0.15	8.57	21	<0.050	5.91	0.613	143	1.09	3.55	-	3.2	0.00259	0.281	0.306	118	12.3	19	6	0.5	2.5
23-0451-0024	QC100	BCL23003101	Field Duplicate Sample	0.00-4.00	4.1	<20	12	0.15	8.29	11	0.065	0.169	<0.070	105	1.03	65.2	-	0	0.00604	0.0153	0.0157	2.61	1.08	11	7	3.7	64.4
23-0451-0025	TP01_0.0	BCL23003101	Testpit Sample - Soil	0.00-0.00	4.7	<20	11	0.2	8.1	22.6	0.414	2.93	0.189	111	0.956	7.71	-	0.8	0.0175	0.13	0.124	7.07	0.455	24	35	3.2	29.1
23-0451-0026	TP01_0.1	BCL23003101	Testpit Sample - Soil	0.00-0.20	4.6	<20	1	0.19	8.25	11.2	0.157	7.5	0.874	105	0.595	1.49	-	4.6	0.00837	0.671	0.399	47.7	5.55	19	5	2.3	8.8
23-0451-0027	TP01_0.9	BCL23003101	Testpit Sample - Soil	0.80-1.00	8.1	<20	<1	0.36	9.01	13.3	0.13	16.3	4.92	107	0.409	0.814	-	15.2	0.004	1.23	0.503	126	37.9	32	3	-	-
23-0451-0028	TP01_1.35	BCL23003101	Testpit Sample - Soil	1.25-1.45	8.9	154	<1	0.49	9.34	10.1	0.095	15.9	6.54	110	0.341	0.635	-	22.1	0.00322	1.57	0.537	167	68.7	30	<2	-	-
23-0451-0029	TP01_1.70	BCL23003101	Testpit Sample - Soil	1.60-1.80	4.5	86	<1	0.32	9.27	10.5	0.061	8.4	3.24	119	0.565	1.25	-	17.4	0.00326	0.799	0.452	138	53.4	19	<2	-	-
23-0451-0030	TP03_0.0	BCL23003101	Testpit Sample - Soil	0.00-0.00	2.6	23	2	0.15	6.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	0.6	51
23-0451-0031	TP03_0.1	BCL23003101	Testpit Sample - Soil	0.00-0.20	<1.5	<20	2	0.05	6.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	0.6	72.8
23-0451-0032	TP03_0.4	BCL23003101	Testpit Sample - Soil	0.30-0.50	5.1	71	<1	0.11	6.63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-
23-0451-0033	TP04_0.0	BCL23003101	Testpit Sample - Soil	0.00-0.00	4.7	<20	<1	0.06	6.74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	11.9	42.9
23-0451-0034	TP04_0.1	BCL23003101	Testpit Sample - Soil	0.00-0.20	3.1	<20	<1	0.02	6.69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	11	41
23-0451-0035	TP04_0.85	BCL23003101	Testpit Sample - Soil	0.75-0.95	7.7	26	<1	0.04	6.96	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-
23-0451-0036	TP04_1.85	BCL23003101	Testpit Sample - Soil	1.75-1.95	3.9	86	<1	0.1	7.61	14.2	0.143	7.16	1.74	88	0.539	1.99	-	6.6	0.0054	0.503	0.271	50.2	12.2	26	2	-	-
23-0451-0037	TP05_0.0	BCL23003101	Testpit Sample - Soil	0.00-0.00	2.6	<20	1	0.05	6.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	0.9	70
23-0451-0038	TP05_0.1	BCL23003101	Testpit Sample - Soil	0.00-0.20	1.7	<20	<1	0.03	6.34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1.3	38.5
23-0451-0039	TP05_0.4	BCL23003101	Testpit Sample - Soil	0.30-0.50	2.2	<20	<1	0.03	6.56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-
23-0451-0040	TP05_0.7	BCL23003101	Testpit Sample - Soil	0.60-0.80	2.6	<20	<1	0.04	6.66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-
23-0451-0041	TP05_1.5	BCL23003101	Testpit Sample - Soil	1.40-1.60	2.6	293	<1	0.21	6.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-
23-0451-0042	QC101	BCL23003101	Field Duplicate Sample	0.00-0.20	6.5	<20	<1	0.1	7.83	15.1	0.231	5.58	0.399	102	0.722	2.71	-	1.9	0.011	0.369	0.267	24.2	1.73	21	5	3.4	28.4

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Queensland Government

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1_ICP		S_DUM_TOC	* S_KJ_AA		S_PSA					* S_PSD										* S_PSD_MECD									
Mn	Zn	OC	TKN	TKP	Clay	Coarse sand	Fine sand	Silt	Total	<2µm	>2000µm	10µm to 63um	2µm to 10um	2µm to 20um	20µm to 200um	200µm to 2000um	63µm to 200um	d(0.9)	Obscuration	<0.24µm	<62.5µm	0.5µm to 0.24um	1µm to 0.5um	1000µm to 500um	125µm to 62um	16µm to 8um	2µm to 1um	2000µm to 1000um	250µm to 125um	31µm to 16um	4µm to 2um
mg/kg	mg/kg	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	µm	%	%	%	%	%	%	%	%	%	%	%	%	%
5.1	<0.1	0.716	0.041	0.02	67.9	14.2	10.6	13.1	105.9	48	<1.0	17	25	32	17	2	7.2	56.4	11.3	32.2	93.6	6	2.1	<1.0	2.8	7.9	8.1	<1.0	1.8	6.7	13.7
11.8	<0.1	0.424	0.028	0.026	66.8	13.9	18.2	9.4	108.4	-	-	-	-	-	-	-	-	96	14.4	26.5	84.9	6.1	2.8	<1.0	5.2	7.8	6.7	<1.0	5.2	7.9	10.3
6.5	0.1	1.49	0.043	0.017	58.2	19.2	18.7	15.1	111.2	-	-	-	-	-	-	-	-	85.8	12.4	15.9	92.1	5.5	2.9	<1.0	5.7	13.1	7.3	<1.0	2.3	11.5	13.1
7.3	<0.1	1.46	0.037	0.016	57.5	20.1	13.9	16.5	108	-	-	-	-	-	-	-	-	88.8	8.4	16.1	89.5	5.3	2.8	<1.0	7	11.7	7.2	<1.0	3.5	11.4	12.4
9.9	<0.1	0.791	0.045	0.018	61.9	15.8	12.5	14.6	104.8	-	-	-	-	-	-	-	-	108	9.3	18.4	88.6	5.5	2.7	<1.0	6	10.9	7	<1.0	3.5	10.3	12.2
4.8	<0.1	0.561	0.035	0.018	70.2	11.9	14.3	12.8	109.2	-	-	-	-	-	-	-	-	-	-	33.8	94.2	5.9	2.3	<1.0	3.4	7.9	8.1	<1.0	2.2	7.1	12.7
5.2	0.3	1.04	0.036	0.02	57.3	22.5	13.5	13	106.4	-	-	-	-	-	-	-	-	-	-	28.4	93.3	6.3	2.8	<1.0	3.6	9.5	7.8	<1.0	2.3	8.6	12.2
2.4	<0.1	0.325	0.027	0.02	67.6	13.2	11.5	10.1	102.4	-	-	-	-	-	-	-	-	-	-	37.7	97	8.3	3.7	<1.0	2.4	7.6	7.7	<1.0	<1.0	6.9	10.4
4.2	<0.1	0.829	0.036	0.017	69.9	13.6	11.2	9.7	104.4	-	-	-	-	-	-	-	-	-	-	34.6	91.5	6.7	2.8	<1.0	4.5	8	6.8	<1.0	3.1	7.2	10
35.9	0.3	1.92	0.046	0.019	34.1	29.9	22.6	16.7	103.2	-	-	-	-	-	-	-	-	-	-	2.5	85.6	3.4	2.6	<1.0	8	15.6	6.4	<1.0	4.7	14.1	13.2
8.2	0.1	2.22	0.026	0.019	40.2	30.1	22.4	12.9	105.7	-	-	-	-	-	-	-	-	-	-	7.7	85	4.7	2.7	<1.0	6.6	14.4	5.9	<1.0	5.2	13.1	11.7
5.9	<0.1	0.592	0.033	0.017	67.3	15.2	14.9	9.5	107	-	-	-	-	-	-	-	-	-	-	40.8	95.6	7.2	2.3	<1.0	2.1	6.9	7.4	<1.0	1.3	5.1	11.9
2.8	<0.1	0.318	0.036	0.017	72.4	5.8	8.5	1	87.8	-	-	-	-	-	-	-	-	-	-	48.8	100	7.1	1.7	<1.0	<1.0	6.6	7.4	<1.0	<1.0	4.2	12.7
<2.0	<0.1	0.292	0.032	0.02	73.1	5.7	9.3	15.7	103.8	-	-	-	-	-	-	-	-	-	-	31.6	96.8	5.6	1.8	<1.0	1.5	10.6	7.7	<1.0	<1.0	7.8	13.8
10.9	0.2	1.02	0.066	0.015	45.6	24.6	19.7	13.8	103.7	-	-	-	-	-	-	-	-	-	-	11.7	89.2	4	1.9	<1.0	4.7	15.1	6.2	<1.0	3.1	12.4	13.4
9.6	<0.1	0.477	0.041	0.021	66.7	9.6	11.9	14.7	102.8	-	-	-	-	-	-	-	-	-	-	27.2	94.7	5	2.2	<1.0	2.3	10.8	8.4	<1.0	1.4	7.5	15
6.3	0.3	3.6	<0.013	0.014	18.7	19.9	39.9	23	101.6	-	-	-	-	-	-	-	-	-	-	<1.0	74.1	<1.0	2.5	<1.0	11.5	16.8	4.1	<1.0	9.7	16.2	7.8
7.4	0.2	2.56	0.021	0.017	22.1	18.4	34	29.8	104.3	-	-	-	-	-	-	-	-	-	-	<1.0	82	1.2	3	<1.0	8.8	18.5	5.4	<1.0	6.4	16	10.7
4.9	0.4	3.71	0.013	<0.013	22.1	47	21.5	13	103.6	-	-	-	-	-	-	-	-	-	-	7	75.3	4.4	2.6	<1.0	7.3	13.6	4	<1.0	8.7	13.2	7.7
9	<0.1	0.909	0.025	0.024	25.8	34.2	28.4	16.4	104.7	-	-	-	-	-	-	-	-	-	-	<1.0	74	2.8	2.3	1.7	8.4	14	4.5	<1.0	7.1	14.2	9.7
11.4	0.2	0.368	0.024	0.034	22.9	35.7	30.3	13.3	102.3	-	-	-	-	-	-	-	-	-	-	<1.0	71.2	2	1.9	1.8	10.5	13.6	4	<1.0	8.4	14.3	9.1
10.3	0.1	0.297	0.017	0.042	22.5	40.1	29.1	13.1	104.9	-	-	-	-	-	-	-	-	-	-	<1.0	82.2	2.5	2.3	<1.0	8.3	16.1	5.3	<1.0	6.8	15.5	11.6
5.8	<0.1	0.568	0.019	0.042	22.6	36.2	30	16.8	105.6	-	-	-	-	-	-	-	-	-	-	<1.0	81.4	2.5	2.3	<1.0	8.6	15.7	5.2	<1.0	5.8	15.1	11.6
26	0.6	1.12	0.035	0.019	62.7	17.2	12	11.7	103.6	-	-	-	-	-	-	-	-	-	-	31.8	96.9	6.2	2.3	<1.0	2.1	8.2	8.9	<1.0	<1.0	6.1	15.7
24.4	<0.1	2.97	0.266	0.02	40.4	6.1	12.1	41.4	100	-	-	-	-	-	-	-	-	-	-	<1.0	78.7	<1.0	1.5	1.6	9.2	18.5	4.2	<1.0	6.1	15.9	10.2
6.6	<0.1	0.48	0.042	<0.013	43.9	5.8	12.6	41.5	103.8	-	-	-	-	-	-	-	-	-	-	<1.0	94.3	<1.0	3	<1.0	3.3	22.3	7	<1.0	1.3	17.1	14.4
-	-	0.57	0.033	<0.013	63.3	4.9	10.8	24.7	103.8	-	-	-	-	-	-	-	-	-	-	2.4	94.1	4.7	5.4	<1.0	2.5	18.4	9.7	<1.0	1.5	13.4	15.1
-	-	0.306	0.022	<0.013	63.8	10.7	10.6	17.6	102.7	-	-	-	-	-	-	-	-	-	-	8.6	94.4	6.6	4.8	<1.0	3.3	17.7	8.1	<1.0	1.9	12.1	13.1
-	-	0.55	0.014	0.014	33.1	34.9	21.3	15.6	104.9	-	-	-	-	-	-	-	-	-	-	<1.0	80.6	3.2	3.2	<1.0	5.9	17	4.5	4.4	3.6	18.6	8.3
33.8	1.6	3.44	0.241	0.024	29.4	25	30.1	20	104.6	-	-	-	-	-	-	-	-	-	-	<1.0	65.7	<1.0	1	2	12.8	13.7	3.2	<1.0	10.9	13.7	8.3
24.4	1.2	2.12	0.136	0.02	29.1	26.7	28.1	21.4	105.3	-	-	-	-	-	-	-	-	-	-	<1.0	68.2	<1.0	1.7	3.5	9.8	13.9	4.3	<1.0	8.5	12.9	9.9
-	-	0.881	0.069	<0.013	73.8	3.9	11.8	15.4	104.8	-	-	-	-	-	-	-	-	-	-	4.7	85.7	5.5	3.4	<1.0	6.5	15.1	5.4	<1.0	4.2	14.3	11.6
62.5	1.8	2.93	0.216	0.054	33.5	31.3	20.5	18.7	104	-	-	-	-	-	-	-	-	-	-	<1.0	74.8	<1.0	<1.0	<1.0	10.4	18.1	2.9	<1.0	8.7	14.8	10
61.7	0.1	1.08	0.067	0.051	32.8	47.9	14.5	10.1	105.3	-	-	-	-	-	-	-	-	-	-	3.4	83.3	2.4	1.5	1.2	6	17.8	4.7	<1.0	4.7	14.4	11.9
-	-	0.344	0.035	0.013	73.6	13.7	10	6.9	104.2	-	-	-	-	-	-	-	-	-	-	28.8	88.6	8.7	3.2	<1.0	5	9.7	4.7	<1.0	4	8.7	8.3
-	-	0.246	0.033	0.014	74.5	9.8	11.3	10.2	105.8	-	-	-	-	-	-	-	-	-	-	40	95.7	9.2	4	<1.0	2.1	7.9	6.1	<1.0	1.1	6.7	8.5
105	2.1	2.99	0.199	0.028	27.4	31.4	31.8	15.2	105.7	-	-	-	-	-	-	-	-	-	-	<1.0	71	<1.0	<1.0	1.3	10.7	16.2	3	<1.0	8.9	14.8	8.9
69.9	0.2	0.745	0.056	0.015	27.1	36.2	34.1	13.3	110.8	-	-	-	-	-	-	-	-	-	-	1.4	79.1	2.3	1.7	<1.0	9.8	15.5	4.9	<1.0	7	13.6	11.8
-	-	0.27	0.029	<0.013	32.5	38.9	22	10	103.4	-	-	-	-	-	-	-	-	-	-	9.2	81.2	5.2	3.2	<1.0	6.5	12.5	5.7	<1.0	5.8	11.4	10.8
-	-	0.245	0.024	<0.013	36.1	33.3	26.6	9.9	106	-	-	-	-	-	-	-	-	-	-	8.5	76.6	4.8	2.8	<1.0	8.7	11.5	5	<1.0	8.8	11.5	9.6
-	-	0.141	0.015	<0.013	34.3	32.7	23.9	11.6	102.6	-	-	-	-	-	-	-	-	-	-	5	73.8	4	2.8	1.6	9.2	10.9	6.1	<1.0	7.5	10.7	11.1
23.1	<0.1	0.578	0.046	<0.013	34	2.8	14.5	54.7	105.9	-	-	-	-	-	-	-	-	-	-	<1.0	90.5	1.3	3.4	<1.0	4.8	20.3	7.1	<1.0	2.7	15.9	13.8

Name: Dan Yousaf

Title: Soil & Plant team leader

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Queensland Government

Department of Environment and Science - Chemistry Centre

Soil Analysis Report

Job No: 23-0451

Report ID: 23-0451-F-V1

					* S_PSD_PRED																* S_PSD_ULTD									
500µm to 250um	62µm to 31um	8µm to 4um	d(0.9)	Obscuration	<0.24µm	<62.5µm	0.5µm to 0.24um	1µm to 0.5um	1000µm to 500um	125µm to 62um	16µm to 8um	2µm to 1um	2000µm to 1000um	250µm to 125um	31µm to 16um	4µm to 2um	500µm to 250um	62µm to 31um	8µm to 4um	d(0.9)	Obscuration	<0.24µm	<62.5µm	0.5µm to 0.24um	1µm to 0.5um	1000µm to 500um	125µm to 62um	16µm to 8um	2µm to 1um	2000µm to 1000um	250µm to 125um
%	%	%	µm	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	µm	%	%	%	%	%	%	%	%	%	%	%
1.6	4.9	12.1	36.4	11.6	32	93.5	5.9	2	<1.0	2.7	7.9	8.1	<1.0	1.6	6.7	13.7	1.4	5	12.1	37.1	11.5	32.9	90.7	6.1	2.1	<1.0	4.8	7.6	7.2	<1.0	3.4
4.5	7.1	9.6	125	14.5	26.8	85.7	6.1	2.8	<1.0	5.1	7.9	6.8	<1.0	4.7	8	10.4	4	7	9.8	113	14.4	28.3	86.4	6.3	2.8	<1.0	5.7	7.9	6.4	<1.0	5.1
<1.0	8.4	14.5	50.6	12.4	15.8	91.8	5.4	2.8	<1.0	5.2	13.1	7.3	<1.0	2.9	11.5	13.1	<1.0	8.3	14.5	52	12.3	17.3	87	5.4	2.7	<1.0	6.4	11.8	6.7	<1.0	3.9
<1.0	9.4	13.1	65.4	8.3	15.7	87.5	5.1	2.6	<1.0	6.6	11.5	7	<1.0	4.8	11.2	12.2	1.3	9.3	12.8	80.1	8.3	17.1	86.2	5.3	2.7	<1.0	7.5	11	6.6	<1.0	5.6
2	8.8	12.7	71.7	9.1	18.2	87.2	5.3	2.6	<1.0	6.1	10.7	6.9	<1.0	4.5	10.1	12	2.3	8.6	12.6	84.3	9	19.5	84.6	5.3	2.5	<1.0	6.7	10.1	6.4	<1.0	5
<1.0	5.3	11.1	35	11.4	33.8	94.4	5.9	2.2	<1.0	3.6	7.9	8.1	<1.0	2	7.1	12.8	<1.0	5.5	11.2	34.8	11.4	34.8	92.1	5.9	2.3	1.8	3.6	7.6	7.5	<1.0	1.8
<1.0	6.1	11.6	40.6	9.6	28.4	93.8	6.3	2.8	<1.0	4	9.5	7.8	<1.0	2.1	8.6	12.3	<1.0	6.2	11.8	39.2	9.5	28.8	90	6.2	2.6	<1.0	4.9	8.9	7	<1.0	3.5
<1.0	4.9	9.8	25.4	5.9	37.8	96.4	8.2	3.6	<1.0	2.7	7.6	7.7	<1.0	<1.0	6.9	10.4	<1.0	4.7	9.7	26.1	5.9	28.7	73.8	6.2	2.5	9.5	4.6	5.6	5.4	<1.0	3.5
<1.0	5.5	9.9	49.7	10.1	34.9	91.9	6.7	2.8	<1.0	3.9	8	6.9	<1.0	2.8	7.2	10.1	1.3	5.5	9.9	47.2	10.1	32.9	82.8	6.2	2.4	1.3	4.8	6.9	5.6	5.3	3
1.8	11.4	16.2	88.8	7.4	2.6	87.3	3.4	2.6	<1.0	7.7	16.1	6.6	<1.0	4.6	14.4	13.6	<1.0	11.1	16.7	78.1	7.4	2.6	76	3.1	2.3	<1.0	10.4	13.5	5.4	<1.0	8.8
3.1	10.3	14.5	103	9.1	7.7	85.9	4.7	2.7	<1.0	7	14.7	6	<1.0	4.4	13.3	11.9	2.7	10.3	14.7	91.3	9	8.2	83.6	4.7	2.6	<1.0	8.2	13.8	5.6	<1.0	5.2
<1.0	3.2	10.8	22.4	10.5	38.2	89.6	6.7	2.1	2.5	2	6.5	6.9	2.6	1.2	4.8	11.2	1.2	3.1	10.1	71.1	10.4	39.3	89.3	6.8	2.1	<1.0	4.2	6.3	6.3	<1.0	3.1
<1.0	<1.0	11.1	8.9	13	48.7	100	7	1.7	<1.0	<1.0	6.7	7.4	<1.0	<1.0	4.2	12.8	<1.0	<1.0	11.2	8.9	13	51.7	100	7.3	1.8	<1.0	<1.0	6.1	6.7	<1.0	<1.0
<1.0	4.1	13.7	24	15.6	32.1	97.8	5.6	1.8	<1.0	<1.0	10.8	7.8	<1.0	<1.0	7.8	14	<1.0	4	13.9	21.9	15.6	33.5	95.1	5.7	1.8	<1.0	2.4	10.2	7.2	<1.0	1.3
2.5	8	16.6	68.7	12	11.7	90.3	4	1.9	<1.0	5	15.2	6.3	<1.0	3.3	12.4	13.5	1.4	8.4	16.8	60.1	12	12.8	88.1	4.3	2	1.1	5.7	14.3	6	<1.0	3.3
1.2	4.1	14.6	28.9	13.7	27.2	94.9	5	2.1	1.1	1.8	10.8	8.5	<1.0	<1.0	7.6	15	1.5	4.1	14.7	28.6	13.7	30.2	94.2	5.3	2.2	<1.0	3.6	10.3	7.8	<1.0	2.1
4.8	13.7	12.3	170	15.7	<1.0	73.5	<1.0	2.5	<1.0	11.5	16.7	4	<1.0	10.6	16	7.7	4.6	13.6	12.2	174	15.7	<1.0	73.6	<1.0	2.5	<1.0	11.6	16.6	4	<1.0	9.9
2.9	11.7	15.5	117	12.4	<1.0	78.9	1.1	2.9	<1.0	8.4	17.9	5.2	<1.0	6.9	15.5	10.3	5.3	11.1	14.9	163	12.4	<1.0	78.3	1.2	2.9	1.8	9.4	17.5	5.1	<1.0	6.2
8.7	11.3	11.2	233	8.9	6.5	71.4	4.2	2.5	2.4	7.5	12.9	3.8	<1.0	7.9	12.7	7.3	10.9	10.8	10.7	307	8.9	6.8	71.6	4.2	2.5	1.6	8.8	12.7	3.7	<1.0	8
8.9	12.5	13	263	10.2	<1.0	71.9	2.7	2.3	2.4	8.2	13.7	4.3	<1.0	7.3	13.9	9.4	10.3	12.1	12.6	300	10.2	1	74.8	2.9	2.3	<1.0	9	14	4.4	<1.0	7.9
8.4	13.4	12.3	253	12.5	<1.0	71.1	2	1.9	1.2	10.8	13.6	4.1	<1.0	8.7	14.3	9.1	8.4	13.3	12.3	242	12.5	<1.0	75.8	2.2	2.1	<1.0	10.6	14.4	4.3	<1.0	7.8
2.8	12.7	15.4	120	15.6	<1.0	79.7	2.4	2.2	<1.0	8.2	15.7	5.1	<1.0	6.7	15	11.3	5.3	12.5	14.8	157	15.6	<1.0	86.7	2.7	2.5	<1.0	7.5	17.1	5.5	<1.0	4.4
4.2	12.9	15.2	127	15.7	<1.0	78.7	2.5	2.2	<1.0	9.1	15.1	5	<1.0	6.5	14.6	11.2	5.3	12.6	14.6	158	15.7	<1.0	85.9	2.8	2.4	<1.0	8.3	16.6	5.5	<1.0	4.5
<1.0	3.9	13.8	22.1	13.3	31.2	94.4	5.9	2.2	<1.0	2.2	8	8.6	<1.0	1.3	5.9	15.2	1.5	4	13.4	29.6	13.2	33.3	96.2	6.4	2.4	<1.0	2.1	8.1	8.5	<1.0	1.1
4.6	12	16.2	156	15.9	<1.0	78.6	<1.0	1.5	1.6	9	18.5	4.2	<1.0	5.3	15.8	10.2	5.7	12	16.2	168	15.9	<1.0	82.9	<1.0	1.7	<1.0	8.4	19.2	4.7	<1.0	4.4
1.1	9.1	20.7	41.5	16.8	<1.0	92.6	<1.0	2.9	<1.0	3.4	21.9	6.8	<1.0	1.8	16.8	14.1	1.9	9	20.3	47.5	16.8	<1.0	95.1	<1.0	3.1	<1.0	3.1	22.4	7.2	<1.0	1
1.6	6.5	18.5	37.2	15.4	2.3	95.7	4.8	5.5	<1.0	2.6	18.8	9.8	<1.0	1.3	13.7	15.4	<1.0	6.5	18.9	32.9	15.3	2.3	93.9	4.9	5.5	<1.0	3.1	18.3	9.5	<1.0	1.7
<1.0	6.1	17.3	35.7	12.1	8.6	93.6	6.5	4.8	<1.0	3.2	17.5	8	<1.0	1.9	12	13	1.3	6	17.1	38.7	12	8.6	95	6.7	4.9	<1.0	3.3	17.7	8.1	<1.0	1.5
<1.0	12.9	12.1	249	10.5	<1.0	80.4	3.3	3.2	<1.0	6.4	17	4.5	4.3	3.1	18.4	8.3	1.7	12.9	12.2	264	10.4	<1.0	86.2	3.3	3.4	<1.0	5.7	18.1	4.7	3	1.9
8.7	13.2	12.5	262	11.2	<1.0	65.3	<1.0	1	3.9	12.7	13.6	3.1	<1.0	10	13.6	8.2	8.2	13.2	12.3	297	11.2	<1.0	70.6	<1.0	1.3	2.3	13.1	14	3.6	<1.0	7.8
10.1	11.5	13.6	321	13.3	<1.0	61.2	<1.0	1.5	10.6	9.3	12.4	3.9	1.6	7.9	11.6	8.8	9.6	10.4	12.2	568	13.3	<1.0	68.1	<1.0	1.8	7.1	10.4	13.3	4.5	<1.0	6.9
3	10.4	15.1	97.6	14.4	4.6	85.5	5.4	3.3	<1.0	6.8	15.1	5.4	<1.0	4.5	14.3	11.5	2.8	10.5	15.1	97.9	14.4	6.1	89.9	6.1	3.7	<1.0	5.4	15.7	6	<1.0	3.3
5.7	11.6	17.1	181	10.4	<1.0	72.3	<1.0	<1.0	<1.0	9.5	17.5	2.8	<1.0	9.3	14.3	9.7	8.3	11.1	16.5	234	10.3	<1.0	80	<1.0	<1.0	<1.0	11.4	18.8	3.2	<1.0	8
4.9	9.7	17.5	140	11.9	3.4	81.4	2.3	1.4	1.4	6	17.3	4.6	<1.0	4.9	14.1	11.6	6.5	9.7	17	189	11.9	4.5	80.3	2.5	1.5	2.8	5.6	16.3	4.7	4.9	3.1
2.4	6.6	10	75.6	11.5	28.6	87.4	8.5	3.1	<1.0	5	9.5	4.7	<1.0	3.9	8.6	8.1	3	6.5	9.8	88.6	11.5	30	87.9	8.5	3	<1.0	4.7	9.2	4.7	<1.0	3.2
1	4.3	9.1	26.7	14.1	40.3	96	9.2	3.9	<1.0	2	7.9	6	<1.0	<1.0	6.8	8.5	<1.0	4.4	9.1	26.2	14	40.3	96.4	9.3	4	<1.0	2.2	7.9	6.1	<1.0	<1.0
8.3	12.7	14.4	242	10.9	<1.0	67.3	<1.0	<1.0	3.9	10.5	15.3	2.8	<1.0	9.1	14	8.4	9.4	12.1	13.6	318	10.9	<1.0	74.6	<1.0	<1.0	1.6	11.1	16.7	3.2	<1.0	7.5
4	11.8	16	138	10.6	1.4	76.9	2.2	1.7	<1.0	10.2	15	4.7	<1.0	7.2	13.3	11.4	5	11.5	15.6	161	10.6	2.1	80.3	2.5	1.8	<1.0	9.2	15.3	5.1	<1.0	7.4
6.4	9.9	13.1	176	13.3	9.1	81.4	5.2	3.2	<1.0	7.5	12.7	5.7	<1.0	6.4	11.5	10.9	4.7	10	13.2	142	13.3	10.8	85.2	5.5	3.3	<1.0	8.1	12.7	6	<1.0	5.7
5.9	11	11.7	186	12.9	8.3	74.7	4.6	2.7	<1.0	8.8	11.2	4.9	<1.0	10.1	11.3	9.4	6.5	10.8	11.4	199	12.9	9.2	75.1	4.7	2.7	<1.0	9.3	10.9	4.8	<1.0	10
8	10.8	12.3	242	15.4	4.9	71.6	3.9	2.7	2.1	8.6	10.6	6	<1.0	7.8	10.4	10.8	10.1	10.3	12	289	15.3	5.3	68.9	3.7	2.5	3.7	9.5	10.1	5.4	<1.0	8.1
1.9	9.7	19.1	59.3	15.7	<1.0	91.1	1.3	3.4	<1.0	4.7	20.4	7.2	<1.0	2.3	16.1	13.9	1.6	9.7	19.2	56	15.7	<1.0	91.2	1.4	3.4	<1.0	5.2	20.3	7.2	<1.0	2.5

Name: Dan Yousaf

Title: Soil & Plant team leader

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Queensland Government

Department of Environment and Science - Chemistry Centre

Soil Analysis Report

Job No: 23-0451

Report ID: 23-0451-F-V1

							* S_PSD	* S_R1-R2		* S_SCP_I	S_WALKLEY	S_CAT_EQ				
31µm to 16um	4µm to 2um	500µm to 250um	62µm to 31um	8µm to 4um	d(0.9)	Obscuration	PSD	R1	R2	S	OC	Ca	K	Mg	Na	Na corr
%	%	%	%	%	µm	%				mg/kg	%	cmol_c/kg	cmol_c/kg	cmol_c/kg	cmol_c/kg	cmol_c/kg
6.9	11.8	1.2	5.4	10.7	56.4	11.3	-	0.33	<0.10	21	0.41	-	-	-	-	-
8	9.8	2.9	7.5	9.4	96	14.4	-	0.45	<0.10	16	0.24	-	-	-	-	-
10.5	11.6	2.2	8.1	12.9	85.8	12.4	-	0.41	0.11	11	0.52	-	-	-	-	-
11	11.2	<1.0	9.3	11.9	88.8	8.4	-	0.39	<0.10	22	0.4	-	-	-	-	-
9.9	10.8	3.3	8.7	11.4	108	9.3	-	0.39	<0.10	33	0.45	-	-	-	-	-
6.9	11.5	<1.0	5.3	10.2	45.6	11.5	-	0.34	<0.10	25	0.29	-	-	-	-	-
8.3	10.9	1.4	6.5	10.6	62.3	9.6	-	0.4	<0.10	18	0.37	-	-	-	-	-
5.6	7.3	8.6	5.4	7	490	5.9	-	0.48	<0.10	20	0.3	-	-	-	-	-
6.4	8.3	<1.0	5.7	8.4	199	9.9	-	0.37	<0.10	27	0.44	-	-	-	-	-
12.8	11.1	4.9	11.4	13.7	165	7.5	-	0.75	0.28	29	0.68	-	-	-	-	-
12.9	11	3	11	13.7	106	9	-	0.67	0.16	18	0.38	-	-	-	-	-
5	9.9	2.9	4.3	9.2	69.9	10.3	-	0.43	<0.10	27	0.32	-	-	-	-	-
4	11	<1.0	1.4	10.1	9.2	12.6	-	0.48	<0.10	29	0.32	-	-	-	-	-
7.3	12.6	<1.0	3.9	12.9	27.2	15.5	-	0.32	<0.10	14	0.31	-	-	-	-	-
11.9	12.7	1.9	8.3	15.7	77.4	11.9	-	0.55	0.26	2	0.94	-	-	-	-	-
7.1	13.6	<1.0	4.2	13.5	31	13.4	-	0.31	<0.10	23	0.39	-	-	-	-	-
16.1	7.6	5.1	13.7	12.1	175	15.9	-	0.93	0.21	115	0.18	-	-	-	-	-
15.4	10	4.5	11.6	14.5	157	12.5	-	0.82	0.37	18	0.31	-	-	-	-	-
12.7	7	10.1	11.6	10.3	280	9.1	-	0.92	0.37	3	0.2	-	-	-	-	-
14.6	9.4	8	13.3	12.7	224	10.4	-	0.88	0.4	13	0.35	-	-	-	-	-
15.4	9.6	5.7	14.5	12.9	173	12.9	-	0.81	0.36	8	0.31	-	-	-	-	-
16.5	12.2	1.5	13.3	16.1	81	16	-	0.81	0.32	6	0.21	-	-	-	-	-
16.1	12.2	1.5	13.2	16	84.9	16.1	-	0.73	0.36	2	0.35	-	-	-	-	-
6.1	14.5	<1.0	4	13	24.1	13.2	-	0.36	<0.10	18	0.35	-	-	-	-	-
16.3	11.2	3.6	12.1	17.3	111	16.3	-	0.61	0.26	37	2.58	-	-	-	-	-
17.2	14.5	<1.0	9.1	20.8	39.1	16.9	-	0.72	0.4	16	0.49	-	-	-	-	-
13.7	14.7	1.3	7	18.1	39	15.4	-	0.88	0.55	62	0.52	-	-	-	-	-
12.3	13	<1.0	6.3	17.2	34.5	12.1	-	0.99	0.78	51	0.2	-	-	-	-	-
20.3	8.7	<1.0	14.2	12.8	92.5	10.9	-	0.83	0.44	33	0.11	-	-	-	-	-
14.9	8.7	6.4	15.2	12.6	216	11.7	-	0.62	0.35	5	3	10.7	0.874	3.13	0.106	<0.080
12.9	9.7	7.3	12.2	13	408	14	-	0.65	0.38	6	1.92	4.99	0.615	3.33	0.201	0.201
14.3	12.4	1.3	9.6	16	62.9	14.5	-	0.82	0.58	14	0.74	4.88	0.196	11.2	2.79	2.59
16.1	10.6	<1.0	13.1	17.7	115	10.9	-	0.4	0.18	4	2.69	14.5	0.501	3.45	<0.080	<0.080
13.5	11.5	1.4	9.4	16.4	442	12	-	0.58	0.25	3	0.92	7.49	0.164	2.84	0.149	0.149
8.4	8.1	3.3	6.4	9.6	83.9	11.7	-	0.61	0.29	4	0.39	11.9	0.176	7.3	1.2	1.12
6.8	8.5	<1.0	4.4	9	25.2	14.2	-	0.79	0.39	<1	0.25	-	-	-	-	-
15.6	9.3	5.4	13.5	15	180	11.2	-	0.58	0.22	5	2.6	8.73	0.578	3.84	<0.080	<0.080
13.7	12	3.1	11.6	16	131	10.8	-	0.6	0.3	6	0.75	5.27	0.108	3.8	0.231	0.231
12.1	11	1.2	10.5	13.1	93.5	13.7	-	0.65	0.31	8	0.24	7.47	0.098	5.9	0.386	0.386
11.4	9	5.8	11.4	10.9	189	13.3	-	0.67	0.28	10	0.22	8.33	0.092	6.74	0.504	0.504
10.2	9.9	9.9	10.7	11	324	15.7	-	0.59	0.24	1	0.11	6.81	0.074	6.29	1.79	0.967
15.9	13.9	1.2	9.9	19.2	55.8	15.8	-	0.56	0.63	9	0.51	-	-	-	-	-

Name: Dan Yousaf

Title: Soil & Plant team leader

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Queensland Government

Department of Environment and Science - Chemistry Centre

Methods of Analysis

Job No: 23-0451

Report ID: 23-0451-F-V1

Method ID	Method Name	Analyte	Name	ALHS	Uncertainty +_%	PQL	Unit	Method Description	Reporting Basis	Method Notes
S_ADM_105 v1	S_ADM_105	ADMC	Air dry moisture content (105ºC)	2A1	8	1.5	%	Soil: Moisture air dry	Oven dry (48 hours at 105°C)	
S_DT1_ICP v2	S_DT1_ICP	Cu	Copper	12A1_Cu	10	0.1	mg/kg	Soil: Cu Fe Mn Zn (trace) 0.005M DTPA ICP	Oven dry (48 hours at 40°C)	
S_DT1_ICP v2	S_DT1_ICP	Fe	Iron	12A1_Fe	10	2	mg/kg	Soil: Cu Fe Mn Zn (trace) 0.005M DTPA ICP	Oven dry (48 hours at 40°C)	
S_DT1_ICP v2	S_DT1_ICP	Mn	Manganese	12A1_Mn	10	2	mg/kg	Soil: Cu Fe Mn Zn (trace) 0.005M DTPA ICP	Oven dry (48 hours at 40°C)	
S_DT1_ICP v2	S_DT1_ICP	Zn	Zinc	12A1_Zn	10	0.1	mg/kg	Soil: Cu Fe Mn Zn (trace) 0.005M DTPA ICP	Oven dry (48 hours at 40°C)	
S_AQ4_AA v3	S_AQ4_AA	Cl	Chloride	5A2a	10.4	20	mg/kg	Soil: Cl NO3-N Aqueous (1:5)	Oven dry (48 hours at 40°C)	
S_AQ4_AA v3	S_AQ4_AA	NO3-N	Nitrate nitrogen	7B1	15	1	mg/kg	Soil: Cl NO3-N Aqueous (1:5)	Oven dry (48 hours at 40°C)	
* S_PSD v3	* S_PSD	<2µm	<2µm		5	1	%	Soil: Particle Size (mechanically dispersed)	Oven dry (48 hours at 65°C)	
* S_PSD v3	* S_PSD	>2000µm	>2000µm		10	1	%	Soil: Particle Size (mechanically dispersed)	Oven dry (48 hours at 65°C)	
* S_PSD v3	* S_PSD	10µm to 63µm	10µm to 63µm		8	1	%	Soil: Particle Size (mechanically dispersed)	Oven dry (48 hours at 65°C)	
* S_PSD v3	* S_PSD	2µm to 10µm	2µm to 10µm		8	1	%	Soil: Particle Size (mechanically dispersed)	Oven dry (48 hours at 65°C)	
* S_PSD v3	* S_PSD	2µm to 20µm	2µm to 20µm		5	1	%	Soil: Particle Size (mechanically dispersed)	Oven dry (48 hours at 65°C)	
* S_PSD v3	* S_PSD	20µm to 200µm	20µm to 200µm		8	1	%	Soil: Particle Size (mechanically dispersed)	Oven dry (48 hours at 65°C)	
* S_PSD v3	* S_PSD	200µm to 2000µm	200µm to 2000µm		10	1	%	Soil: Particle Size (mechanically dispersed)	Oven dry (48 hours at 65°C)	
* S_PSD v3	* S_PSD	63µm to 200µm	63µm to 200µm		8	1	%	Soil: Particle Size (mechanically dispersed)	Oven dry (48 hours at 65°C)	
* S_PSD v3	* S_PSD	d(0.9)	90% of particles less than		0	1	µm	Soil: Particle Size (mechanically dispersed)	Oven dry (48 hours at 65°C)	
* S_PSD v3	* S_PSD	Obscuration	Obscuration		0	1	%	Soil: Particle Size (mechanically dispersed)	Oven dry (48 hours at 65°C)	
* S_SCP_ICP v1	* S_SCP_ICP	S	Sulfur	10B3	10	1	mg/kg	Soil: S extractable 0.01M Ca(H2PO4)2 ICP	Oven dry (48 hours at 40°C)	
S_DUM_TOC v4	S_DUM_TOC	OC	Organic carbon	6B3a	10	0.05	%	Soil: Total Organic Carbon; Combustion	Oven dry (48 hours at 40°C)	
S_WALKLEY v2	S_WALKLEY	OC	Organic carbon	6A1	10	0.03	%	Soil: C organic (Walkley & Black)	Air dry (48 hours at 40°C)	
S_COLWELL v2	S_COLWELL	P	Phosphorus (Colwell)	9B2	10	2	mg/kg	Soil: P extractable 0.5M NaHCO3 AA	Oven dry (48 hours at 40°C)	
S_AQ4_EL v1	S_AQ4_EL	EC	Electrical conductivity	3A1	10	0.01	dS/m	Soil: pH EC Aqueous (1:5)	Oven dry (48 hours at 40°C)	
S_AQ4_EL v1	S_AQ4_EL	pH	pH	4A1	5	0	-	Soil: pH EC Aqueous (1:5)	Oven dry (48 hours at 40°C)	
* S_KJ_AA v4	* S_KJ_AA	TKN	Kjeldahl Nitrogen	7A2a	10	0.013	%	Soil: Total N and P Kjeldahl digest AA	Air dry (48 hours at 40°C)	Soil: Total N and P Kjeldahl digest AA

Queensland Government

Department of Environment and Science - Chemistry Centre

Methods of Analysis

Job No: 23-0451

Report ID: 23-0451-F-V1

Method ID	Method Name	Analyte	Name	ALHS	Uncertainty +_%	PQL	Unit	Method Description	Reporting Basis	Method Notes
* S_KJ_AA v4	* S_KJ_AA	TKP	Kjeldahl Phosphorus	9A3a	10	0.013	%	Soil: Total N and P Kjeldahl digest AA	Air dry (48 hours at 40°C)	Soil: Total N and P Kjeldahl digest AA
* S_R1-R2 v2	* S_R1-R2	R1	Dispersion Ratio (R1)	2Z1_R1	0	0.1		Soil: R1-R2 Dispersion Ratios	Oven dry (48 hours at 40°C)	
* S_R1-R2 v2	* S_R1-R2	R2	Dispersion Ratio (R2)	2Z1_R2	0	0.1		Soil: R1-R2 Dispersion Ratios	Oven dry (48 hours at 40°C)	
* S_PSD_WT v1	* S_PSD_WT	PSD	Particle Size Distribution			0		Sediment: Particle Size Wt batch for linked analysis	As received	Sediment: Particle Size Wt Batch
* S_PSD_MECD v1	* S_PSD_MECD	<0.24µm	<24 µm (Extremely fine clay)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	<62.5µm	<62.5 µm (Silt and Clay)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	0.5µm to 0.24µm	0.5 µm - 0.24 µm - (Very fine clay)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	1µm to 0.5µm	1 µm - 0.5 µm (Fine clay)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	1000µm to 500µm	1000 µm - 500 µm (Coarse sand)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	125µm to 62µm	125 µm - 62 µm (Very fine sand)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	16µm to 8µm	16 µm - 8 µm (Fine silt)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	2µm to 1µm	2 µm - 1 µm (Medium clay)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	2000µm to 1000µm	2000 µm - 1000 µm (Very coarse sand)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	250µm to 125µm	250 µm - 125 µm (Fine sand)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	31µm to 16µm	31µm - 16 µm (Medium silt)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	4µm to 2µm	4 µm - 2 µm (Coarse clay)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	500µm to 250µm	500 µm - 250 µm (Medium sand)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	62µm to 31µm	62 µm - 31 µm (Coarse silt)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	8µm to 4µm	8 µm - 4 µm (Very fine silt)		10	1	%	Sediment: Particle Size (mechanically dispersed)	As received	

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Department of Environment and Science - Chemistry Centre

Methods of Analysis

Job No: 23-0451

Report ID: 23-0451-F-V1

Method ID	Method Name	Analyte	Name	ALHS	Uncertainty +_%	PQL	Unit	Method Description	Reporting Basis	Method Notes
* S_PSD_MECD v1	* S_PSD_MECD	d(0.9)	90% of particles less than		10	1	µm	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_MECD v1	* S_PSD_MECD	Obscuration	Obscuration		0	1	%	Sediment: Particle Size (mechanically dispersed)	As received	
* S_PSD_PRED v1	* S_PSD_PRED	<0.24µm	<0.24 µm (Extremely fine clay)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	<62.5µm	<62.5 µm (Silt and Clay)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	0.5µm to 0.24µm	0.5 µm - 0.24 µm (Very fine clay)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	1µm to 0.5µm	1 µm - 0.5 µm (Fine clay)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	1000µm to 500µm	1000 µm - 500 µm (Coarse sand)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	125µm to 62µm	125 µm - 62 µm (Very fine sand)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	16µm to 8µm	16 µm - 8 µm (Fine silt)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	2µm to 1µm	2 µm - 1 µm (Medium clay)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	2000µm to 1000µm	2000 µm - 1000 µm (Very coarse sand)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	250µm to 125µm	250 µm - 125 µm (Fine sand)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	31µm to 16µm	31 µm - 16 µm (Medium silt)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	4µm to 2µm	4 µm - 2 µm (Coarse clay)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	500µm to 250µm	500 µm - 250 µm (Medium sand)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	62µm to 31µm	62 µm - 31 µm (Coarse silt)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	8µm to 4µm	8 µm - 4 µm (Very fine silt)		10	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	d(0.9)	90% of particles less than		10	1	µm	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_PRED v1	* S_PSD_PRED	Obscuration	Obscuration		0	1	%	Sediment: Particle Size (pre dispersion)	As received	Sediment: Particle Size (pre dispersion)
* S_PSD_ULTD v1	* S_PSD_ULTD	<0.24µm	<0.24 µm (Extremely fine clay)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	<62.5µm	<62.5 µm (Silt and Clay)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	0.5µm to 0.24µm	0.5 µm - 0.24 µm (Very fine clay)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)

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Department of Environment and Science - Chemistry Centre

Methods of Analysis

Job No: 23-0451

Report ID: 23-0451-F-V1

Method ID	Method Name	Analyte	Name	ALHS	Uncertainty +_%	PQL	Unit	Method Description	Reporting Basis	Method Notes
* S_PSD_ULTD v1	* S_PSD_ULTD	1µm to 0.5µm	1 µm - 0.5 µm (Fine clay)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	1000µm to 500µm	1000 µm - 500 µm (Coarse sand)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	125µm to 62µm	125 µm - 62 µm (Very fine sand)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	16µm to 8µm	16 µm - 8 µm (Fine silt)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	2µm to 1µm	2 µm - 1 µm (Medium clay)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	2000µm to 1000µm	2000 µm - 1000 µm (Very coarse sand)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	250µm to 125µm	250 µm - 125 µm (Fine sand)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	31µm to 16µm	31 µm - 16 µm (Medium silt)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	4µm to 2µm	4 µm - 2 µm (Coarse clay)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	500µm to 250µm	500 µm - 250 µm (Medium sand)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	62µm to 31µm	62 µm - 31 µm (Coarse silt)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	8µm to 4µm	8 µm - 4 µm (Very fine silt)		10	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	d(0.9)	90% of particles less than		10	1	µm	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
* S_PSD_ULTD v1	* S_PSD_ULTD	Obscuration	Obscuration		0	1	%	Sediment: Particle Size (ultrasound dispersed)	As received	Sediment: Particle Size (ultrasound dispersed)
S_CAT_ALC v1	S_CAT_ALC	Ca	Calcium	15C1_Ca	10	0.6	cmol_c/kg	Soil: Cations exchangeable alcoholic NH4Cl pH 8.5	Oven dry (48 hours at 40°C)	
S_CAT_ALC v1	S_CAT_ALC	K	Potassium	15C1_K	12	0.05	cmol_c/kg	Soil: Cations exchangeable alcoholic NH4Cl pH 8.5	Oven dry (48 hours at 40°C)	
S_CAT_ALC v1	S_CAT_ALC	Mg	Magnesium	15C1_Mg	8	0.07	cmol_c/kg	Soil: Cations exchangeable alcoholic NH4Cl pH 8.5	Oven dry (48 hours at 40°C)	
S_CAT_ALC v1	S_CAT_ALC	Na	Sodium	15C1_Na	10	0.07	cmol_c/kg	Soil: Cations exchangeable alcoholic NH4Cl pH 8.5	Oven dry (48 hours at 40°C)	
* S_CEC v2	* S_CEC	CEC	Cation exchange capacity	15C1_CEC	15	2	cmol/kg	Soil: CEC alcoholic NH4Cl pH 8.5 AA	Oven dry (48 hours at 40°C)	
S_CAT_ALCC v1	S_CAT_ALCC	Base sat	Base saturation	15L1	10	1	%	Soil: Cations exchangeable alcoholic NH4Cl pH 8.5 calculations	Oven dry (48 hours at 40°C)	

Queensland Government

Department of Environment and Science - Chemistry Centre

Methods of Analysis

Job No: 23-0451

Report ID: 23-0451-F-V1

Method ID	Method Name	Analyte	Name	ALHS	Uncertainty +_%	PQL	Unit	Method Description	Reporting Basis	Method Notes
S_CAT_ALCC v1	S_CAT_ALCC	Ca:CEC	Calcium to cation exchange capacity ratio	15M1_Ca/CEC	10	0		Soil: Cations exchangeable alcoholic NH4Cl pH 8.5 calculations	Oven dry (48 hours at 40°C)	
S_CAT_ALCC v1	S_CAT_ALCC	Ca:Mg	Calcium to magnesium ratio	15M1_Ca/Mg	10	0		Soil: Cations exchangeable alcoholic NH4Cl pH 8.5 calculations	Oven dry (48 hours at 40°C)	
S_CAT_ALCC v1	S_CAT_ALCC	CEC:Clay	Cation exchange capacity:clay	15Z1_CEC/clay	0	0		Soil: Cations exchangeable alcoholic NH4Cl pH 8.5 calculations	Oven dry (48 hours at 40°C)	
S_CAT_ALCC v1	S_CAT_ALCC	ESP	Exchangable sodium percentage	15N1	0	0.1	%	Soil: Cations exchangeable alcoholic NH4Cl pH 8.5 calculations	Oven dry (48 hours at 40°C)	
S_CAT_ALCC v1	S_CAT_ALCC	K:CEC	Potassium to cation exchange capacity ratio	15M1_K/CEC	10	0		Soil: Cations exchangeable alcoholic NH4Cl pH 8.5 calculations	Oven dry (48 hours at 40°C)	
S_CAT_ALCC v1	S_CAT_ALCC	Mg:Ca	Magnesium to calcium ratio	15M1_Mg/Ca	10	0		Soil: Cations exchangeable alcoholic NH4Cl pH 8.5 calculations	Oven dry (48 hours at 40°C)	
S_CAT_ALCC v1	S_CAT_ALCC	Mg:CEC	Magnesium to cation exchange capacity ratio	15M1_Mg/CEC	10	0		Soil: Cations exchangeable alcoholic NH4Cl pH 8.5 calculations	Oven dry (48 hours at 40°C)	
S_CAT_ALCC v1	S_CAT_ALCC	Mg:K	Magnesium to potassium ratio	15M1_Mg/K	10	0		Soil: Cations exchangeable alcoholic NH4Cl pH 8.5 calculations	Oven dry (48 hours at 40°C)	
S_CAT_ALCC v1	S_CAT_ALCC	Na:K	Sodium to potassium ratio	15M1_Na/K	10	0		Soil: Cations exchangeable alcoholic NH4Cl pH 8.5 calculations	Oven dry (48 hours at 40°C)	
S_PSA v1	S_PSA	Clay	Clay: hydrometer <2 µm	2Z2_Clay	5	1	%	Soil: Particle size analysis	Oven dry (48 hours at 105°C)	
S_PSA v1	S_PSA	Coarse sand	Coarse sand: Sieve 0.2 – 2.0 mm	2Z2_CS	10	1	%	Soil: Particle size analysis	Oven dry (48 hours at 105°C)	
S_PSA v1	S_PSA	Fine sand	Fine sand: Sieve 0.02 – 0.2 mm	2Z2_FS	8	1	%	Soil: Particle size analysis	Oven dry (48 hours at 105°C)	
S_PSA v1	S_PSA	Silt	Silt: hydrometer 2 – 20 µm	2Z2_Silt	8	1	%	Soil: Particle size analysis	Oven dry (48 hours at 105°C)	
S_PSA v1	S_PSA	Total		2Z2_sum	0	1	%	Soil: Particle size analysis	Oven dry (48 hours at 105°C)	
S_CAT_EQ v3	S_CAT_EQ	Ca	Calcium	15A1_Ca	10	0.14	cmol_c/kg	Soil: Cations extractable NH4Cl pH 7 ICP	Oven dry (48 hours at 40°C)	
S_CAT_EQ v3	S_CAT_EQ	K	Potassium	15A1_K	10	0.03	cmol_c/kg	Soil: Cations extractable NH4Cl pH 7 ICP	Oven dry (48 hours at 40°C)	
S_CAT_EQ v3	S_CAT_EQ	Mg	Magnesium	15A1_Mg	10	0.03	cmol_c/kg	Soil: Cations extractable NH4Cl pH 7 ICP	Oven dry (48 hours at 40°C)	

RESULTS OF SOIL ANALYSIS

40 samples supplied by Epic Environmental Pty Ltd on 4/07/2023. Lab Job No. P2645.
Samples submitted by Andrew Hughes. Your Job: BCL230021.01
Level 17 BRISBANE QLD 4000

SAMPLE ID	*Job No.*	Emerson Dispersion Class
	Method	***See sheet 2 - Emerson Aggregate Test (EAT)*
SP01_01	*P2645/1*	4
SP01_02	*P2645/2*	4
SP01_03	*P2645/3*	4
SP01_04	*P2645/4*	4
SP01_05	*P2645/5*	4
SP06_06	*P2645/6*	4
SP01_07	*P2645/7*	4
SP01_08	*P2645/8*	4
SP01_09	*P2645/9*	4
SP01_10	*P2645/10*	4
SP01_11	*P2645/11*	4
SP01_12	*P2645/12*	4
SP01_13	*P2645/13*	4
SP01_14	*P2645/14*	4
SP02_01	*P2645/15*	4
SP03_01	*P2645/16*	4
SP04_01	*P2645/17*	4
SP04_02	*P2645/18*	4
SP05_01	*P2645/19*	4
SP05_02	*P2645/20*	2
SP05_03	*P2645/21*	4
SP05_04	*P2645/22*	4
SP05_05	*P2645/23*	4
TP01_0.0	*P2645/24*	4
TP01_0.1	*P2645/25*	3
TP01_0.9	*P2645/26*	2
TP01_1.35	*P2645/27*	2
TP01_1.70	*P2645/28*	3
TP03_0.0	*P2645/29*	4
TP03_0.1	*P2645/30*	3
TP03_0.4	*P2645/31*	2
TP04_0.0	*P2645/32*	4
TP04_0.1	*P2645/33*	3
TP04_0.85	*P2645/34*	3
TP04_1.85	*P2645/35*	3
TP05_0.0	*P2645/36*	3
TP05_0.1	*P2645/37*	3
TP05_0.4	*P2645/38*	3
TP05_0.7	*P2645/39*	4
TP05_1.5	*P2645/40*	3

Notes:

1. All results as dry weight DW - samples were dried at 40oC for 24-48hrs prior to crushing and analysis.
2. Australian Standard 1289.3.8.1-1997 (see summary attached as sheet 2)
3. Analysis conducted between sample arrival date and reporting date.
4. ** NATA accreditation does not cover the performance of this service.
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8. This report was issued on 31/07/2023.

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

checked:.....
Graham Lancaster

GRAIN SIZE ANALYSIS (hydrometer techniques)

2 soil samples supplied by Epic Environmental Pty Ltd on 4th July, 2023 - Lab Job No. P2646
Analysis requested by Andrew Hughes. Job Ref: BCL230021.01
Level 17, 95 North Quay BRISBANE QLD 4000

SAMPLE ID	Lab Code	TEXTURE USDA classification	TEXTURE ISSS classification	MOISTURE CONTENT (105 °C) (% Moisture)	GRAVEL > 2 mm (%)	SAND > 50 µm USDA (< 2 mm fraction)	SAND > 20 µm ISSS (< 2 mm fraction)	SILT 2–50 µm USDA (< 2 mm fraction)	SILT 2–20 µm ISSS (< 2 mm fraction)	CLAY < 2 µm (< 2 mm fraction)	R1 DISPERSION	R2 DISPERSION
QC101	P2646/1	Silty clay	Silty Clay	18.2%	0.4%	11.0%	22.0%	47.6%	36.7%	41.3%	0.53	0.20
QC200	P2646/2	Clay	Clay	9.9%	19.1%	19.9%	25.1%	19.3%	14.1%	60.8%	0.16	0.04

Note:

1. The Hydrometer Analysis method was used to determine the percentage sand, silt and clay,
modified from SOP meth004 (California Dept of Pesticide Regulation), using method of Gee & Bauder (1986)," &
in Methods of Soil Analysis. Part 1 Agron. Monogr. 9 (2nd Ed). Klute, A., American Soc. of Agronomy Inc., Soil Sci. Soc. America Inc., Madison WI: 383-411.
2. The texture classification was based on the hydrometer results and the appropriate texture triangle.
3. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (see EAL website: scu.edu.au/eal).
4. This report is not to be reproduced except in full.
5. This report was issued on 02/08/2023.

checked: .....
Graham Lancaster (Nata signatory)
Laboratory Manager

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AGRICULTURAL SOIL ANALYSIS REPORT

2 samples supplied by Epic Environmental Pty Ltd on 04/07/2023. Lab Job No.P2646

Analysis requested by Andrew Hughes. Your Job: BCL230021.01

Level 17 BRISBANE QLD 4000

			Sample 1	Sample 2	*Heavy Soil*	*Medium Soil*	*Light Soil*	*Sandy Soil*
		Sample ID:	QC101	QC200				
		Crop:	Soil	Soil				
		Client:	Calliope Soil Survey	Calliope Soil Survey	*Clay*	*Clay Loam*	*Loam*	*Loamy Sand*
	Parameter		Method reference	P2646/1	P2646/2	Indicative guidelines - refer to Notes 6 and 8			
	Phosphorus (mg/kg P)		**Rayment & Lyons 2011 - 9B2 (Colwell)	6.1	7.2	*80*	*50*	*45*	*35*
	Nitrate Nitrogen (mg/kg N)		**Inhouse S37 (KCl)	1.2	12	*15*	*13*	*10*	*10*
	Ammonium Nitrogen (mg/kg N)			1.9	1.3	*20*	*18*	*15*	*12*
	Sulfur (mg/kg S)			16	25	*10.0*	*8.0*	*8.0*	*7.0*
	pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)	8.21	8.43	*6.5*	*6.5*	*6.3*	*6.3*
	Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.144	0.154	*0.200*	*0.150*	*0.120*	*0.100*
	Estimated Organic Matter (% OM)		**Calculation: Total Carbon x 1.75	1.4	2.1	*> 5.5*	*>4 .5*	*> 3.5*	*> 2.5*
	Exchangeable Calcium	(cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	15	26	*15.6*	*10.8*	*5.0*	*1.9*
		(kg/ha)		6,916	11,615	*7000*	*4816*	*2240*	*840*
		(mg/kg)		3,087	5,185	*3125*	*2150*	*1000*	*375*
	Exchangeable Magnesium	(cmol+/kg)		8.2	0.93	*2.4*	*1.7*	*1.2*	*0.60*
		(kg/ha)		2,228	253	*650*	*448*	*325*	*168*
		(mg/kg)		995	113	*290*	*200*	*145*	*75*
	Exchangeable Potassium	(cmol+/kg)		0.30	<0.12	*0.60*	*0.50*	*0.40*	*0.30*
		(kg/ha)		265	<112	*526*	*426*	*336*	*224*
		(mg/kg)		118	<50	*235*	*190*	*150*	*100*
	Exchangeable Sodium	(cmol+/kg)		0.83	0.08	*0.3*	*0.26*	*0.22*	*0.11*
		(kg/ha)		430	44	*155*	*134*	*113*	*57*
		(mg/kg)		192	19	*69*	*60*	*51*	*25*
	Exchangeable Aluminium	(cmol+/kg)	**Inhouse S37 (KCl)	0.04	0.03	*0.6*	*0.5*	*0.4*	*0.2*
		(kg/ha)		7.3	6.7	*121*	*101*	*73*	*30*
		(mg/kg)		3.3	3.0	*54*	*45*	*32*	*14*
	Exchangeable Hydrogen	(cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	*0.6*	*0.5*	*0.4*	*0.2*
		(kg/ha)		<1	<1	*13*	*11*	*8*	*3*
		(mg/kg)		<1	<1	*6*	*5*	*4*	*2*
	Effective Cation Exchange Capacity (ECEC) (cmol+/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	25	27	*20.1*	*14.3*	*7.8*	*3.3*
	Calcium (%)		**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	62	96	*77.6*	*75.7*	*65.6*	*57.4*
	Magnesium (%)			33	3.4	*11.9*	*11.9*	*15.7*	*18.1*
	Potassium (%)			1.2	0.22	*3.0*	*3.5*	*5.2*	*9.1*
	Sodium - ESP (%)			3.4	0.31	*1.5*	*1.8*	*2.9*	*3.3*
	Aluminium (%)			0.15	0.12	*6.0*	*7.1*	*10.5*	*12.1*
	Hydrogen (%)			0.00	0.00				
	Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol+/kg)	1.9	28	*6.5*	*6.4*	*4.2*	*3.2*

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AGRICULTURAL SOIL ANALYSIS REPORT

2 samples supplied by Epic Environmental Pty Ltd on 04/07/2023. Lab Job No.P2646

Analysis requested by Andrew Hughes. Your Job: BCL230021.01

Level 17 BRISBANE QLD 4000

			Sample 1	Sample 2	*Heavy Soil*	*Medium Soil*	*Light Soil*	*Sandy Soil*
		Sample ID:	**QC101**	**QC200**				
		Crop:	**Soil**	**Soil**				
		Client:	**Calliope Soil Survey**	**Calliope Soil Survey**	*Clay*	*Clay Loam*	*Loam*	*Loamy Sand*
	Parameter	**Method reference**	**P2646/1**	**P2646/2**	**Indicative guidelines - refer to Notes 6 and 8**			
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	<0.5	<0.5	*6.0*	*5.0*	*4.0*	*3.0*
	Manganese (mg/kg)		41	6.9	*25*	*22*	*18*	*15*
	Iron (mg/kg)		44	4.7	*25*	*22*	*18*	*15*
	Copper (mg/kg)		3.8	0.54	*2.4*	*2.0*	*1.6*	*1.2*
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.36	0.17	*2.0*	*1.7*	*1.4*	*1.0*
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	44	5.3	*50*	*45*	*40*	*35*
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	0.77	1.2	*> 3.1*	*> 2.6*	*> 2.0*	*> 1.4*
	Total Nitrogen (%)		0.08	0.07	*> 0.30*	*> 0.25*	*> 0.20*	*> 0.15*
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	9.8	18	*10–12*	*10–12*	*10–12*	*10–12*
	Basic Texture	**Inhouse S65	Clay	Clay	..	..	..	..
	Basic Colour		Brownish	Red	..	..	..	..
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	92	99	..	..	..	..
	Chloride (mg/kg)	**Rayment & Lyons 2011 - 5A3a	21	16	..			
	pH	**Rayment & Lyons 2011 - 4B4 ($CaCl_2$)	7.4	7.8	..			

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
10. Conversions for 1 cmol+/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
13. ** NATA accreditation does not cover the performance of this service.
14. Analysis conducted between sample arrival date and reporting date.
15. This report is not to be reproduced except in full. Results only relate to the item tested.
16. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer SCU.edu.au/eal/t&cs).
17. This report was issued on 19/07/2023.

Quality Checked: Kris Saville
Agricultural Co-Ordinator

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Atterberg Limits Report

Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 1/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Brown**

Sample Number :	**S/205511**	Sampling Method :	**As Received**
Date Tested :	**17/07/2023**	Time :	**09:01**
Material Source :	-	Location 1 :	**TP01_0.0**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Nil Occurred**
Mould Length (mm) :	**125**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**51**	**22**	**29**	**13.0**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Joshua Andres - Signatory

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Atterberg Limits Report

Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 2/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Brown**

Sample Number :	**S/205512**	Sampling Method :	**As Received**
Date Tested :	**17/07/2023**	Time :	**09:01**
Material Source :	-	Location 1 :	**TP01_0.1**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Nil Occurred**
Mould Length (mm) :	**128**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**49**	**21**	**28**	**12.0**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

Protest Engineering (Gold Coast) Accreditation Number - 19667

Base Laboratory Site Number - 22838 - Gold Coast

Base Laboratory Address - 8/36 Blanck Street, ORMEAU, QLD 4208

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Atterberg Limits Report

Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 3/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Black**

Sample Number :	**S/205513**	Sampling Method :	**As Received**
Date Tested :	**19/07/2023**	Time :	**09:01**
Material Source :	-	Location 1 :	**TP01_0.9**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Cracking and curling Occurred**
Mould Length (mm) :	**124**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**54**	**26**	**28**	**10.5**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

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Atterberg Limits Report

Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 4/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Light Brown**

Sample Number :	**S/205514**	Sampling Method :	**As Received**
Date Tested :	**19/07/2023**	Time :	**09:01**
Material Source :	-	Location 1 :	**TP01_1.35**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Curling Occurred**
Mould Length (mm) :	**124**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**55**	**25**	**30**	**14.0**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Base Laboratory Address - 8/36 Blanck Street, ORMEAU, QLD 4208

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Atterberg Limits Report

Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 5/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Light Brown**

Sample Number :	**S/205515**	Sampling Method :	**As Received**
Date Tested :	**19/07/2023**	Time :	**09:01**
Material Source :	-	Location 1 :	**TP01_1.70**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Curling and cracking Occurred**
Mould Length (mm) :	**125**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**49**	**22**	**27**	**13.0**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

Protest Engineering (Gold Coast) Accreditation Number - 19667

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Atterberg Limits Report

Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 6/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Black**

Sample Number :	**S/205516**	Sampling Method :	**As Received**
Date Tested :	**19/07/2023**	Time :	**09:02**
Material Source :	-	Location 1 :	**TP03_0.0**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Cracking and Curling Occurred**
Mould Length (mm) :	**122**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**53**	**21**	**32**	**7.5**
Specifications :				

Remarks :	-

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Note: The results contained in this report relate only to the item/s that were tested/sampled
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Atterberg Limits Report

Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 7/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Black**

Sample Number :	**S/205517**	Sampling Method :	**As Received**
Date Tested :	**19/07/2023**	Time :	**09:02**
Material Source :	-	Location 1 :	**TP03_0.1**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Cracking and Curling Occurred**
Mould Length (mm) :	**128**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**52**	**23**	**29**	**8.5**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Atterberg Limits Report

Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 8/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Brown**

Sample Number :	**S/205518**	Sampling Method :	**As Received**
Date Tested :	**19/07/2023**	Time :	**09:02**
Material Source :	-	Location 1 :	**TP03_0.4**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Cracking and curling Occurred**
Mould Length (mm) :	**125**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**47**	**16**	**31**	**16.5**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 9/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Brown**

Sample Number :	**S/205519**	Sampling Method :	**As Received**
Date Tested :	**18/07/2023**	Time :	**09:02**
Material Source :	-	Location 1 :	**TP04_0.0**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Nil Occurred**
Mould Length (mm) :	**125**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**52**	**22**	**30**	**11.0**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 10/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Brown**

Sample Number :	**S/205520**	Sampling Method :	**As Received**
Date Tested :	**18/07/2023**	Time :	**09:02**
Material Source :	-	Location 1 :	**TP04_0.1**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**- Occurred**
Mould Length (mm) :	**125**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**50**	**22**	**28**	**12.0**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 11/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Brown**

Sample Number :	**S/205521**	Sampling Method :	**As Received**
Date Tested :	**18/07/2023**	Time :	**09:02**
Material Source :	-	Location 1 :	**TP04_0.85**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Curling Occurred**
Mould Length (mm) :	**126**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**34**	**18**	**16**	**9.0**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Atterberg Limits Report

Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 12/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Brown**

Sample Number :	**S/205522**	Sampling Method :	**As Received**
Date Tested :	**18/07/2023**	Time :	**09:02**
Material Source :	-	Location 1 :	**TP04_1.85**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Cracking Occurred**
Mould Length (mm) :	**125**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**70**	**22**	**48**	**18.0**
Specifications :				

Remarks :	-

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Note: The results contained in this report relate only to the item/s that were tested/sampled
Accredited for Compliance with ISO/ IEC 17025 - Testing
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Atterberg Limits Report

Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 13/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Brown**

Sample Number :	**S/205523**	Sampling Method :	**As Received**
Date Tested :	**18/07/2023**	Time :	**09:02**
Material Source :	-	Location 1 :	**TP05_0.0**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Nil Occurred**
Mould Length (mm) :	**125**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**51**	**24**	**27**	**12.5**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Atterberg Limits Report

Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 14/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Brown**

Sample Number :	**S/205524**	Sampling Method :	**As Received**
Date Tested :	**19/07/2023**	Time :	**09:02**
Material Source :	-	Location 1 :	**TP05_0.1**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Cracking Occurred**
Mould Length (mm) :	**126**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**30**	**19**	**11**	**5.0**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 15/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Clayey SAND - Brown**

Sample Number :	**S/205525**	Sampling Method :	**As Received**
Date Tested :	**19/07/2023**	Time :	**09:02**
Material Source :	-	Location 1 :	**TP05_0.4**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Curling Occurred**
Mould Length (mm) :	**125**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**24**	**11**	**13**	**7.0**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 16/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Brown**

Sample Number :	**S/205526**	Sampling Method :	**As Received**
Date Tested :	**18/07/2023**	Time :	**09:02**
Material Source :	-	Location 1 :	**TP05_0.7**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Curling Occurred**
Mould Length (mm) :	**125**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**41**	**21**	**20**	**11.0**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Base Laboratory Address - 8/36 Blanck Street, ORMEAU, QLD 4208

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Client :	**Epic Environmental Pty Ltd**	Report Number :	**SR/PTP/12350 - 17/1**
Client Address :	**Level 17/95 North Quay, Brisbane City, 4000, QLD**	Report Date :	**20/07/2023**
Project Name :	**Calliope Soil Survey - BCL230021.01**	Test Request :	-
Project Number :	**PTP/12350**	**Page 1 of 1**	
Location :	**Brisbane**		

Test Methods :	**AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.3.3.1, AS1289.2.1.1**
Material Description :	**Sandy CLAY - Brown**

Sample Number :	**S/205527**	Sampling Method :	**As Received**
Date Tested :	**18/07/2023**	Time :	**09:02**
Material Source :	-	Location 1 :	**TP05_1.5**
For use as :	-	Location 2 :	-
Lot Number :	-	Location 3 :	-
ATT Specification Number :	**N/A**	Location 4 :	-

History of Sample :	**Air Dried**
Method of Preparation :	**Dry Sieved**
Linear Shrinkage & Defects :	**Cracking Occurred**
Mould Length (mm) :	**126**

Atterberg Limits Test Results	*Liquid Limit (%) :*	*Plastic Limit (%) :*	*Plasticity Index (%) :*	*Linear Shrinkage (%) :*
Results :	**40**	**22**	**18**	**8.5**
Specifications :				

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

Protest Engineering (Gold Coast) Accreditation Number - 19667

Base Laboratory Site Number - 22838 - Gold Coast

Base Laboratory Address - 8/36 Blanck Street, ORMEAU, QLD 4208

APPROVED SIGNATORY

Joshua Andres - Signatory

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Appendix E Landholder Statement

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Graymont Calliope
MS 24 Taragoola Road
Calliope QLD 4680

07 July 2025

Landholder Statement – Retention of Access Tracks and Eastern/Western Levees
Calliope Limestone Quarry (EPML00969013)

Graymont (Calliope) Pty Ltd is the landowner (Landowner) of Lot 7SP215269, 22SP215268, 26SP228426, 90SP275218, 100CTN1823, 1RP610128, and 4RP610128 (the Land) which contain the following mining leases (MLs); ML3594, ML3595, ML3596, ML3597, ML3598, ML3599, ML3600, ML3602, ML3603, ML3604, ML3605, ML3606, ML3608, ML3609, ML80036, ML80189, ML80190, ML80191 and ML80192. The Landowner agrees that all access tracks, as well as the eastern and western levees currently on the Land, as identified in the 2023 Progressive Rehabilitation and Closure Plan (PRC Plan) submission to the Department of Environment and Science, will be retained at end of mine life after relinquishment of all MLs, and that the Landowner will be responsible for these items.

Kind regards



Simon Havis
Site Manager, Graymont
T +61 418 816 510
Simon.havis@graymont.com

Appendix F Hydrogeological Assessment

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Calliope

Hydrogeological Assessment for Operations Progressive Rehabilitation and Closure Plan and Environmental Authority amendment



Contributors:

Mineral Resource Development
Operations
Consultants

GRAYMONT

Rev	Date	Prepared By	Comments
4	June 2026	Ian Oppy	Updated to address October 2025 Information Request Notice
3	June 2025	Ian Oppy	Updated to address November 2024 Information Request Notice
2	February 2024	Stephen Feiss	Updated to address August 2023 Information Request Notice
1	March 2023	Stephen Feiss	Created from Guidelines for activities with impacts to water and for Progressive Rehabilitation and Closure (PRC) Plans

FORWARD

This Hydrogeological Assessment report has been prepared to support a Progressive Rehabilitation and Closure (PRC) Plan application in consideration of a planned Environmental Authority (EA) amendment.

The report versions have many common threads but there is a technical difference between versions 1-2 and versions 3-4 with change of authorship.

In Versions 1-2 elevated water levels in Pit 3 following large rainfall events were attributed to be from leakage through the western bund wall, in conjunction with large groundwater volumes entering the pit void by groundwater discharge. The aquifer was considered to be semi-confined to confined. A final pit void Pit 3-4 Water Balance was constructed based on high groundwater inflow which predicted that pit water could potentially overflow into Awoonga Dam.

In Version3 elevated water levels in Pit 3 following large rainfall events were attributed to be surface water run-off from the Farm Dam sub-catchment and groundwater appears to be a minor component of inflows to Pit 3. The aquifer is unconfined. This understanding was based on the results of investigations in 2011, 2018 and investigative drilling undertaken in 2025. A final void Pit 3-4 Water Balance Model was constructed based on minor groundwater inflow which predicted that pit water would not overflow into Awoonga Dam.

Further hydrogeological data has been gathered in 2025/26 and the groundwater monitoring network expanded from two to ten monitoring bores. Water level, sampling with analysis and slug testing has been undertaken on all monitoring bores. Additional data aligns and supports the technical understanding outlined in Version 3 which is the technical framework for this Hydrogeological Assessment.

Water Balance modelling has been undertaken of Pit 3, Pit 2 final void and Pit 3-4 final void.

The Pit 2 and Pit 4 Water Balance models predict water fill and the accumulation of salt expressed as Electrical Conductivity (µS/cm), pH and Total Suspended Solids from inflows and evaporation under the current and predicted High GHG climate scenarios.

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APPENDICES

Appendix 1: Bore Completion Reports FM7 to FM13

Appendix 2: Bore Monitoring March 2026 Field notes and Sampling Results Laboratory Certificate of Analysis

Appendix 3: Slug test Analysis June 2025 and June 2026

1 INTRODUCTION

1.1 Report Objectives

A Hydrogeological Assessment report has been prepared to support a Progressive Rehabilitation and Closure (PRC) Plan and a planned Environmental Authority (EA) amendment for the Calliope Limestone mine.

1.2 Project Location

The Calliope Limestone mine (Calliope) is located 12 kilometres south of the township of Calliope and 36km south of the major centre of Gladstone, Queensland Australia. The Calliope is covered by nineteen Mining Leases as shown in Figure 1 and is bordered to the east, west and south by Awoonga Dam, which is the fresh water source for the Gladstone and Calliope region.

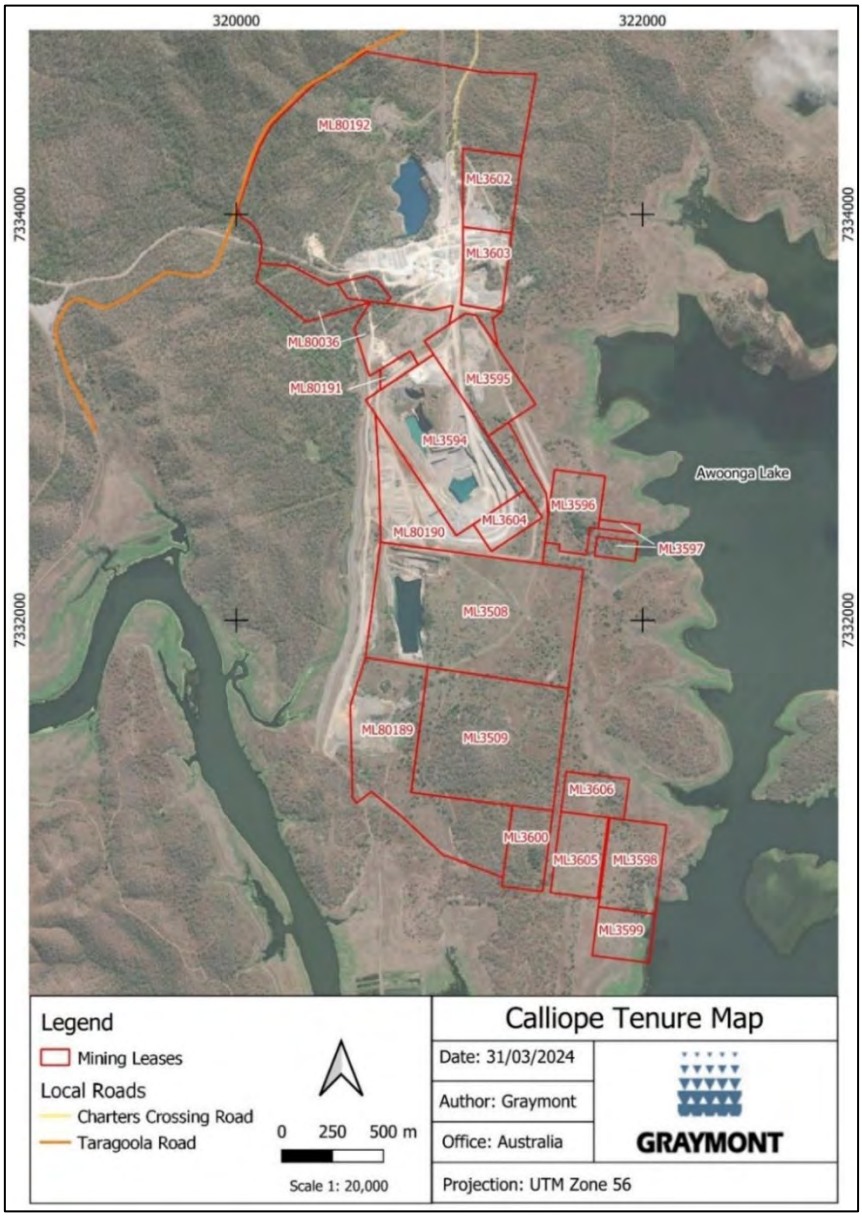


Figure 1 Calliope Tenure Map

The Calliope operational areas are predominately located on Graymont freehold land except for Lot 90 on SP275218 (Figure 2) which is freehold owned by the Gladstone Area Water Board (GAWB), who manage the Awoonga Dam water storage. Graymont has a land access agreement with GAWB.

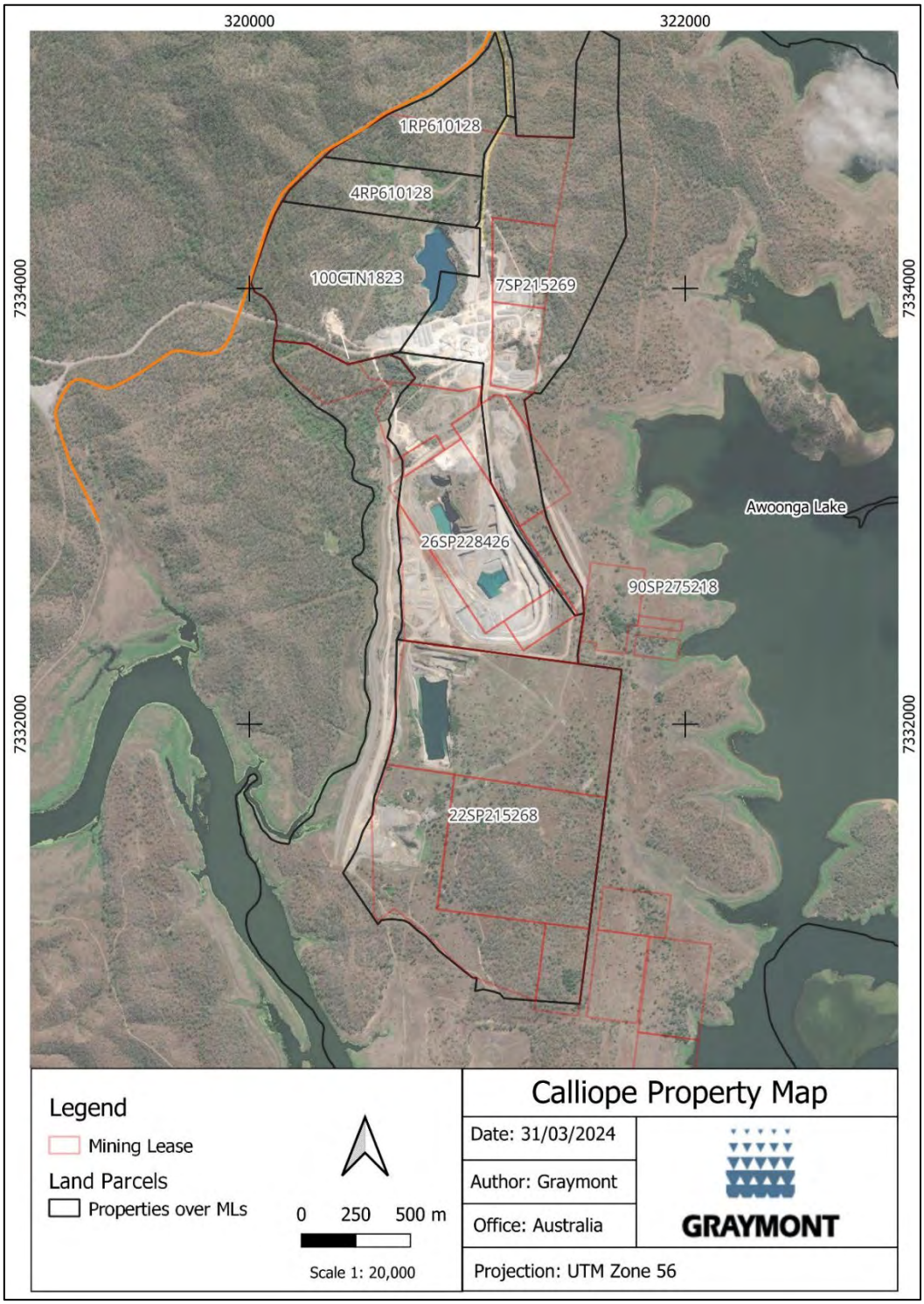


Figure 2 Calliope Property Map

A site map is provided below in Figure 3 which shows site elements which relevant to this report, including mining voids, flood protection bund walls, Waste Dump, Farm Dam and Awoonga Dam.

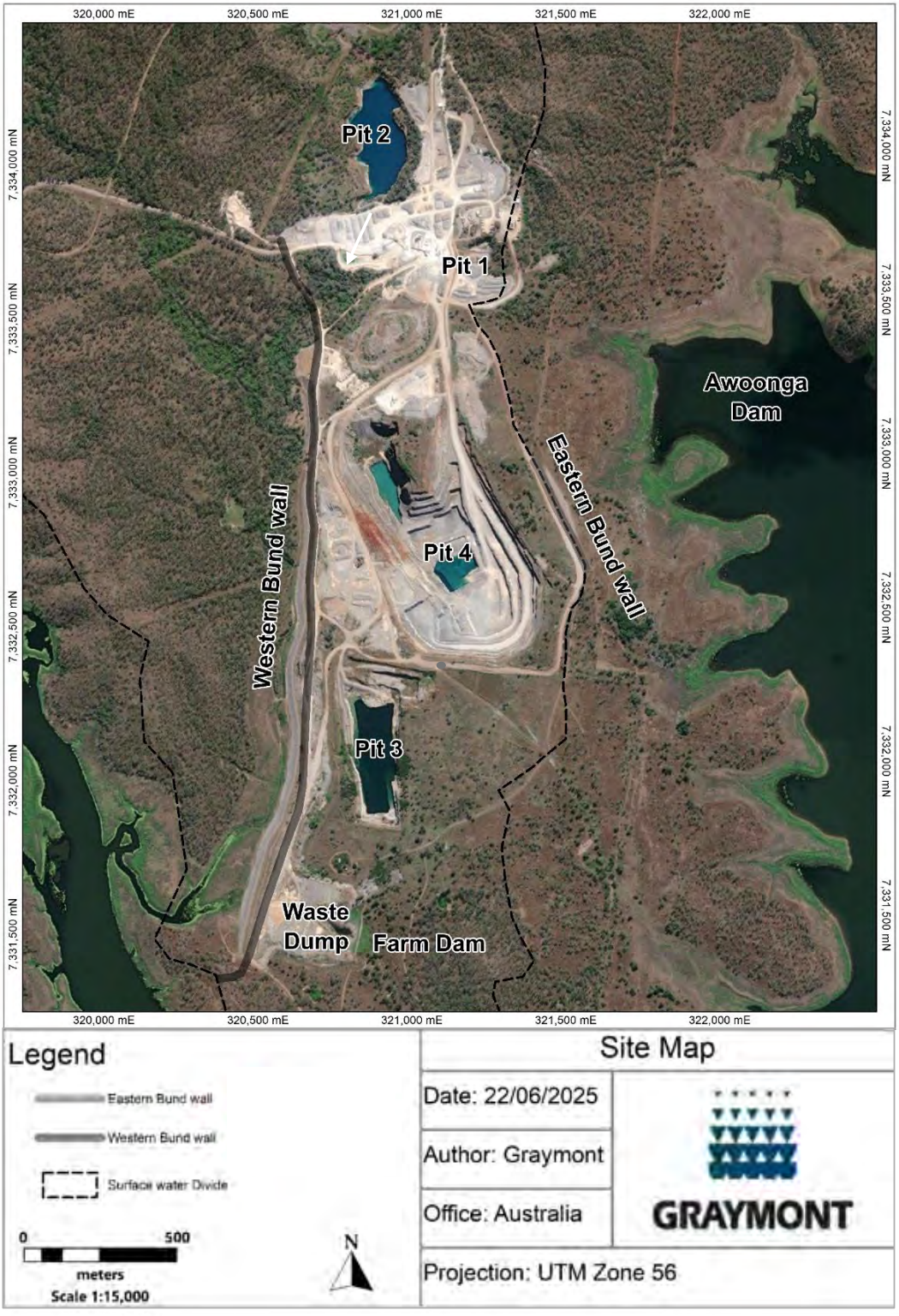


Figure 3 Site Map

At the time of this report only one of the four pits, Pit 4, was active in the mining of limestone. It is planned in future decades to extend the active mine to include Pit 3 immediately south of Pit 4. The combined future mine pit will be herein referred to as Pit 3-4. The main high water bunds protecting the site from rising surface water levels in Lake are the Western Bund and Eastern Bund Report.

1.3 Hydrogeological Assessment objectives

The aim of this Hydrogeological Assessment is to address the requirements of the following as they relate to groundwater impacts, including:

- Sections 2, 3, and 4 of the *Guideline for Application requirements for activities with impacts to water* (ESR/2015/1837)
- Sections 3.1 and 3.6.1 of the *Statutory guideline Progressive rehabilitation and closure plans (PRC plans)* (ESR2019/4964)
- Items 16, 17 and 18 of the *Information Request Notice* for the application of a PRCP schedule (reference: C-EATPRCP-100177101) dated 7 August 2023
- Items 6 and 7 of the *Information Request Notice* for the amendment application for the EA (reference: C-EA-100720590) dated 13 November 2024
- Items 5,6,9, 10 and 11 of the *Information Request Notice* for the application of a PRCP schedule (reference: C-PRCP-100905311) dated 10 October 2025
- Conditions C21 and C22 e) of the draft EPML00969013 Permit renewed 15 July 2025

A cross-reference table detailing the relevant requirements and how these have been addressed throughout the report is provided below.

Ref.	Regulatory Requirement	How addressed in this Report	Report Section
Guideline for Application requirements for activities with impacts to water			
2	The activity will be managed so that stormwater contaminated by the activity that may cause an adverse effect on an environmental value will not leave the site without prior treatment.	Storm water runoff is managed in accordance with the Calliope Water Management Plan (WMP). Details of how the WMP ensures no contamination of water values has been provided in this Rreport.	4.6.1
2	Any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland.	Pit water discharge is in accordance with the WMP which provides control measures for managing water discharge to achieve the EA surface water contaminant release limits.	4.6.1
2	The activity will be managed so that adverse effects on environmental values are prevented or minimised.	The WMP describes the risks and control measures required to manage water flow and quality on site.	4.6.1
2	There will be no direct or indirect release of contaminants to groundwater from the operation of the activity.	There is little groundwater at Calliope. Groundwater outside the pit voids slowly drains into the pit voids where it is mixed with surface water to become pit water. Pit water is released in accordance with EA conditions.	8.3 7.2.3
2	There will be no actual or potential adverse effect on groundwater from the operation of the activity, or, the activity will be managed to prevent or minimise adverse effects on groundwater or any associated surface ecological systems.	Groundwater monitoring is undertaken in accordance with EA license requirements to assess potential adverse effects to groundwater and any non-compliances are investigated and any required control measures would be implemented.	2.1.2
3	Site plan Identify on a scaled site plan 1. Topographical contours 2. Identify the direction(s) of surface water runoff and drainage lines that pass through, or are near, the site and any surface waters 3. Any existing or proposed water bores or groundwater monitoring wells within or on land adjacent to the site.	A plan of the Groundwater Monitoring Network is provided with drainage lines and topographical contours	8.2.5
3	Provide a conceptual model showing the movement (including direction and rate of flow) of groundwater in the area. This requirement is essential for activities which have	A conceptual model is provided showing the movement of groundwater.	11

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Ref.	Regulatory Requirement	How addressed in this Report	Report Section
	a high risk of contaminating groundwater to determine appropriate locations for compliance monitoring.		
3	If the environmental authority application is for a resource ERA (mining or petroleum), identify any environmentally sensitive places within or adjacent to the proposed mining tenement.	The environmentally sensitive places adjacent to the project are Upper norther creeks area, which includes the Raggote Creek catchment – Calliope; Awoonga Dam and groundwater. Environmental values for these have been provided in the report.	3.2
3	Provide a description of hydrogeological features of the site which include soil and rock types (including porosity, permeability) and stratigraphy (including faulting and fracture propensity).	Project Description includes soil, geology and aquifers.	4.2 4.3 4.5 10
3	Identify and describe any barriers which are overlying and underlying aquifers.	The aquifer is unconfined and there are no overlying or underlying barriers identified.	4.2 8.2.1
3	Identify the environmental values of potentially affected groundwater the location and depth to groundwater (including perched aquifers or water tables) and the depth to water level/potentiometric surface on the site.	Calliope environmental values are described and are in alignment with Boyne River Basin environmental values.	4.8
3	Details of any groundwater bores in the vicinity of the proposal and the uses of extracted water.	A map of registered bores within 9 km of the site is provided and discussed.	3.9.2
3	Details of the background quality of groundwater, specifically for common anions and cations to characterise the water and for other qualities that may be affected by the proposed ERA e.g. hydraulic conductivity, transmissivity and flow rate. This is only required for activities which pose a material or significant risk of impacting on the quality of groundwater through direct or indirect releases or alteration of hydrology.	Groundwater chemistry based on historical sampling and analysis is provided and discussed.	9.2 9.3
3	Results of any testing to confirm aquifer properties.	Slug test results from 2002 and 2025 provide an estimate of Hydraulic Conductivity but there is insufficient groundwater for pump testing.	10.3.2
3	Where there are underground ecosystems or groundwater dependant ecosystems associated with the groundwater and the proposed activity presents a real risk to these ecosystems, details of those ecosystems and their interactions with the groundwater will be required.	A search of Queensland Globe revealed that there are no GDE's in the Ragotte Creek catchment	4.8.1
4	Identification of potential contaminants and expected concentrations and/or daily and annual loads (including range)	EA conditions stipulate potential contaminants with release limits for surface water and trigger values for groundwater. Daily and annual loads have not been calculated.	2.1.2
4	Identification of whether any contaminants are persistent, toxic, or bio-accumulative and Description of the source(s) of contaminants	Potential contaminants of concern are listed on EA licence and discussed in Project Description	2.1.2 4.6 4.7
4	Identify activities that could lead to direct or indirect impacts and unplanned / uncontrolled release of contaminants to waters, such as, spills, seeps, leaks, or stream bed and/or bank disturbance and describe the magnitude of the disturbance.	Potential contaminant sources are discussed for surface water and groundwater..	4.6 4.7
4	Where groundwater interacts with surface waters, it is necessary to identify whether the impacts on groundwater quality or elevation, will compromise any identified environmental values and water quality objectives for those waters, or adversely affect a surface ecological system (i.e. through surface–groundwater interactions), or impact on other surface environmental values e.g. agriculture, terrestrial ecosystems. In order to obtain approval for a direct release of contaminants to groundwater, the department must be satisfied that there are no other viable alternatives, and the release is to a confined aquifer and will not deteriorate the environmental values of the receiving groundwater.	Pit water, which is predominantly surface water but has a small groundwater component. Any pit water released in accordance with the EA is in accordance with the water quality limits.	2.1.2 7.2.4
4	Where the groundwater hosts an underground aquatic ecosystem, the ANZECC water quality guidelines recommends that that the highest level of protection should be provided to these ecosystems.	Not applicable – The operation does not host an underground aquatic ecosystem	n/a

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Ref.	Regulatory Requirement	How addressed in this Report	Report Section
4	Where the applicant proposes an impact to groundwater, monitoring is likely to be required prior to the commencement of the proposed ERA in order to collect sufficient baseline information, as well as at regular intervals during the life of the ERA, including during establishment and any rehabilitation and site closure, to determine if there are any adverse impacts to groundwater as a result of the operation.	Groundwater monitoring has been undertaken since 2012 and EA EPML00969013 conditions C17-24 stipulate groundwater monitoring requirements for the Calliope groundwater monitoring network, which is currently for bores FM5 and FM6.	2.1.2
4	Where there is an indirect release or potential release of contaminants to groundwater, applicants must provide the following information:	Potential sources of contaminants are described. Hydrocarbons and metals Hydrocarbons and metals are not routinely monitored in Pit 2 but FM6 provides groundwater quality data for flow in Pit2 from six monthly annually monitoring. Bore FM5 provides groundwater quality data for flow into Pit 4. Metal concentrations in both the bores are low and are at or near detection limits	4.7 7.2
	The geological stability of the relevant site for the ERA.	Geological stability is discussed in the geotechnical report.	n/a
	The location, quality and use, or potential use, of the receiving groundwater.	The regional groundwater and its use are described.	3.9
	The permeability of the earth under the place where the ERA is carried out.	Permeability of Waste Dumps is discussed in the geotechnical report. Permeability of groundwater in rock is determined from the slug tests.	10
	The presence of containment devices at the relevant site for the ERA and their effectiveness in preventing or minimising the release of the waste.	Not applicable – The operation does not have contaminant devices.	n/a
	The distance separating the receiving groundwater from any containment device.	Not applicable – The operation does not have contaminant devices.	n/a
	The potential for fluctuations in the level of the receiving groundwater.	Not applicable – The operation does not have contaminant devices.	n/a
	The way in which materials, including contaminants, will be removed from the containment system	Not applicable – The operation does not have contaminant devices.	n/a
	The way in which materials, including contaminants, will be removed from the containment system	Not applicable – The operation does not have contaminant devices.	n/a
4	Risk assessments are undertaken to determine the significance of a risk and to assist applicants and the assessing officers to decide whether it is acceptable for an ERA, or action, to proceed given the mitigation measures proposed. A risk assessment helps determine the level of environmental risk by quantifying the probability of an event happening, as well as its severity and consequences. A risk assessment may be qualitative or quantitative and can consider environmental, economic, social and other impacts. Risk assessments should not adopt assumptions that conflict with protection of water quality and environmental values of waters or compliance with s. 440ZG of the Act e.g. concluding contaminating waters in a green zone is acceptable because persons are not allowed to take the seafood for consumption.	The WMP forms part of site's Environmental Management Plan. The WMP describes the risks and control measures required to manage water flow and quality on site, monitor water quality and regulate safe water discharge from site	4.6.1
4	Groundwater impact assessment for activities that pose a high risk of impacting groundwater, a full groundwater impact assessment must be conducted including appropriate modelling to demonstrate that the ERA will not cause adverse impacts on groundwater resources.	Groundwater Impact Assessment undertaken There is little groundwater at Calliope. Water Balance Modelling undertaken is commensurate with the risk profile to groundwater users.	3.7 12
4	A groundwater impact assessment must include a detailed assessment of current groundwater resources including geological and geochemical characteristics.	Groundwater investigations and monitoring from these investigations, and from bores, have been used to characterise groundwater behaviour.	8 9
4	Hydrogeological assessment of groundwater resources including groundwater flow characteristics, storativity, hydraulic conductivity and permeability in zones to be impacted by the proposed activities.	Groundwater flow has been determined from investigative drilling and bore monitoring. Permeability has been determined from a slug test of a monitoring bore because there is insufficient groundwater for a pumping bore to accurately determine aquifer parameters including storativity.	8 9 10

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Ref.	Regulatory Requirement	How addressed in this Report	Report Section
	Details on how seepage detection between deep and shallow groundwater will be considered and managed.	Not applicable – Groundwater is shallow and unconfined.	8.2
4	Connectivity with surface water resources.	Groundwater slowly flows into mining voids so connectivity is restricted to mixing with surface water on the pit floor prior to the discharge of pit water.	8.2
4	Impact on groundwater quality as a result of the proposed ERA.	Groundwater slowly flows into mining voids so connectivity is restricted to mixing with surface water on the pit floor prior to the discharge of pit water.	8.2
4	Impact on groundwater flow regimes and drawdown.	There is insufficient groundwater for a pumping licence so there is no dewatering of the aquifer or drawdown of the aquifer.	8.2
4	Impact on existing users and future potential uses.	Groundwater slowly flows into mining voids so connectivity is restricted to mixing with surface water on the pit floor prior to the discharge of pit water. Assessment undertaken of pit water potential impacts on environmental values .	8.2 4.8
4	Numeric groundwater modelling of groundwater resources and expected impacts of the proposed ERA.	Not applicable – Groundwater modelling has been undertaken commensurate with low groundwater risk profile. There is little groundwater at site and groundwater flow is towards the mining voids.	n/a
4	Groundwater lowering/reduction in hydraulic head (from new voids e.g. caves/karst systems).	Groundwater level map has been created from groundwater monitoring and investigation level measurements. Blasting creates fractures which can extend into the pit floor which capture surface water which is artificial groundwater. There is no creation of larger scale voids.	8.3
4	Cones of depression and associated impacts.	There is no groundwater pumping and no cone of depression from pumping because there is insufficient groundwater. There are no receiving environments potentially exposed to groundwater level drawdown from the project.	8.3
4	Potential contaminants generated and the impacts on the identified environmental values. Potential sources for ground water contaminants include: − Waste rock dumps and tailings disposed underground/in pit − Workshops − Seepage from tailings dam, waste rock dumps, heap leach, process ponds or the direction of pits toward any relevant catchment or town water supply	Potential contaminants identified and control measures implemented in the Water Management Plan and the Groundwater Management Plan. Assessment undertaken of pit water potential impacts on environmental values	4.6 4.7 4.8
4.2	**Proposed management practices** Once the magnitude and risk of each impact to the environmental values is known, applicants must identify avoidance, mitigation, monitoring, reporting and offset strategies, where appropriate, to address the risks. These strategies can include physical works, processes or treatments. Similarly, they could include management or monitoring practices. In many cases, adequate environmental management will require both physical works as well as management practices. When identifying avoidance, mitigation, monitoring, reporting and offset strategies the applicant should clearly detail how the works or practices will link back to and address the previously identified risk.	Potential impacts identified and control measures implemented in the Water Management Plan and the Groundwater Management Plan. Assessment undertaken of pit water potential impacts on environmental values	4.6 4.8
4.4	**Groundwater monitoring program** One of the performance outcomes for water is establishing contingency measures. For activities that pose a high risk of impacting groundwater, applicants are strongly encouraged to establish a groundwater monitoring program for the site. The monitoring program should be suitable to monitor the impacts to the environment and provide a detection system to identity if environmental harm has or has the potential to occur.	Groundwater Monitoring network of two bores was established in 2012 and monitoring results and network suitability is annually reported to the EPA. The network has been expanded to ten monitoring bores.	8.2.5
4.4	**Water management plans**	The Water Management Plan (WMP) forms part of site's Environmental Management Plan	4.6

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Ref.	Regulatory Requirement	How addressed in this Report	Report Section
	Applicants for mining ERAs are encouraged to develop a water management plan. The primary purpose of a mining project water management plan is to examine and address all issues relevant to the importation, generation, use, and management of water on a mining project in order to minimise the quantity of water that is contaminated and released by and from the project.		
Statutory guideline Progressive rehabilitation and closure plans			
3.1	**Baseline information** In addition to the legislative requirements, the following information about the site, where relevant, is considered necessary by the administering authority (as per section 126C(1)(j) of the EP Act) to decide whether to approve the PRCP schedule: • geological setting • site hydrology and fluvial networks • groundwater levels and properties	Project Description includes soil, geology and aquifers. The site hydrology, fluvial network, groundwater levels and properties are explained throughout the document.	3-7
3.6.1	Assess the hydrogeology of the site and all connected strata and develop a conceptual model of the mine site's groundwater systems. This information must be integrated into the design of rehabilitation strategies and choice of PMLU or NUMA.	A conceptual model is provided from an assessment of site hydrogeology.	11
3.6.1	The hydrogeological assessment should include the following steps:		
	determining the groundwater occurrence including the existence of, and depth to, aquifers and aquitards	Limestone and the volcanics can form either a weak, unconfined, fracture rock aquifer or an aquitard depending upon the connectivity of fractures in these rocks. The depth to groundwater is variably but is typically 15-20 metres depth below natural surface.	4.5 10
	locating groundwater recharge and discharge locations locally and regionally	Regional recharge is in topographic elevated positions associated with thin soil cover and discharge is in topographic lows associated with deep soil and regolith. Groundwater flow at Calliope is from topographic high to topographic low.	8.4 8.3
	groundwater quality within each of the aquifers and from surface expressions (i.e. seeps and springs)	Groundwater quality of limestone is chemically distinguishable from volcanic rock based on anionic ratios	9.3
	current and potential future uses of groundwater including existing groundwater extraction bores	Not applicable – No groundwater licence or extraction at Calliope because of an absence of groundwater.	2.1.2
	groundwater flow direction and velocity, including field tests to determine hydraulic conductivity	Groundwater flow has been determined by investigative drilling. Hydraulic conductivity has been determined by slug tests. There is insufficient groundwater for pump testing.	10 8.5
	the development of potentiometric mapping and hydro stratigraphic cross sections	Groundwater is a watertable not a potentiometric surface. Hydro stratigraphic cross-sections have been created from groundwater intersections from drillholes.	4.5 8.3.3
	groundwater modelling to determine contaminant transport and potential changes to groundwater level from dewatering or waste storage.	Not applicable - No dewatering of pit voids or waste storage	8.5
3.6.1	**Water management** The management of surface and groundwater is a key consideration in achieving long-term rehabilitation success. The rehabilitation planning part must include a description of the following:		
3.6.1	A description of the contaminants that pose a risk to environmental values of the receiving environment	Potential contaminants identified and mitigations measures outlined in Water Management Plans. An Assessment was undertaken of pit water potential impacts on environmental values.	4.6 4.7 4.8
	source, pathway and fate of contaminants that have the potential to impact environmental values	Pathway receptor linkages identified and assessed	4.7
	infiltration and seepage intervention and collection controls	The WMP outlines water control measures	4.6

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Ref.	Regulatory Requirement	How addressed in this Report	Report Section
	surface water diversions and long-term management requirements	The WMP outlines water control measures. In the long-term surface water diversion modifications will be required when Pit 3 combines with Pit 4 and works required will be addressed at that time.	4.6
	dewatering requirements	There is no groundwater dewatering.	2.1.2
	on-going water management and reduction requirements (i.e. treatment).	There is no groundwater dewatering.	2.1.2
3.6.3	**Voids** For mine sites with voids, the rehabilitation planning part must include a void closure plan that includes, but is not limited to, the following:		
	void hydrology, addressing the long-term water balance and water level in the voids, stratification connections to groundwater resources and potential for overflow	Water Balance modelling shows that the Pit 3-4 void will remain a sink post mining	12.3
	groundwater modelling to determine whether the void is acting as a sink or a source for groundwater	Water Balance modelling shows that the Pit 3-4 void will remain a sink post mining	12.3
	a water balance study including an assessment of void surface and groundwater interactions such as: • groundwater lowering/reduction in hydraulic head (from new voids) (e.g. caves/karst systems) o cones of depression and associated impacts • the drainage and flooding behaviours of surface waters in the vicinity of the void • the potential extent of flooding and implications of interactions with the void • a conceptual model that incorporates all projected inflows, outflows, and recharge rates • water storage and long-term water balance • each of the major water fluxes into and out of the void • the sources of surface water within the mine catchment that are likely to influence the water quality in the void • predicted water quality in the long-term including potential stratification • a 3D void design plan • rehabilitation strategies	A Water Balance model has been derived from water investigations for Pit 3 which has been used to create Water Balance Models for Pit 2 and Pit 3-4. Pit water stratification was investigated in Pit 3 which displays some stratification which is common for deeper water columns.	12,2 12.3 12.4 7.2.5
Information Request Notice C-EATPRCP-100177101			
16	Appendix E *(F)* and section 7.2 of the PRC plan discusses drilling records for various bores but no information on these records is provided. There may also be some uncertainty in some hydraulic parameters used in groundwater modelling (section 2.2 of Appendix F). Provide: • Omitted information on monitoring bore construction details. • Update hydraulic parameters to reflect site geology and water flow dynamics.	Bore construction details are summarised and bore logs appended. Hydraulic parameters are updated to reflect site geology and water flow dynamics.	8.2.5 10
17	Section 2.3 of Appendix E *(F)* includes a water balance model to predict water levels in the final void, but no information is provided on which model was used or the input parameter values used. The model must be referenced and described in the PRC plan document Include a detailed description of the water balance model used to predict final pit water levels.	The Water Balance Model in v2 which used an average groundwater seepage of 43 l/s for the final Pit 3-4 void has been superseded by a Water Balance Model in this report version used an average groundwater seepage of 1 l/s based on observed minor groundwater inflows for both pits. Sensitivity analysis of the Water Balance Model in this report shows that if average groundwater seepage is <25 l/s with seasonally varying rainfall pit water will remain contained within the pit void. A detailed description is provided of methodology, assumptions, parameters and predicted pit water fill under different climatic scenarios.	12.3

Ref.	Regulatory Requirement	How addressed in this Report	Report Section
18	Appendix E *(F)* shows predicted groundwater contours and flow directions, with flow near the site to be west to east. The predicted future water table (Figure 10a) suggests the final void will be a flow through system. Figure 7 shows the bores on site but there appears to be few bores along the eastern boundary, across which is the predicted direction of groundwater flow. Additional groundwater monitoring bores are required to be installed, along this eastern boundary to confirm groundwater levels and flow directions, to better describe and model the hydrogeological character of the site (Section 2.10.3 of Appendix E *(F)*). This is important in terms of quantifying groundwater flow direction particularly as the final void will be a flow through landform in direct contact with the regional groundwater. Include a hydrogeological assessment that accurately describes the groundwater flow and velocity and provide modelling to determine contaminant transport.	Investigative drilling confirmed that groundwater divide aligns with surface water divide with groundwater flowing east and west from the divide. The predicted future water table will remain a closed system. Monitoring bore installation and subsequent water level monitoring is in accordance with historical investigations. Currently there is minor groundwater seepage into combined Pit 3 and Pit 4 voids and in accordance with the Water Balance Model if there is <25l/s of groundwater at final landform then the final landform Pit 3-4 void will remain a sink. This hydrogeological assessment accurately describes groundwater flow because it is based on recent intensive fieldwork and extensive historical fieldwork, some of which was not previously reported.	8.3
Information Request Notice C-EA-100720590			
6	The application provided a hydrogeological assessment for the site however the analytical modelling is based on the limited available groundwater data and did not consider the complexity of the geology associated with the site.	A total of 34 holes were drilled in 2025 around the perimeter of Pit 4, Pit 1 and east of Pit 3 which defined geology and groundwater behaviour. The majority of holes were drilled dry and slowly made water. All drillholes were capped and collars surveyed to ensure groundwater data integrity. Limestone in pit void is bedded sub-vertically and is flanked outside the pit void by volcanic rock. Geology is simple and there is sufficient groundwater data, in addition to drilling, to demonstrate that there is little groundwater and that analytical modelling is appropriate.	8.3.2
6	Provide a numerical hydrogeological model which considers the complexity of the mining site including but not limited to:	A numerical model was constructed in 2002 but this construction was hampered by an absence of hydraulic aquifer parameters, because of insufficient groundwater to undertake a pump test and modelled results have been proven to be unreliable. An example is that the model predicted a possible 10 fold increase in groundwater at 40mAHD. Pit 4 is currently at -20mAHD, being 78% the depth of modelled pit depth, and groundwater inflows remain very low. The analytical water balance model and predictions as outlined in v2 is not in alignment with the 2011 conceptual and analytical mode. The 2011 model was derived from field sampling and showed that there is little groundwater entering Pit 3 void. The 2011 model was verified by investigative drilling in 2018, being 14 holes west of Pit 3, and recent investigation has showed that there is also little groundwater entering Pit 4 void. A numerical model has not been derived because sensitivity analysis of the updated analytical water balance model, based on all available water data, demonstrates that there is little groundwater at final void and numerical modelling of groundwater is not justifiable based on the low risk of groundwater interaction with any other water bodies outside the pit void.	12

Ref.	Regulatory Requirement	How addressed in this Report	Report Section
	Inclusion of cross section for all voids that identifies the limestone resource in comparison to the final projected void levels.	Cross-sections included for Pit 3 and Pit 4.	4.5
	Consideration of adjacent geological formations and faulting Further Clarification Note: Section 3.4 states, 'specific lithological boundaries are not necessarily constraining the flow of groundwater and hence a lithostratigraphic boundary for the aquifer is not appropriate' however, there is no discussion on the likely groundwater connectivity between Calliope beds and the other nearby geological formations and as such this statement appears unsupported by data. The interaction between the geological formations is critical for understanding potential impacts of mining and how modelling of the mining impacts should be undertaken	Groundwater -lithological relationship further investigated by drilling. The majority of drilled were dry with the most groundwater intersected at and near the volcanic -limestone contact. Site blast hole drilling driller logs of water intersection confirm that groundwater intersections are uncommon. There is no known faulting in Pit 3-4. Drilling confirmed that groundwater occurrence is variable between lithologies. Groundwater chemistry of drillholes and bores from both lithologies are similarly variable and there is no clear distinction between groundwater from limestone and volcanic. A lithostratigraphic boundary can be defined but it is not a groundwater boundary condition.	4.5 8
6	Consideration of recharge to the groundwater system through north-south groundwater gradient and rainfall Further Clarification Note: The application identifies that the groundwater flows eastward from the Boyne Range State Forest towards Lake Awoonga, however any recharge from this area may have limited impacts on the mining area given the faulting between the Rockhampton Beds and the Calliope Beds. The only certain groundwater gradient currently proven is from north to south from FM6 to FM5 and recharge in the area may be attributed to the elevated areas in the north (in the Calliope Beds) and draining south	Investigative drilling confirmed that groundwater divide aligns with surface water divide. Groundwater level maps constructed from March 2025 investigative drilling and March 2026 monitoring bore data. Rainfall response of groundwater is similar in both FM5 and FM6 which indicates similar recharge. Rockhampton Beds lie to the west of current and life of mine Pit 3-4 void and do not influence the conceptual and analytical water balance modelling presented in this report. Additional investigative drilling of 34 holes has proven that groundwater flow is easterly and westerly from the groundwater divide.	8.3 8.4
6	Consideration of hydraulic connectivity that considers changing ground elevation Further Clarification Note: The model assumes constant hydraulic conductivity in all directions in what appears to be a single layer model which potentially does also not account for changing ground level elevations	Limestone and volcanic are primarily an aquitard but both can host groundwater in fractures. There is minor groundwater inflow into the pit voids and it is very unlikely that significant groundwater will be intersected in Pit 3-4 final void based on pit floor drilling. Hydraulic conductivity from slug test vary but do not affect modelled outcomes due to minor groundwater inflows.	10.3
6	Consideration of connectivity to Awoonga Dam and changes to water levels over time Further Clarification Note: It does not appear to consider the connection with Awoonga dam including the significant seepage that can occur at times from Awoonga dam to the pit/s or the changing water levels over time in Awoonga dam and how that is impacting groundwater.	Awoonga Dam leakage to Pit 3 was proposed by GHD in 2011, however no physical evidence has been found of piping from all Western Bund wall inspections. Water chemistry confirms that water flowing into Pit 3 is not related to Awoonga Dam water the Pit 3 water is from surface water flowing from the Farm Dam. The water inflow into Pit 3 is not from Awoonga Dam leakage or groundwater seepage.	7.3.2
6	Consideration of clarification of the limestone resource and final water bodies Further Clarification Note: The assessment lacks consistency and clarity on the limestone resource in relation to the site hydrogeology. Section 1.2 of the report gives the appearance that the limestone extends to 8 m below the surface by identifying that grey limestone with clay filled cavities is present to a depth of between 5 to 8 meters however, section 2.3.2 assumes that the void will be approximately 100 m below the natural surface.	Drilling confirms that the Limestone Resource extends to -105.1mAHD being m below the natural surface but limestone is weathered with some voids, that are generally clayed, at shallow depths beneath the natural surface.	4.2 8.2.1
	Consideration of the influence of all voids when determining the impacts to groundwater and the inclusion of a map identifying the location of each pit. Further Clarification Note: Appendix 6 Figure 2 appears to indicate that the proposed future combined pit 3 and pit 4 has been represented by two extraction	End of mine life Pit 3-4 will remain a void, Pit 1 has been filled and Pit 2 will also remain a void. Groundwater is mounded at Pit 1 between Pit 2 and Pit 3-4. Pit 2 is currently used for water storage of pumped Pit 4 water to be used on site. Groundwater will slowly flow and seep into Pit 2 void but is unlikely to	12

Ref.	Regulatory Requirement	How addressed in this Report	Report Section
	points. This does not appear to be representative of the full pit area or any impacts that pit 2 may be continuing to have.	measurably change water quality given the large volumetric difference between pit water and groundwater seepage. A map of all pits is included.	
	Consideration of limitations associated with this monitoring network and potential limitations that this place on the groundwater modelling Further Clarification Note: The inadequate groundwater monitoring network provides a significant limitation to modelling in its inability to provide an initial understanding of the groundwater levels and flow direction.	Additional piezometers have been installed.	8.2.5
Information Request Notice C-PRCP-100905311			
5	Provide an assessment of the predicted water quality for Pit 3/4 that considers the accumulation of contaminants from inflows to the pit and the impact of evaporation	A Pit 3 Water Balance model was calibrated for electrical conductivity (EC) from Pit 3 catchment monitoring results. The Pit 3 model was expanded to include Pit 4 and the Pit 3-4 Water Balance model predicts EC. The behaviour of the potential contaminants pH and TSS is predicted based on pH and TSS monitoring results.	12.4
6	Provide an updated PRC plan that considers the Pit 2 water balance and the long-term water quality based on parameters that will impact water level and quality.	A Pit 2 Water Balance model predicts water level and EC. The behaviour of the potential contaminants pH and TSS is predicted based on pH and TSS monitoring results.	12.3
9	Update the hydrogeological, assessment to include a 3D numerical groundwater flow model in order to assess the groundwater impact on the receiving environment in accordance with Australian Groundwater Modelling Guidelines (Barnett, et. al, 2012). The model should be used to predict existing and future pit inflow rates, groundwater drawdown as well as to predict potential groundwater impacts on the receiving environment.	Monitoring data is being collected and analysed such that by 31 March 2028, an independent appropriately qualified person must prepare a groundwater assessment report that includes a recommendation for whether a numerical groundwater model is required	n/a
10	Include additional monitoring bores in the PRCP schedule to monitor groundwater levels and water quality	Additional piezometers have been installed.	8.2.5
	Install additional monitoring bores west of Pit 3/4 and down gradient of the WRD to monitor potential impacts to groundwater levels and contaminant releases.	Additional piezometers have been installed.	8.2.5
10	Complete hydraulic testing on previously drilled and newly installed bores;	Slug testing undertaken on all monitoring bores. Slug tests provide an estimate of near bore hydraulic conductivity. There is insufficient groundwater for pump testing which is required to determine aquifer hydraulic conductivity.	10.3
	Hydraulic properties of each hydro-stratigraphic units based on updated testing; and	Hydrostratigraphy is discussed. Limestone in pit envelope has very low hydraulic conductivity whereas volcanic rock hydraulic conductivity is mainly low but is elevated in two piezometers.	10.4
11	Update void water balance model based on the revised Dam hydraulic conductivity.	Additional Water Balance modelling undertaken but no update of Pit 3-4 Water Balance Model required.	12
Draft EPML00969013 Permit			
C21	By 31 August 2026, hydraulic testing of all groundwater monitoring bores stipulated in Figure 4 Calliope Groundwater monitoring locations must be completed and the hydrogeological characterisation of all bores in the network must be determined.	The Groundwater Monitoring Network has been expanded with the installation of four additional monitoring bores. Slug testing undertaken on all monitoring bores.	8.2.5 10.3
C22	By 31 March 2028, an independent appropriately qualified person must prepare a groundwater assessment report that include e) recommendation for whether a numerical groundwater model is required	To be prepared	n/a

Table 1 Cross-Reference Report Table

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1.4 Assessment Method

The Calliope is an established operation with an Environmental Authority license and an Environmental Management Plan (EMP). The EMP defines environmental protection measures for the management of impacts associated with the project and addresses Environmental Authority license conditions. The EMP outlines Water Management Objectives, Environmental Values, potential impacts, target and key performance indicators, control measures, monitoring and reporting. Further details on Water Management are provided in the Water Management Plan (WMP) and in the Groundwater Management and Monitoring Plan (GMMP). Surface water management structures at Calliope effectively controls the flow of rainfall run-off and store excess run-off to prevent uncontrolled releases and allow continued mining operations. There is little groundwater inflow to the pits and the pit walls remain dry in the absence of rain and groundwater has not been intersected on the pit floor. The assessment method adopted in this study has been:

- Review and summarise existing Water Management
- Synthesis historical groundwater investigations, surface water and groundwater monitoring results and identify data gaps
- Undertake a groundwater investigation in 2025 to bridge data-gaps relating to groundwater behaviour and risk profile and to install additional piezometers to provide further data
- Determine the Boyne River Basin Plan environmental values relevant to Calliope
- Identify mechanisms of potential impact and risks to environmental values of the Boyne River Basin
- Model water level and water quality behaviour in Pit voids based on monitoring results
- Reporting to address regulatory requirements

2 REGULATORY FRAMEWORK

2.1 Project Environmental Approvals

2.1.1 Water License

The Calliope is in the Boyne River Basin, which has a water plan that :

- regulates the take and interference of surface water
- allows for the take of groundwater and overland flow water
- provides for water allocations, water licences and seasonal water assignment

Under the *Water Act 2000*, 'associated water' refers to underground water that is taken or interfered with as a result of an authorised activity (such as mining). This usually involves activities like dewatering mine pits. These activities are managed through the underground water management framework outlined in Chapter 3 of the *Water Act 2000*. As the Calliope only uses water stored in Pit 2 and does not access any additional surface water or groundwater, this is considered 'associated water' and therefore does require a water license under the *Water Act 2000.*

2.1.2 Environmental Authorities

Mining activities are undertaken in accordance with regulatory approved Mine Plans and Environmental Authority (EA) licence conditions. The current EAs for Calliope are listed in Table 1 and include a prescribed EA for the taking of quarry material and a Resource Activity EA for mining of limestone. The Resource Activity EA is the subject of this application and is discussed further below.

EA Reference	Permit Type	Approval Authority	Status	Date Granted
EPML00969013	Resource Activity	Dept of Environment and Science	Active	1st February 2021
EPPR00881913	Prescribed ERA	Dept of Environment and Science	Active	18th January 2019

Table 2 Calliope EAs

EA EPML00969013 outlines the requirement for Calliope Limestone Operation to ensure offsite impacts are minimised and any discharge waters are within acceptable limits. Release limits for licensed surface water discharge points and their monitoring frequency are shown below. Condition C2 of the EA states that the release of contaminants to waters must only occur from specified release points F1, F2, C1 and C2. See Table 1.

Release Point (RP)	Easting (GDA94)	Northing (GDA94)	Contaminant source and location	Monitoring point	Receiving waters
F1	321432	7332026	Pit 3 and Pit 4	End of pipe F1 (Discharge Monitoring Point)	Lake Awoonga Dam
F2	320399	7331469	Undisturbed natural flow and/or Pit 3	Raggote Ck at F2 (Downstream Monitoring Point)	Farmers Dam
C1	320757	7333601	Pit 1, Pit 2 and Pit 4	C1 dam spillway (Discharge Monitoring Point)	Pit 2 and/or Recycled Water Storage Dam
C2	320102	7333854	Undisturbed natural stormwater flow	C2 creek adjacent to rail siding road (Upstream Monitoring Point)	Raggote Creek

Table 3 Surface water release points

A map of EA surface water release points and groundwater monitoring locations is shown in Figure 4.

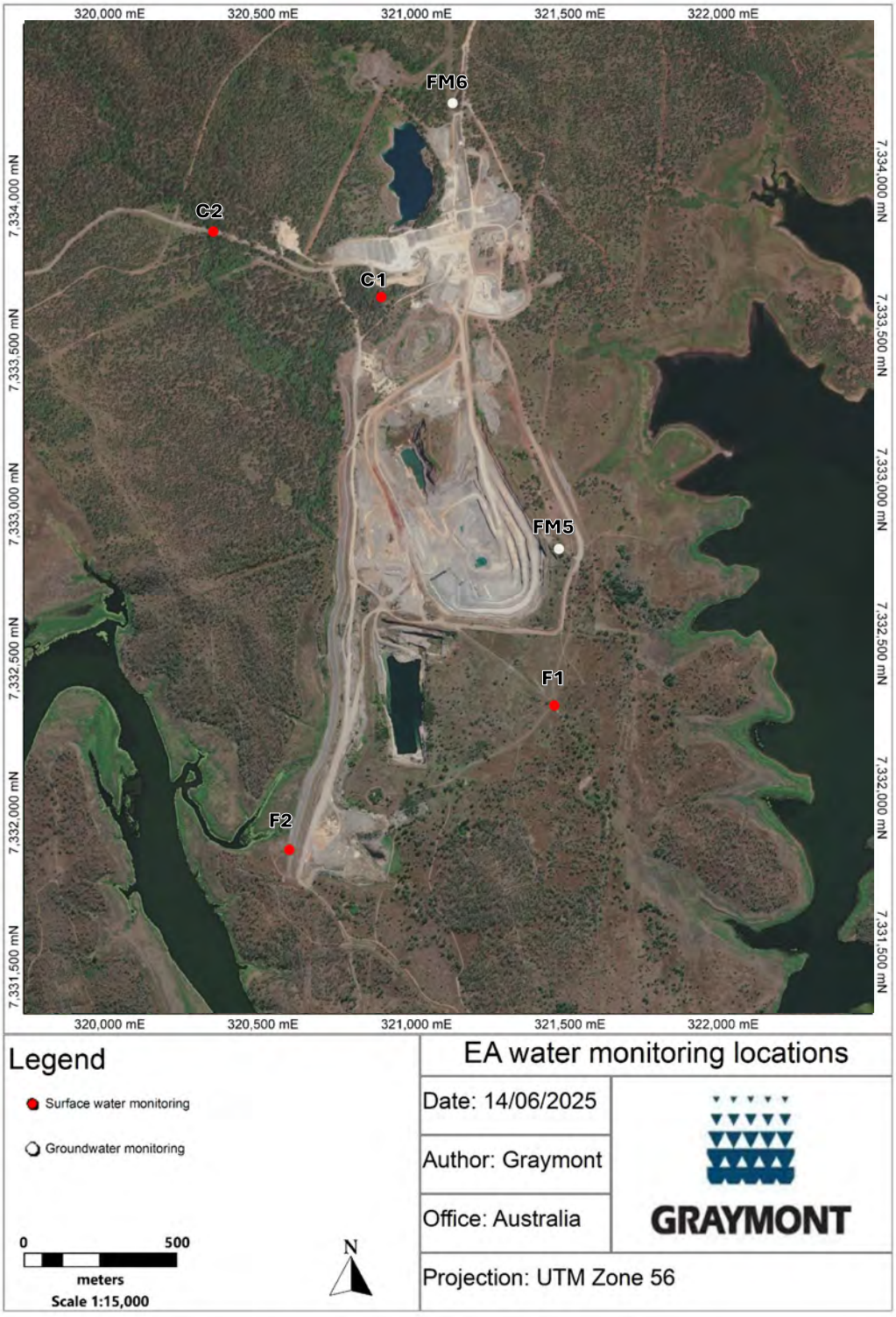


Figure 4 Surface water and groundwater monitoring locations

Surface water contaminant release limits are tabled below.

Quality Characteristic	Release Limits	Monitoring Frequency
Electrical Conductivity (µS/cm)	900	Weekly during discharge
pH (pH Unit)	6.5 (minimum), 8.5 (maximum)	Weekly during discharge
Total Suspended Solids (mg/L)	100 (maximum), or when measured at C1, F2 or F1 not more than 110% of the value at monitoring point C2.	Weekly during discharge

Table 4 Surface Water Contaminant release limits

The origins of the release limits is not known but they are similar to, but more stringent than, the ANZECC Guidelines for the default maximum values for Tropical Australia freshwater lakes & reservoirs which are 900 µS/cm, pH 6.0-8.0 and turbidity 200NTU. The risks and control measures required to manage water flow and quality on site, monitor water quality and regulate safe water discharge from site, are described in the Calliope Water Management Plan (WMP) forms part of Calliope Environmental Management Plan. See Section 4.6.

Groundwater

There is insufficient groundwater for pumping and aquifer dewatering and Calliope does not have a groundwater take and use licence. Groundwater outside the pit voids slowly drains into the pit voids where it is mixed with surface water to become pit water. Pit water is released in accordance with EA conditions. In July 2012 Sibelco developed and implemented a Background Groundwater Monitoring Program in accordance with MINB100942509 groundwater conditions C17-25. The aim of the Background Groundwater Monitoring Program (BGMP) was to provide sufficient data for developing a Groundwater Management and Monitoring Plan (GMMP). Groundwater monitoring bores FM5 and FM6 were installed in July 2012. Bore FM5 benchmarks radial inward groundwater flow to the active Pit 4 whereas Bore FM6 benchmarks radial groundwater inward flow to Pit 2. Comparative Analysis of the water quality from bores is undertaken to assess FM5 water quality changes against FM6 water quality changes. Groundwater monitoring results taken from FM5 and FM6 in the period July 2012 to October 2013 were used to benchmark groundwater water quality parameters results, from which EPML00969013 groundwater trigger values were derived. Sinclair Knight Merz Pty Ltd was engaged by Sibelco to develop the GMMP for the Calliope Quarry which, in accordance with EA conditions must:

i. Be able to detect a significant change to groundwater quality values due to activities that are part of this mining project
ii. Include measures to minimise the impact of the mining activities on groundwater resources

EA (EA) EPML00969013 conditions C17-24 stipulate groundwater monitoring requirements for the Calliope groundwater monitoring network, which is currently for bores FM5 and FM6. Groundwater monitoring locations were shown in Figure 4. EPML00969013 groundwater trigger values are shown in Table 3.

Water Quality Indicator	Unit	Trigger Value
Calcium (Ca)	mg/L	250
Chloride (Cl)	mg/L	200
CO3	mg/L	500
Electrical Conductivity (EC)	µS/cm	1500
HCO3	mg/L	500
Magnesium (Mg)	mg/L	35
Petroleum Hydrocarbons (Total)	mg/L	1.0
pH	pH units	6.5 – 8.5
Potassium (K)	mg/L	5.0
SO4	mg/L	20
Sodium (Na)	mg/L	100
Total Suspended Solids (TSS)	mg/L	1500

Table 5 Groundwater trigger values

Groundwater level monitoring of the bores is undertaken quarterly. Groundwater quality sampling of EC, TSS, pH and major anions (and cations) is six monthly, whereas metal screen and hydrocarbons are monitored annually. See Table 6.

Monitoring point	Monitoring frequency			
	Groundwater level	EC, TSS, pH and Major Anions	Metal Screen	Hydrocarbon
FM5	Quarterly (Jan, Mar, Jul, Sep)	Six monthly (Jan, Jul)	Annual (Jul)	Annual (Jul)
FM6				

Table 6 Groundwater monitoring frequency

Analysis of FM5 and FM6 monitoring data is provided in Sections 7 and 8.

Groundwater sampling which exceeds trigger levels is investigated and investigation results reported with 28 days to DETSI in accordance with EA conditions.

Calliope Water Management is discussed in Section 4.6.

2.2 PRC Plan

A PRC Plan is required for all mines with a site-specific EA for a resource activity. In accordance with the *Environmental Protection Act 1994,* all site-specific EAs for resource activities must also have an approved PRC Plan. The site is currently progressing a transitional approvals process for the Calliope Limestone PRC Plan.

Decision criteria used by the administering authority when assessing a PRC Plan is outlined in Section 2.5.1 of the PRC Plan guidelines and includes:

- Regulatory Requirements
- Site Specific EA application
- Proposed PRC Plan schedule
- Response to an information request
- Standard criteria
- PRC plan guideline

In 2023, Graymont developed a PRC Plan (PRC Plan-EPML00969013-v1) to meet the requirements of:

- The transition notice issued to Graymont on 31 March 2021 by the DETSI (formerly DES)
- The Mining *and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act)
- Sections 126B, 126C and 126D of the *Environmental Protection Act 1994* (EP Act)
- PRC Plans Guideline (ESR/2019/4964) (PRC Plan Guideline) (DESI 2024g)
- Schedule 8A of the *Environmental Protection Regulation 2019* (EP Regulation)

To ultimately align this PRC Plan with the EA, an EA amendment application (the EA amendment) was submitted to the Administrating Authority on 10 September 2024 and is in Information Request (IR) phase.

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3 PROJECT SETTING -BOYNE RIVER BASIN

3.1 Boyne River Basin and Calliope

The Boyne River Basin (Basin) is in Queensland's central coast region. The Calliope is located within the Basin adjacent to Awoonga Dam at the northern end of the Basin catchment (Figure 5).

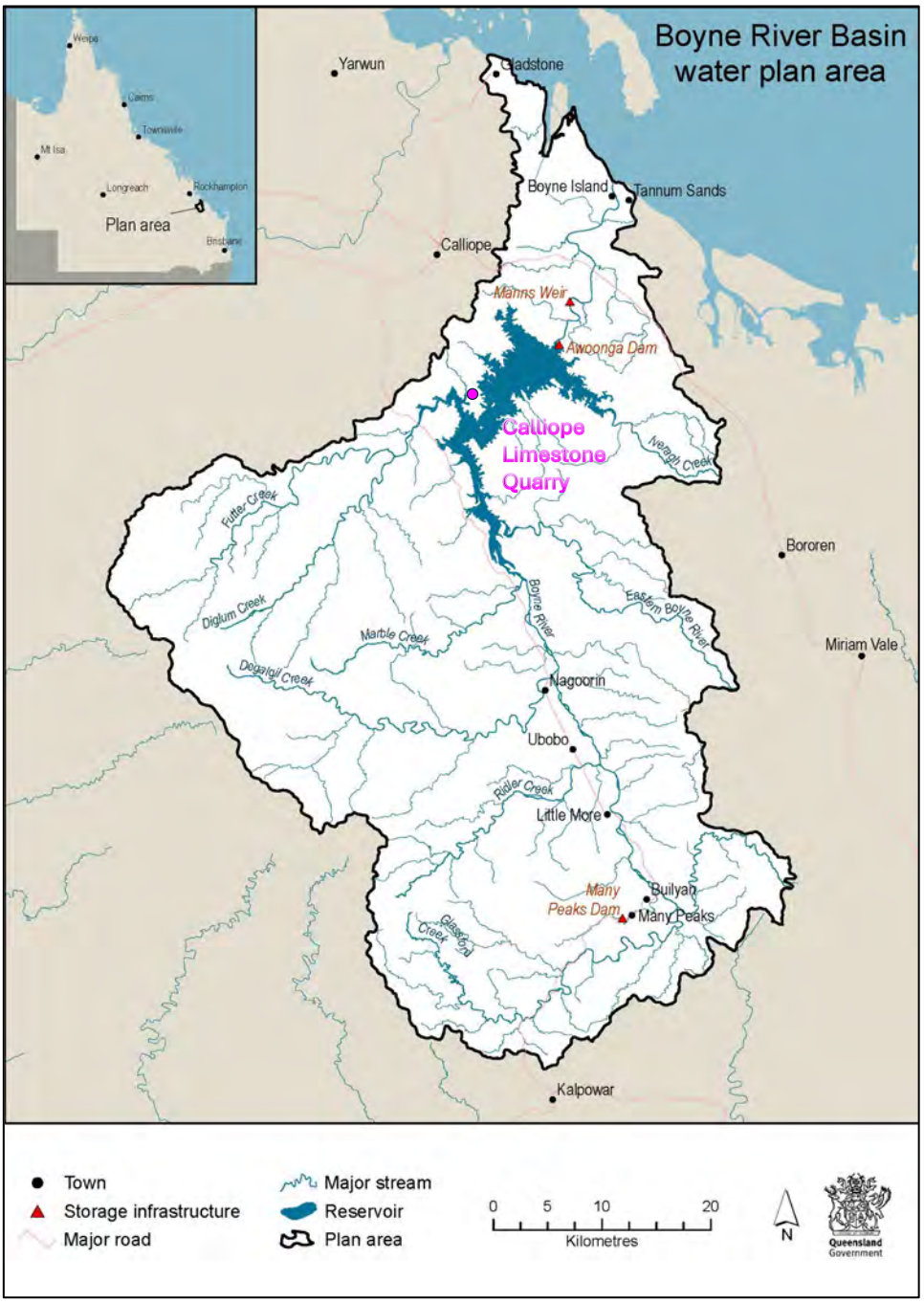


Figure 5 Boyne River Basin (from Boyne River Basin Plan)

The Calliope is located at the southern end of the Ragotte Creek catchment. Ragotte Creek flows into Awoonga Dam which is located approximately 20 km upstream of the mouth the Boyne River (Figure 6).

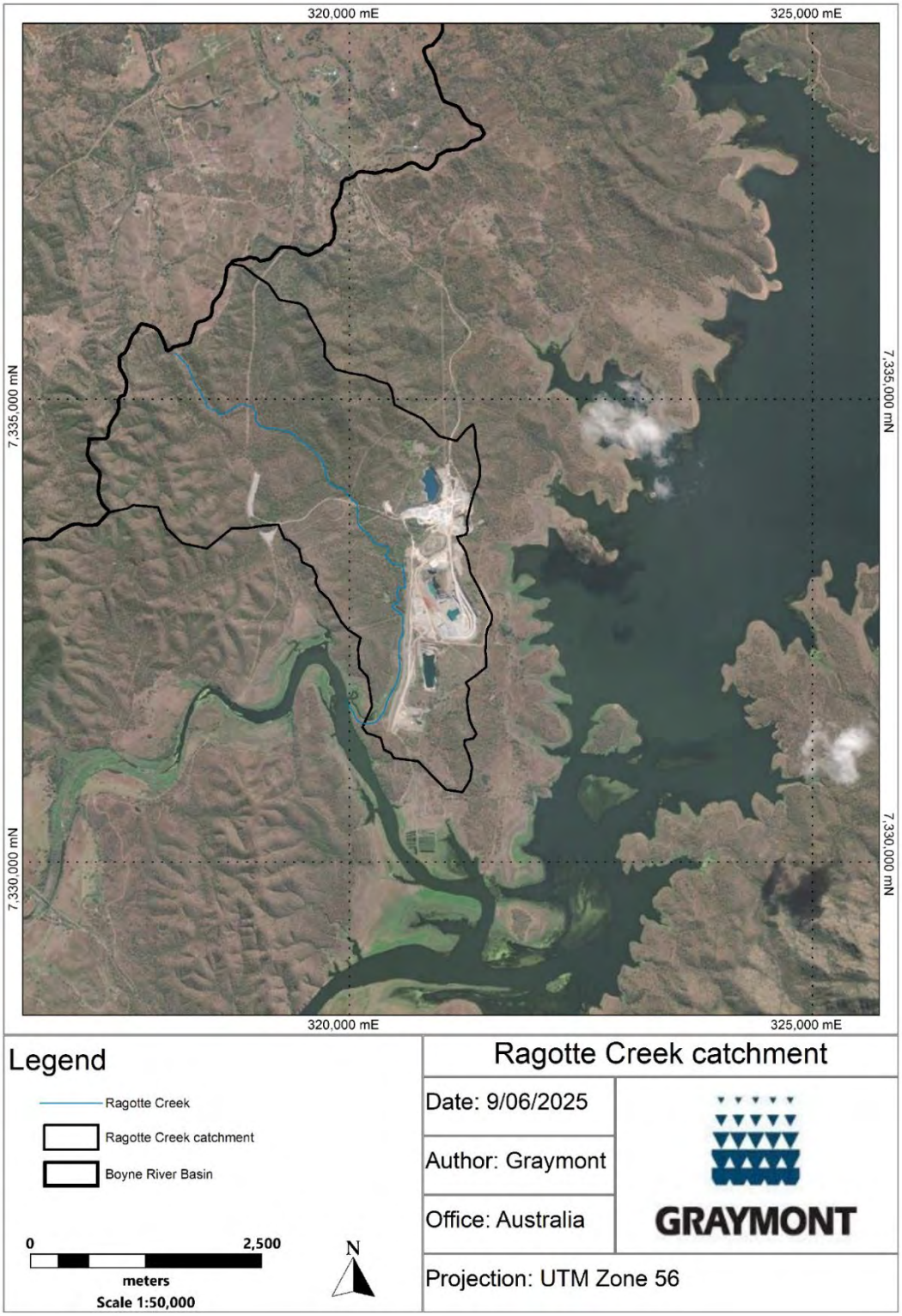


Figure 6 Ragotte Creek catchment

Mining creates sub-catchments at the southern end of the Ragotte Creek catchment. See Section 4.1.3.

3.2 Environmental values

Water quality targets have been set for each catchment that drains to the Great Barrier Reef under the Reef 2050 Water Quality Improvement Plan. The Boyne River Basin has end of catchment anthropogenic load reductions by 2050 for dissolved inorganic nitrogen, fine sediment, particulate phosphorous and nitrogen. The Boyne catchment has minimal loads of anthropogenic dissolved inorganic nitrogen and small loads of fine sediment. Most anthropogenic fine sediment loads come from grazing and streambank erosion areas. Most sediment erosion comes from hillslopes and streambanks in the Boyne catchment. The Boyne River Basin Environmental Protection (Water) Policy 2009 Central Queensland map outlines environmental values across the Boyne River Basin and environmental values relevant to Calliope are shown below in Table 7.

Boyne River Basin Environmental values			
Environmental values	Upper northern creeks	Awoonga Dam	Groundwater (bores, etc)
Aquatic ecosystems	✓	✓	✓
Drinking water	✓	✓	✓
Primary recreation	✓	✓	
Secondary recreation	✓	✓	
Visual recreation	✓	✓	
Human consumer	✓	✓	
Cultural and spiritual values	✓	✓	✓
Aquaculture	✓	✓	
Farm supply/use	✓		✓
Irrigation	✓		✓
Stock water	✓	✓	✓
Industrial use		✓	✓

Table 7 Boyne River Basin Environmental values relevant to Calliope

3.2.1 Awoonga Dam

Awoonga Dam is the main source of drinking water for the greater Gladstone region and was constructed in the Boyne River to supply water for industrial and urban use. The Awoonga Dam is owned and operated by the Gladstone Area Water Board (GAWB). The Awoonga Dam water supply is the key environmental value in the local area and due to the downstream connection with the Boyne River valley, may indirectly impact downstream environmental values. The quality of water within Awoonga Dam is significantly influenced by the type and management of land use activities in the catchment, with nutrients and sediment levels attributed to the land clearing and cattle grazing that has occurred in the Boyne Valley over the past 100 years. (GAWB, 2025).

GAWB manage the Awoonga Dam water supply which may indirectly impact downstream environmental values but do not manage control impacts from land use activities in the catchment such as land clearing and cattle grazing. Released dam water is assessed against Water Quality Guidelines and specifically Australian Drinking Water Guidelines as water supply is the primary function of Awoonga Dam. GAWB cannot control downstream impacts of released water flows through rural and urban environments to the coast.

3.2.2 Upper northern creeks

The upper northern creeks are unregulated and flow into Awoonga Dam. The Ragotte Creek catchment lies within the Upper norther creeks sub-zone, which has a moderately disturbed aquatic environmental value.

3.2.3 Groundwater

Regional groundwater and its beneficial use is discussed in Section 3.9.

3.3 Climate

The climate of the Boyne River Basin is sub-tropical with warm to hot summers and mild dry winters. The average daily temperature is 22°C/year; annual potential evapotranspiration ranges from 1750-2300 mm/year for an average of 1870mm and annual rainfall ranges from 500-1875 mm/year for an average of 1000 mm/year (Queensland Government, 2023). Daily rainfall and evaporation was obtained from the Bureau of Meteorology (BOM) Long Paddock website from a node located approximately 1km west of Pit 2 for the 50 year period 1975-2025. The average annual rainfall for this 50 year period at Calliope was 840mm and average annual evaporation 1885mm. Monthly rainfall, evaporation and temperature is shown in Figure 7 from 1975-2025.

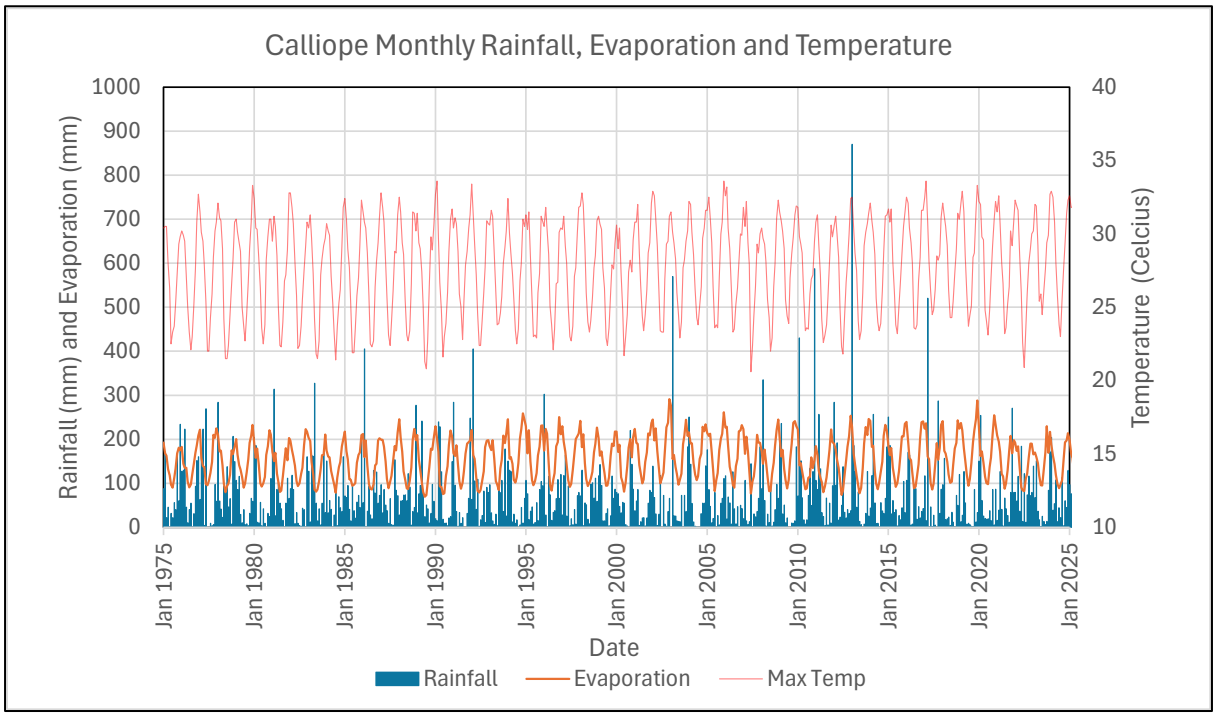


Figure 7 Monthly Rainfall, Evaporation and Temperature 1975-2025

From 2003-2017 there were six extreme rainfall events which elevated Awoonga dam water level and led to excess pit water capture but there have been none since 2017.

Global Climate Models are provided by the Queensland Government which display projected impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission (GHGE) scenarios on the Boyne River Basin. Climate change trends are discussed in respect to projected change (no trend/increase/ decrease), magnitude of change (none/slight/small/ medium/large) and the level of confidence in the projection (weak/moderate/strong). See Figure 8.

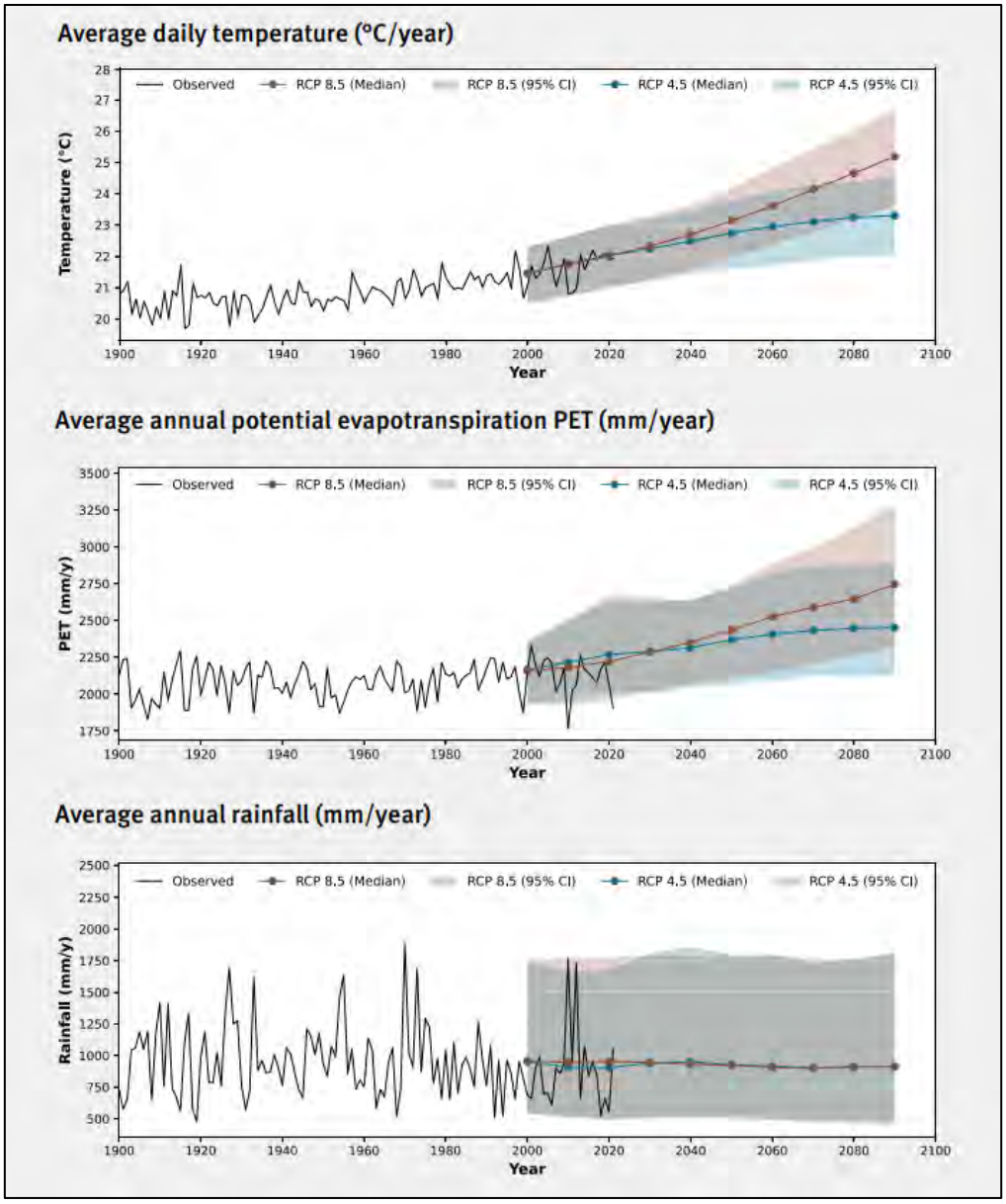


Figure 8 Boyne River Basin Global Climate Model scenarios

The climate at 2100 is projected to be hotter (large increase, strong confidence), drier (medium increase, strong confidence) with a slight decrease in rainfall (weak confidence). Projected seasonal climate trends are an average monthly temperature increase for all seasons; evaporation increase for all seasons, particularly in summer and spring, and rainfall decrease in winter and spring but with an increase in summer. Climate Models (GCM) show a general warming across the state and for the Boyne River Basin the higher GHGE scenarios indicate a 6.3% increase in evaporation and the lower GHGE a 3.8% in evaporation.

3.4 Topography

The Calliope Limestone operation is located within the Boyne River catchment of the Fitzroy Region. Topography of the Boyne River catchment varies from steep ranges down to the river valleys and Awoonga Dam (Figure 9).

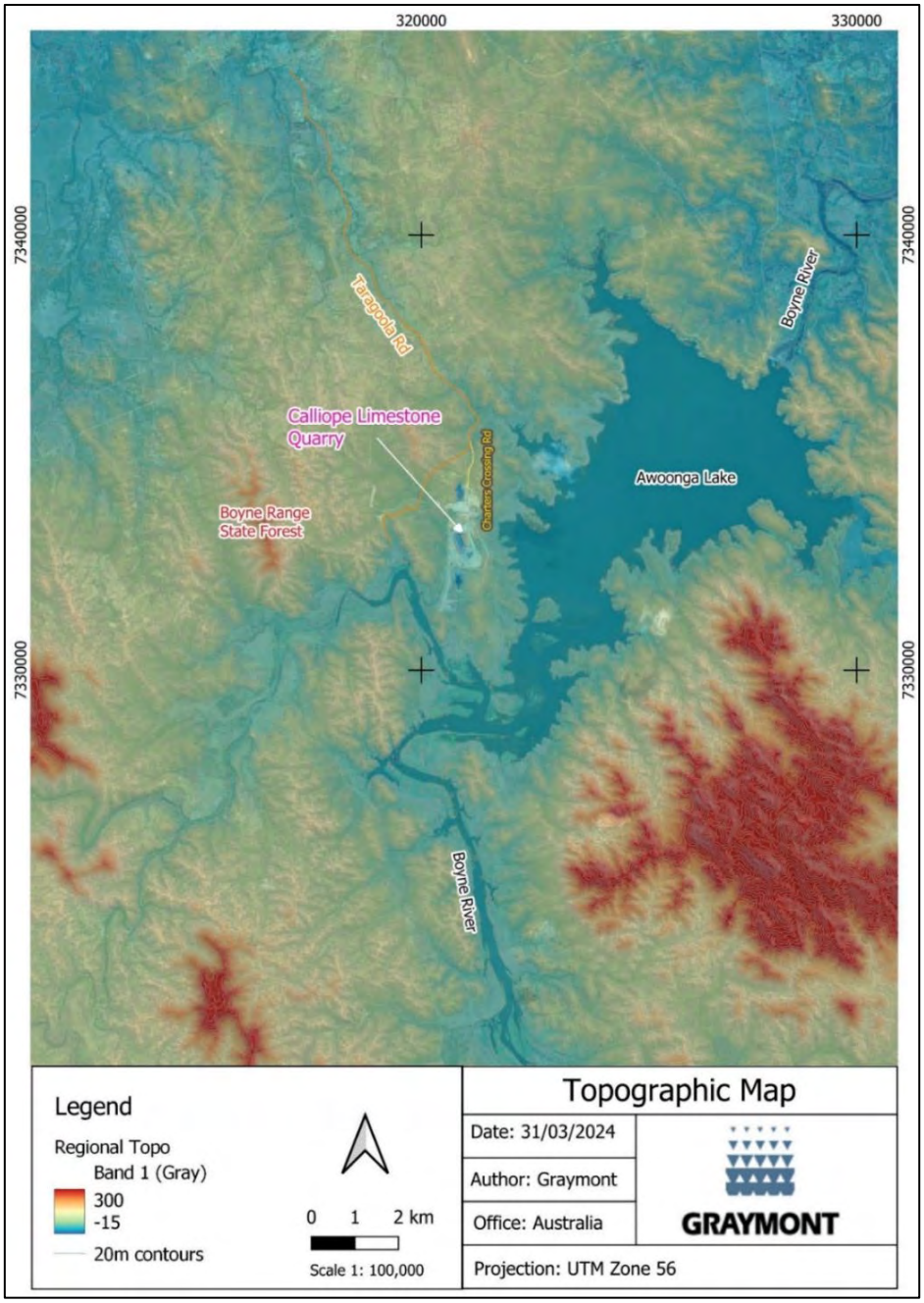


Figure 9 Regional topography

3.5 Regional Geology

The Calliope lies within the New England Orogen, part of Tasman Orogenic Belt, a Palaeozoic continental convergent plate margin. The belt is composed of Palaeozoic deep and shallow water marine sedimentary rocks, mafic volcanic rocks and is intruded by granitic plutons with extensive Quaternary cover. Around Calliope the area is divided into the Calliope, Coastal, and the Rockhampton Sub-provinces which are separated and bounded by regional faults. The Calliope is in the Silurian-Devonian aged Calliope Beds. (Figure 10).

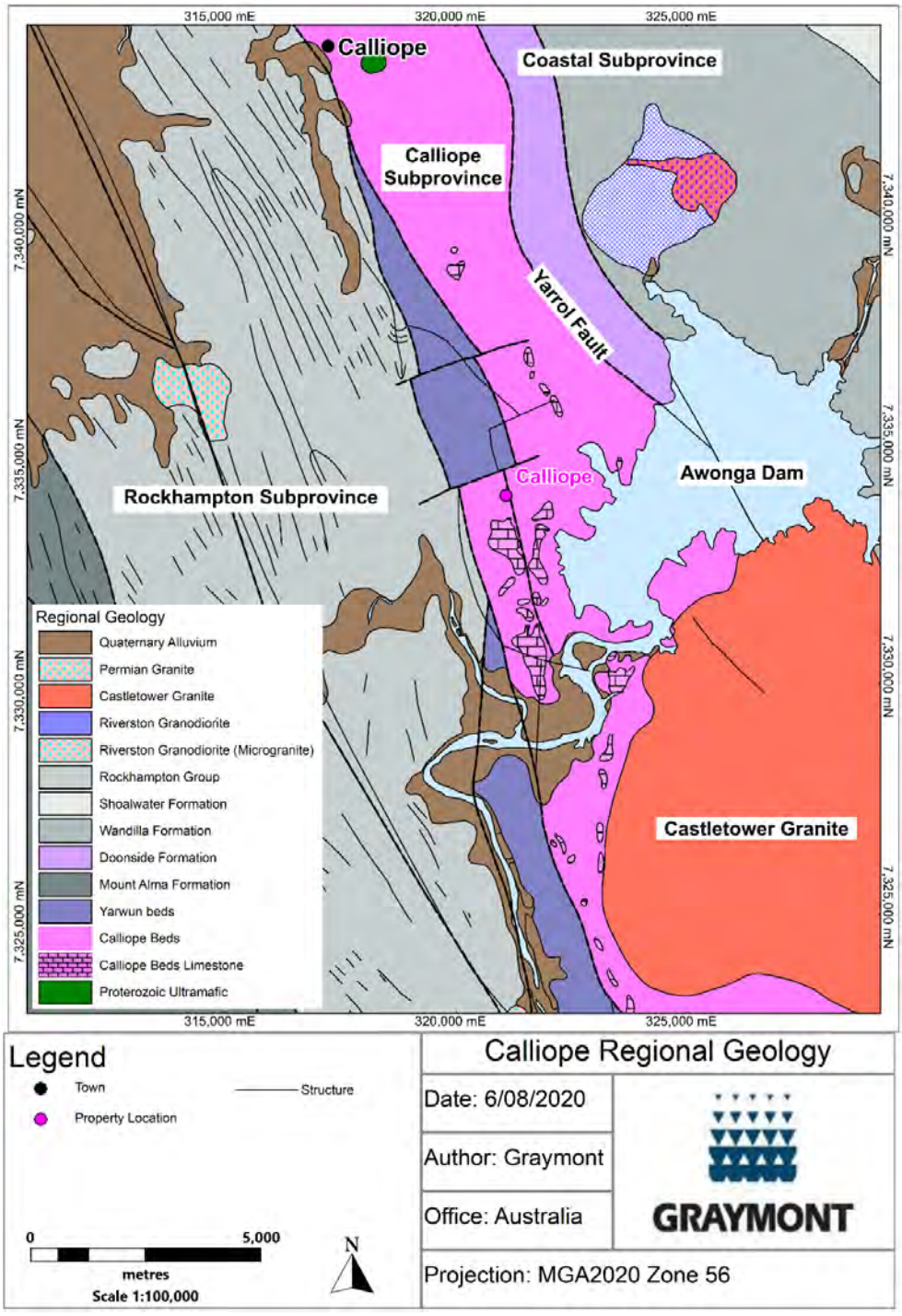


Figure 10: Regional Geology

3.6 Land use and local resources

Land uses of the Boyne catchment include grazing (74%), nature conservation (16%) and forestry (5%). Recreation including camping, fishing hiking and mountain biking in the region provides an economic boost to the region. Mining is a small part of land use in the catchment. The Awoonga Dam provides recreation facilities for picnicking and camping and is a popular spot for boating and fishing. Offshore from the Gladstone area lies several Great Barrier Marine Park zones that aim to manage the waterway use for the protection of the Reef.

Curtis Island, hosts a large National Park and Conservation area just north of Gladstone offers recreational activities including rainforest walks and camping.

3.7 Vegetation

Catchment vegetation includes eucalypt woodland dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*) with an understorey of native tussock grasses. The eucalyptus woodland is described as open woodland often with a shrubby layer and occurs on undulating rises and low hills, often with distinct strike pattern formed on moderately to strongly deformed and metamorphosed sediments and interbedded volcanics and Permian sediments.

3.8 Surface water

The Boyne River and its tributaries flow northerly into Awoonga Dam. The Awoonga Dam weir is located on the downstream side (northern end) of the dam. Awoonga Dam is a regulated structure providing water supply to the region. Downstream of the Weir, the Boyne River continues northeast toward the coast between the towns of Boyne Island and Tannum Sands 12 kilometres south of Gladstone. The Boyne River is joined by several tributaries along its length. The Awoonga Dam at full supply level (FSL) of 40m AHD holds 777,000 ML and a surface area of 6,791 hectares. The maximum water level recorded at the spillway was 48.3m AHD on 27th January 2013, and the lowest levels on 4th February 2003 of 20.84m AHD. The Awoonga Dam receives surface water release from Calliope.

3.9 Regional Groundwater and its beneficial use

The *Boyne River Basin Water Plan 2013* allows for the take of groundwater and overland flow water but because groundwater take is not licensed, there is potential to extract water using bores from groundwater adjacent to the watercourse, which may impact on surface water availability. This is considered a low risk. (*Ministers Performance assessment Report - Boyne River Basin Plan, 2019*). Regional groundwater in the Boyne Basin is primarily used for pastoral, horticultural, and domestic purposes.

3.9.1 Regional groundwater recharge and discharge

Regional recharge is in topographic elevated positions associated with thin soil cover and discharge is in topographic lows associated with deep soil and regolith.

3.9.2 Regional groundwater bores

A 9 km radius search of bores on the Queensland State database from Calliope showed 39 bores. Of the 39 bores, 28 are classified as 'Existing', and the remaining 11 are classified as 'Abandoned and Destroyed'. See Figure 11. Hydrogeological information from the data is limited. Water level data is sporadic, and no continuous data exists to derive trends for water levels or water quality. The closest bore to the site is Bore ID 111,148 which is located 2.8km up catchment from Calliope. This bore is in the Yarwun beds, which have been fault offset from the Calliope beds and which a different aquifer system from the Calliope Beds aquifer system. Bore ID 111,148 has a yield of 1.15l/s.

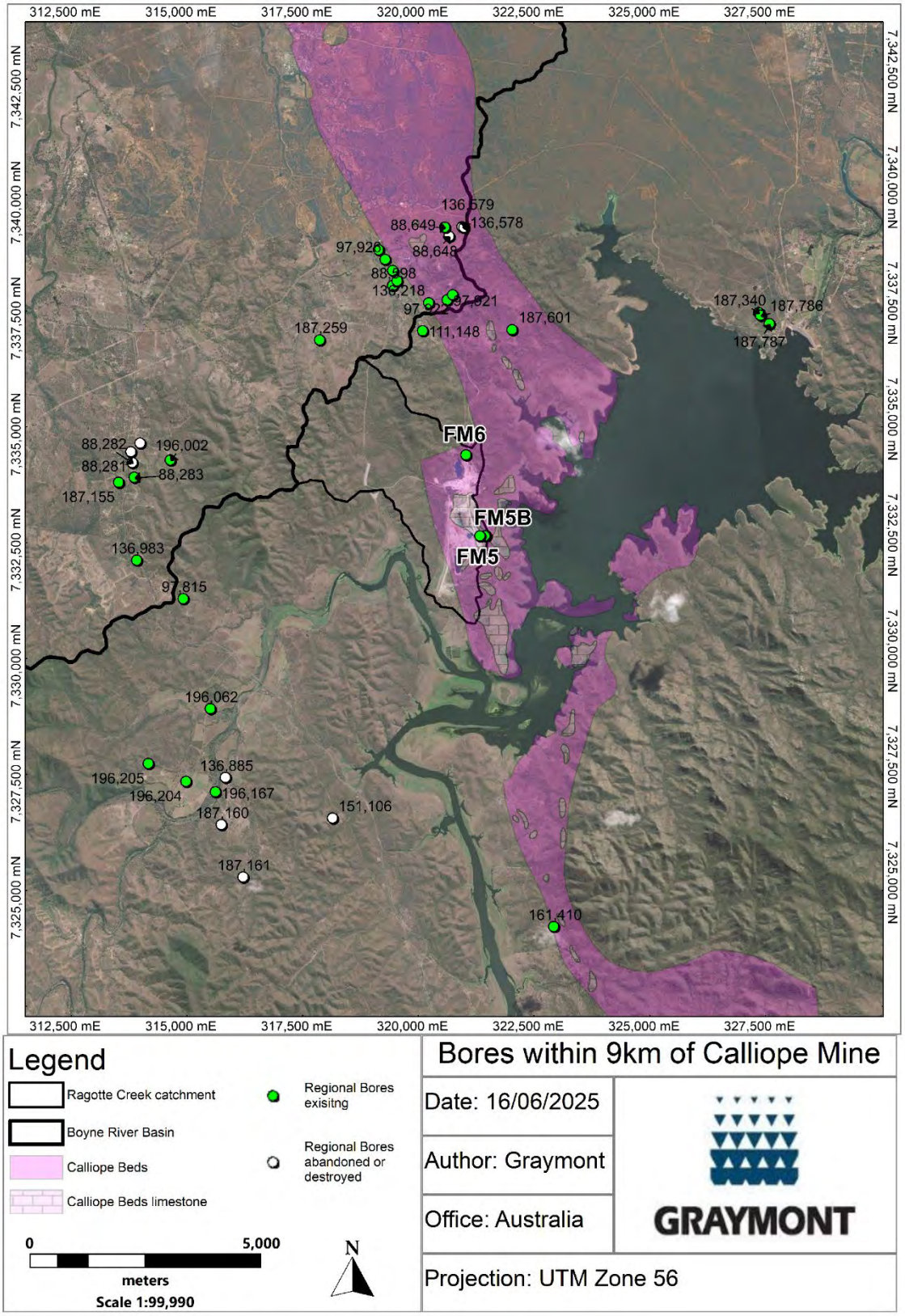


Figure 11 Bores within 9km of Calliope from QGlobe

A summary of registered bores constructed in the Calliope Beds within 9km of the Calliope is provided below in Table 8.

Registered number	Status	Bore depth	Yield l/s	Aquifer	Aquifer depth interval
88648	Abandoned and destroyed	75	None	Limestone	Dry
88649	Existing	47	1.5	Limestone	15 - 47m
97921	Existing	31	1.01	Andesite	27 - 31m
97922	Existing	14	0.74	Andesite	7.3 - 14m
136218	Existing	13.5	0.51	Limestone	
136578	Abandoned and destroyed	60.96	None	Limestone	Dry
136579	Abandoned and destroyed	18.29	None	Limestone	Dry
151688 (FM6)	Existing	60.5	n/a	Andesite	
151689	Existing	16		unknown	15 - 16m
161410	Existing	17.68	1.26	Limestone	6.71 - 17.68
187601	Existing	25	0.65	Andesite	8 -13.8m
187861	Abandoned and destroyed	51	None	Limestone	Dry
187863 (FM5)	Existing	30	n/a	Limestone	18 - 24m
187863 (FM5B)	Existing	30	n/a	Andesite	

Table 8 Registered bores constructed in Calliope Beds within 9km of the Calliope

The Calliope beds limestone and andesite is predominantly an aquitard but with connected fractures can form a yielding fracture rock aquifer. The maximum recorded bore yield from the Calliope Beds within 9km of the Calliope is 1.5l/s.

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4 PROJECT DESCRIPTION – CALLIOPE

4.1 Mining voids and mining created sub-catchments

4.1.1 Site History

Limestone Exploration in the early 1960's led to the granting of mining leases to Frost Enterprises and Comalco with mining commencing in 1967 coinciding with the development of the Queensland Alumina Limited (QAL) alumina refinery at Gladstone. Limestone extraction began at Pit 1 (ML3603) and on the Comalco lease now called Pit 4 (ML3594). A 1969 aerial photograph of the Calliope is provided below as Figure 12.

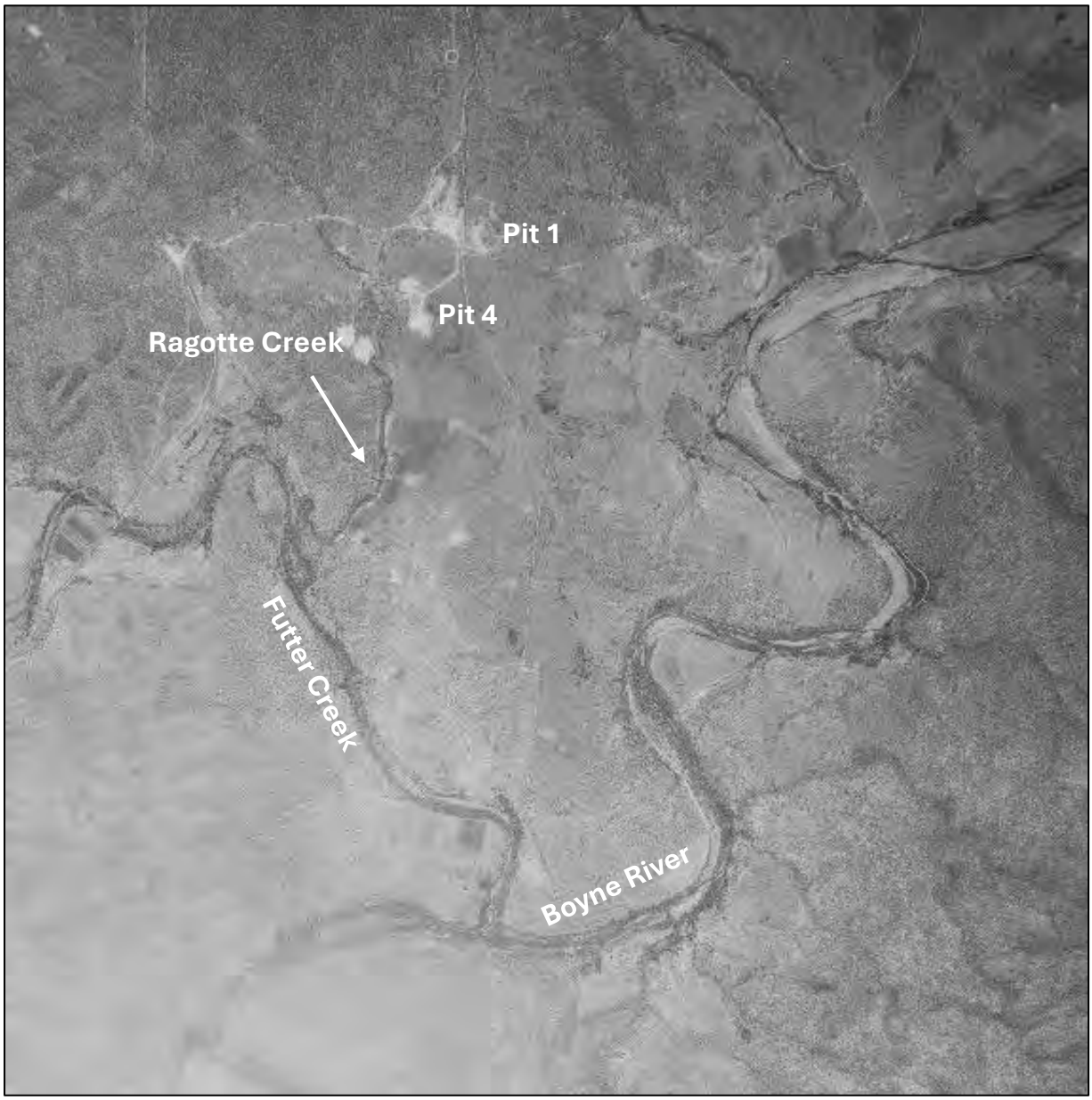


Figure 12: Calliope 29 November 1969

Limestone is extracted by conventional open cut benching methods. Four pits have been excavated at the Calliope, being Pits 1-4, although Pit 1 has now been backfilled.

In the 1980s the raising of Awoonga Dam wall by 24 metres did not impact the Calliope but the planned raising of the Awoonga Dam wall by a further 11 metres to 47mAHD in 2001 led GAWB to initiate earthworks for flood protection of the then named 'Frost Quarry. Frost Enterprises provided the construction services to widen and raise the spoil heaps, supply of crusher dust and haul trucks for material transport. The earthworks were completed in 2002.

Unimin acquired Frost Enterprises in September 2004. At this time, Unimin operated the two pits, the 'Frost Pit' now called Pit 3 and the 'Comalco Pit' now called Pit 4. Unimin merged with Sibelco Australia in 2011 assuming ownership of the site. Several additional mining leases were granted in 2013 to make the tenure more contiguous. In 2019 Graymont took ownership of the Calliope Limestone operation.

4.1.2 Mining Summary

Limestone is mined by conventional open cut benching methods. Mining begins with topsoil stripping and removal of clay rich overburden and waste rock. This material has been used for the construction of the western and eastern bund walls, which are large barriers to prevent surface water inundation of the quarry workings, as well as for safety bunding around pit voids and for surface water flow control. Excess overburden waster material is hauled to the Waste Dump, located south of Pit 3. The Waste Dump extends from the western bund wall as an increasingly widening barrier against potential flood inundation from Awoonga Dam.

Limestone is extracted by drilling and blasting to produce a high-quality limestone suitable for calcination and hydration and a medium quality limestone suitable for crushed rock and aggregates.

There are no geochemically reactive or acid forming wastes, tailings dams, or heap leach pads onsite, and the environmental risks from the inert waste rock is considered low/negligible.

The Calliope currently operates three pits with only Pit 4 currently used for extraction. Mining over the next 70 years will lead to the am amalgamation of Pit 4 with Pit 3 (Pit3-4) and end of mine life is currently scheduled for 2100, but this may change depending on reserves and yearly sales quantities. A PRC Plan amendment will be undertaken if there are any material changes to operations that will impact the rehabilitation staging of the Project. All future disturbance until EOML will be authorised by, and undertaken in accordance with, the amended EA.

4.1.3 Mining created sub-catchments

Prior to the commencement of mining surface water flow in Ragotte Creek catchment was inward and southerly to Futter Creek. A June 1997 aerial photograph of Pit 3 catchment is provided as Figure 13.

In 1997 waste material was being placed to the west of Pit 3, in a southerly direction, which provided a barrier between Ragotte Creek and mine workings. Surface water at this southern end of the Calliope Mine flowed southerly into Pit 3 and westerly into Ragotte Creek. Surface water and groundwater flowed into the Pit 3 from the western wall of Pit 3 as marked in Figure 13. Surface water flowed along an unnamed drainage line into Ragotte Creek through what is now the Farm Dam.

An organic rich black clay is shown in Figure 13 which indicates that the area to the west of Pit 3 is a natural topographical low. Prior to mining modifying surface water flow, surface water would have flowed southerly to the unnamed drainage line and then into Ragotte Creek. This organic black clay layer provides the conduit for the current northerly flow of surface water from the Farm Dam to Pit 3.

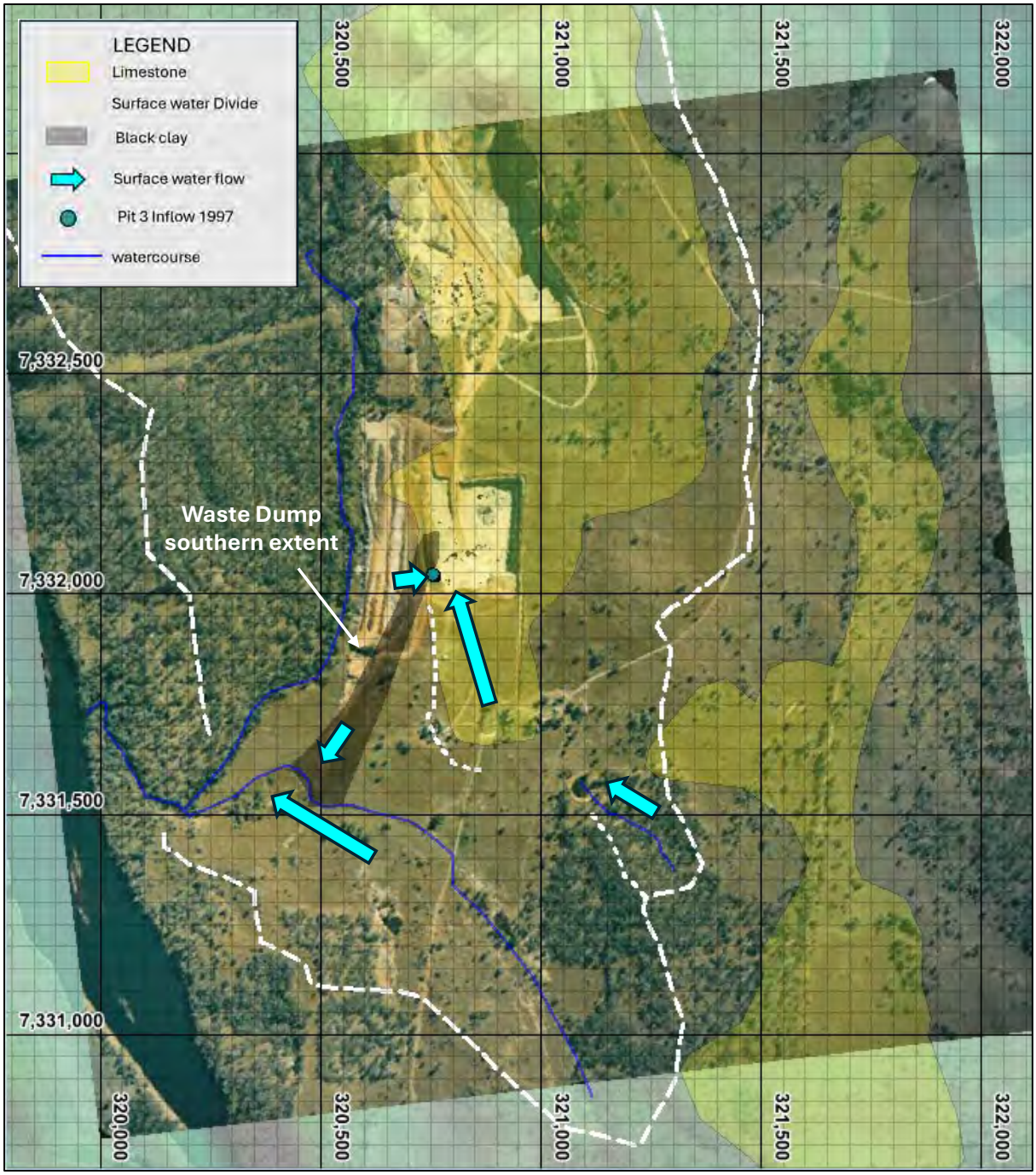


Figure 13 Pit 3 catchment in June 1997

A surface water inflow point source (Pit 3 Inflow) to Pit 3 is observable in June 1997 as marked in Figure 13. GHD (2011) proposed that flow at this location was by piping failure through the Awoonga Dam wall but since the inflow was present in 1997 prior to the raising of the western bund wall this feature could not be caused by Awoonga Dam water. The source of surface water run-off into Pit 3 is from the catchment and Waste Dumps.

The construction of the Western Bund Wall in 2002 impeded westerly surface water flow to Ragotte Creek and created the closed Pit 3 and Farm Dam sub-catchments. A 2002 Calliope map of spoil heaps used in the construction of the Western Bund Wall is shown as Figure 14.

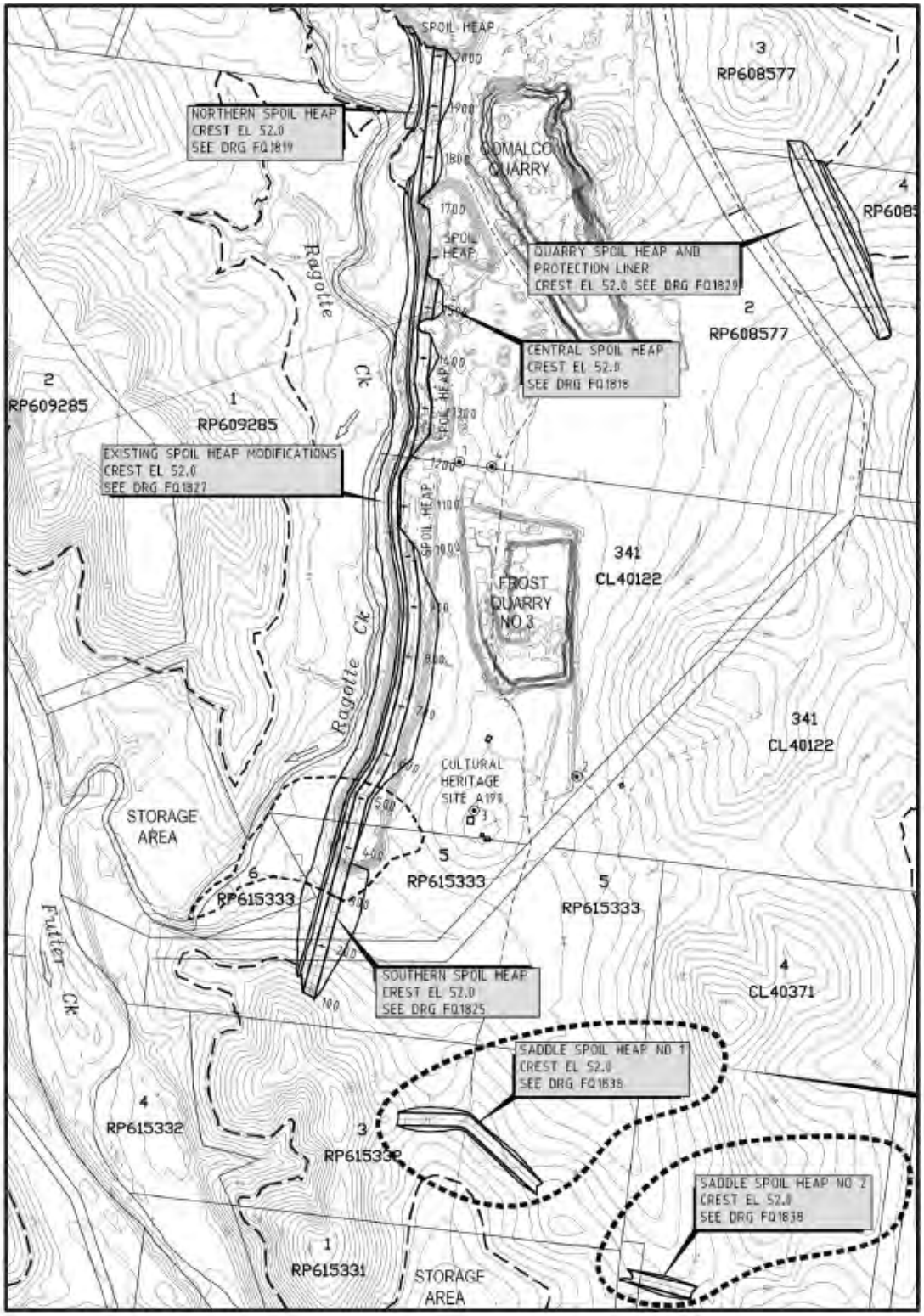


Figure 14 Spoil heaps used in the construction of the Western Bund wall (GAWB, 2002)

The construction map provides a chainage distance for the western bund wall, from south to north, which is referenced by later investigations of potential leakage of this wall. Pit 3 Inflow is located at chainage 860. A September 2004 aerial photograph of Pit 3 catchment is provided as Figure 15.

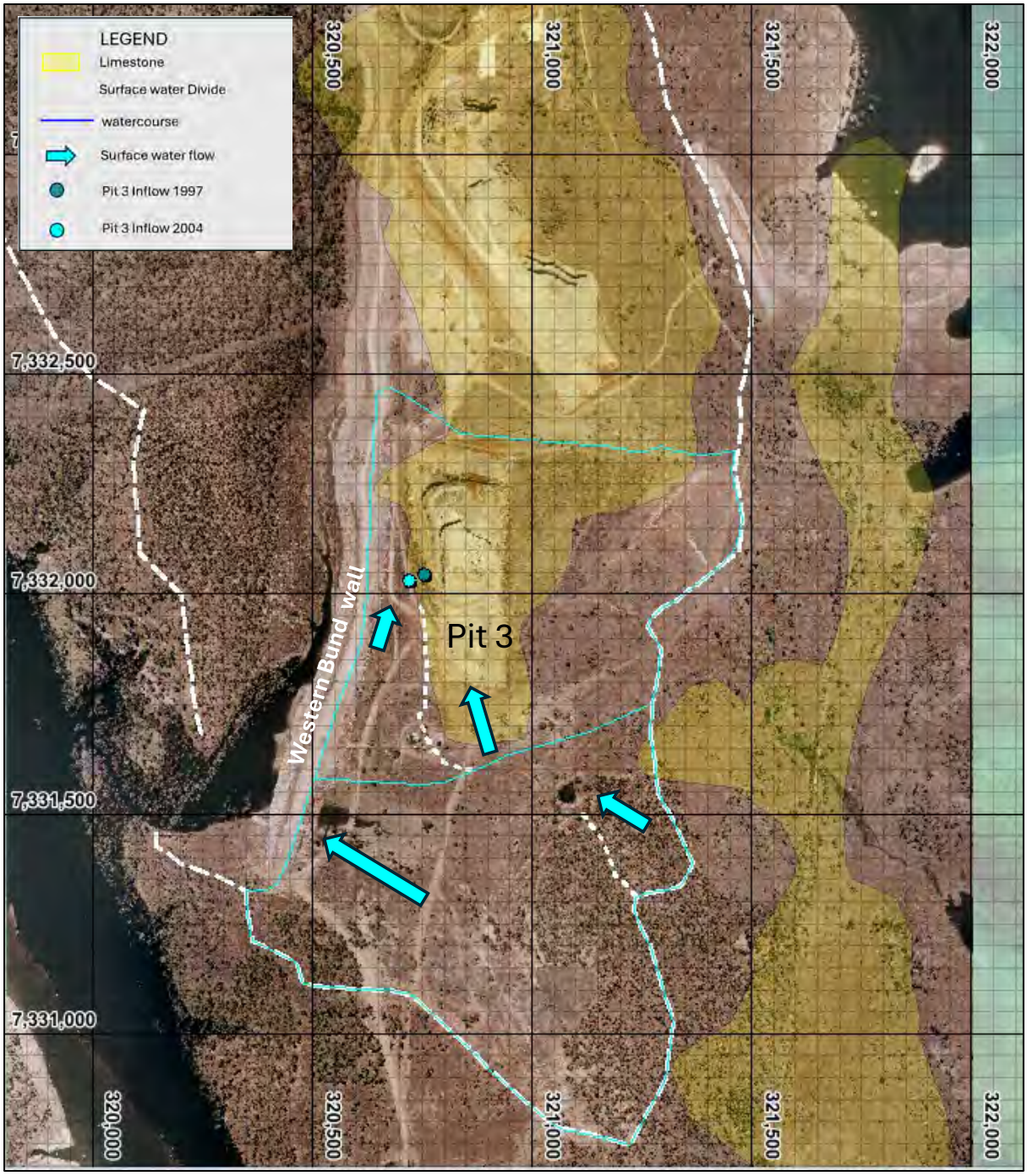


Figure 15 Pit 3 void and Farm Dam sub-catchments in September 2004

In September 2004 Pit 3 was dry and erosion had caused Pit 3 Inflow to migrate westerly (Figure 16). Although Pit 3 was dry at this time there was water in Ragotte Creek and minor water in the Farm Dam. The relevance of observed water in the Farm Dam and Ragotte Creek is that GHD (2011) proposed that excess water in Pit 3 following an extreme rainfall event was due to a possible piping failure mechanism from the ponding of water by the Farm Dam against the unlined eastern side of the Western Bund Wall. In 2004 water was ponding on the eastern side of the western bund wall because the Western Bund Wall impeded surface water flow that previously flowed into Ragotte Creek.

In March 2011 a high rainfall event led to excess water in Pit 3. Pit 3 Inflow to Pit 3 (Figures 12 and 14) and its water dynamics are discussed in detail in Sections 7 and 8. Surface water flow in November 2012 from the catchment above Pit 3 is shown in Figure 16.

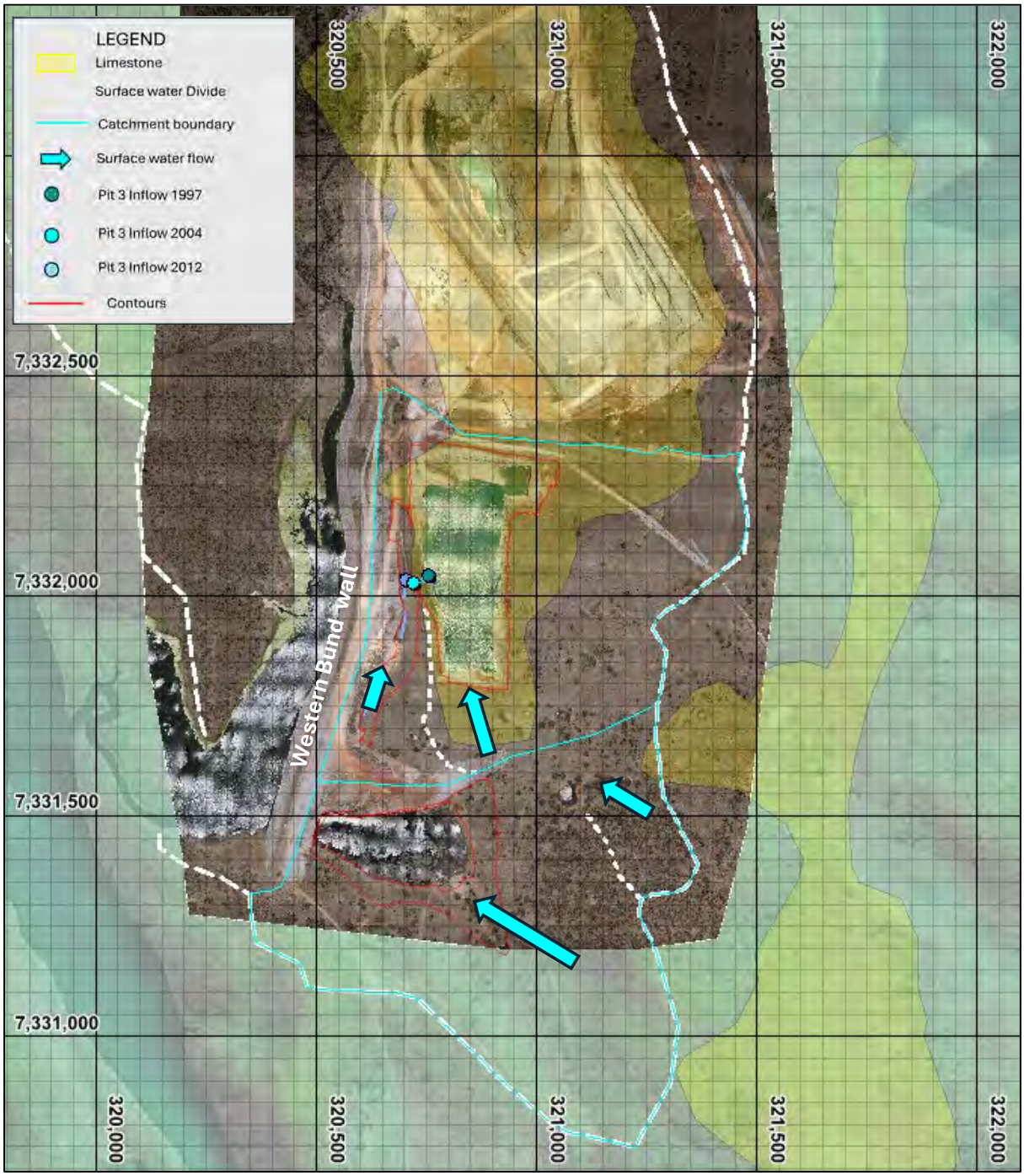


Figure 16 Pit 3 and Farm Dam sub-catchments November 2012

In November 2012 surface water flowed along the western bund wall from the Farm Dam and into Pit 3. Pit 3 Inflow had further migrated to the west with erosion and during a high rainfall event in 2013 slumping occurred creating the current scoured channel from the Western Bund Wall into Pit 3.

The landform has been modified since 2012 by expansion of Pit 4 void, expansion of the Waste Dump in the 'Farm Dam' area and the infill of Pit 1. Current mine sub-catchment boundaries are shown below in Figure 17.



Figure 17 Mine sub-catchments

A description of the individual sub-catchments is provided below .

Pit 1

The Pit 1 catchment area has a roadside bund separating clean rainfall run-off water from the active mine area on the east side of the catchment. Pit 1 has been backfilled and drainage within the catchment is directed northwest and into the Sediment Dam catchment. Surface water run-off that has come in contact with stockpiled limestone material flows into the Sediment Dam catchment. The northern part of the catchment includes the employees crib room, workshop and access track.

Pit 2

Pit 2 catchment area includes the main entrance to the site, the contractor truck waiting area at the site entrance, main office and plant stockpile storage areas. Pit 2 is an inactive pit void for mining purposes and acts as a water storage facility for the site. Process water for the plant operation is obtained from Pit 2 storage. Water is also used for dust suppression purposes and washdowns. The Pit 2 void is the focus for drainage for this catchment. Overflow from the adjacent slurry dam catchment area will flow to the Pit 2 void under higher run-off conditions.

Sediment Dam and Slurry Pond

Run-off from the wash plant and screening area flows west toward the sediment dam which captures and settles sediment before discharge through release point C1. Release only occurs in wet climate conditions and after monitoring has confirmed water quality compliance. Run-off from Pit 1 area is also directed into the Sediment Dam catchment.

Run-off from the crushed limestone stockpiles which can include fine material, flows west into the slurry pond where settling occurs. During higher wash plant water use and wet climate periods, overflow is directed northward to Pit 2 void via subsurface pipeline.

Pit 4

Pit 4 currently has two void compartments. The main water supply and storage void is the northern compartment with a pontoon and pump system installed. The southern void compartment is the active mine area. Pit 4 water is primarily pumped from Pit 4 to Pit 2, and if required to C1 release point provided water quality parameters are met.

Pit 3

Pit 3 is currently inactive for mining but will become active in the future. The void receives surface water run-off and potentially groundwater seepage and/or leakage from Awoonga Dam. The relative contribution of these water sources has been subject to numerous investigations. In more extreme wet climate conditions if storage capacity is significantly reduced, water can be pumped to the F1 release point provided water quality parameters are met.

Farm Dam and Waster Rock Dump

The Farm Dam and its sub-catchment have been created by the construction of the western bund wall which impounded surface water which prior to the construction of the western bund wall flowed into Ragotte Creek. The western side of the Farm Dam catchment is progressively being developed as a waste dump. Water storage in the Farm Dam is continually modified by the ongoing placement of waste material against the eastern side of the Western Bund Wall. The Farm Dam has a theoretical run-off overflow at 43mAHD to Pit 3 but does not fill beyond 38mAHD because of sub-surface water flow beneath the western wall of the Waste Dump which becomes. surface water flow along the western bund wall from the Farm Dam to the surface water inflow point and then into Pit 3 void..

4.2 Geology

A map of Calliope geology is provided below in Figure 18.

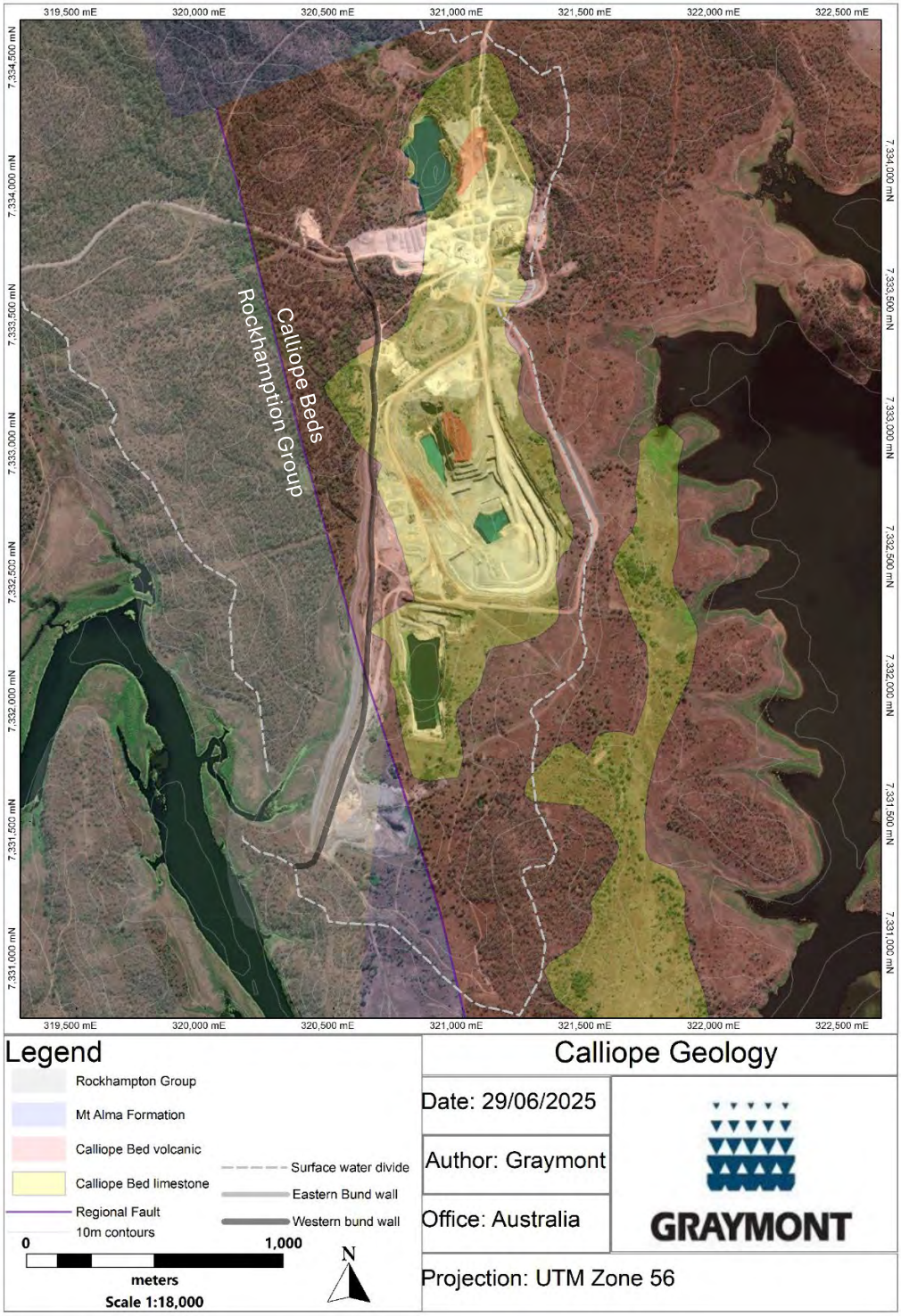


Figure 18 Calliope geology

The Calliope is located within the Silurian-Devonian aged Calliope Beds of limestone and volcanic rocks. Limestone outcrops as two well defined, elongated north-south sub-vertical lenses which abut the volcanics and in places is capped by volcanic rock. The limestone-volcanic contacts are sub-vertical, except for isolated remnant sub-horizontal volcanic caps. Bedding and cleavage are orientated north-south and joint direction generally vary between northeast-southwest and southeast-northwest. The younger Rockhampton Group sediments lie to the west of a north north-west trending fault, which lies outside Pit 3 and 4 voids. The fault is to the east of the Farm Dam abutment with the western bund wall and to the west of the surface water inflow point and has no apparent relationship to both these features. See Figure 18.

Volcanics rocks vary in colour from being blue grey to black and from green-grey to purple-red to red. Volcanic is present as a sub-vertical sills and sub-horizontal dykes. This is unusual because sills are mainly sub-horizontal and dykes sub-vertical and imply regional thrusting. The volcanic rocks are mainly basaltic and are typically 40-55% SiO_2, 4-10% CaO, 3-7% MgO, 2-4% Na_2O, 9-13% Fe_2O_3 and 0.3% SO_3. Fresh Limestone is typically 0.5% SiO_2, 54.5%CaO, 0.3%MgO, 0.01% Na_2O, 0.2% Fe_2O_3 and 0.05% SO_3.

The limestone has been subjected to regional metamorphism, folding and faulting with numerous joint sets. The limestone is massive, fine grained and even textured, light to dark grey but can vary to pink, red and pale brown in zones around faults and dykes. A photograph of a black mafic volcanic exposed by mining in the eastern wall of Pit 4 is shown as Figure 19.



Figure 19 Black mafic volcanic in the eastern wall of Pit 4 (from Rocktest, 2023)

The limestone has been weathered and clayed as shown in a photograph mosaic of the western wall of Pit 4 in Figure 20.



Figure 20 Weathering of limestone in the western wall of Pit 4

An E-W, north viewing, geological cross-section 7332650N of Pit 4 is shown below in Figure 21.

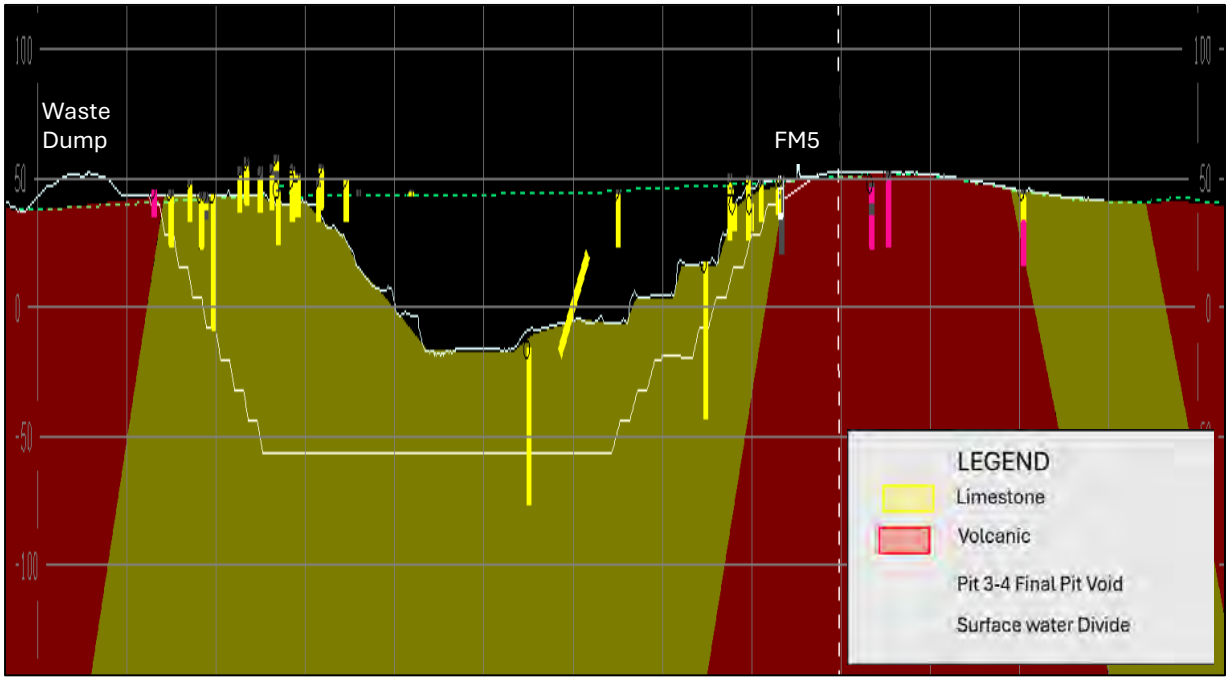


Figure 21 Cross-section 7332650N showing Pit 4 geology

Limestone in Pit 4 is bounded by volcanic which is exposed as fresh rock in Figure 20 in an upper bench. An E-W, north viewing, geological cross-section 7332175N of Pit 3 is shown below in Figure 22.

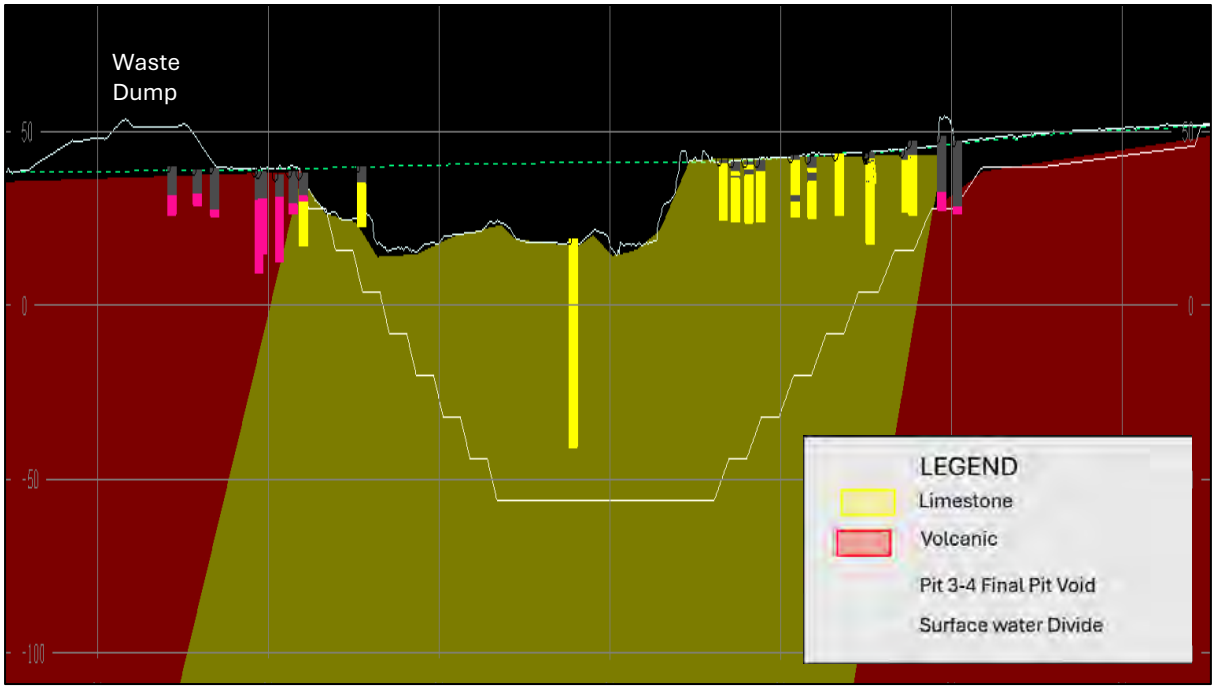


Figure 22 Cross-section 7332175N showing Pit 4 geology

The geological cross-section of Pit 3 is very similar to the Pit 4 geological cross-section.

4.3 Soils

Limestone occurs as either low outcrops or beneath a shallow cover of dominantly red-brown earths, topsoil and clay. Limestone is flanked by volcanic rocks which to the east are overlain by red-brown earths and red hematite iron-oxides associated with this topographic high. Overburden depth ranges from 10-15 metres. Volcanic rocks to the east are overlain by yellow brown earths and yellow brown goethite, which is a hydrated iron-oxide, in the topographic low. Black organic rich clay is present along the eastern flank of the western bund wall being on the western high wall of Pit 3, which includes the surface water inflow point into Pit 3.

4.4 Voids, mineral dissolution salt stores

Limestone is weathered and clayed near the surface with voids created by dissolution of infiltrating slightly acidic rainfall forming a karstic landscape. Voids are filled by red to orange clay. Clayed and cavitated limestone is currently exposed on the western side of Pit 4 to an average depth of 10 metres. Limestone becomes fresher with depth to form a massive crystalline layer, Volcanic rocks are also weathered, clayed and cavitated and fresher with depth to form a massive crystalline layer. The voids have formed by water dissolving minerals in the rock and releasing cations and anions to the regolith. Weathering of volcanic rocks releases the cations Ca, Mg, Na, Fe and some S to the regolith, and limestone weathering releases Ca. XRF results reveal that the SO_3% of volcanic is a low 0.28% and for limestone a very low 0.05%. Carbon is added to groundwater via CO_2 in soil water at roots of plants and by $CaCO_3$ dissolution and anions and cations are leached to groundwater.

The primary source of salinity in Central Queensland is the deposition of cyclic salts by precipitation and aeolian dust (Oppy, 1999). There is an additional contribution from mineral weathering of cations and CO_3 anion from the dissolution of CO_2 in soil water. Stream salinity is attributed to salting in dryland and irrigation areas, discharges of saline groundwater, cyclic salt and the dissolution of surface salts in run-off water. The salinisation of groundwater is generally attributed to a changing water balance associated with salt affected regolith. Rainfall typically causes an initial increase in surface water salinity from flushing of salts out of the regolith (first flush) but extended rainfall causes a decrease in salinity by dilution. Rainfall typically causes an increase in groundwater salinity by leaching of salts from the regolith. The regolith salt store decreases in wet periods. Evaporation, in extended dry periods typically causes an increase in salinity by concentration. Groundwater salinity decreases in extended dry periods as groundwater lowers and salt is precipitated out of groundwater into the regolith. The regolith salt store increases in dry periods. Rainfall adds major ions to the regolith, groundwater and surface water which leads to the formation of the salts halite NaCl and gypsum $CaSO_4$. Kalf and Associates (2003) calculated dissolved minerals in water samples from bores FM1 and FM4, located west of Pit 4 and of Inflow into the western edge of Pit 3. See Table 9.

Location	FM1			FM4			Pit3 Inflow top			Pit3 Inflow bottom		
	mg/L	mmol/L	%	mg/L	mmol/L	%	mg/L	mmol/L	%	mg/L	mmol/L	%
Halite NaCl	2.14	0.037	1%	33.08	0.566	12%	89.06	1.522	23%	86.52	1.479	22%
Carbonate CaCO3	184.04	1.840	53%	164.18	1.642	58%	203.41	2.034	54%	214.44	2.144	55%
Dolomite (Ca,Mg)CO3	151.46	0.823	43%	68.46	0.370	24%	53.01	0.288	14%	53.01	0.288	14%
Anhydrite CaSO4	11.34	0.083	3%	18.43	0.135	6%	34.03	0.250	9%	32.61	0.239	8%

Table 9 Calculation of dissolved minerals

Groundwater in bores FM1 and FM4 have lower carbonates than Pit 3 Inflow but higher dolomite. Pit 3 Inflow has higher halite and anhydrite than groundwater in the bores. Mining operations can sometimes lead to Acid Mine Drainage however, this is not considered to be likely given the nature of the geology, carbonate based, which leads to near neutral groundwater.

4.5 Quarry aquifers and aquitards

The Calliope beds limestone and volcanics are predominantly an aquitard because there is no primary porosity but connected fractures can create a secondary porosity that forms a low yielding unconfined fractured rock aquifer. An E-W, north viewing, hydrogeological cross-section 7332650N of Pit 4 is shown in Figure 23.

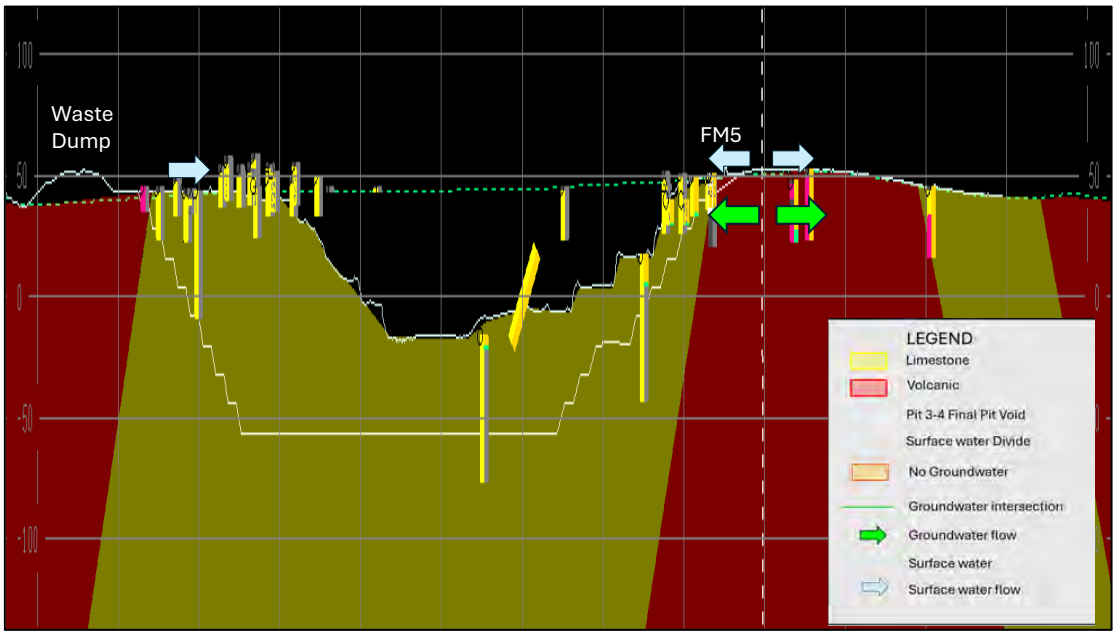


Figure 23 Cross-section 7332650N showing Pit 4 geology and groundwater intersections

An E-W, north viewing, hydrogeological cross-section 7332175N of Pit 3 is shown in Figure 24.

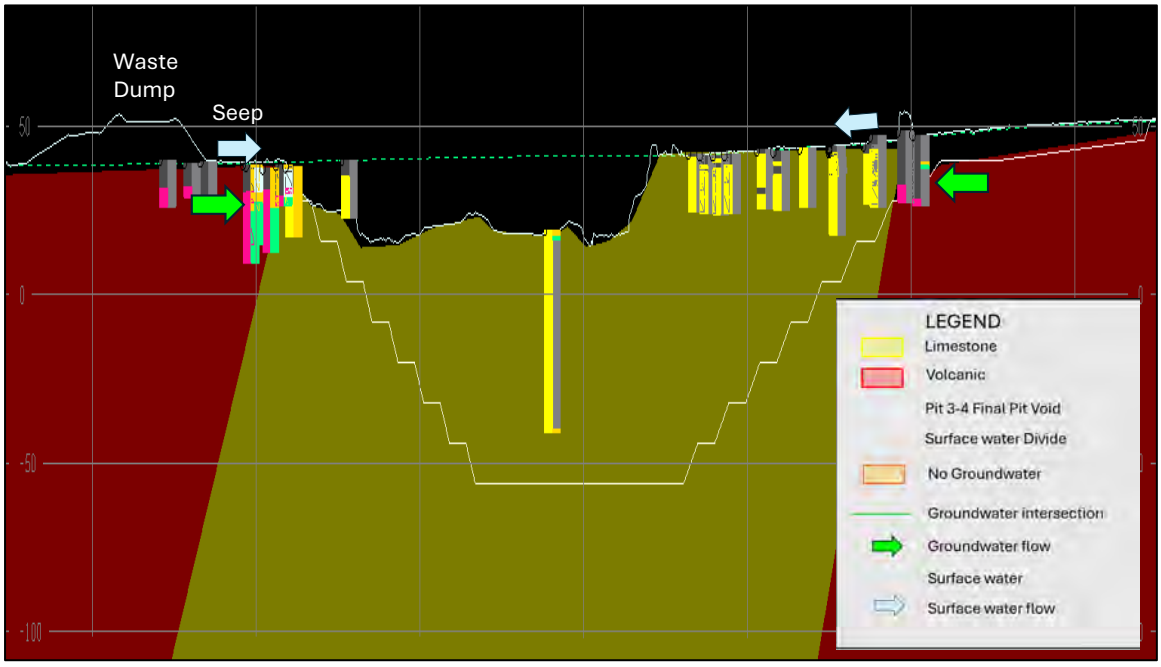


Figure 24 Cross-section 7332175N showing Pit 4 geology and groundwater intersections

Aquifers are discussed in further detail in Section 10.

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4.6 Water Management

4.6.1 Water Management Plan

The Water Management Plan (WMP) forms part of site's Environmental Management Plan. The WMP describes the risks and control measures required to manage water flow and quality on site, monitor water quality and regulate safe water discharge from site to achieve ---the following objectives:

- Manage discharge waters leaving site to within water quality limits as prescribed in the EA.
- Manage rainfall run-off to ensure 'clean' (uncontaminated by mine operation areas) is separated from 'dirty water' (rainfall run-off that has been in contact with disturbed areas of the operation).
- Design, construct and maintain Water management structures to effectively control the flow of rainfall run-off and store excess run-off to prevent uncontrolled releases and allow continued mining operations. Pit water storage and reuse form an important component of site water management.
- Transfer captured dirty water between water management structures on site to optimise the reuse of dirty water on site for mine plant use and dust management, minimising the need for off-site discharge.
- Treat captured 'dirty water' through natural settling processes via sediment dams and natural drainage filtration routes prior to discharge.
- Ensure hydrocarbon sources are suitably bunded to prevent contamination off-site.
- Monitoring of water including in-pit accumulation, discharge, water transfer and re-use
- Monitoring of condition and performance of water management structures

4.6.2 Groundwater Management and Monitoring Plan

The Groundwater Management and Monitoring Plan (GMMP) forms part of site's Environmental Management Plan. The GMMP outlines a program that has the following objectives:

- Detect a significant change to groundwater quality values due to activities that are part of this mining project
- Include measures to minimise the impact of the mining activities on groundwater resources
- Include contingency procedures for emergencies
- Include a program for monitoring and review of the effectiveness of the groundwater monitoring and management program

4.6.3 Compliance Monitoring and Reporting

Compliance monitoring and any identified non-compliances are investigated and reported in accordance with EA conditions. Water monitoring and compliance against EA conditions are annually reported in Annual Returns and the Annual Groundwater Report.

4.6.4 Ground Control Management Plan

The Ground Control Management Plan describes the geotechnical systems and procedures at Calliope with water related aspects which include.

- Probe drill potential karst areas. Loss of return air during blast hole drilling on upper benches or subsidence of the floor or a work zone or ramp may indicate that a karst void is below the floor
- Daily pit inspections to minimise the potential for water to enter cracks behind the crest of a wall; extent to which water on berms infiltrates into blast damaged benches and extent of erosion and scouring of the batters and berms.

4.7 Potential contaminants

Contaminants are substances that are either present in an environment where they do not belong or are present at levels that have the potential to harm human or environmental health. Contaminants in water can be physical, chemical, biological, radiological substances or matter. Based on the nature of the operation, site geology, historical monitoring data and EA requirements, the contaminants considered relevant to this assessment are electrical conductivity (EC) in µS/cm, pH, total suspended solids, sulphate, nitrate, metals and hydrocarbons. These contaminants are evaluated in subsequent sections using available surface water and groundwater monitoring data'

Water is managed at Calliope to meet regulatory EA surface water release limits and groundwater trigger values within the regulatory framework of the Boyne River Basin Plan and the Reef 2050 Water Quality Improvement Plan. See Figure 25.

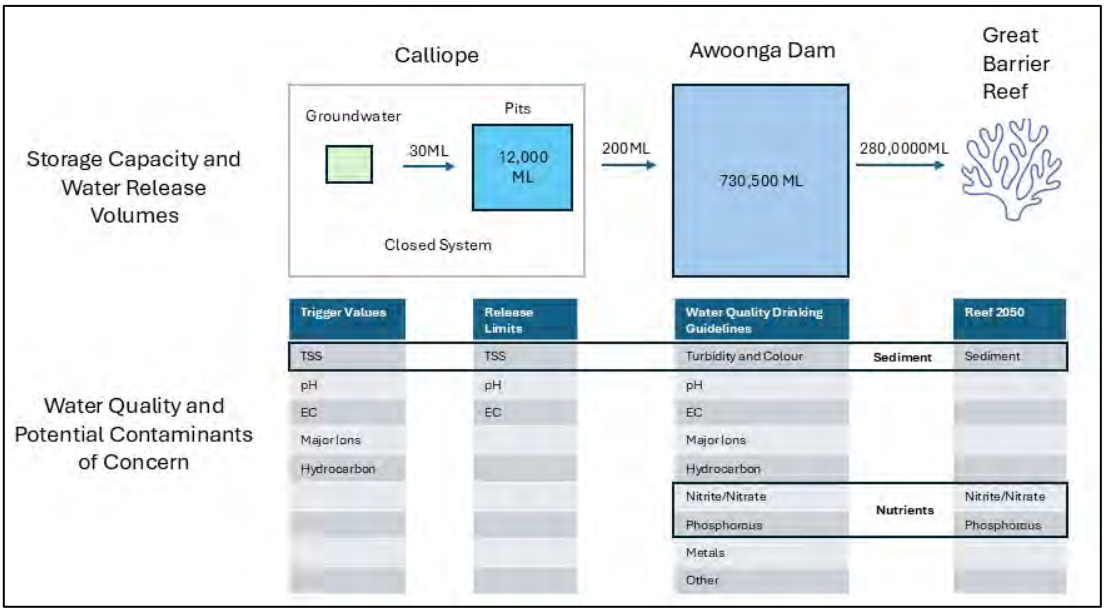


Figure 25 Calliope Regulatory requirements within the Boyne River Basin regulatory framework

Water quality at Calliope and Awoonga Dam compliance is compared with the concentration values of analytes (Table 4) whereas the Reef 2020 targets are based on load reductions. There is a large volume disparity between Calliope water release and Awoonga Dam storage and release, which combined land clearing and cattle grazing across the Boyne Basin swamps any potential impacts on water quality by Calliope activities.

4.7.1 Potential contaminants in surface water

Mining can be a source of potential contaminants and voids created by mining can be sinks for potential contaminants. Calliope operates as a closed system with flood protection bunds and natural topographic highs preventing overland flow off-site to Awoonga Dam and conversely, protection from inundation from high water levels from Awoonga Dam. The pits are also closed systems and are sinks for surface water run-off and groundwater flow.

Potential sources of contaminants include primary sources from natural processes and secondary sources introduced by mining. Primary potential contaminants are the physiochemical parameters of salinity (measured as Electrical Conductivity), pH, suspended solids, nutrients (nitrate), metals and hydrocarbons. Mining activities can potentially disrupt, change and redistribute these water quality parameters. Secondary sourced potential contaminants include the above listed primary potential contaminants and sewage effluent.

The potential contaminant sources for surface water are:

- Pit Water
- Surface water runoff
- Sewage Effluent
- Fuels, Oils and Lubricants

Pit water
Pit water at Calliope Limestone Operation is considered a low risk source of contaminants. The generation of salts within the mining operations and accumulated within the pits is low, and on-going monitoring has shown the pit water is within the EA limits (Section 7.2.3). Other potential contaminants such as pH and suspended solids within in the pits also achieve the required EA criteria. Hydrocarbons are managed through bunding and refuelling procedures and pesticides are not used on site. Hydrocarbons have not been detected in pit water samples. Metal concentrations are low. Oxidisation of limestone and volcanic rocks is a natural process which is accelerated on the waste dump but limestone purity and low volumes of volcanic material ensures that pH remains near neutral and there are no acid forming waters at site. Pit water potential contaminants are salinity, pH, suspended solids, sulphate, nutrients (nitrate), metals and hydrocarbons.

Surface water runoff
Drainage channels and diversion bunds control rainfall run-off from mine affected areas to the relevant pit void or sediment control structure. Clean water drainage control bunds separate clean rainfall run-off from mine affected run-off. Run-off from 'Sediment Dam' catchment, which includes the Production office area and mobile crushing plant area, is directed to the sediment dam for settling prior to discharge through a small wetland system and then past the C1 discharge site.

Sewage effluent
Treatment and disposal of sewage effluent is managed by a dedicated septic system and is not considered significant in the water management system.

Fuels, Oils and Lubricants
Fuels and oil storages are located east of Pit 2. The storage area for fuel is bunded for containment purposes. Any overflow or leakages are directed via a drain to a humeceptor. Any potential overflow from this system is directed to Pit 2 and therefore remains within a closed system.

4.7.2 Potential contaminants in groundwater

Groundwater is generally microbiologically safe and chemically stable; however, shallow or unconfined aquifers can be subject to contamination from discharges or seepages associated with agricultural practices (pathogens, nitrates and pesticides), septic tank discharges (pathogens and nitrates), industrial wastes and leaking hydrocarbons (such as fuels, oils, and hydraulic fluids) from machinery and storage. Potential source pathways to groundwater include infiltration of surface water, seepage from pit water storages and mobilisation of naturally occurring constituents (e.g. sulphate, nitrate and metals), noting these are discussed elsewhere in the assessment. Groundwater intercepted by mining activities accumulates in sumps and is pumped to surface water storages on site, transferring potential contaminants. The potential contaminants in groundwater are the physiochemical parameters of salinity (measured as Electrical Conductivity), pH, suspended solids, nutrients (nitrate), metals and hydrocarbons.

Fuels, Oils and Lubricants
Hydrocarbons are routinely monitored as part of the groundwater monitoring program.

Groundwater trigger value exceedances
Groundwater trigger exceedances are investigated in accordance with EA and GMMP requirements, and that natural causes are evaluated as part of the investigation process. Exceedances of sulphate have led to several

investigations which led to the conclusion that sulphate is from natural processes and that the trigger level of the FM5 replacement bore, being FM5B, required new trigger values.

4.8 Potential impacts and risks to Environmental Values

The Boyne River Basin Plan Environmental values relevant to Calliope were outlined in Section 3.2 and the potential impact to Calliope Environmental values was assessed by pathway receptor linkage and the results are provided below in Table 10.

Calliope Environmental values			
Environmental values	Description		Pathway Receptor Linkage
Aquatic ecosystems	✓	Calliope Mine is located in Ragotte Creek adjacent to Awoonga Dam, a tributary to Boyne River. Areas downstream may support aquatic ecosystems. Water discharges from the site are in accordance with EA licence conditions.	Unlikely
Drinking water	✓	Raw water from Lake Awoonga is processed at water treatment plants for drinking. Graymont annual. Water discharges from the site are in accordance with EA licence conditions.	Unlikely
Primary recreation	✓	Areas adjacent to the site support recreational activities including swimming and diving. Water discharges from the site are in accordance with EA licence conditions.	Unlikely
Secondary recreation	✓	Lake Awoonga supports recreational fishing and boating activities. Water discharges from the site are in accordance with EA licence conditions.	Unlikely
Visual recreation	✓	The site is located approximately 7km south west of the Lake Awoonga lookout, boat ramp, and camping area, and is not clearly visible from this location. Potential contamination at the site is unlikely to be contributing to deterioration of the aesthetics of Lake Awoonga.	Unlikely
Human consumer	✓	Areas downstream from the site may be utilised for the consumption of aquatic foods, including fish.	Unlikely
Cultural and spiritual values	✓	Mining is in accordance with Regulatory approved cultural heritage requirements and it seems unlikley that the cultural and spiritual values of Lake Awoonga are impacted, but it is acknowledged that they may possibly be impacted.	Possible
Aquaculture	✓	The site is not located in proximity to any aquaculture facilities.	Unlikely
Farm supply/use	✓	The site is bounded by woodland is not located in proximity to any farms and groundwater flow is toward voids and surface water flow to Awoonga Dam.	Unlikely
Irrigation	✓	There are no groundwater bores in the Ragotte catchment. Pit water is mainly surface wtare and any groundwater in pit voids is naturally mixed on the pit floor and pit water is then released in accordance with EA licence conditions.	Unlikely
Stock water	✓	Water discharges from the site are in accordance with EA licence conditions, which is suitable for livestock.	Unlikely
Industrial use	✓	Not applicable	Unlikely
Groundwater	✓	Mining voids are groundwtaer sinks.	Unlikely

Table 10 Potential impacts to Calliope Environmental values

Calliope Water potential contaminants are discussed in Section 4.7.

4.8.1 Mechanisms of potential impacts and risks to environmental values

The mechanisms of potential impacts and risks to environmental values are:

- Mixing of potentially contaminates pit water and Awoonga Dam water
- Seepage of potentially contaminated pit water into Awoonga Dam
- Mine void interaction with potentially contaminated groundwater
- Reduced groundwater supply to regional bores
- Reduced groundwater supply to Groundwater Dependent Ecosystems

Mixing of pit water and Awoonga Dam water
The potential impacts arising from the formation of the pit void may occur via several mechanisms.

A connection between the final void pit water and Awoonga Dam water may occur via overland flow in a scenario where Lake Awoonga floods to the extent that floodwater enter the void and pt lake water is released into the flood waters. The highest Awoonga Dam water levels recorded was in January 2013 which peaked at 48.3m AHD without breaching the levees surrounding the mine. The rainfall event that caused the maximum water level observed at Awoonga Dam was 870mm in 24 hours (SILO data, Queensland Government "Long Paddock database) and is equivalent to greater than 1 in 2000-year event (BoM rainfall designs database). According to the 'Awoonga Dam Emergency Action Plan', the top of the flood control bunds (at 52.0 mAHD) would not be breached until an event less likely than a 1 in 10,000 AEP flood event (that would result in a dam height of 50.12 m). Modelling outputs presented in the 'Flood Mapping for the Boyne River Basin' suggest that flooding of Awoonga Dam may result in floodwaters entering the Calliope voids. However, given the unlikely nature of the event, the benign nature of the pit lake water and the vast dilution of pit water that would result from a PMF, the risk to downstream environmental values from this mechanism is negligible.

Flooding of the final void due to inflows from on-site catchments could resulting in water overtopping the void and perimeter bunds and reaching Awoonga Dam. The flood modelling prepared by Engen showed that even during a PMF, the water level in the final voids was below the crest of the voids and do not indicate a risk of voids overtopping. This is consistent with Water Balance modelling which predicts that the pit will not fill under a likely lower greenhouse gas emission scenario.

Seepage of pit water into Awoonga Dam
Seepage of pit water through the bedrock to Awoonga Dam is extremely low to negligeable because the long-term void water levels will be lower than the Awoonga Dam water levels, hence the groundwater gradient will remain towards the mining void. See Section 12.4.

Mine voids interaction with groundwater
The primary groundwater affecting activity at the site is the mining void creation which can disrupt groundwater flow, although there is little groundwater at the site and flow. The main mining void (combined Pit 3 and Pit 4) will be dewatered progressively as required to access the limestone resource and will remain a water storage post-mining. Pit 2 void is planned to remain a water storage facility for the current life of mine and post-mine. Pit 1 void has been filled, and post-mine will be used for light grazing.

Reduction in groundwater supply to regional bores
Two monitoring bores, FM5 (State water database RN187863) and FM6 (Queensland State water database RN151688), are the current registered groundwater monitoring bores for the site as required under the current Environmental Authority (EA). Groundwater levels and groundwater quality data are obtained 6-monthly to analyse and report trends. An additional monitoring bore (RN187863, also known as FM5B) located close to the original FM5 was drilled in January 2021 due to low groundwater levels in FM5 during mid-2019 to late-2020. FM6 (State water database RN151688) is located at the northern end of the Calliope.

There are no pumping bores in the Ragotte Creek catchment or the Calliope because only minor groundwater has been intersected which is insufficient for a groundwater pumping bore (Kalf and Associates, 2003). The Calliope beds limestone and andesite is predominantly an aquitard but with connected fractures can form a low yielding fractured rock aquifer. The maximum recorded bore yield from the Calliope Beds is 1.5l/s. Regional drilling of the Calliope Beds is in alignment with the Calliope drilling results which are discussed in Sections 8.2 and 8.3, Groundwater seepage at the Calliope is minor which is in alignment with a maximum yield from the Calliope Beds of 1.5l/s from regional drilling. There are two bores within the Boyne catchment, excluding the Calliope monitoring bores, that are in the Calliope Beds. One bore is located south of Awoonga Dam and the other in another catchment east of the Calliope. Groundwater behaviour in both bores is not related to groundwater observed at the Calliope, because of geographical position and groundwater flow is

under gravity towards the Awoonga Dam. Mining activities at the Calliope are a negligible risk to human groundwater beneficial users in the Boyne River Basin.

Reduction on groundwater supply to Groundwater Dependent Ecosystems

A search of Queensland Globe was undertaken to assess whether mining activities could impact other biological organisms in groundwater. The results from this search was that there are no Groundwater Dependent Ecosystems (GDE) in the Ragotte Creek and adjacent catchment. GDE's categories investigated were surface expression, terrestrial, subterranean and potential GDE's. Since there are no GDEs in Ragotte Creek catchment and groundwater flows under gravity towards the Awoonga Dam, mining activities at the Calliope are a negligible risk to GDE's in the Boyne River Basin.

4.8.2 Monitoring – asssessing against Water Quality Guidelines

The Australian Drinking Water Guidelines (ADWG) (NHMRC 2011) provide a basis for determining the quality of water to be supplied to consumers in all parts of Australia. The Guidelines are not mandatory legally enforceable standards, and the implementation of the guidelines is at the discretion of each state and territory. With a few exceptions (e.g. nitrate, copper, sulphate, fluoride), all health-based guideline values relate to lifetime exposure, such that a single result above the guideline value is unlikely to present an immediate health risk (Australian Drinking Water Guidelines, 2025). See Table 11.

Parameter	Water Guidelines			EA Compliance		FM5 groundwater		FM6 groundwater		Pit 4 active pit		Pit 3 inactive pit		Pit 2 water storage		Discharge F1 (2023-25)		Discharge C1 (2023-25)		Discharge C2 (2023-25)	
	Drinking		Stock	Surface water discharge	Ground water trigger																
	Health	Aesthetic				Median	Count	Median	Count	Median	Count	Median	Count	Median	Count	Median	Count	Median	Count	Median	Count
Salinity (µS/cm)	NA	938	5,970	**900**	**1500**	1212	24	1184	32	472	3	737	27	557	2	700	93	548	83	176	5
pH	NA	6.5 – 8.5	NA	**6.5-8.5**	**6.5-8.5**	6.7	24	6.8	32	8.0	3	8.1	26	8.2	2	8.1	99	8.1	83	7.6	5
TSS (mg/L)	-	-	-	**100**	**1500**	181	24	19	32			7	3	72	2	<5	116	<5	67	<5	3
Ca (mg/L)	-	-	-		250	180	24	159	32	57	3	62	9	42	1						
Mg (mg/L)	-	-	-		35	14	24	25	32	11	3	7	9	12	1						
Na (mg/L)	-	-	-		100	59	24	66	32	24	3	60	9	53	1						
K (mg/L)	-	-	-		5	1	24	2	32	0.5	3	0.5	9	0.5	1						
HCO_3 (mg/L)	-	-	-		500	455	24	468	32	116	3	121	9	137	1						
CO_3 (mg/L)	-	-	-		500	<1	24	<1	32	0.5	3	0.5	9	0.5	1						
Cl (mg/L)	NA	250	NA		200	91	24	114	32	18	3	119	9	43	1						
SO_4 (mg/L)	NA	250	1,000		20	15	24	10	32	88	3	33	9	50	1						
TPH (mg/L)	-	-	-		1	<0.05	24	<0.05	32	<0.05	3	<0.05	2	<0.05	1						
As (mg/L)	0.01	-	5			<0.001	5	0.002	8	<0.001	3	<0.001	2	0.001	1						
Cd (mg/L)	0.02	-	0.01			<0.0001	5	<0.0001	8	<0.0001	3	<0.0001	2	<0.0001	1						
Cr (mg/L)	-	-	-			0.001	5	<0.001	8	<0.001	3	<0.001	2	<0.001	1						
Cu (mg/L)	2	1	1			0.005	5	0.005	8	<0.001	3	<0.001	2	<0.001	1						
Pb (mg/L)	-	-	-			0.031	5	0.009	8	<0.001	3	<0.001	2	<0.001	1						
Ni (mg/L)	0.02	-	1			0.005	5	0.002	8	<0.001	3	<0.001	2	<0.001	1						
Zn (mg/L)	NA	3	20			0.038	5	0.014	8	<0.005	3	<0.05	2	0.020	1						
nitrate (mg/L)	50	-	-			5.1	1	0.04	1	3.27	2	0.36	1	0.23	1						
TN (mg/L)	-	-	-			5.7	1	0.1	1	3.88	2	0.57	1	0.34	1						

Table 11 Monitoring bores compared to Water Quality Guidelines

Water quality data presented in Table 11 indicate that pit water and groundwater generally comply with the relevant stock water and groundwater trigger values. Groundwater salinity at FM5 and FM6 exceeds the ADWG aesthetic guideline value (938 µS/cm) but remains below the stock water guideline and groundwater trigger value. Future post-mining water quality is assessed in Section 12.

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5 RAINFALL AND EVAPORATION

5.1 Methodology

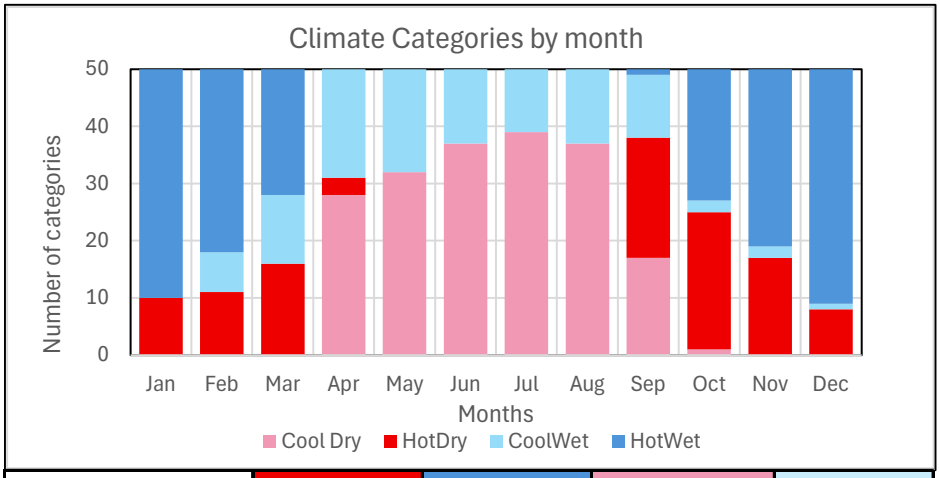
Daily, monthly and annual rainfall (mm), evaporation (mm) and temperature data was acquired from the Queensland Government Long Paddock website. The down loaded data was from a climate model node located approximately 1km west of Pit 2. Event rainfall sampling by site staff undertaken to characterise rainfall chemistry. Rainwater sample was collected in a bucket in accordance with sampling procedure.

5.2 Queensland Government Rainfall and Evaporation data

A 50 year rainfall and evaporation record from 1975-2025 was downloaded from the BOM Long Paddock website.

Data Analysis and Interpretation

The 50 year rainfall and evaporation set was analysed and it was determined that monthly median rainfall is 45mm and monthly median evaporation is 157mm. The median rainfall and evaporation for this record was used to categorise monthly climate into the four categories of Hot Dry, Hot Wet, Cool Dry and Cool Wet for Water Modelling purposes (Figure 26).



Category	Hot Dry	Hot Wet	Cool Dry	Cool Wet
Rainfall (mm)	<45	>45	<45	>45
Evaporation (mm)	>157	>157	<157	<157

Figure 26 Climate categories

The 50 year rainfall and evaporation record was used to predict the 2100-2200 rainfall and evaporation for the Water Balance model by replicating and repeating this 50 year cycle.

5.3 Site rainfall sampling

The Calliope is in a sub-tropical region with high average annual rainfall of 840mm/year for the 50 year period from 1975-2025. Summer rain is dominantly from a N to NE direction whereas winter and spring fronts are from the SW to W. A rain water sample was collected on the 24 July 2025 from 17mm of rain tracking from the NW with a SW wind, being an onshore wind sample. See Table 12.

Water Quality Parameter	Unit	Result
pH Value	pH Unit	**7.25**
Electrical Conductivity @ 25°C	µS/cm	**35**
Suspended Solids (SS)	mg/L	**13**
Hydroxide Alkalinity as CaCO3	mg/L	<1
Carbonate Alkalinity as CaCO3	mg/L	<1
Bicarbonate Alkalinity as CaCO3	mg/L	15
Total Alkalinity as CaCO3	mg/L	15
Sulfate as SO4 - Turbidimetric	mg/L	2
Chloride	mg/L	<1
Calcium - dissolved	mg/L	6
Magnesium - dissolved	mg/L	<1
Sodium - dissolved	mg/L	2
Potassium - dissolved	mg/L	<1
Calcium - total	mg/L	5
Magnesium - total	mg/L	<1
Sodium - total	mg/L	2
Potassium - total	mg/L	<1
Ammonia as N	mg/L	0.18
Nitrite as N	mg/L	<0.01
Nitrate as N	mg/L	0.11
Nitrite + Nitrate as N	mg/L	0.11
Total Kjeldahl Nitrogen as N	mg/L	0.2
Total Nitrogen as N	mg/L	**0.3**
Total Phosphorus as P	mg/L	0.03

Table 12 Rain water chemistry

Data Analysis and Interpretation

Particulates in rain include salts, dust and biological matter. Onshore winds carry particulates that have higher concentrations of crustal elements, sulphates, and nitrates. Offshore winds are dominated by sea-salt ions sodium, chloride, and magnesium because of sea-spray. The onshore wind sample shown in Table 12 has low sodium and chloride (halite) which indicates an absence of sea spray/particulate salt.

The Total Nitrogen (TN) of 0.3mg/L for rainfall at Calliope is the ANZECC default trigger values for TN from tropical Australian waterbodies is 0.2-0.3mg/L for lowland river (Calliope) which is less than the concentration of your rainfall. The default TN trigger value for Awoonga Dam is 0.35mg/L.

6 PIT WATER LEVEL AND VOLUME

Pit water composition is from direct rainfall capture, surface water and groundwater inflow, and is modified by evaporation. Surface water flow is a function of hydrological parameters such as rainfall, evapotranspiration and soil moisture, and geomorphological parameters such as topography, surface roughness, soil type, permeability and infiltration. Groundwater flow is a function of parameters which include rainfall, geology and topography. Geology and topography influence both surface water and groundwater flow.

6.1 Methodology

Drone surveying creating a digital terrain model and aerial photography has been undertaken at Calliope since 2012. Propellor drone surveying is accurate to 3cm in northing, easting and elevation. LIDAR surveying has also been undertaken at Calliope which allows for the accurate surveying of bench floor when the pit voids store water. Surface surveying has also been undertaken at the site.

Surveying allows for the accurate calculation of pit water levels and pit void volumes. Pit water levels can also be determined from other aerial imagery such as Google Earth and lightplane aerial photography by identifying surface features in the pit envelope with surveyed elevation.

6.2 Pit water inflow

6.2.1 Rainfall

Rainfall is directly captured in the pit voids and this capture is calculated in Water Balance models (Section 12).

6.2.2 Surface water run-off into pit voids

The volume of surface water runoff into the pit void with rainfall is dependent upon soil/rock type which affects moisture, permeability, infiltration, slope angle and surface roughness. Pit 1 has been backfilled. Pit 2 is an inactive pit void and acts as a water storage facility for the site which is filled by direct rainfall capture, surface water run-off and pumped Pit 4 water. Pit 3 is an inactive pit void. Pit 3 water is mainly surface water run-off and modified by rainfall and evaporation. Pit 4 is an active pit. Pit 4 has little surface water inflow because of mounding at the top of the access ramp redirects surface water but rainfall is captured directly on the pit benches and floor.

6.2.3 Surface water inflow into Pit 3

The primary source of surface water inflow into Pit 3 (Pit 3 Inflow) from the western high wall has been investigated by site hydrogeologists, consultants engaged by both Sibelco/Graymont and the Gladstone Area Water Board (GAWB) and potential sources of this water include :

- A possible piping failure mechanism failure by ponding of water against the unlined eastern side of the Western Bund Wall (GHD, 2011b)
- Surface water run-off from the Farm Dam area (Sibelco, 2011)
- Groundwater seepage (Sibelco- Feiss, 2017)

Kalf and Associates(2003) reported that Pit 3 inflow was estimated by mine staff estimated 1.2-3.5 litres and that this water inflow occurs primarily from seepages on a continuous basis. Pit 3 inflow is reported as a spring but it was not known whether the inflow estimates included contribution of direct rainfall and surface water run-off into the pit (Kalf and Associates, 2003). Bucket testing was undertaken in 2018 and 2025 and it was estimated that Pit 3 Inflow was 2 litres/second. Groundwater testing undertaken in 2018 revealed that groundwater was approximately 6 metres below the surface water entry point to Pit 3 at 32mAHD. A composite March 2010 and March 2025 photograph shows surface water inflow into Pit 3 (Figure 27). A March 2015 photograph shows surface water inflow to Pit 3 at 38mAHD and groundwater level at 32mAHD (Figure 28).



Figure 27 Surface water inflow into Pit 3 March 2010 and March 2025

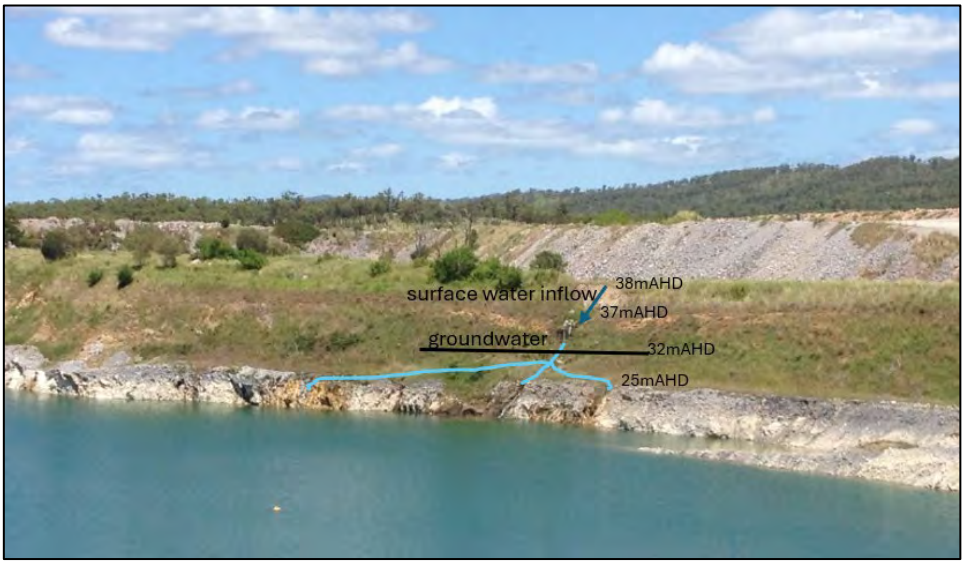


Figure 28 Surface water inflow into Pit 3 and groundwater level 4 March 2015

A February 2015 photograph (Figure 29) shows surface water pooled in the Farm Dam, water flowing between pools along the edge of the Western Bund wall to the surface water inflow point and then into Pit 3. The water quality of Awoonga Dam, Farm Dam and Pit 3 is visually very different with Awoonga Dam water having a brown discolouration and high turbidity from the agitation of clay by the previous 3 days of high rainfall. The Farm Dam water is black and indicates a contribution of organic matter and tannins, with no evidence of clayed material entering the Farm Dam; and Pit 3 water is the typical green-blue tinged colour of pit water in limestone.



Figure 29 Western bund wall surface water flow into Pit 3 on 22 February 2015

Surface water in the Farm Dam sub-catchment is temporarily captured by the Waste Dump whereby some of this water seeps through to the adjoining Pit 3 void catchment and then flows as surface water entry to Pit 3.

The Farm Dam theoretical overflow is at 43mAHD, being the elevation of material extending north-easterly from the Waste Dump, but water is regulated such that the water level in the Farm Dam does not exceed 38mAHD.

Surface water sampling was undertaken in March 2011 of Awoonga Dam, Farm Dam, water flowing along the western bund wall and Pit 3 Inflow. Sampling results are presented and discussed in Section 7.

Data Analysis and Interpretation

The March 2011 investigation led to the conclusion that the most likely source of the continuous flow of water from the Farm Dam northwestern corner along the western bund wall was from the Farm Dam. Water chemistry supports a Farm Dam sub-catchment source for the surface water inflow to Pit 3 (Section 7).

6.2.4 Groundwater inflow to pit voids

The pit walls remain dry except during high rainfall events and most drilled holes are dry. .

6.2.5 Pit water pumping

Pit 4 is mainly pumped to Surface water release point C1 but is directly pumped to Pit 2 when required.

6.3 Pit water storage

6.3.1 Pit water level

Pit 3 water levels from 2003-2025 are presented below in Figure 30.

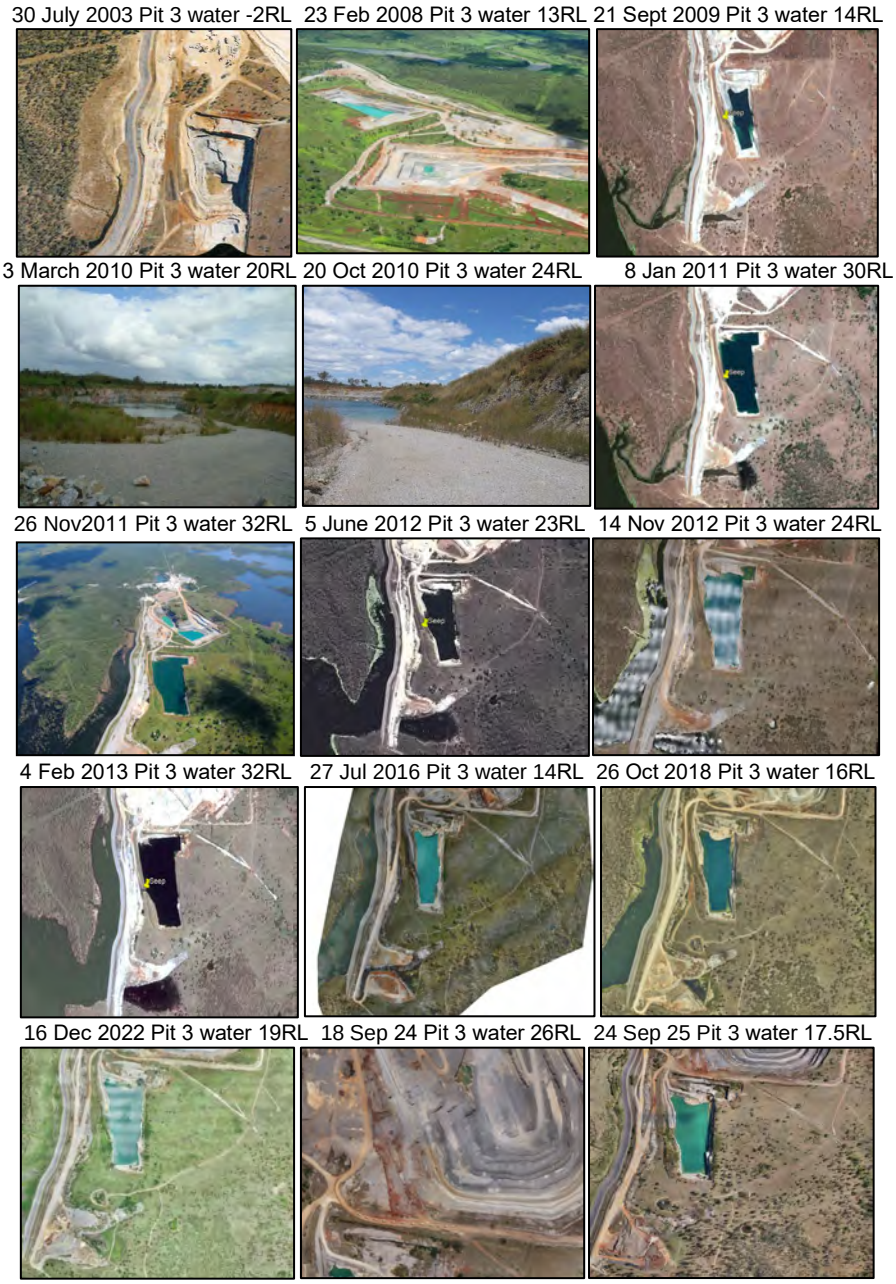


Figure 30 Pit 3 water level (RL is mAHD)

Rain events raise water levels in Pit 3 and site maintain, when able, water levels at approximately 18mAHD to provide large freeboard for prolonged rainfall events such as from December 2010 to April 2011 and January 2013 to March 2013.

Pit 3 water level

Data loggers were installed in Pit 3 in 2017/18 to further investigate the source of excess pit water and this data has been used to set-up and calibrate the Pit 3 Water Balance Model (Section 12.2). A hydrograph of Pit 3 water levels for the period January 2017 to April 2018 is presented below in Figure 31.

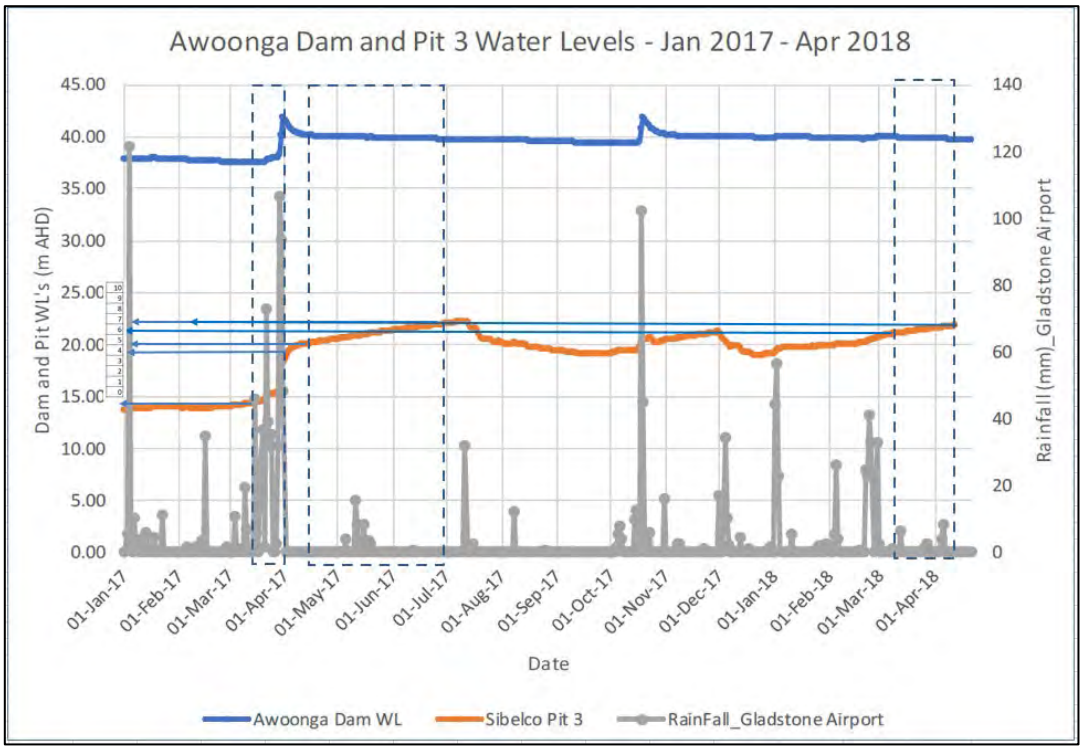


Figure 31 Calibration events obtained in Pit 3 from January 2017 to April 2018

Data Analysis and Interpretation

Three calibration events were identified(Figure 31) in three different climate categories (Figure 26) and pit water fluctuations in Pit 3 for these events have been used to derive surface water run-off coefficients for the different climate categories. Pit 3 water modelling is described in Section 12.2.2.

Pit 2 water level

Pit 2 water levels from 2020-2026 are presented below in Figure 32.

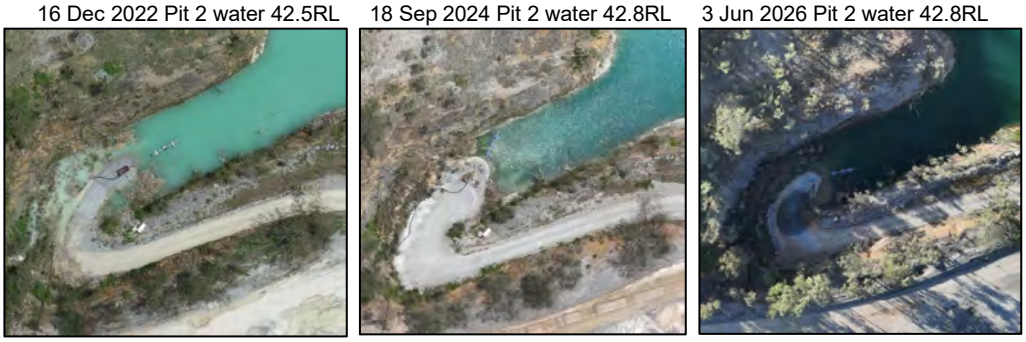


Figure 32 Pit 2 water level (RL is mAHD)

6.3.2 Pit water void capacity

Pit 2 water is stored for site use. Site maintain water levels in Pit 2 at approximately 42.5mAHD. Site aim to maintain Pit 3 water level at 18mAHD but following rain events water levels can rise up to 32mAHD. Pit water level and void capacities are estimated below in Table 13.

Catchment Pit Void	Maximum water level (mAHD)	Void empty capacity (ML)
Pit 2		655
Pit 4	42.4	10,580
Pit 3	42.4	861
Pit3-4	50 (crest 52)	58,171

Table 13 Pit water level and void capacities

6.3.3 Pit water fill

Pit 2 Is used as a water storage and is topped up with water from Pit 4 when required.

Data Analysis and Interpretation

Water Balance modelling was undertaken for Pit 3, Pit 2 and Pit 3-4. The Pit 3 Water Balance model predicts that Pit 3 would overflow in the absence of pumping.

The Pit 2 Water Balance model predicts that under the current climatic conditions pit water post mining will fill to a fluctuation level around 44mAHD and be contained in the pit void. In predicted future lower greenhouse gas emission scenarios the post mining water fill will be lower and fluctuate around 40mAHD (Section 12.3.4)

The Pit 3-4 final void Water Balance model predicts that under the current climatic conditions pit water post mining will fill to a fluctuation level around 30mAHD and be contained in the pit void. In predicted future lower greenhouse gas emission scenarios the post mining water fill will be lower and fluctuate around 28mAHD. (Section 12.4.4)

6.4 Pit water outflow

6.4.1 Pit water pumping, use and disposal

Pit floor pumping is intermittent and seasonal. Pit 2 water is pumped to surface water release point C1. Pit 3 water is pumped to surface water release point F1. Pit 4 water is pumped to surface water release point C1 and Pit 2.

6.4.2 Pump location

A site map showing the location of pit pumps and surface water release points is provided below in Figure 33.

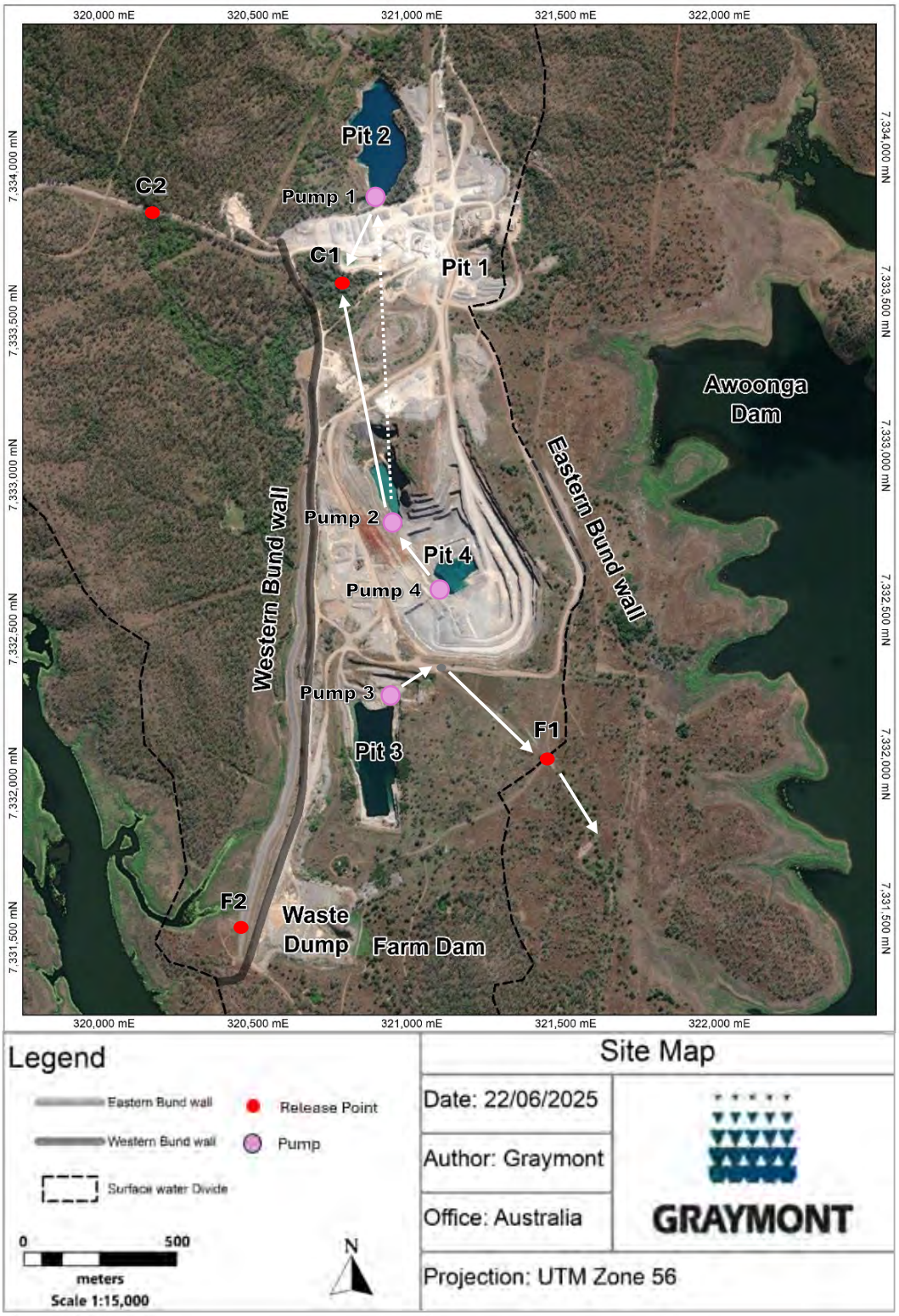


Figure 33 Location of pit pumps and surface water release points

6.4.3 Pump metering

There is no legislative requirement to meter pumped water but pumps in Pits 2-4 are metered but have incomplete meter records. Additional meters were installed in 2025 to improve quantification of water movements and to predict groundwater inflows during dry periods in the absence of rainfall and surface water run-off. Pit pump volume and run hours for June 2024 to May 2025 are provided below in Figure 34.

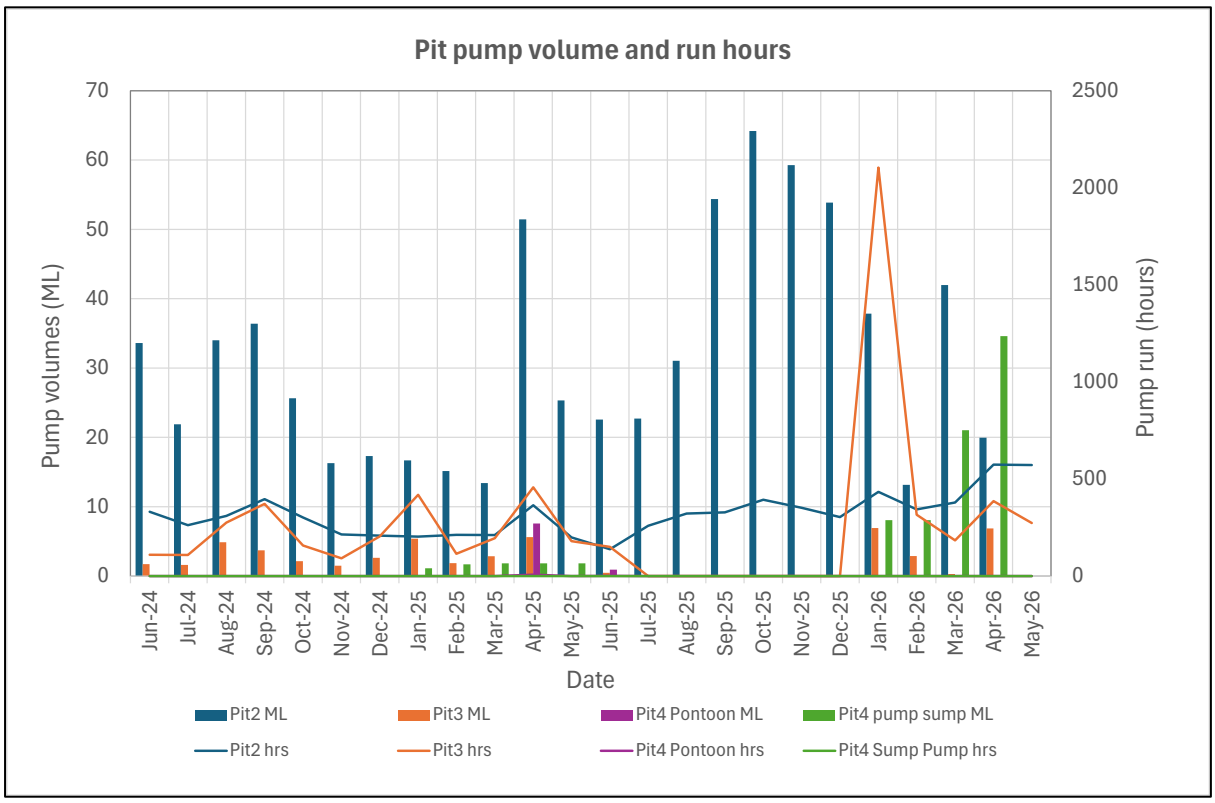


Figure 34 Pit pump volume and run hours June 2024-May 2025

Pit 2 water pumping from 1 January to 30 June 2025 was 19ML. Pit 3 water pumping was 35ML for the same period and Pit 4 it was 18.3ML for the same period.

Data Analysis and Interpretation

The pumping volumes are low which indicate that there is minor groundwater entering the pit voids and that pit water levels, which fluctuate with rainfall and surface water run-off, are naturally regulated by evaporation. The pumping rate for Pit 4 is only 1.4ML for the 5months from January-July 2025.

6.4.4 Pit water use

Minimal water is used on site for production purposes but the Plant may use approximately 25 L/s when required. This water is sourced from Pit 2 water storage via a pontoon based pump and pipe system. Water use includes.

- Dust suppression at the crushing and screening plant
- Wash plant
- Vehicle washdown
- Filling radiators
- Roadway dust suppression
- Mixing of wet road bases and
- Hosing down and cleaning under conveyers

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7 PIT WATER QUALITY

7.1 Methodology

Water sampling is undertaken during field investigations and to meet regulatory requirements. Water chemistry is discussed under physiochemical parameters and Major Ion chemistry. The physiochemical parameters discussed are include electrical conductivity (µS/cm), pH, Total Suspended Solids (mg/L) and nutrients (nitrate). The major ions are calcium, magnesium, sodium, potassium, bicarbonate, carbonate, chloride and sulphate.

7.2 Physiochemical Parameters (potential contaminants)

The physiochemical parameters of salinity (measured as Electrical Conductivity), pH, suspended solids, nutrients (nitrate), metals and hydrocarbons are potential contaminants in pit water.

7.2.1 Pit 3 Surface water inflow

Water sampling in March 2011 was undertaken which included Awoonga Dam, the Farm Dam, the water flowing along the western bund wall and surface water inflow into Pit 3. Water salinity and chemistry results from this sampling event are shown in Table 14.

Physiochemical Parameters		OFFSITE	ONSITE		
		Awoonga Dam - due south of seep	Water Flow from beneath toe of mullock wall into gully	Farm Dam - approx 500m east of gully	Surface Water flow from east into gully
Electrical Conductivity @ 25°C	µS/cm	282	632	601	618
Total Dissolved Solids @180°C	mg/L	161	345	341	325
Redox Potential	mV	144	158	167	164
pH	pH Unit	7.8	7.4	7.3	7.2

Table 14 Water sampling results from March 2011

Data Analysis and Interpretation

Water sampled from Awoonga Dam is half the EC (µS/cm) of water from the Farm Dam, water flow along the western bund wall and the surface water inflow to Pit 3. These results indicated that Awoonga Dam was unlikely to be the water source of the surface water inflow because EC (µS/cm) cannot double while piping through the dam wall and that the water was primarily surface run-off from the Farm Dam.

To further test this conclusion salinity profiling was undertaken in 2018 of Awoonga Dam to investigate whether there was salinity stratification of the water column; specifically whether water on the floor of the Dam was twice as saline as at the surface. Salinity profiling was undertaken from a boat on Awoonga Dam at eight locations and no change in salinity with depth was observed (Figure 35).

Further follow-up water sampling was undertaken in2025 which included Awoonga Dam, catchment dams, the Farm Dam, surface water inflow into Pit 3 and Pit 3. The 2011,2018 and 2025 monitoring demonstrated that Awoonga Dam salinity was much fresher than Pit 3 salinity. Salinity sampling does not support the GHD (2011) hypothesis that Pit 3 water inflow is from Awoonga Dam by a possible piping failure mechanism.

A map showing the location of the 2011, 2018 and 2025 monitoring points with salinity sampling results is presented as Figure 35.

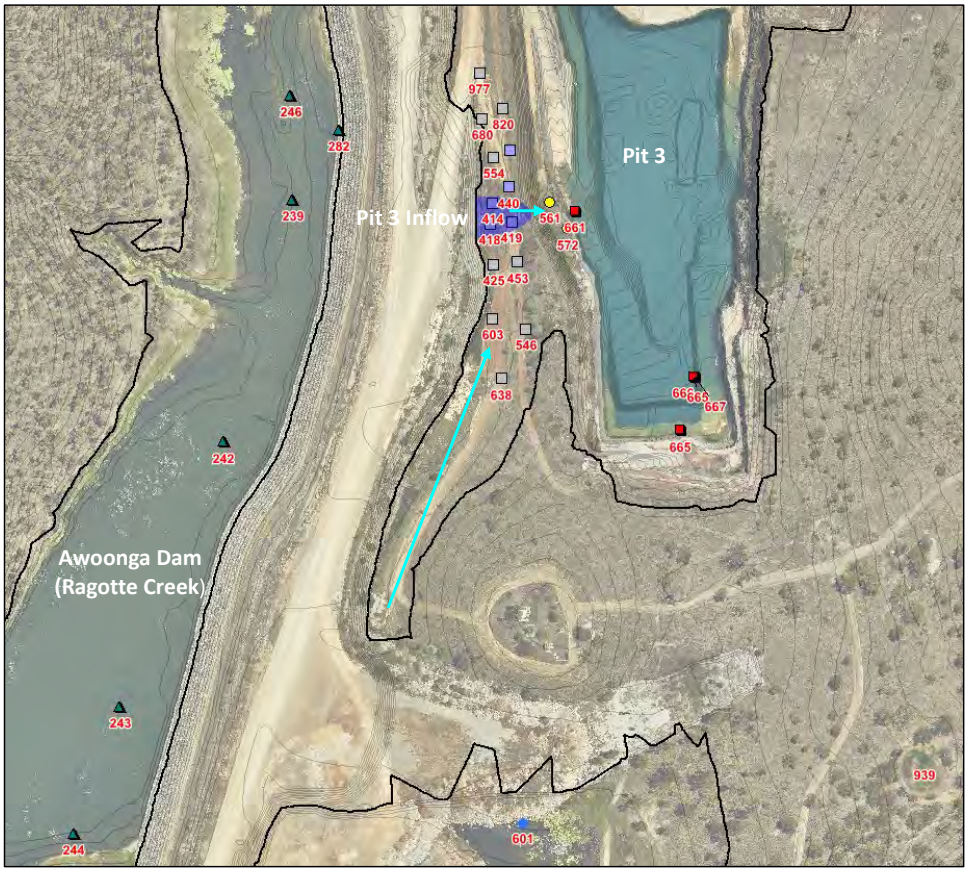


Figure 35 Surface water salinity sampling results 2011 and 2018

7.2.2 Pit water storage

Pit water EC (µS/cm) and pH is tabled below.

Parameter	Climate			EC (µS/cm)			pH		
Date	Rainfall	Evaporation	Category	Pit 3	Pit 4	Pit 2	Pit 3	Pit 4	Pit 2
Nov-02	35.8	237.3	HotDry	601	615	584	7.6	8.0	8.1
Oct-16	21.4	203.5	CoolDry	684	658	543	8.0	8.0	7.8
Nov-16	35.8	238.9	CoolDry	655			7.8		
Oct-18	72.4	191.9	CoolWet				8.1		
Nov-18	49.7	243.2	CoolWet	665					
Feb-19	27.7	220.4	CoolDry	666					
May-23	17.2	116.7	CoolDry	730			8.1		
Jun-23	1.7	95.8	CoolDry	730			8.2		
Jul-23	24.7	94.9	CoolDry	769			8.1		
Aug-23	13.4	132.4	CoolDry	745			8.1		
Sep-23	5.8	171.1	CoolDry	762			8.0		
Nov-23	84	169.1	CoolWet	772			8.1		
Jan-24	203.9	187.9	CoolWet	716			8.0		
Mar-25	68.8	156.9	CoolWet	733	472		8.1	8.2	
May-25	41.8	99	CoolDry	698	436	570	8.0	8.0	8.6
			count	13	3	2	12	3	2
			median	730	472	557	8.1	8.0	8.2

Table 15 Pit water storage sampling results

The data presented in Table 15 is reproduced graphically in Figures 36-37.

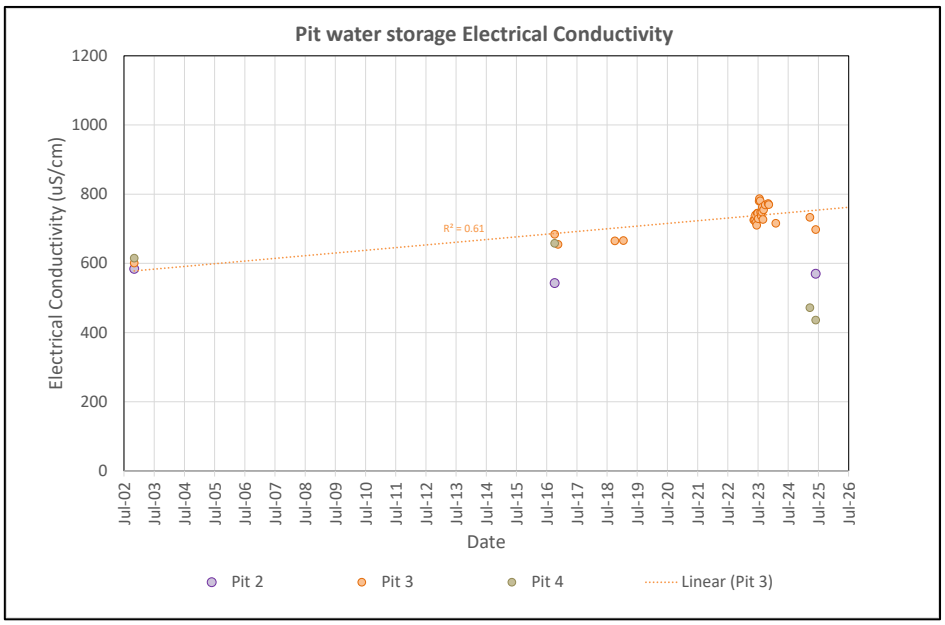


Figure 36 Pit water storage Electrical Conductivity

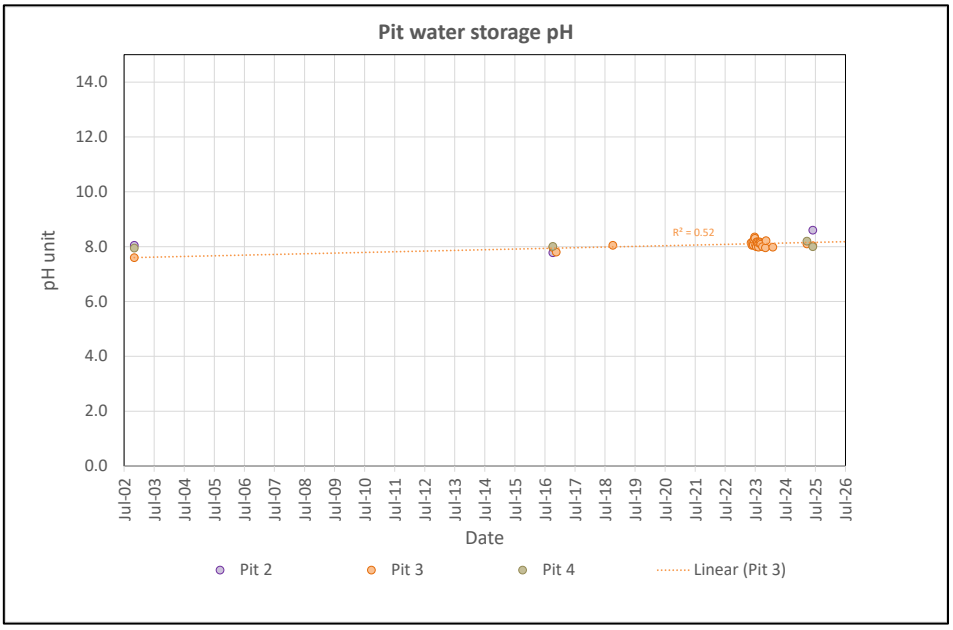


Figure 37 Pit water storage pH

Data Analysis and Interpretation

Pit 3 water median salinity is 730 µS/cm which is higher than Pit 2 median being 557 µS/cm and Pit 4 median being 472 µS/cm. Pit 3 has constant surface water run-off from the Farm Dam which influences water quality. Pit 3 has permanently stored water which is subject to evaporation and EC (µS/cm(has a trend increase of approximately 14% from 2002 to 2025 and pH appears to show a minor increase, noting that both sample sets are too small in isolation for definitive conclusions.

Pit 4 water has little surface water entering the pit following heavy rainfall and rainfall dilutes pit water salinity which is the main mechanism for the salinity difference between Pit 3 and Pit 4.

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Nitrogen

Nitrogen sampling was undertaken of pit storages with catchment dam and groundwater in 2025 and the results are presented in Table 16.

Site	Aquifer	Date	Ca	Mg	Na	K	HCO3	CO3	Cl	SO4	Ammonia	Nitrite as N	Nitrate as N	TKN as N	TN as N
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
D23	Volc	29/05/2025	78	182	522	3	788	0.5	910	47	0.90	0.67	0.64	2.90	4.21
D28	Volc	29/05/2025	369	206	468	4	703	0.5	1510	52	2.46	0.01	0.01	3.40	3.41
FM5	LST	29/05/2025	185	14	63	0.5	370	0.5	59	151	0.005	0.01	5.10	0.60	5.71
FM5B	Volc	29/05/2025	198	15	67	0.5	374	0.5	61	148	0.005	0.01	5.69	0.80	6.50
FM6	Volc	29/05/2025	144	9	34	1	409	0.5	18	10	0.005	0.01	0.04	0.05	0.10
Awoonga Dam	n/a	29/05/2025	18	12	33	3	95	0.5	44	5	0.01	0.01	0.07	0.40	0.48
Catchment Dam1	n/a	29/05/2025	9	4	11	9	52	0.5	16	0.5	0.19	0.01	0.02	3.30	3.33
Catchment Dam2	n/a	29/05/2025	15	5	18	5	67	0.5	22	0.5	0.16	0.01	0.03	0.90	0.94
Farm Dam	n/a	29/05/2025	96	14	14	6	86	0.5	14	124	0.01	0.01	0.19	0.90	1.10
Pit 2	n/a	29/05/2025	42	12	53	0.5	137	0.5	43	50	0.01	0.01	0.23	0.10	0.34
Pit 3	n/a	29/05/2025	71	8	63	0.5	117	0.5	147	41	0.04	0.01	0.36	0.20	0.57
Pit 4	n/a	29/05/2025	58	11	18	0.5	90	0.5	17	89	0.01	0.01	4.27	0.60	4.88
Pit 4	n/a	29/05/2025	57	12	47	0.5	128	0.5	37	88	0.01	0.01	2.27	0.50	2.78
Seep	n/a	29/05/2025	130	8	93	0.5	242	0.5	178	57	0.01	0.01	0.11	0.10	0.22

Table 16 Groundwater and surface water nitrogen results from 2025 investigation

Data Analysis and Interpretation

Total Nitrogen (TN) in groundwater in the Farm Dam sub-catchment, represented by drillholes D23 and D28, is similar to TN of groundwater in FM5 and FM5B but the composition of TN is very different. D23 has proportionally elevated organic nitrogen, D28 has proportionally elevated ammonia and FM5 and FM5B have proportionally higher nitrate. Catchment Dam 1 has proportionally elevated organic nitrogen.

The concentration of nitrogen forms vary with changing conditions N_2 in the atmosphere can be fixed (converted to ammonia and nitrate) by rainfall and by bacteria and archaea in soil and water. Plants decompose to organic nitrogen and in warm moist conditions bacteria in soil convert organic nitrogen to ammonia and in oxidising conditions ammonia is converted to nitrite then nitrate. Nitrate concentrations can be reduced by plant uptake or in reducing conditions denitrified to ammonium. Nitrate not taken up by plants can be leached into groundwater. Table 16 shows that the water samples have been taken at different stages of nitrogen conversion and that similar TN in samples near and away from mining voids indicate natural processes.

Nitrates

Nitrates are naturally occurring in surface water and groundwater from nitrogen transforming processes. Nitrate concentrations seasonally and water sampling on the 29 May 2025 gave results of 4.37mg/L and 2.27mg/L from Pit 4 and 0.36mg/L from Pit 3. Drinking water quality recommended limit is 50mg/L.

Sulphates

Sulphate is a major ion and a component of salinity and is regularised analysed for in groundwater samples but not pit water. Although sulphate is not regularly analysed for in pit water it was historically analysed for in discharge water until 2013 after which changed EA conditions no longer routinely required this analysis. A graph of sulphate concentrations at surface water release points is provided below with pit water, other surface water and groundwater results are provided in Figure 38.

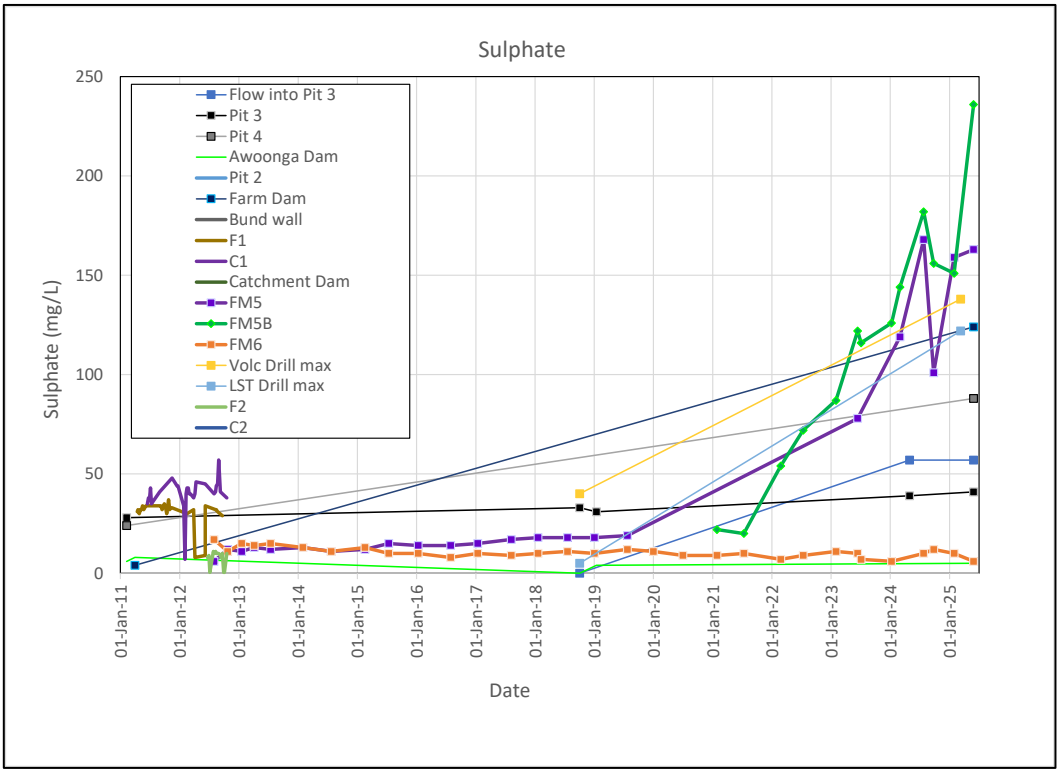


Figure 38 Sulphate in discharge water, pit water, other surface water and groundwater

Data Analysis and Interpretation

In 2012-13 sulphate in groundwater was lower than sulphate in surface water that was pumped from the Pit 3 and Pit 4 voids and therefore the source of elevated sulphate in these pit voids is not considered to be groundwater. Elevated sulphate in the pit voids is understood to be from rainfall and surface water inflow and the primary source is the dissolution of gypsum (CaSO4). Elevated sulphate in pit water is from cyclic salts and the dissolution of surface salts in run-off water to the pit voids, with sulphate concentrations modified by evaporation. In the absence of mining and the construction of the Western Bund wall, surface salts in run-off water at Calliope were discharged to the Boyne River via Ragotte Creek. This natural salt discharge path has now been modified to collection in a mine void and salt collected in the mining voids is pumped to Awoonga Dam. The concentration of sulphate in Awoonga Dam in May 2025 was 5mg/L.

7.2.3 Pit water release

Pit 2 water is pumped to surface water release point C1. Pit 3 water is pumped to surface water release point F1. Pit 4 water is pumped to surface water release point C1 and Pit 2. Monitoring is undertaken of water planned to be pumped and released from a licensed surface water release point. If water sampling results meet Release limit requirements for EC (µS/cm), pH and TDS then the surface water is released but if it does not meet Release limit requirements it is not released and instead used in operational activities. The specified release points F1, F2, C1 and C2 to test suitability for release. The water quality parameters tested are Electrical Conductivity (µS/cm), pH (pH Unit) and Total Suspended Solids (mg/L). Surface water release sampling results in a wetter climate is represented by 2012 sampling results. See Table 17.

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Parameter	EC (µS/cm)				pH				SS (mg/L)				Sulphate (mg/L)			
EA Limit	< 900 µS/cm				6.5 (min) 8.5 (max)				< 100 mg/L				< 500 mg/L			
Date	F1	F2	C1	C2	F1	F2	C1	C2	F1	F2	C1	C2	F1	F2	C1	C2
25/01/2012			434				8.0				100				34	
2/02/2012				194				7.8				8				7
9/02/2012			437				7.9				<5				40	
15/02/2012			457				8.0				<5				43	
20/02/2012	556				8.1				<5				30			
23/02/2012			487				8.3				<5				43	
29/02/2012			448				8.0				9				40	
7/03/2012			525				8.0				<5				40	
14/03/2012																
21/03/2012																
22/03/2012	555		322	91	8.2		8.1	7.8	5		38	20	32		30	2
27/03/2012	559		406		8.1		8.1		<5		<5		32		38	
4/04/2012		242	445			7.9	8.0			6	10			8	40	
11/04/2012			498				8.1				<5				46	
18/04/2012																
19/04/2012			568				7.6				9				44	
26/04/2012	592	256	478		8.1	8.1	8.0		<5	8	20		29	8	33	
3/05/2012		272				8.0				8				12		
14/05/2012	269				8.0				<5				9			
30/05/2012		268				8.2				<5				10		
6/06/2012		260				8.6				<5				9		
7/06/2012	563		533		8.2		8.1		83		24		33		45	
13/06/2012																
20/06/2012		262				8.1				<5				8		
29/06/2012		252				7.8				6				9		
5/07/2012		264				8.3				<5				<1		
27/07/2012		275				8.5				5				11		
31/07/2012		293	560			8.4	8.1			5	15			10	40	
9/08/2012	591	274	546		8.0	8.0	8.1		<5	<5	24		32	11	41	
14/08/2012	589	269	578		7.7	8.0	7.9		<5	<5	<5		32	10	44	
22/08/2012	598	273	609		8.0	8.2	8.1		<5	11	20		31	10	45	
29/08/2012		281	662			7.8	8.1			8	6			10	57	
5/09/2012		267	511			8.0	8.1			7	5			9	41	
12/09/2012		276				8.2				14				8		
20/09/2012	652	298	709		8.2	8.6	8.1		<5	8	8		29	10	50	
28/09/2012		1650				8.2				<5				<1		
3/10/2012		286				8.3				7				<1		
10/10/2012																
17/10/2012		296	630			8.3	8.1			7	6			10	38	
24/10/2012		285				8.1				8				11		
31/10/2012		291				8.2				7				8		
7/11/2012		267				8.3				9				11		
12/11/2012		294				8.0				8				9		
14/11/2012																
22/11/2012	618	301			8.0	8.7			19	8			36	10		
28/11/2012	602	290	622		8.0	8.7	7.9		8	6	24		28	8	45	
12/12/2012	617				8.1				<5				31			
19/12/2012	585				8.1				12				30			
Maximum	652	1650	709	194	8.2	8.7	8.3	7.8	83	14	100	20	36	12	57	7
Median	590	275	518	143	8.1	8.2	8.1	7.8	12	8	15	14	31	10	41	5
Minimum	269	242	322	91	7.7	7.8	7.6	7.8	5	5	5	8	9	8	30	2

Table 17 Surface water release samples from 2012 in a wetter climate

In 2012, which was a wetter year, most surface water sample results met surface water release criteria. Sulphate was routinely sampled and the median sulphate concentration from F1 was 31mg/L. Surface water release sampling testing in a drier climate is represented by 2020 sampling results. See Table 18.

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Parameter	EC (µS/cm)			pH			TSS (mg/L)		
EA Limit	< 900 µS/cm			6.5 (min) 8.5 (max)			< 100 mg/L		
Date	F1	F2	C1	F1	F2	C1	F1	F2	C1
6/01/2020	706	273		7.9	9.0		5	13	
3/02/2020	703	267		8.2	9.1		<5	<5	
26/02/2020	716	277	760	7.9	8.6	8.0	<5	<5	<5
11/03/2020	704	302	712	8.2	8.1	7.4	<5	<5	<5
18/03/2020	695	279		8.1	9.6		<5	<5	
25/03/2020	710	273		8.0	9.3		<5	<5	
1/04/2020	704	280		8.0	8.8		<5	8	
9/04/2020	699	258		7.6	9.5		<5	<5	
15/04/2020	711	274		8.1	8.8		<5	<5	
28/04/2020	700	268		7.9	9.6		<5	5	
5/05/2020	692	698		3.1	3.0		<5	<5	
15/05/2020	696	298		7.3	7.9		<5	<5	
19/05/2020	727	267		7.6	9.5		<5	6	
26/05/2020	702	269		7.9	9.7		<5	<5	
2/06/2020	702	265		7.9	9.9		<5	<5	
9/06/2020	7	265		7.9	9.7		<5	<5	
16/06/2020	7	3		7.8	9.7		<5	<5	
21/06/2020	7	3		7.7	9.7		<5	<5	
30/06/2020	6	3		6.1	7.6		<5	<5	
7/07/2020	7	3		7.7	8.9		<5	<5	
21/07/2020	700	278		8.0	8.6		11	<5	
29/07/2020	702	280		8.0	8.9		6	8	
4/08/2020	700	267		7.4	8.1		<5	<5	
11/08/2020	7	298		6.8	7.6		<5	<5	
18/08/2020	775	300		4.8	6.6		<5	<5	
26/08/2020	786	306		7.6	6.9		<5	<5	
3/09/2020	762	303		8.2	8.1		<5	<5	
8/09/2020	765	297		7.2	7.6		<5	14	
15/09/2020	791	289		8.0	12.4		<5	9	
22/09/2020	741	294		7.2	7.2		<5	<5	
30/09/2020	795	276		7.1	9.0		<5	<5	
7/10/2020	795	318		7.4	8.0		<5	64	
14/10/2020	783	360		9.3	8.6		<5	6	
10/11/2020	769	281		5.9	7.7		<5	18	
19/11/2020	759	289		6.9	7.2		<5	14	
24/11/2020	823	307		5.9	4.2		<5	<5	
2/12/2020	7	318		7.0	791.0		<5	<5	
7/12/2020	722	259		8.1	9.7		<5	5	
Maximum	823	698	760	9	791	8	11	64	
Median	704	279	736	8	9	8	6	9	
Minimum	6	3	712	3	3	7	5	5	

Table 18 Surface water release samples from 2020 in a drier climate

In 2020, which was a drier year, numerous surface water sample results did not meet surface water release criteria. Surface water release in 2023 is provided in Table 19 with discharge volumes and Pit 3 water sampling results.

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Parameter	EC (µS/cm)				pH				TSS (mg/L)				Flow		
EA Limit	< 900 µS/cm			n/a	6.5 (min) 8.5 (max)			n/a	< 100 mg/L			n/a	Discharge ML		
Date	F1	F2	C1	Pit 3	F1	F2	C1	Pit 3	F1	F2	C1	Pit 3	F1	F2	C1
13/01/2023			534				8.3				8				0.01
16/01/2023			520				8.3				11				0.02
24/01/2023			539				7.6				5				0.02
31/03/2023			546				8.0				9				0.02
2/02/2023			537				8.0				<5				0.02
7/02/2023			561				8.0				6				0.02
15/02/2023			564				7.8				<5				0.01
3/03/2023			573				7.9				12				0.01
15/03/2023			489				8.1				8				0.02
21/03/2023			485				8.3				7				0.02
28/03/2023			520				8.2				12				0.02
4/04/2023			592				8.1				15				0.01
11/05/2023			540	725			8.1	8.1			<5	<5			0.01
22/05/2023				726				8.1				15			
31/05/2023				740				8.2				<5			
6/06/2023				718				8.1				<5			
14/06/2023				710				8.2				5			
22/06/2023				745				8.4				<5			
27/06/2023				745				8.3				<5			
3/07/2023				729				8.1				7			
14/07/2023				780				8.0				<5			
18/07/2023			611	787			8.1	8.2			5	<5			0.01
27/07/2023	782			781	8.2			8.1	<5			<5	18.55		
2/08/2023	763			748	8.1			8.2	<5			<5	20.76		
9/08/2023	758			737	8.1			8.0	5			<5	22.28		
16/08/2023	739			748	8.2			8.1	<5			<5	22.38		
23/08/2023	769			763	8.2			8.2	<5			<5	21.97		
30/08/2023	729			727	8.1			8.1	<5			<5	21.47		
6/09/2023	756			755	8.2			8.1	<5			<5	10.03		
27/09/2023				769				8.0				<5			
1/11/2023				773				8.0				<5			
8/11/2023				770				8.2				<5			
Maximum	782		611	787	8		8	8			15	15			
Median	758		540	747	8		8	8			8	7			
Minimum	729		485	710	8		8	8			5	5			
Total													137.4		0.2

Table 19 Surface water release samples from 2023 with Pit 3 sampling results

In 2023 a total of 137.4ML was discharged at surface water release point F1. Surface water at this release point is sourced from Pit 3 and Pit 4. In 2023 additional sampling was undertaken of Pit 3. Pit 3 water quality is very similar to F1 water quality which indicates that F1 discharge was almost exclusively from Pit 3.

7.2.4 Impact of evaporation on contaminants in pit voids post for post mining prediction

The effect that storage and evaporation has on the surface water release parameters of EC, pH and TSS was investigated by integrating Pit water and Pit water release datasets and to use this analysis to predict post mining behaviour of these water quality parameters.

A summary of monthly surface water EC and pH is presented below in Table 20.

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Parameter	Climate			EC (µS/cm)							pH						
Date	Rainfall	Evaporation	Category	Farm Dam	Pit 3 inflow	Inflow + Farm Dam	Pit 3	F1	Pit 4	Pit 2	Farm Dam	Pit 3 inflow	Inflow + Farm Dam	Pit 3	F1	Pit 4	Pit 2
Nov-02	35.8	237.3	HotDry				601		615	584				7.6		8.0	8.1
Mar-11	256.4	128.5	CoolWet	538	584	538											
Oct-16	21.4	203.5	CoolDry				684		658	543				8.0		8.0	7.8
Nov-16	35.8	238.9	CoolDry				655							7.8			
Jan-17	116.8	224.1	CoolWet					666							8.3		
Feb-17	15.2	236.1	CoolDry					665							8.3		
Aug-17	5.1	142.5	CoolDry					631							8.3		
Sep-17	0	191.6	CoolDry					609							8.1		
Oct-17	286.9	153.4	CoolWet					562							8.3		
Dec-17	86.5	232.6	CoolWet					533							7.9		
Jan-18	96.9	241.3	CoolWet					586							7.2		
Feb-18	156.4	173.4	CoolWet					610							8.2		
May-18	22.9	120.3	CoolDry					642							8.2		
Jun-18	4.5	101.1	CoolDry					651							8.3		
Sep-18	0.9	179.3	CoolDry					624							8.2		
Oct-18	72.4	191.9	CoolWet		561	561		634				8.0	8.0	8.1	8.0		
Nov-18	49.7	243.2	CoolWet				665	639							7.0		
Dec-18	119.9	223.9	CoolWet					671							7.9		
Jan-19	13	237.1	CoolDry					658							8.0		
Feb-19	27.7	220.4	CoolDry				666	663							7.9		
Jan-20	150.7	228.3	CoolWet					706							7.9		
Feb-20	253.8	162.3	CoolWet					710							8.0		
Mar-20	61.2	172.2	CoolWet					703							8.1		
Apr-20	25.6	146.9	CoolDry					704							7.9		
May-20	20	115.2	CoolDry					705							6.0		
Jun-20	18.3	100.4	CoolDry					702							7.5		
Jul-20	19.3	98.2	CoolDry					700							7.8		
Aug-20	37.7	137	CoolDry					754							6.6		
Sep-20	15	158.5	CoolDry					771							7.5		
Oct-20	85.7	210.7	CoolWet					789							8.3		
Nov-20	5.6	254.8	CoolDry					784							6.2		
Dec-20	86.4	233.9	CoolWet					722							7.5		
May-21	3.3	115.8	CoolDry					787							8.1		
Jun-21	66.3	87.5	CoolWet					722							8.1		
Apr-22	36.8	135.2	CoolDry					705							8.0		
May-23	17.2	116.7	CoolDry				730							8.1			
Jun-23	1.7	95.8	CoolDry				730							8.2			
Jul-23	24.7	94.9	CoolDry				769	782						8.1	8.2		
Aug-23	13.4	132.4	CoolDry				745	751.60						8.1	8.14		
Sep-23	5.8	171.1	CoolDry				762	756						8.0	8.2		
Nov-23	84	169.1	CoolWet				772							8.1			
Jan-24	203.9	187.9	CoolWet				716							8.0			
Feb-24	38.7	162.9	CoolDry					724							7.7		
Mar-24	53.9	144	CoolWet					743							7.9		
May-24	12.5	98.3	CoolDry					741							7.8		
Jul-24	21.9	96.8	CoolDry					738							7.9		
Oct-24	60.5	193.1	CoolWet					741							7.8		
Feb-25	76.2	167.2	CoolWet					462							7.8		
Mar-25	68.8	156.9	CoolWet		1144	1144	733	721	472			8.1	8.1	8.1	7.9	8.2	
Apr-25	124.4	122.3	CoolWet					620							8.1		
May-25	41.8	99	CoolDry	247	960	247	698		436	570	7.6	7.6	7.6	8.0		8.0	8.6
Jun-25	18.3	81.8	CoolDry					688							8.1		
Jul-25								742							8.0		
Aug-25								708							8.1		
Dec-25								650							8.2		
			count	2	4	4	13	46	3	2	1	3	3	12	46	3	2
			median	393	772	550	730	703	472	557	7.6	8.0	8.0	8.1	8.0	8.0	8.2

Table 20 Monthly Surface water EC and pH

The median EC from combined Farm Dam and surface water inflow to Pit 3 sampling is 550 µS/cm.

Electrical Conductivity

A graph of pit water storage and release salinity, expressed as electrical conductivity (µS/cm) is presented below in Figure 39.

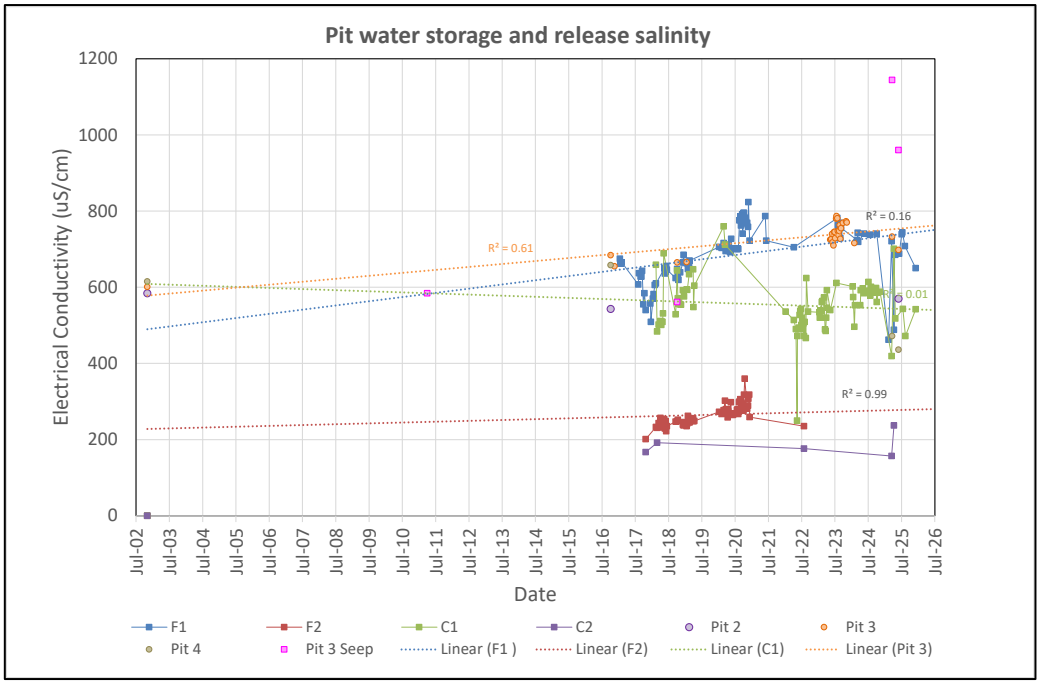


Figure 39 EC variability with pit water storage and release

To investigate possible sample bias the sample record from 2010-13 was removed and the results are displayed below in Figure 40.

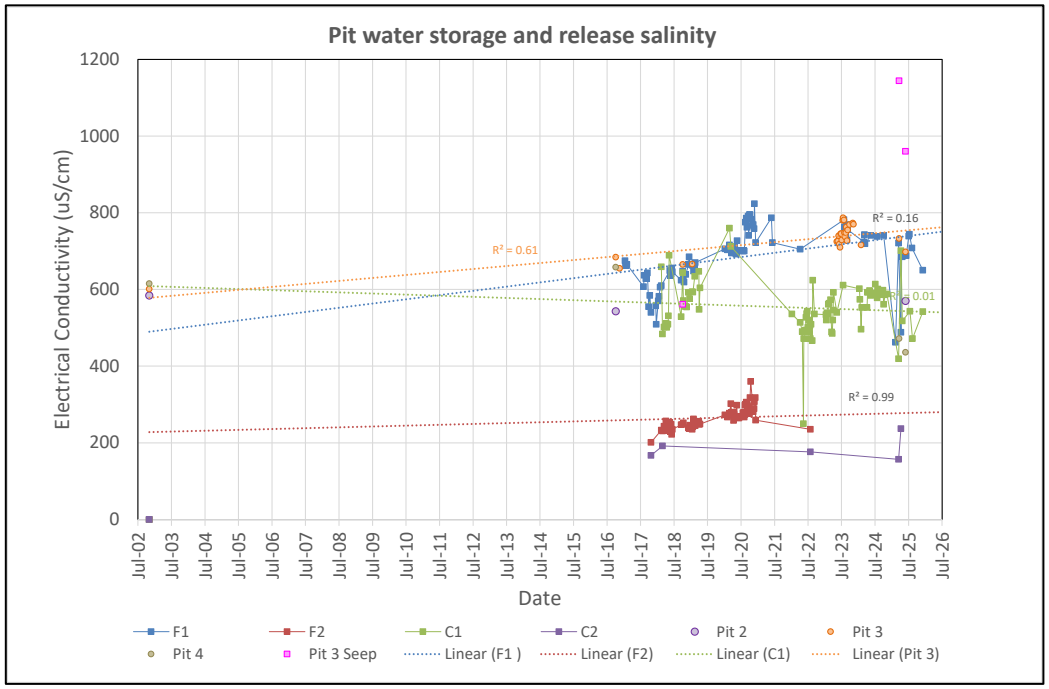


Figure 40 Data subset of EC variability with pit water storage and release

Data Analysis and Interpretation

Pit water EC

Sampling of Pit 3 water is sparse over the longer term but has been sampled during investigation periods. Pit 3 water shows a trend of increasing EC (Figure 40) which indicates an increase from 600 to 750 µS/cm from July 2002 to July 2023, with a correlation coefficient of 0.61 but because of seasonal variability this is considered an indicative trend only.

There is insufficient long term water sampling of Pit 2 and Pit 4 to be able to determine trends. Pit 4 is pumped to surface water release Point C1 and every few years to Pit 2 when Pit 2 water level becomes low. Pit 2 water level and chemistry is modified by the using this mining void as a water storage facility for the site.

Surface water release EC

There is large seasonal variability in EC (µS/cm) of released pit water with rainfall and extended dry periods.

Surface water release point F1 from Pit 3 has a long term record which shows seasonal fluctuation and within this seasonal fluctuation there appears to be a gradual increase in EC. The data subset (Figure 40) still shows a gradual EC increase for F1 but it is more subdued than with the 2013 record and a correlation coefficient of 0.16 indicates no correlation. F1 has an increasing trend of EC.

Surface water release point F2, which is natural flow without storage, and has a correlation coefficient of 0.99 (Figure 40).

Surface water release point C1 receives water from Pit 4 and can also receive water from Pit 2 and water behaviour at C1 is variable.

Comparison between Pit 3 and surface water release point F1 EC

Pit 3 water, being the source of F1, appears to have a gradual increase in EC. Pit 3 EC aligns well with F1 EC and salt exported from Pit 3 is representative of Pit 3 EC. The export of salt from Pit 3 reduces the salt load in Pit 3 and therefore the concentration of salts. The EC records of Pit 3 and F1 indicated an EC increase in the order of a 14% increase every decade with pumping and salt export and without export the evaporation effect would be higher. The EC of the final void for Pit and Pit3-4 are also predicted to increase by at least 14% every decade.

There is no physical or climatic relationship between F2 and Pit 3.

pH

The pH of rain at site was 7.25 although rainfall is generally naturally a bit more acidic and the pH of water in limestone is typically near neutral to weakly alkaline at 7.5-8.5. Limestone naturally buffers pH changes to water. The pH of Monitoring Point F2, which is from undisturbed surface water flow, is more variable than pit water. A temporal pH trend of Pit water storage and release water is presented below in Figure 41. An isolated elevated pH and two low pH readings are considered to be outliers attributed to sampling during low flow and are not representative of pH variability.

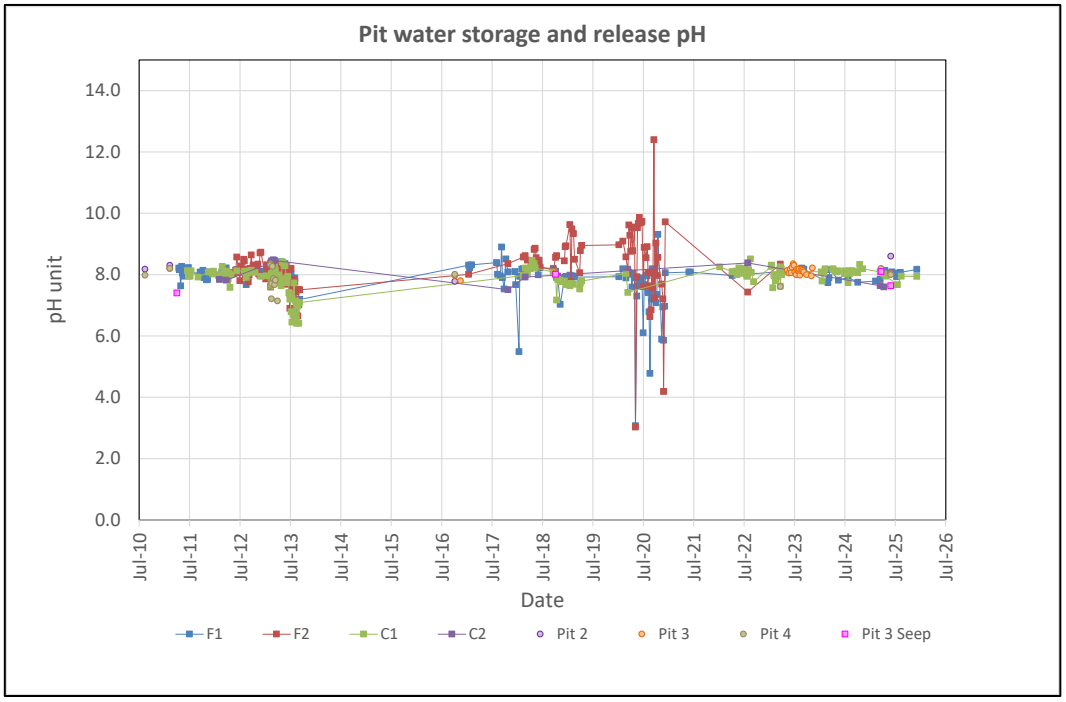


Figure 41 pH variability with pit water storage and release

The pH of the final void Pit3-4 is predicted to be near neutral and naturally fluctuate with rainfall and evaporation.

Total Suspended Solids

TDS will increase near the surface with surface water run-off and then settle on the pit floor.

7.2.5 Stratification

Salinity profiling of Pit 3 was undertaken from a boat on the 4 October 2018. See Figure 42.

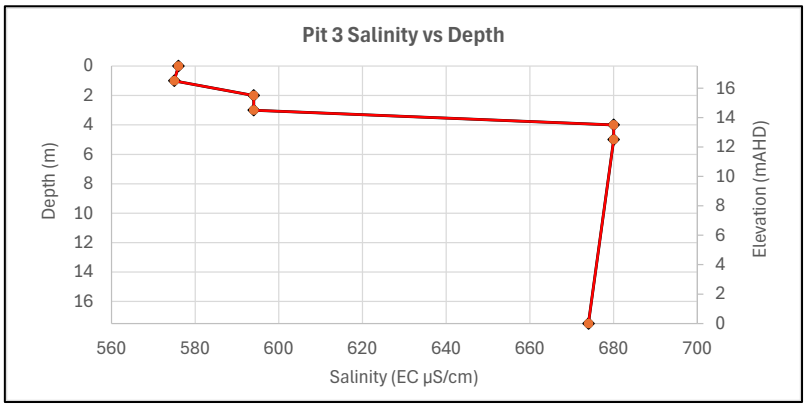


Figure 42 EC stratification of Pit 3 water profile

Stratification of the Pit 3 water profile was observed at 4 metres depth which equated to 17.5mAHD, where pit water salinity increased by 86 µS/cm from 594 to 680 µS/cm. This is common for deeper water columns. The salinity of the water column beneath the 4 metres depth was uniform. Salinity profiling of Awoonga Dam next to Ragotte Creek whose depth is typically less than 2.5 metres, shows that there is no stratification of Awoonga Dam water in Ragotte Creek.

7.3 Major Ion Chemistry

Major ion chemistry has assisted with understanding geochemical processes of water bodies, particularly rainfall (dilution) and evaporation, and to classify the water bodies by Piper diagrams.

7.3.1 Pit water major ion chemistry

A Piper plot of Pit 3 and Pit 4 is provided below in Figure 43.

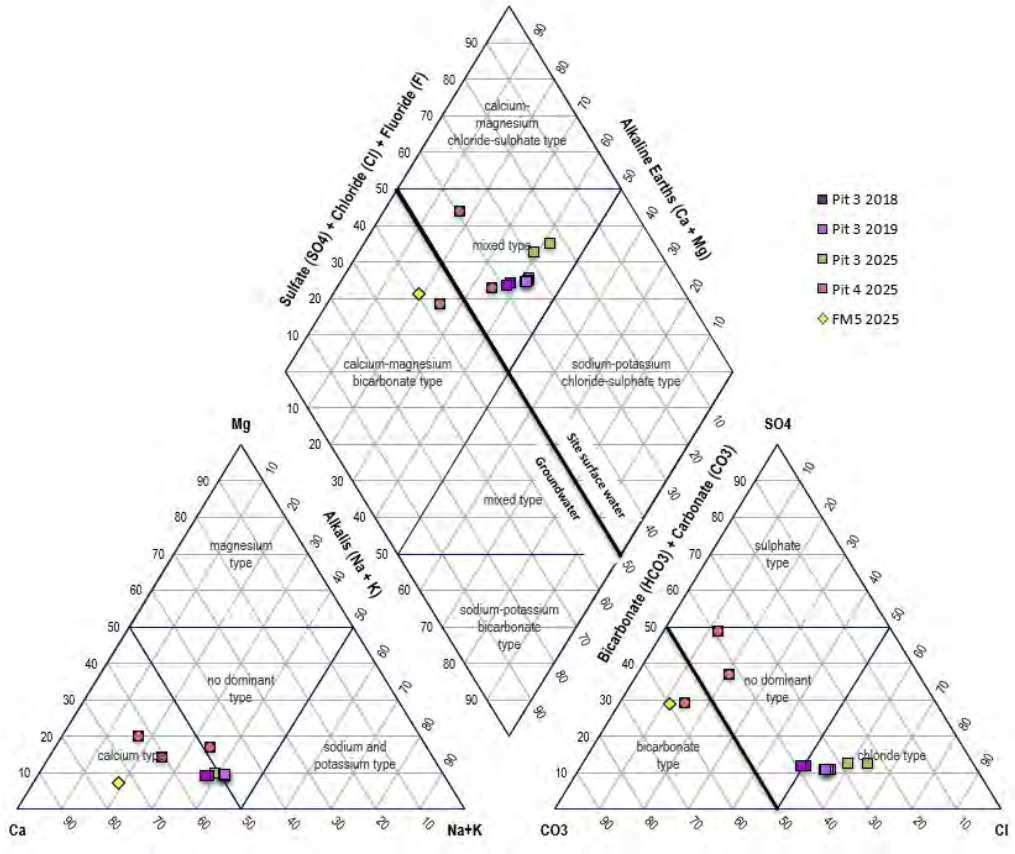


Figure 43 Piper Plot of Pit 3 and Pit 4 major ions water chemistry

Data Analysis and Interpretation

Pit 3 major ion water chemistry is mixed type and seasonally varies. Pit 4 major ion water chemistry is also mixed type and seasonally varies.

A Piper plot of Pits 2-4 major and catchment dam is provided below in Figure 44.

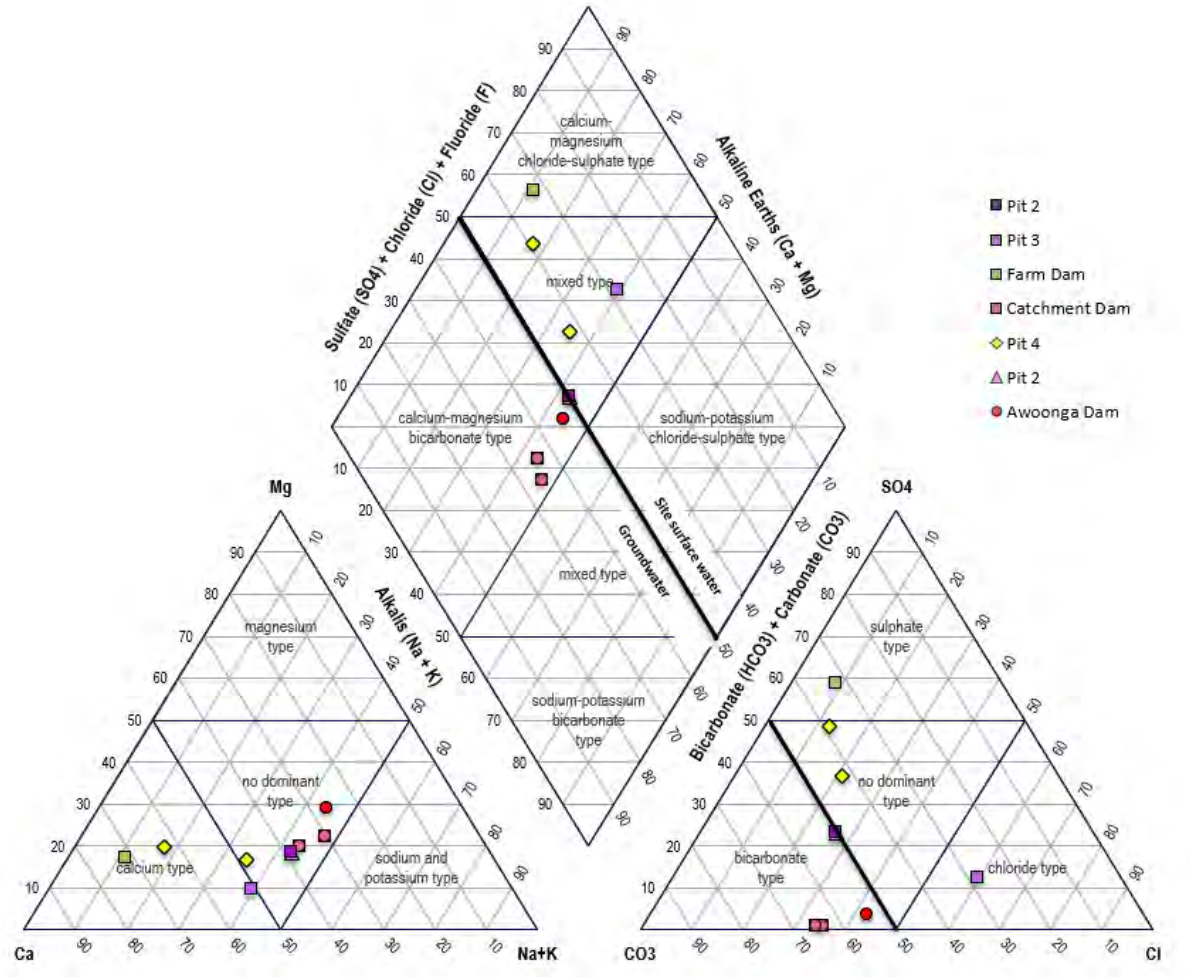


Figure 44 Piper Plot of Pits 2-4 and catchment dam major ions water chemistry

Data Analysis and Interpretation

Pit 3 and Pit 4 major ion water chemistry is mixed type and the Farm dam is Ca-Mg-Cl-SO_4 type. Water sampled in small catchment dams is chemically distinct from the pit and Farm Dam water but is comparable to Awoonga Dam water.

7.3.2 Pit 3 water interaction with Awoonga Dam water

The GHD hypothesis that excess water in Pit 3 was possibly leaking through the Western Bund Wall was investigated by Sibelco (2011). At the time of this investigation water freely flowed along the western bund from the Farm Dam along the bund wall and then flowed into Pit 3. Awoonga Dam water level at this time was at 40.3 mAHD.

Major Ion water chemistry of surface water results are presented as a Piper plot in Figure 45.

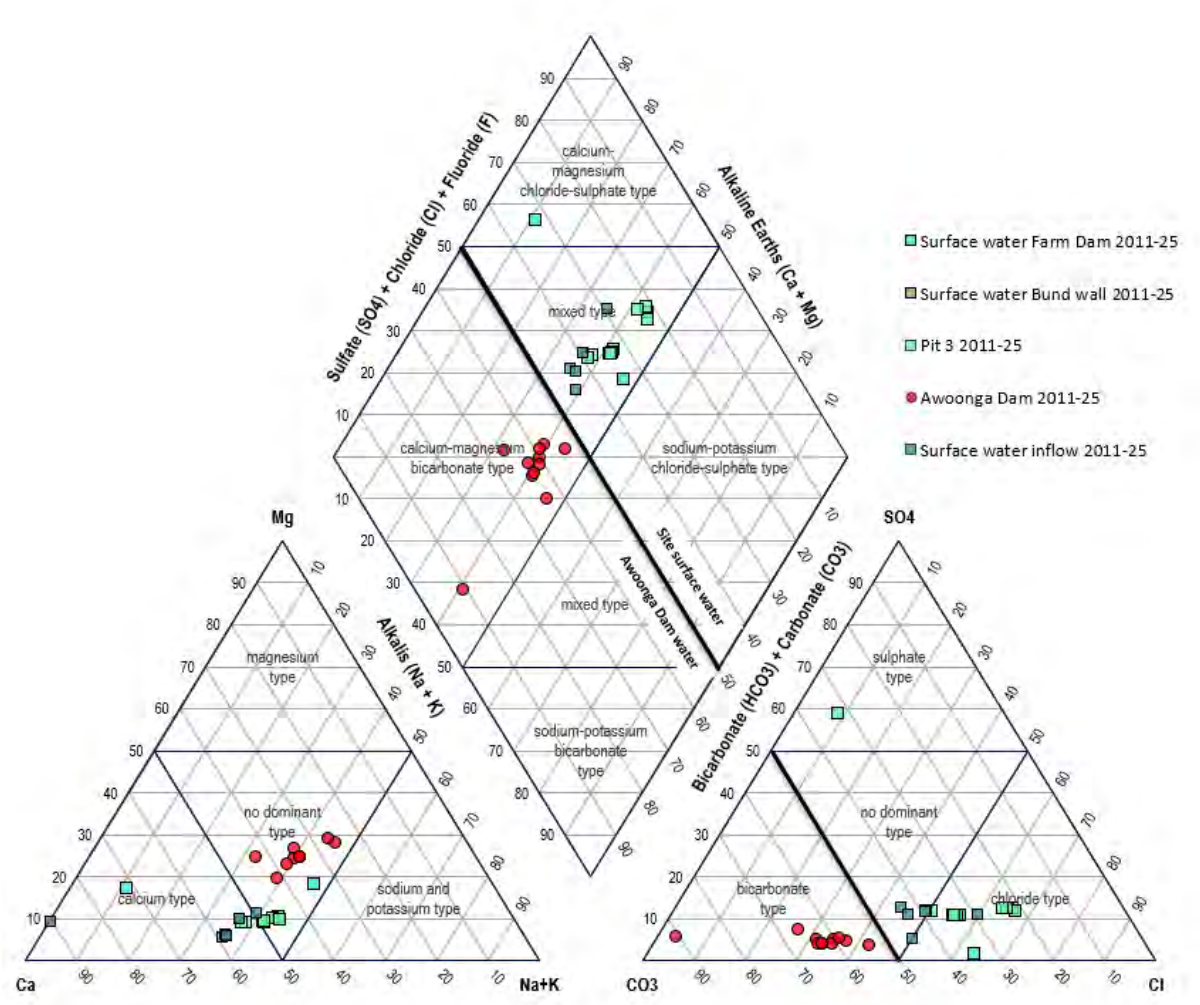


Figure 45 Piper Plot of Awoonga Dam with Pit 3 and Farm Dam surface water

Data Analysis and Interpretation

Awoonga Dam water is chemically distinct from Pit 3 sub catchment and Farm Dam sub-catchment water. Awoonga Dam water is Ca-Mg-HCO_3 type water whereas the Farm Dam and water flowing along the bund wall and Pit 3 water are mixed type water with similar chemistry and the catchment dam is a Na-K-Cl-SO_4 type water.

Major Ion water chemistry indicates that Awoonga Dam is chemically distinct from site surface water and this does not support the GHD (2011) hypothesis that Pit 3 water inflow is from Awoonga Dam by a possible piping failure mechanism. Salinity sampling also does not support this hypothesis (Section 7.2.1). No physical evidence has been found of piping from all Western Bund wall inspections by GAWB and operational staff and it is concluded that Awoonga Dam does not leak through the western bund wall.

8 GROUNDWATER INTERSECTION, LEVEL AND FLOW

8.1 Methodology

Groundwater intersection, level and flow is available from multiple sources which include:

- Geological drilling logs from Resource definition drilling
- Discussions with Production drillers, Supervisor and shot firers regarding the presence of groundwater in production drill holes
- Geological logs from targeted investigative drilling
- Driller and geological logs from constructed Bores

Rotary Air Blast (RAB) drilling is routinely undertaken for drill and blast production at the quarry as well as geological resource definition drilling and investigative water drilling. Groundwater intersected by geological and investigative drilling is recorded in the Geological Database. Drilled water intersections and post drilling groundwater measurements assist with interpretating groundwater behaviour and the host aquifer.

Investigation drilling holes are constructed so that they remain open for a short time, by installing a pre-collar when required if collared in unstable unconsolidated material. All drillholes were capped and collars surveyed to ensure groundwater data integrity. At the completion of the investigation the holes are backfilled.

Groundwater measurements are made of the drilled hole void to determine whether the groundwater elevation of intersected groundwater has changed post-drilling or if a dry hole has slowly made water. Observed groundwater response is categorised as shown in Figure 46.

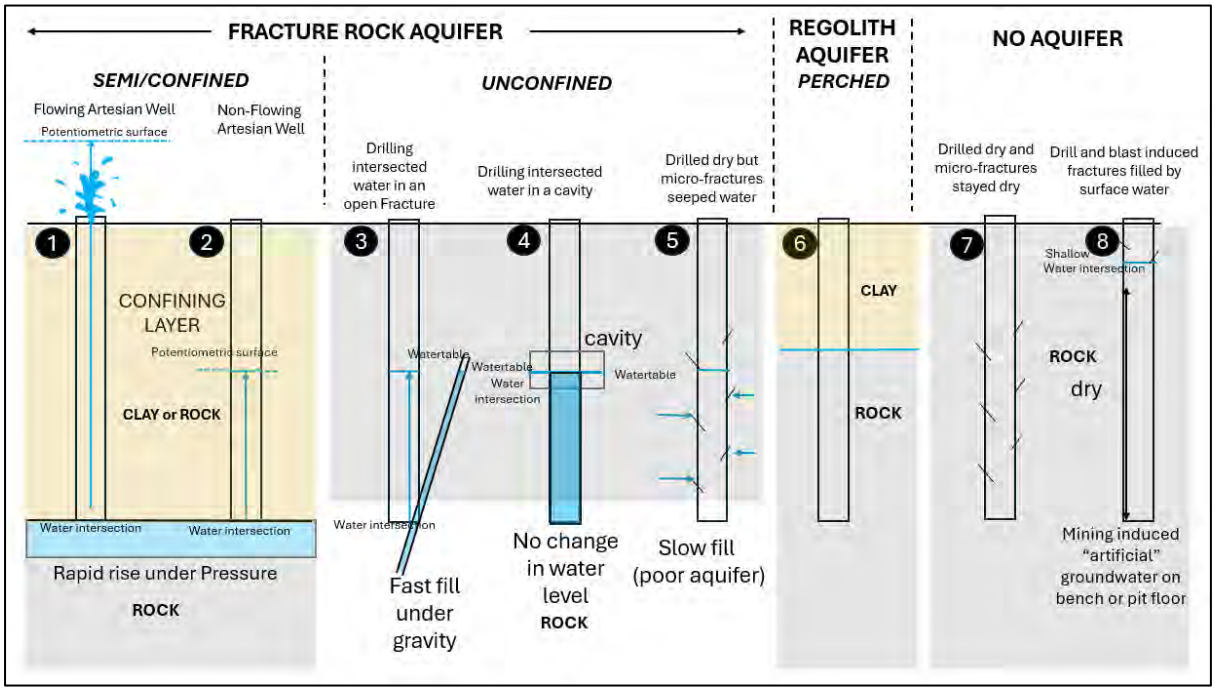


Figure 46 Drilled groundwater intersection types

Drilling through dry rock into a water-bearing fracture of an unconfined aquifer allows the water to equalize to the height of the surrounding water table. Unconfined aquifers do not have an impermeable overlying cap and therefore there is no pressure to force the water level higher than the actual water table.

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8.2 Groundwater Intersection

The response of groundwater intersected in a fracture by drilling assist with aquifer identification (Figure 39). An absence of groundwater indicates that no groundwater bearing fracture was intersected in the vertical drillhole.

8.2.1 Resource Definition drilling

Geological drilling results from resource definition and production are housed in a database which currently contains 800 drillholes. Groundwater intersection data is routinely recorded and groundwater was intersected in 20 drillholes (3%). The drillholes which intersected groundwater are shown in Table 21.

Location Details				Drilling Details					
Hole ID	East	North	Natural surface mAHD	Drill Date	Hole Depth (m)	EOH mAHD (m)	Aquifer	Groundwater intersection DBNS	Groundwater intersection mAHD
64T3	321148	7332854	47.7	29/08/1964	86.9	-39.2	CAVITY	13.7	34.0
65T14	320759	7333060	47.9	8/11/1964	19.1	28.8	LST	16.5	31.4
AH2	320623	7332994	45.6	18/11/1965	14.5	31.1	LST	12.9	32.7
1E	320092	7333729	49.1	1/01/1966	7.7	41.4	VOLC	7.6	41.5
F9524	321086	7334064	58.5	3/11/1995	19.5	39.0	AND	17.4	41.1
F9537	320751	7331949	39.0	3/11/1995	3.0	36.0	CLAY	0.0	39.0
F9631	321101	7332143	47.3	1/04/1996	21.0	26.3	CLAY	9.0	38.3
F9607	320939	7331928	41.6	21/12/1996	18.0	23.6	LST	10.0	31.6
F99058	321633	7331720	45.2	1/12/1999	24.6	20.6	LST	13.8	31.4
F99059	321639	7331771	46.6	1/12/1999	24.6	22.0	LST	13.8	32.8
F99068	321531	7331690	46.6	1/12/1999	24.6	22.0	AND	20.0	26.6
F99084	321474	7331683	48.3	1/12/1999	24.6	23.7	LST	17.4	30.9
F99093	321347	7331591	52.9	1/12/1999	24.6	28.3	LST	22.0	30.9
CAB0004	320849	7333263	46.2	20/01/2009	16.0	30.2	CLAY/LST	14.0	32.2
CAB0006	321397	7332651	40.0	5/07/2011	10.0	30.0	LST	9.9	30.1
CAB0007	321378	7332637	40.0	5/07/2011	10.0	30.0	LST	9.9	30.1
CAB0008	321427.41	7332611.55	50.0	5/07/2011	14.0	36.0	LST	13.9	36.1
CAB0009	321408.25	7332597.98	50.0	5/07/2011	16.0	34.0	LST	15.9	34.1
CRC02	320985	7333012	66.3	15/08/2022	108.0	-41.7	LST	49	17.3
CRC04	321230	7332846	16.0	17/08/2022	60.0	-44.0	LST	16	0.0
CRC05	321346	7332597	17.4	18/08/2022	60.0	-42.6	LST	12	5.4

Table 21 Drilled groundwater intersections

There has been no groundwater intersected by drilling below 5.4mAHD. In 2020-22 Resource drilling was undertaken to create a life of mine geological model, which was then used to create the final void pit design. A total of 12 holes were drilled to a maximum depth of -105.1mAHD and groundwater was intersected in 2 drillholes (17%) at 17.3mAHD in CRC02 and 5.4mAHD in CRC05. A summary of groundwater intersection data form the 2020-22 Resource drilling is provided in Table 22.

Location Details				Drilling Details					
Hole ID	East	North	Natural surface mAHD	Drill Date	Hole Depth (m)	EOH mAHD (m)	Aquifer	Groundwater intersection DBNS	Groundwater intersection mAHD
CDD01	321054.50	7332823.20	-5.1	18/03/2020	100.0	**-105.1**	LST	dry	
CRC01	320997.00	7333107.00	55.8	18/03/2020	22.1	33.8	LST	dry	
CDD02	321200.50	7332433.20	5.1	19/03/2020	63.9	**-58.8**	LST	dry	
CDD03	320794.50	7332699.10	43.8	20/03/2020	52.1	-8.3	LST	dry	
CRC01	320997	7333107	55.8	18/03/2020	22	33.8	LST	dry	
CRC02	320985	7333012	66.3	15/08/2022	108.0	-41.7	LST	49	17.3
CRC03	320974	7333040	66.0	17/08/2022	48.0	18.0	LST	dry	
CRC04	321230	7332846	16.0	17/08/2022	60.0	-44.0	LST	16	0.0
CRC05	321346	7332597	17.4	18/08/2022	60.0	-42.6	LST	12	5.4
CRC06	321148	7332576	-16.3	19/08/2022	60.0	**-76.3**	LST	4#	
CRC07	320876	7332231	19.2	20/08/2022	60.0	-40.8	LST	2#	
CRC08	320879	7332531	43.9	22/08/2022	78.0	-34.1	LST	dry	
CRC09	320800	7332900	28.2	23/08/2022	78.0	**-49.8**	LST	dry	

Water intersected is surface w ater in fractures from blasting based on shot drilling results

Table 22 2020-22 Resource definition drilling groundwater intersections

Data Analysis and Interpretation

Geological drilling and mapping reveal that there is no cap on limestone at Calliope which indicates that a semi confined/confined aquifer and a potentiometric surface is unlikely. There has been no artesian flow observed in any Resource definition drilled holes (1) whereas groundwater level has been observed to rise in an open drillhole post-drilling. The rise of groundwater post-drilling could possibly be interpreted as (2) but because of the delayed slow response are generally interpreted as (3) to (5) although (6) has been observed outside the pit envelope. Some holes were drilled dry and remained dry (7). Blasting on benches and the pit floor has created fractures that have led to the sub-surface capture of water in the fractures, being an artificial groundwater (8). Artificial groundwater is usually within 5 metres from the surface and can be distinguished from natural groundwater based on water chemistry. Resource drilling indicates minor groundwater.

8.2.2 Production drilling

Discussions with Production drillers, Supervisor and shot firers have revealed that water is rarely present in any production drill holes unless it has rained between drilling and blasting. Probe drilling is routinely undertaken of karst areas. Loss of return air during blast hole drilling on upper benches or subsidence of the floor or a work zone or ramp may indicate that a karst void is below the floor. Production drilling indicates that there is little groundwater at Calliope.

8.2.3 Pit 3 investigative drilling in 2018-19

Groundwater seepage was proposed by (Sibelco- Feiss, 2017) to be a potential source of near continuous surface water inflow to Pit 3. Other potential sources for this flow was Awoonga Dam through a possible piping failure mechanism (GHD, 2011b) and surface water run-off from the Farm Dam area (Sibelco, 2011). A surface water origin of the near continuous flowing surface water was discussed in Section 6.2.3.

Rotary Air Blast (RAB) drilling investigation was undertaken 2018-19 to investigate the source of near continuous water flow into Pit 3 from the western high wall. The drilling was undertaken with a 3 metre pre-collar which provided stability around the hole collar to help prevent hole collapse. A total of 14 holes were drilled on the Pit 3 western high wall and all the holes were drilled in volcanic rock except for C05 which was drilled in limestone. All drillholes were capped and collars surveyed to ensure groundwater data integrity. Most of the holes slowly made water and were water level tested either the next day or late in the same day. Although C06 was drilled dry groundwater was measured at 34.2mAHD the next day. Water samples were obtained from the drillholes. See Table 23 and Figure 47.

Location Details				Drilling Details					
Drill site	Easting	Northing	Natural surface m AHD	Dril Date	Hole Depth	Clay Depth	Aquifer	Groundwater intersection DBNS	Groundwater intersection m AHD
C01	320712	7332119	38	2/10/2018	12	9.5	Volcanic	9.5	28.5
C02	320694	7332110	38.3	2/10/2018	23.5	7.6	Volcanic	11	27.3
C03	320718	7332083	38.3	2/10/2018	21	6.7	Volcanic	dry	
C04	320704	7332077	37.5	2/10/2018	25	6.3	Volcanic	12	25.5
C05	320717	7332051	38	2/10/2018	25	10	Limestone	12	26
C06	320703	7332037	37.7	2/10/2018	25	8	Volcanic	dry	
C07	320701	7332019	37.4	2/10/2018	25	10.5	Volcanic	dry	
C08	320720	7332021	38	2/10/2018	26	11	Volcanic	dry	
C10	320704	7331984	37.9	3/10/2018	16.5	6	Volcanic	7	30.9
C11	320732	7331928	39.2	3/10/2018	25	7	Volcanic	7	32.2
C12	320703	7331937	38.2	3/10/2018	22	8	Volcanic	7	31.2
C13	320711	7331885	38.6	3/10/2018	25	8.5	Volcanic	10	28.6
C14	320692	7332150	38.6	3/10/2018	29	8.4	Volcanic	dry	

Table 23 2018 Pit 3 Drilling groundwater intersections

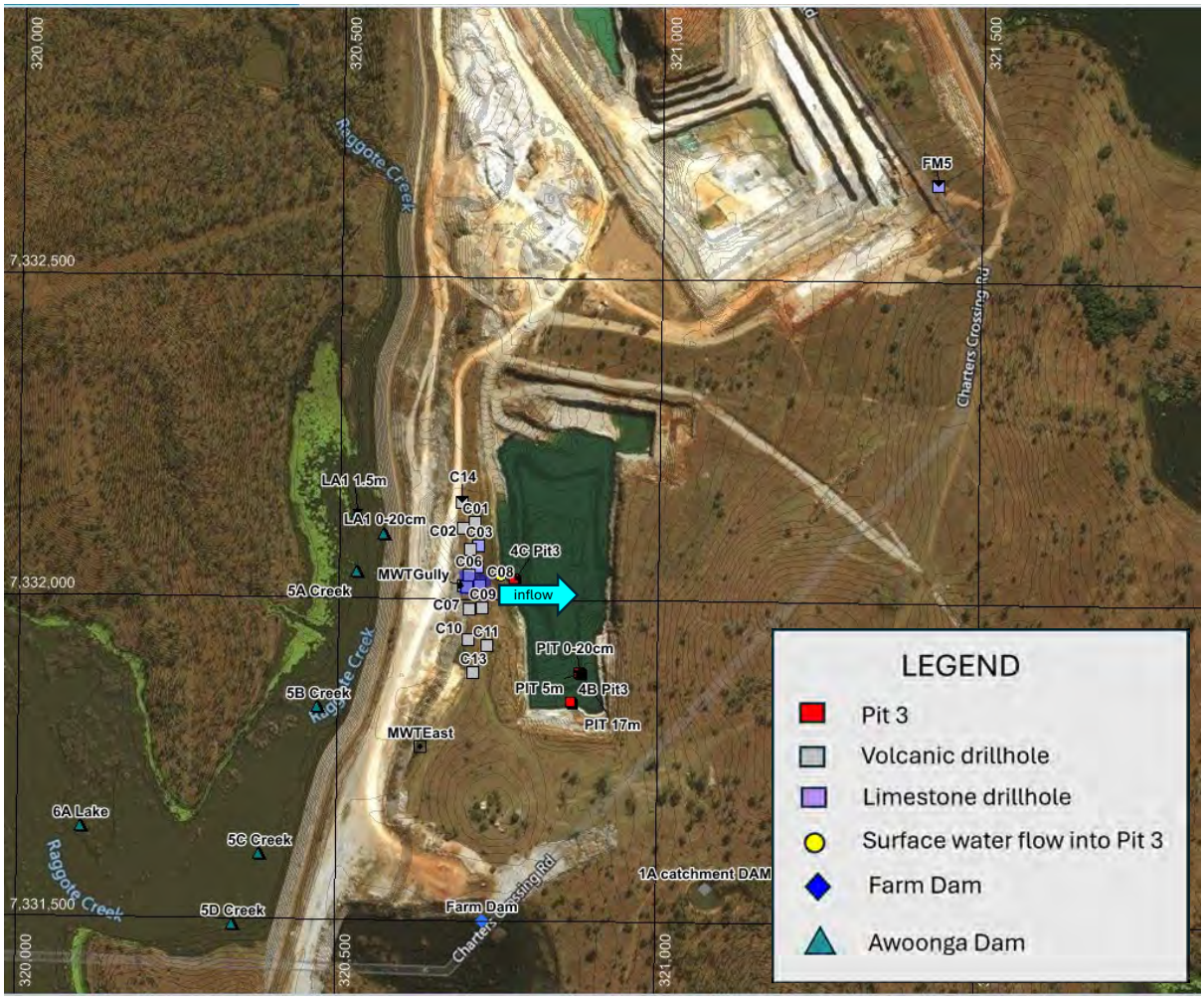


Figure 47 2018 Pit 3 drillhole and surface water locations

8.2.4 Site-wide investigative drilling in 2025

A total of 34 holes were drilled in 2025 around the perimeter of Pit 4, Pit 1 and east of Pit 3 define groundwater behaviour and further investigate groundwater -lithological relationships. The drilling intersected volcanics in 20 holes, limestone in 13 holes, with these 33 holes being in Calliope Beds. One drillhole, D30, intersected metasediment, being metamorphosed and Rockhampton Group sedimentary rock. Drillhole location and groundwater intersection details are shown in Table 24.

Location Details				Drilling Details					
Hole ID	East	North	Natural surface mAHD	Drill Date	Hole Depth (m)	Clay Depth (m)	Aquifer	Groundwater intersection DBNS	Groundwater intersection mAHD
D01	320722	7332520	46	4/03/2025	25	13	Volc	13	33
D02	320806	7332367	46.4	4/03/2025	29	14	Volc	14	32.4
D03	320916	7332338	42.2	4/03/2025	25	20	LST	dry	
D04	321127	7332322	45.7	4/03/2025	25	8	LST	dry	
D05	321334	7332305	52.8	4/03/2025	29	4	LST	dry	
D06	321510	7332466	58.2	4/03/2025	29	10	Volc	dry	
D07	321551	7332638	52.8	4/03/2025	29	4	Volc	dry	
D08	321532	7332742	48.1	4/03/2025	25	12.5	Volc	21	27.1
D09	321702	7332679	45.2	4/03/2025	29	2	Volc	dry	
D10	321374	7333021	52.4	4/03/2025	25	3	Volc	24.5	27.9
D11	321318	7333156	61.8	4/03/2025	29	3	Volc	dry	
D12	321270	7333333	58.5	5/03/2025	29	9	Volc	dry	
D13	321195	7333480	56.5	5/03/2025	29	2	Volc	23.5	33
D14	321239	7333633	60.1	5/03/2025	29	2	Volc	dry	
D15	321135	7333732	61.5	5/03/2025	8	6.5	LST	dry	
D16	321133	7333734	61.4	5/03/2025	29	6.5	LST	14.5	46.9
D17	320986	7333320	50.6	5/03/2025	29	4	LST	dry	
D18	320740	7333178	44.6	5/03/2025	29	4	LST	dry	
D19	320700	7332964	45.7	5/03/2025	29	4	LST	dry	
D20	320704	7332752	44.4	5/03/2025	29	9	Volc	dry	
D21	321323	7332317	51.5	31/03/2025	29	3 (fill)	LST	24	27.5
D22	321212	7332216	49.7	1/04/2025	29	2	LST	dry	
D23	321433	7332040	61	1/04/2025	29	2	Volc	dry	
D24	321184	7331834	58.7	1/04/2025	29	2	Volc	dry	
D25	320819	7331696	42.3	1/04/2025	14.5	3	Volc	dry	
D26	320963	7331713	43.5	1/04/2025	13.5	2	LST	12	31.5
D27	320970	7331477	42.4	1/04/2025	14	1	Volc	14	28.4
D28	321029	7331167	43.6	1/04/2025	18	1	Volc	17.5	26.1
D29	321085	7330868	54	1/04/2025	23	3	Volc	dry	
D30	320743	7331231	45.1	1/04/2025	18	3	MetaSED	17.5	27.6
D31	320815	7331556	40.1	1/04/2025	18	3 (fill)	Volc	17.5	22.6
D32	320662	7333082	51.4	31/03/2025	18	4.5	LST	18	33.4
D33	321139	7333273	54	31/03/2025	29	3 (fill)	LST	dry	
D34	321409	7332693	47.3	31/03/2025	29	3 (fill)	Volc	dry	

Table 24 2025 drilling groundwater intersections

The majority of drilled were dry with the most groundwater intersected at and near the volcanic -limestone contact. Most of the holes slowly made water and were water level tested either the next day or late in the same day. Water samples were obtained from the drillholes. All the 2025 drillholes were capped and collars surveyed to ensure groundwater data integrity. A 2025 Investigation drillhole map is shown as Figure 48.

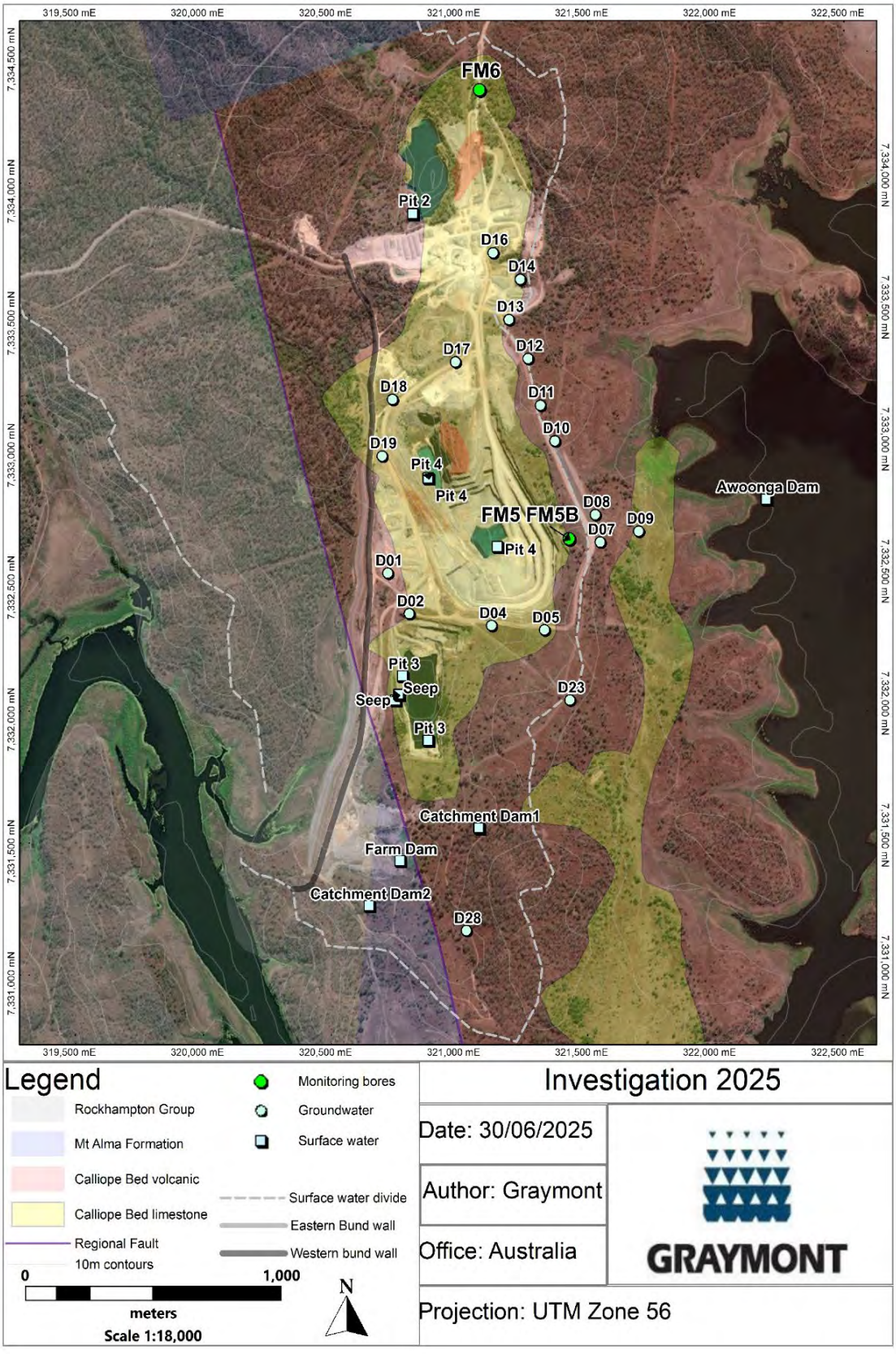


Figure 48 2025 Groundwater Investigative drilling with surface water sites

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8.2.5 Bore Monitoring Network

A total of fourteen piezometers have been installed at the quarry. A summary of construction details is provided below in Table 25. See Appendix 1 for FM5-FM13 Bore Completion Reports.

Location Details				Drilling Details		Construction Details					
Hole ID	GDA2020 Easting	GDA2020 Northing	Natural surface mAHD	Drill Date	Hole Depth (m)	Casing (mm)	Screen top (mAHD)	Screen bottom (mAHD)	Measuring Point MP (m)	Top of Casing TOC mAHD	Top of Monument mAHD
FM1	321337	7332964	47.40	28/10/2002	60	50	23.4	-12.6	n/a	n/a	n/a
FM2	321412	7332815	43.70	29/10/2002	24	50	37.7	19.7	n/a	n/a	n/a
FM3	321332	7332864	44.50	29/10/2002	66	50	n/a	n/a	n/a	n/a	n/a
FM4	321256	7332790	45.00	30/10/2002	72	50	27.0	-27.0	n/a	n/a	n/a
FM5	321450	7332632	50.81	3/07/2012	16.0	50	45.1	36.1	0.65	51.46	51.56
FM5B	321451	7332633	50.76	12/01/2021	30.0	50	33.8	20.8	0.67	51.43	51.75
FM6	321036	7334352	64.36	26/06/2012	60.5	50	15.9	3.9	0.43	64.79	65.03
FM7	321133	7333734	60.84	29/08/2025	30.0	60.6	46.1	34.1	0.68	61.52	61.60
FM8	321546	7332639	52.54	30/08/2025	30.0	60.6	39.8	24.8	0.70	53.24	53.19
FM9	320720	7332520	46.14	31/08/2025	30.0	60.6	33.9	18.9	0.82	46.96	46.98
FM10	320544	7333648	48.98	8/02/2026	7.7	60	44.3	41.3	0.64	49.62	49.63
FM11	320710	7332069	38.55	8/02/2026	24.8	60	19.8	13.8	0.48	39.03	39.20
FM12	320489	7331308	47.71	7/02/2026	31.0	60	22.7	16.7	0.69	48.40	48.52
FM13	321519	7331815	50.11	6/02/2026	31.0	60	25.1	19.1	0.60	50.71	50.82

Table 25 Quarry bore drilling and construction details

A summary of groundwater intersections and first monitoring reading of groundwater for Bores FM1-13 is provided below in Table 26.

Location Details				Drilling Details						
Hole ID	GDA2020 Easting	GDA2020 Northing	Natural surface mAHD	Drill Date	Hole Depth (m)	Aquifer	Groundwater intersection		Watertable	
							DBNS	mAHD	DBNS	mAHD
FM1	321337	7332964	47.40	28/10/2002	60	LST	43.5	3.90	13.33	34.07
FM2	321412	7332815	43.70	29/10/2002	24	Volc	dry	n/a	9.85	33.85
FM3	321332	7332864	44.50	29/10/2002	66	LST	dry	n/a	12.20	32.30
FM4	321256	7332790	45.00	30/10/2002	72	LST	dry	n/a	56.81	-11.81
FM5	321450	7332632	50.81	3/07/2012	16.0	LST	15	35.81	12.00	38.81
FM5B	321451	7332633	50.76	12/01/2021	30.0	Volc	18	32.76	18.00	32.76
FM6	321036	7334352	64.36	26/06/2012	60.5	Volc	54.5	9.86	21.00	43.36
FM7	321133	7333734	60.84	29/08/2025	30.0	LST	dry	n/a	15.66	45.18
FM8	321546	7332639	52.54	30/08/2025	30.0	Volc	dry	n/a	16.17	36.37
FM9	320720	7332520	46.14	31/08/2025	30.0	Volc	dry	n/a	10.98	35.16
FM10	320544	7333648	48.98	8/02/2026	7.7	Volc	4	44.98	2.70	46.28
FM11	320710	7332069	38.55	8/02/2026	24.8	Volc	19	19.55	13.00	25.55
FM12	320489	7331308	47.71	7/02/2026	31.0	Volc	26.1	21.61	14.40	33.31
FM13	321519	7331815	50.11	6/02/2026	31.0	Volc	25.2	24.91	16.70	33.41

Table 26 Piezometers FM1-13

A location map of the Groundwater Monitoring Network is show in Figure 49. Piezometer Groundwater intersections are shown in Figure 50.



Figure 49 Groundwater Monitoring Network

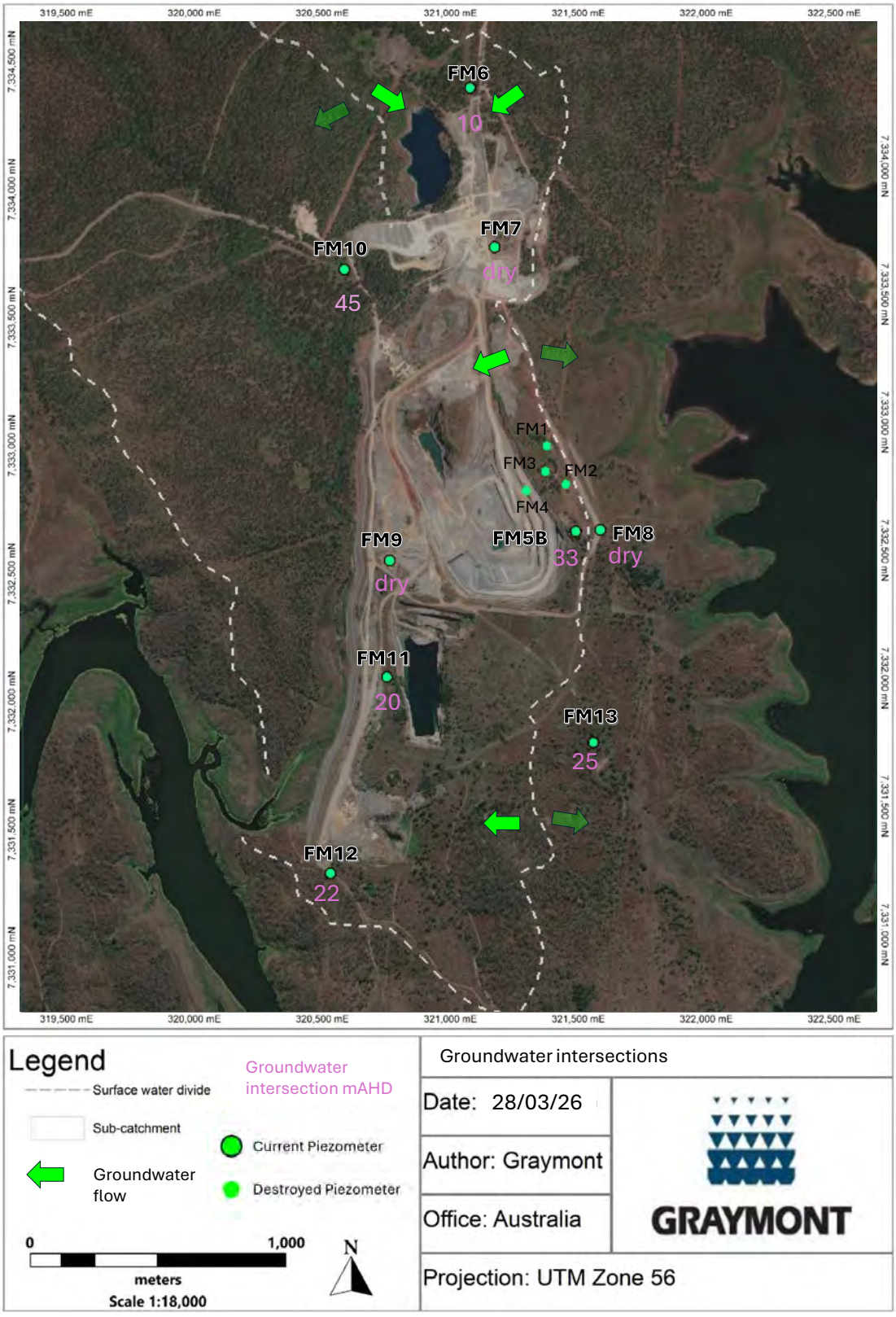


Figure 50 Piezometer groundwater intersections

8.3 Groundwater level

8.3.1 Pit 3 investigative drilling in 2018-19

A year after drilling eight of the 14 drillholes had partially collapsed while five of the drillholes were intact. The intact holes were monitored and following sampling all holes were backfilled. See Table 27 and Figure 51.

Groundwater Monitoring									
Drill site	Monitor Date	GW DBNS	Hydraulic head mAHD	Field EC	Water Sample	Monitor Date	GW DBNS	Hydraulic head mAHD	Field EC
C01	3/10/2018	6.79	31.21	820	✓	×			
C02	3/10/2018	6.45	31.85	680	✓	×			
C03	3/10/2018	dry			×	×			
C04	3/10/2018	6.47	31.03	554	✓	8/10/2019	6.91	30.59	391
C05	3/10/2018	6.50	31.50	440	✓	×			
C06	3/10/2018	3.50	34.20	414	✓	8/10/2019	5.15	32.55	303
C07	3/10/2018	3.24	34.16	418	✓	8/10/2019	3.74	33.67	306
C08	3/10/2018	6.84	31.16	419	✓	8/10/2019	7.34	30.66	319
C10	3/10/2018	5.67	32.23	425	✓	×			
C11	3/10/2018	5.36	33.84	546	✓	×			
C12	3/10/2018	7.24	30.96	603	✓	×			
C13	3/10/2018	5.52	33.08	638	✓	×			
C14	3/10/2018	8.37	30.23	977	✓	8/10/2019	7.63	30.97	781

Table 27 2018 Drillhole groundwater level

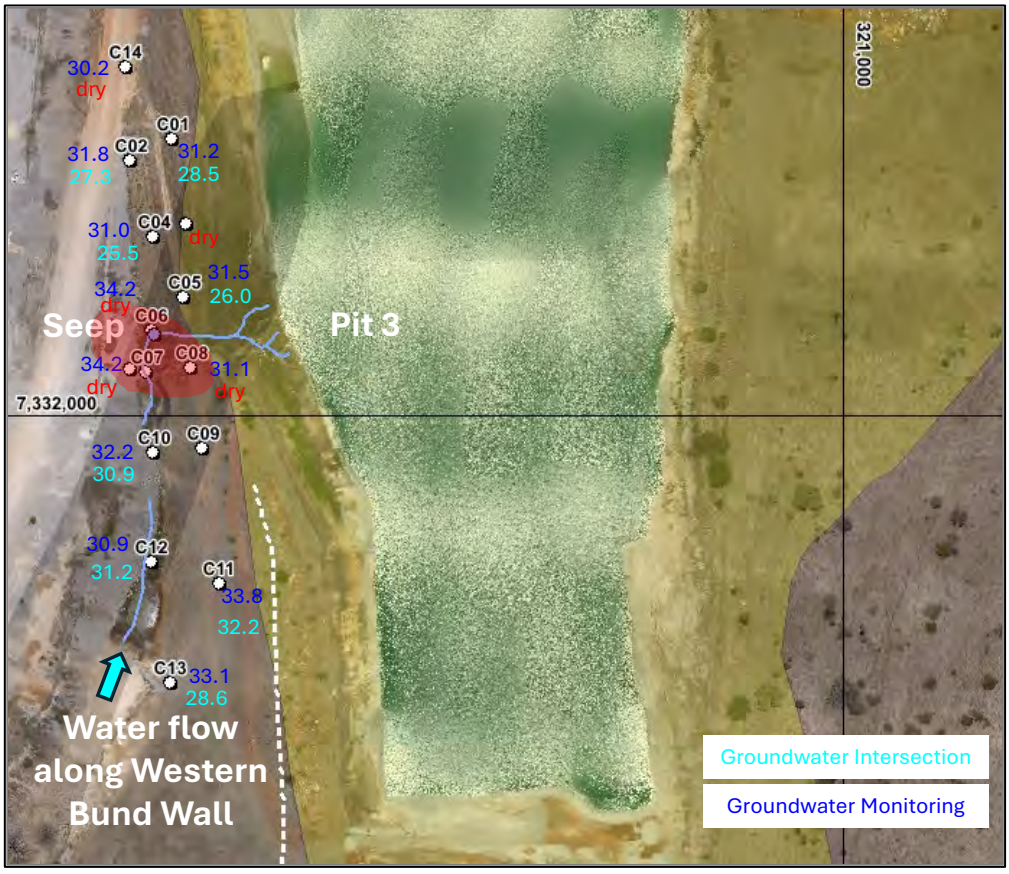


Figure 51 2018 Drillhole groundwater level map

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Data Analysis and Interpretation

Groundwater intersections indicated possible westerly flow away from Pit 3, but since the water level in Pit 3 was at 16mAHD the groundwater could not be from Pit 3. Groundwater level monitoring in October 2018 showed that groundwater was elevated to 34mAHD in holes C06 and C07 at the surface water flow entry point, which is at an elevation of 38mAHD. Groundwater level varies from 31-34mAHD with an average of 32mAHD being 6 metres below the surface water flow entry point and therefore this surface water inflow is not groundwater. Groundwater level monitoring in October 2018 indicates radial flow away from the surface water inflow point.

8.3.2 Pit 3 investigative drilling in 2018-19

Monitoring results are provided in Table 28.

Groundwater Monitoring														
Hole ID	Monitor Date	DBNS (m)	Hydraulic head mAHD	Field EC	Monitor Date	DBNS (m)	Hydraulic head mAHD	EC	Water Sample	Monitor Date	DBNS (m)	Hydraulic head mAHD	EC	Water Sample
D01	4/03/2025	10.53	35.47	813	10/03/2025	10.6	35.4	331	✓	29/05/2025				×
D02	4/03/2025	12.96	33.44	1002	10/03/2025	12.8	33.6	419	✓	29/05/2025				×
D03	4/03/2025	dry			10/03/2025	dry			×	29/05/2025				×
D04	4/03/2025	dry			10/03/2025	19.8	25.9	4310	✓	29/05/2025				×
D05	4/03/2025	dry			10/03/2025	27.3	25.5	975	✓	29/05/2025				×
D06	4/03/2025	dry			10/03/2025	dry			×	29/05/2025				×
D07	4/03/2025	28.18	24.62	1689	10/03/2025	23	29.8	221	✓	29/05/2025	14.76	38.04		×
D08	4/03/2025	12.14	35.96	1928	10/03/2025	12.2	35.9	741	✓	29/05/2025				×
D09	4/03/2025	28.5	16.7	503	10/03/2025	27.6	17.6	875	✓	29/05/2025	12.2	33		×
D10	4/03/2025	16.33	36.07	2107	10/03/2025	15.8	36.6	382	✓	29/05/2025				×
D11	4/03/2025	27.91	33.89	2640	10/03/2025	23.5	38.3	3250	✓	29/05/2025				×
D12	5/03/2025	28.56	29.94	796	10/03/2025	16.4	42.1	377	✓	29/05/2025	15.1	43.4		×
D13	5/03/2025	16.65	39.85	1277	10/03/2025	10.7	45.8	120	✓	29/05/2025	14.7	41.8		×
D14	5/03/2025	19.63	40.47	864	10/03/2025	13.2	46.9	780	✓	29/05/2025	13.1	47		×
D15	5/03/2025	dry			10/03/2025	dry			×	29/05/2025	14	47.5		×
D16	5/03/2025	14.72	46.68	1328	10/03/2025	12.8	48.6	1022	✓	29/05/2025	10.65	50.75		×
D17	5/03/2025	28.58	22.02	930	10/03/2025	12.8	37.8	1022	✓	29/05/2025	12	38.6		×
D18	5/03/2025	27.57	17.03	823	10/03/2025	6.5	38.1	646	✓	29/05/2025	6.5	38.1		×
D19	5/03/2025	dry			10/03/2025	25.4	20.3	447	✓	29/05/2025				×
D20	5/03/2025	dry			10/03/2025	dry			×	29/05/2025	24.6	19.8		×
D21										29/05/2025				×
D22										29/05/2025				×
D23										29/05/2025	25	36	3700	✓
D24										29/05/2025	12.4	46.3		×
D25										29/05/2025	14.65	27.65		×
D26										29/05/2025				×
D27										29/05/2025				×
D28										29/05/2025	14.4	29.2	5240	✓
D29										29/05/2025				×
D30										29/05/2025				×
D31										29/05/2025	7.8	32.3		×
D32										29/05/2025				×
D33										29/05/2025				×
D34										29/05/2025				×

Table 28 Groundwater level monitoring of the 2025 drillholes

Data Analysis and Interpretation

A groundwater level map was constructed from investigative drilling monitoring (Table 28) and current bores FM5, FM5B and FM6 in consideration of destroyed bores FM1-4. See Figure 52.

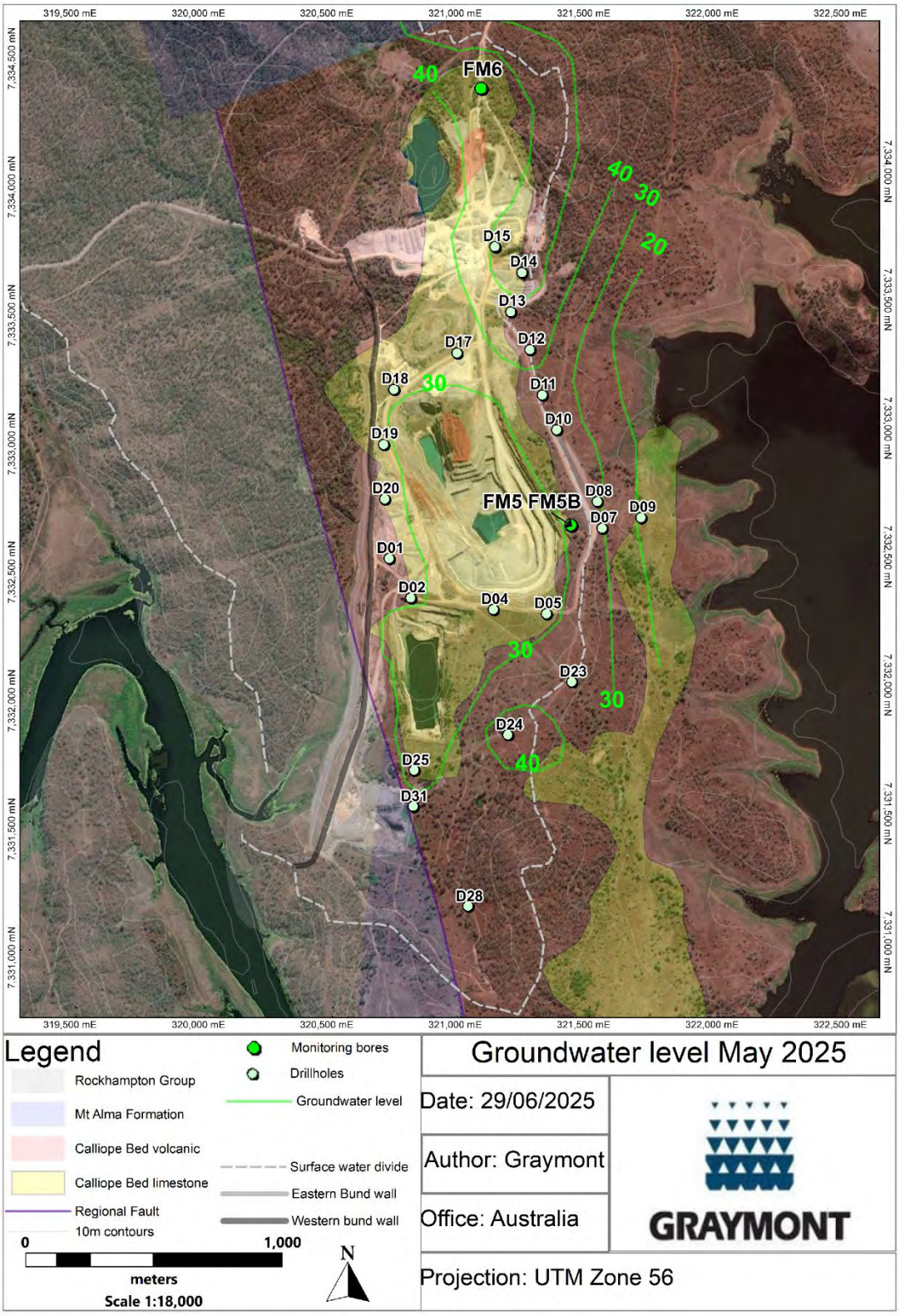


Figure 52 Groundwater level May 2025

The 2025 Investigative drilling confirmed that a groundwater divide aligns with the surface water divide. Groundwater flow is north to south from Pit 2 to SE of Pit 4 while also flowing easterly and westerly from the groundwater divide. Groundwater at FM6 flows westerly and does not flow toFM5, and groundwater at FM5 flows to Pit 4. Investigative drilling and subsequent water monitoring has confirmed groundwater levels and flow direction and that Pit 3 and Pit 4 voids are groundwater sinks. The predicted future water table will remain a closed system.

There is no groundwater extraction outside the pit void so the aquifer is not being depressurized as groundwater approaches the pit void. There is little groundwater present in the pit void and there is no cone of depression extending beyond the mined area or associated impacts to potential receptors. Groundwater levels and chemistry respond to recharge and therefore groundwater is driven by infiltration rather than seepage from Awoonga Dam

8.3.3 Bore Monitoring

A hydrograph of monitoring bores FM5-12 based on quarterly reading is shown below as Figure 53.

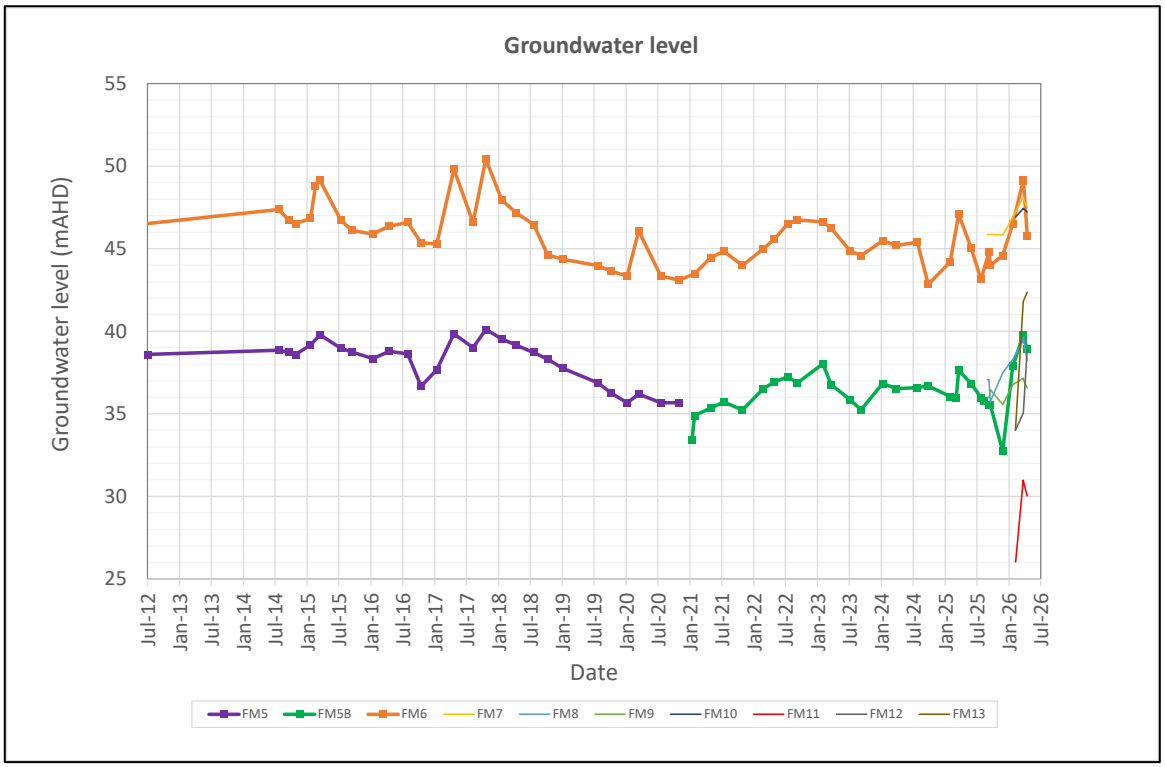


Figure 53 Groundwater level of monitoring bores FM5-13

Data Analysis and Interpretation

Monitoring bores both respond to rainfall and drain equally well which demonstrates that groundwater fluctuations are driven by infiltration.

A March 2026 groundwater level map was constructed from monitoring bore readings and is displayed with drillhole groundwater intersections (Figure 54). See Appendix 2 for March 2026 Bore monitoring field notes. The Certificate of Analysis from March 2026 water sampling is also provided in Appendix 2.



Figure 54 March 2026 Groundwater level and groundwater intersections

The March 2026 groundwater level map constructed from piezometers (Figure 54) is very similar to the March 2025 groundwater level map constructed from investigative drillholes (Figure 52). Both groundwater level maps demonstrate that groundwater flow direction is towards the pit voids and act as groundwater sinks.

A March 2026 groundwater level surface was created from the groundwater level contours and is displayed below as an oblique view. See Figure 55.

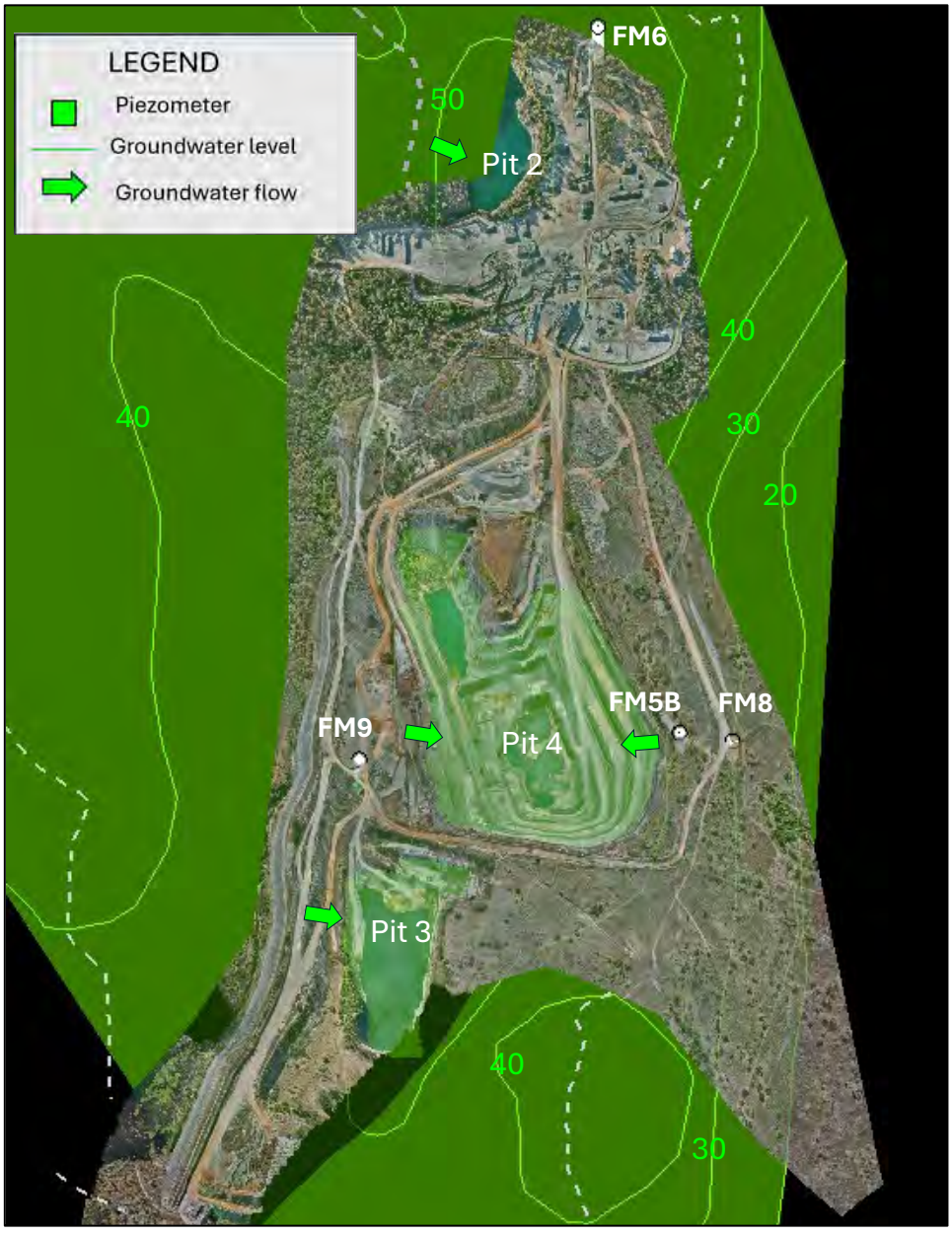


Figure 55 Oblique view of March 2026 groundwater surface

Figure 55 shows that in the absence of groundwater drawdown from pumping groundwater could potentially seep into Pit 3 and Pit 4 high walls at approximately 30mAHD. Groundwater seepage is not observed in the Pit 4 high walls but could potentially seep into the Pit 3 western high wall at approximately 32mAHD.

A cross section of groundwater flow based on piezometers FM8, FM5B and FM9 monitored water level results is presented in Figure 56.

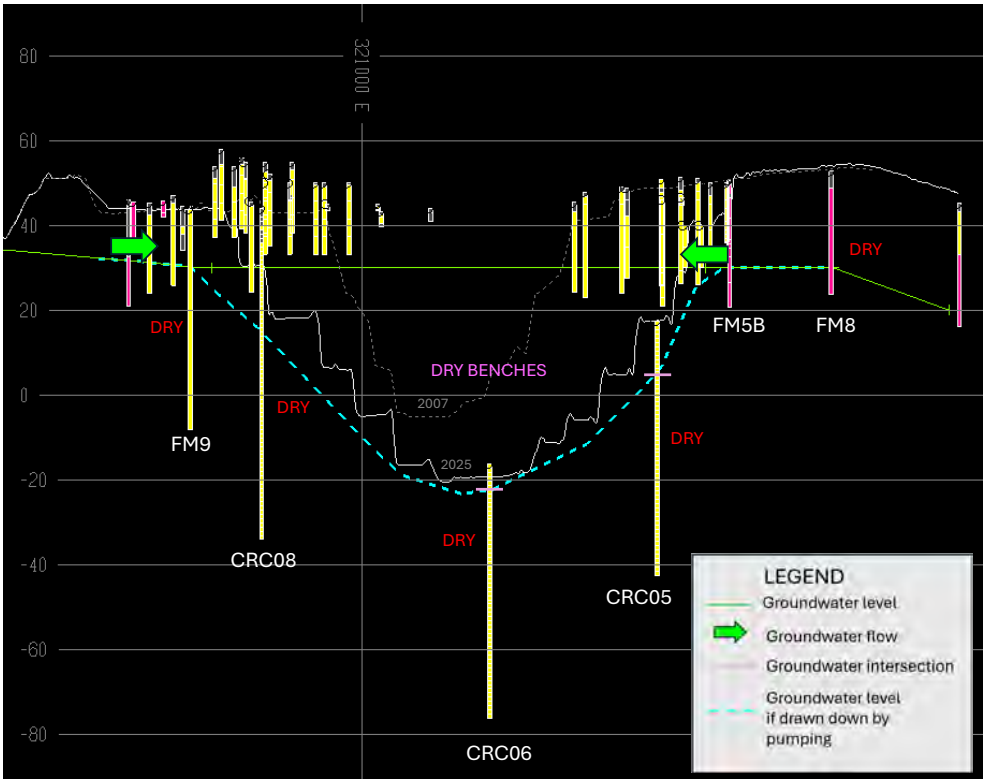


Figure 56 Pit 4 E-W Cross section of groundwater flow

Shallow groundwater was intersected in CRC05 and CRC06 but the holes then became dry and the water was interpreted to be mining induced artificial groundwater.

Figure 56 provides a scenario of groundwater drawdown by pumping creating a cone of depression and depressurising the aquifer. Under this scenario in the absence of pumping groundwater would rise into the pit floor. This is not the case and the pit floor and benches remains dry. There is insufficient groundwater seepage flow to exceed evaporation. A pumping rate of only 1.4ML in 5months i from January-July 2025 (Section 6.4.3) is insufficient to dewater an aquifer and drawdown a potentiometric groundwater surface from approximately 30mAHD to below the aquifer floor at -20mAHD, being 50 metres of potentiometric head. Groundwater level behaviour near CRC05 was further investigated and a table of bores FM1-6 with groundwater intersection and groundwater level readings is shown below in Table 29.

Piezometer	FM1	FM2	FM3	FM4	FM5	FM5B
Aquifer	LST	VOLC	LST	LST	LST	VOLC
Date	Depth mAHD	Depth mAHD	Depth mAHD	Depth mAHD	Depth mAHD	Depth mAHD
28-30/10/2002	34.9, 3.9	dry	14.5	dry		
1/11/2002	34.07	33.85	32.3	-11.81		
12/12/2002	34.24	33.74	33.57	28.33		
19/10/2010	39.32	37.55		19.46		
3/07/2012					35.81	
12/01/2021						32.76
4/03/2025	36.49					35.96

Water Intersection Water level

Table 29 Groundwater level monitoring of FM1-FM5B

FM4 was drilled north of CRC05 and was destroyed by mining in 2010. FM4 was drilled dry and slowly made water whereas FM2 was drilled dry but made water more quickly indicating different responses.

8.3.4 Continous groundwater level data

Data loggers have been installed in piezometers FM5B-13 following installation of piezometers FM10-13 in February 2026. Piezometer data for FM5B-8 from September 2025 to March 2026 is shown in Figure 57.

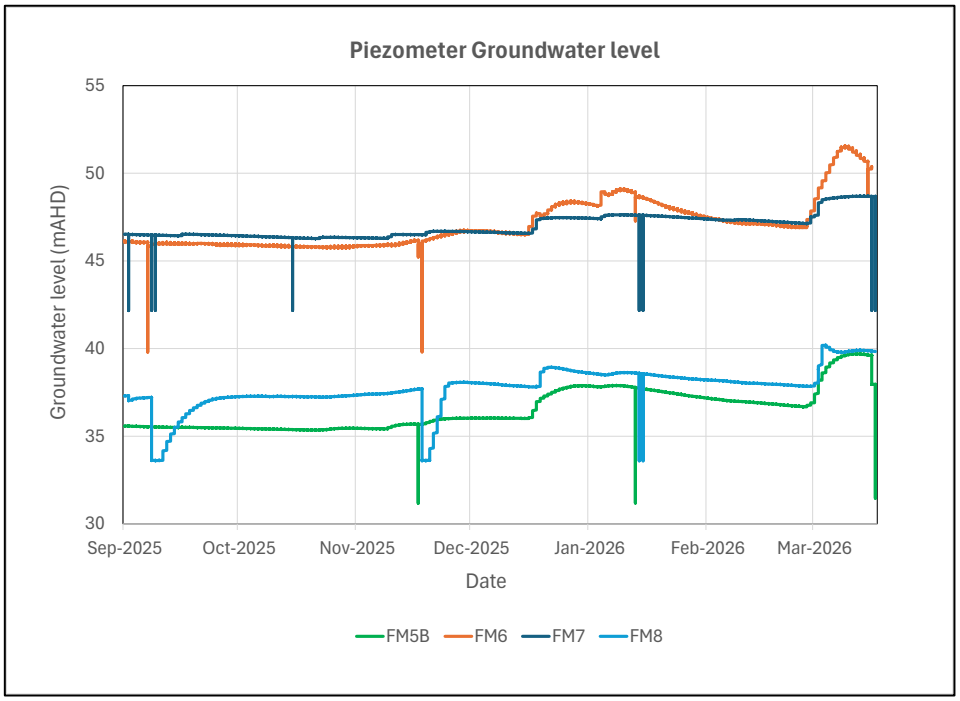


Figure 57 Data logger data for FM5B-9

Data Analysis and Interpretation

FM5B and FM6 behave similarly and both lie west of the groundwater divide (See Figure 54). FM8 groundwater level behaviour is more subdued than FM5b and FM6 and the piezometer recovers very slowly from water sampling. FM8 was drilled dry and there is little groundwater flow through fractures at this location. FM7 was also drilled dry and groundwater level behaviour is also subdued like FM8 and is little groundwater flow through fractures at this location.

8.4 Groundwater recharge and discharge

Regional recharge is in topographic elevated positions associated with thin soil cover and discharge is in topographic lows associated with deep soil and regolith. Investigation drilling demonstrates that the most elevated groundwater levels coincide with the most topographically elevated position and that the surface water divide coincides with a groundwater divide.

Data Analysis and Interpretation

A natural topographic high and surface water divide lies to the east of Pits 3 and 4 within volcanic rock, which is a local recharge area for infiltration to groundwater. To the west of Pits 3 and 4 is a natural topographic low and is an area for potential groundwater discharge. Mining of limestone in Pit 3 has exposed the volcanic-limestone contact and groundwater is present at 32mAHD. A black large organic clay ed area located west of Pit 3 indicates that prior to mining a surface depression existed at this location (Figure 13). The Pit3 surface water inflow point is a natural topographic low and any water shedding from within or from the Waste Dumps,

which are permeable as identified by GAWB in 2002, will naturally flow into the topographic low and then into Pit 3.

8.5 Groundwater Pumping

Groundwater use in the region is primarily for stock and domestic use because of poor bore yields. Calliope does not have a pumping bore because of poor yields and there is no direct pumping of groundwater at the site for production or dewatering purposes.

8.6 Groundwater interaction with Awoonga Dam water

Piezometer FM1, FM5 and FM5B are presented below with Awoonga Dam water levels. See Figure 58.

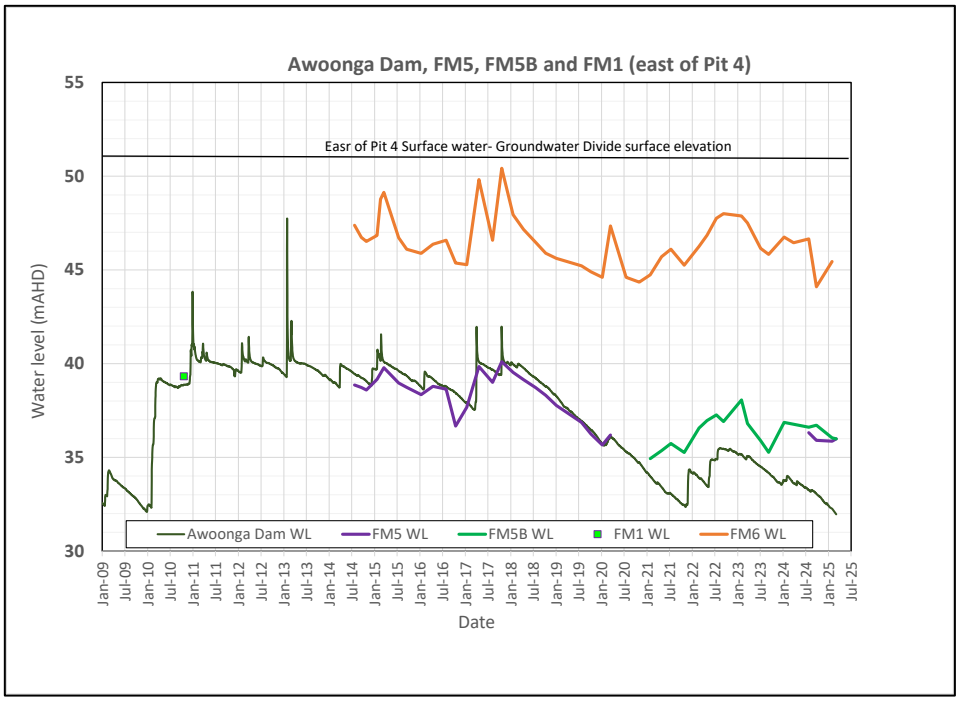


Figure 58 FM5, FM5B and FM6 groundwater levels with Awoonga Dam water level

Data Analysis and Interpretation

Groundwater seepage was proposed to be a potential source of excess Pit 3 water. Monitoring bore FM6 is located on the edge of the inactive Pit 2 whereas FM5 is located on the edge of the active Pit 4 but behave similarly. Groundwater in the bores respond to rainfall and drain equally well and naturally seasonal fluctuate greater than 2 metres/year. Groundwater levels declined from 2018-19 during a drier climate.

The relationship between Awoonga Dam water and groundwater determines whether elevated Awoonga Dam water can potentially enter the mining voids by groundwater flow. If Awoonga Dam was hydraulic connected to groundwater at Calliope then investigation drilling should have the same pressure head but this is not the case. Drilling on the pit floor has not intersected groundwater but if it did it would be artesian if connected to Awoonga Dam. Groundwater levels in FM5 and FM6 behave similarly as does Awoonga Dam when water levels are above 36mAHD. When groundwater levels are less then 35mAHD groundwater behaves differently from Awoonga Dam which denstrates that groundwater is not connected to Awoonga Dam water level.

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9 GROUNDWATER QUALITY

9.1 Methodology

Groundwater quality data is available from multiple sources which include:

- Geological drilling logs from Resource definition drilling
- Driller discussions with Production Supervisor regarding production drilling
- Geological logs from targeted investigative drilling
- Driller and geological logs from constructed Bores

Groundwater sampling undertaken by Alpha Concepts is purged until the returning water has stabilised field testing. Sampling was undertaken to investigate water chemistry changes before, after and 24 hours after purging. See Table 30.

Bore		**FM 5B**	**FM 5B**	**FM 5B**
Date		24/07/2025	24/07/2025	25/07/2025
Status		Before Purge	After Purge	24 Hrs After Purge
Field tests	**Unit**			
Water Depth	metre	15.6	15.7	15.65
pH	pH units	7.1	6.9	6.95
Electrical Conductivity	µS/cm	1,270	1,220	1,260
Temperature	°C	23.9	24.8	23.8
Dissolved Oxygen	%Sat	2.9	2.7	3.4
Turbidity	NTU	129	8.6	65.6
Comments		Cloudy	Clear	Slightly Silty
Laboratory tests	**Unit**			
Suspended Solids	mg/L	42	<5	86
Hydroxide Alkalinity as CaCO3	mg/L	<1	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	mg/L	400	400	418
Total Alkalinity as CaCO3	mg/L	400	400	418
Silicon as SiO2	mg/L	29.6	30.6	32
Silicon as SiO2	mg/L	32.2	34.3	40.4
Sulfate as SO4 - Turbidimetric	mg/L	222	181	222
Chloride	mg/L	42	50	45
Calcium	mg/L	182	187	196
Magnesium	mg/L	16	14	15
Sodium	mg/L	68	64	70
Potassium	mg/L	<1	<1	<1
C6 - C9 Fraction	µg/L	<20	<20	<20
C10 - C14 Fraction	µg/L	<50	<50	<50
C15 - C28 Fraction	µg/L	<100	300	<100
C29 - C36 Fraction	µg/L	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	<50	300	<50
Benzene	µg/L	<1	<1	<1
Toluene	µg/L	<2	<2	<2
Ethylbenzene	µg/L	<2	<2	<2
meta- & para- Xylene	µg/L	<2	<2	<2
ortho-Xylene	µg/L	<2	<2	<2
^ Total Xylenes	µg/L	<2	<2	<2
^ Sum of BTEX	µg/L	<1	<1	<1
Naphthalene	µg/L	<5	<5	<5

Table 30 FM5B purged and unpurged samples

Purging reduced pH, EC, dissolved oxygen, turbidity and sulphate but the C15-C28 was elevated to above detection limit but lower than the trigger value of 1 mg/L.

The Certificate of Analysis from March 2026 water sampling is provided in Appendix 2.

9.2 Physiochemical Parameters (potential contaminants)

The physiochemical parameters of salinity (measured as Electrical Conductivity), pH, suspended solids, nutrients (nitrate), metals and hydrocarbons are potential contaminants in groundwater. Groundwater chemistry data from bores FM5 and FM6 and is annually reported and analysed. Graph of electrical conductivity and pH are presented in Figures 59-60.

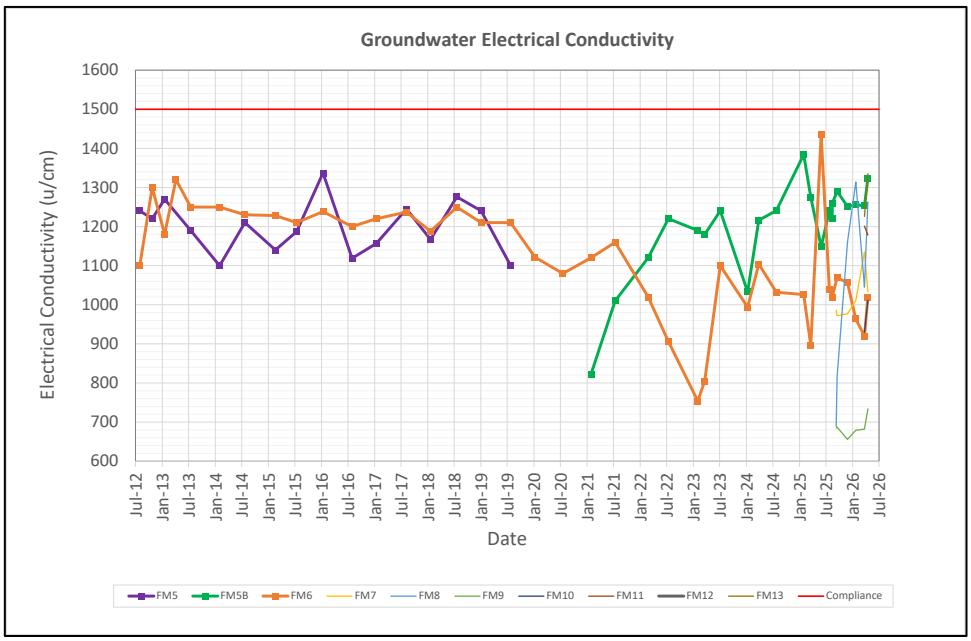


Figure 59 Groundwater Electrical Conductivity

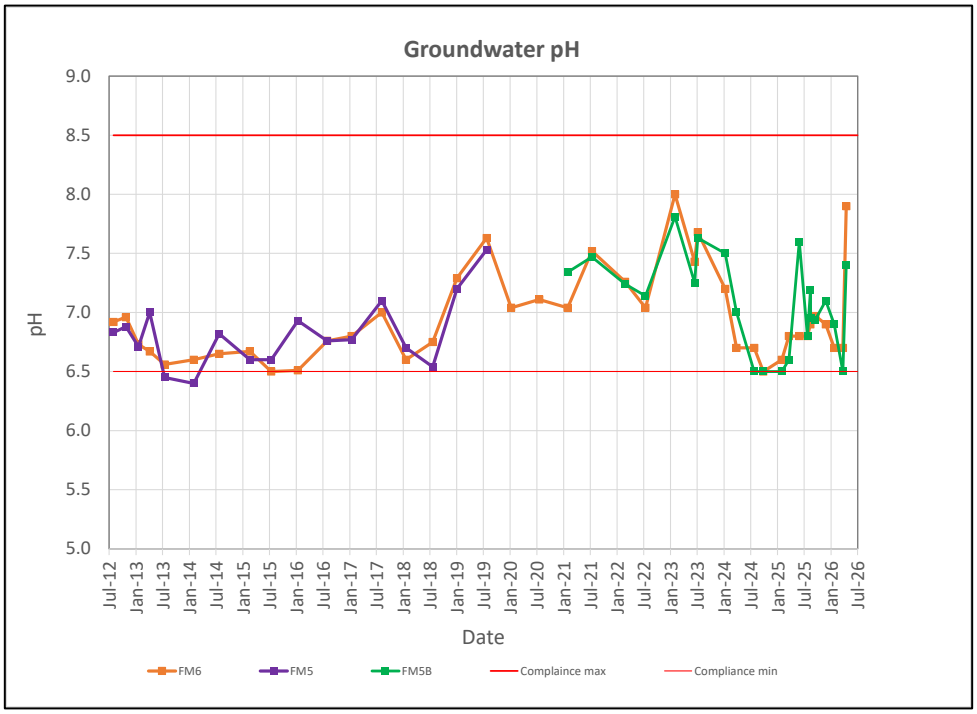


Figure 60 FM5, FM5B and FM6 pH

Data Analysis and Interpretation

Groundwater pH typically fluctuates between 6.5-8.0 in accordance with carbonate equilibrium and at groundwater pH <8 there is negligible CO_3 in water samples and carbon is present as HCO_3. If groundwater pH>8, such as in very dry conditions, then CO_3 might be detected in groundwater samples and $CaCO_3$ precipitation might occur following Ca saturation which would lead to a decrease of HCO_3 in groundwater.

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Nitrate

Nitrates are naturally occurring in surface water and groundwater from nitrogen transforming processes.

Metals

Metals in groundwater are analysed six monthly and a table of results for Bores FM5, FM5B and FM6 are presented in Table 34.

Date	Bore	Arsenic mg/L		Cadmium mg/L		Chromium mg/L		Copper mg/L		Nickel mg/L		Lead mg/L		Zinc mg/L	
		Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
20/07/18	**FM5**	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.005
	FM6	0.008	0.010	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.067	0.014
17/07/20	**FM6**	<0.001		<0.0001		<0.001		<0.001		0.008		<0.001		0.128	
12/07/21	**FM5**	<0.001		<0.0001		<0.001		0.002		0.002		<0.001		0.006	
	FM6	0.006		<0.0001		<0.001		<0.001		<0.001		<0.001		0.092	
24/02/2022	**FM5**	0.001		<0.0001		<0.0001		0.047		0.003		0.003		0.064	
	FM6	0.002		<0.0001		<0.0001		0.052		0.004		<0.001		0.035	
13/07/2022	**FM5**	0.001		<0.0001		0.003		0.108		0.005		0.038		0.155	
	FM6	0.003		<0.0001		0.003		0.032		0.006		0.011		0.083	
5/07/2023	**FM5B**		0.004		<0.0001		0.004		0.081		0.004		0.019		0.094
	FM6		0.001		<0.0001		<0.001		<0.001		0.002		0.009		0.007
9/01/2024	**FM5B**		0.004		<0.0001		0.004		0.081		0.004		0.019		0.094
	FM6		0.001		<0.0001	0.001	0.001		<0.001		0.002		0.009		0.007
1/03/2024	**FM5**	<0.001	<0.001	<0.0001	<0.0001	0.001	0.001	0.002	0.002	<0.001	<0.001	<0.001	<0.001	<0.005	<0.005
	FM5B	<0.001	<0.001	<0.0001	<0.0001	0.001	0.001	0.006	0.006	<0.001	<0.001	<0.001	<0.001	<0.005	0.007
25/07/24	**FM5**	<0.001	<0.001	<0.0001	<0.0001	<0.001	0.001	0.002	0.005	0.001	0.001	0.003	0.013	0.023	0.011
	FM5B	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.001	0.006	0.006	0.001	<0.001	<0.001	<0.001	0.054	0.010
	FM6	0.002	0..003	<0.0001	<0.0001	<0.001	0.002	0.002	0.006	0.002	0.004	0.002	0.010	0.019	0.028
29/01/2025	**FM5**	<0.001	0.003	<0.0001	<0.0001	<0.001	0.008	0.12	0.049	0.002	0.009	0.007	0.049	0.268	0.064
	FM5B	<0.001	0.001	<0.0001	<0.0001	0.004	0.002	0.028	0.045	0.008	0.003	0.002	0.003	0.232	0.056
	FM6	0.001	0.001	<0.0001	<0.0001	<0.001	<0.001	0.005	0.004	0.003	0.002	0.002	0.001	0.035	0.013
24/07/2025	**FM5B**	<0.001	0.002	<0.0001	<0.0001	<0.001	0.003	0.008	0.081	0.001	0.004	<0.001	0.004	0.029	0.091
	FM6	<0.001	0.001	<0.0001	<0.0001	<0.001	0.001	0.003	0.012	0.002	0.003	<0.001	0.001	0.053	0.065
16/09/2025	**FM5B**	<0.001	<0.001	<0.0001	<0.0001	<0.001	0.002	0.004	0.011	0.012	0.14	<0.001	<0.001	0.022	0.015
	FM6	<0.001	<0.001	<0.0001	<0.0001	<0.001	0.002	<0.001	0.002	0.028	0.032	<0.001	<0.001	0.011	0.91
	FM7	0.004	0.017	<0.0001	0.0011	0.002	0.026	0.014	0.447	0.025	0.68	0.005	0.015	0.046	0.359
	FM8	<0.001	0.012	<0.0001	0.0001	<0.001	0.017	0.008	0.035	0.019	0.5	<0.001	0.13	0.018	0.108
	FM9	<0.001	0.002	<0.0001	<0.0001	<0.001	0.004	0.002	0.002	0.007	0.029	<0.001	0.001	0.011	0.063
23/03/2026	**FM5B**	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.001	0.011	0.063	<0.001	0.002	0.002	0.003	0.027	0.013
	FM6	<0.001	<0.001	<0.0001	<0.0001	<0.001	0.006	0.002	0.022	<0.001	<0.001	0.051	0.056	0.024	0.025
	FM7	<0.001	0.001	<0.0001	<0.0001	<0.001	<0.001	0.004	0.01	<0.001	<0.001	0.002	<0.001	0.03	0.006
	FM8	0.002	0.004	<0.0001	<0.0001	<0.001	0.003	0.011	0.016	<0.001	0.002	0.003	0.004	0.018	0.014
	FM9	<0.001	<0.001	<0.0001	<0.0001	0.003	0.003	0.01	0.017	<0.001	<0.001	0.006	0.007	0.022	0.026
	FM10	<0.001	<0.001	<0.0001	<0.0001	0.001	0.003	0.005	0.005	<0.001	<0.001	0.017	0.02	0.024	0.022
	FM11	<0.001	<0.001	<0.0001	<0.0001	<0.001	0.001	0.006	0.001	<0.001	<0.001	0.019	0.02	0.014	0.008
	FM12	<0.001	<0.001	<0.0001	<0.0001	0.002	0.002	0.044	0.043	<0.001	<0.001	0.013	0.011	0.031	0.017
	FM13	0.001	0.001	<0.0001	<0.0001	0.001	0.004	0.014	0.029	<0.001	<0.001	0.013	0.013	0.013	0.01
15/04/2026	**FM5B**	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.001	0.015	0.018	<0.001	<0.001	0.002	0.001	0.021	0.01
	FM6	<0.001	<0.001	<0.0001	<0.0001	0.002	0.003	0.009	0.01	0.001	0.001	0.045	0.048	0.025	0.029
	FM7	0.002	0.008	<0.0001	<0.0001	0.002	0.009	0.028	0.079	0.002	0.006	0.005	0.007	0.046	0.06
	FM8	0.003	0.003	<0.0001	<0.0001	<0.001	<0.001	0.02	0.021	<0.001	<0.001	0.002	0.002	<0.005	0.006
	FM9	<0.001	0.001	<0.0001	<0.0001	0.001	0.003	0.012	0.017	<0.001	<0.001	0.005	0.006	0.016	0.021
	FM10	<0.001	<0.001	<0.0001	<0.0001	<0.001	0.001	0.002	0.002	<0.001	<0.001	0.123	0.137	0.007	0.011
	FM11	<0.001	<0.001	<0.0001	<0.0001	0.001	0.002	0.002	0.002	<0.001	<0.001	0.09	0.086	0.008	0.01
	FM12	<0.001	<0.001	<0.0001	<0.0001	<0.001	0.003	0.019	0.021	<0.001	<0.001	0.013	0.013	0.012	0.015
	FM13	0.001	0.001	<0.0001	<0.0001	<0.001	<0.001	0.01	0.016	<0.001	<0.001	0.008	0.009	<0.005	0.006

Table 31 FM5, FM5B and FM6 metals

All metal values are at low concentrations and there are no trigger values for metal suite.

Petroleum Hydrocarbons

Total Petroleum Hydrocarbon (TPH) are low and are usually below detection limits. There has been one exceedance of the 1mg/L trigger level which was investigated and determined to be a false positive.

9.3 Major Ion Chemistry

Major ion chemistry has assisted with understanding geochemical processes of water bodies, particularly rainfall (dilution) and evaporation, and to classify the water bodies by Piper diagrams.

9.3.1 Pit 3 investigative drilling in 2018-19

Sampling of the drillholes and surface water bodies was undertaken to characterise groundwater and its relationship with surface water. Groundwater and surface water major ion chemistry from the 2018-19 water investigation is shown in Table 32.

Site	Type	Date	Ca	Mg	Na	K	HCO3	CO3	Cl	SO4
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
C01	Groundwater	3/10/2018	106	8	88	0.5	334	0.5	100	24
C02	Groundwater	3/10/2018	94	9	88	0.5	343	0.5	68	16
C04	Groundwater	3/10/2018	71	8	63	0.5	295	0.5	40	10
C05	Groundwater	3/10/2018	70	3	37	0.5	230	0.5	35	5
C06	Groundwater	3/10/2018	68	3	39	0.5	192	0.5	52	6
C07	Groundwater	3/10/2018	70	3	32	0.5	208	0.5	35	4
C08	Groundwater	3/10/2018	69	3	28	0.5	201	0.5	35	6
C10	Groundwater	3/10/2018	74	3	28	0.5	220	0.5	36	4
C11	Groundwater	3/10/2018	95	4	36	0.5	256	0.5	41	32
C12	Groundwater	3/10/2018	102	6	41	0.5	270	0.5	57	27
C13	Groundwater	3/10/2018	105	6	48	0.5	262	0.5	62	40
C14	Groundwater	3/10/2018	150	14	70	0.5	300	0.5	167	32
Awoonga Dam	Surface water	3/10/2018	21	6	22	2	87	0.5	31	6
Awoonga Dam	Surface water	3/10/2018	19	7	22	2	79	9	30	5
Pit 3	Surface water	3/10/2018	67	7	56	0.5	135	0.5	106	33
Pit 3	Surface water	3/10/2018	69	7	56	0.5	140	0.5	104	33
Seep	Surface water	3/10/2018	65	4	56	0.5	233	0.5	42	10
Seep2	Surface water	3/10/2018	80	3	36	0.5	205	0.5	48	19
Awoonga Dam	Surface water	15/01/2019	12	8	24	2	83	0.5	24	5
Awoonga Dam	Surface water	15/01/2019	17	7	21	2	77	0.5	26	5
Awoonga Dam	Surface water	15/01/2019	16	7	21	2	81	0.5	24	4
Awoonga Dam	Surface water	15/01/2019	17	8	21	2	81	0.5	25	4
Awoonga Dam	Surface water	15/01/2019	16	7	21	2	81	0.5	25	4
Awoonga Dam	Surface water	15/01/2019	16	7	21	2	80	0.5	27	4
Awoonga Dam	Surface water	15/01/2019	16	7	21	2	84	0.5	26	4
Catchment Dam1	Surface water	15/01/2019	39	29	119	3	117	0.5	124	141
Pit 3	Surface water	15/01/2019	62	7	61	0.5	120	0.5	121	31
Pit 3	Surface water	15/01/2019	62	7	61	0.5	121	0.5	119	31
Pit 3	Surface water	15/01/2019	62	7	60	0.5	123	0.5	116	30
Pit 3	Surface water	15/01/2019	61	7	60	0.5	121	0.5	116	30

Table 32 Groundwater and surface water major ion chemistry from 2018-19 investigation

Groundwater chemistry is variable with concentration of the anions HCO_3, Cl and SO_4 being higher in drillholes north of the Seep (surface water inflow) such as C14 and C01 which were the northern most drilled holes (Figure 32) and the lowest concentrations were C05-C10 which are located at the surface water inflow location. The lower concentrations in the surface water inflow location indicate leaching into groundwater from the surface water inflow. Groundwater has a sulphate concentration of 4-6mg/L which is the same as Awoonga Dam water which indicates that there is minor groundwater seepage beneath the Western Bund wall through bedrock fractures at approximately 32mAHD. Groundwater has a bicarbonate concentration over double Awoonga Dam which indicates a residence and geochemical processes that are different from

Awoonga Dam. Groundwater cannot leak or flow rapidly, in seconds, from Awoonga Dam through the Western Bund wall and over double the concentration of HCO_3.

A Piper plot of groundwater chemistry west of Pit 3 and surface water shows that they are chemically different with groundwater being Ca-MG-HCO3 type and the Pit 3 surface water inflow mixed type (Figure 61).

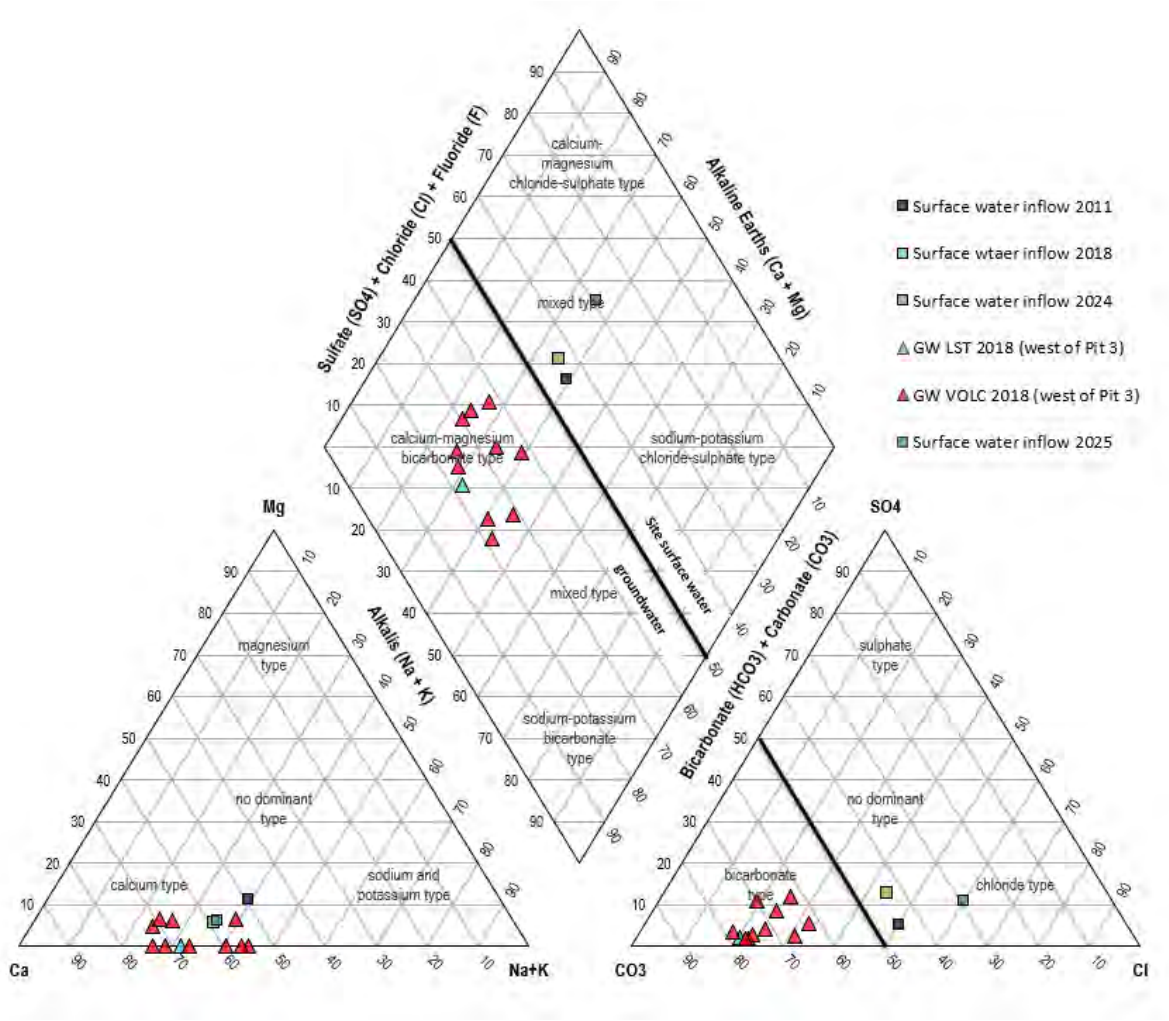


Figure 61 Piper Plot of groundwater chemistry and surface water inflow into Pit 3

The water chemistry of groundwater is distinct from the chemistry of the surface water inflow.

The Pit 3 surface water inflow is not groundwater and there is insufficient groundwater on the bench to be sampled and it is concluded that there may be a groundwater contribution to Pit 3 form seepage below the Western Bund wall, but this is <1 l/s and cannot be sampled where observed on the bench surface. The surface water flowing from the Farm Dam is the major source and influence on the water quality of Pit 3.

9.3.2 Site-wide investigative drilling in 2025

Sampling of the 2025 Investigative drillholes and surface water bodies was undertaken to characterise groundwater and its relationship with surface water. Groundwater and surface water major ion chemistry from the 2025 water investigation is shown below with May 2025 monitoring bore results (Table 33).

Site	Aquifer	Date	Ca	Mg	Na	K	HCO3	CO3	Cl	SO4
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
D01	Volc	10/03/2025	47	5	5	0.5	125	0.5	9	18
D02	Volc	10/03/2025	39	10	17	0.5	123	0.5	23	12
D04	LST	10/03/2025	376	10	464	0.5	323	0.5	1180	27
D05	LST	10/03/2025	156	18	23	2	23300	0.5	28	31
D07	Volc	10/03/2025	21	8	9	1	101	0.5	4	3
D08	Volc	10/03/2025	66	62	130	2	712	0.5	65	13
D09	Volc	10/03/2025	120	28	14	3	408	0.5	29	138
D10	Volc	10/03/2025	32	9	23	1	156	0.5	2	3
D11	Volc	10/03/2025	59	105	291	4	886	0.5	221	20
D12	Volc	10/03/2025	27	11	31	0.5	154	0.5	4	4
D13	Volc	10/03/2025	15	3	9	1	98	0.5	5	4
D14	Volc	10/03/2025	95	19	17	0.5	237	0.5	8	95
D16	LST	10/03/2025	122	12	66	2	383	0.5	40	48
D17	LST	10/03/2025	114	19	57	0.5	278	0.5	31	122
D18	LST	10/03/2025	104	4	18	0.5	1970	0.5	20	38
D19	LST	10/03/2025	70	2	9	0.5	157	0.5	16	13
D23	Volc	29/05/2025	78	182	522	3	788	0.5	910	47
D28	Volc	29/05/2025	369	206	468	4	703	0.5	1510	52
FM5	LST	29/05/2025	185	14	63	0.5	370	0.5	59	151
FM5B	Volc	29/05/2025	198	15	67	0.5	374	0.5	61	148
FM6	Volc	29/05/2025	144	9	34	1	409	0.5	18	10
Pit 3	n/a	19/03/2025	60	7	59	0.5	89	0.5	142	37
Pit 4	n/a	19/03/2025	50	7	24	0.5	116	0.5	18	47
Seep	n/a	19/03/2025	126	7	87	0.5	242	0.5	143	55
Awoonga Dam	n/a	29/05/2025	18	12	33	3	95	0.5	44	5
Catchment Dam1	n/a	29/05/2025	9	4	11	9	52	0.5	16	0.5
Catchment Dam2	n/a	29/05/2025	15	5	18	5	67	0.5	22	0.5
Farm Dam	n/a	29/05/2025	96	14	14	6	86	0.5	14	124
Pit 2	n/a	29/05/2025	42	12	53	0.5	137	0.5	43	50
Pit 3	n/a	29/05/2025	71	8	63	0.5	117	0.5	147	41
Pit 4	n/a	29/05/2025	58	11	18	0.5	90	0.5	17	89
Pit 4	n/a	29/05/2025	57	12	47	0.5	128	0.5	37	88
Seep	n/a	29/05/2025	130	8	93	0.5	242	0.5	178	57

Table 33 Groundwater and surface water major ion from 2025 investigation

A Piper plot of 2025 drillhole is presented with 2018 drillhole data as Figure 62.

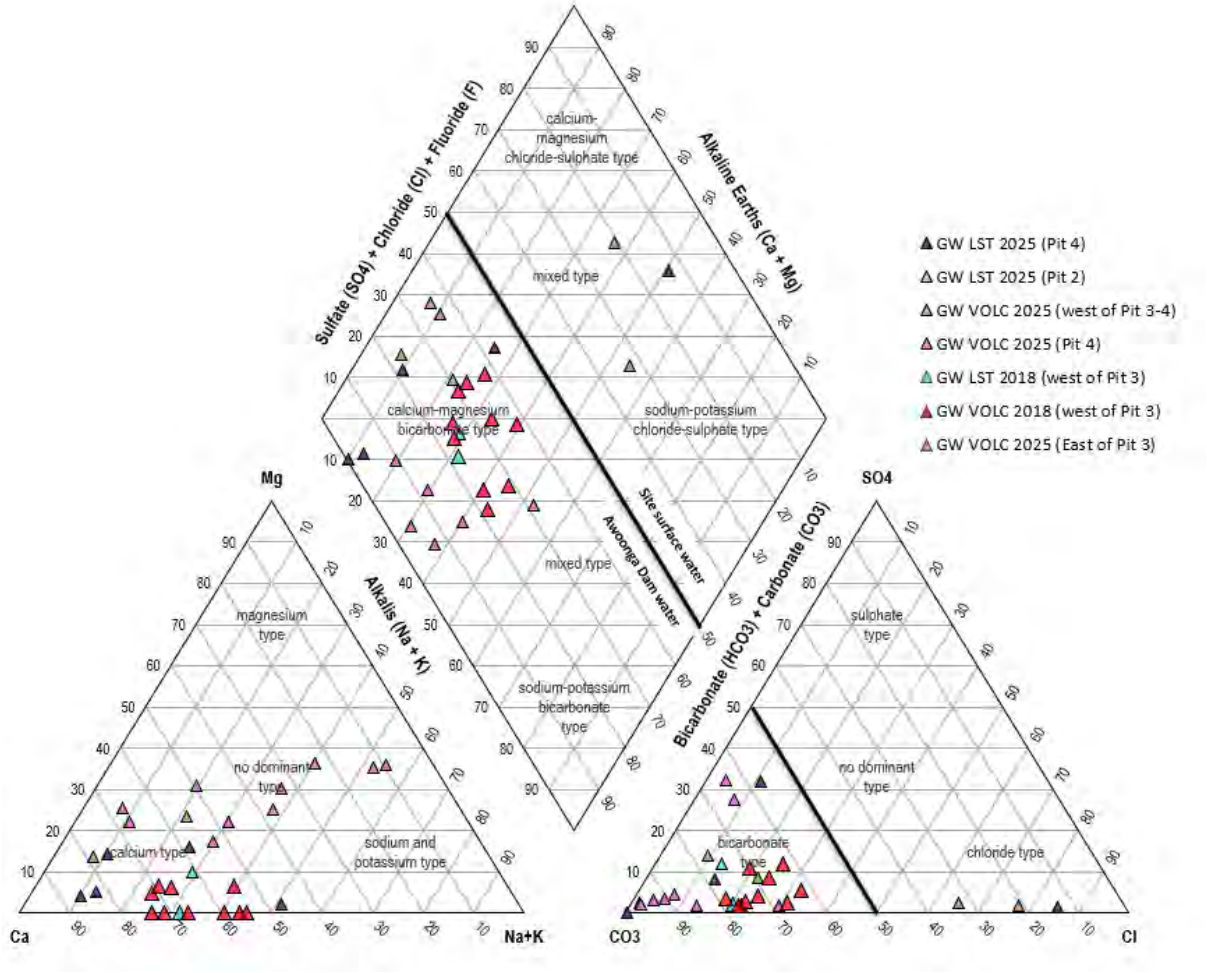


Figure 62 Piper Plot of Investigative drilling 2025 with 2018 drillhole data

Groundwater is Ca-Mg-HCO3 with the exception of a limestone drillhole (D04) which is south of Pit 4 and has elevated NaCl and the two volcanic drillholes east of Pit which have elevated NaCl. Elevated NaCl in groundwater south and east of the pit voids is attributed to halite stored in the regolith.

Investigative drilling has confirmed that groundwater chemistry for limestone and volcanic are similarly variable and there is no clear distinction between groundwater chemistry in limestone and volcanic. A lithostratigraphic boundary can be defined but it is not a groundwater boundary condition. Hydrostratigraphic boundaries are defined in Section 10.4 based on hydraulic conductivity differences.

The geology at Calliope is simple with sub-vertical lithological contacts. There is sufficient groundwater data to demonstrate that there is little groundwater and that the Water Balance analytical modelling approach outlined in Section 12 is appropriate.

Groundwater level maps with bicarbonate, chloride and sulphate from Table 19 are provided in Figures 63-65 respectively.

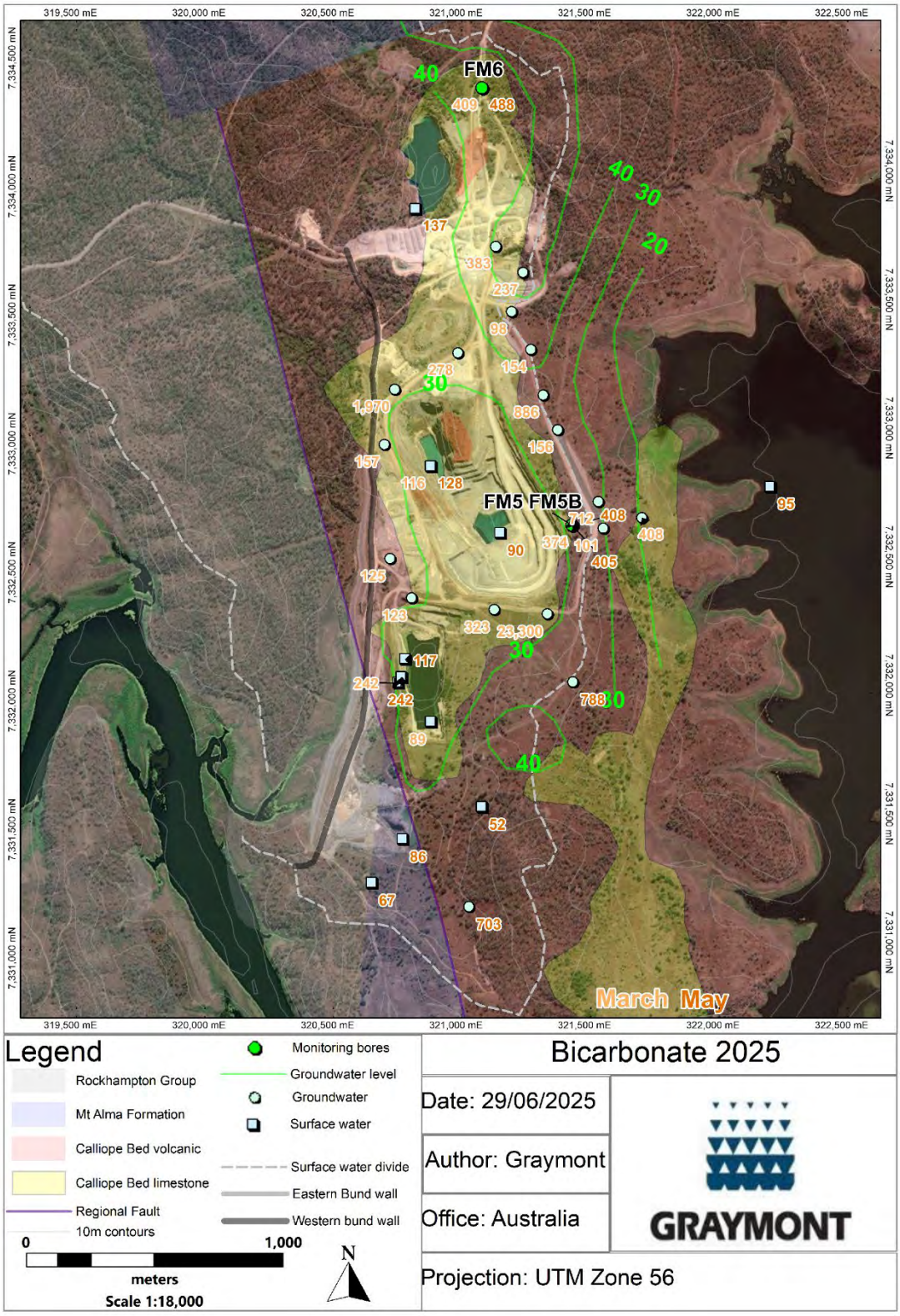


Figure 63 Water sampling results for bicarbonate 2025

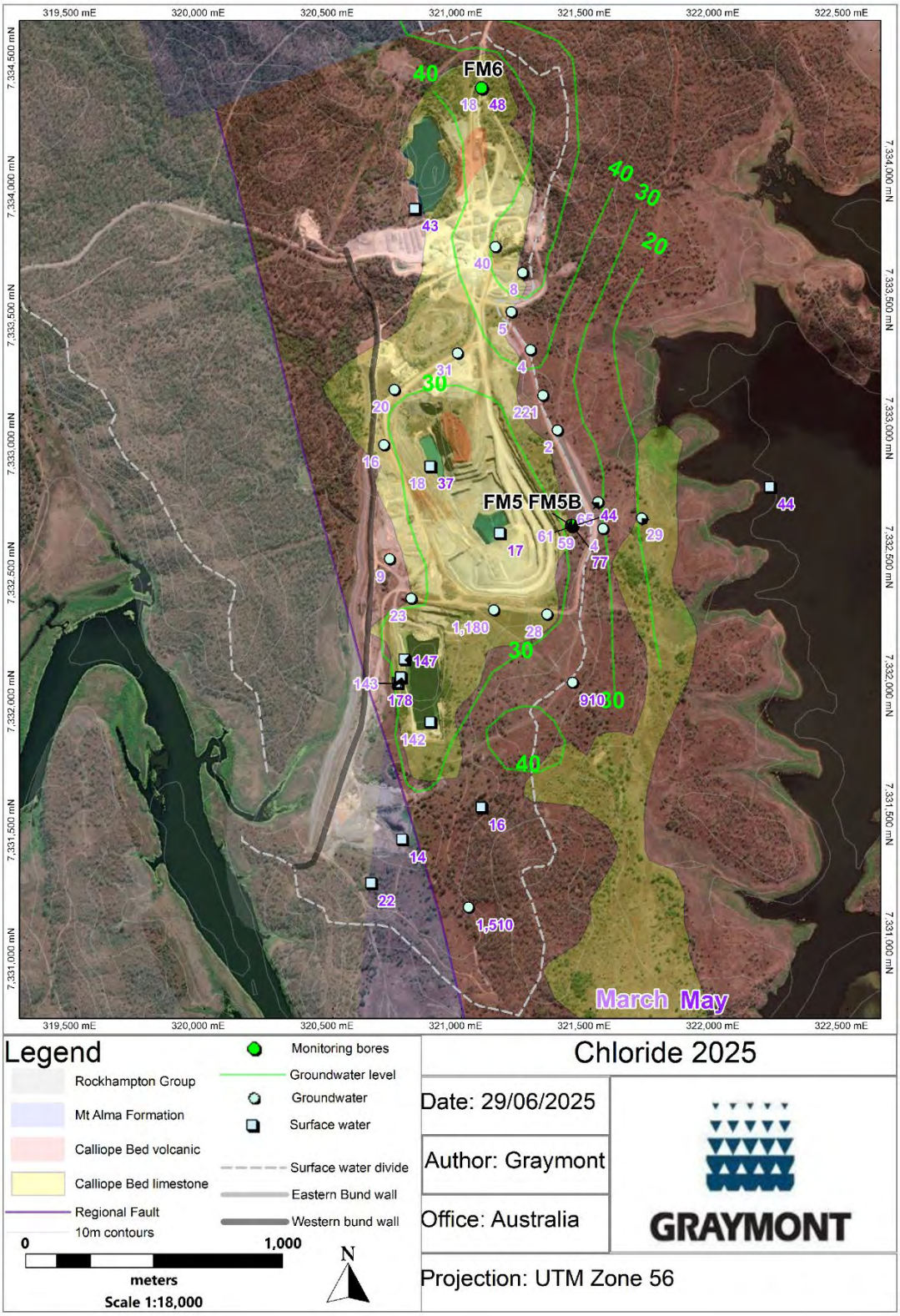


Figure 64 Water sampling results for chloride 2025

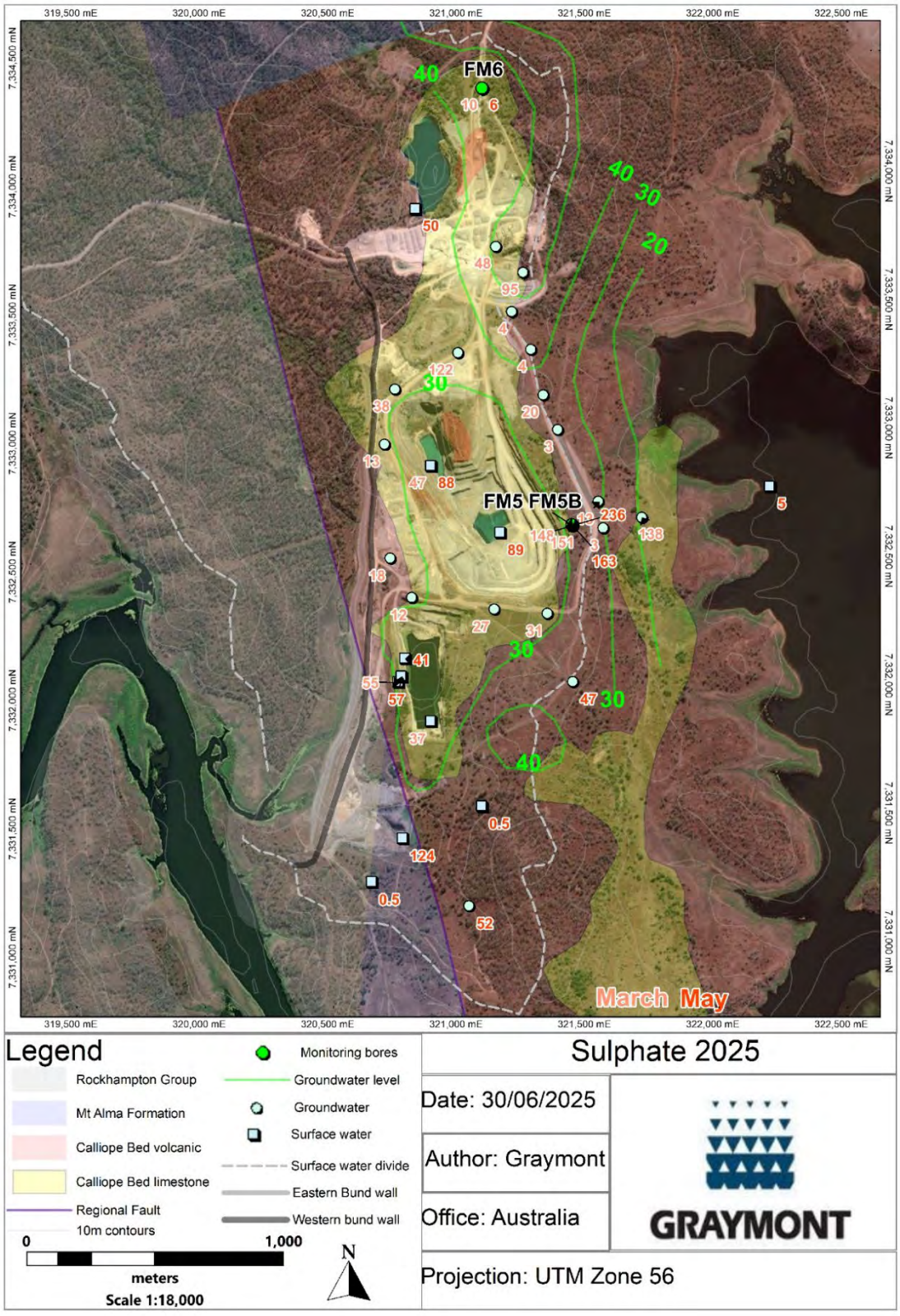


Figure 65 Water sampling results for sulphate 2025

Chloride and Sulphate are both low in groundwater at the ground divide east of Pit 4 which is a recharge zone. Sulphate increases with flow both westerly and easterly from the groundwater divide.

9.3.3 Bore Monitoring Network

Major ion chemistry from groundwater sampling of piezometers in March 2026 and the older piezometers FM1 and FM4 is presented below in Table 34 with hydraulic conductivity.

Site	Aquifer	Hydraulic Conductivity	Sample Date	Ca	Mg	Na	K	HCO3	CO3	Cl	SO4
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
FM1	LST	0.003	3/01/2003	110	20	55	6	374	0	46	8
FM4	LST	0.002	3/01/2003	86	9	13	5	237	0	21	13
FM5B	Volc		23/03/2026	193	17	73	<1	353	<1	72	179
FM6	Volc	0.036	23/03/2026	145	11	46	<1	386	<1	27	64
FM7	LST		23/03/2026	130	10	69	1	320	<1	38	53
FM8	Volc	0.12	23/03/2026	63	42	127	<1	590	<1	18	13
FM9	Volc	6.48	23/03/2026	103	5	31	<1	218	<1	26	10
FM10	Volc	28.12	23/03/2026	93	15	95	<1	302	<1	57	89
FM11	Volc	1	23/03/2026	148	22	82	1	301	<1	171	58
FM12	Volc	0.31	23/03/2026	353	162	428	6	528	<1	1080	354
FM13	Volc	0.52	23/03/2026	63	54	144	2	491	<1	128	24

Table 34 FM piezometer major ion chemistry and hydraulic conductivity

The recently installed piezometers FM10-12 have elevated sulphate.

Long term monitoring has been undertaken of piezometer FM5/FM5B and FM6. See Figure 66-71.

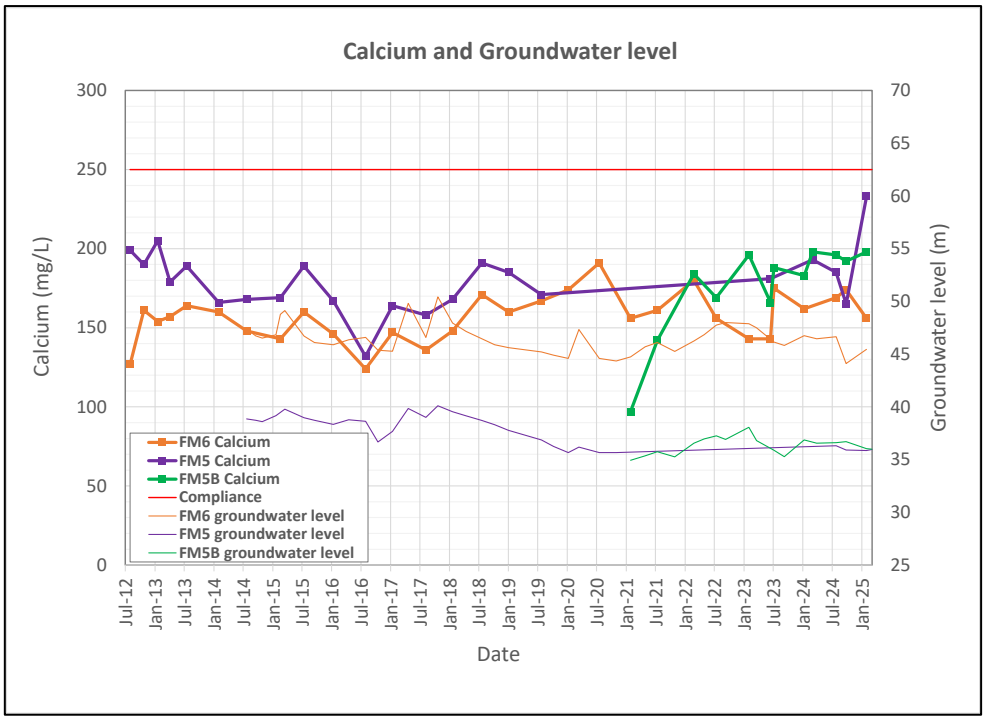


Figure 66 FM5, FM5B and FM6 calcium and groundwater level

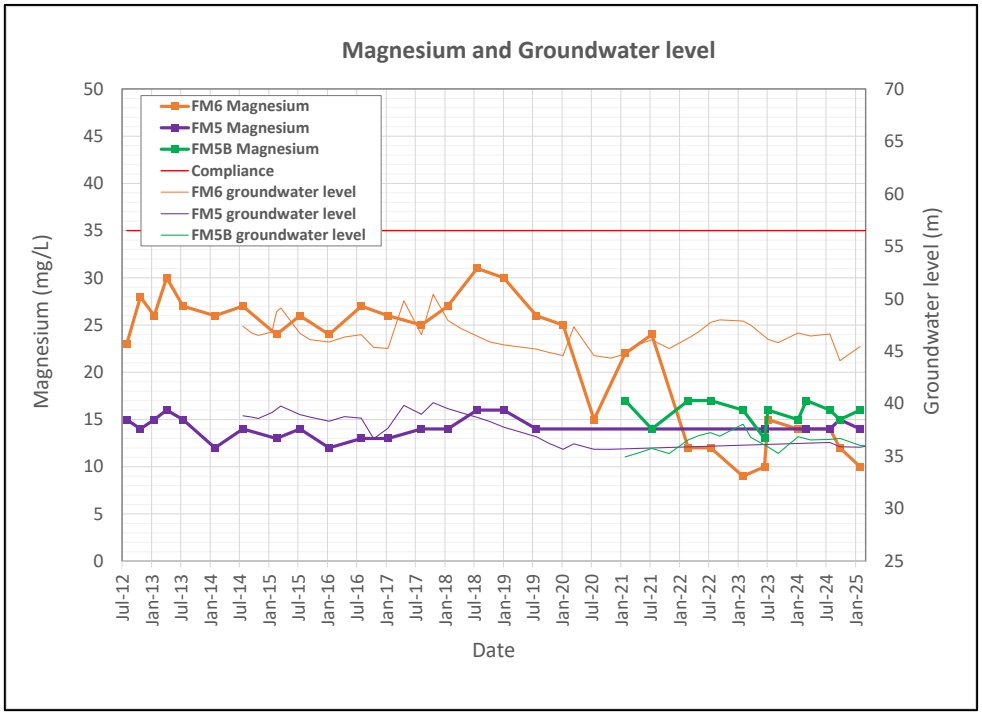


Figure 67 FM5, FM5B and FM6 magnesium and groundwater level

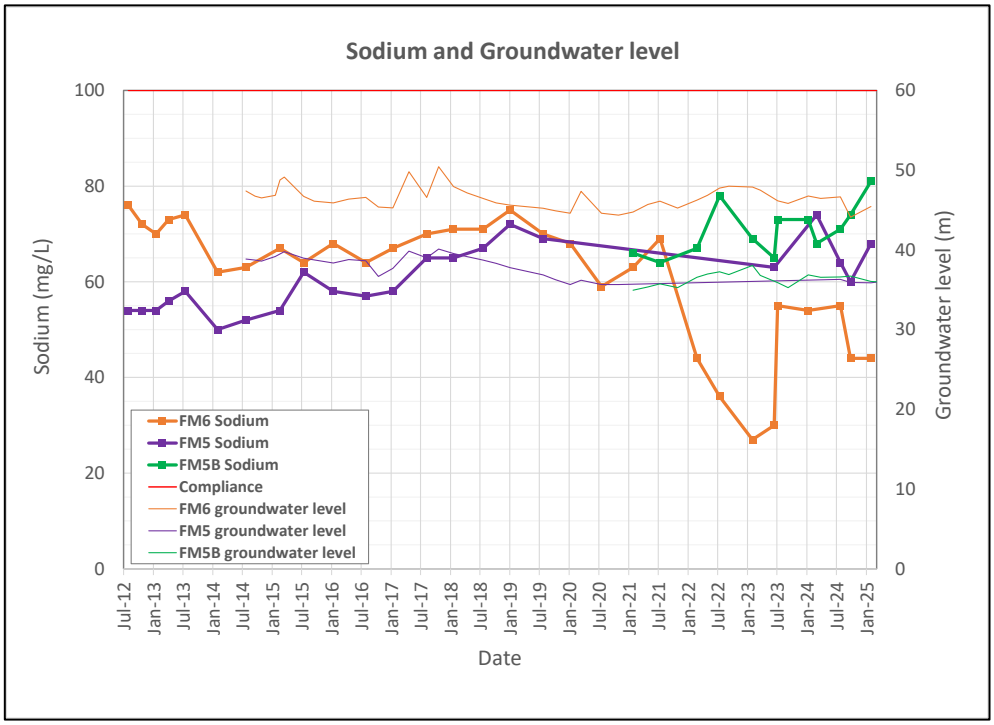


Figure 68 FM5, FM5B and FM6 sodium and groundwater level

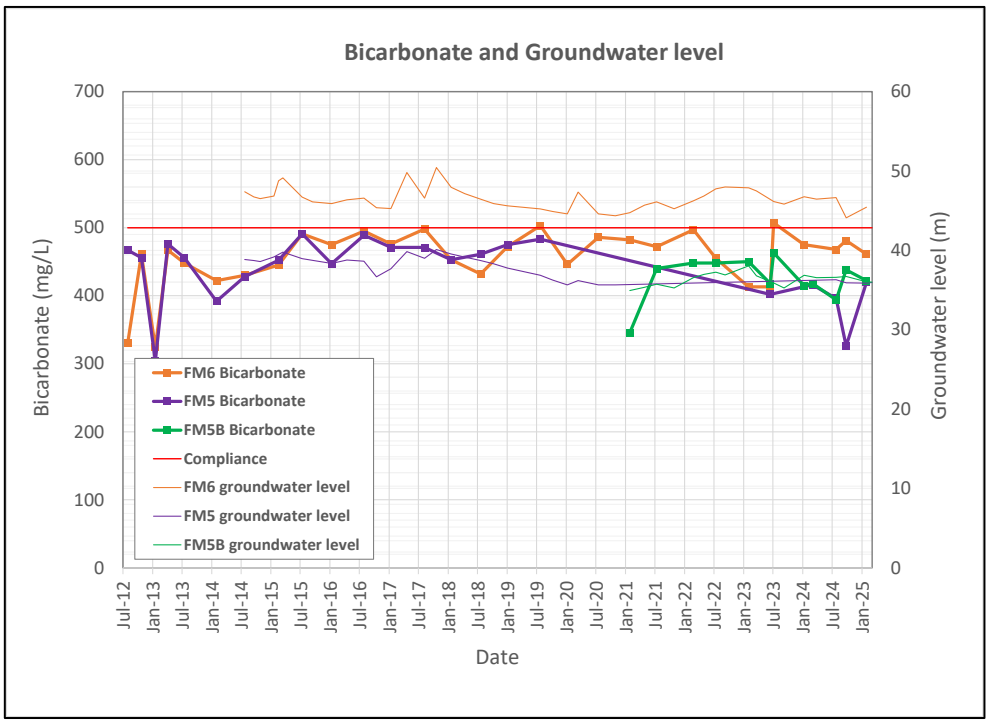


Figure 69 FM5, FM5B and FM6 bicarbonate and groundwater level

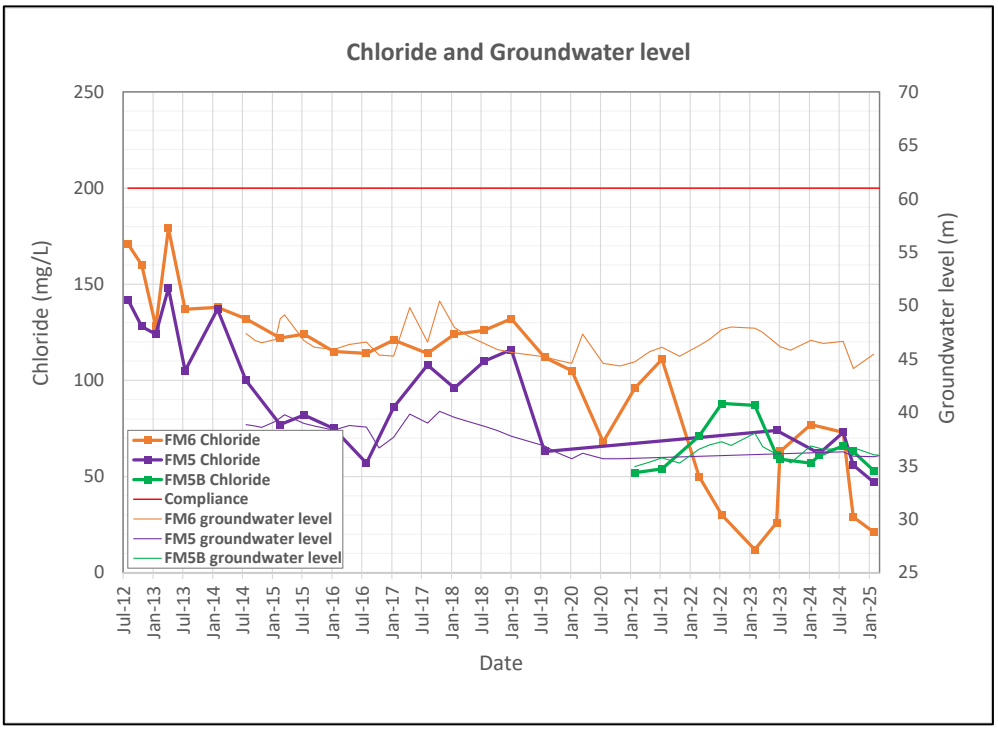


Figure 70 FM5, FM5B and FM6 chloride and groundwater level

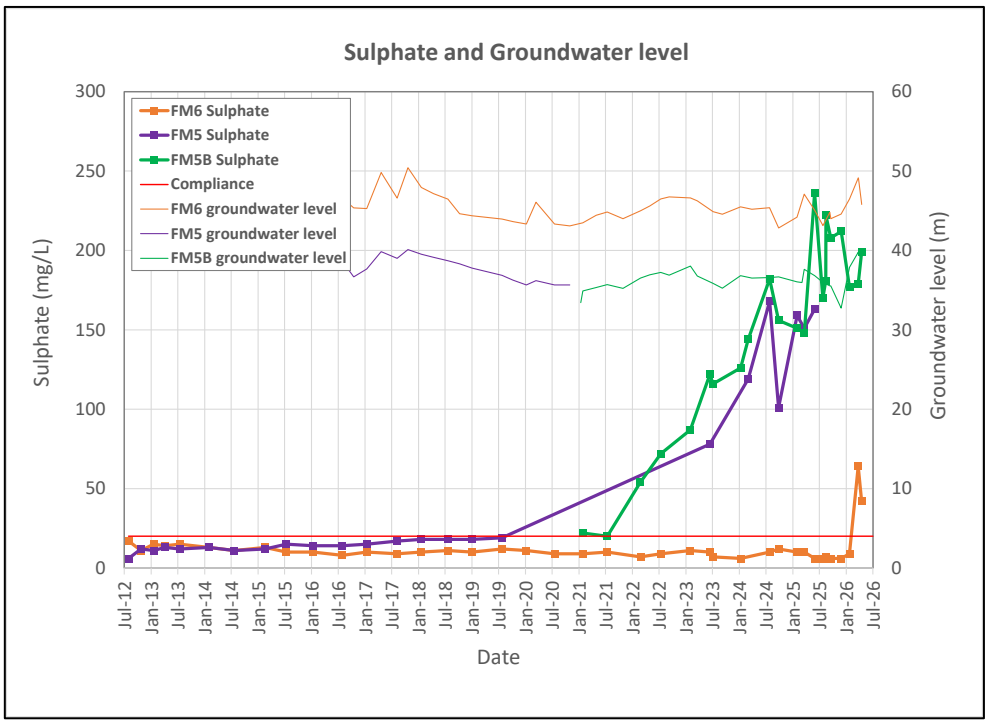


Figure 71 FM5, FM5B and FM6 sulphate and groundwater level

Sulphate

A hydrograph of groundwater level and sulphate with rainfall is presented as Figure 72.

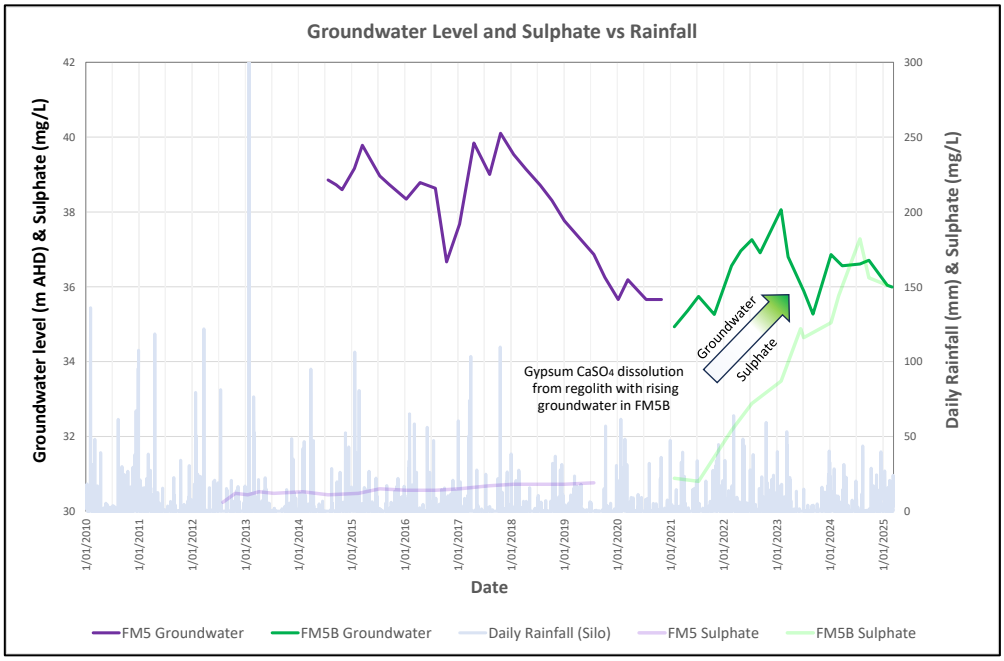


Figure 72 FM5, FM5B and FM6 sulphate and groundwater level

The cause of sulphate increase in FM5B and FM5 is attributed to dissolution of gypsum ($CaSO_4$) and leaching sulphate ions into groundwater. The groundwater chemistry of Groundwater chemistry in Bores FM5 and FM5B appears to be equilibrating following the installation of FM5B.

The primary source of major ions is the deposition of cyclic salts by precipitation and aeolian dust with additional cations added by mineral weathering and CO_3 anion from the dissolution of CO_2 in soil water. Groundwater quality is driven by the nature of rainfall and properties of the unsaturated zone. Rainfall entering the soil zone undergoes significant changes in chemical composition and pH by processes such as root respiration and decomposition of organic matter via chemical reactions such as sorption and redox. The chemical constituency of infiltrating water in turn modifies groundwater chemistry by processes such as leaching, dilution/concentration as well as dissolution/precipitation. Water quality is dependent upon the nature of rainfall (ie. timing, intensity, duration...etc) and salt storage in the regolith, which determines whether infiltration provides a diluting effect and/or a leaching effect on ions and/or metals. (Graymont, 2019)

In near coastal Central Queensland rainfall typically provides a leaching effect with infiltration causing a deterioration of water quality as salts are flushed into groundwater whereas water quality improves in extended dry periods (Graymont, 2021).

A Piper Plot of major ion water chemistry of all groundwater is presented as Figure 73 with samples categorised in respect to hydraulic conductivity and their topographic position in the landscape.

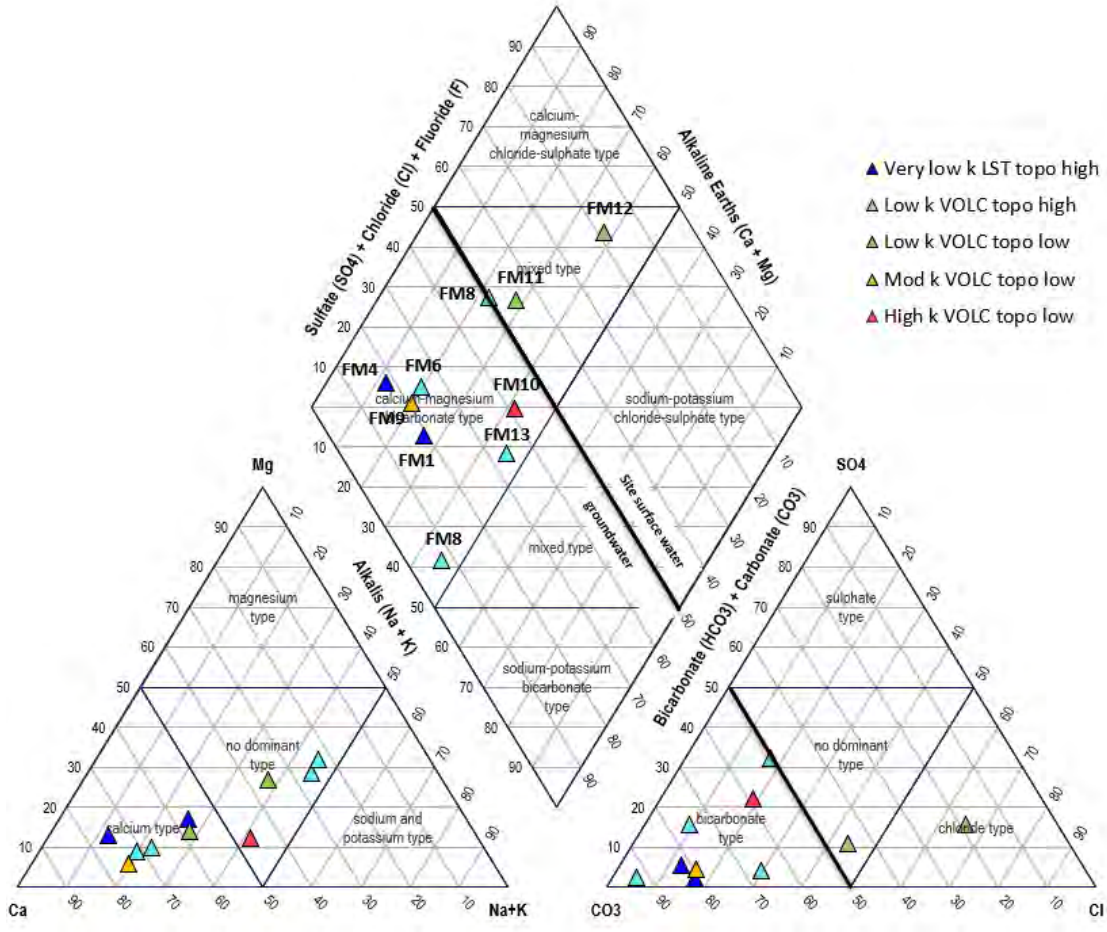


Figure 73 Piper Plot of piezometer groundwater

Data Analysis and Interpretation

The major ion chemistry of groundwater from the different piezometers varies indicates that the piezometers have intersected localised fractures and that there is not a strong hydraulic connection between the piezometers.

Limestone vs Volcanic rock aquifer

The major ion chemistry of low k volcanic rock aquifer (FM11 and FM12) is mixed type as per Pit 3 water (Figure 73). FM11 is located near the surface water inflow point to Pit 3 and FM12 is located near the Farm Dam. Groundwater in the volcanic rock is more variable than in limestone, but both are Ca-Mg-HCO3 type water and although comprising an unconfined aquifer. A Piper plot of long term monitoring of FM5, FM5B and FM6 is shown in figure 74.

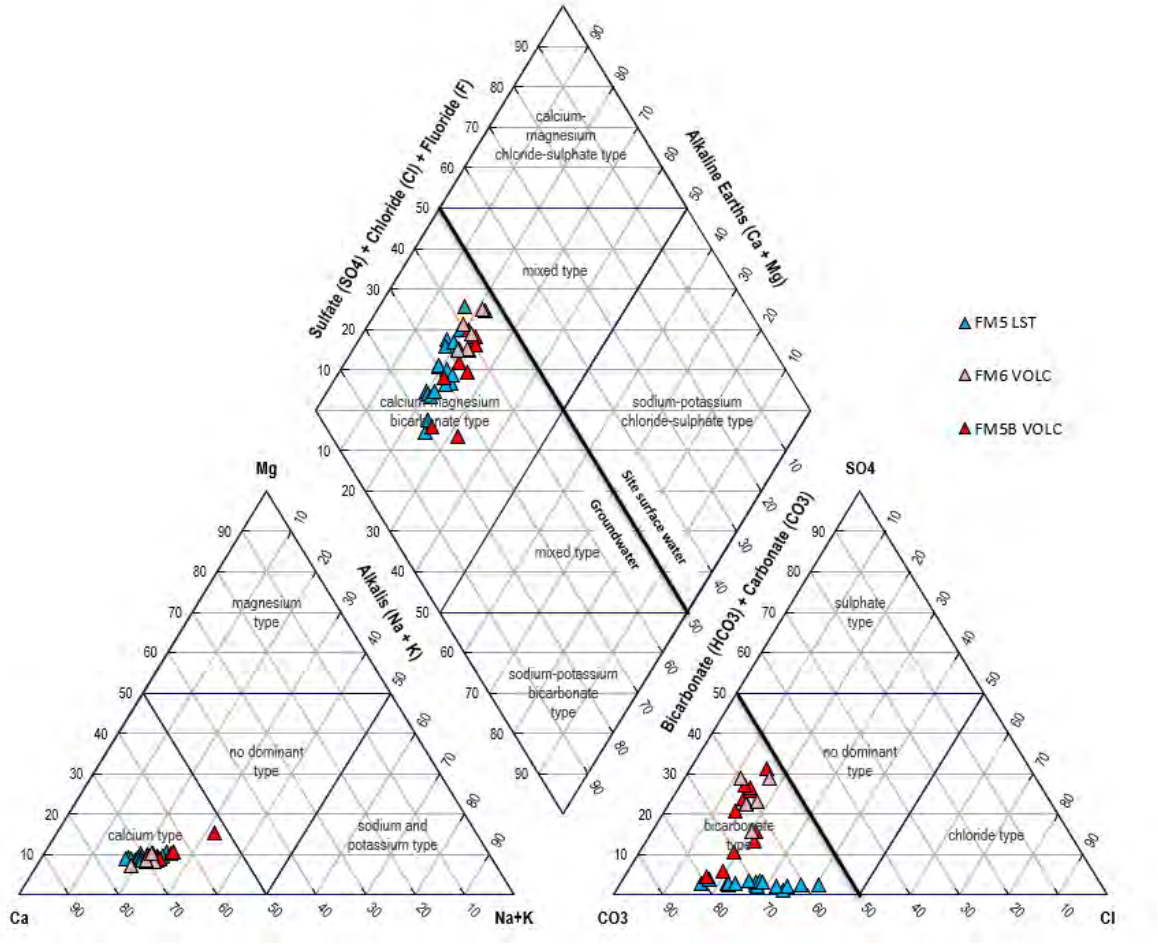


Figure 74 Piper Plot of FM5-6 long term monitoring

Groundwater in limestone is similar to groundwater in volcanics but can be differentiated by Anions as groundwater in limestone varies in CO3:Cl ratio whereas groundwater in volcanic varies with CO3:SO4 ratio.

The major ion chemistry between FM5 and FM6 is generally similar, except for sulphate in FM5B and FM5 since 2024, Sulphate in FM5 and FM6 was similar until the installation of Bore FM5B. Similar groundwater levels and the observation of drawdown in FM5 during sampling of FM5B indicates hydraulic connection between the two wells.

The FM5-6 data set was expanded to include 2018 and 2025 groundwater investigation data and FM1 and FM4 (Figure 75) and then further expanded in Figure 76 to include Pit water.

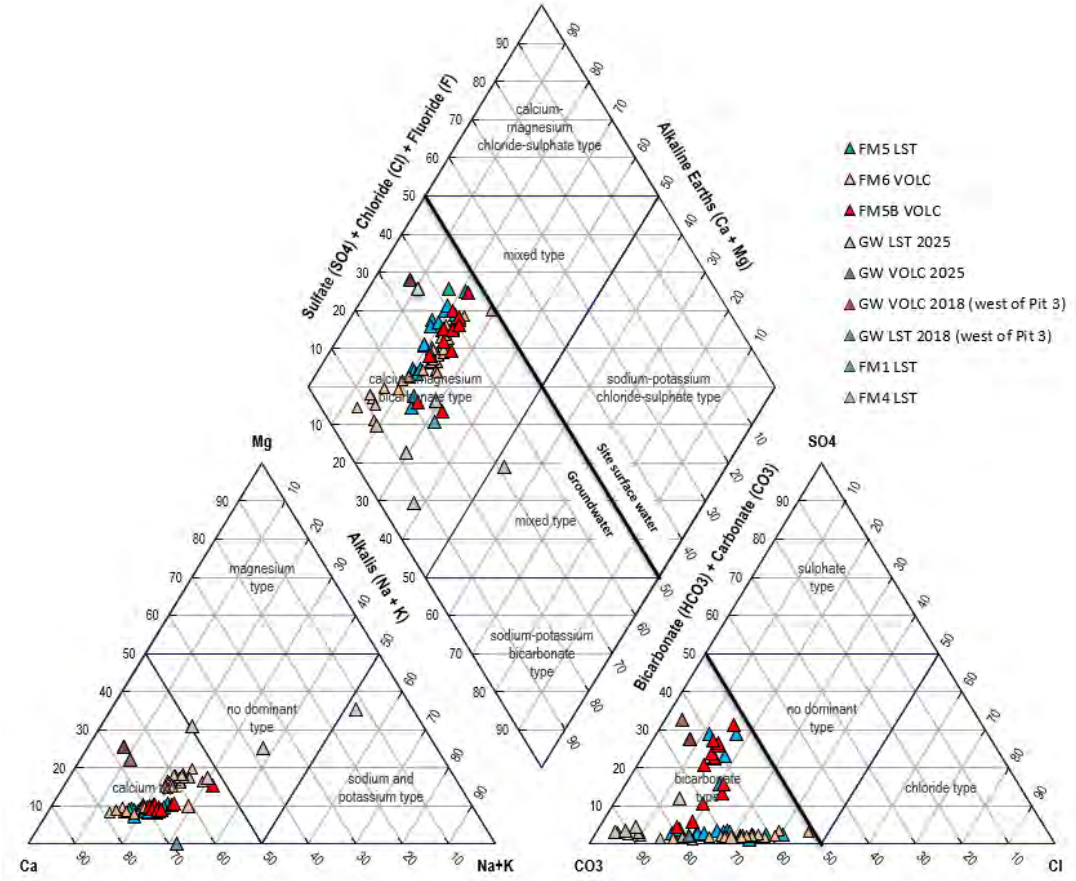


Figure 75 Piper Plot of FM5-6, FM1, FM4 and 2018 drilling

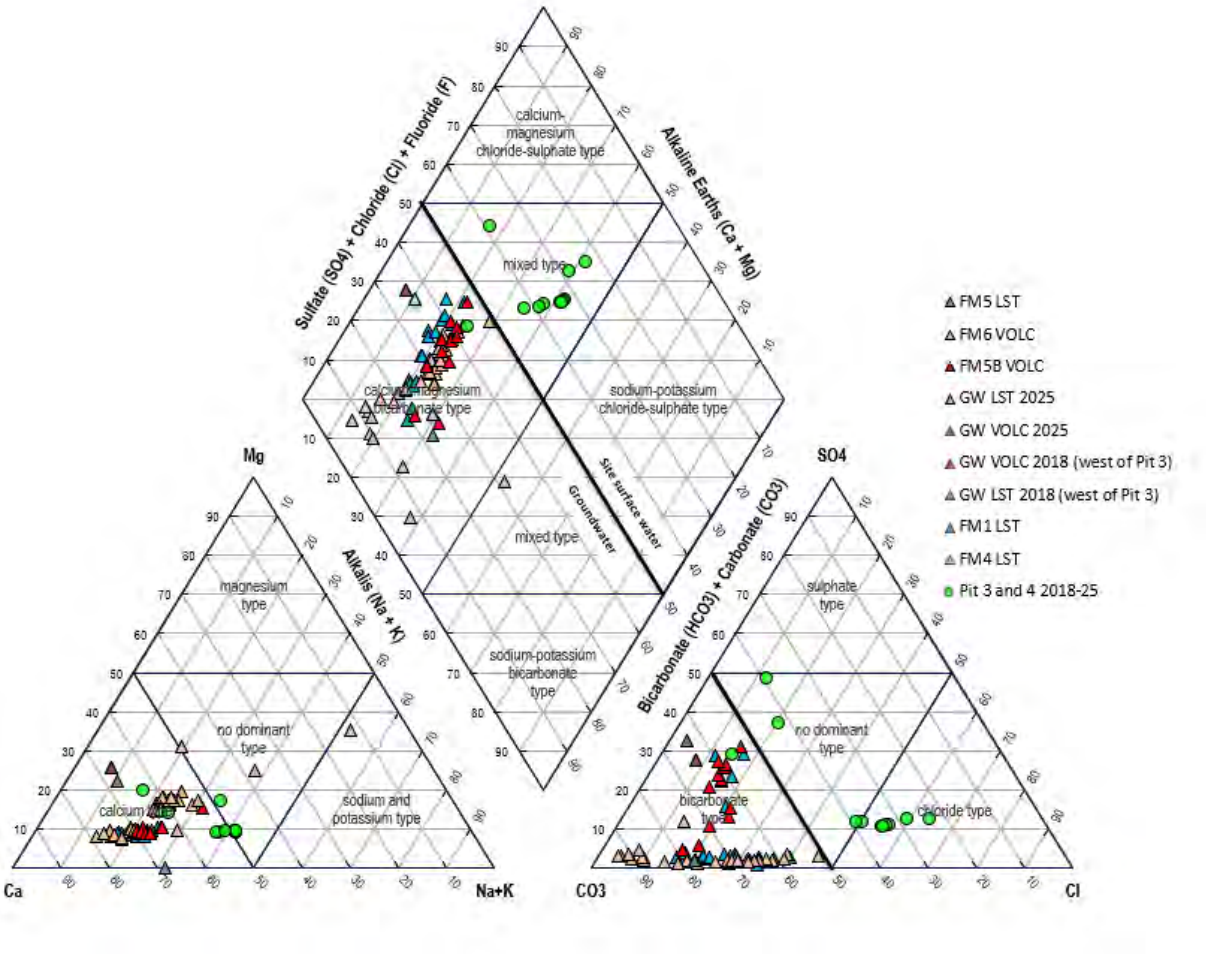


Figure 76 Piper Plot of FM5-6, FM1, FM4, 2018 drilling and pit water

10 AQUIFERS AND AQUITARDS

10.1 Methodology

The nature of the aquifer has been determined by drilling and aquifer hydraulic properties by slug testing of piezometers.

10.2 Aquifer description

An E-W, north viewing, hydrogeological cross-section 7332650N of Pit 4 is shown in Figure 77 and an E-W, north viewing, hydrogeological cross-section 7332175N of Pit 3 is shown in Figure 78.

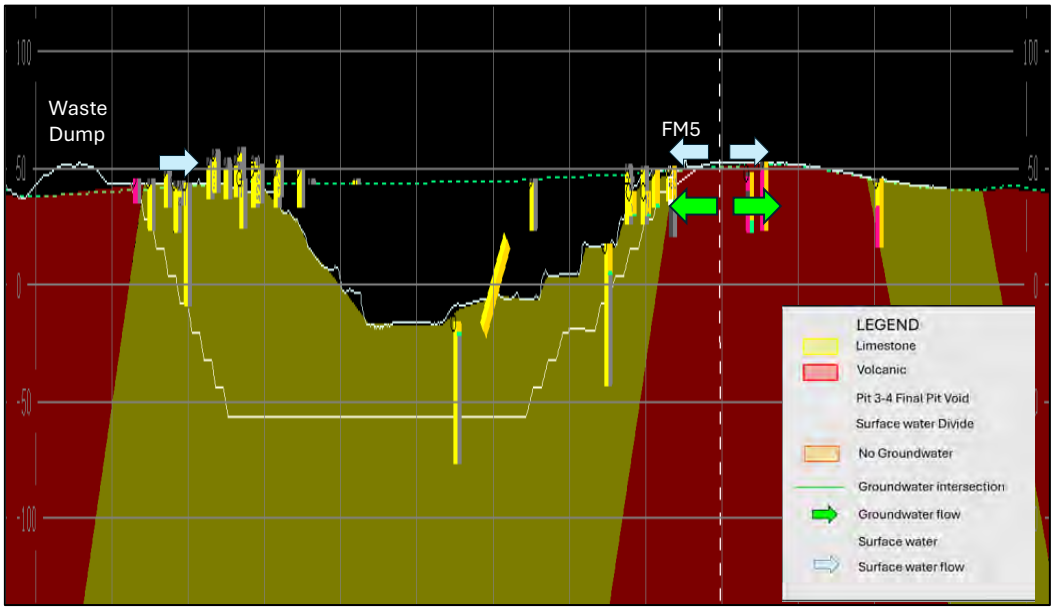


Figure 77 Cross-section 7332650N showing Pit 4 geology and groundwater intersections

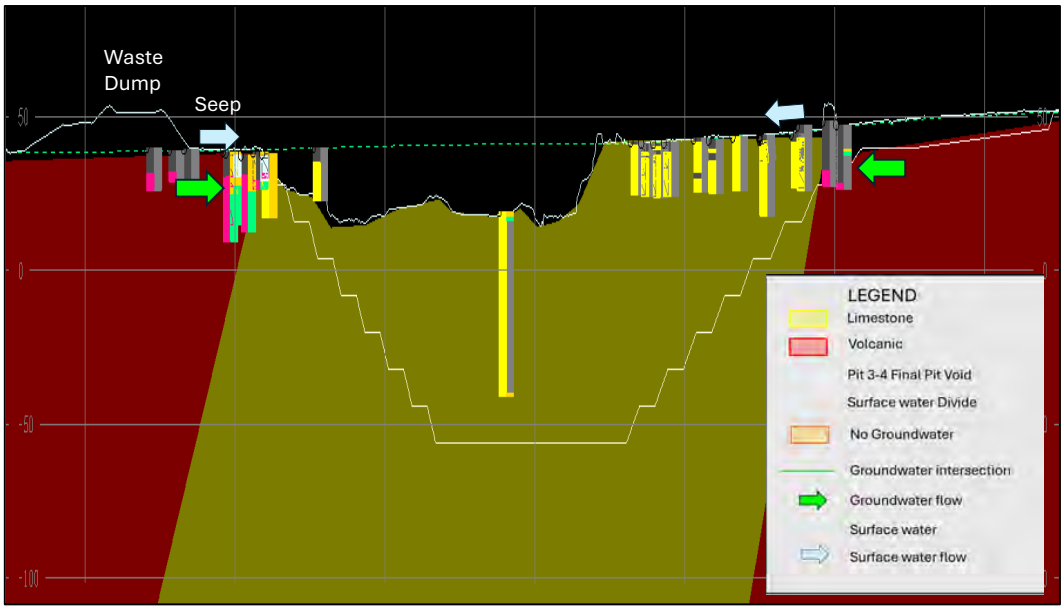


Figure 78 Cross-section 7332175N showing Pit 4 geology and groundwater intersections

Data Analysis and Interpretation

The Calliope beds limestone and volcanics are predominantly an aquitard but with connected fractures can form a low yielding unconfined fractured rock aquifer which are generally unsuitable for groundwater pumping. Groundwater is primarily hosted in volcanic rock and not limestone and occurs at or near volcanic-limestone contacts. Drilling records indicate that most holes are drilled dry but slowly make water through fractures. Fractures are sufficiently open to allow some groundwater flow but are too closed for appreciable groundwater flow.

Groundwater levels rapidly respond to rainfall recharge and indicate hydraulic conductivity anisotropy. The groundwater divide provides a natural buffer against Awoonga Dam water level rises.

10.3 Aquifer Hydraulic properties

10.3.1 Methodology

Hydraulic properties of groundwater systems can be obtained from the pumping of bores constructed for groundwater pumping purposes. Hydraulic conductivity and transmissivity can be determined by pumping and slug tests. Pump tests stress the aquifer and the aquifer response is quantifiable. Slug tests provide an estimate of near bore hydraulic conductivity. A pumping bore was not installed following water investigative drilling because a lift test yielded insufficient groundwater to proceed with constructing a pumping bore.

Slug testing data collection and analysis of FM1-4 was undertaken by Kalf and Associates in 2003. Slug testing data was undertaken by Alpha Concepts in 2025 and 2026. Analysis of this data was undertaken by Epic/Onterris.

10.3.2 Slug testing results

A summary of slug testing results is provided in Table 35. See Appendix 3 for Slug test analysis.

Year	Bore	Aquifer Screened	Slug Test method	Analysis Method	Hydraulic Conductivity m/day
2002	FM1	Limestone	Recovery	Hvorslev	0.003
2002	FM2	Volcanic	Recovery	Hvorslev	0.004
2002	FM3	Limestone	Recovery	Hvorslev	0.003
2002	FM4	Limestone	Recovery	Hvorslev	0.002
2025	FM5	Limestone	Recovery	Invalid	n/a
2025	FM5B	Volcanic	Recovery	Invalid	n/a
2025	FM6	Volcanic	Recovery	Bouwer-Rice	0.036
2025	FM6	Volcanic	Drawdown	Bouwer-Rice	0.056
2026	FM7	Limestone	Drawdown	Invalid	n/a
2026	FM8	Volcanic	Recovery	Bouwer-Rice	0.12
2026	FM8	Volcanic	Recovery	KGS	0.59
2026	FM9	Volcanic	Recovery	Bouwer-Rice	6.48
2026	FM10	Volcanic	Drawdown	Springer-Gelhar	16.42
2026	FM10	Volcanic	Recovery	Springer-Gelhar	28.12
2026	FM11	Volcanic	Drawdown	KGS	1
2026	FM12	Volcanic	Drawdown	Bouwer-Rice	0.27
2026	FM12	Volcanic	Drawdown	Bouwer-Rice	0.31
2026	FM13	Volcanic	Drawdown	Bouwer-Rice	0.96
2026	FM13	Volcanic	Recovery	KGS	0.52

Table 35 Slug test results

Data Analysis and Interpretation

Hydraulic conductivity from slug testing varies from very low in limestone to high. Limestone hydraulic conductivity is consistently very low whereas volcanic hydraulic conductivity is variable from low to high.

The hydraulic conductivity of FM9 was higher than predicted being k=6.48m/day for a bore that was drilled dry which indicates that the small development is drawing water out of the sand pack and a longer test is required, if possible, to stress units. A pump was undertaken on FM5B in 2025 but this was unsuccessful because of interference from FM5.

The general absence of groundwater and inability to conduct a pump test informs the most suitable modelling approach at Calliope. Pump test aquifer data is required for numerical groundwater modelling, specifically Transmissivity (T) and Storativity (S)/Specific Yield (Sy). A numerical model was constructed in 2002 in the absence of pump derived aquifer properties and the predictions made by this model were not realised with pit expansion (Section 12.1).

Pit water is essentially stored direct rainfall and surface water run-off and a surface water modelling approach is required. Analytical Water Balance Models were constructed using surface water correlation coefficients derived from volumetric changes in Pit 3 with rainfall and evaporation (Section 12.2).

10.4 Hydrostratigraphy

Groundwater occurs at or near volcanic-limestone contacts. Most piezometers are constructed in volcanic rock near the limestone contact. Groundwater is present in discrete fractures.

Limestone

Limestone in the pit envelope has a very low k at 0.002-0.003m/day and little connected fractures.

Volcanic

Volcanic rock has low k except for FM9 which had moderate K and the shallow piezometer FM10 has high k. These piezometers are located west of the Pit 3-4 final void in a potentially more fractured pre-mining discharge zone. The only known seepage is west of Pit 3 in a similar lower topographic and geological setting which indicates that exposing the western volcanic-limestone contact by future mining increases the risk of groundwater inflow. A seepage velocity estimate of 0.002m/day (0.73m/year) was made of advective travel time, using a US EPA online tool for Site Assessment calculation tool, between drill holes 7 and 12 located near the topographic divide.

Piezometer FM12 is in meta-sediment. Hydraulic conductivities are plotted with geology on Figure 79.

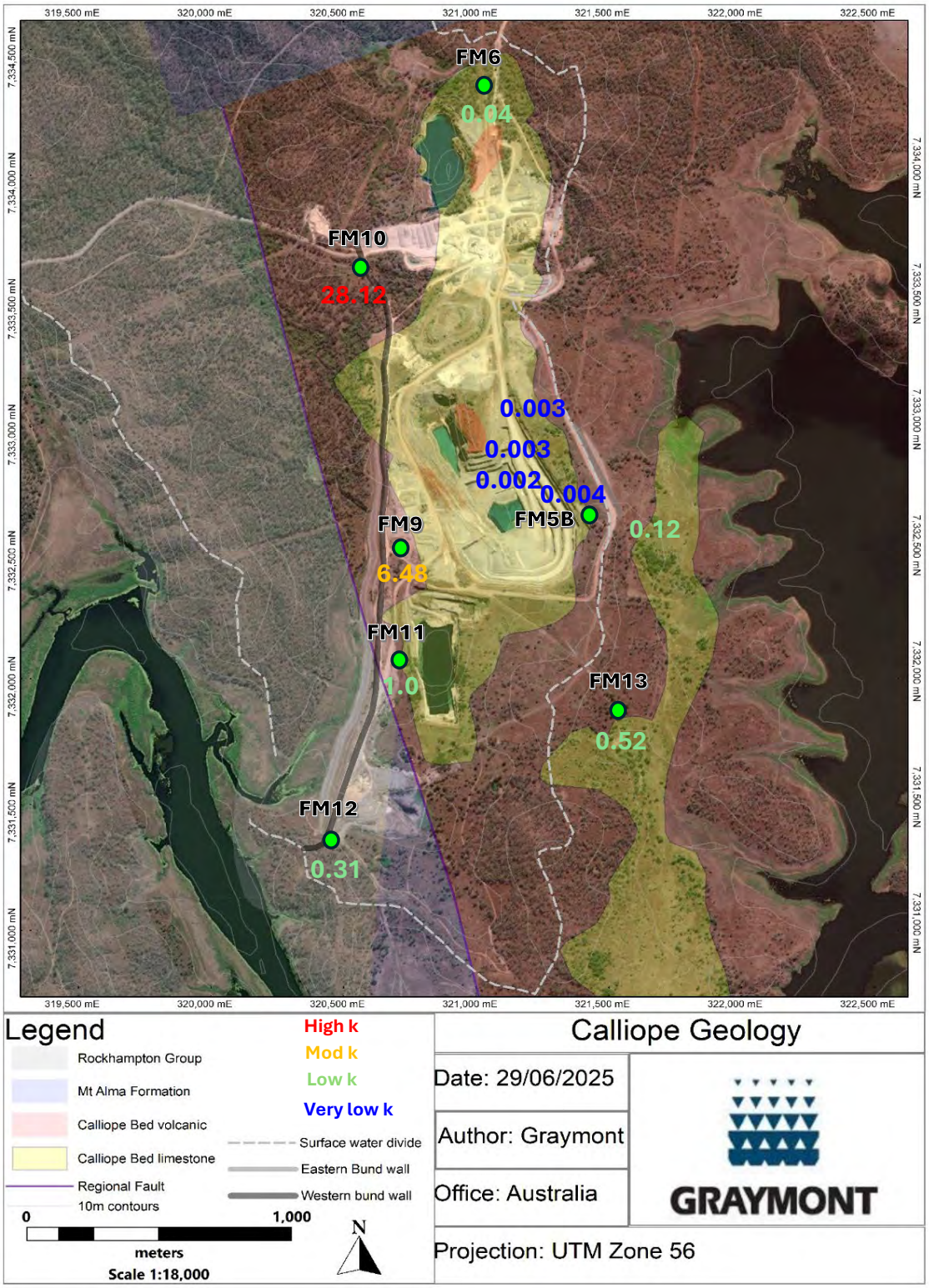


Figure 79 Hydraulic conductivity and geology

11 CONCEPTUAL WATER FLOW MODEL

A Conceptual Water Flow Model of the Pit 3-4 final void is provided below in Figure 80.

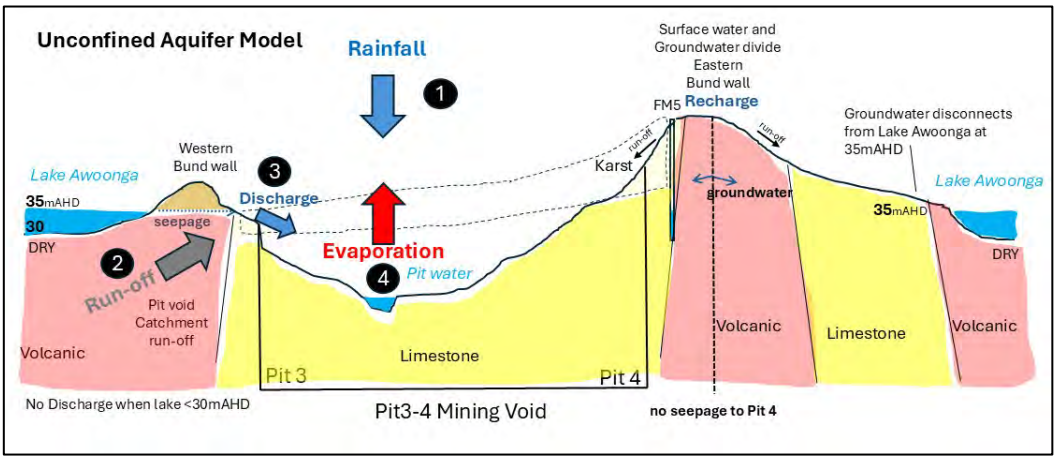


Figure 80 Pit Water Conceptual Model of future combined Pits 3-4

Some features of the Pit 3-4 Conceptual Model are:

- Pit water is created in a mining void from direct rainfall, surface water run-off and minor groundwater seepage. Pit water levels are naturally lowered by evaporation or by pumping from the pit floor.
- During, and post-high rainfall events, surface water runoff occurs from the Farm Dam/Waste Dump area along the western bund wall into Pit 3 (Section 6.2.3)
- The Pit envelope is bunded for edge protection and this redirects rainfall and surface water run-off away from the pit edge reducing surface water inflows into the pit void.
- Groundwater occurs within connected fractures in both limestone and volcanic units, forming a low-yield fractured rock aquifer, although the majority of the rock mass behaves as an aquitard.
- Groundwater flow direction is towards the pit voids and act as groundwater sinks (Section 8.3)
- Groundwater level (Section 8.6) and chemistry (Section 9.3.3) respond to recharge and therefore groundwater is driven by infiltration rather than seepage from Awoonga Dam
- There is no groundwater extraction outside the pit void so the aquifer is not being depressurized as groundwater approaches the pit void. There is little groundwater present in the pit void and there is no cone of depression extending beyond the mined area or associated impacts to potential receptors.
- Water flow from the high western wall of Pit 3 is from surface water run-off from the Farm Dam catchment and is not groundwater or Awoonga Dam wall piping failure (Section 7.3 and Section 9.3)
- There are no effective confining layers and there is no observed discharge under pressure either laterally or upward into the pit void and no evidence of a potentiometric surface or artesian conditions have been observed.
- Groundwater appears to be a minor component of inflows to pit voids. If there was significant groundwater discharge into the pit, then large volumes of water would need to be dewatered from the pit to prevent the pit from filling to a potentiometric surface at the elevation of the dam water level. This is not the case. Pit floor pumping is intermittent and seasonal and the pumping rate is insufficient to drawdown a potentiometric surface from approximately 35mAHD to below the aquifer floor at -20mAHD, being 55 metres of potentiometric head. In the 5 months from January-July 2025 only 1.4ML of pit water was pumped from Pit 4.

Water Balance Models have been created based on the Conceptual Model to assess future water levels within the planned life of mine for Pi3 (Section 8.1), Pit 2 (Section 8.2) and Pit 3-4 (Section 8.3).

12 WATER MODELLING

12.1 Pit 3 Numerical Model

12.1.1 Purpose

The proposed 10 m raising of Awoonga Dam wall in 2001 from a full supply water level of 30 to 40mAHD was identified as potentially causing inundation and flooding of Pit 3. The increased dam water level could induce increased groundwater flow into existing and future deeper pits through the limestone and other rock strata. A hydrogeological assessment was undertaken to determine the potential and magnitude of possible future water inflows.

12.1.2 Methodology

MODFLOW numerical models were constructed for Pit 4 Eastern bund wall, Pit 4 north west seepage zone and the Pit 3 pit western seepage zone. A numerical model was created of Pit 3 based on the scale conceptual model of groundwater inflow into Pit 3 . See Figure 81.

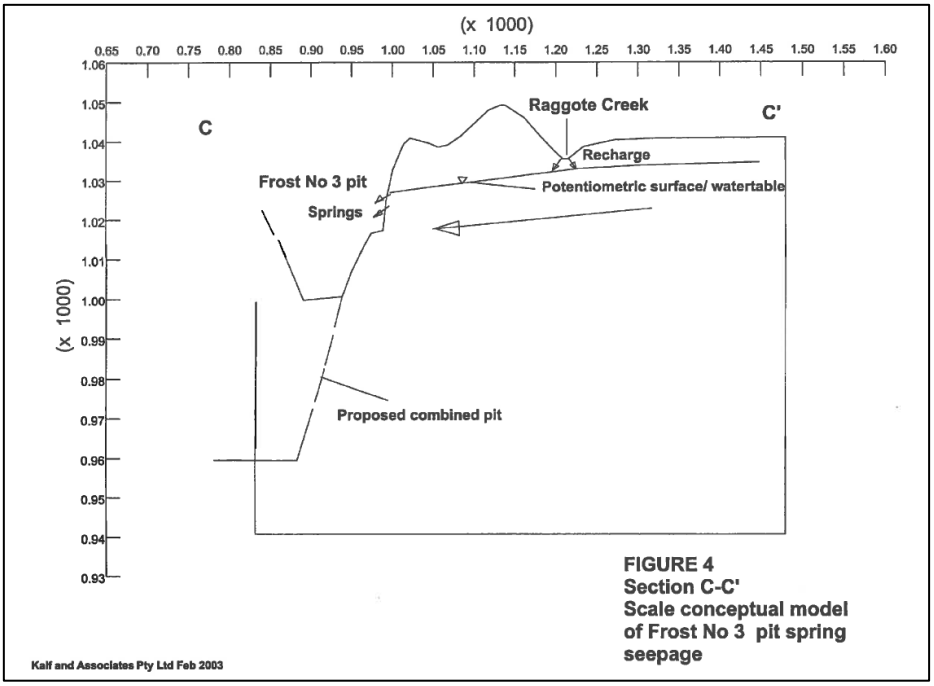


Figure 81 Pit 3 sectional conceptual model (Kalf and Associates, 2003)

The permeability of the fracture zone and inflow rate is not known precisely and therefore absolute inflow rate cannot be simulated easily or precisely (Kalf and Associates, 2003). A simulation was made using a higher permeability in section, with k=0.5m/day arbitrarily chosen ((Kalf and Associates, 2003). No permeability testing was undertaken near Pit 3 but hydraulic conductivity testing results from near Pit 4 indicated a very low value of 0.003m/day, being 2 orders of magnitude lower than values used in the model.

12.1.3 Modelling Results

No permeability testing was undertaken near Pit 3 but hydraulic conductivity testing results from near Pit 4 indicated a very low value of 0.003m/day, being 2 orders of magnitude lower than values used in the model. Modelled outcomes are shown in Figure 82.

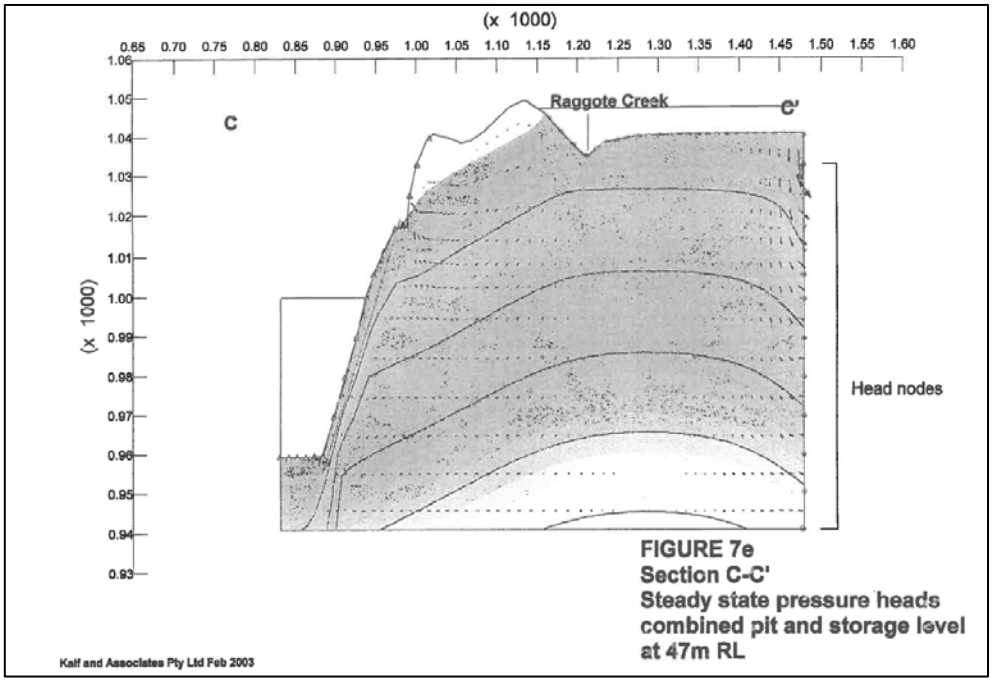


Figure 82 Pit 3 sectional numerical model (Kalf and Associates, 2003)

12.1.4 Assessment of Modelled Results

The conceptual model shown in Figure 81 shows a potentiometric surface or a watertable being recharged from Ragotte Creek and discharging into Pit 3 at an elevation of approximately 30mAHD. Groundwater testing in 2018 indicated that groundwater is at approximately 32mAHD but is 6 metres below the surface water inflow which is termed a Spring in Figure 81. This is contradictory because the Spring in Figure 81 is the surface water inflow point to Pit 3. In 1997 the surface water inflow point was at the location shown in Figure 81 but by 2004 it had migrated westerly up the slope by erosion (Section 4.1.3).

The Pit 3 modelled outcome(Figure 82) does not align with the conceptual model which shows a watertable in an unconfined aquifer seeping into the pit from high in the pit wall whereas the numerical model outcome shows groundwater, as a potentiometric surface, being drawn down below the pit floor. Numerical modelling does not align with the conceptual model and numerical model predictions do not align with field observations.

Model simulation results indicate that current inflows for both Pit 3 and Pit 4 could increase by a factor of 2 when Awoonga Dam reaches 47mAHD. It was also proposed that excavation to -40mAHD could increase inflow by a factor of 10 but the probability of a fracture extending uniformly to the base of such a pit is very low based on the data available (Kalf and Associates, 2003). The current Pit 4 floor is at -20mAHD being 78% of modelled depth and groundwater inflows remain unchanged which supports the conclusion that the numerical modelled outcomes are unreliable.

12.2 Pit 3 Water Balance model

12.2.1 Purpose

Water Balance modelling of Pit 3 was undertaken to provide a template for modelling the final void Pit 3-4 and to investigate the likelihood that Pit 3 water would overflow to Pit 4 in the absence of pumping.

12.2.2 Methodology

Data loggers were installed in Pit 3 in 2017/18 to further investigate the source of excess pit water as discussed in Section 6.3.1 and a hydrograph of this data was presented as Figure 31.

GRAYMONT

Surface water runoff coefficients were derived from calibration of observe pit water level changes for events under different climatic categories which are discussed in Section 5.2. The calibrated events are presented in Table 36.

Parameters	Investigation Period	20 Oct 2010 - 18 Jan 2011	15 Mar 2017 - 31 Mar 2017	15 Apr 2017 - 30 Jun 2017	8 Mar 2018 - 7 Apr 2018
Rainfall and Evaporation	Days	91	17	77	31
	Rainfall (mm)	806	491	48.6	25
	Rainfall rate (mm/day)	8.9	28.9	0.6	0.8
	Pit 3 Evaporation (mm)	452	70	264	159
	Evaporation rate (mm/day)	5.0	4.1	3.4	5.1
	Pit 3 Evaporation (ML)	-22	-3	-13	-8
	Climate Category	Cool Wet	Hot Wet	Cool Dry	Hot Dry
	Catchment Condition	Wet	Wet	Average	Average
Pit 3 void	Pit 3 Rainfall Capture Area (sqm)	48000	48000	48000	48000
	Pit 3 Direct Rainfall capture (ML)	39	24	2	1
	Pit 3 water level change mAHD	24-32	14-19	20-22.5	
	Pit 3 water volume storage change	**634**	**252**	**152**	**0**
Pit 3 void sub-catchment	Pit 3 Void sub-catchment excluding void (sqm)	496000	496000	496000	496000
	Run-off coefficient	**0.8**	**0.5**	**0.3**	**0**
	Surface water runfoff to Pit 3 input (ML)	320	122	7	0
Farm Dam sub-catchment	Surface water baseflow and groundwater rate (ML/day)	0.2	0.2	0.2	0.2
	Surface water baseflow from Farm Dam to Pit 3 (ML)	16	3	13	5
	Farm Dam sub-catchment (sqm)	595000	595000	595000	595000
	Run-off coefficient	0.8	0.5	0.3	0.0
	Surface water runfoff to Farm Dam input (ML)	234	146	88	0
	Total surface water runoff inflow	586	291	98	-1

Table 36 Pit 3 Water Input calibration events

A 50 year rainfall and evaporation record from 1975-2025 was obtained from the BOM Long Paddock website which has a monthly median rainfall of 45mm and monthly median evaporation of 157mm. This data was used to categorise monthly climate into the four categories of Hot Dry, Hot Wet, Cool Dry and Cool Wet (Figure 26). Surface water run-off is dependent upon previous rainfall, specifically how much moisture is at and near the surface. Catchment condition (Wet, Average and Dry) has been calculated each month based on monthly rainfall and the preceding 3 months of rainfall. Surface water run-off coefficients for the three catchment conditions are presented in Table 37.

Wet catchment				
Category	Hot Dry	Hot Wet	Cool Dry	Cool Wet
Rainfall (mm)	<45	>45	<45	>45
Evaporation (mm)	>157	>157	<157	<157
Coefficient	0.8	0.8	0.8	0.8
Average catchment				
Category	Hot Dry	Hot Wet	Cool Dry	Cool Wet
Rainfall (mm)	<45	>45	<45	>45
Evaporation (mm)	>157	>157	<157	<157
Coefficient	0	0.5	0.3	0.8
Dry catchment				
Category	Hot Dry	Hot Wet	Cool Dry	Cool Wet
Rainfall (mm)	<45	>45	<45	>45
Evaporation (mm)	>157	>157	<157	<157
Coefficient	0	0	0	0

Table 37 Pit 3 run-off coefficients based on catchment condition

Climate Models (GCM) show a general warming across the state and for the Boyne River Basin the higher GHGE scenarios indicate a 6.3% increase in evaporation and the lower GHGE a 3.8% in evaporation. A 2% decrease in rainfall is predicted for both scenarios. The analytical final void Pit 3-4 Water Balance model has been created based on the formula:

Pit water inflow = direct rainfall capture +surface water run-off + groundwater inflow – pit evaporation

The Pit 3 model was setup as follows:

Source data:

- Monthly rainfall and evaporation 50 year record from 1975-2025
- Pit void surface area from pit design for Pit 3
- One meter high bench blocks derived in SURPAC from the pit design. The area of the top of the bench block provides the evaporation surface area of pit water. The volume of the pit block is the water volume which the model fills and then rises to the next 1 meter block.
- Catchments and their surface areas calculated for each catchment and effective void
    - Pit 3 Void (for direct rainfall capture)
    - Pit 3 Void Boundary Catchment (for surface water run-off entering Pit 3 and Pit 4 voids excluding surface water run-off from the Farm Dam catchment)
    - Farm Dam Catchment (for surface water currently entering Pit 3 void)
- Surface run-off co-efficient derived for Pit 3 applied to the model based on climate categories

Model Assumptions:

- No dam leakage
- Surface water inflow (which includes groundwater) has a base flow of 2 litres/second being 0.173 ML/day based on historical site records and bucket testing of inflow (Section 6.2.3)

Farm Dam wet catchment overflow is calculated in the model.

Calibration:

- Surface water run-off coefficients were derived from data logger measurements of Pit 3 water level
- The median EC of Farm Dam and the surface water inflow to Pit 3 samples of 550EC (Section 7.2) was calibrated to monitoring results by applying a Wet catchment salt flushing factor which accounts for a reduction in EC during higher surface water run-off events.

A summary of model setup parameters is provided below in Table 38.

Climate	Rainfall (mm)	Evaporation (mm)
Water flow		
Groundwater inflow ML/month (calculated from l/s)		-
Farm Dam baseline flow and groundwater to Pit 3 (ML/day)		0.2
Farm Dam flow wet catchment overflow to Pit 3 (ML/day)		
Catchment areas		
input parameter EC		544,000
Pit 3 Void Direct Capture (sqm)		48,000
Pit 3 Void Boundary sub-catchment (sqm)		474,000
Farm Dam cub-catchment (sqm)		595,500
Pit 3 Void Boundary and Farm Dam sub-catchment (sqm)		1,069,500
Water Quality	**EC as µS/cm**	**EC as mg/L**
Rainfall	35	22
Surface water	550	344
Groundwater	1200	750
Farm Dam	550	344
Wet catchment salt flushing factor (calibration to monitor	0.3	0.3

Table 38 Pit 3 Water Balance Model set-up

12.2.3 Modelled Results

Predicted water level

A prediction of pit water in the absence of pumping is shown below with pumping and measured pit water level (Figure 83).

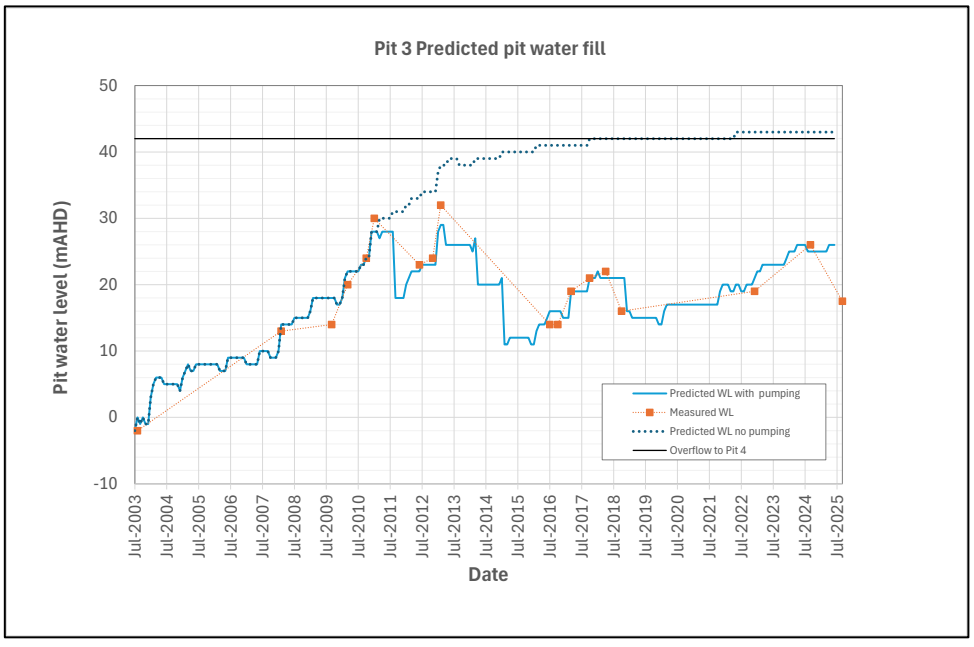


Figure 83 Pit 3 predicted water level behaviour in the absence of pumping

Pit 3 is predicted to have overflowed into Pit 4 in the absence of pit pumping.

Predicted water quality

A modelled prediction of salt load expressed from EC in the absence of pumping is shown below with pumping (Figure 84).

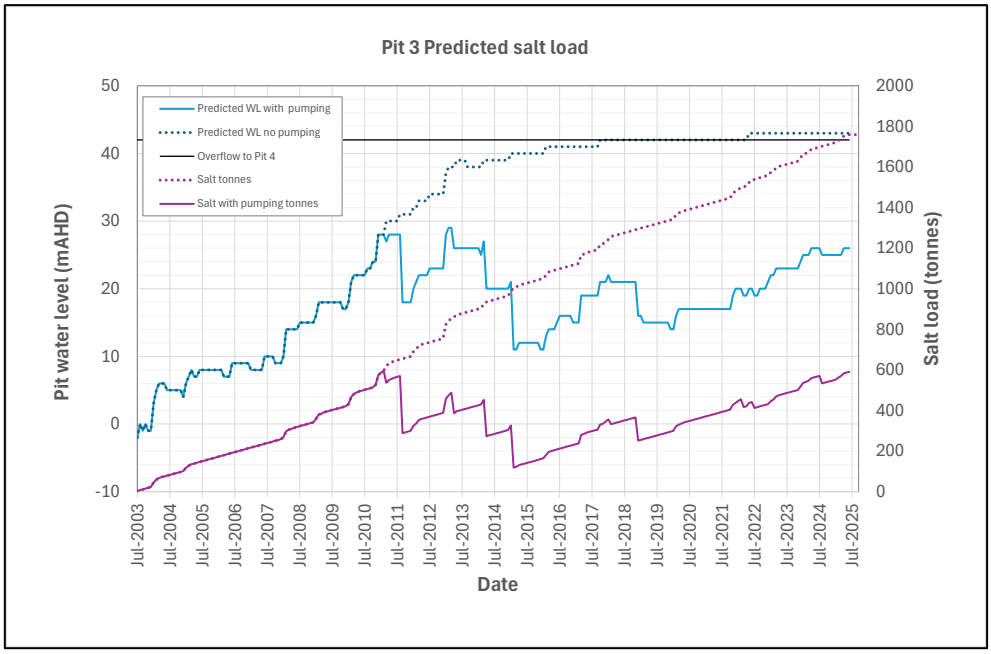


Figure 84 Pit 3 predicted salt load

Pit 3 pumping and release reduces the salt load. A modelled prediction of EC in the absence of pumping is shown below with pumping and measured EC (Figure 85).

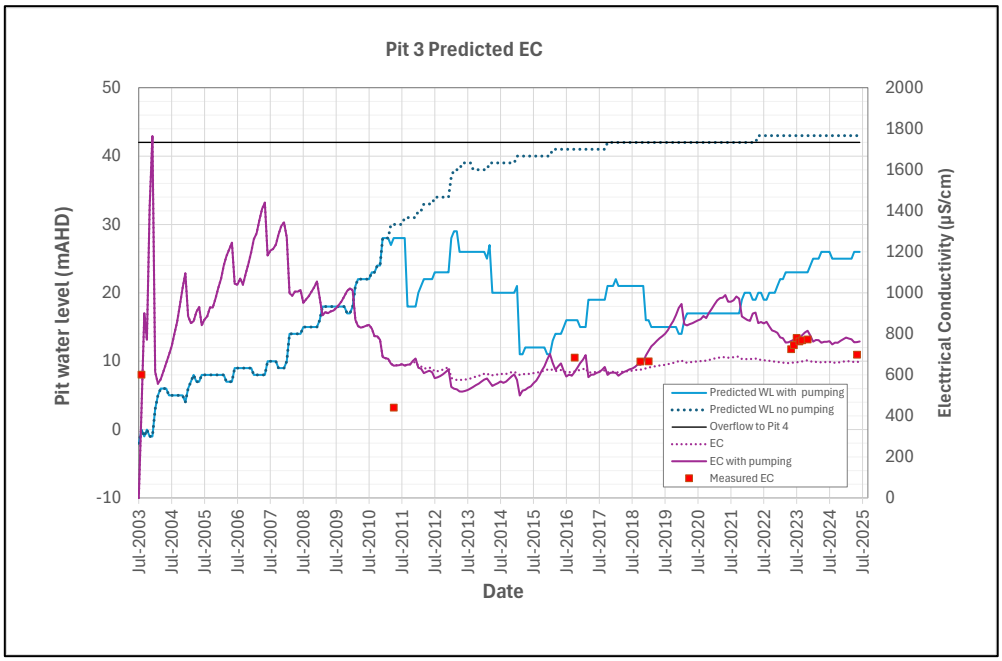


Figure 85 Pit 3 predicted EC

12.2.4 Assessment of Modelled Results

Pit 3 pumping release reduces the salt but increases EC because fresher water refills the pit to the water level prior to discharge. Monitoring of Pit 3 indicates an evaporation effect in the order of a 14% increase every decade (Section 7.2.4). The pH is near neutral and naturally fluctuate with rainfall and evaporation. TDS increases near the surface with surface water run-off but then settles on the pit floor.

Stratification

Stratification of the Pit 3 water profile was observed at 4 metres depth.

12.3 Pit 2 Water Balance model

12.3.1 Purpose

Water Balance modelling of Pit 2 was undertaken to predict final void Pit 2 water level behaviour and to investigate the likelihood that Pit 2 water would overflow.

12.3.2 Methodology

A water model was constructed for Pit 2 based on the methodology described for Pit 3 in Section 12.2.2.

12.3.3 Model setup

The Pit 2 model was setup as follows:

Source data:

- Monthly rainfall and evaporation 50 year record from 1975-2025 replicated for 2 centuries
- Pit void surface area from pit design for Pit 2 blocked as per Pit 3
- Catchments and their surface areas calculated for each catchment and effective void
    - Pit 2 Void (for direct rainfall capture)
    - Pit 2 Void Boundary Catchment
- Surface run-off co-efficient derived for Pit 3 applied to the model based on climate categories

Model Assumptions:

- Groundwater inflow 1l/s

Calibration:

- Surface water run-off coefficients were derived from data logger measurements of Pit 3 water level
- The median EC of Farm Dam and surface water inflow point to Pit 3 were applied to Pit 2 in the absence of extensive field data. EC was calibrated to monitoring by applying a Wet catchment salt flushing factor which accounts for a reduction in EC during higher surface water run-off events.

A summary of model setup parameters is provided below in Table 39.

Climate	Rainfall (mm)	Evaporation (mm)
50 year record 1975-2024 repeated for base data	100%	100%
Predicted Higher Greenhouse Gas (HGG) hotter drier climate	98%	106%
Water flow		
Groundwater inflow l/s		1.0
Groundwater inflow ML/month (calculated from l/s)		2.6
Farm Dam baseline flow and groundwater to Pit 3 (ML/day)		-
Farm Dam flow wet catchment overflow to Pit 3 (ML/day)		
Catchment areas		
Pit 2 Effective Catchment (sqm)		128,000
Pit 2 Void Direct Capture (sqm)		49,000
Pit 2 Void Boundary sub-catchment (sqm)		79,000
Farm Dam cub-catchment (sqm)		-
Pit 3 Void Boundary and Farm Dam sub-catchment (sqm)		-
Water Quality	**EC as µS/cm**	**EC as mg/L**
Rainfall	35	22
Surface water	550	344
Groundwater	1200	750
Farm Dam	0	0
Wet catchment salt flushing factor (calibration to monitori	0.3	0.3

Table 39 Pit 2 Water Balance Model set-up

12.3.4 Predicted water level

A prediction of pit water in the absence of pumping is shown below with pumping and measured pit water level (Figure 86).

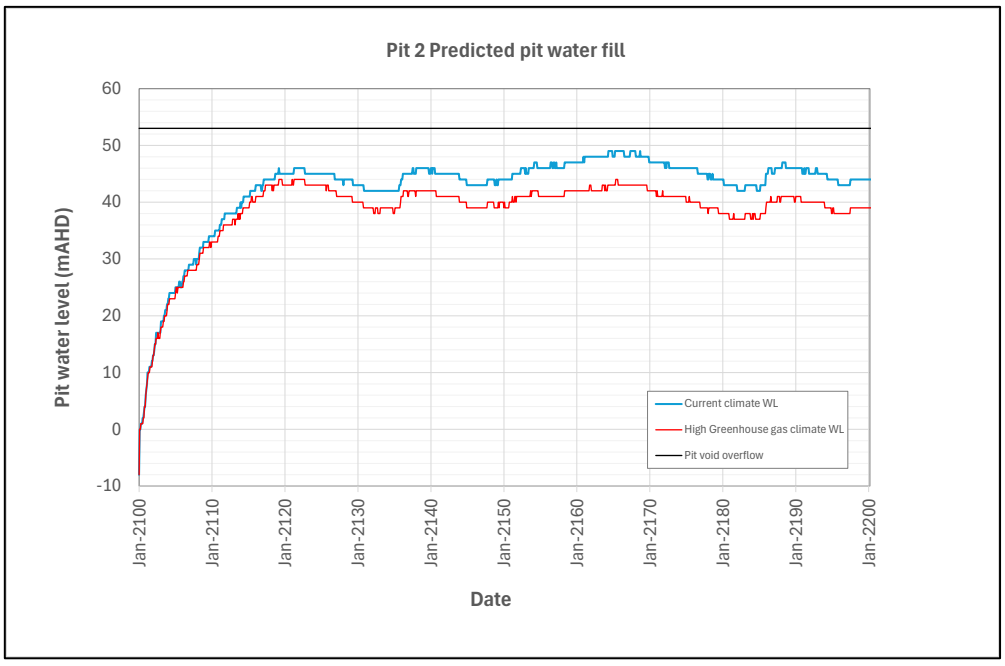


Figure 86 Pit 2 predicted water level behaviour post mining

The Pit 2 Water Balance model predicts that under the current climatic conditions pit water post mining will fill to a fluctuation level around 44mAHD and be contained in the pit void. In predicted future lower greenhouse gas emission scenarios the post mining water fill will be lower and fluctuate around 40mAHD.

12.3.5 Predicted water quality

Historical monitoring of Pit 3 indicates an evaporation effect in the order of a 14% increase every decade (Section 7.2.4) and Pit 2 is predicted to behave similarly. The pH will remain near neutral and naturally fluctuate with rainfall and evaporation. TDS will increase near the surface with surface water run-off but then settle on the pit floor.

A modelled prediction of salt load expressed from EC (Figure 87).

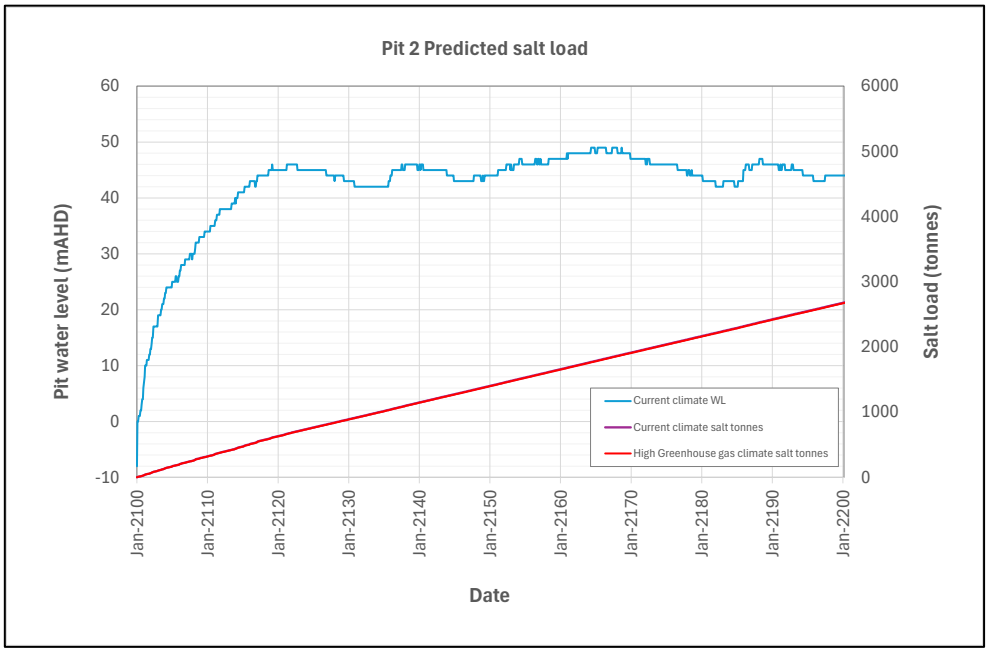


Figure 87 Pit 2 predicted salt load

The salt load is similar but marginally reduced under the high greenhouse gas scenario.

A modelled prediction of EC was made under the different climate scenarios of current and high greenhouse gas (Figure 88).

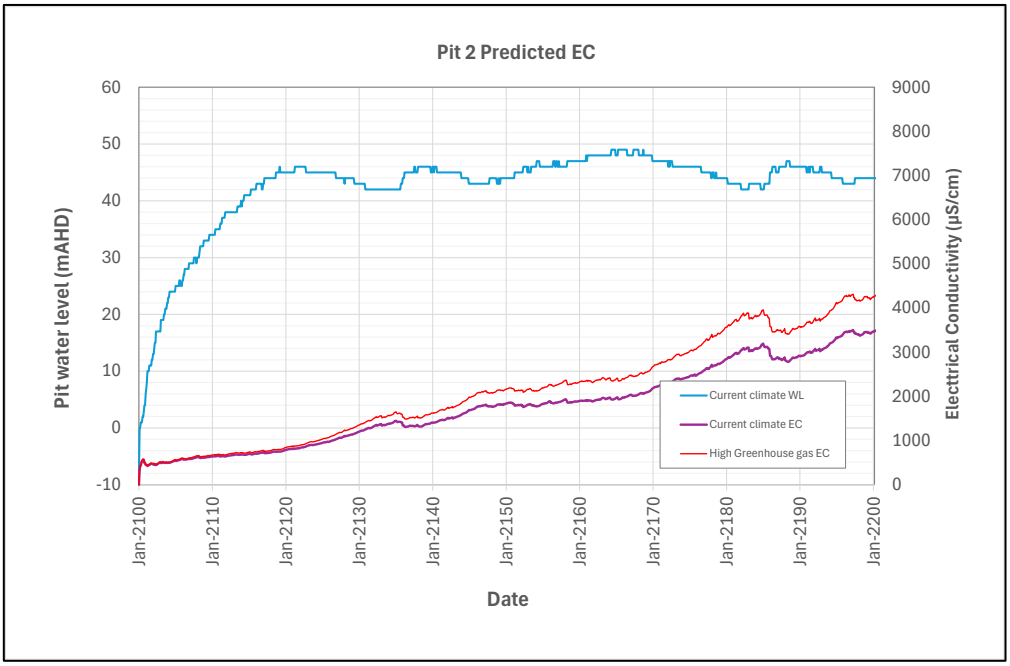


Figure 88 Pit 2 predicted EC

The modelled EC predicts an increase from 500 µS/cm to 4215 µS/cm under the High GHG scenario using the salt flushing factor applied to the Pit 3 model which is a 20% EC increase/decade instead of the measured and predicted 14% increase/decade as per Pit 3 (Section 7.2.4). The salt flushing factor is almost certainly different for the Pit 2 catchment and it is concluded that EC will increase 14-20%/decade.

Stratification
Stratification of the Pit 3 water profile was observed at 4 metres depth and similar stratification near the surface is predicted for Pit 2 final void.

12.4 Pit 3-4 Water Balance model

12.4.1 Purpose
Water Balance modelling of Pit 3-4 was undertaken to predict final void Pit 2 water level behaviour and to investigate the likelihood that Pit 3 water would interact with Awoonga Dam water.

12.4.2 Methodology
A water model was constructed for Pit 3-4 based on the methodology described for Pit 3 in Section 12.2.2.

12.4.3 Model setup
The Pit 3-4 model was setup as follows:

Source data:

- Monthly rainfall and evaporation 50 year record from 1975-2025 replicated for 2 centuries
- Pit void surface area from pit design for Pit 3-4 blocked as per Pit 3
- Catchments and their surface areas calculated for each catchment and effective void
    - Pit 3-4 Void
    - Pit 3-4 Void Boundary Catchment
    - Farm Dam Catchment
- Surface run-off co-efficient derived for Pit 3 applied to the model based on climate categories

The final landform design has the main open pit void being the combined present day Pit 3 and Pit 4 with an abandonment bund surrounding the void and partial backfill of the north end of the pit (Figure 89).



Figure 89 Pit 3-4 final void and Climate data node

The abandonment bund is planned as rock fill and not a flood mitigation structure. The broad bench floor evaporates most water as compared to sumps and internal voids on the pit floor which store some water.

Model Assumptions:

- No dam leakage
- Surface water inflow (which includes groundwater) has a base flow of 0.173 ML/day

Climate Scenario modelling
Climate Models (GCM) show a general warming across the state and for the Boyne River Basin the higher GHGE scenarios indicate a 6.3% increase in evaporation and the lower GHGE a 3.8% in evaporation. A 2% decrease in rainfall is predicted for both scenarios. Monthly rainfall and evaporation records from 1975-2025 for the Calliope are provided in Section 4.2. The 1975-2025 rainfall and evaporation record was used to predict rainfall and evaporation from 2100 by applying GHGE estimate high and lower scenarios to the monthly rainfall and evaporation data. The predicted pit water fill is based on the lower GHGE scenario and is presented with current climate and a higher GHGE scenario

A summary of model setup is provided in Table 40.

Climate	**Rainfall (mm)**	**Evaporation (mm)**
Predicted High Greenhouse Gas (HGG) hotter drier climate	98%	106%
Predicted Lower Greenhouse Gas (LGG) hotter drier climate	98%	104%
Water flow		
Groundwater inflow l/s		1.0
Groundwater inflow ML/month (calculated from l/s)		2.6
Farm Dam baseline flow and groundwater to Pit 3 (ML/day)		1.7
Farm Dam flow wet catchment overflow to Pit 3 (ML/day)		
Catchment areas		
Pit 3-4 Catchment (sqm)		1,929,200
Pit 3-4 Void Direct Capture (sqm)		905,600
Pit 3-4 Void Boundary sub-catchment (sqm)		428,100
Farm Dam cub-catchment (sqm)		595,500
Pit 3 Void Boundary and Farm Dam sub-catchment (sqm)		1,023,600
Water Quality	**EC as µS/cm**	**EC as mg/L**
Rainfall	35	22
Surface water	550	344
Groundwater	1200	750
Farm Dam	550	344
Wet catchment salt flushing factor (calibration to monitoring)	0.3	0.3

Table 40 Pit 3-4 Water Balance Model set-up

12.4.4 Predicted water level

Pit void water balance and final water level equilibrium is shown below for the predicted lower greenhouse gas emission scenario (Figure 90).

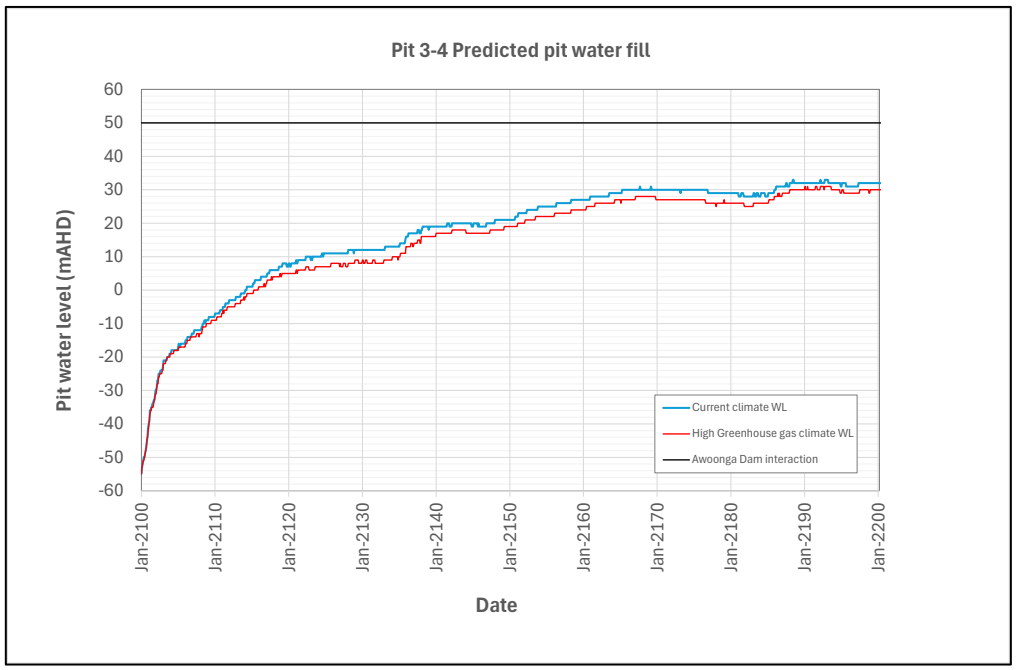


Figure 90 Pit 3-4 predicted water level behaviour post mining

The Pit 3-4 Water Balance model predicts that under the current climatic conditions pit water post mining will fill to a fluctuation level around 30mAHD and be contained in the pit void. In predicted future lower greenhouse gas emission scenarios the post mining water fill will be lower and fluctuate around 28mAHD.

Model uncertainty and sensitivity testing

The model was sensitivity tested by changing input parameters variables in consideration of model assumptions. The variable with the greatest influence on water inputs is groundwater. The model is not sensitive to monthly total water inflow changes of 10-20 ML because it can be a relatively small percentage of total inflow. Groundwater inflow volumes is a determining factor on whether pit water equilibria is achieved within the pit void and pit water is contained within the pit void or if pit water escapes the pit void to Awoonga Dam.

<u>Increase groundwater flow to 25 l/s</u>

Groundwater inflows were increased from the current observed and modelled 1 l/s to 25l/s and the pit (Figure 91) , which is currently a sink and will remain a sink because groundwater will be at 40mAHD which is less than 50mAHD groundwater interaction threshold with Awoonga Dam.

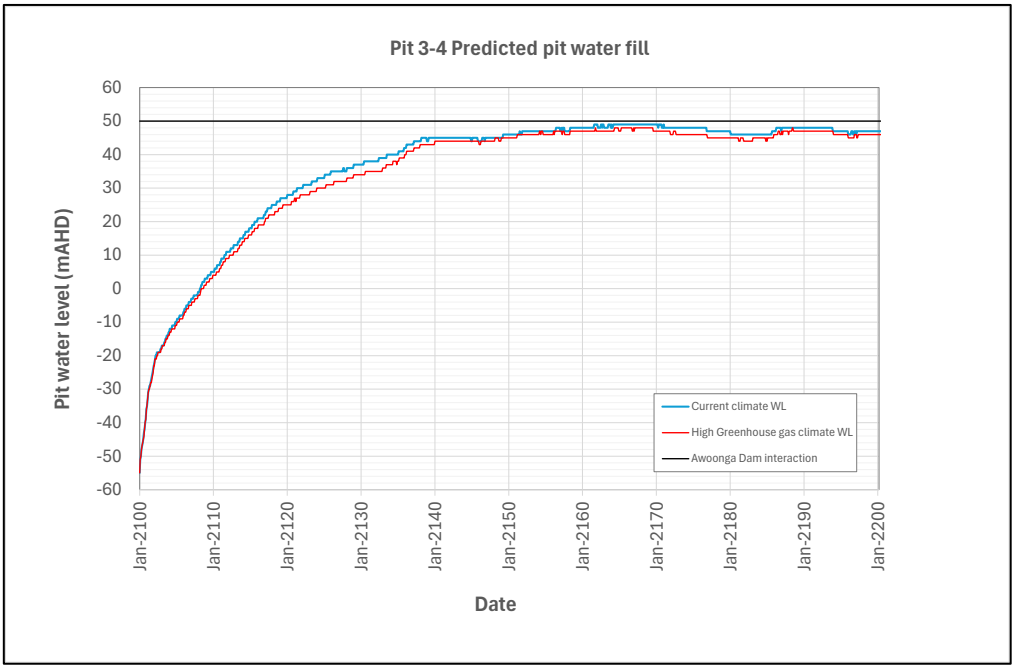


Figure 91 Pit 3-4 with groundwater increased to 25l/s

12.4.5 Predicted water quality

The water quality of the final pit void is predicted to be a mix of current Pit 3 and Pit 4 water quality. Pit 3 water is a mixed type whereas Pit 4 a Ca-Mg-HCO3 type water.

A modelled prediction was made of salt load expressed from EC (Figure 92).

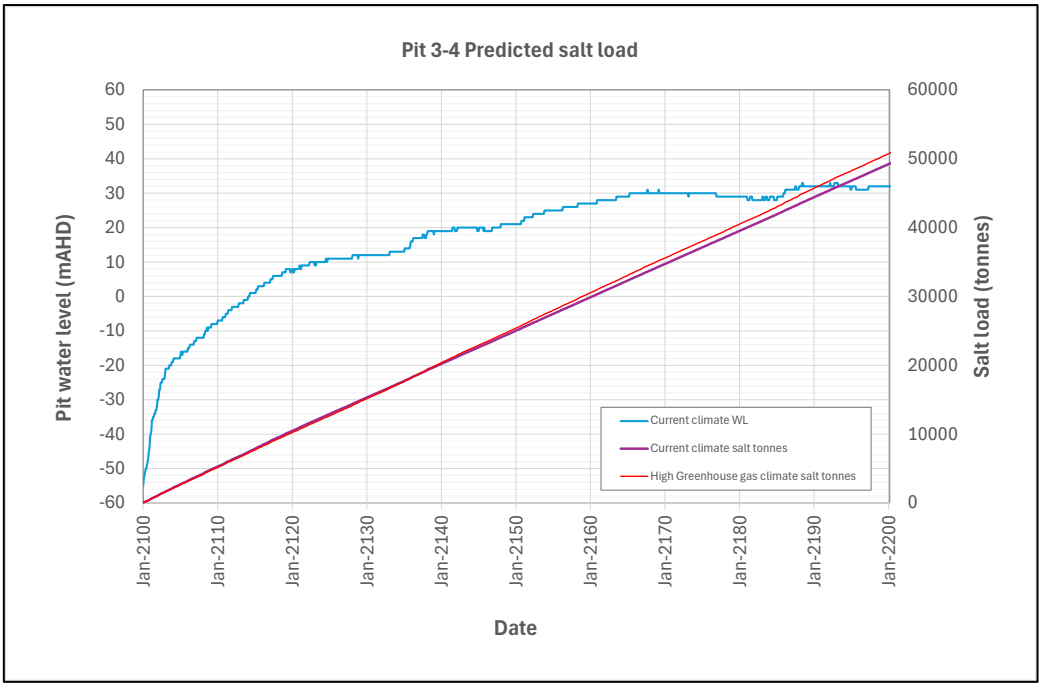


Figure 92 Pit 3-4 predicted salt load

The salt load is predicted to marginally increase under the high GHG scenario. A modelled prediction was made of EC under the different climate scenarios of current and high GHG (Figure 93).

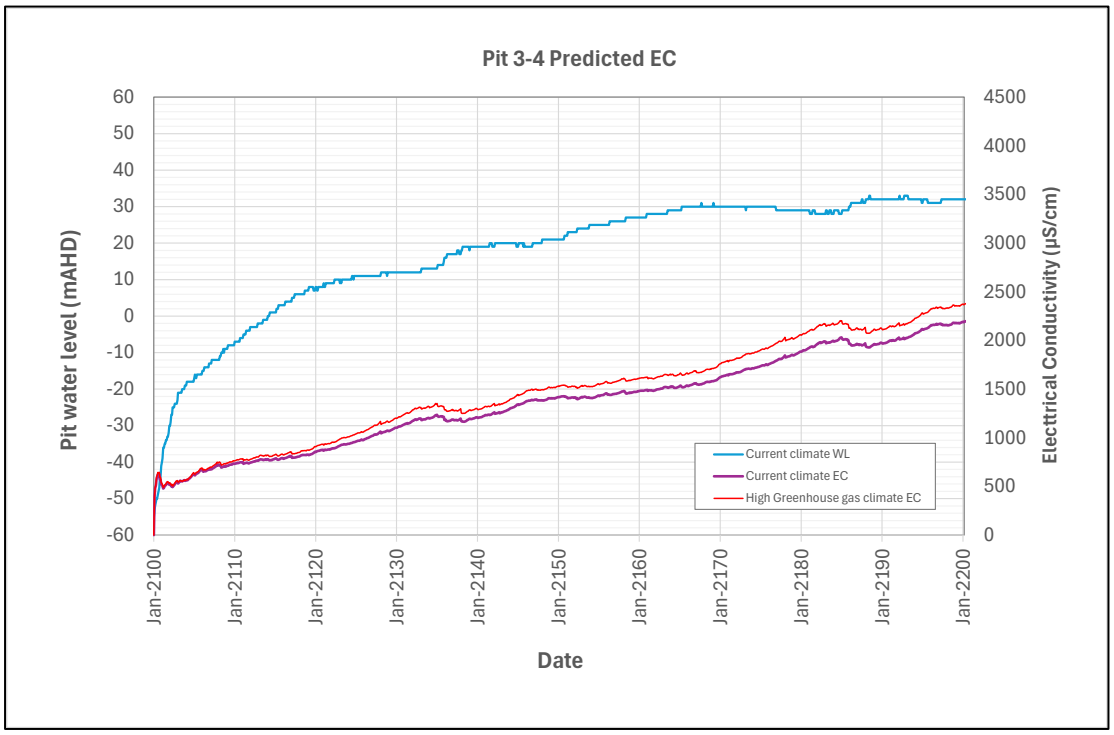


Figure 93 Pit 3-4 predicted EC

The modelled EC predicts an increase from 500 µS/cm to 3471 µS/cm under the current climatic scenario using the salt flushing factor applied to the Pit 3 model which is a 20% EC increase/decade instead of the measured and predicted 14% increase/decade as per Pit 3 (Section 7.6.1). EC is predicted to be higher under a High GHG scenario and EC will likely increase 14-20%/decade.

The pH will remain near neutral and naturally fluctuate with rainfall and evaporation. TDS will increase near the surface with surface water run-off but then settle on the pit floor.

Stratification

Stratification of the Pit 3 water profile was observed at 4 metres depth and similar stratification near the surface is predicted for Pit 3-4 final void.

Final landform abandonment bund

Abandonment bunds will reduce particulate matter and nutrients entering the pit voids, which is anticipated to provide a control measure for minimising the risk of algae growth.

GRAYMONT

13 REFERENCES

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SKM 2012b, *Calliope Groundwater Management and Monitoring Plan,* Sinclair Knight Merz Pty Ltd

Appendix 1: Bore Completion Reports FM5 to FM13

Bore Report

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
187863	Sub-Artesian Facility	Existing	12/01/2021	Rockhampton	3360 - GLADSTONE REGIONAL

Details

Description			
Parish	6000 - NO LONGER USED		
Original Name			
Driller Name	IRVINE, DON		
Drill Company	CAPRICORN DRILLING SERVICES		
Const Method	ROTARY AIR		
Bore Line			
D/O File No		**Polygon**	
R/O File No		**Equipment**	
H/O File No		**RN of Bore Replaced**	
Log Received Date	29/01/2021	**Data Owner**	
Roles	Sub-Artesian Monitoring		

Location

Latitude	24-06-31	**Basin**	1330
Longitude	151-14-36	**Sub-area**	
GIS Latitude	-24.10858676	**Lot**	7
GIS Longitude	151.24325446	**Plan**	SP215269
Easting	321451		
Northing	7332633	**Map Scale**	
Zone	56	**Map Series**	
Accuracy		**Map No**	
GPS Accuracy		**Map Name**	
Checked	Yes	**Prog Section**	

Casing

7 ***records for RN*** **187863**

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	12/01/2021	1	0.00	30.00	Polyvinyl Chloride	7.500	WT - Wall Thickness	65
A	12/01/2021	2	18.00	29.00	Perforated or Slotted Casing	1.000	AP - Aperture Size	65
X	12/01/2021	3	0.00	6.00	Grout			203
X	12/01/2021	4	6.00	16.00	Cuttings or other fill between casing and hole wall			203
X	12/01/2021	5	16.00	17.00	Bentonite Seal			203

Bore Report

From Year:

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
X	12/01/2021	6	17.00	30.00	Gravel Pack			203
X	12/01/2021	7	25.00		Centraliser			

Strata Logs

5 *records for RN* **187863**

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	1.00	SURFACE SOIL
2	1.00	9.00	BROWN, SILTY SAND
3	9.00	18.00	BROWN SILTY STONE
4	18.00	24.00	SAND AND GRAVEL
5	24.00	30.00	PINK LIMESTONE

Stratigraphies

0 *records for RN* **187863**

Aquifers

1 *records for RN* **187863**

Rec	Top (m)	Bottom (m)	Lithology	Date	SWL (m)	Flow	Quality	Yield (L/s)	Contr	Cond	Formation Name
1	18.00	24.00	SAGR - Sand and Gravel			N	POTABLE		Y	UC	

Pump Tests Part 1

1 *records for RN* **187863**

Pipe	Date	Rec	RN of Pumped Bore	Top (m)	Bottom (m)	Dist (m)	Meth	Test Types	Pump Type	Suction Set (m)	Q Prior to Test (l/s)	Dur of Q PR (mins)	Pres on Arriv (m)	Q on Arriv (l/s/)
A	12/01/2021	1	187863	18.00	24.00		PUM		AIR	30.00				

Pump Tests Part 2

1 *records for RN* **187863**

Pipe	Date	Rec	Test	SWL(m)	Recov	Resid	Max DD	Q at	Time to	Max Q	Calc	Design	Design	Suct.	Tmsy	Stor

Bore Report

From Year:

		Dur (mins)	Time (mins)	DD (m)	or P RED (m)	Max DD (l/s)	Max DD (mins)	(l/s)	Stat HD (m)	Yield (l/s)	BP (m)	Set (m)	(m2/Day)
A	12/01/2021	1	180	-28.00			2.00					30.00	

Bore Conditions

0 *records for RN* **187863**

Elevations

0 *records for RN* **187863**

Water Analysis Part 1

0 *records for RN* **187863**

Water Analysis Part 2

0 *records for RN* **187863**

Water Levels

0 *records for RN* **187863**

Wire Line Logs

0 *records for RN* **187863**

Field Measurements

1 *records for RN* **187863**

Pipe	Date	Depth (m)	Conduct (uS/cm)	pH	Temp (C)	NO3 (mg/L)	DO2 (mg/L)	Eh (mV)	Alkalinity (mV)	Samp	Method	Samp	Source
A	12/01/2021		270	7.0						AI	Air Lifting	GB	Groundwater - from Bore

Special Water Analysis

0 *records for RN* **187863**

Bore Report

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
151688	Sub-Artesian Facility	Existing	26/06/2012	Rockhampton	3360 - GLADSTONE REGIONAL

Details

Description			
Parish	4022 - RIVERSTON		
Original Name			
Driller Name	DART, GREGORY		
Drill Company	BURNETT & GLADSTONE DRILLING		
Const Method	ROTARY AIR		
Bore Line			
D/O File No		**Polygon**	
R/O File No		**Equipment**	
H/O File No		**RN of Bore Replaced**	
Log Received Date	16/07/2012	**Data Owner**	
Roles			

Location

Latitude	24-05-34	**Basin**	1330
Longitude	151-14-22	**Sub-area**	
GIS Latitude	-24.09274641	**Lot**	4
GIS Longitude	151.2395018	**Plan**	RP610128
Easting	321047		
Northing	7334383	**Map Scale**	
Zone	56	**Map Series**	
Accuracy		**Map No**	
GPS Accuracy		**Map Name**	
Checked	Yes	**Prog Section**	

Casing

6 ***records for RN*** **151688**

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	26/06/2012	1	0.00	60.50	Polyvinyl Chloride	5.000	WT - Wall Thickness	50
A	26/06/2012	2	48.50	60.50	Perforated or Slotted Casing	0.500	AP - Aperture Size	
X	26/06/2012	3	0.00	7.00	Grout			115
X	26/06/2012	4	7.00	45.50	Cuttings or other fill between casing and hole wall			115
X	26/06/2012	5	45.50	47.00	Bentonite Seal			115

Bore Report

From Year:

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
X	26/06/2012	6	47.00	60.50	Gravel Pack	3.000	GR - Gravel Size	115

Strata Logs

11 ***records for RN*** **151688**

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	2.00	TOP SOIL
2	2.00	3.50	BROWN ROCK, WHITE CLAY
3	3.50	5.50	CLAY: BROWN
4	5.50	10.00	ROCK: BLUE GREY
5	10.00	10.50	CLAY: BROWN
6	10.50	20.00	ROCK: BLUE GREY
7	20.00	37.00	ROCK: RED, WHITE
8	37.00	46.50	ROCK: DARK GREY, RED
9	46.50	48.50	ROCK: BROWN, RED
10	48.50	51.00	ROCK: LIGHT BROWN
11	51.00	60.50	ROCK: BLUE GREY, WHITE *

Stratigraphies

0 ***records for RN*** **151688**

Aquifers

1 ***records for RN*** **151688**

Rec	Top (m)	Bottom (m)	Lithology	Date	SWL (m)	Flow	Quality	Yield (L/s)	Contr	Cond	Formation Name
1	54.50		XXXX - Unknown	26/06/2012	-21.00	N			N	XX	CALLIOPE BEDS

Pump Tests Part 1

0 ***records for RN*** **151688**

Pump Tests Part 2

0 ***records for RN*** **151688**

Bore Report

From Year:

Bore Conditions

0 *records for RN* **151688**

Elevations

0 *records for RN* **151688**

Water Analysis Part 1

0 *records for RN* **151688**

Water Analysis Part 2

0 *records for RN* **151688**

Water Levels

0 *records for RN* **151688**

Wire Line Logs

0 *records for RN* **151688**

Field Measurements

1 *records for RN* **151688**

Pipe	Date	Depth (m)	Conduct (uS/cm)	pH	Temp (C)	NO3 (mg/L)	DO2 (mg/L)	Eh (mV)	Alkalinity (mV)	Samp	Method	Samp	Source
A	26/06/2012		1720							AI	Air Lifting	GB	Groundwater - from Bore

Special Water Analysis

0 *records for RN* **151688**

Bore Report

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
151689	Sub-Artesian Facility	Existing	03/07/2012	Rockhampton	3360 - GLADSTONE REGIONAL

Details

Description			
Parish	4022 - RIVERSTON		
Original Name			
Driller Name	DART, GREGORY		
Drill Company	BURNETT & GLADSTONE DRILLING		
Const Method	ROTARY AIR		
Bore Line			
D/O File No		**Polygon**	
R/O File No		**Equipment**	
H/O File No		**RN of Bore Replaced**	
Log Received Date	16/07/2012	**Data Owner**	
Roles			

Location

Latitude	24-06-31	**Basin**	1330
Longitude	151-14-37	**Sub-area**	
GIS Latitude	-24.10855516	**Lot**	7
GIS Longitude	151.2435008	**Plan**	SP215269
Easting	321476		
Northing	7332637	**Map Scale**	
Zone	56	**Map Series**	
Accuracy		**Map No**	
GPS Accuracy		**Map Name**	
Checked	Yes	**Prog Section**	

Casing

5 ***records for RN*** **151689**

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	03/07/2012	1	0.00	14.70	Polyvinyl Chloride	5.000	WT - Wall Thickness	50
A	03/07/2012	2	5.70	14.70	Perforated or Slotted Casing	0.500	AP - Aperture Size	
X	03/07/2012	3	0.00	5.00	Grout			115
X	03/07/2012	4	5.00	5.70	Bentonite Seal			115
X	03/07/2012	5	5.70	14.70	Gravel Pack	3.000	GR - Gravel Size	115

Bore Report

From Year:

Strata Logs

4 *records for RN* **151689**

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	1.00	TOP SOIL
2	1.00	4.00	BROWN CLAY, BROKEN ROCK
3	4.00	14.00	ROCK: WEATHERED
4	14.00	16.00	ROCK: BROKEN *

Stratigraphies

0 *records for RN* **151689**

Aquifers

1 *records for RN* **151689**

Rec	Top (m)	Bottom (m)	Lithology	Date	SWL (m)	Flow	Quality	Yield (L/s)	Contr	Cond	Formation Name
1	15.00		AGGL - Agglomerate	03/07/2012	-12.00	N			Y	FR	CALLIOPE BEDS

Pump Tests Part 1

0 *records for RN* **151689**

Pump Tests Part 2

0 *records for RN* **151689**

Bore Conditions

0 *records for RN* **151689**

Elevations

0 *records for RN* **151689**

Water Analysis Part 1

0 *records for RN* **151689**

Water Analysis Part 2

0 *records for RN* **151689**

Water Levels

0 *records for RN* **151689**

Wire Line Logs

0 *records for RN* **151689**

Field Measurements

0 *records for RN* **151689**

Bore Report

From Year:

Special Water Analysis

0 *records for RN* **151689**

HSM ☐ PUM ☐

CQE
THE DRILLER OF CHOICE

Date: 08/09/2025

Client: GRAYMONT PTY LTD

Ph: 07 49754100

Job Report

HOLE FM7

Date Commenced: 29/08/2025

Date Completed: 29/08/2025

Water bore Depth From: 0 m

Water Bore Depth To: 30 m

Casing 50 **mm Inside Diameter From:** + .68 m

Casing 50 **mm Inside Diameter To:** 26.75 m

Your Aquifer Depth From: N/A m

Your Aquifer Depth To: N/A m

Your Water Bore Yield, Litres/Second: N/A

Your Water Bore quality, Total Solids: EC 695

Recommended Pump Suction Placement Depth: N/A m

Standing Water Level: 15.66 m

Comments: STANDING WATER LEVEL RECORDED FROM TOP OF 50MM CASING.
NO AQUIFER INTERSECTED. INSUFFICIENT FLOW TO MEASURE

DON IRVINE

Central Queensland Exploration Pty Ltd, 6 Bentley Street Gladstone South QLD 4680

ABN: 28658799314

SECTI... | Typ & materia size | Cement | Bentonite | G-Pack 2-3mm | G-Pack 2-3mm | 1/1

W2F136 v6
Collection of information on this form is the Department. The information may be

Water bore drilling log

Queensland Government

Ensure you have generated a Log ID number prior to submitting >

Click to

Log ID # 40485048

Authorisation details
Registered number _____ Development permit number _____ Works reference number _____

SECTION A—LOCATION DETAILS

Name of landholder GRAYMONT PTY LTD WEll No:FM7 Phone No. 0749754100

Postal address _____ Postcode _____

Real property address MS 24 TARAGOOLA ROAD CALLIOPE QLD Postcode 4680

Real property description Lot 7 Plan SP215269 or Bore location GPS. Latitude -24.098646 Longitude 151.240270 Datum WGS-84

Easting _____ Northing _____ Zone _____

SECTION B—BORE COMPLETION DETAILS

Date commenced 29/8/25

Date completed 29/8/25

SECTION C—DRILLING METHOD

☐ Rotary mud ☐ Cable tool
☐ Auger ☑ Rotary air
☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
171	0	30

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
PVC	60.60	5.3	+ .68	26.75

SECTION F—CENTRALISERS

Type	Location (metres) From	To
kwikzip	@	13m

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
Slots	60.60	1.00	14.75	26.75

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
Cement	171	60.60	0	7
Bentonite	171	60.60	7	8
G-Pack 2-3mm	171	60.60	8	26.75
G-Pack 2-3mm	171		26.75	30

SECTION I—BORE PURPOSE

☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial
☐ Urban ☐ Industrial ☑ Other (please specify) Monitoring Bore

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	1	Surface Top Soils	
1	6	Brown Rock and White Clays	
6	12	Decomposed Andesite	
12	16	Brown Andesite	
16	30	Blue Grey Limestones	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Conductivity (µS/cm)*	pH
None				
Seepage				
Only	N/A	None		

Final Conductivity (µS/cm): 695 Final pH:

*Fresh, brackish or salty. Laboratory testing is recommended before human consumption.

SECTION L—SUB ARTESIAN BORE ON COMPLETION

Depth to standing water level from ground level: 14.98 (metres)

Depth to pump suction or bottom of drill stem: N/A (metres)

Type of test used ☐ Air ☐ Bail ☐ Pump

Estimated supply: None (litres/second)

Duration of test: 2 (hours)

Drawdown level from surface: N/A (metres)

SECTION M—ARTESIAN BORE ON COMPLETION

Shut-in pressure (kPa)

Free flow (litres/second)

Temperature (°C)

SECTION N—REMARKS

No Aquifer intersected, unable to measure flow, SWL and EC recorded 1 week after drilling. For monitoring purposes only.

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 is true and accurate.

Driller name Don Irvine Driller's licence no. 3476

Trainee Driller name N. Blackenesee Driller's licence no. N/A

Signature of driller _____ Date 8/9/2025

Contractor name CENTRAL QUEENSLAND EXPLORATION PTY LTD

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HSM ☐ PUM ☐

CQE
THE DRILLER OF CHOICE

Date: 08/09/2025

Client: GRAYMONT PTY LTD

Ph: 07 49754100

Job Report

HOLE FM8

Date Commenced:	30/08/20205	
Date Completed:	30/08/2025	
Water bore Depth From:	0	m
Water Bore Depth To:	30	m
Casing 50 **mm Inside Diameter From:**	+ .7	m
Casing 50 **mm Inside Diameter To:**	27.7	m
Your Aquifer Depth From:	N/A	m
Your Aquifer Depth To:	N/A	m
Your Water Bore Yield, Litres/Second:	N/A	
Your Water Bore quality, Total Solids: EC	662	
Recommended Pump Suction Placement Depth:	N/A	m
Standing Water Level:	16.17	m

Comments: STANDING WATER LEVEL AND EC MEASURED 7 DAYS AFTER DRILL.
NO AQUIFER INTERSECTED. NO FLOW. INSUFFICIENT WATER TO TEST.

DON IRVINE

Water bore drilling log

Queensland Government

Ensure you have generated a Log ID number prior to submitting >

Click to generate log ID

Log ID # 85421754

Authorisation details
Registered number ____ Development permit number ____ Works reference number ____

SECTION A—LOCATION DETAILS

Name of landholder: GRAYMONT PTY LTD Well No: FM8 Phone No.: 49754100

Postal address: ____ Postcode: ____

Real property address: MS 24 TARAGOOLA ROAD CALLIOPE QLD Postcode: 4680

Real property description Lot: 7 Plan: SP215269 or Bore location GPS. Latitude: -24.108563 Longitude: 151.244195 Datum: WGS-84

Easting: ____ Northing: ____ Zone: ____

SECTION B—BORE COMPLETION DETAILS

Date commenced: 30/8/25

Date completed: 30/8/25

SECTION C—DRILLING METHOD

- ☐ Rotary mud
- ☐ Cable tool
- ☐ Auger
- ☑ Rotary air
- ☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
171	0	30

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
PVC	60.60	5.30	+.70	27.7

SECTION F—CENTRALISERS

Type	Location (metres) From	To
Kwikzip	@	13

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
Slots	60.60	1.00	12.7	27.7

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
Cement	171	60.60	0	9
Bentonite	171	60.60	9	10
G-Pack 2-3mm	171	60.60	10	27.7
G-Pack 2-3mm	171		27.7	30

SECTION I—BORE PURPOSE

- ☐ Domestic
- ☐ Stock
- ☐ Irrigation
- ☐ Commercial
- ☐ Urban
- ☐ Industrial
- ☑ Other (please specify) Monitoring

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	1	Surface Soils	
1	7	Brown Silty Rock	
7	11	Decomposed Andesite	
11	15.5	Brown Andesite	
15.5	30	Blue/Grey Limestones	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Conductivity (µS/cm)*	pH
None				

Final Conductivity (µS/cm): 662 Final pH:

*Fresh, brackish or salty. Laboratory testing is recommended before human consumption.

SECTION L—SUB ARTESIAN BORE ON COMPLETION

Depth to standing water level from ground level: 15.47 (metres)

Depth to pump suction or bottom of drill stem: N/A (metres)

Type of test used ☐ Air ☐ Bail ☐ Pump

Estimated supply	Duration of test	Drawdown level from surface
None (litres/second)	2 (hours)	(metres)

SECTION M—ARTESIAN BORE ON COMPLETION

Shut-in pressure	Free flow	Temperature
(kPa)	(litres/second)	(°C

SECTION N—REMARKS

No Aquifer Intersected, Insufficient water flow to measure. SWL and Conductivity measured 1 week after drilling. Very slight seepage only.

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 is true and accurate.

Driller name: Don Irvine Driller's licence no.: 3476

Trainee Driller name: Neville Blackenesee Driller's licence no.: ____

Signature of driller: ____ Date: 8/9/2025

Contractor name: CENTRAL QUEENSLAND EXPLORATION PTY LTD

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HSM ☐ PUM ☐

CQE

THE DRILLER OF CHOICE

Date: 08/09/2025

Client: GRAYMONT PTY LTD

Ph: 07 49754100

Job Report

HOLE FM9

Date Commenced:	31/08/2025	
Date Completed:	31/08/2025	
Water bore Depth From:	0	m
Water Bore Depth To:	30	m
Casing 50 **mm Inside Diameter From:**	+ .82	m
Casing 50 **mm Inside Diameter To:**	27.21	m
Your Aquifer Depth From:	N/A	m
Your Aquifer Depth To:	N/A	m
Your Water Bore Yield, Litres/Second:	N/A	
Your Water Bore quality, Total Solids:	606	
Recommended Pump Suction Placement Depth:	N/A	m
Standing Water Level:	10.98	m

Comments: CLEAN OUT AND COMPLETE. NO AQUIFER INTERSECTED.
INSUFFICIENT FLOW TO MEASURE

DON IRVINE

Water bore drilling log

Ensure you have generated a Log ID number prior to submitting >

Click to generate log ID

Log ID # 11701900

Authorisation details
Registered number _____ Development permit number _____ Works reference number _____

SECTION A—LOCATION DETAILS
Name of landholder: Graymont Pty Ltd Well No:FM9 Phone No. 49754100
Postal address _____ Postcode _____
Real property address: MS 24 TARAGOOLA ROAD CALLIOPE QLD Postcode 4680
Real property description Lot 7 Plan SP215269 or Bore location GPS. Latitude -24.109556 Longitude 151.236067 Datum WGS-84
Easting _____ Northing _____ Zone _____

SECTION B—BORE COMPLETION DETAILS
Date commenced 31/8/25
Date completed 31/8/25

SECTION C—DRILLING METHOD
☐ Rotary mud ☐ Cable tool
☐ Auger ☑ Rotary air
☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
171	0	30

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
PVC	60.60	5.30	+.82	27.21

SECTION F—CENTRALISERS

Type	Location (metres) From	To
Kwikzip	@	13

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
Slots	60.60	1.0	12.21	27.21

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
Cement	171	60.60	0	9.50
Bentonite	171	60.60	9.50	11
G-Pack 2-3mm	171	60.60	11	27.21
G-Pack 2-3mm	171	60.60	27.21	30

SECTION I—BORE PURPOSE
☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial
☐ Urban ☐ Industrial ☑ Other (please specify) Monitoring

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	1	Top Soils	
1	7	Brown Rock and Light silty clays	
7	11	Decomposed Andesites	
11	16	Brown Andesites	
16	30	Blue and Grey Limestone	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Conductivity (µS/cm)*	pH
None				

Final Conductivity (µS/cm): 606 Final pH:
*Fresh, brackish or salty. Laboratory testing is recommended before human consumption.

SECTION L—SUB ARTESIAN BORE ON COMPLETION
Depth to standing water level from ground level: 10.16 (metres)
Depth to pump suction or bottom of drill stem: N/A (metres)
Type of test used ☐ Air ☐ Bail ☐ Pump
Estimated supply: None (litres/second)
Duration of test: 2 (hours)
Drawdown level from surface: (metres)

SECTION M—ARTESIAN BORE ON COMPLETION
Shut-in pressure: (kPa)
Free flow: (litres/second)
Temperature: (°C)

SECTION N—REMARKS
No Aquifer Intersected, Insufficient flow to measure. SWL and Ec measured 1 week after drilling slight seepage only.

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 is true and accurate.
Driller name: Don Irvine Driller's licence no. 3476
Trainee Driller name: Neville Blackenesee Driller's licence no. NA
Signature of driller _____ Date 8/9/2025
Contractor name: CENTRAL QUEENSLAND EXPLORATION PTY LTD

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Water bore drilling log

Ensure you have generated a Log ID number prior to submitting > Click to generate log ID

Log ID # 7960371

Authorisation details
Registered number ..... Development permit number ..... Works reference number .....

SECTION A—LOCATION DETAILS
Name of landholder Graymont Phone No. .....
Postal address ..... Postcode .....
Real property address Taragoola Road, Taragoola Postcode 4680
Real property description Lot ..... Plan ..... or Bore location GPS. Latitude 24.06.48"S Longitude 151.14.09"E Datum .....
Easting ..... Northing ..... Zone .....

SECTION B—BORE COMPLETION DETAILS
Date commenced 8/2/26
Date completed 8/2/26

SECTION C—DRILLING METHOD
☐ Rotary mud ☐ Cable tool
☐ Auger ☑ Rotary air
☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
100	0	24.8

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
pvc	60	cl18	0	24.8

SECTION F—CENTRALISERS

Type	Location (metres) From	To

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
screen	60	0.5	18.8	24.8

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
cement	100	60	0	8
cuttings	100	60	8	10
bentonite	100	60	10	11
gravel	100	60	11	24.8

SECTION I—BORE PURPOSE
☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial
☐ Urban ☐ Industrial ☑ Other (please specify) Monitoring

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	1	Fill	
1	2	Black Soil	
2	3	Clay	
3	7	Weathered Rock	
7	25	Rock	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Conductivity (µS/cm)*	pH
19	13	0.25	360	

Final Conductivity (µS/cm): Final pH:
*Fresh, brackish or salty. Laboratory testing is recommended before human consumption.

SECTION L—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 ☐ Air ☐ Bail ☐ Pump
Estimated supply (litres/second)
Duration of test (hours)
Drawdown level from surface (metres)

SECTION M—ARTESIAN BORE ON COMPLETION
Shut-in pressure (kPa)
Free flow (litres/second)
Temperature (°C)

SECTION N—REMARKS
HOLE 11 - Monument Installed

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 is true and accurate.
Driller name Tony W Driller's licence no. 3523
Trainee Driller name ..... Driller's licence no. .....
Signature of driller ..... Date 10/2/2026
Contractor name JAB Drilling

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Water bore drilling log

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Authorisation details
Registered number ..... Development permit number ..... Works reference number .....

Log ID # 15848284

SECTION A—LOCATION DETAILS
Name of landholder Graymont Phone No. .....
Postal address ..... Postcode .....
Real property address Taragoola Road, Taragoola Postcode 4680
Real property description Lot ..... Plan ..... or Bore location GPS. Latitude 24.06.57"S Longitude 151.14.38"E Datum .....
Easting ..... Northing ..... Zone .....

SECTION B—BORE COMPLETION DETAILS
Date commenced 6/2/26
Date completed 6/2/26

SECTION C—DRILLING METHOD
☐ Rotary mud ☐ Cable tool
☐ Auger ☑ Rotary air
☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
100	0	31

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
pvc	60	cl18	0	31

SECTION F—CENTRALISERS

Type	Location (metres) From	To

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
screen	60	0.5	25	31

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
cement	100	60	0	8
cuttings	100	60	8	19
bentonite	100	60	19	21
gravel	100	60	21	31

SECTION I—BORE PURPOSE
☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial
☐ Urban ☐ Industrial ☑ Other (please specify) Monitoring

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	1	Topsoil and rocks	
1	31	Blue rock	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Conductivity (µS/cm)*	pH
25.2	16.7	0.25	622	

Final Conductivity (µS/cm): Final pH:
*Fresh, brackish or salty. Laboratory testing is recommended before human consumption.

SECTION L—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 ☐ Air ☐ Bail ☐ Pump
Estimated supply (litres/second) Duration of test (hours) Drawdown level from surface (metres)

SECTION M—ARTESIAN BORE ON COMPLETION
Shut-in pressure (kPa) Free flow (litres/second) Temperature (°C)

SECTION N—REMARKS

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 is true and accurate.
Driller name Tony W Driller's licence no. 3523
Trainee Driller name ..... Driller's licence no. .....
Signature of driller ..... Date 10/2/2026
Contractor name JAB Drilling

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Water bore drilling log

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Log ID # 71752018

Authorisation details
Registered number ..... Development permit number ..... Works reference number .....

SECTION A—LOCATION DETAILS
Name of landholder Graymont Phone No. .....
Postal address ..... Postcode .....
Real property address Taragoola Road, Taragoola Postcode 4680
Real property description Lot ..... Plan ..... or Bore location GPS. Latitude 24.07.13"S Longitude 151.14.00"E Datum .....
Easting ..... Northing ..... Zone .....

SECTION B—BORE COMPLETION DETAILS
Date commenced 7/2/26
Date completed 7/2/26

SECTION C—DRILLING METHOD
☐ Rotary mud ☐ Cable tool
☐ Auger ☑ Rotary air
☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
100	0	31

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
pvc	60	cl18	0	31

SECTION F—CENTRALISERS

Type	Location (metres) From	To

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
screen	60	0.5	25	31

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
cement	100	60	0	8
cuttings	100	60	8	19
bentonite	100	60	19	21
gravel	100	60	21	31

SECTION I—BORE PURPOSE
☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial
☐ Urban ☐ Industrial ☑ Other (please specify) Monitoring

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	1	Topsoil and rocks	
1	3	Yellow Rock	
3	16	Weathered Rock	
16	31	Rock	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Conductivity (µS/cm)*	pH
26.1	14.4	0.15	424	

Final Conductivity (µS/cm): Final pH:
*Fresh, brackish or salty. Laboratory testing is recommended before human consumption.

SECTION L—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 ☐ Air ☐ Bail ☐ Pump
Estimated supply (litres/second)
Duration of test (hours)
Drawdown level from surface (metres)

SECTION M—ARTESIAN BORE ON COMPLETION
Shut-in pressure (kPa)
Free flow (litres/second)
Temperature (°C)

SECTION N—REMARKS
HOLE 12 - Monument Installed

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 is true and accurate.
Driller name Tony W Driller's licence no. 3523
Trainee Driller name ..... Driller's licence no. .....
Signature of driller ..... Date 10/2/2026
Contractor name JAB Drilling

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Water bore drilling log

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Log ID # 74444745

Authorisation details
Registered number ..... Development permit number ..... Works reference number .....

SECTION A—LOCATION DETAILS
Name of landholder Graymont Phone No. .....
Postal address ..... Postcode .....
Real property address Taragoola Road, Taragoola Postcode 4680
Real property description Lot ..... Plan ..... or Bore location GPS. Latitude 24.05.57"S Longitude 151.14.04"E Datum .....
Easting ..... Northing ..... Zone .....

SECTION B—BORE COMPLETION DETAILS
Date commenced 8/2/26
Date completed 9/2/26

SECTION C—DRILLING METHOD
☐ Rotary mud ☐ Cable tool
☐ Auger ☑ Rotary air
☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
100	0	7.7

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
pvc	60	cl18	0	7.7

SECTION F—CENTRALISERS

Type	Location (metres) From	To

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
screen	60	0.5	4.7	7.7

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
cement	100	60	0	2
bentonite	100	60	2	3
Gravel	100	60	3	7.7

SECTION I—BORE PURPOSE
☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial
☐ Urban ☐ Industrial ☑ Other (please specify) Monitoring

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	1	Top Soil	
1	4	Sandy Clay	
4	7.7	Rock	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Conductivity (µS/cm)*	pH
4	2.7	1.0	298	

Final Conductivity (µS/cm): Final pH:
*Fresh, brackish or salty. Laboratory testing is recommended before human consumption.

SECTION L—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 ☐ Air ☐ Bail ☐ Pump
Estimated supply (litres/second) | Duration of test (hours) | Drawdown level from surface (metres)

SECTION M—ARTESIAN BORE ON COMPLETION
Shut-in pressure (kPa) | Free flow (litres/second) | Temperature (°C)

SECTION N—REMARKS
HOLE 10 - Monument Installed

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 is true and accurate.
Driller name Tony W Driller's licence no. 3523
Trainee Driller name ..... Driller's licence no. .....
Signature of driller ..... Date 10/2/2026
Contractor name JAB Drilling

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Appendix 2: Bore Monitoring March 2026 Field notes and Laboratory Certificate of Analysis

Alpha Concepts
innovation implementation

GROUNDWATER MONITORING FIELD SHEET

Project Name:	Graymont Bore Monitoring		
Project Number:		**Well ID:** FMB 515	
Recorded By:	L Rehm	**Well Type:** (Monitoring) Other	
Sampled By:	L Rehm	**Well Material:** (PVC) SS	
Field Instruments Used	**Model**	**Calibration Frequency**	**Field Calibration Date**
Oakton PC Testr35		Fortnightly	2013
Extech DO Meter		After several days of non-use	2013 - 23/3
Palintest Turbimeter CT12^		SDVB calibration recommended monthly using SDVB standards	2013

WELL PURGING: Purge the well to remove stagnant water from the bore. Remove a minimum of three well volumes, and purge until the EC, pH and Temp stabilise (see table below). Effective purging is demonstrated by stabilisation of water quality parameters. A representative sample can then be collected.

Well Measurements: Well Diameter (**D**): 50 mm Well Radius (**R**): 0.025 m

Total Depth of Well (**TD**): _____ m bTOC Surface Water Level (**SWL**): 11.65 m bTOC

Calculate Three Well Volumes:

Water column length (**H**)= **TD - SWL**= 18.35 m

Well Volume (**WV**)= 3.14*R^2*H= 0.036 m^3

Three well volumes (in litres) = 3***WV***1000= 108 L (where WV in m^3)

Date: 23/3/26 **SWL$_{initial}$:** 11.65 m bTOC **SWL$_{final}$:** 13.4 m bTOC **Total Purge Volume:** 125 L

Record of physio-chemical parameters during purging

Time	Vol. Purged (L)	EC (µS/cm)	pH	Temp (°C)	Turbidity (NTU)	DO (mg/L)	Comments (colour, turbidity, sheen, odour)
9:31	25	1474	6.0	26.8	7.57	4.0	Clear
9:35	50	1494	5.8	26.8	9.07	4.2	
9:39	75	1452	5.8	26.2	7.28	3.4	
9:43	100	1518	5.7	25.9	9.51	3.5	
Groundwater equilibrium reached at:		**± 10%**	**± 3%**	**± 0.2°C**	-	-	

Disposal of Purged Water: (Surface) Drums Sewer Stormwater Other

WELL SAMPLING:

Date: 24/3 **Time:** 09:24 **Time elapsed since purging:** **SWL$_{initial}$:** 12.35 m bTOC

Sampling Method: Bailer – Type: Teflon PVC SS Pump – Type: Submersible Bladder Other

Sample ID	EC (µS/cm)	pH	Temp (°C)	DO (mg/L)	Turbidity (NTU)	Comments
FMS B	1255	6.85	26.4	2.9	56.2	Slightly silty

Quality Control Samples:

Sample ID	Type (Rep, Split, Rinsate, Trip Blank)	Primary

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GROUNDWATER MONITORING FIELD SHEET

Project Name:	Groyne and Bore Monitoring		
Project Number:		**Well ID:** EMBH6	
Recorded By:	C Rahm	**Well Type:** (Monitoring) Other	
Sampled By:	C Rahm	**Well Material:** (PVC) SS	
Field Instruments Used	**Model**	**Calibration Frequency**	**Field Calibration Date**
Oakton PC Testr35		Fortnightly	2015
Extech DO Meter		After several days of non-use	23/5
Palintest Turbimeter CT12^		SDVB calibration recommended monthly using SDVB standards	2015

WELL PURGING: Purge the well to remove stagnant water from the bore. Remove a minimum of three well volumes, and purge until the EC, pH and Temp stabilise (see table below). Effective purging is demonstrated by stabilisation of water quality parameters. A representative sample can then be collected.

Well Measurements: Well Diameter (**D**): 50 mm Well Radius (**R**): 0.025 m
Total Depth of Well (**TD**): ~~50.5~~ m bTOC Surface Water Level (**SWL**): 18.65 m bTOC
Calculate Three Well Volumes:
Water column length (**H**)= **TD** - **SWL**= 44.85 m
Well Volume (**WV**)= 3.14*R^2*H= 0.088 m^3
Three well volumes (in litres) = 3***WV***1000= 264 L (where WV in m^3)

Date: 23/5 **SWL**$_{Initial}$: 18.65 m bTOC **SWL**$_{final}$: 17.4 m bTOC **Total Purge Volume:** 75 L

Record of physio-chemical parameters during purging

Time	Vol. Purged (L)	EC (µS/cm)	pH	Temp (°C)	Turbidity (NTU)	DO (mg/L)	Comments (colour, turbidity, sheen, odour)
15:29	25	1096	5.0	26.5	24.4	6.6	Clear with white particles
15:40	50	1196	5.7	26.8	16.38	6.6	"
15:46	60	1123	5.8	26.6	10.16	6.7	"
Groundwater equilibrium reached at:		**± 10%**	**± 3%**	**± 0.2°C**	-	-	

Disposal of Purged Water: (Surface) Drums Sewer Stormwater Other

WELL SAMPLING:

Date: 24/5 **Time:** 12:27 **Time elapsed since purging:** 15:7 **SWL**$_{Initial}$: 18.69 m bTOC
Sampling Method: Bailer – Type: Teflon PVC SS Pump – Type: Submersible Bladder Other

Sample ID	EC (µS/cm)	pH	Temp (°C)	DO (mg/L)	Turbidity (NTU)	Comments
	920	6.7	25.5	3.3	38.6	

Quality Control Samples:

Sample ID	Type (Rep, Split, Rinsate, Trip Blank)	Primary

Alpha Concepts
Innovation Implementation

GROUNDWATER MONITORING FIELD SHEET

Project Name:	Graymont Bore Monitoring		
Project Number:		**Well ID:** FMB#7	
Recorded By:	L Rehan	**Well Type:** Monitoring Other	
Sampled By:	L Rehan	**Well Material:** PVC SS	
Field Instruments Used	**Model**	**Calibration Frequency**	**Field Calibration Date**
Oakton PC Testr35		Fortnightly	2013
Extech DO Meter		After several days of non-use	2013 - 23/3
Palintest Turbimeter CT12^		SDVB calibration recommended monthly using SDVB standards	2013

WELL PURGING: Purge the well to remove stagnant water from the bore. Remove a minimum of three well volumes, and purge until the EC, pH and Temp stabilise (see table below). Effective purging is demonstrated by stabilisation of water quality parameters. A representative sample can then be collected.

Well Measurements: Well Diameter (**D**): 50 mm Well Radius (**R**): 0.025 m
Total Depth of Well (**TD**): 30 m bTOC Surface Water Level (**SWL**): 13.4 m bTOC
Calculate Three Well Volumes:
Water column length (**H**)= **TD** - **SWL**= 16.6 m
Well Volume (**WV**)= 3.14*R^2*H= 0.0326 m^3
Three well volumes (in litres) = 3***WV***1000= 97.7 L (where WV in m^3)

Date: 23/3/26 **SWL$_{initial}$:** 13.4 m bTOC **SWL$_{final}$:** 13.6 m bTOC **Total Purge Volume:** 115 L

Record of physio-chemical parameters during purging

Time	Vol. Purged (L)	EC (µS/cm)	pH	Temp (°C)	Turbidity (NTU)	DO (mg/L)	Comments (colour, turbidity, sheen, odour)
0853	25	1138	7.3	26.0	113	3.2	slightly silty
0858	50	1136	6.5	26.2	32.0	3.5	Clear
0902	75	1161	5.9	25.9	14.02	3.3	
0907	100	1134	6.5	26.1	9.73	3.1	
0909	115	1139	6.4	26.1	7.98	3.2	
Groundwater equilibrium reached at:		± 10%	± 3%	± 0.2°C	-	-	

Disposal of Purged Water: (Surface) Drums Sewer Stormwater Other

WELL SAMPLING:

Date: 24/3 **Time:** 09:02 **Time elapsed since purging:** **SWL$_{initial}$:** 13.58 m bTOC
Sampling Method: Bailer – Type: Teflon PVC SS Pump – Type: Submersible Bladder Other

Sample ID	EC (µS/cm)	pH	Temp (°C)	DO (mg/L)	Turbidity (NTU)	Comments
FMBH7	1135	7.0	25.9	4.3	256	Clear Silty

Quality Control Samples:

Sample ID	Type (Rep, Split, Rinsate, Trip Blank)	Primary

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GROUNDWATER MONITORING FIELD SHEET

Project Name:	Grayment Bore Monitoring		
Project Number:		**Well ID:**	FMB #8
Recorded By:	C Rehan	**Well Type:**	(Monitoring) Other
Sampled By:	C Rehan	**Well Material:**	(PVC) SS

Field Instruments Used	Model	Calibration Frequency	Field Calibration Date
Oakton PC Testr35		Fortnightly	20/3
Extech DO Meter		After several days of non-use	23/3
Palintest Turbimeter CT12^		SDVB calibration recommended monthly using SDVB standards	20/3

WELL PURGING: Purge the well to remove stagnant water from the bore. Remove a minimum of three well volumes, and purge until the EC, pH and Temp stabilise (see table below). Effective purging is demonstrated by stabilisation of water quality parameters. A representative sample can then be collected.

Well Measurements: Well Diameter (**D**): 50 mm Well Radius (**R**): 0.025 m
Total Depth of Well (**TD**): 30 m bTOC Surface Water Level (**SWL**): 13.8 m bTOC
Calculate Three Well Volumes:
Water column length (**H**)= **TD** - **SWL**= ~~0.0318~~ 16.2 m
Well Volume (**WV**)= 3.14*R^2*H= 0.032 m^3
Three well volumes (in litres) = 3***WV***1000= ~~95.57~~ L (where WV in m^3)

Date: 22/3/26 | **SWL$_{initial}$:** 13.8 m bTOC | **SWL$_{final}$:** 15.4 m bTOC | **Total Purge Volume:** 60 L

Record of physio-chemical parameters during purging

Time	Vol. Purged (L)	EC (µS/cm)	pH	Temp (°C)	Turbidity (NTU)	DO (mg/L)	Comments (colour, turbidity, sheen, odour)
10:11	20	1505	7.3	26.5	176	0.9	Silty
10:19	35	1300	7.5	26.7	139	2.5	
10:30	50	1298	7.5	26.7	54.9	2.5	clear
10:36	60	1317	7.5	26.5	39.6	2.6	
Groundwater equilibrium reached at:		**± 10%**	**± 3%**	**± 0.2°C**	-	-	

Disposal of Purged Water: Surface Drums Sewer Stormwater Other

WELL SAMPLING:

Date: 24/3 **Time:** 09:45 **Time elapsed since purging:** **SWL$_{initial}$:** 13.9 m bTOC
Sampling Method: Bailer – Type: Teflon PVC SS Pump – Type: Submersible Bladder Other

Sample ID	EC (µS/cm)	pH	Temp (°C)	DO (mg/L)	Turbidity (NTU)	Comments
FMB ~~#8~~	1045	7.5	26.1	2.6	77.7	Slightly silty

Quality Control Samples:

Sample ID	Type (Rep, Split, Rinsate, Trip Blank)	Primary

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GROUNDWATER MONITORING FIELD SHEET

Project Name:	Graymoat Bore Monitoring		
Project Number:		**Well ID:** FMB #9	
Recorded By:	L Rehn	**Well Type:** Monitoring Other	
Sampled By:	L Rehn	**Well Material:** PVC SS	
Field Instruments Used	**Model**	**Calibration Frequency**	**Field Calibration Date**
Oakton PC Testr35		Fortnightly	2013
Extech DO Meter		After several days of non-use	2.5.13
Palintest Turbimeter CT12^		SDVB calibration recommended monthly using SDVB standards	2013

WELL PURGING: Purge the well to remove stagnant water from the bore. Remove a minimum of three well volumes, and purge until the EC, pH and Temp stabilise (see table below). Effective purging is demonstrated by stabilisation of water quality parameters. A representative sample can then be collected.

Well Measurements: Well Diameter (**D**): 50 mm Well Radius (**R**) 0.025 m

Total Depth of Well (**TD**): 30 m bTOC Surface Water Level (**SWL**): 9.8 m bTOC

Calculate Three Well Volumes:

Water column length (**H**)= **TD - SWL**= 20.2 m

Well Volume (**WV**)= 3.14***R**²***H**= 0.0396 m³

Three well volumes (in litres) = 3***WV***1000= 119 L (where WV in m³)

Date: 13/3/26 **SWL**$_{initial}$: 9.8 m bTOC **SWL**$_{final}$: 9.8 m bTOC **Total Purge Volume:** 120 L

Record of physio-chemical parameters during purging

Time	Vol. Purged (L)	EC (µS/cm)	pH	Temp (°C)	Turbidity (NTU)	DO (mg/L)	Comments (colour, turbidity, sheen, odour)
13:57	25	828	5.5	25.7	13.9	2.3	Clear
14:01	50	836	5.3	25.5	15.98	2.3	
14:05	75	815	5.2	25.5	13.46	2.3	
Groundwater reached at:	**equilibrium**	**± 10%**	**± 3%**	**± 0.2°C**	-	-	

*5.2

Disposal of Purged Water: Surface Drums Sewer Stormwater Other

WELL SAMPLING:

Date: 24/3 **Time:** 12-03 **Time elapsed since purging:** **SWL**$_{initial}$: 9.8 m bTOC

Sampling Method: Bailer – Type: Teflon PVC SS Pump – Type: Submersible Bladder Other

Sample ID	EC (µS/cm)	pH	Temp (°C)	DO (mg/L)	Turbidity (NTU)	Comments
	682	7.3	26.1	4.6	44.5	Clear

Quality Control Samples:

Sample ID	Type (Rep, Split, Rinsate, Trip Blank)	Primary

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GROUNDWATER MONITORING FIELD SHEET

Project Name:	Graymont Bore Monitoring		
Project Number:		**Well ID:**	FMB BL0
Recorded By:	C Rehan	**Well Type:**	Monitoring Other
Sampled By:	C Rehan	**Well Material:**	PVC SS

Field Instruments Used	**Model**	**Calibration Frequency**	**Field Calibration Date**
Oakton PC Testr35		Fortnightly	2013
Extech DO Meter		After several days of non-use	23/3
Palintest Turbimeter CT12^		SDVB calibration recommended monthly using SDVB standards	2013

WELL PURGING: Purge the well to remove stagnant water from the bore. Remove a minimum of three well volumes, and purge until the EC, pH and Temp stabilise (see table below). Effective purging is demonstrated by stabilisation of water quality parameters. A representative sample can then be collected.

Well Measurements: Well Diameter (**D**): 50 mm Well Radius (**R**): 0.025 m

Total Depth of Well (**TD**): 30 m bTOC Surface Water Level (**SWL**): 2 m bTOC

Calculate Three Well Volumes:

Water column length (**H**)= **TD** - **SWL**= 28 m

Well Volume (**WV**)= 3.14*R^2*H= 0.055 m^3

Three well volumes (in litres) = 3***WV***1000= ~~165~~ 165 L (where WV in m^3)

Date: 23/3/16 **SWL$_{initial}$:** 2 m bTOC **SWL$_{final}$:** 2.3 m bTOC **Total Purge Volume:** 225L

Record of physio-chemical parameters during purging =>2.1m =>3300L 12:40

Time	Vol. Purged (L)	EC (µS/cm)	pH	Temp (°C)	Turbidity (NTU)	DO (mg/L)	Comments (colour, turbidity, sheen, odour)
11:38	25	1110	6.7	25.0	16.93	5.2	Clear
11:41	50	1080	5.7	24.5	6.25	3.3	
11:44	75	1122	4.8	24.5	4.48	1.4	
11:47	100	1141	3.6	24.1	3.66	1.3	
11:53	150	1137	4.2	24.2	6.99	0.7	
11:59	200	1131	4.4	24.2	6.37	0.8	
Groundwater equilibrium reached at:		**± 10%**	**± 3%**	**± 0.2°C**	-	-	

Disposal of Purged Water: Surface Drums Sewer Stormwater Other

WELL SAMPLING:

Date: 24/3 **Time:** 10:20 **Time elapsed since purging:** **SWL$_{initial}$:** 2.1 m bTOC

Sampling Method: Bailer – Type: Teflon PVC SS Pump – Type: Submersible Bladder Other

Sample ID	EC (µS/cm)	pH	Temp (°C)	DO (mg/L)	Turbidity (NTU)	Comments
#10	930	7.4	26.4	3.2	40.1	Clear - some silt

Quality Control Samples:

Sample ID	Type (Rep, Split, Rinsate, Trip Blank)	Primary

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GROUNDWATER MONITORING FIELD SHEET

Project Name:	Grayground Bore Monitoring		
Project Number:		**Well ID:** FMB11	
Recorded By:	C Rehm	**Well Type:** Monitoring Other	
Sampled By:	C Rehm	**Well Material:** PVC SS	
Field Instruments Used	**Model**	**Calibration Frequency**	**Field Calibration Date**
Oakton PC Testr35		Fortnightly	2013
Extech DO Meter		After several days of non-use	25/3
Palintest Turbimeter CT12^		SDVB calibration recommended monthly using SDVB standards	2013

WELL PURGING: Purge the well to remove stagnant water from the bore. Remove a minimum of three well volumes, and purge until the EC, pH and Temp stabilise (see table below). Effective purging is demonstrated by stabilisation of water quality parameters. A representative sample can then be collected.

Well Measurements: Well Diameter (**D**): 50 mm Well Radius (**R**): 0.025 m

Total Depth of Well (**TD**): 29 m bTOC Surface Water Level (**SWL**): 7.95 m bTOC

Calculate Three Well Volumes:

Water column length (**H**)= **TD** - **SWL**= 21.9 m

Well Volume (**WV**)= 3.14*R^2*H= 0.043 m^3

Three well volumes (in litres) = 3*WV*1000= 128 L (where WV in m^3)

Date: 25/3 **SWL**$_{initial}$: 7.95 m bTOC **SWL**$_{final}$: 8.1 m bTOC **Total Purge Volume:** 125 L

Record of physio-chemical parameters during purging

Time	Vol. Purged (L)	EC (µS/cm)	pH	Temp (°C)	Turbidity (NTU)	DO (mg/L)	Comments (colour, turbidity, sheen, odour)
13:27	25	1426	5.7	25.0	42.9	2.4	Clear
13:31	50	1392	4.5	25.2	25.2	1.6	
13:34	75	1404	3.9	25.0	16.44	1.5	
13:38	100	1392	4.1	25.2	16.18	1.6	
Groundwater equilibrium reached at:		**± 10%**	**± 3%**	**± 0.2°C**	-	-	

Disposal of Purged Water: Surface Drums Sewer Stormwater Other

WELL SAMPLING:

Date: 25/3 **Time:** 11:10 **Time elapsed since purging:** **SWL**$_{initial}$: 7.1 m bTOC

Sampling Method: Bailer – Type: Teflon PVC SS Pump – Type: Submersible Bladder Other

Sample ID	EC (µS/cm)	pH	Temp (°C)	DO (mg/L)	Turbidity (NTU)	Comments
	1201	7.2	25.5	2.3	19.2	Clear

Quality Control Samples:

Sample ID	Type (Rep, Split, Rinsate, Trip Blank)	Primary

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GROUNDWATER MONITORING FIELD SHEET

Project Name:	Graymont Bore Monitoring		
Project Number:		**Well ID:** FMT3617	
Recorded By:	L Richter	**Well Type:** Monitoring Other	
Sampled By:	L Richter	**Well Material:** PVC SS	
Field Instruments Used	**Model**	**Calibration Frequency**	**Field Calibration Date**
Oakton PC Testr35		Fortnightly	20/3
Extech DO Meter		After several days of non-use	23/3
Palintest Turbimeter CT12^		SDVB calibration recommended monthly using SDVB standards	20/3

WELL PURGING: Purge the well to remove stagnant water from the bore. Remove a minimum of three well volumes, and purge until the EC, pH and Temp stabilise (see table below). Effective purging is demonstrated by stabilisation of water quality parameters. A representative sample can then be collected.

Well Measurements: Well Diameter (**D**): 50 mm Well Radius (**R**): 0.025 m
Total Depth of Well (**TD**): 30 m bTOC Surface Water Level (**SWL**): 13.3 m bTOC
Calculate Three Well Volumes:
Water column length (**H**)= **TD** - **SWL**= 16.7 m
Well Volume (**WV**)= 3.14*R^2*H= 0.033 m^3
Three well volumes (in litres) = 3***WV***1000= 99 L (where WV in m^3)

Date: 23/3 **SWL$_{initial}$:** 13.3 m bTOC **SWL$_{final}$:** 13.2 m bTOC **Total Purge Volume:** 125 L

Record of physio-chemical parameters during purging

Time	Vol. Purged (L)	EC (µS/cm)	pH	Temp (°C)	Turbidity (NTU)	DO (mg/L)	Comments (colour, turbidity, sheen, odour)
12:37	25	5580	6.1	27.8	56.7	1.4	Clear
12:42	50	6160	4.7	25.7	45.2	1.7	
12:48	75	6240	2.8	25.6	38.7	1.0	
12:53	100	6550	3.6	26.5	34.7	1.2	
Groundwater equilibrium reached at:		**± 10%**	**± 3%**	**± 0.2°C**	-	-	

Disposal of Purged Water: (Surface) Drums Sewer Stormwater Other

WELL SAMPLING:

Date: 24/3 **Time:** 10:50 **Time elapsed since purging:** **SWL$_{initial}$:** 13.25 m bTOC

Sampling Method: Bailer – Type: Teflon PVC SS Pump – Type: Submersible Bladder Other

Sample ID	EC (µS/cm)	pH	Temp (°C)	DO (mg/L)	Turbidity (NTU)	Comments
	4570	6.8	26.8	2.6	46.6	clear

Quality Control Samples:

Sample ID	Type (Rep, Split, Rinsate, Trip Blank)	Primary

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GROUNDWATER MONITORING FIELD SHEET

Project Name:	Graymont Bore Monitoring		
Project Number:		**Well ID:** FMB MB15	
Recorded By:	C Rehbein	**Well Type:** (Monitoring) Other	
Sampled By:	C Rehbein	**Well Material:** (PVC) SS	
Field Instruments Used	**Model**	**Calibration Frequency**	**Field Calibration Date**
Oakton PC Testr35		Fortnightly	2013
Extech DO Meter		After several days of non-use	2313
Palintest Turbimeter CT12^		SDVB calibration recommended monthly using SDVB standards	2013

WELL PURGING: Purge the well to remove stagnant water from the bore. Remove a minimum of three well volumes, and purge until the EC, pH and Temp stabilise (see table below). Effective purging is demonstrated by stabilisation of water quality parameters. A representative sample can then be collected.

Well Measurements: Well Diameter (**D**): 50 mm Well Radius (**R**): 0.025 m

Total Depth of Well (**TD**): 20 m bTOC Surface Water Level (**SWL**): 8.85 m bTOC

Calculate Three Well Volumes:

Water column length (**H**)= **TD** - **SWL**= 21.15 m

Well Volume (**WV**)= 3.14*R^2*H= 0.042 m^3

Three well volumes (in litres) = 3***WV***1000= 124 L (where WV in m^3)

Date: 23/3 **SWL$_{initial}$:** 8.85 m bTOC **SWL$_{final}$:** 9.5 m bTOC **Total Purge Volume:** 125L

Record of physio-chemical parameters during purging

Time	Vol. Purged (L)	EC (µS/cm)	pH	Temp (°C)	Turbidity (NTU)	DO (mg/L)	Comments (colour, turbidity, sheen, odour)
14:28	25	1528	4.7	25.1	25.0	1.7	Clear
14:33	50	1464	5.2	24.7	55.0	0.7	
14:37	75	1558	5.1	24.2	73.7	0.7	
14:43	100	1532	5.2	24.3	60.1	0.7	
Groundwater equilibrium reached at:		**± 10%**	**± 3%**	**± 0.2°C**	-	-	

Disposal of Purged Water: (Surface) Drums Sewer Stormwater Other

WELL SAMPLING:

Date: 24/3 **Time:** 11:43 **Time elapsed since purging:** **SWL$_{initial}$:** 8.8 m bTOC

Sampling Method: Bailer – Type: Teflon PVC SS Pump – Type: Submersible Bladder Other

Sample ID	EC (µS/cm)	pH	Temp (°C)	DO (mg/L)	Turbidity (NTU)	Comments
	1225	7.3	25.3	2.2	71.7	Cloudy

Quality Control Samples:

Sample ID	Type (Rep, Split, Rinsate, Trip Blank)	Primary

CERTIFICATE OF ANALYSIS

Work Order	: **EB2610576**	Page	: 1 of 11
Client	: **ALPHA CONCEPTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: LUKAS REHM	Contact	: Kelly Schafer
Address	: 55 CAIRNCROSS STREET GLADSTONE QLD, AUSTRALIA 4680	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61 7 4978 7944
Project	: Graymont	Date Samples Received	: 25-Mar-2026 10:25
Order number	:	Date Analysis Commenced	: 25-Mar-2026
C-O-C number	: 95663	Issue Date	: 01-Apr-2026 12:20
Sampler	: LUKAS REHM		
Site	: Graymont Monitoring Bores		
Quote number	: EN222 ALS Compass Quote V7		
No. of samples received	: 9		
No. of samples analysed	: 9		

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
- Surrogate Control Limits

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.

Signatories	*Position*	*Accreditation Category*
Beatriz Llarinas	Senior Chemist	Brisbane Inorganics, Stafford, QLD
Beatriz Llarinas	Senior Chemist	Brisbane Organics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Liam Cooley	Chemist	Brisbane Organics, 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.

- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- It is recognised that EG020T (Total Metals by ICP-MS) is less than EG020F (Dissolved Metals by ICP-MS) for some samples. However, the difference is within experimental variation of the methods.
- It is recognised that ED093T (Total Major Cations by ICP) is less than ED093F (Dissolved Major Cations by ICP) for some samples. However, the difference is within experimental variation of the methods.
- It is recognised that ED040T (Total Major Anions by ICP-AES) is less than ED040F (Dissolved Major Anions by ICP-AES) for 'FM 10' (EB2610576-004). However, the difference is within experimental variation of the methods.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: **GROUNDWATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	FMB 7	FM 5B	FM 8	FM 10	FMB 12
				Sampling date / time	24-Mar-2026 09:12	24-Mar-2026 09:33	24-Mar-2026 09:53	24-Mar-2026 10:31	24-Mar-2026 10:52
					EB2610576-001	EB2610576-002	EB2610576-003	EB2610576-004	EB2610576-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**6.96**	**7.04**	**8.05**	**7.27**	**7.04**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**810**	**1150**	**1030**	**870**	**4790**
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		**166**	**97**	**114**	**16**	**32**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	----	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		**320**	**353**	**590**	**302**	**528**
Total Alkalinity as CaCO3	----	1	mg/L		**320**	**353**	**590**	**302**	**528**
ED040F: Dissolved Major Anions									
Silicon as SiO2	7440-21-3	0.1	mg/L		**30.4**	**31.0**	**35.9**	**46.4**	**36.0**
ED040T: Total Major Anions									
Silicon as SiO2	7440-21-3	0.1	mg/L		**36.9**	**32.3**	**42.3**	**46.2**	**39.0**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**53**	**179**	**13**	**86**	**354**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**38**	**72**	**18**	**57**	**1080**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**130**	**193**	**63**	**93**	**353**
Magnesium	7439-95-4	1	mg/L		**10**	**17**	**42**	**15**	**162**
Sodium	7440-23-5	1	mg/L		**69**	**73**	**127**	**95**	**428**
Potassium	7440-09-7	1	mg/L		**1**	<1	<1	<1	**6**
ED093T: Total Major Cations									
Calcium	7440-70-2	1	mg/L		**150**	**206**	**68**	**104**	**397**
Magnesium	7439-95-4	1	mg/L		**10**	**17**	**44**	**15**	**164**
Sodium	7440-23-5	1	mg/L		**66**	**70**	**128**	**95**	**434**
Potassium	7440-09-7	1	mg/L		<1	<1	<1	<1	**5**

Analytical Results

Sub-Matrix: **GROUNDWATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	FMB 7	FM 5B	FM 8	FM 10	FMB 12
				Sampling date / time	24-Mar-2026 09:12	24-Mar-2026 09:33	24-Mar-2026 09:53	24-Mar-2026 10:31	24-Mar-2026 10:52
					EB2610576-001	EB2610576-002	EB2610576-003	EB2610576-004	EB2610576-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.07**	**0.02**	**0.53**	**0.11**	**0.31**
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	**0.002**	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	**0.001**	**0.002**
Copper	7440-50-8	0.001	mg/L		**0.004**	**0.011**	**0.011**	**0.005**	**0.044**
Nickel	7440-02-0	0.001	mg/L		**0.002**	**0.002**	**0.003**	**0.017**	**0.013**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**0.030**	**0.027**	**0.018**	**0.024**	**0.031**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	**0.38**	**0.19**	**0.37**
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**1.59**	**0.99**	**2.38**	**0.39**	**0.67**
Arsenic	7440-38-2	0.001	mg/L		**0.001**	<0.001	**0.004**	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	**0.003**	**0.003**	**0.002**
Copper	7440-50-8	0.001	mg/L		**0.010**	**0.063**	**0.016**	**0.005**	**0.043**
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.003**	**0.004**	**0.020**	**0.011**
Lead	7439-92-1	0.001	mg/L		<0.001	**0.002**	**0.002**	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**0.006**	**0.013**	**0.014**	**0.022**	**0.017**
Iron	7439-89-6	0.05	mg/L		**2.29**	**1.12**	**3.08**	**0.74**	**0.95**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	mg/L		**31.6**	**32.1**	**34.4**	**42.2**	**34.0**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**8.57**	**12.8**	**12.6**	**9.43**	**48.4**

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Sample ID	FMB 7	FM 5B	FM 8	FM 10	FMB 12
				Sampling date / time	24-Mar-2026 09:12	24-Mar-2026 09:33	24-Mar-2026 09:53	24-Mar-2026 10:31	24-Mar-2026 10:52
Compound	CAS Number	LOR	Unit		EB2610576-001	EB2610576-002	EB2610576-003	EB2610576-004	EB2610576-005
					Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued									
ø Total Cations	----	0.01	meq/L		**10.3**	**14.2**	**12.1**	**10.0**	**49.7**
ø Ionic Balance	----	0.01	%		**9.35**	**5.16**	**1.79**	**2.96**	**1.36**
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	**270**	**80**	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	**380**	**240**	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	**650**	**320**	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	**340**	**110**	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	**300**	**210**	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	**640**	**320**	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	**340**	**110**	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Sample ID	FMB 7	FM 5B	FM 8	FM 10	FMB 12
				Sampling date / time	24-Mar-2026 09:12	24-Mar-2026 09:33	24-Mar-2026 09:53	24-Mar-2026 10:31	24-Mar-2026 10:52
Compound	CAS Number	LOR	Unit		EB2610576-001	EB2610576-002	EB2610576-003	EB2610576-004	EB2610576-005
					Result	Result	Result	Result	Result
EP080S: TPH(V)/BTEX Surrogates - Continued									
1.2-Dichloroethane-D4	17060-07-0	2	%		**72.8**	**75.8**	**71.8**	**77.3**	**74.8**
Toluene-D8	2037-26-5	2	%		**82.1**	**84.2**	**90.3**	**105**	**93.3**
4-Bromofluorobenzene	460-00-4	2	%		**89.2**	**91.8**	**94.4**	**106**	**98.5**

Analytical Results

Sub-Matrix: **GROUNDWATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	FM 11	FM 13	FM 9	FM 6	----
				Sampling date / time	24-Mar-2026 11:12	24-Mar-2026 11:45	24-Mar-2026 12:08	24-Mar-2026 13:48	----
					EB2610576-006	EB2610576-007	EB2610576-008	EB2610576-009	--------
					Result	Result	Result	Result	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.18**	**7.89**	**6.95**	**7.14**	**----**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**1080**	**1200**	**601**	**743**	**----**
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		**13**	**70**	**31**	**15**	**----**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	----	1	mg/L		<1	<1	<1	<1	**----**
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	**----**
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**301**	**491**	**218**	**386**	**----**
Total Alkalinity as CaCO3	----	1	mg/L		**301**	**491**	**218**	**386**	**----**
ED040F: Dissolved Major Anions									
Silicon as SiO2	7440-21-3	0.1	mg/L		**31.1**	**38.5**	**32.3**	**51.3**	**----**
ED040T: Total Major Anions									
Silicon as SiO2	7440-21-3	0.1	mg/L		**32.6**	**40.8**	**32.5**	**53.3**	**----**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**58**	**24**	**10**	**64**	**----**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**171**	**128**	**26**	**27**	**----**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**148**	**63**	**103**	**145**	**----**
Magnesium	7439-95-4	1	mg/L		**22**	**54**	**5**	**11**	**----**
Sodium	7440-23-5	1	mg/L		**82**	**144**	**31**	**46**	**----**
Potassium	7440-09-7	1	mg/L		**1**	**2**	<1	<1	**----**
ED093T: Total Major Cations									
Calcium	7440-70-2	1	mg/L		**156**	**70**	**120**	**164**	**----**
Magnesium	7439-95-4	1	mg/L		**19**	**56**	**5**	**11**	**----**
Sodium	7440-23-5	1	mg/L		**73**	**141**	**31**	**45**	**----**
Potassium	7440-09-7	1	mg/L		**1**	**2**	<1	<1	**----**

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Sample ID	FM 11	FM 13	FM 9	FM 6	----
				Sampling date / time	24-Mar-2026 11:12	24-Mar-2026 11:45	24-Mar-2026 12:08	24-Mar-2026 13:48	----
Compound	CAS Number	LOR	Unit		EB2610576-006	EB2610576-007	EB2610576-008	EB2610576-009	--------
					Result	Result	Result	Result	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.17**	**0.71**	**0.19**	<0.01	**----**
Arsenic	7440-38-2	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	**----**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	**----**
Chromium	7440-47-3	0.001	mg/L		<0.001	**0.001**	**0.003**	<0.001	**----**
Copper	7440-50-8	0.001	mg/L		**0.006**	**0.014**	**0.010**	**0.002**	**----**
Nickel	7440-02-0	0.001	mg/L		**0.019**	**0.013**	**0.006**	**0.051**	**----**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**----**
Zinc	7440-66-6	0.005	mg/L		**0.014**	**0.013**	**0.022**	**0.024**	**----**
Iron	7439-89-6	0.05	mg/L		**0.23**	**0.63**	**0.57**	<0.05	**----**
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.52**	**1.96**	**0.62**	**0.13**	**----**
Arsenic	7440-38-2	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	**----**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	**----**
Chromium	7440-47-3	0.001	mg/L		**0.001**	**0.004**	**0.003**	**0.006**	**----**
Copper	7440-50-8	0.001	mg/L		**0.001**	**0.029**	**0.017**	**0.022**	**----**
Nickel	7440-02-0	0.001	mg/L		**0.020**	**0.013**	**0.007**	**0.056**	**----**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**----**
Zinc	7440-66-6	0.005	mg/L		**0.008**	**0.010**	**0.026**	**0.025**	**----**
Iron	7439-89-6	0.05	mg/L		**1.25**	**2.51**	**3.10**	**0.64**	**----**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	**----**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	**0.0006**	<0.0001	<0.0001	**----**
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	mg/L		**28.9**	**33.3**	**29.1**	**49.5**	**----**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**----**	**----**	**6.38**	**----**	**----**

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Sample ID	FM 11	FM 13	FM 9	FM 6	----
				Sampling date / time	24-Mar-2026 11:12	24-Mar-2026 11:45	24-Mar-2026 12:08	24-Mar-2026 13:48	----
Compound	CAS Number	LOR	Unit		EB2610576-006	EB2610576-007	EB2610576-008	EB2610576-009	--------
					Result	Result	Result	Result	----
EN055: Ionic Balance - Continued									
ø Total Anions	----	0.01	meq/L		**12.0**	**13.9**	**----**	**9.81**	**----**
ø Total Cations	----	0.01	meq/L		**12.8**	**13.9**	**6.90**	**10.1**	**----**
ø Ionic Balance	----	0.01	%		**----**	**----**	**3.92**	**----**	**----**
ø Ionic Balance	----	0.01	%		**2.99**	**0.06**	**----**	**1.68**	**----**
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	**----**
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	**----**
C15 - C28 Fraction	----	100	µg/L		<100	<100	**110**	**100**	**----**
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	**----**
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		<50	<50	**110**	**100**	**----**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	**----**
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	**----**
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	**----**
>C16 - C34 Fraction	----	100	µg/L		<100	<100	**110**	**110**	**----**
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	**----**
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	**110**	**110**	**----**
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	**----**
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	**----**
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	**----**
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	**----**
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	**----**
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	**----**
^ **Total Xylenes**	----	2	µg/L		<2	<2	<2	<2	**----**
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	**----**

Analytical Results

Sub-Matrix: **GROUNDWATER** (Matrix: **WATER**)			Sample ID	**FM 11**	**FM 13**	**FM 9**	**FM 6**	**----**
			Sampling date / time	24-Mar-2026 11:12	24-Mar-2026 11:45	24-Mar-2026 12:08	24-Mar-2026 13:48	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2610576-006**	**EB2610576-007**	**EB2610576-008**	**EB2610576-009**	**--------**
				Result	Result	Result	Result	----
EP080: BTEXN - Continued								
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	**----**
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**80.8**	**83.6**	**81.9**	**85.6**	**----**
Toluene-D8	2037-26-5	2	%	**96.2**	**90.0**	**91.0**	**91.7**	**----**
4-Bromofluorobenzene	460-00-4	2	%	**98.5**	**99.4**	**97.5**	**92.4**	**----**

Surrogate Control Limits

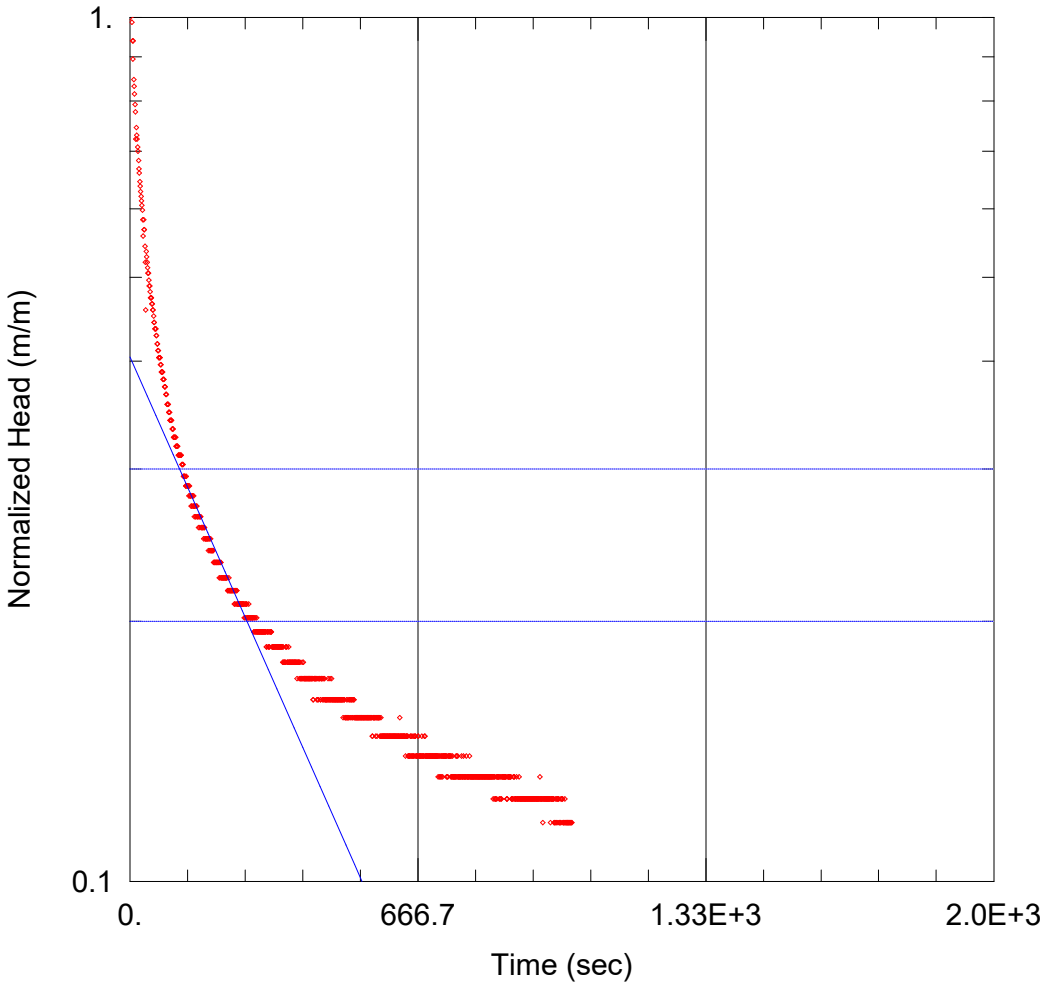
Sub-Matrix: **GROUNDWATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	66	138
Toluene-D8	2037-26-5	79	120
4-Bromofluorobenzene	460-00-4	74	118

Appendix 3: Slug test Analysis June 2025 and June 2026

FM6: Hydraulic Conductivity Test Analysis - June 2025

Prepared By:	Prepared For:
EnvironMine/Epic Environmental	Graymont
Project:	**Location:**
BAA250025.01	Calliope



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 4.244E-7 m/sec y0 = 0.2144 m

AQUIFER DATA

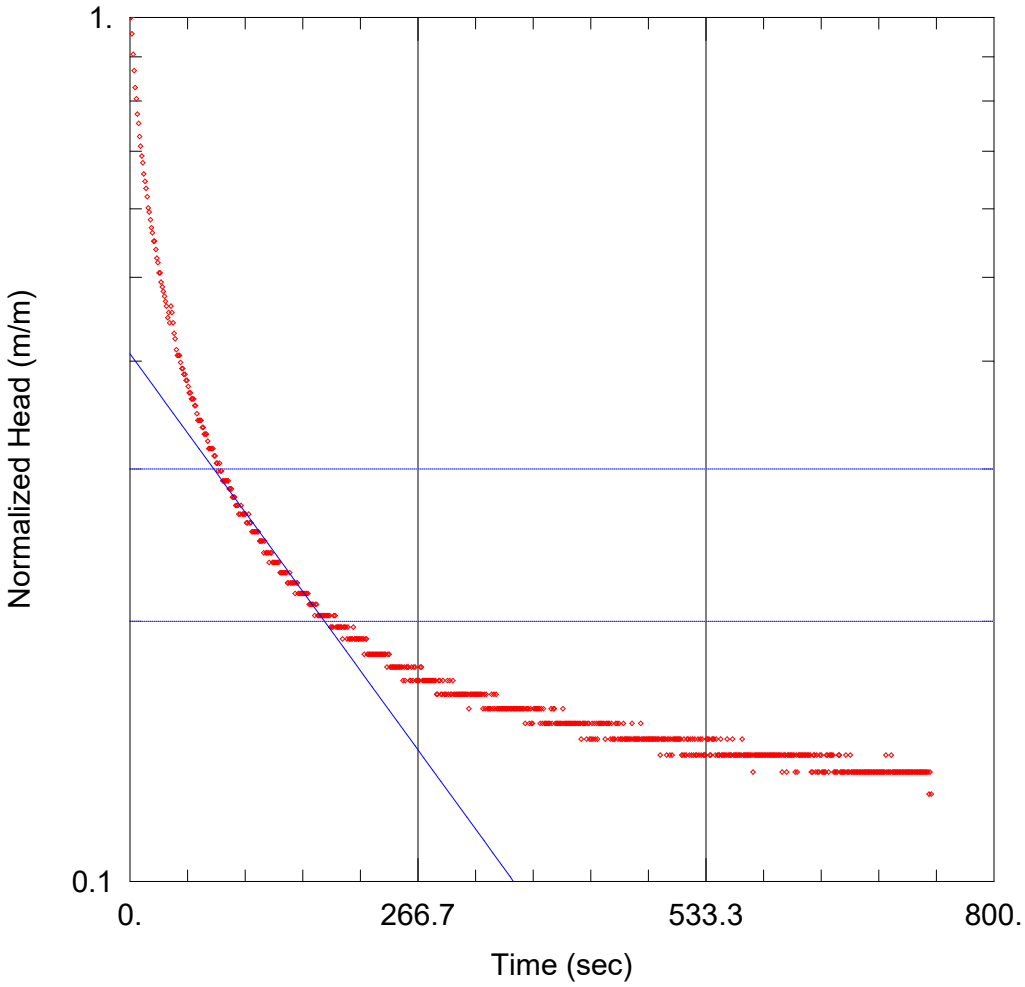
Saturated Thickness: 41.5 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (FM6)

Initial Displacement: 0.53 m
Static Water Column Height: 41.5 m
Total Well Penetration Depth: 41.5 m
Screen Length: 12. m
Casing Radius: 0.025 m
Well Radius: 0.0575 m

FM6: Hydraulic Conductivity Test Analysis - June 2025

Prepared By:	Prepared For:
EnvironMine/Epic Environmental	Graymont
Project:	**Location:**
BAA250025.01	Calliope



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 6.458E-7 m/sec y0 = 0.2651 m

AQUIFER DATA

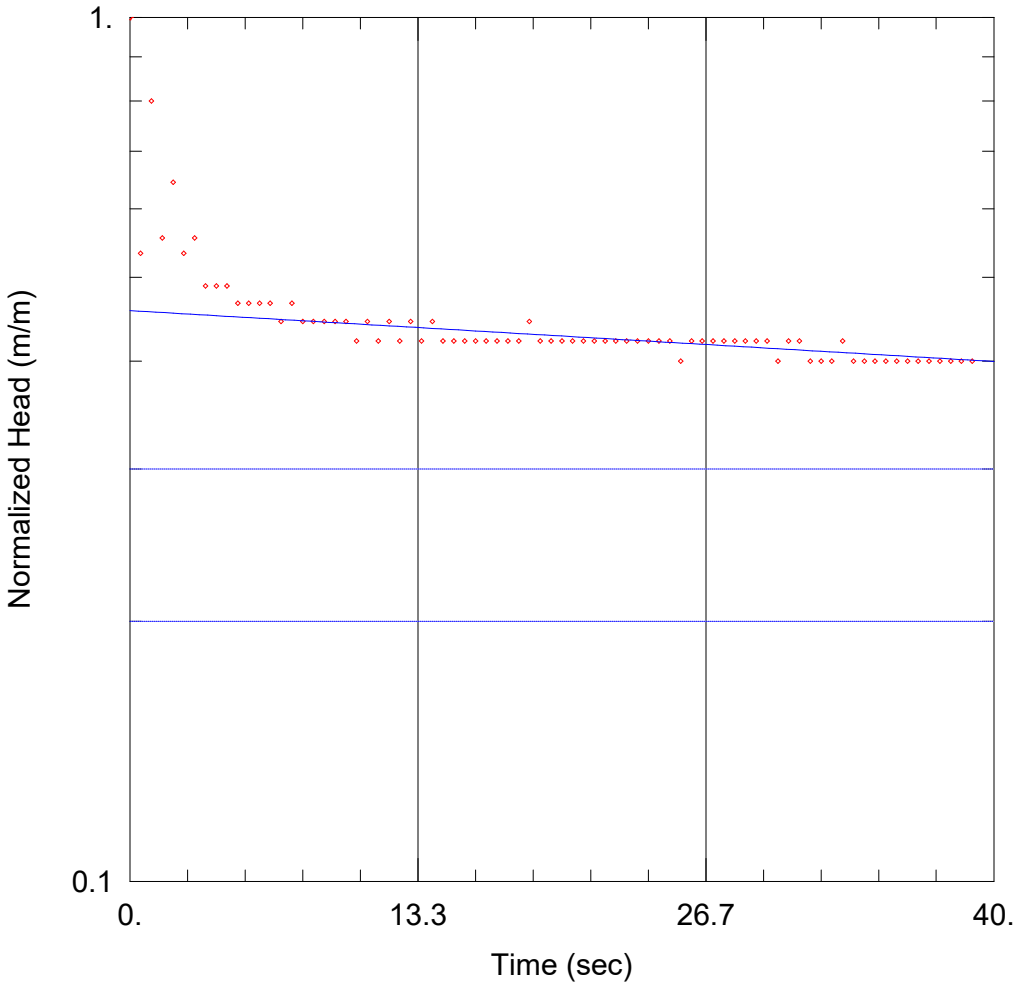
Saturated Thickness: 41.5 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (FM6)

Initial Displacement: 0.65 m
Static Water Column Height: 41.5 m
Total Well Penetration Depth: 41.5 m
Screen Length: 12. m
Casing Radius: 0.025 m
Well Radius: 0.0575 m

FM8: Hydraulic Conductivity Test Analysis - June 2026

Prepared By:	Prepared For:
Onterris	Graymont
Project:	**Location:**
BAA250025.01	Calliope



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.374E-6 m/sec y0 = 0.2059 m

AQUIFER DATA

Saturated Thickness: 10.5 m Anisotropy Ratio (Kz/Kr): 0.1

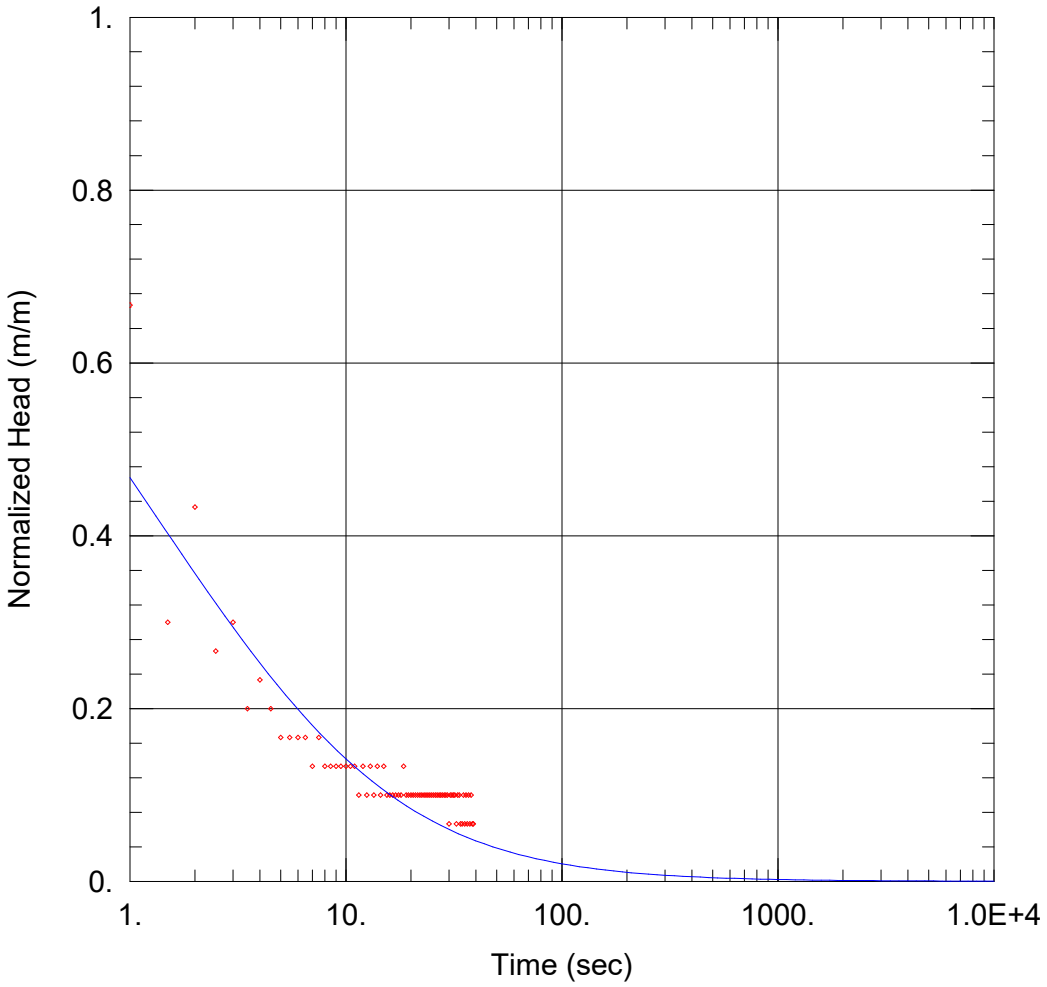
WELL DATA (FM8)

Initial Displacement: 0.45 m
Static Water Column Height: 10.5 m
Total Well Penetration Depth: 10.5 m
Screen Length: 10.5 m
Casing Radius: 0.025 m
Well Radius: 0.0855 m
Gravel Pack Porosity: 0.25

Onterris™

FM8: Hydraulic Conductivity Test Analysis - June 2026

Prepared By:	Prepared For:
Onterris	Graymont
Project:	**Location:**
BAA250025.01	Calliope



SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 6.769E-6 m/sec Ss = 0.01 m^{-1}
Kz/Kr = 0.1

AQUIFER DATA

Saturated Thickness: 10.5 m

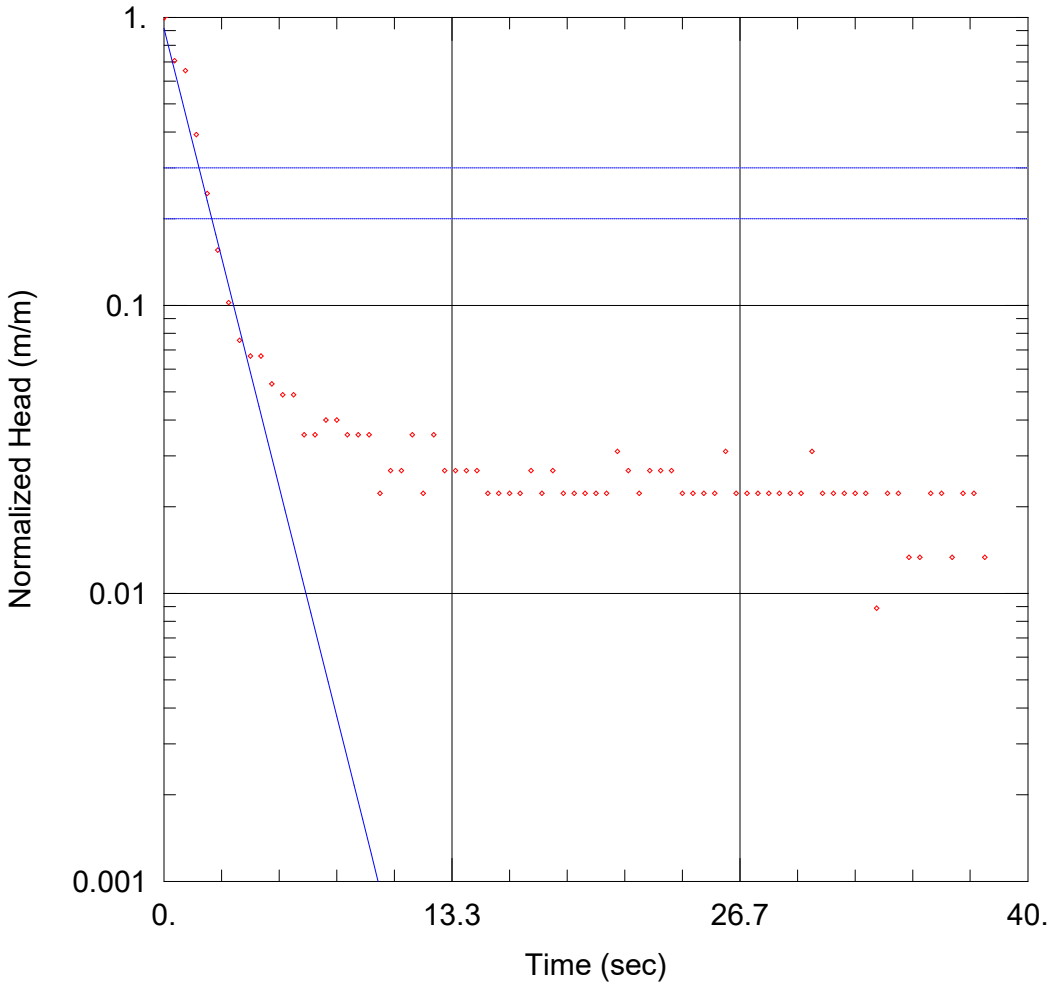
WELL DATA (FM8)

Initial Displacement: 0.3 m
Static Water Column Height: 10.5 m
Total Well Penetration Depth: 10.5 m
Screen Length: 10.5 m
Casing Radius: 0.025 m
Well Radius: 0.0855 m
Gravel Pack Porosity: 0.25

Onterris™

FM9: Hydraulic Conductivity Test Analysis - June 2026

Prepared By:	Prepared For:
Onterris	Graymont
Project:	**Location:**
BAA250025.01	Calliope



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 7.532E-5 m/sec y0 = 0.2059 m

AQUIFER DATA

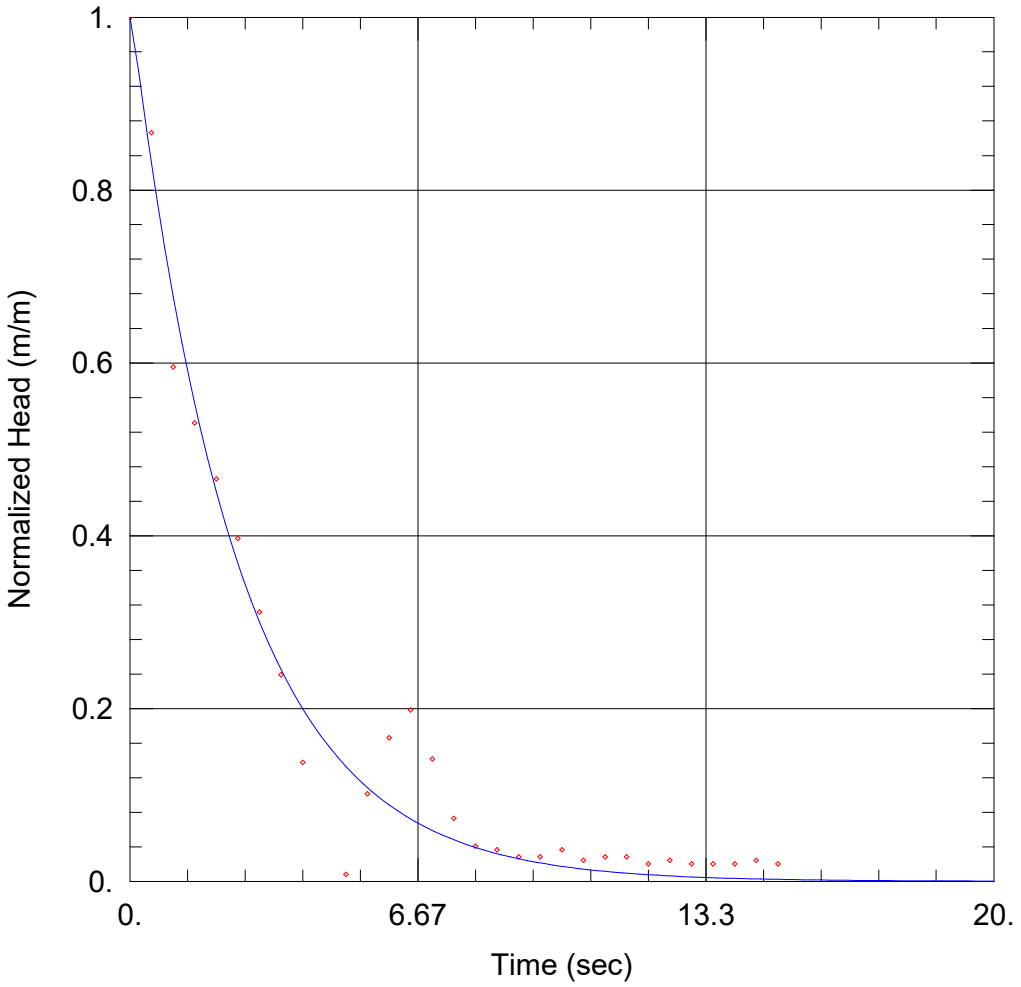
Saturated Thickness: 17.18 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (FM8)

Initial Displacement: 0.225 m
Static Water Column Height: 17.18 m
Total Well Penetration Depth: 17.18 m
Screen Length: 15. m
Casing Radius: 0.025 m
Well Radius: 0.0855 m

FM10: Hydraulic Conductivity Test Analysis - June 2026

Prepared By:	Prepared For:
Onterris	Graymont
Project:	**Location:**
BAA250025.01	Calliope



SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar

K = 0.0001875 m/sec Le = 1. m

AQUIFER DATA

Saturated Thickness: 5.64 m Anisotropy Ratio (Kz/Kr): 0.1

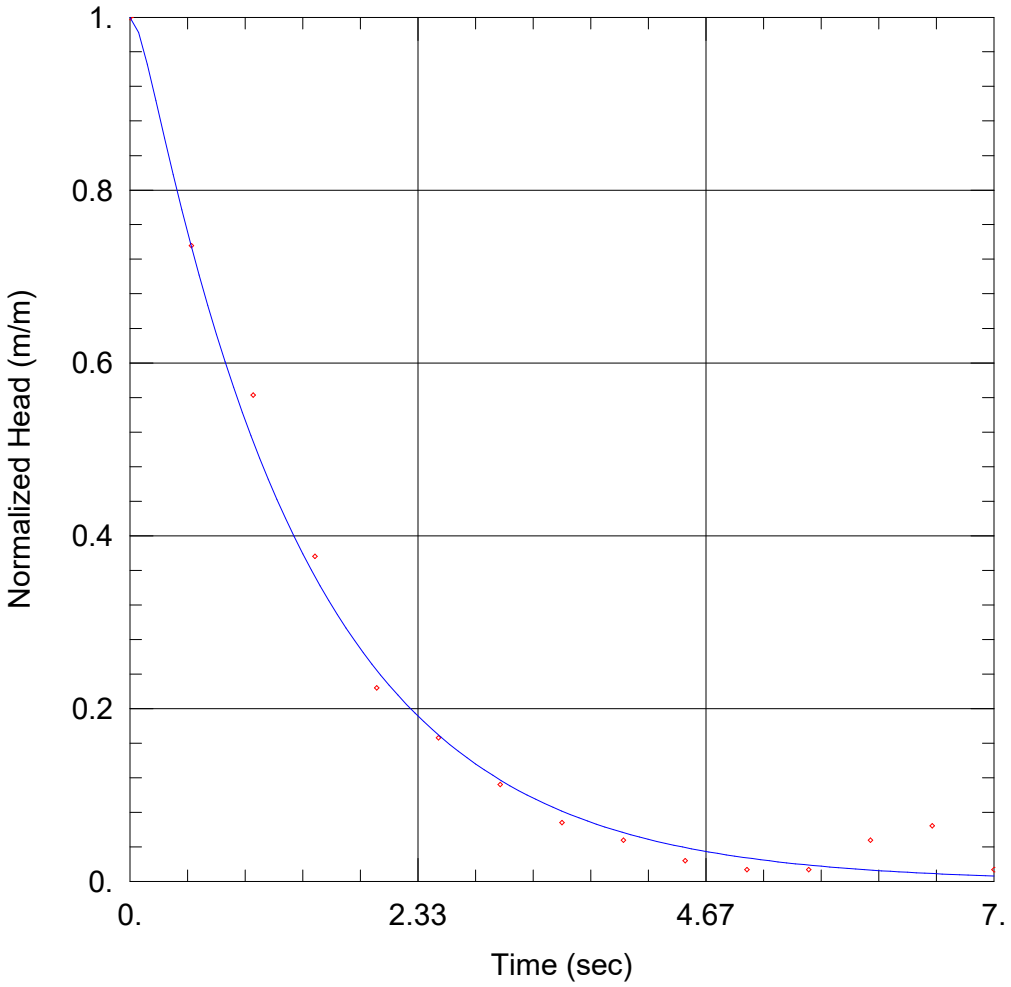
WELL DATA (FM10)

Initial Displacement: 0.2264 m
Static Water Column Height: 5.64 m
Total Well Penetration Depth: 5.64 m
Screen Length: 3. m
Casing Radius: 0.025 m
Well Radius: 0.05 m

Onterris™

FM10: Hydraulic Conductivity Test Analysis - June 2026

Prepared By:	Prepared For:
Onterris	Graymont
Project:	**Location:**
BAA250025.01	Calliope



SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar

K = 0.0003255 m/sec Le = 1. m

AQUIFER DATA

Saturated Thickness: 5.64 m Anisotropy Ratio (Kz/Kr): 0.1

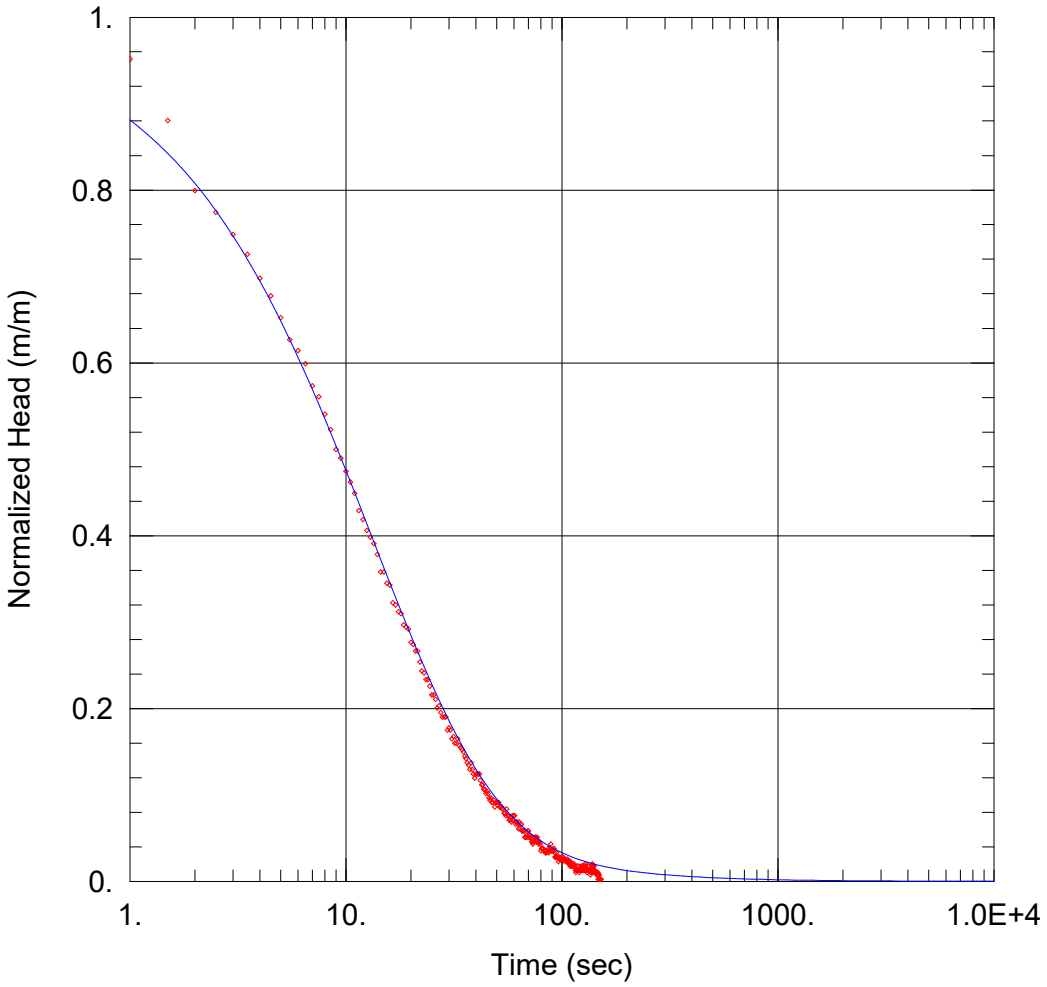
WELL DATA (FM10)

Initial Displacement: 0.295 m
Static Water Column Height: 5.64 m
Total Well Penetration Depth: 5.64 m
Screen Length: 3. m
Casing Radius: 0.025 m
Well Radius: 0.05 m

Onterris™

FM11: Hydraulic Conductivity Test Analysis - June 2026

Prepared By:	Prepared For:
Onterris	Graymont
Project:	**Location:**
BAA250025.01	Calliope



SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 1.16E-5 m/sec Ss = 0.0001753 m^{-1}
Kz/Kr = 0.1

AQUIFER DATA

Saturated Thickness: 16.53 m

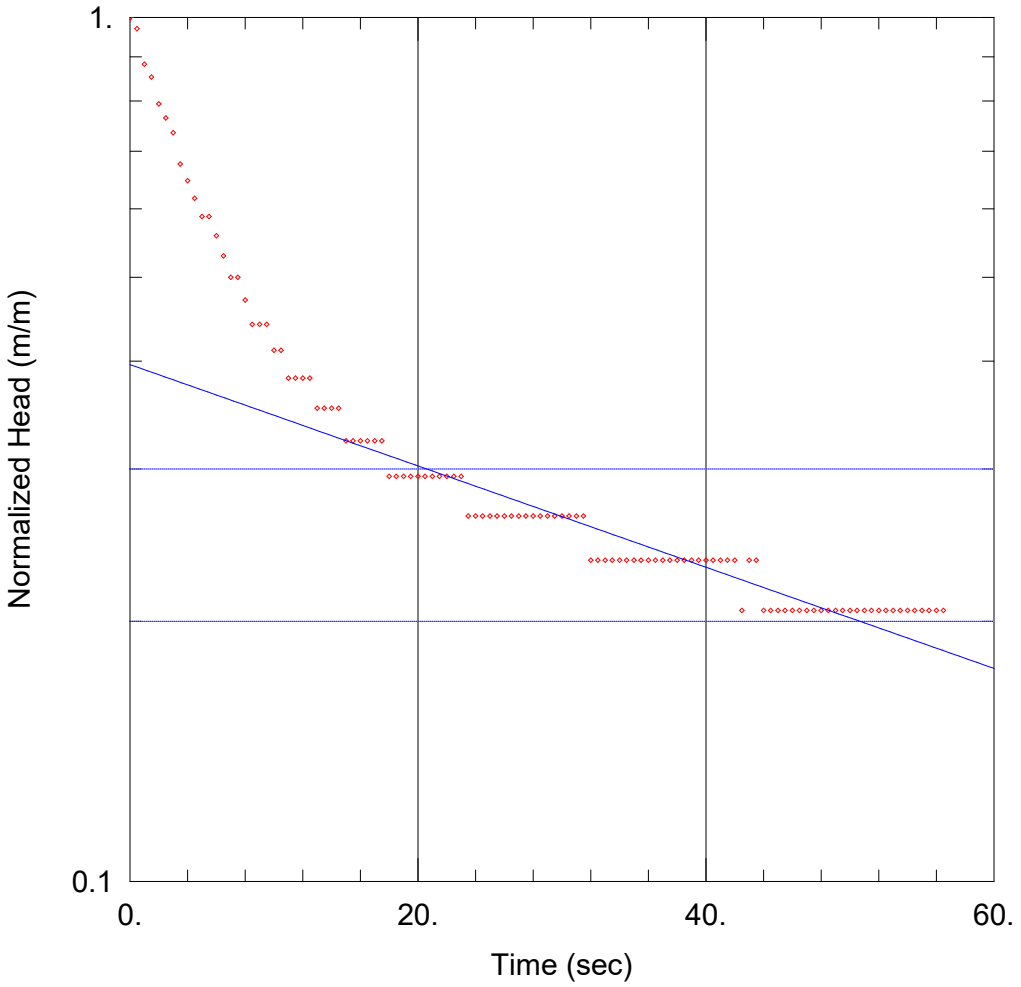
WELL DATA (FM11)

Initial Displacement: 0.394 m
Static Water Column Height: 16.53 m
Total Well Penetration Depth: 16.53 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.05 m

Onterris™

FM12: Hydraulic Conductivity Test Analysis - June 2026

Prepared By:	Prepared For:
Onterris	Graymont
Project:	**Location:**
BAA250025.01	Calliope



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.106E-6 m/sec y0 = 0.1348 m

AQUIFER DATA

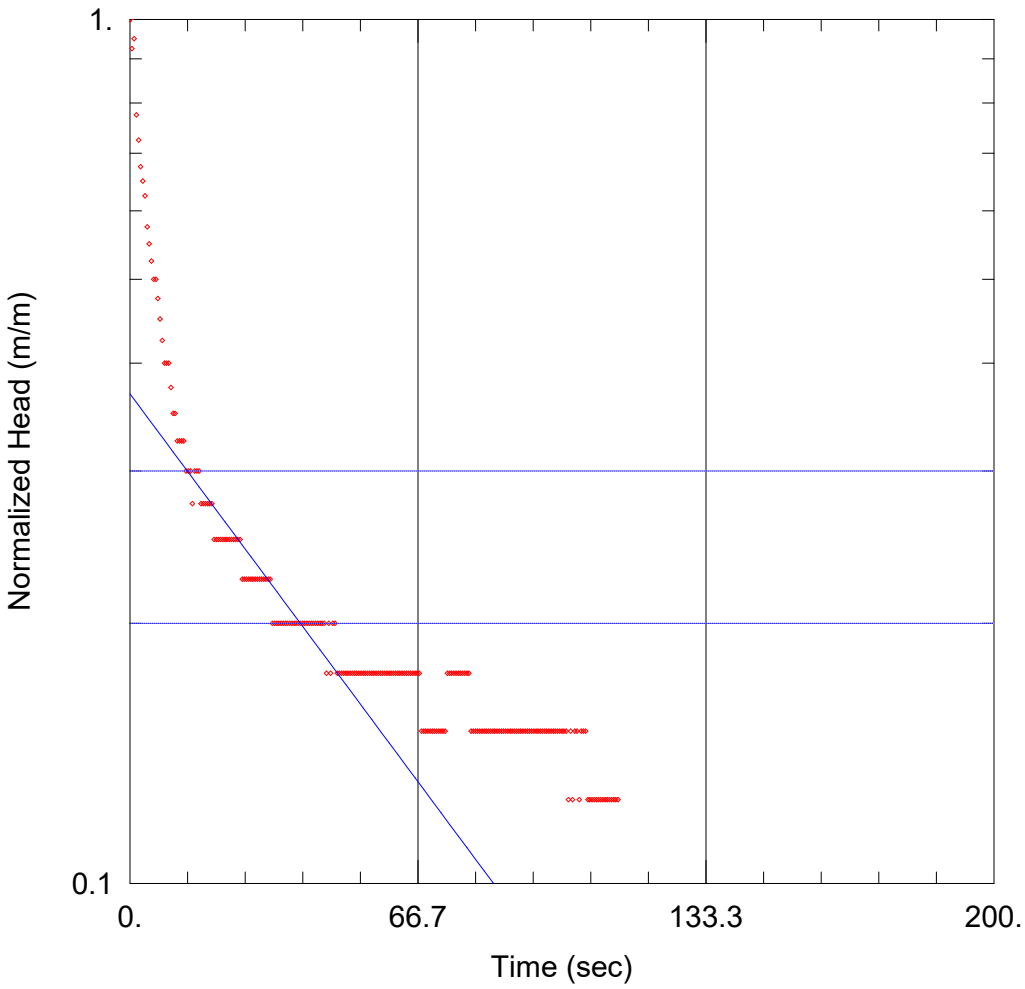
Saturated Thickness: 18.96 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (FM12)

Initial Displacement: 0.34 m
Static Water Column Height: 18.96 m
Total Well Penetration Depth: 18.96 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.05 m

FM12: Hydraulic Conductivity Test Analysis - June 2026

Prepared By:	Prepared For:
Onterris	Graymont
Project:	**Location:**
BAA250025.01	Calliope



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.568E-6 m/sec y0 = 0.1474 m

AQUIFER DATA

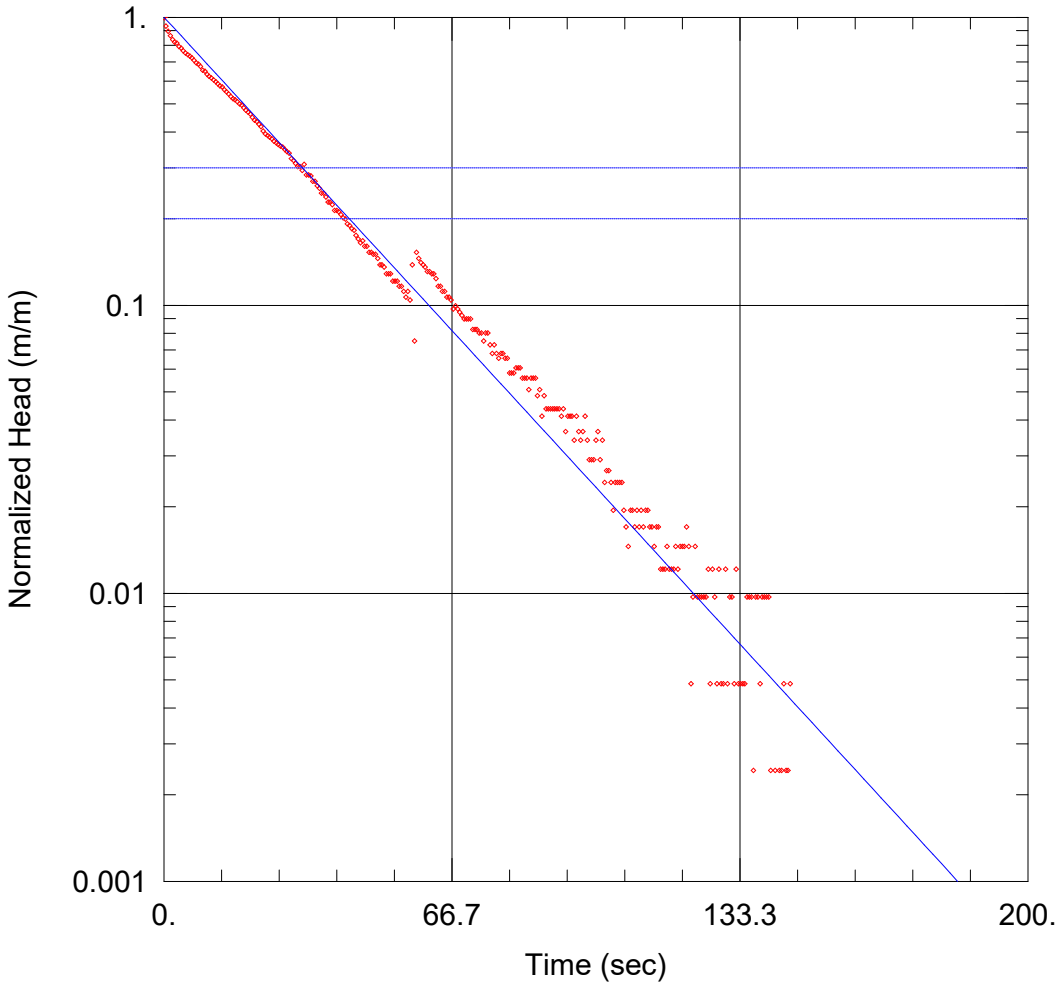
Saturated Thickness: 18.96 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (FM12)

Initial Displacement: 0.4 m
Static Water Column Height: 18.96 m
Total Well Penetration Depth: 18.96 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.05 m

FM13: Hydraulic Conductivity Test Analysis - June 2026

Prepared By:	Prepared For:
Onterris	Graymont
Project:	**Location:**
BAA250025.01	Calliope



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.107E-5 m/sec y0 = 0.413 m

AQUIFER DATA

Saturated Thickness: 22.3 m Anisotropy Ratio (Kz/Kr): 0.1

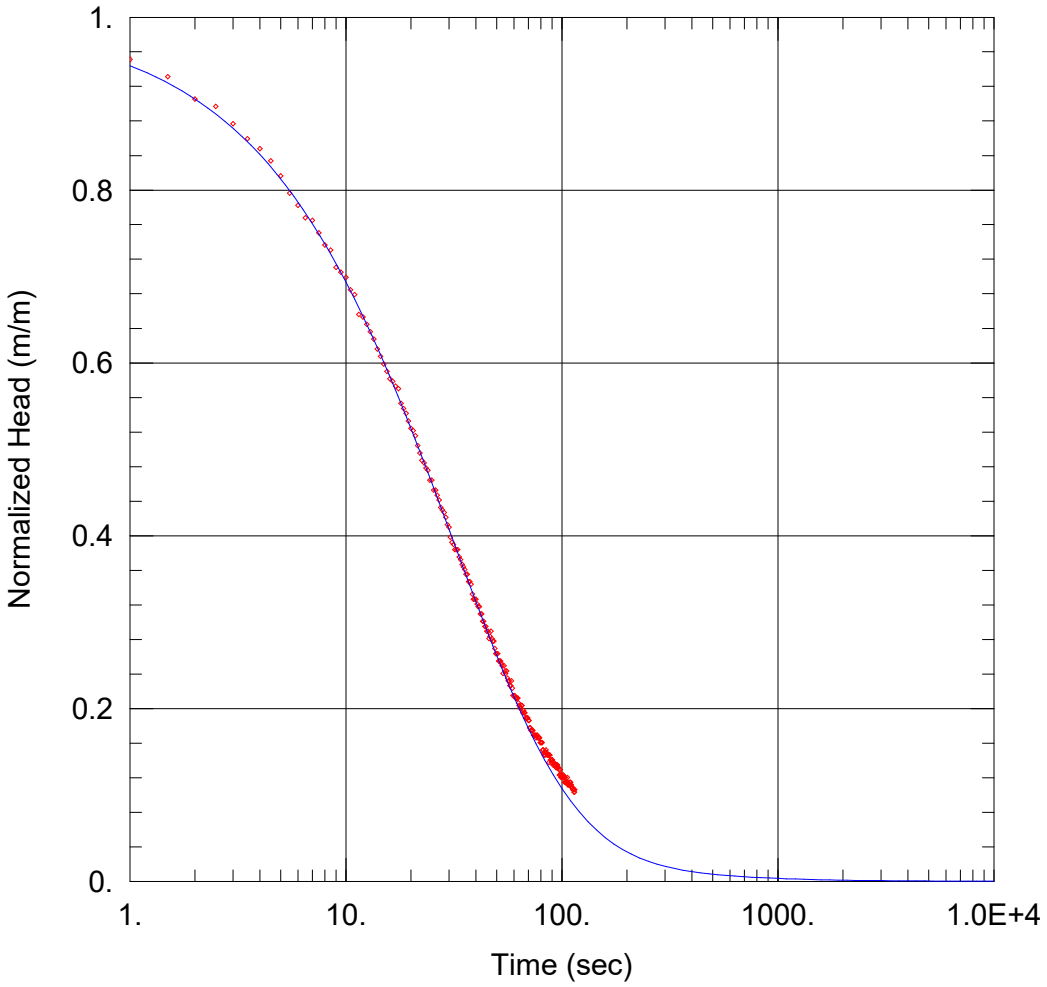
WELL DATA (FM13)

Initial Displacement: 0.412 m
Static Water Column Height: 22.3 m
Total Well Penetration Depth: 22.3 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.05 m

Onterris™

FM13: Hydraulic Conductivity Test Analysis - June 2026

Prepared By:	Prepared For:
Onterris	Graymont
Project:	**Location:**
BAA250025.01	Calliope



SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 5.985E-6 m/sec Ss = 5.003E-5 m^{-1}
Kz/Kr = 0.1

AQUIFER DATA

Saturated Thickness: 22.3 m

WELL DATA (FM13)

Initial Displacement: 0.349 m
Static Water Column Height: 22.3 m
Total Well Penetration Depth: 22.3 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.05 m

Appendix G Bore Reports

Bore Report

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
187863	Sub-Artesian Facility	Existing	12/01/2021	Rockhampton	3360 - GLADSTONE REGIONAL

Details

Description			
Parish	6000 - NO LONGER USED		
Original Name			
Driller Name	IRVINE, DON		
Drill Company	CAPRICORN DRILLING SERVICES		
Const Method	ROTARY AIR		
Bore Line			
D/O File No		**Polygon**	
R/O File No		**Equipment**	
H/O File No		**RN of Bore Replaced**	
Log Received Date	29/01/2021	**Data Owner**	
Roles	Sub-Artesian Monitoring		

Location

Latitude	24-06-31	**Basin**	1330
Longitude	151-14-36	**Sub-area**	
GIS Latitude	-24.10858676	**Lot**	7
GIS Longitude	151.24325446	**Plan**	SP215269
Easting	321451		
Northing	7332633	**Map Scale**	
Zone	56	**Map Series**	
Accuracy		**Map No**	
GPS Accuracy		**Map Name**	
Checked	Yes	**Prog Section**	

Casing

7 ***records for RN*** **187863**

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	12/01/2021	1	0.00	30.00	Polyvinyl Chloride	7.500	WT - Wall Thickness	65
A	12/01/2021	2	18.00	29.00	Perforated or Slotted Casing	1.000	AP - Aperture Size	65
X	12/01/2021	3	0.00	6.00	Grout			203
X	12/01/2021	4	6.00	16.00	Cuttings or other fill between casing and hole wall			203
X	12/01/2021	5	16.00	17.00	Bentonite Seal			203

Bore Report

From Year:

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
X	12/01/2021	6	17.00	30.00	Gravel Pack			203
X	12/01/2021	7	25.00		Centraliser			

Strata Logs

5 *records for RN* **187863**

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	1.00	SURFACE SOIL
2	1.00	9.00	BROWN, SILTY SAND
3	9.00	18.00	BROWN SILTY STONE
4	18.00	24.00	SAND AND GRAVEL
5	24.00	30.00	PINK LIMESTONE

Stratigraphies

0 *records for RN* **187863**

Aquifers

1 *records for RN* **187863**

Rec	Top (m)	Bottom (m)	Lithology	Date	SWL (m)	Flow	Quality	Yield (L/s)	Contr	Cond	Formation Name
1	18.00	24.00	SAGR - Sand and Gravel			N	POTABLE		Y	UC	

Pump Tests Part 1

1 *records for RN* **187863**

Pipe	Date	Rec	RN of Pumped Bore	Top (m)	Bottom (m)	Dist (m)	Meth	Test Types	Pump Type	Suction Set (m)	Q Prior to Test (l/s)	Dur of Q PR (mins)	Pres on Arriv (m)	Q on Arriv (l/s/)
A	12/01/2021	1	187863	18.00	24.00		PUM		AIR	30.00				

Pump Tests Part 2

1 *records for RN* **187863**

Pipe	Date	Rec	Test	SWL(m)	Recov	Resid	Max DD	Q at	Time to	Max Q	Calc	Design	Design	Suct.	Tmsy	Stor

Bore Report

From Year:

		Dur (mins)	Time (mins)	DD (m)	or P RED (m)	Max DD (l/s)	Max DD (mins)	(l/s)	Stat HD (m)	Yield (l/s)	BP (m)	Set (m)	(m2/Day)
A	12/01/2021	1	180	-28.00	2.00							30.00	

Bore Conditions

0 *records for RN* **187863**

Elevations

0 *records for RN* **187863**

Water Analysis Part 1

0 *records for RN* **187863**

Water Analysis Part 2

0 *records for RN* **187863**

Water Levels

0 *records for RN* **187863**

Wire Line Logs

0 *records for RN* **187863**

Field Measurements

1 *records for RN* **187863**

Pipe	Date	Depth (m)	Conduct (uS/cm)	pH	Temp (C)	NO3 (mg/L)	DO2 (mg/L)	Eh (mV)	Alkalinity (mV)	Samp	Method	Samp	Source
A	12/01/2021		270	7.0						AI	Air Lifting	GB	Groundwater - from Bore

Special Water Analysis

0 *records for RN* **187863**

Bore Report

From Year:

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Bore Report

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
151688	Sub-Artesian Facility	Existing	26/06/2012	Rockhampton	3360 - GLADSTONE REGIONAL

Details

Description			
Parish	4022 - RIVERSTON		
Original Name			
Driller Name	DART, GREGORY		
Drill Company	BURNETT & GLADSTONE DRILLING		
Const Method	ROTARY AIR		
Bore Line			
D/O File No		**Polygon**	
R/O File No		**Equipment**	
H/O File No		**RN of Bore Replaced**	
Log Received Date	16/07/2012	**Data Owner**	
Roles			

Location

Latitude	24-05-34	**Basin**	1330
Longitude	151-14-22	**Sub-area**	
GIS Latitude	-24.09274641	**Lot**	4
GIS Longitude	151.2395018	**Plan**	RP610128
Easting	321047		
Northing	7334383	**Map Scale**	
Zone	56	**Map Series**	
Accuracy		**Map No**	
GPS Accuracy		**Map Name**	
Checked	Yes	**Prog Section**	

Casing

6 ***records for RN*** **151688**

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	26/06/2012	1	0.00	60.50	Polyvinyl Chloride	5.000	WT - Wall Thickness	50
A	26/06/2012	2	48.50	60.50	Perforated or Slotted Casing	0.500	AP - Aperture Size	
X	26/06/2012	3	0.00	7.00	Grout			115
X	26/06/2012	4	7.00	45.50	Cuttings or other fill between casing and hole wall			115
X	26/06/2012	5	45.50	47.00	Bentonite Seal			115

Bore Report

From Year:

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
X	26/06/2012	6	47.00	60.50	Gravel Pack	3.000	GR - Gravel Size	115

Strata Logs

11 *records for RN* **151688**

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	2.00	TOP SOIL
2	2.00	3.50	BROWN ROCK, WHITE CLAY
3	3.50	5.50	CLAY: BROWN
4	5.50	10.00	ROCK: BLUE GREY
5	10.00	10.50	CLAY: BROWN
6	10.50	20.00	ROCK: BLUE GREY
7	20.00	37.00	ROCK: RED, WHITE
8	37.00	46.50	ROCK: DARK GREY, RED
9	46.50	48.50	ROCK: BROWN, RED
10	48.50	51.00	ROCK: LIGHT BROWN
11	51.00	60.50	ROCK: BLUE GREY, WHITE *

Stratigraphies

0 *records for RN* **151688**

Aquifers

1 *records for RN* **151688**

Rec	Top (m)	Bottom (m)	Lithology	Date	SWL (m)	Flow	Quality	Yield (L/s)	Contr	Cond	Formation Name
1	54.50		XXXX - Unknown	26/06/2012	-21.00	N			N	XX	CALLIOPE BEDS

Pump Tests Part 1

0 *records for RN* **151688**

Pump Tests Part 2

0 *records for RN* **151688**

Bore Report

From Year:

Bore Conditions

0 *records for RN* **151688**

Elevations

0 *records for RN* **151688**

Water Analysis Part 1

0 *records for RN* **151688**

Water Analysis Part 2

0 *records for RN* **151688**

Water Levels

0 *records for RN* **151688**

Wire Line Logs

0 *records for RN* **151688**

Field Measurements

1 *records for RN* **151688**

Pipe	Date	Depth (m)	Conduct (uS/cm)	pH	Temp (C)	NO3 (mg/L)	DO2 (mg/L)	Eh (mV)	Alkalinity (mV)	Samp	Method	Samp	Source
A	26/06/2012		1720							AI	Air Lifting	GB	Groundwater - from Bore

Special Water Analysis

0 *records for RN* **151688**

Bore Report

From Year:

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Bore Report

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
151689	Sub-Artesian Facility	Existing	03/07/2012	Rockhampton	3360 - GLADSTONE REGIONAL

Details

Description			
Parish	4022 - RIVERSTON		
Original Name			
Driller Name	DART, GREGORY		
Drill Company	BURNETT & GLADSTONE DRILLING		
Const Method	ROTARY AIR		
Bore Line			
D/O File No		**Polygon**	
R/O File No		**Equipment**	
H/O File No		**RN of Bore Replaced**	
Log Received Date	16/07/2012	**Data Owner**	
Roles			

Location

Latitude	24-06-31	**Basin**	1330
Longitude	151-14-37	**Sub-area**	
GIS Latitude	-24.10855516	**Lot**	7
GIS Longitude	151.2435008	**Plan**	SP215269
Easting	321476		
Northing	7332637	**Map Scale**	
Zone	56	**Map Series**	
Accuracy		**Map No**	
GPS Accuracy		**Map Name**	
Checked	Yes	**Prog Section**	

Casing

5 ***records for RN*** **151689**

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	03/07/2012	1	0.00	14.70	Polyvinyl Chloride	5.000	WT - Wall Thickness	50
A	03/07/2012	2	5.70	14.70	Perforated or Slotted Casing	0.500	AP - Aperture Size	
X	03/07/2012	3	0.00	5.00	Grout			115
X	03/07/2012	4	5.00	5.70	Bentonite Seal			115
X	03/07/2012	5	5.70	14.70	Gravel Pack	3.000	GR - Gravel Size	115

Bore Report

From Year:

Strata Logs

4 *records for RN* **151689**

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	1.00	TOP SOIL
2	1.00	4.00	BROWN CLAY, BROKEN ROCK
3	4.00	14.00	ROCK: WEATHERED
4	14.00	16.00	ROCK: BROKEN *

Stratigraphies

0 *records for RN* **151689**

Aquifers

1 *records for RN* **151689**

Rec	Top (m)	Bottom (m)	Lithology	Date	SWL (m)	Flow	Quality	Yield (L/s)	Contr	Cond	Formation Name
1	15.00		AGGL - Agglomerate	03/07/2012	-12.00	N			Y	FR	CALLIOPE BEDS

Pump Tests Part 1

0 *records for RN* **151689**

Pump Tests Part 2

0 *records for RN* **151689**

Bore Conditions

0 *records for RN* **151689**

Elevations

0 *records for RN* **151689**

Water Analysis Part 1

0 *records for RN* **151689**

Water Analysis Part 2

0 *records for RN* **151689**

Water Levels

0 *records for RN* **151689**

Wire Line Logs

0 *records for RN* **151689**

Field Measurements

0 *records for RN* **151689**

Bore Report

From Year:

Special Water Analysis

0 *records for RN* **151689**

Bore Report

From Year:

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CQE

THE DRILLER OF CHOICE

HSM ☐ PUM ☐

Date: 08/09/2025

Client: GRAYMONT PTY LTD

Ph: 07 49754100

Job Report

HOLE FM7

Date Commenced: 29/08/2025

Date Completed: 29/08/2025

Water bore Depth From: 0 m

Water Bore Depth To: 30 m

Casing 50 **mm Inside Diameter From:** + .68 m

Casing 50 **mm Inside Diameter To:** 26.75 m

Your Aquifer Depth From: N/A m

Your Aquifer Depth To: N/A m

Your Water Bore Yield, Litres/Second: N/A

Your Water Bore quality, Total Solids: EC 695

Recommended Pump Suction Placement Depth: N/A m

Standing Water Level: 15.66 m

Comments: STANDING WATER LEVEL RECORDED FROM TOP OF 50MM CASING.
NO AQUIFER INTERSECTED. INSUFFICIENT FLOW TO MEASURE

DON IRVINE

Central Queensland Exploration Pty Ltd, 6 Bentley Street Gladstone South QLD 4680

ABN: 28658799314

SECTI... | Typ & materia size | Cement | Bentonite | G-Pack 2-3mm | G-Pack 2-3mm | 1/1

W2F136 v6
Collection of information on this form is the Department. The information may be

Water bore drilling log

Queensland Government

Ensure you have generated a Log ID number prior to submitting >

Click to

Log ID # 40485048

Authorisation details

Registered number _____ Development permit number _____ Works reference number _____

SECTION A—LOCATION DETAILS

Name of landholder GRAYMONT PTY LTD WEll No:FM7 Phone No. 0749754100

Postal address _____ Postcode _____

Real property address MS 24 TARAGOOLA ROAD CALLIOPE QLD Postcode 4680

Real property description Lot 7 Plan SP215269 or Bore location GPS. Latitude -24.098646 Longitude 151.240270 Datum WGS-84

Easting _____ Northing _____ Zone _____

SECTION B—BORE COMPLETION DETAILS

Date commenced 29/8/25

Date completed 29/8/25

SECTION C—DRILLING METHOD

☐ Rotary mud ☐ Cable tool

☐ Auger ☑ Rotary air

☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
171	0	30

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
PVC	60.60	5.3	+ .68	26.75

SECTION F—CENTRALISERS

Type	Location (metres) From	To
kwikzip	@	13m

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
Slots	60.60	1.00	14.75	26.75

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
Cement	171	60.60	0	7
Bentonite	171	60.60	7	8
G-Pack 2-3mm	171	60.60	8	26.75
G-Pack 2-3mm	171		26.75	30

SECTION I—BORE PURPOSE

☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial

☐ Urban ☐ Industrial ☑ Other (please specify) Monitoring Bore

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	1	Surface Top Soils	
1	6	Brown Rock and White Clays	
6	12	Decomposed Andesite	
12	16	Brown Andesite	
16	30	Blue Grey Limestones	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Conductivity (µS/cm)*	pH
None				
Seepage				
Only	N/A	None		

Final Conductivity (µS/cm): 695 Final pH:

*Fresh, brackish or salty. Laboratory testing is recommended before human consumption.

SECTION L—SUB ARTESIAN BORE ON COMPLETION

Depth to standing water level from ground level: 14.98 (metres)

Depth to pump suction or bottom of drill stem: N/A (metres)

Type of test used ☐ Air ☐ Bail ☐ Pump

Estimated supply	Duration of test	Drawdown level from surface
None (litres/second)	2 (hours)	N/A (metres)

SECTION M—ARTESIAN BORE ON COMPLETION

Shut-in pressure	Free flow	Temperature
(kPa)	(litres/second)	(°C

SECTION N—REMARKS

No Aquifer intersected, unable to measure flow, SWL and EC recorded 1 week after drilling. For monitoring purposes only.

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 is true and accurate.

Driller name Don Irvine Driller's licence no. 3476

Trainee Driller name N. Blackenesee Driller's licence no. N/A

Signature of driller _____ Date 8/9/2025

Contractor name CENTRAL QUEENSLAND EXPLORATION PTY LTD

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HSM ☐ PUM ☐

CQE
THE DRILLER OF CHOICE

Date: 08/09/2025

Client: GRAYMONT PTY LTD

Ph: 07 49754100

Job Report

HOLE FM8

Date Commenced:	30/08/20205	
Date Completed:	30/08/2025	
Water bore Depth From:	0	m
Water Bore Depth To:	30	m
Casing 50 **mm Inside Diameter From:**	+ .7	m
Casing 50 **mm Inside Diameter To:**	27.7	m
Your Aquifer Depth From:	N/A	m
Your Aquifer Depth To:	N/A	m
Your Water Bore Yield, Litres/Second:	N/A	
Your Water Bore quality, Total Solids: EC	662	
Recommended Pump Suction Placement Depth:	N/A	m
Standing Water Level:	16.17	m

Comments: STANDING WATER LEVEL AND EC MEASURED 7 DAYS AFTER DRILL.
NO AQUIFER INTERSECTED. NO FLOW. INSUFFICIENT WATER TO TEST.

DON IRVINE

Water bore drilling log

Queensland Government

Ensure you have generated a Log ID number prior to submitting >

Click to generate log ID

Log ID # 85421754

Authorisation details
Registered number _____ Development permit number _____ Works reference number _____

SECTION A—LOCATION DETAILS
Name of landholder GRAYMONT PTY LTD Well No:FM8 Phone No. 49754100
Postal address _____ Postcode _____
Real property address MS 24 TARAGOOLA ROAD CALLIOPE QLD Postcode 4680
Real property description Lot 7 Plan SP215269 or Bore location GPS. Latitude -24.108563 Longitude 151.244195 Datum WGS-84
Easting _____ Northing _____ Zone _____

SECTION B—BORE COMPLETION DETAILS
Date commenced 30/8/25
Date completed 30/8/25

SECTION C—DRILLING METHOD
☐ Rotary mud ☐ Cable tool
☐ Auger ☑ Rotary air
☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
171	0	30

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
PVC	60.60	5.30	+.70	27.7

SECTION F—CENTRALISERS

Type	Location (metres) From	To
Kwikzip	@	13

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
Slots	60.60	1.00	12.7	27.7

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
Cement	171	60.60	0	9
Bentonite	171	60.60	9	10
G-Pack 2-3mm	171	60.60	10	27.7
G-Pack 2-3mm	171		27.7	30

SECTION I—BORE PURPOSE
☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial
☐ Urban ☐ Industrial ☑ Other (please specify) Monitoring

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	1	Surface Soils	
1	7	Brown Silty Rock	
7	11	Decomposed Andesite	
11	15.5	Brown Andesite	
15.5	30	Blue/Grey Limestones	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Conductivity (µS/cm)*	pH
None				

Final Conductivity (µS/cm): 662 Final pH:
*Fresh, brackish or salty. Laboratory testing is recommended before human consumption.

SECTION L—SUB ARTESIAN BORE ON COMPLETION
Depth to standing water level from ground level: 15.47 (metres)
Depth to pump suction or bottom of drill stem: N/A (metres)
Type of test used ☐ Air ☐ Bail ☐ Pump
Estimated supply: None (litres/second)
Duration of test: 2 (hours)
Drawdown level from surface: (metres)

SECTION M—ARTESIAN BORE ON COMPLETION
Shut-in pressure: (kPa)
Free flow: (litres/second)
Temperature: (°C)

SECTION N—REMARKS
No Aquifer Intersected, Insufficient water flow to measure. SWL and Conductivity measured 1 week after drilling. Very slight seepage only.

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 is true and accurate.
Driller name Don Irvine Driller's licence no. 3476
Trainee Driller name Neville Blackenesee Driller's licence no. _____
Signature of driller _____ Date 8/9/2025
Contractor name CENTRAL QUEENSLAND EXPLORATION PTY LTD

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HSM ☐ PUM ☐

CQE

THE DRILLER OF CHOICE

Date: 08/09/2025

Client: GRAYMONT PTY LTD

Ph: 07 49754100

Job Report

HOLE FM9

Date Commenced:	31/08/2025	
Date Completed:	31/08/2025	
Water bore Depth From:	0	m
Water Bore Depth To:	30	m
Casing 50 **mm Inside Diameter From:**	+ .82	m
Casing 50 **mm Inside Diameter To:**	27.21	m
Your Aquifer Depth From:	N/A	m
Your Aquifer Depth To:	N/A	m
Your Water Bore Yield, Litres/Second:	N/A	
Your Water Bore quality, Total Solids:	606	
Recommended Pump Suction Placement Depth:	N/A	m
Standing Water Level:	10.98	m

Comments: CLEAN OUT AND COMPLETE. NO AQUIFER INTERSECTED. INSUFFICIENT FLOW TO MEASURE

DON IRVINE

Water bore drilling log

Queensland Government

Ensure you have generated a Log ID number prior to submitting >

Click to generate log ID

Log ID # 11701900

Authorisation details

Registered number _____ Development permit number _____ Works reference number _____

SECTION A—LOCATION DETAILS

Name of landholder: Graymont Pty Ltd Well No: FM9 Phone No. 49754100

Postal address _____ Postcode _____

Real property address: MS 24 TARAGOOLA ROAD CALLIOPE QLD Postcode 4680

Real property description Lot 7 Plan SP215269 or Bore location GPS. Latitude -24.109556 Longitude 151.236067 Datum WGS-84

Easting _____ Northing _____ Zone _____

SECTION B—BORE COMPLETION DETAILS

Date commenced 31/8/25

Date completed 31/8/25

SECTION C—DRILLING METHOD

☐ Rotary mud ☐ Cable tool

☐ Auger ☑ Rotary air

☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
171	0	30

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
PVC	60.60	5.30	+.82	27.21

SECTION F—CENTRALISERS

Type	Location (metres) From	To
Kwikzip	@	13

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
Slots	60.60	1.0	12.21	27.21

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
Cement	171	60.60	0	9.50
Bentonite	171	60.60	9.50	11
G-Pack 2-3mm	171	60.60	11	27.21
G-Pack 2-3mm	171	60.60	27.21	30

SECTION I—BORE PURPOSE

☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial

☐ Urban ☐ Industrial ☑ Other (please specify) Monitoring

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	1	Top Soils	
1	7	Brown Rock and Light silty clays	
7	11	Decomposed Andesites	
11	16	Brown Andesites	
16	30	Blue and Grey Limestone	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Conductivity (µS/cm)*	pH
None				

Final Conductivity (µS/cm): 606 Final pH:

*Fresh, brackish or salty. Laboratory testing is recommended before human consumption.

SECTION L—SUB ARTESIAN BORE ON COMPLETION

Depth to standing water level from ground level: 10.16 (metres)

Depth to pump suction or bottom of drill stem: N/A (metres)

Type of test used ☐ Air ☐ Bail ☐ Pump

Estimated supply: None (litres/second)

Duration of test: 2 (hours)

Drawdown level from surface: (metres)

SECTION M—ARTESIAN BORE ON COMPLETION

Shut-in pressure: (kPa)

Free flow: (litres/second)

Temperature: (°C)

SECTION N—REMARKS

No Aquifer Intersected, Insufficient flow to measure. SWL and Ec measured 1 week after drilling slight seepage only.

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 is true and accurate.

Driller name: Don Irvine Driller's licence no. 3476

Trainee Driller name: Neville Blackenesee Driller's licence no. NA

Signature of driller _____ Date 8/9/2025

Contractor name: CENTRAL QUEENSLAND EXPLORATION PTY LTD

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Water bore drilling log

Ensure you have generated a Log ID number prior to submitting > Click to generate log ID

Log ID # 7960371

Authorisation details
Registered number ____ Development permit number ____ Works reference number ____

SECTION A—LOCATION DETAILS
Name of landholder Graymont Phone No. ____
Postal address ____ Postcode ____
Real property address Taragoola Road, Taragoola Postcode 4680
Real property description Lot ____ Plan ____ or Bore location GPS. Latitude 24.06.48"S Longitude 151.14.09"E Datum ____
Easting ____ Northing ____ Zone ____

SECTION B—BORE COMPLETION DETAILS
Date commenced 8/2/26
Date completed 8/2/26

SECTION C—DRILLING METHOD
☐ Rotary mud ☐ Cable tool
☐ Auger ☑ Rotary air
☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
100	0	24.8

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
pvc	60	cl18	0	24.8

SECTION F—CENTRALISERS

Type	Location (metres) From	To

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
screen	60	0.5	18.8	24.8

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
cement	100	60	0	8
cuttings	100	60	8	10
bentonite	100	60	10	11
gravel	100	60	11	24.8

SECTION I—BORE PURPOSE
☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial
☐ Urban ☐ Industrial ☑ Other (please specify) Monitoring

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	1	Fill	
1	2	Black Soil	
2	3	Clay	
3	7	Weathered Rock	
7	25	Rock	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Conductivity (µS/cm)*	pH
19	13	0.25	360	

Final Conductivity (µS/cm): Final pH:
*Fresh, brackish or salty. Laboratory testing is recommended before human consumption.

SECTION L—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 ☐ Air ☐ Bail ☐ Pump
Estimated supply (litres/second)
Duration of test (hours)
Drawdown level from surface (metres)

SECTION M—ARTESIAN BORE ON COMPLETION
Shut-in pressure (kPa)
Free flow (litres/second)
Temperature (°C)

SECTION N—REMARKS
HOLE 11 - Monument Installed

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 is true and accurate.
Driller name Tony W Driller's licence no. 3523
Trainee Driller name ____ Driller's licence no. ____
Signature of driller ____ Date 10/2/2026
Contractor name JAB Drilling

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Water bore drilling log

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Authorisation details
Registered number ..... Development permit number ..... Works reference number .....

Log ID # 15848284

SECTION A—LOCATION DETAILS
Name of landholder Graymont Phone No. .....
Postal address ..... Postcode .....
Real property address Taragoola Road, Taragoola Postcode 4680
Real property description Lot ..... Plan ..... or Bore location GPS. Latitude 24.06.57"S Longitude 151.14.38"E Datum .....
Easting ..... Northing ..... Zone .....

SECTION B—BORE COMPLETION DETAILS
Date commenced 6/2/26
Date completed 6/2/26

SECTION C—DRILLING METHOD
☐ Rotary mud ☐ Cable tool
☐ Auger ☑ Rotary air
☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
100	0	31

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
pvc	60	cl18	0	31

SECTION F—CENTRALISERS

Type	Location (metres) From	To

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
screen	60	0.5	25	31

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
cement	100	60	0	8
cuttings	100	60	8	19
bentonite	100	60	19	21
gravel	100	60	21	31

SECTION I—BORE PURPOSE
☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial
☐ Urban ☐ Industrial ☑ Other (please specify) Monitoring

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	1	Topsoil and rocks	
1	31	Blue rock	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Conductivity (µS/cm)*	pH
25.2	16.7	0.25	622	

Final Conductivity (µS/cm): Final pH:
*Fresh, brackish or salty. Laboratory testing is recommended before human consumption.

SECTION L—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 ☐ Air ☐ Bail ☐ Pump
Estimated supply (litres/second) Duration of test (hours) Drawdown level from surface (metres)

SECTION M—ARTESIAN BORE ON COMPLETION
Shut-in pressure (kPa) Free flow (litres/second) Temperature (°C)

SECTION N—REMARKS

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 is true and accurate.
Driller name Tony W Driller's licence no. 3523
Trainee Driller name ..... Driller's licence no. .....
Signature of driller ..... Date 10/2/2026
Contractor name JAB Drilling

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Water bore drilling log

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Log ID # 71752018

Authorisation details
Registered number ..... Development permit number ..... Works reference number .....

SECTION A—LOCATION DETAILS
Name of landholder Graymont Phone No. .....
Postal address ..... Postcode .....
Real property address Taragoola Road, Taragoola Postcode 4680
Real property description Lot ..... Plan ..... or Bore location GPS. Latitude 24.07.13"S Longitude 151.14.00"E Datum .....
Easting ..... Northing ..... Zone .....

SECTION B—BORE COMPLETION DETAILS
Date commenced 7/2/26
Date completed 7/2/26

SECTION C—DRILLING METHOD
☐ Rotary mud ☐ Cable tool
☐ Auger ☑ Rotary air
☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
100	0	31

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
pvc	60	cl18	0	31

SECTION F—CENTRALISERS

Type	Location (metres) From	To

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
screen	60	0.5	25	31

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
cement	100	60	0	8
cuttings	100	60	8	19
bentonite	100	60	19	21
gravel	100	60	21	31

SECTION I—BORE PURPOSE
☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial
☐ Urban ☐ Industrial ☑ Other (please specify) Monitoring

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	1	Topsoil and rocks	
1	3	Yellow Rock	
3	16	Weathered Rock	
16	31	Rock	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Conductivity (µS/cm)*	pH
26.1	14.4	0.15	424	

Final Conductivity (µS/cm): Final pH:
*Fresh, brackish or salty. Laboratory testing is recommended before human consumption.

SECTION L—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 ☐ Air ☐ Bail ☐ Pump
Estimated supply (litres/second)
Duration of test (hours)
Drawdown level from surface (metres)

SECTION M—ARTESIAN BORE ON COMPLETION
Shut-in pressure (kPa)
Free flow (litres/second)
Temperature (°C)

SECTION N—REMARKS
HOLE 12 - Monument Installed

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 is true and accurate.
Driller name Tony W Driller's licence no. 3523
Trainee Driller name ..... Driller's licence no. .....
Signature of driller ..... Date 10/2/2026
Contractor name JAB Drilling

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Water bore drilling log

Ensure you have generated a Log ID number prior to submitting > Click to generate log ID

Log ID # 74444745

Authorisation details
Registered number ..... Development permit number ..... Works reference number .....

SECTION A—LOCATION DETAILS
Name of landholder Graymont Phone No. .....
Postal address ..... Postcode .....
Real property address Taragoola Road, Taragoola Postcode 4680
Real property description Lot ..... Plan ..... or Bore location GPS. Latitude 24.05.57"S Longitude 151.14.04"E Datum .....
Easting ..... Northing ..... Zone .....

SECTION B—BORE COMPLETION DETAILS
Date commenced 8/2/26
Date completed 9/2/26

SECTION C—DRILLING METHOD
☐ Rotary mud ☐ Cable tool
☐ Auger ☑ Rotary air
☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
100	0	7.7

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
pvc	60	cl18	0	7.7

SECTION F—CENTRALISERS

Type	Location (metres) From	To

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
screen	60	0.5	4.7	7.7

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
cement	100	60	0	2
bentonite	100	60	2	3
Gravel	100	60	3	7.7

SECTION I—BORE PURPOSE
☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial
☐ Urban ☐ Industrial ☑ Other (please specify) Monitoring

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	1	Top Soil	
1	4	Sandy Clay	
4	7.7	Rock	

Appendix H Revegetation Plan



Revegetation Plan

Calliope Limestone Quarry

Prepared for: Graymont (Australia) Pty Ltd

Prepared by: Onterris Australia Pty Ltd

10 August 2026

Revision 3.0

Level 3, 95 North Quay
Brisbane QLD 4000
1800 52 4357
Onterris.com

For Planet & Progress™

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1 Introduction

Onterris Australia Pty Ltd (Onterris) was engaged by Graymont (Australia) Pty Ltd (Graymont) to provide a Revegetation Plan to support the Progressive Rehabilitation Closure Plan (PRCP) for the rehabilitation of Calliope Limestone Quarry. The quarry covers 19 existing mining leases (MLs) held by Graymont (the site) and is located 28 km south of Gladstone in south-east Queensland. This Revegetation Plan was prepared in accordance with Section 3.6.1 of the PRCP guidelines (DES 2021).

1.1 The Site

The site is located approximately 11 kilometres (km) south of the township of Calliope and 28 km south of Gladstone in south-east Queensland (**Figure 1**).

1.1.1 Mining Tenure and Environmental Authority

Mining activities are authorised under Environmental Authority (EA) EPML00969013 and EPPR00881913 (the EA held by Graymont (formerly Unimin Lime (NSW) Pty Ltd).

EA EPML00969013 authorises the following Environmentally Relevant Activities:

- Schedule 3 21: A mining activity that is an ineligible ERA, other than a mining activity mentioned in items 9 to 20.
- Location: ML3594, ML3595, ML3596, ML3597, ML3598, ML3599, ML3600, ML3602, ML3603, ML3604, ML3605, ML3606, ML3608, ML3609, ML80036, ML80189, ML80190, ML80191, ML80192.

EA EPPR00881913 authorises following Environmentally Relevant Activities:

- ERA 8 (3a) - Chemical storage >10m^3 but <500m^3 class C1 or C2 combustible liquids
- ERA 16 (2d) – Extracting in a year >1,000,000t of material
- ERA 16 (3c) – Screening in a year >1,000,000t of material
- ERA 50 (2) - Bulk material handling >100t day.

1.2 Objective

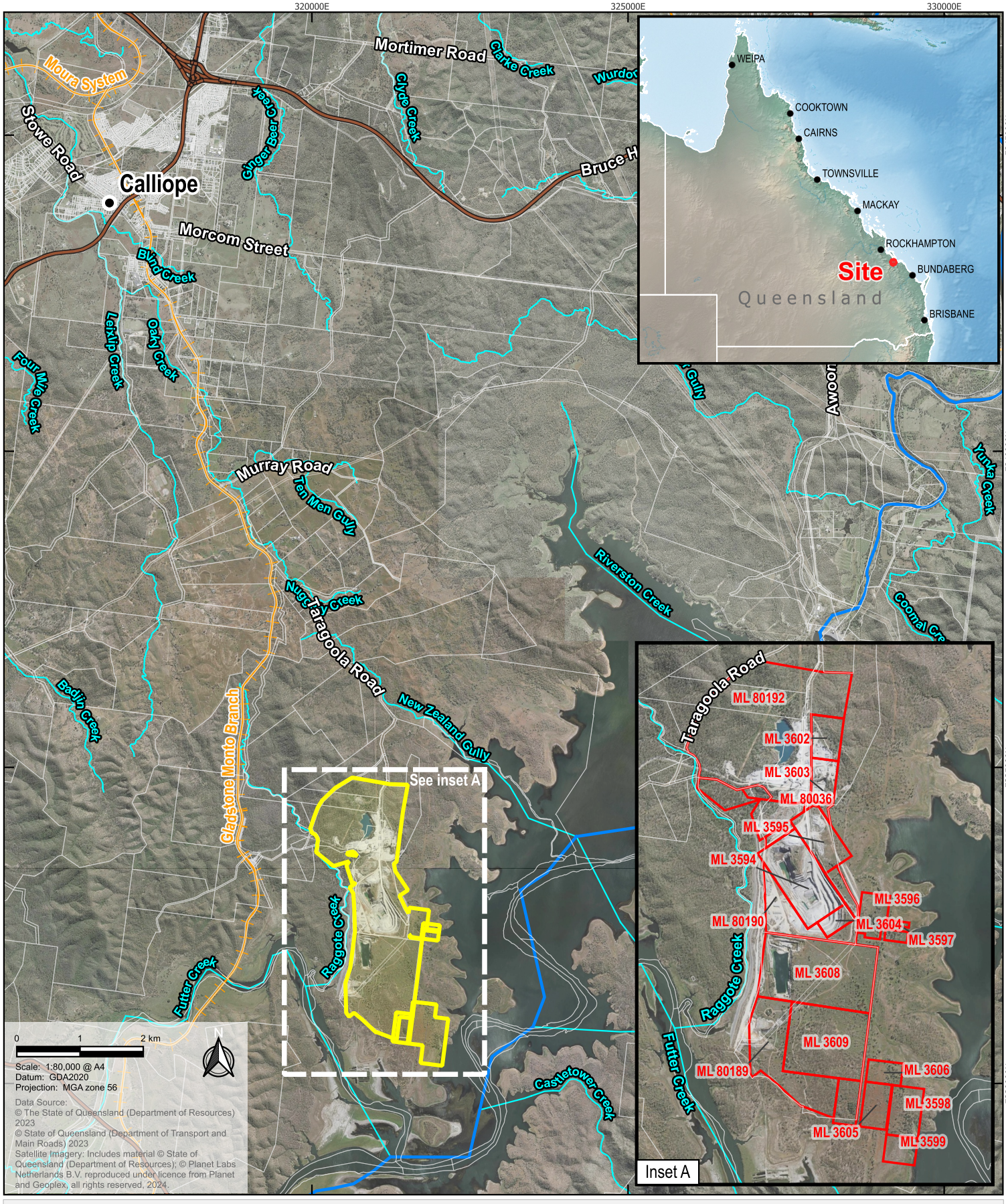
The objective of this Revegetation Plan is to propose activities that will establish self-sustaining vegetation communities appropriate for the intended Post Mining Land Use (PMLU). Proposed PMLUs of the site include the following:

- Access tracks
- Low intensity grazing
- Water storage.

Areas that will be rehabilitated to low intensity grazing will be revegetated and are subject to this Revegetation Plan. Revegetated areas will aim to support self-sustaining vegetation communities compatible with pastoralism.

1.3 Scope

The scope of this Revegetation Plan is restricted to areas within the site with the proposed PMLU of low intensity grazing. This Revegetation Plan does not apply to the rehabilitation of abandonment bunds, access tracks or water storage PMLU rehabilitation areas.



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 Revegetation Plan\Rev 3\Figure 1 Site Location.ggz

Legend

- Site boundary
- Mining leases
- Cadastre (DCDB)
- State controlled roads
- Railways

Watercourses

- Major
- Minor

Graymont
Calliope Limestone Quarry
Revegetation Plan

Figure 1
Site location

2 Existing Site Conditions

2.1 Current Condition

The majority of the site outside of the operational areas is comprised of open grazing land with scattered trees and small patches of remnant vegetation. Operational areas include open pits, topsoil storage areas, waste rock dumps, sediment basins, infrastructure and hardstand areas, spoil piles, silt dumps, and access tracks.

2.2 Topography and Landform

The Calliope deposit comprises a large orebody of steeply dipping north-south, striking limestone. The limestone is fine grained to crystalline, light grey with cream inclusions, very-high strength, fresh to slightly weathered, moderately jointed to massive. Discontinuities are sharp and generally clean.

Dissolution of the upper surface has created some minor karst features, predominantly a slightly irregular surface, dilated joint apertures, small caverns and shafts. These features are most obvious to a depth of ≈20 m below the surface. These features are likely to have negligible detrimental influences on the performances of the pit walls.

The limestone is overlain by red-brown clayey sand. The cover ranges in thickness from 0.5 m to 5 m. Where thickest, it contains boulders of limestone up to 1 m diameter. Stripping of the upper bench involves stockpiling clean soil north of the pit for future use in rehabilitation and sending bouldery soil to the waste rock dump.

Basaltic to andesitic mafic volcanics have intruded around the site. The most obviously regions are centred north of the pit at 321000E 7333000N and south of the pit at 321500E 7333000N. There have not been many significant intrusions into the section of the ore body being mined, but most notable are those on the north and south walls.

2.3 Vegetation Communities

2.3.1 Regional Ecosystem Mapping

Current Regional Ecosystem (RE) and Regulated Vegetation mapping for the site includes remnant and regrowth eucalypt woodland dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*) with an understorey of native tussock grasses. Mapped REs within the site are described below in **Table 1** and depicted in **Figure 2**.

Table 1. Vegetation communities

RE	Condition	Short description[1]	VM Act status[2]	EP Act status[3]
11.11.15	Remnant and regrowth	*Eucalyptus crebra* woodland to open woodland on deformed and metamorphosed sediments and interbedded volcanics	Least concern	No concern at present
11.11.4	Regrowth	*Eucalyptus crebra* woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges.	Least concern	No concern at present
11.11.4a	Regrowth	*Eucalyptus tereticornis* dominated woodland. Other tree species listed above may occur as sub or co-dominant species. Not a wetland.	Least concern	No concern at present

1. REDD V12.0 (Queensland Herbarium 2021)

2.3.2 Ground-Truthed Vegetation Communities

An inspection of portions of the site was completed over a three-day period during 27 February to 1 March 2023 by two Onterris staff, including a suitably qualified ecologist (Dr Oliver Robertson). The site inspection involved a census of flora species (including weeds) in addition to the ground-truthing of REs. Vegetation communities within the Project area were verified and mapped as per the *Methodology for surveying and mapping regional ecosystems and vegetation communities in Queensland Version 6.0* (Neldner et al. 2022). Four vegetation communities including two RE types were identified within the site (**Figure 3**):

- Remnant RE 11.11.15 - *Eucalyptus crebra* woodland to open woodland on deformed and metamorphosed sediments and interbedded volcanics (**Plate 1**)
- Regrowth RE 11.11.15 - *Eucalyptus crebra* woodland to open woodland on deformed and metamorphosed sediments and interbedded volcanics (**Plate 2**)
- Remnant RE 11.3.25 - *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines (**Plate 3**)
- Disturbed non-remnant vegetation (**Plate 4**).



Plate 1. Remnant E*ucalyptus crebra* woodland



Plate 2. Regrowth *Eucalyptus crebra* woodland



Plate 3. Remnant *Eucalyptus tereticornis* fringing woodland



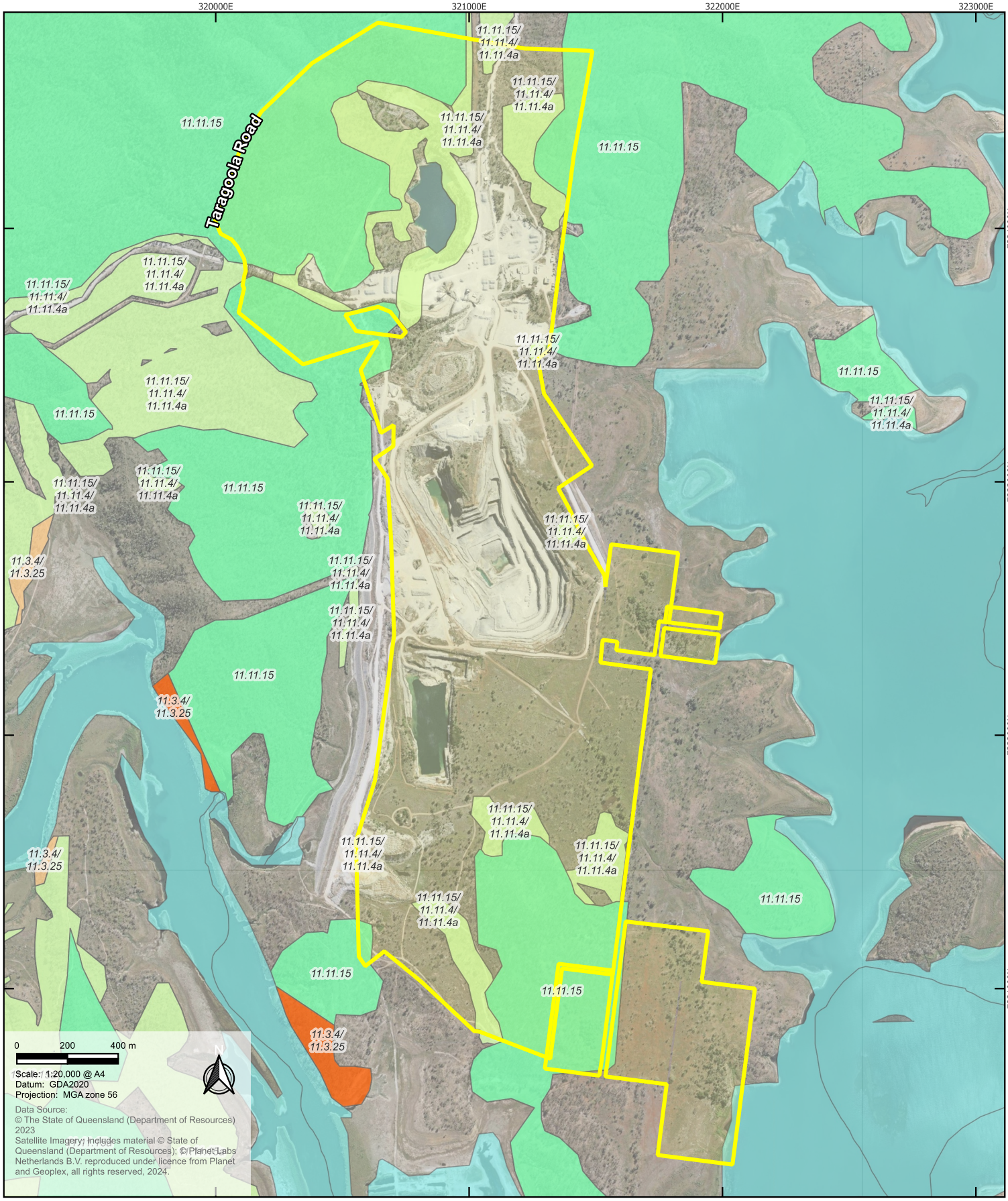
Plate 4. Areas of disturbed non-remnant vegetation adjacent to open-pits

REs ground-truthed within the Project area are detailed below in **Table 2**. The project area is dominated by RE 11.11.15, with only two small patches of RE 11.3.25 mapped in association with drainage lines (**Figure 3**). Further details regarding the methods and results of ground-truthed RE mapping for the Project area are provided in the Ecological Assessment Report (Epic 2023) for the project. Some areas currently mapped as non-remnant or regrowth vegetation on the regulated vegetation map meet the definition of remnant vegetation analogous to RE 11.11.15.

Table 2. Ground-truthed REs within the Project area

RE	Condition	Short description[1]	VM Act status[2]	EP Act status[3]
11.11.15	Remnant and regrowth	*Eucalyptus crebra* woodland to open woodland on deformed ad metamorphosed sediments and interbedded volcanics	Least concern	No concern at present
11.3.25	Remnant and regrowth	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Least concern	Of concern

1. REDD V13.1 (Queensland Herbarium 2024)



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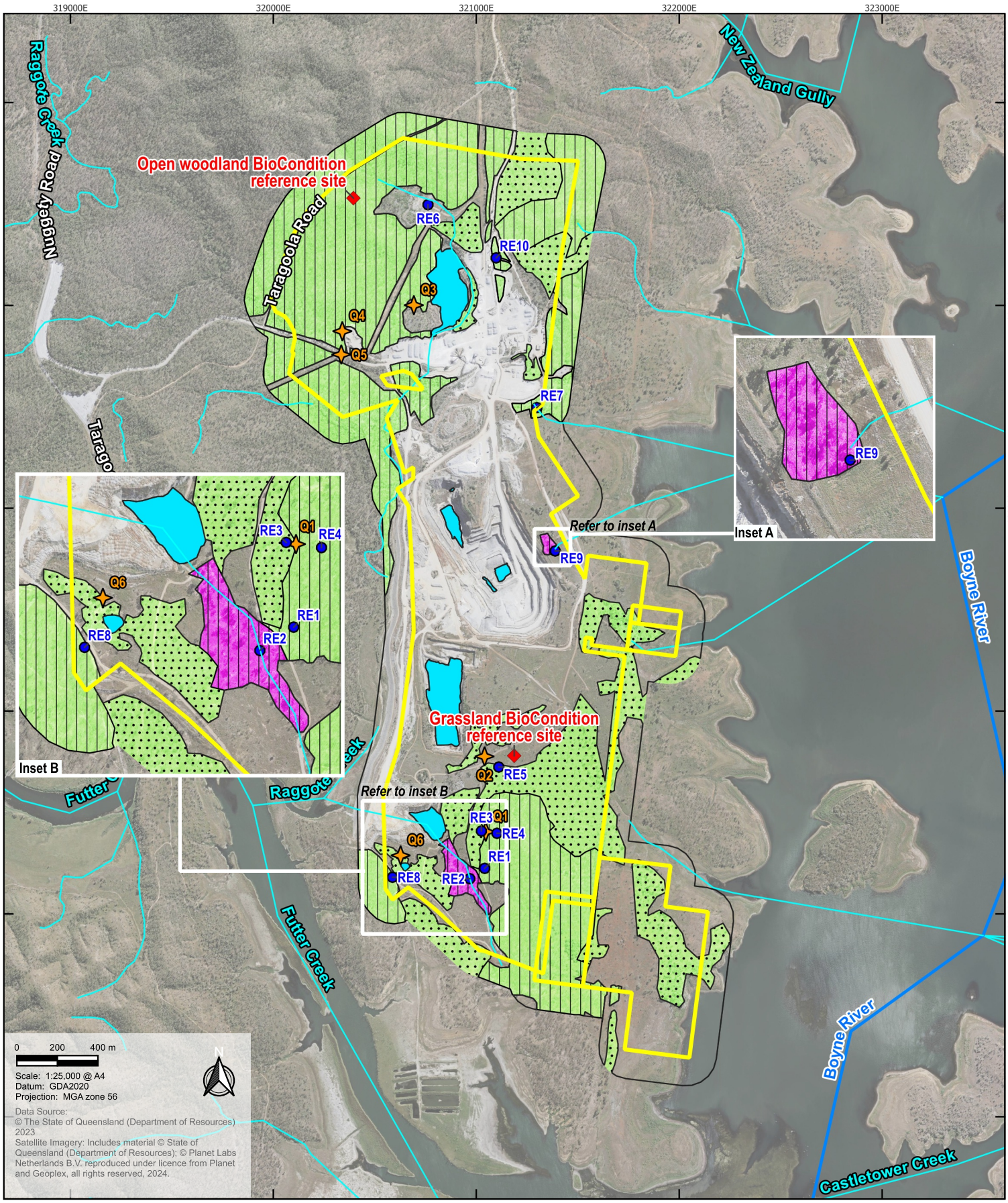
- Site boundary

Regional Ecosystems v13

- Category A or B area containing of concern
- Category A or B area that is least concern
- Category C or R area containing of concern
- Category C or R area that is of least concern
- Non-remnant
- Water

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Calliope Limestone Quarry
Revegetation Plan

Figure 2
Vegetation communities (Queensland government)



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Legend

- Site boundary

Ground-truthed Regional Ecosystems

- 11.11.15
- 11.3.25
- Non-remnant
- Water

Biodiversity status

- Regrowth
- Remnant
- Water
- Non-remnant

Vegetation management watercourses and drainage features v7

- Major
- Minor

Survey sites

- Quaternary RE
- Secondary RE
- BioCondition

Graymont
Calliope Limestone Quarry
Revegetation Plan

Figure 3
Ground-truthed regional ecosystems mapping

3 Rehabilitation Activities

3.1 Revegetation Areas

Two distinct vegetation areas – open woodland and grassland – have been identified as viable areas for reference sites for benchmarking rehabilitation via revegetation. A total of seven areas, which are defined in **Table 3** and illustrated in **Figure 4**, are proposed to be used as reference sites for rehabilitation via revegetation, with the intended PMLU of low intensity grazing land. Methods proposed in this report are consistent with the Office of the Queensland Mine Rehabilitation Commissioner's Technical Paper for grazing as a PMLU (State of Queensland 2024).

Grassland with or without low density trees is considered suitable for low intensity grazing. However, the planting of trees is not considered suitable for some rehabilitation areas that are highly disturbed and/or very rocky. As a result, trees will only be planted in RA8 and RA9 areas (refer **Table 3**). The total area proposed for grassland revegetation is 56.03 ha and the total area proposed for open woodland revegetation is 9.30 ha.

A total of seven rehabilitation areas (RAs) are proposed to be revegetated to achieve low intensity grazing land PMLU (**Figure 4**). A description and the area of each rehabilitation area proposed for revegetation is provided below in **Table 3** and illustrated in **Figure 5**.

Table 3. Revegetation areas

Rehabilitation area ID	Rehabilitation area description	Revegetation treatment	Area (ha)
RA1	**Cleared areas and laydowns** - this includes laydown areas, the cleared area in the northern extent of the site (within ML80192) that was previously required for operations, and inactive Pit 1 which will be backfilled with material from the Northern WRD.	Grassland	5.72
RA2	**Silt dump** –this incorporates the maximum extent of the silt dump.	Grassland	1.11
RA4	**Infrastructure and ROM pad-** this incorporates the run-of-mine infrastructure, administration, workshop and storage infrastructure, crushing and screening plant, wash plant, and processing area; inclusive of all buildings, powerlines, conveyors, concrete pads, communications towers, groundwater bores, fuel storage, hardstand areas, laydown yards, and equipment. This incorporates former Pit 1 which has been backfilled and is intended to be used for aglime production and stockpile area.	Grassland	27.34
RA5	**Southern WRD-** this includes the current, future, and buffer areas of the southern WRD. The footprint includes an exclusionary area comprising a perimeter access track and rock armour bund around the base of the WRD.	Grassland	15.83

Rehabilitation area ID	Rehabilitation area description	Revegetation treatment	Area (ha)
RA7	**Spoil pile areas**- this includes all areas required for spoil pile storage until end of mine life, outside of the Pit 2 and Pit 3-4 abandonment bunds. This will also incorporate the (former) Northern WRD area at end of mine life.	Grassland	6.03
Grassland subtotal revegetation areas			56.03
RA8	**Sediment ponds**- this incorporates the extent of the two sediment ponds onsite.	Open woodland	1.46
RA9	**Topsoil stockpile areas and silt dump** - this includes all areas required for topsoil until the end of mine life, outside of the Pit 2 and Pit 3-4 abandonment bunds.	Open woodland	7.84
Open woodland subtotal revegetation area			9.30
Total revegetation area			65.33

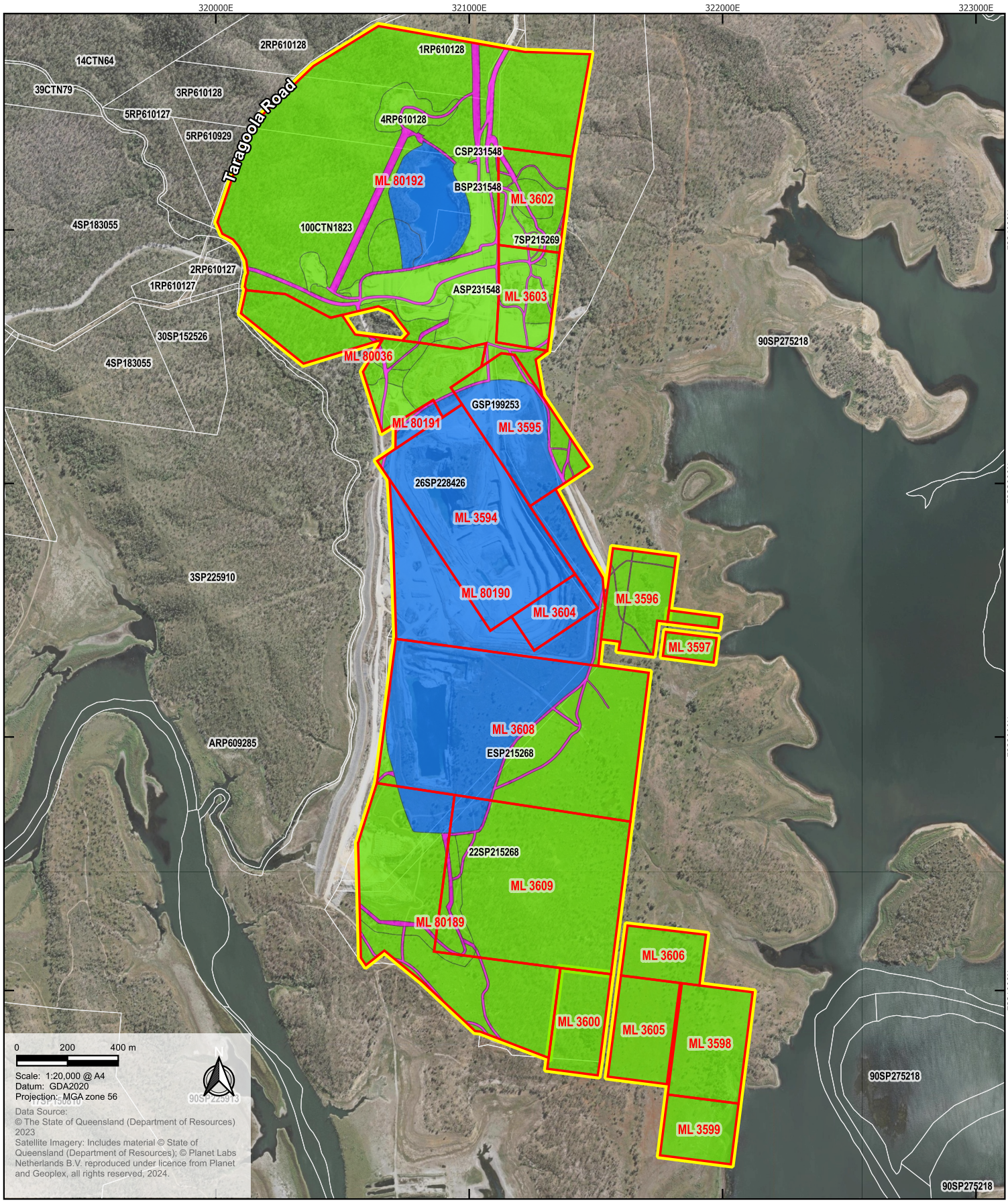
3.1.1 Rehabilitation of Water Storage and Access Tracks

It is noted that RA3 Pit 2, and RA6 Pit 3-4 have an intended PMLU of water storage, consistent with Table 8 of the EA. Additionally, RA10 access tracks will be retained post-closure in accordance with landholder agreements. These areas are not suitable for supporting a vegetated asset as:

Existing tracks will remain in situ post-closure to achieve intended PMLU by facilitating undisrupted access through the site

Pit 2 and Pit 3-4 will require installation of an abandonment bund set back from the top of the Pit to exclude access. To minimise risks to humans or livestock, no access or rehabilitation activities will occur within the extent of the abandonment bund.

The abandonment bund will be comprised of compacted clayey soil and covered in unweathered crushed limestone coarse rock and will remain unvegetated to aid their instability. This rehabilitation method is considered suitable for this Project.



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Legend

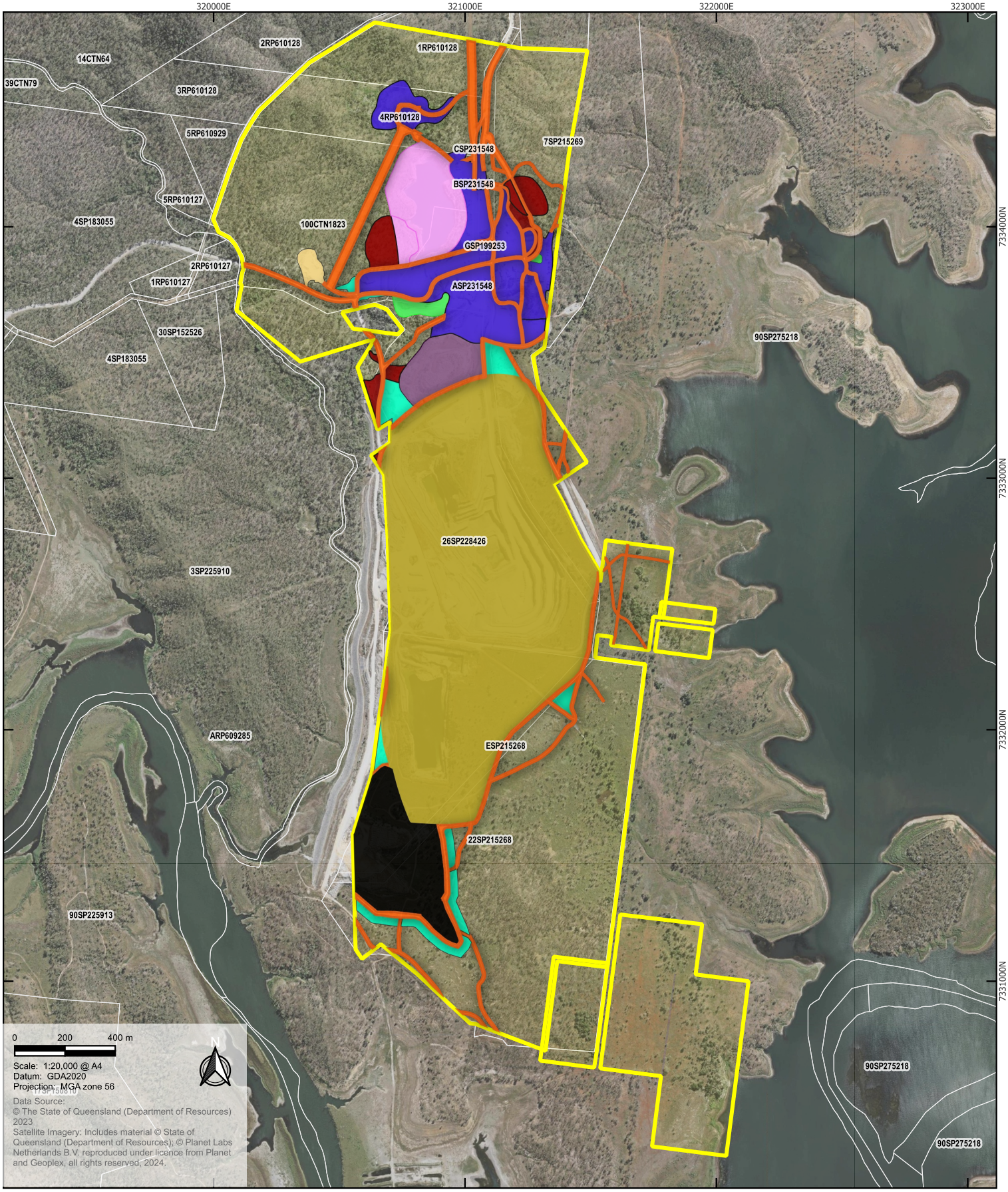
- Site boundary
- Mining leases
- Cadastre (DCDB)

Post mining land uses

- Grazing
- Other
- Water storage

Graymont
Calliope Limestone Quarry
Revegetation Plan

Figure 4
Designated post mining land uses



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 Revegetation Plan\Rev 3\Figure 5 Designated rehabilitation areas.qgz

Legend

- Site boundary

Rehabilitation areas

- RA01 - Cleared areas and laydowns
- RA02 - Silt dump
- RA03 - Pit 2
- RA04 - Infrastructure and ROM pad
- RA05 - Southern waste rock dump
- RA06 - Pit 3-4
- RA07 - Spoil piles
- RA08 - Sediment ponds
- RA09 - Topsoil areas
- RA10 - Access tracks

Graymont
Calliope Limestone Quarry
Revegetation Plan

Figure 5
Designated rehabilitation areas

3.2 Revegetation Works

3.2.1 Objectives

The purpose of the proposed revegetation works is to revegetate the above-mentioned revegetation areas with functional and self-sustaining vegetation communities that are suitable for low intensity grazing. Prior to commencement of mining, the site supported pastoralism and cultivation. Small to medium sized patches of remnant vegetation were retained within a matrix of cleared open-areas and scattered trees comprising thinned open woodland. A combination of native grassland areas and open woodland areas is proposed for the rehabilitation areas.

3.2.2 Topsoil Preparation

The topsoil proposed for use in the revegetation works will be sourced from the site and off-site areas. Topsoil sourced from the site is comprised of neutral sandy clay with a pH range of 6.1-6.9 and 2.1% organic carbon in the A Horizon (Epic 2023). This topsoil is considered suitable for revegetation without the application of soil ameliorants. Additional topsoil will be sourced from off-site.

The application and preparation of topsoil should occur as follows:

- Compacted soil (i.e. hardstand areas) should be ripped using a suitable machine such as an excavator with ripper attachment or bulldozer
- 200 mm top dress using salvaged soil
- Topsoil will be sourced from site overburden and other sources from off-site
- Prior to applying topsoil, any weeds will be removed from the area by hand, ensuring complete removal of the root system
- Following the spread of topsoil and prior to sowing of native grass seeds targeted weed removal should occur
- Where slope is >10° coir logs should be placed in rows traversing the slope parallel to slope contours with 10 m intervals to control erosion and sedimentation downstream.

3.2.3 Sourcing Seedings and Seeds

A mix of species analogous to RE 11.11.15 will be planted during autumn. Seedlings should be sourced where possible from local provenance stock. Planting stock will be provided in forestry tubes with a minimum plant height of 20 cm and a well-developed root system. Seedlings are to be healthy and displaying signs of active growth. Any plants displaying yellowing, disease, root curling or are root bound are not to be planted, nor are any plants with weeds growing within forestry tubes. Seedlings are to be watered with a minimum of 5-10 litres of water each at the time of planting and then watered as part of general maintenance requirements. Seeds should be sourced from local provenance

stock, however due to the large quantity required for the Project, local harvesting is likely to be insufficient and additional sources may be required.

3.2.4 Sowing Native Grass Seeds

Prior to the planting of any tubestock for shrubs and trees, native grass seeds of species identified in **Table 4** will be sown into the topsoil during autumn. Targeted weed removal should occur following the spread of topsoil and prior to the sowing of native grass seeds.

Application of broad-scale non-residual herbicide should occur during the spring following seed sowing and during the spring in the following year. Standard agricultural machinery should be used to sow seeds at a rate of 25 kg per ha. The species selected for the seed mix were all observed within the Project area and tolerant of drought. Slender Bamboo Grass in particular was observed throughout the site in high density including rock piles and spoil areas. It is expected that additional native ground cover plants will colonise the revegetation sites from nearby woodlands and grasslands including forbs and other species.

Table 4. Native grass seeds species and quantities

Common name	Species name	Seed mix %
Slender Bamboo Grass	*Austrostipa verticillata*	50
Black Speargrass	*Heteropogon contortus*	10
Kangaroo Grass	*Themeda triandra*	10
Pitted Bluegrass	*Bothriochloa decipiens*	10
Hairy Panic	*Panicum effusum*	10
Barbed-wire Grass	*Cymbopogon refractus*	10

3.2.5 Shrubs and Trees

To achieve a vegetation community analogous to RE 11.11.15 open woodland suitable for low intensity grazing, a combination of the species listed in **Table 5** is proposed to be planted within RA8 and RA9 areas. Additional native shrub species such as Acacias are expected to colonise the revegetation areas and it is considered unnecessary to plant them.

Table 5. Tree and shrub species planting mix

Common name	Species name	Planting density (plants/100 m^2)
Trees		
Narrow-leaved Ironbark	*Eucalyptus crebra*	2
Red Bloodwood	*Corymbia erythrophloia*	1
Shrubs		
Pretty Wattle	*Acacia decora*	4

Common name	Species name	Planting density (plants/100 m^2)
Corky Apple	*Planchonia careya*	1
Wild Orange	*Capparis canescens*	1
Currant Bush	*Carissa ovata*	1

3.2.6 Planting Method

The following planting method is recommended to occur in the autumn following the sowing of native grass seeds:

- Planting:
  - Trees and shrubs should be planted in rows installed at 5 m intervals and should be configured parallel to the site's contours to allow management access in between rows.
  - Plants should be spaced 2 m apart
  - Planting will involve planting in a slight shallow, twice the size of the tube container, ensuring root ball is just below the soil surface
  - Soil is to be backfilled to the same level as when the plant was in the container
  - An application of mulch to a depth of 50-100 mm is then required to surround the plant, but not touch the stem
  - Ring mulching or blanket mulching is acceptable
  - Shrubs and trees will be planted at a density of 10 plants per 100 m^2.
- Timing:
  - Autumn following significant rainfall and when the surface soil moisture levels are optimum.
- Watering:
  - If using a water cart use 10-15 litres water per plant for a minimum of eight weeks
  - Water twice in the first week, then once per week from weeks 2-8
  - Less water required per plant if hand watering.
- Maintenance:
  - Weed management to ensure weeds do not outcompete establishing plants
  - Supplementary planting should be carried out in areas where plants have been subject to significant die-off
  - Additional watering if hot, dry conditions persist, particularly during the first 8 weeks
  - Maintenance program continuing for a minimum of 12-24 months.

3.2.7 Schedule

The planting and maintenance schedule for the initial planting, sowing native grass seeds and planting shrubs and trees is outlined in **Table 6**. The commencement date of the planting and maintenance schedule will vary and is outlined in the PRCP (Onterris 2026).

Table 6. Planting and maintenance schedule

Year	Season			
	Summer	Autumn	Winter	Spring
1	Site preparation Targeted weed removal Spread topsoil	Sow native grass seeds Herbicide spot spray Commence maintenance and irrigation		Broad-scale non-residual herbicide application
2	Weeds survey	Plant tree and shrub tubestock (**RA8 and RA9 only**) Herbicide spot spray	End irrigation	Broad-scale non-residual herbicide application
3	Weeds survey	Herbicide spot spray		
4	Weeds survey	Herbicide spot spray End maintenance (weeding control and supplementary planting)		
5	Weeds survey	Start cattle grazing		
6	Weeds survey			
7	Weeds survey			
8	Weeds survey			
9	Weeds survey			
10	Final weed survey	PMLU achieved		

3.3 Rehabilitation Limitations

3.3.1 Stock Damage

The presence of domestic cattle within the revegetation areas is the greatest potential limitation to the success of site rehabilitation works. The presence of cattle can have the following adverse impacts:

- Introduction and spreads of weeds
- Soil compaction
- Seedling loss from herbivory.

3.3.2 Erosion

The potential for topsoil erosion is greatest in areas with a slope of >10°. Erosion may occur during and/or after rainfall events and may include the following types of erosion:

- Gully erosion
- Sheet erosion
- Tunnelling
- Subsidence.

3.3.3 Fire

The proposed revegetation areas and adjacent woodland areas are susceptible to bushfire. Whilst many of the species proposed for planting are adapted to bushfire, the exposure of seedlings to bushfire is likely to result in significant seedling mortality.

3.3.4 Weeds

Invasive plants have the potential to limit the success of the revegetation works. Weeds can outcompete native species and smother young plants. A total of 25 non-native flora species identified within the Project area are detailed below in **Table 7**. The control of Rubber Vine (*Cryptostegia grandiflora*) and Lantana (*Lantana camara*) is a potential risk to the revegetation works. Both species area capable of smothering large areas in the absence of control measures. Weed monitoring and management should pay particular attention to Lantana and Rubber Vine.

Table 7. Non-native flora species identified within the Project area

Common name	Species name	Biosecurity Act category	WoNS
African Lovegrass	*Eragrostis curvula*	-	-
American Ratstail Grass	*Sporobolus jacquemontii*	3	Yes
Argentine Peppercress	*Lepidium bonariense*	-	-
Balloon Cottonbush	*Gomphocarpus physocarpus*	-	-
Blue Billygoat Weed	*Ageratum houstonianum*	-	-
Canadian Fleabane	*Conyza bonariensis*	-	-
Castor Oil Bush	*Ricinus communis*	-	-
Cobbler's Pegs	*Bidens pilosa*	-	-
Corky Passion Flower	*Passiflora suberosa*	-	-
Creeping Lantana	*Lantana montevidensis*	3	-
Dwarf Poinsettia	*Euphorbia cyathophora*	-	-
Flannel Weed	*Sida cordifolia*	-	-
Lantana	*Lantana camara*	3	Yes
Maynes Pest	*Glandularia aristigera*	-	-
Mimosa Bush	*Vachellia farnesiana*	3	-
Noogoora Burr	*Xanthium occidentale*	-	-
Prickly Pear	*Opuntia stricta*	3	Yes
Red Natal Grass	*Melinis repens*	-	-
Rubber vine	*Cryptostegia grandiflora*	3	Yes
Shrubby Stylo	*Stylosanthes scabra*	-	-
Siratro	*Macroptilium atropurpureum*	-	-
Snake Weed	*Stachytarpheta cayennensis*	-	-

Common name	Species name	Biosecurity Act category	WoNS
Urena Weed	*Urena lobata*	-	-
Verbena	*Verbena littoralis*	-	-
Woolly Rattlepod	*Crotalaria incana*	-	-

3.4 Mitigation Measures

3.4.1 Fencing

Cattle and other livestock, and native marsupials or feral animals (i.e. wallabies, pigs, rabbits) may trample or feed on new vegetation and hinder its establishment within dedicated rehabilitation areas. To ensure the success of rehabilitated revegetation areas, these species that pose a risk of damage or herbivory on new vegetation should be excluded from the revegetation areas for the first five years following revegetation. If monitoring identifies over-browsing as a limitation to rehabilitation success, temporary animal proof fencing will be needed (e.g. hinge-lock wallaby fencing and/or rabbit proof netting) to create an exclusion zone while the vegetation in these areas becomes established. To avoid damage to vegetation via trampling, cattle will be excluded from the revegetation areas until rehabilitation has been completed.

3.4.2 Erosion and Sedimentation Control

During the early phases of revegetation, the loss of topsoil during rainfall events is a risk that should be mitigated through erosion and sedimentation control measures. These measures should be applied in areas with a slope >10° and include the placement of coir logs in rows running parallel to slope contours, with rows spaced in 10 m intervals.

As noted in **Section 3.4.1**, if cattle movement over newly revegetated areas is visibly causing erosion, temporary exclusion fencing will be installed.

3.4.3 Fire Management

The mitigation of bushfire risk to revegetation areas involves fire management in adjacent woodland areas. Fire management guidelines for RE 11.11.15 are as follows (Queensland Herbarium 2022):

- Season: Late wet to early dry season if soil moisture high, early storm season or following good rains
- Intensity: various
- Interval: 6-15 years
- Strategy: <30% annually during conditions of good soil moisture and when plants are actively growing.

The practicality and scope of fire management within and adjacent to the site is however, likely to be limited due to safety concerns for the site and adjacent properties and issues regarding land tenure of adjacent properties.

3.4.4 Weed Management

Weed management should be completed annually across the revegetation areas. Weeds listed as a restricted matter in the Queensland *Biosecurity Act 2014*, have been identified on site (refer **Section 3.3.4**). Weed management actions to be implemented are outlined in **Table 8**. A combination of weed removal techniques may be implemented to effectively manage weeds. Specific weed removal techniques for restricted matter identified on site are outlined in **Table 9**.

Table 8. Weed management actions

Purpose: control restricted plants and minimise weed dispersal on and off the site
Performance criteria: • Control all restricted plants to <5% cover • Control further spread of unrestricted environmental weeds • Prevent the introduction of new restricted plants and environmental weeds
Responsibility: • Site supervisor and civil contractor
Timing: • Weed control is most effective during December-April • Weed removal/treatment repeated annually
Management actions: • Targeted herbicide application and spot spray restricted and environmental weeds • Restricted weeds are to be stockpiled separately and disposed of at an appropriate waste disposal facility • Vehicle/machinery hygiene measures (i.e. valid weed and seed free certificate) to be implemented to prevent the introduction and/or further spread of weeds on and off the site • Temporary exclusion fencing as needed
Monitoring: • Monitor the germination or regrowth of weed species annually • The Site supervisor is to monitor weed removal and ensure management strategies are adhered to
Corrective actions: • Undertake weed removal to treat germinated or regrown weed species
Reporting: • Any incidents of non-compliance are to be managed in accordance with the contractor's incident management procedure or recorded in an environmental diary

Table 9. Weed removal techniques

Weed species	Technique
American Ratstail Grass	• Spot spray with glyphosate and/or flupropanate • Limit stock/vehicle movements through infested areas • Restrict vehicles to access tracks

Weed species	Technique
	• Comply with weed seed hygiene management
Lantana	• A combination of fire, mechanical control and herbicide control is recommended for Lantana. • Regular burning of dense infestations • Ploughing, grubbing or stick raking for larger areas • Herbicide spot spray and/or cut-stump
Creeping Lantana	• A combination of fire, mechanical control and herbicide control is recommended for Creeping Lantana. • Fire and stock spelling • Ploughing, grubbing or stick raking for larger areas • Herbicide spot spray and/or cut-stump
Mimosa Bush	• Herbicide control is recommended for the control of Mimosa Bush: • Basal bark spray • Cut stump treatment
Prickly Pear	• Mechanical control is not recommended for Prickly Pear control. The use of fire, herbicide and biological control is recommended: • Spot spray with glyphosate and/or flupropanate • Distribute pads of infected Cactoblastis and cochineal insects to other Prickly Pear infestations
Rubber vine	• A combination of fire, mechanical and herbicide control is recommended for Rubber Vine: • Biannual burns • Slashing, blade-ploughing or stick raking • Foliar spray, basal bark treatment cut stump treatment, or soil treatment

4 Monitoring

4.1 Objective

The objective of monitoring the proposed revegetation works across the site is to ensure rehabilitation activities are consistent with the measures outlined in **Section 3** of this Revegetation Plan.

4.2 Schedule

Monitoring of vegetation within the rehabilitation zones subject to revegetation will continue until the areas are rehabilitated to a stable landform with self-sustaining vegetation cover in accordance with Section 3.6.1 of the PRCP guidelines.

An annual survey of invasive weeds across the revegetation areas is recommended to document the effectiveness of weed control. Monitoring should occur in summer to inform the following application of weed control techniques during autumn. The weed survey should be completed by a suitably qualified person such as an ecologist or botanist.

Monitoring will also include checking that revegetation works are properly maintained including:

- Supplementary planting in areas where plants have significant die-off
- Ensure weeds do not outcompete establishing plants
- Coir logs should be placed in rows to control erosion where slope is >10°
- Temporary exclusion fencing is secure

4.3 Reference Sites

Reference sites within undisturbed areas of the Project's mining leases have been assessed to provide benchmarks for the evaluation of revegetation works as per the Bio Condition framework and in accordance with the *Method for the Establishment and Survey of Reference Sites for Bio Condition* (Eyre et al. 2017). The framework is commonly used for monitoring native vegetation condition in Queensland and provides a benchmark against which revegetation sites are compared and scored (Eyre et al. 2015). The benchmark is derived from equivalent reference sites of a particular vegetation community type and condition that occupied the site prior to disturbance (i.e. mining) (Neldner and Ngugi 2014). Benchmarks represent a vegetation condition that is self-sustaining and compatible with the intended PMLU. The Bio Condition framework provides a score of vegetation condition. The Bio Condition score is standardised to between 0 and 1 by adding the weighted score for each site-based attribute and dividing by the maximum possible score.

For open woodland benchmarks, a Bio Condition reference site was established within remnant bushland in the far north-west of the site, whilst for the grassland benchmarks, a Bio Condition reference site was established in a cleared grassland area in the south of the site (**Figure 3**). Further details regarding the Bio Condition reference sites are provided in the following sections. Bio Condition reference site field data is provided in **Appendix A**.

4.3.1 Open Woodland Reference Site

The open woodland reference site was established to derive a benchmark for revegetation of RA8 and RA9 areas. This reference site is located in remnant woodland. The intention of vegetation within RA8 and RA9 is to achieve a lower density of trees and shrubs. Furthermore, the large tree and course woody debris (CWD) attributes are not considered reasonable for the assessment of mine rehabilitation works as a minimum of 50 years would be required to reach equivalency with these benchmarks (Neldner and Ngugi 2014). As such, the Bio Condition site-attributes of number of large trees and CWD of remnant woodland are not considered relevant to the intended PMLU of low intensity grazing. The benchmarks for the site-attributes of canopy tree cover was reduced by 50%. The site attributes and benchmarks intended for assessment of RA8 and RA9 revegetation works are provided in **Table 10**. For successful achievement of the intended PMLU a Bio Condition score of 1 is required. **Table 10** provides the site-attribute targets required for achieving a Bio Condition score of 1. All targets must be reached to achieve the PMLU. It is anticipated that achievement of the intended PMLU will occur within 10 years following commencement of revegetation works.

Table 10. Open woodland site-attribute benchmarks

Site attribute	Reference site benchmark	BioCondition scoring[1]		Revegetation target
		Description	Score	
Canopy tree height (m)	14.5	<25%	0	≥10.2
		≥25% to 70%	3	
		≥70%	5	
Canopy tree recruitment (%)	100	<20%	0	≥75%
		≥20-75%	3	
		≥75%	5	
Canopy tree cover (%)	15.5	<10%	0	7.8-31%
		≥10% and <50%	2	
		≥50% or ≤200%	5	
		>200%	3	
Tree species richness	2	<25%	0	≥2
		≥25% to 90%	2.5	
		≥90%	5	
Shrub cover (%)	7.3	<10%	0	3.7-14.6%

Site attribute	Reference site benchmark	BioCondition scoring[1]		Revegetation target
		Description	Score	
		≥10% and <50% or >200%	3	
		≥50% or ≤200%	5	
Shrub species richness	8	<25%	0	≥8
		≥25% to 90%	2.5	
		≥90%	5	
Grass species richness	8	<25%	0	≥8
		≥25% to 90%	2.5	
		≥90%	5	
Other species richness	9	<25%	0	≥9
		≥25% to 90%	2.5	
		≥90%	5	
Non-native plant cover (%)	0	>50%	0	<5%
		≥25% to 50%	3	
		≥5% to 25%	5	
		<5%	10	
Perennial grass cover (%)	40.4	<10%	0	≥36.4%
		≥10% to 50%	1	
		≥50% to 90%	3	
		≥90%	5	
Organic litter cover (%)	19	<10%	0	9.5-38%
		≥10% to <50% or >200%	3	
		≥50% or ≤200%	5	

1. As per BioCondition Assessment Manual (Eyre et al 2015)

4.3.2 Grassland Reference Site

The grassland reference site was established to derive a benchmark for revegetation of RA1, RA2, RA4, RA5, and RA7. The reference site is located in a grassland cleared of trees and other woody vegetation. As with the Bio Condition site attributes for open woodland, number of large trees and CWD are not included in the assessment. Due to the absence of trees and shrubs from grassland ecosystems, the following site attributes are excluded from the assessment (Eyre et al 2015):

- Large trees

- Tree canopy height
- Recruitment of dominant canopy species
- Tree canopy cover
- Shrub layer cover
- Course woody debris
- Native tree species richness.

No trees or shrubs are intended as part of grassland revegetation. The site attributes and benchmarks intended for assessment of RA1, RA2, RA4, RA5, and RA7 revegetation works are provided in **Table 11**. For successful achievement of the intended PMLU, a Bio Condition score of 1 is required. **Table 11** provides the site-attribute targets required for achieving a Bio Condition score of 1. All targets must be reached to achieve the PMLU. It is anticipated that achievement of the intended PMLU will occur within 10 years following commencement of revegetation works.

Table 11. Grassland site-attribute benchmarks

Site attribute	Reference site benchmark	Bio Condition scoring[1]		Revegetation target
		Description	Score	
Grass species richness	5	<25%	0	≥5
		≥25% to 90%	2.5	
		≥90%	5	
Other species richness	2	<25%	0	≥2
		≥25% to 90%	2.5	
		≥90%	5	
Non-native plant cover (%)	0	>50%	0	<5%
		≥25% to 50%	3	
		≥5% to 25%	5	
		<5%	10	
Perennial grass cover (%)	75	<10%	0	≥67.5%
		≥10% to 50%	1	
		≥50% to 90%	3	
		≥90%	5	
Organic litter cover (%)	10	<10%	0	5-20%
		≥10% to <50% or >200%	3	
		≥50% or ≤200%	5	

1. As per BioCondition Assessment Manual (Eyre et al 2015)

4.4 Rehabilitation Milestones

To track the progress of the revegetation works and identify any limitation to success, expected milestone have been suggested and are provided in **Table 12**. A landform is considered stable when it can sustain the intended PMLU (DES 2021).

Table 12. Rehabilitation milestone for revegetation areas

Milestone	Description	Year
1	Site prepared, weed removal completed, topsoil spread, grass seed sown, commenced maintenance and irrigation	1
2	Tree and shrub planted (RA8 and RA9 only), commence weed surveys, end irrigation, broad-scale non-residual herbicide applied	2
3	End maintenance (weeding control and supplementary planting)	5
4	Start cattle grazing	6
5	Final weed survey, PMLU achieved	10

5 References

DES 2021, Guideline - Progressive rehabilitation and closure plans (PRC plans) Version 2.0, Department of Environment and Science, Queensland Government, Brisbane.

Epic 2023, *Sampling analysis and quality plan*. Epic Environmental Pty Ltd, on behalf of Graymont.

Onterris 2026 *Progressive Rehabilitation Closure Plan*. Epic Environmental Pty Ltd, on behalf of Graymont.

Eyre, T.J., Kelly, A.L, Neldner, V.J., Wilson, B.A., Ferguson, D.J., Laidlaw, M.J. and Franks, A.J. 2015, *BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual. Version 2.2*. Queensland Herbarium, Department of Science, Information Technology, Innovation and Arts, Brisbane.

Eyre TJ, Kelly AL and Neldner VJ 2017, *Method for the Establishment and Survey of Reference Sites for BioCondition. Version 3*. Queensland Herbarium, Department of Science, Information Technology and Innovation, Brisbane.

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Appendix A Bio Condition Reference Site Field Data

Site	Open woodland	Grassland
# Eucs > 30cm	13	-
Large tree benchmark	34	N/A
# large trees	10	-
Large Euc diameter	39, 38, 37, 31, 31, 45, 30, 36, 39, 41, 35, 41, 36	
Canopy species	Eucalyptus crebra, Corymbia erythrophloia	-
Tree sp rich #	2	N/A
Canopy height range (m)	14-15.5	-
Canopy height (m)	14.5	-
Recruitment%	100	-
Canopy cover%	31	-
Sub-canopy height (m)	7	-
Sub-canopy cover (%)	5	-
Shrub cover%	7.3	-
Shrub species	*Acacia decora, Acacia excelsa, Grewia latifolia, Acacia disparrima, Capparis canescens, Planchonia careya, Alyxia ruscifolia, Melia azedarach*	-
Shrub sp rich	8	-
Grass species	*Aristida queensladicum, Bothriochloa decipiens, Heteropogon contortus, Aristida calycina, Panicum decompositum, Themeda triandra, Eragrostis brownii, Enneapogon mucronata*	*Austrostipa verticillata, Heteropogon contortus, Bothriochloa decipiens, Aristida calycina, Panicum effusum*
Grass speceies rich	8	5
Forbs_other	*Sida subspicata, Cyperus gracilis, Rhynchosia minima, Cyanthillium cinereum, Glycine tomentella, Phyllanthus virgatus, Indigofera pratensis, Euphorbia drummondii, Alternanthera nana*	*Indigofera australis, Indigofera linifolia*
Forbs_other species rich	9	2
Total species rich	27	7
CWD	50	N/A
Weed cover %	5	1
Weeds	*Melinis repens, Opuntia stricta, Ageratum houstonianum, Stachytarpheta cayennensis, Lantana montevidensis, Lantana camara*	
Q1 perrenial grass %	2	
Q1 litter %	20	
Q2 perrenial grass %	75	
Q2 litter %	20	
Q3 perrenial grass %	20	
Q3 litter %	40	
Q4 perrenial grass %	15	
Q4 litter %	5	
Q5 perrenial grass %	90	
Q5 litter %	10	
Mean perrenial grass %	40.4	75
Mean litter %	19	10

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Appendix I Flood Assessment

MEMORANDUM

Project:	Calliope PRCP	Date:	19 June 2026
To:	Epic Environmental	From:	Engeny
ATT:	Shaille Hargreaves	CC:	Romin Nejad
Subject:	Calliope Limestone Quarry PRCP – Landform Drainage Review		

INTRODUCTION

Engeny have been engaged by Epic Environmental (Epic) to undertake a drainage review of the southern water rock dump (WRD) for the revised final landform design proposed for Calliope Limestone Quarry progressive rehabilitation and closure plan (PRCP). The original PRCP submission received comments from the regulator on 10 October 2025, around the southern WRD design and the ponded area that would remain post closure. The final landform design has since been revised to prevent ponding, and this memo provides a review of the revised landform drainage to assist with preparing a response to the regulator comments. The regulator comment which this memo addresses is provided in Table 1.

TABLE 1: REGULATOR COMMENT

Item	Matter	Request for Information
3	The flood assessment identifies that there is potential ponding where waters will accumulate to a depth greater than 1 meter adjacent to the waste rock dump, and while the geotechnical report considers water management regarding rainfall, no consideration has been given to the potential impacts to the stability of the WRD resulting from this accumulated water. In addition, although RM5.1 requires that all rehabilitated landforms are water shedding RM5.3 proposes that the final landform does not contain low points that may pond water for more than one month. Water ponding has the potential to impact on the achievement of the PMLU with potential impacts to vegetation establishment and structural stability. Clarification is required on the timing and locations of all potential ponding and an assessment is required to assess the potential impacts of ponding on the PMLU.	Provided an updated PRC plan that includes: • clarification on potential areas where ponding may occur; and • an assessment on the potential impacts to the achievement of the PMLU resulting from the ponding of floodwaters.

REVISED LANDFORM DESIGN

The Southern WRD is located immediately south of the proposed final void and partially covers an existing drainage line that will flow to the final void post closure. The previous WRD design covered a significant extent of the existing drainage path, resulting in ponding up to 8.9 m deep before water could overflow the natural ridge and flow to the final void. The ponded area had a capacity of 556 ML and was expected to regularly store water against the WRD landform. The previous southern WRD extent and resulting ponded area is shown in Figure 1.

The revised southern WRD design has a reduced overall footprint and has been optimised to improve drainage around the dump extent. It involves backfill of the gully area to the south east and incorporates dump toe drains around the southern and eastern extents of the WRD. This ensures the WRD and surrounding upstream areas can free drain to the final void without ponding against the final landform. The revised WRD design and the dump toe drains are also shown in Figure 1 in comparison to the previous design.

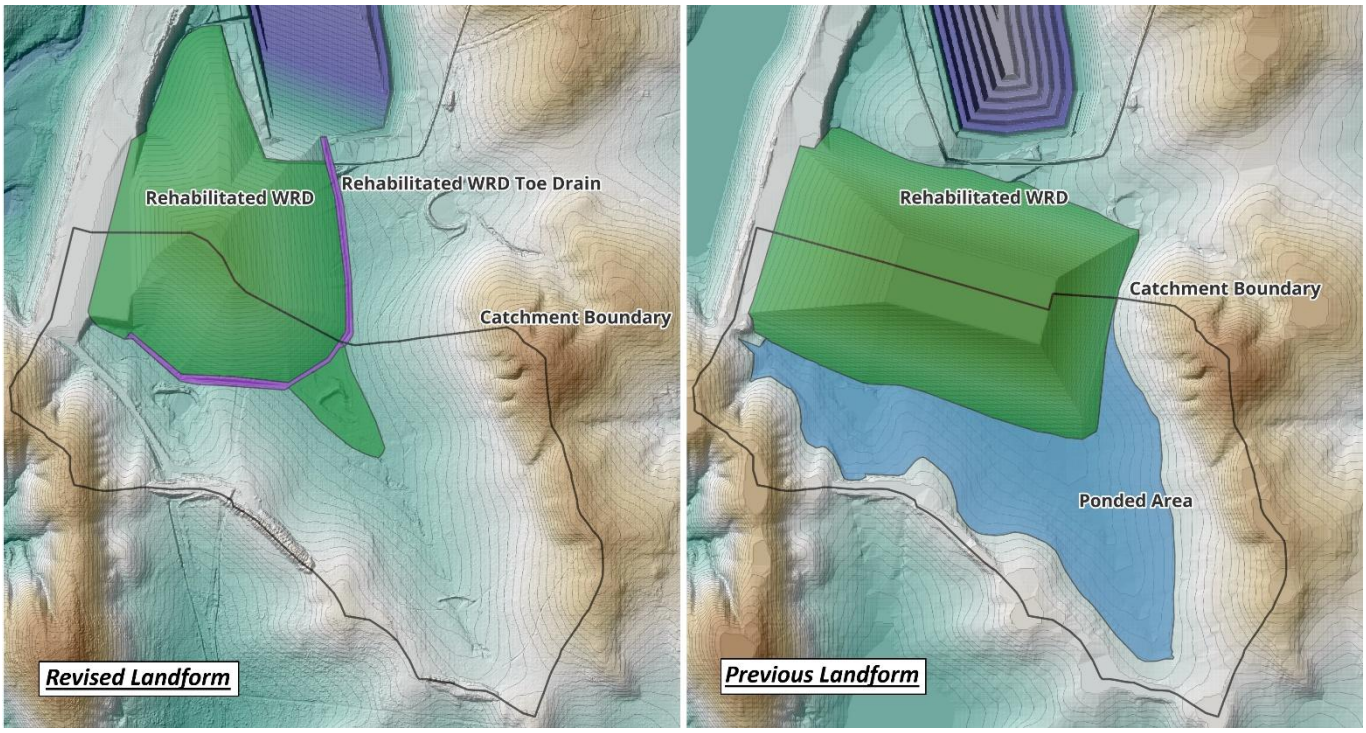


Figure 1: Southern WRD Design (Revised vs Previous)

LANDFORM DRAINAGE

The drainage paths off the revised southern WRD design is shown in Figure 2. The backfill area in the gully to the southeast of the main WRD has been designed with an approximate longitudinal grade of 0.6% towards the WRD toe which is significantly flatter than the existing drainage path that has a grade of approximately 1.5%. The southern WRD toe drains will flow in an eastern and northern direction around the WRD extent. The drain collects the drainage gully to the southeast before draining to the final void. The drain is proposed to be a trapezoidal channel with a base width of 1m and batter slopes of 20%, with a depth typically less than 1m. The drain has a very flat longitudinal grade of 0.2% which is significantly flatter than the existing natural drainage paths (approximately 1.5%). The very flat grade of the WRD toe drains (0.2%) ensures peak flow velocities remain very low with a low risk of erosion or scour.

DISCUSSION

The Southern WRD design has been revised to prevent ponding against the landforms and ensure the WRD and surrounding areas are free draining to the final void. The WRD toe drains are proposed to be constructed at a very flat grade with flat channel batters indicating a low risk of erosion or scour. The revised landform is considered to provide a lower risk outcome for the Project in terms of drainage due to the removal of the ponded area upstream of the WRD, incorporation of stable drainage features and reduced batter slopes of the WRD.

It is recommended the future detailed design of the Southern WRD include the toe drains extending into the final void and tying into a level below the predicted equilibrium lake level of the final void. This will ensure flows are controlled over the backfilled pit floor to further reduce the risk of erosion.

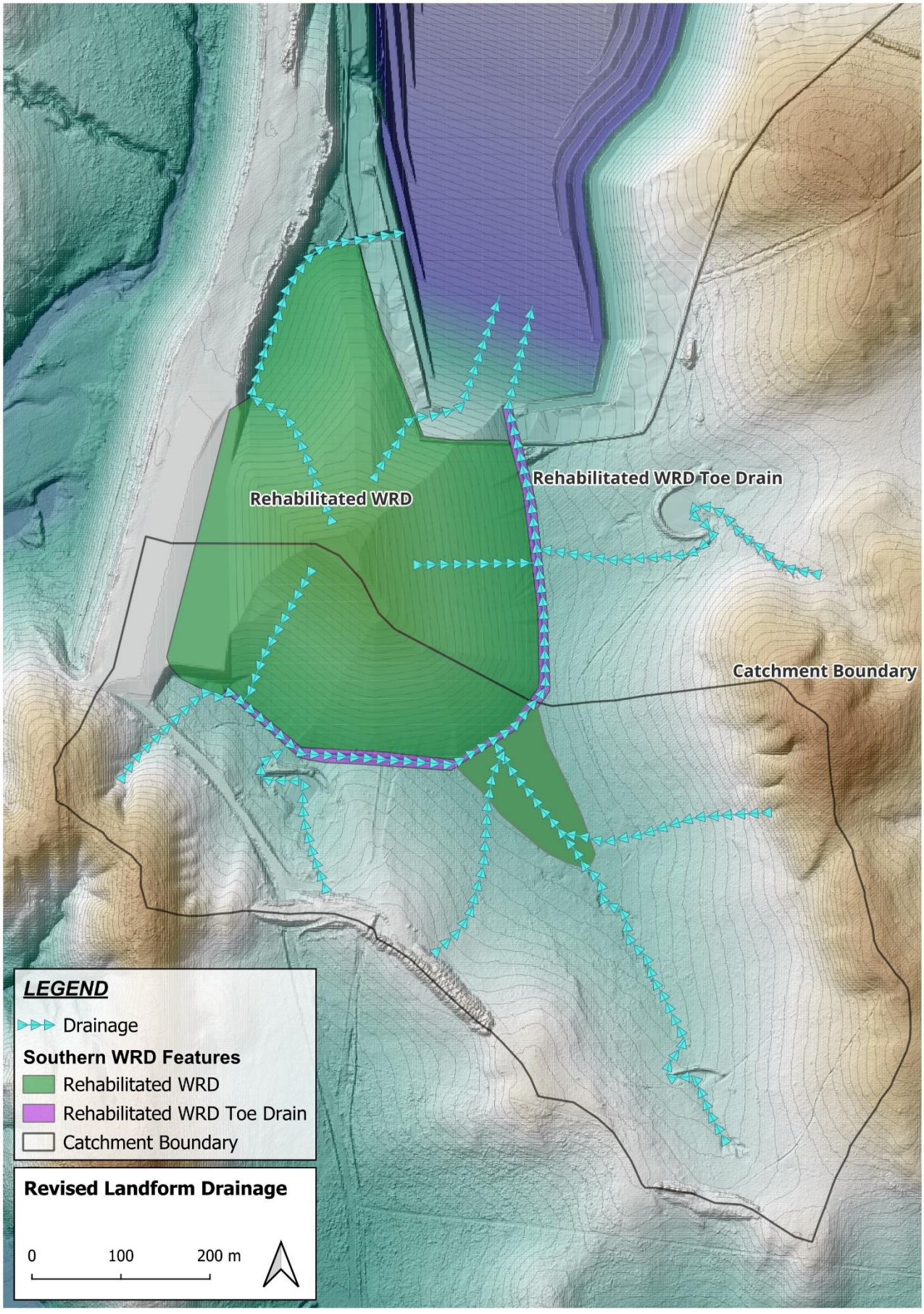


Figure 2: Revised Southern WRD Design Drainage

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MEMORANDUM

Project:	Calliope PRCP	Date:	27 June 2025
To:	Epic Environmental	From:	Engeny
ATT:	Shaille Hill	CC:	Romin Nejad
Subject:	Calliope Limestone Quarry PRCP – Final Landform Flood Assessment		

FINAL LANDFORM FLOOD ASSESSMENT

Engeny have been engaged by Epic Environmental (Epic) to undertake the flood assessment of the proposed final landform for the closure of the Calliope Limestone Quarry. Epic have supplied Engeny with the final landform surface which is proposed to be constructed by end of life in the year 2100. Engeny have undertaken flood modelling of the key waterways and final landform surface to assess susceptibility and influence across the Site to inform rehabilitation and final landform planning regarding flood runoff. It is noted that the Site is bounded by Awoonga Lake on the eastern side and a tributary of the Boyne River on the western side. The flood assessment was completed to comply with Section 3.6.1 of the *Progressive Rehabilitation and Closure Plans Guideline (DES, March 2021).*

Hydrology

Development of a hydrologic model of the catchment was undertaken to determine runoff hydrographs for a range of storm Annual Exceedance Probabilities (AEPs) and durations. The 1% AEP, 0.1% AEP, 0.01% AEP and Probable Maximum Flood (PMF) design storms were applied to key overland flow paths with consideration of future mine domains and landforms to determine potential flood risks to the ongoing stability of the final landform.

PMF rainfall depths were developed in accordance with *The Estimation of Probably Maximum Precipitation in Australia: Generalised Short-Duration Method (BoM, 2003).* Only the burst of the PMF was modelled and therefore it is assumed that sufficient pre-burst rainfall has occurred such that the soil conditions are saturated, therefore an initial/continuing loss regime of 0 mm & 1 mm/h was adopted. The full ensemble of the ten rarest temporal patterns were modelled as well as the BoM Average Variability Method (AVM) temporal pattern to determine the median catchment response.

0.01% AEP rainfall depths were determined by interpolating between the 0.1% AEP and PMF storm depths. Losses for events exceeding the 1% AEP storm were interpolated between the 1% AEP and PMF.

The temporal patterns for the 1% AEP match the 10 ensemble patterns recommended in ARR 2019, events rarer than the 1% AEP adopted the same temporal patterns as the PMF.

Hydraulics

Development of a hydraulic model of the mine area and tributary waterway downstream was undertaken to determine the flood risk profile in the final landform scenario. Modelling of the design storms included the effects of the tributary waterway to represent any potential alteration of flows upstream and downstream of the Site. The effects of Awoonga Lake was considered by applying the tailwater level consistent with the design of the outlet weir control structure as extracted from the 1m LiDAR dataset. Model inflows and domains were applied to appropriately represent key overland flow paths and potential flood levels or ponded areas to determine the extent of flooding in the final landform scenario.

A summary of the key model inputs for hydrology and hydraulics are provided below in Table 1.

The final landform surface as modelled in TUFLOW is shown below in Figure 1 and the catchment breakdown is provided in Figure 2.

TABLE 1: FINAL LANDFORM MODEL ASSUMPTIONS

Model Item	Data Used	Source
Catchments	Gladstone 2009 1m LiDAR Final Landform Surface	Elevation and Depth Foundation Spatial Data (ELVIS) Epic Environmental
Rainfall	**1% & 0.1% AEP** BOM IFD's **0.01% AEP** Interpolated between 0.1% AEP and PMF **PMF** *The Estimation of Probably Maximum Precipitation in Australia: Generalised Short-Duration Method*	Bureau of Meteorology
Temporal patterns	**1% AEP** ARR ensemble patterns **Events rarer than the 1% AEP** 10 rarest temporal patterns BoM AVM	Australian Rainfall and Runoff (ARR) 2019 Bureau of Meteorology
Catchment hydrographs	WBNM hydrologic software package	
DEM	Gladstone 2009 1m LiDAR Final Landform Surface (dxf dated 250528)	Elevation and Depth Foundation Spatial Data (ELVIS) Epic Environmental
Hydraulic roughness	Final Landform Land Use	Epic Environmental
Tailwater	Gladstone 2009 1m LiDAR	Elevation and Depth Foundation Spatial Data (ELVIS)
Flood Extents	TUFLOW hydraulic software package	

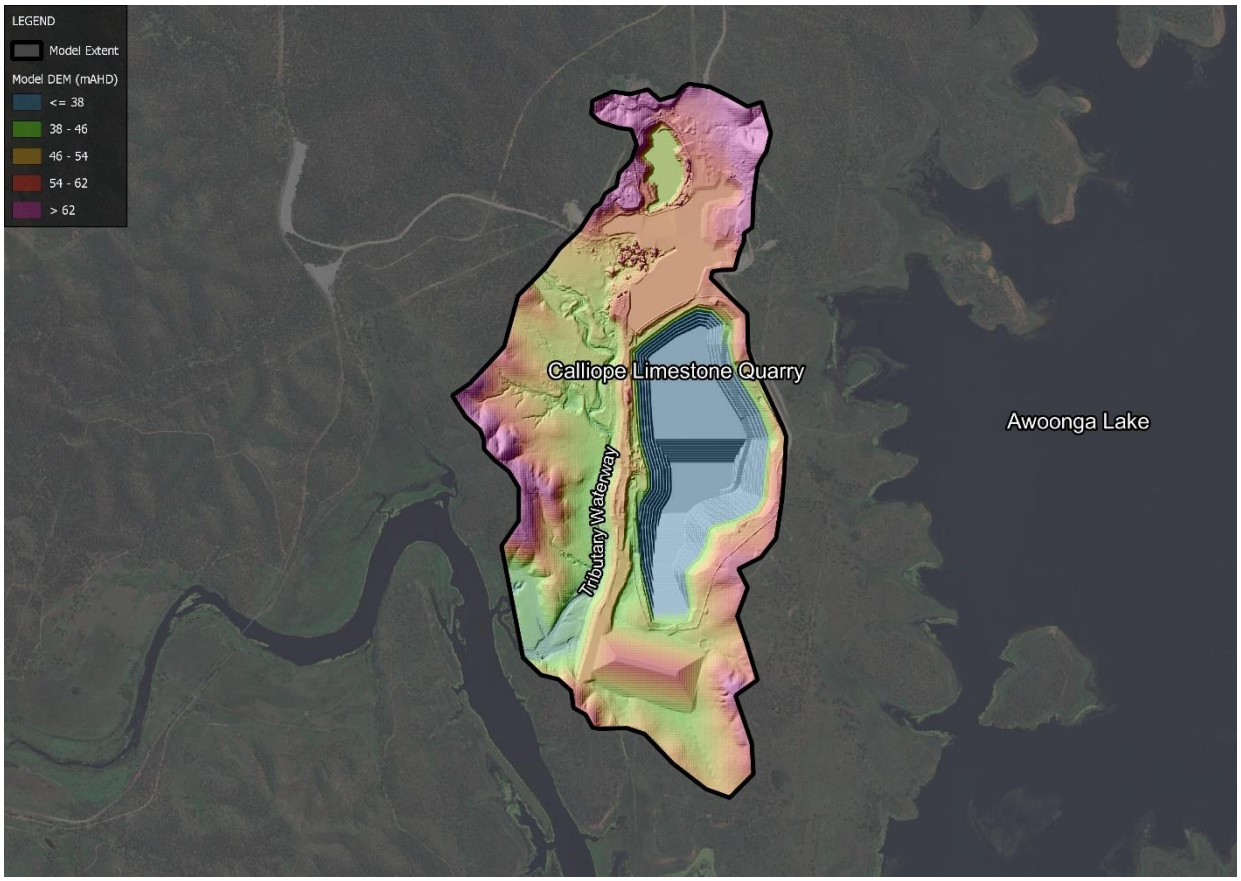


Figure 1: Final Landform DEM

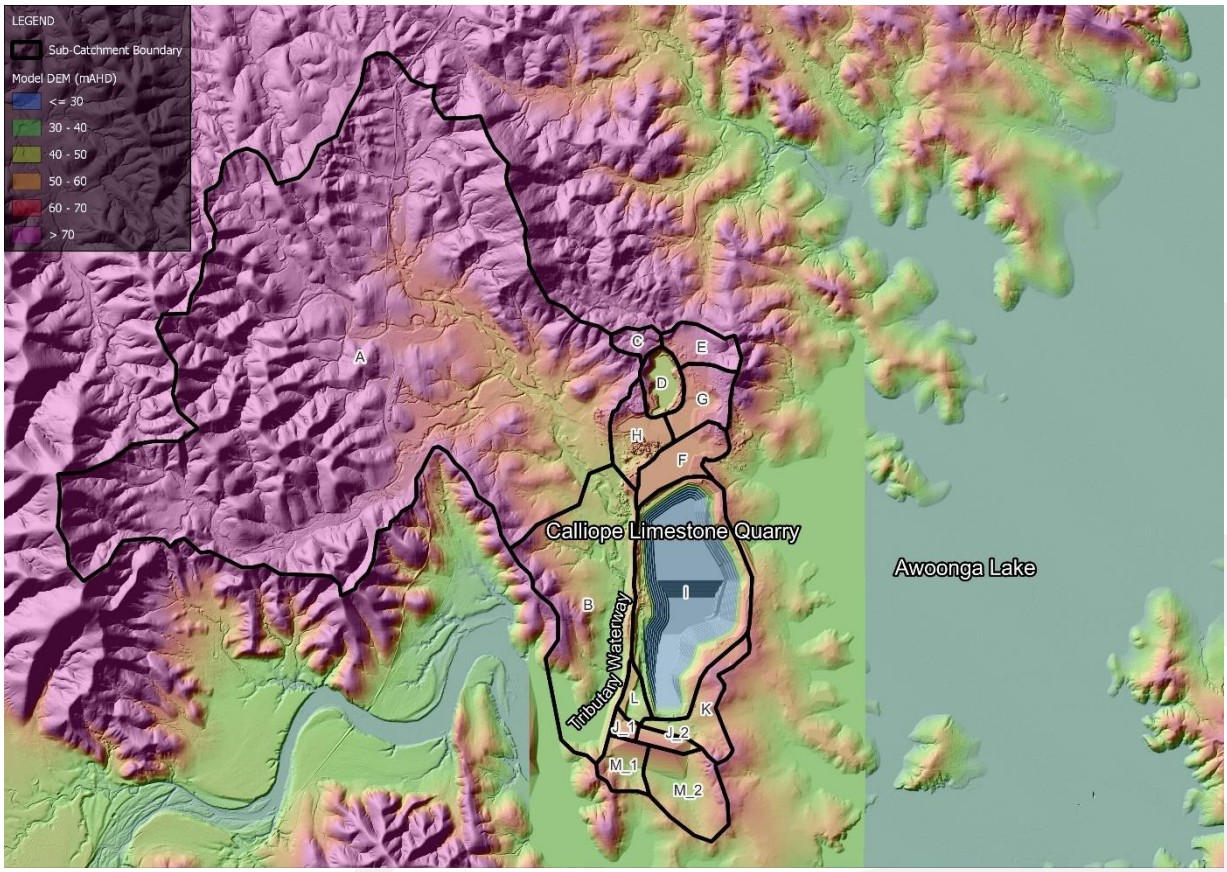


Figure 2: Catchment Breakdown

Final Landform Flood Risk Profile

The flood depth and velocity mapping of the final landform scenario is shown below in Figure 3 to Figure 10. The flood depth maps demonstrate that ponding is anticipated to occur across the Site following all simulated flood events, with standing water expected both within and external to the voids.

It is noted that there are 4 locations at Pit 3-4, and 1 location at Pit 2, where inflow to the voids is observed by overtopping of the pit protection structures. Overtopping of the pit protection structures is predicted to occur in all simulated design events. However, these void inflows are caused by local catchment runoff only and it is not anticipated that the flooding within the tributary of the Boyne River on the western side would generate any inflows to the voids based on the flood results and ground levels.

Velocities at the pit inflow locations are in excess of 1.5 m/s based on the velocity mapping. It is therefore recommended that these locations are suitably protected (i.e. with rock, or some alternative form of armouring), to minimise scour potential and ensure the longevity of the final landform. Velocities across the remainder of the landform are generally less than 1.5 m/s and can therefore be protected from erosion through application of revegetation outcomes. There is a location adjacent Pit 2 (east) and a single location south of the waste rock dump where velocities exceed 1.5 m/s, these areas should be considered for additional rock armouring controls for long term landform stability.

LEGEND

Model Extent

Flood Depth (m)

<= 0.05

0.05 - 0.10

0.10 - 0.30

0.30 - 0.50

0.50 - 1.00

> 1.00

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NOTES:

N

0 0.1 0.2 km

SCALE @ A3 - 1:10,000

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DATA SOURCE

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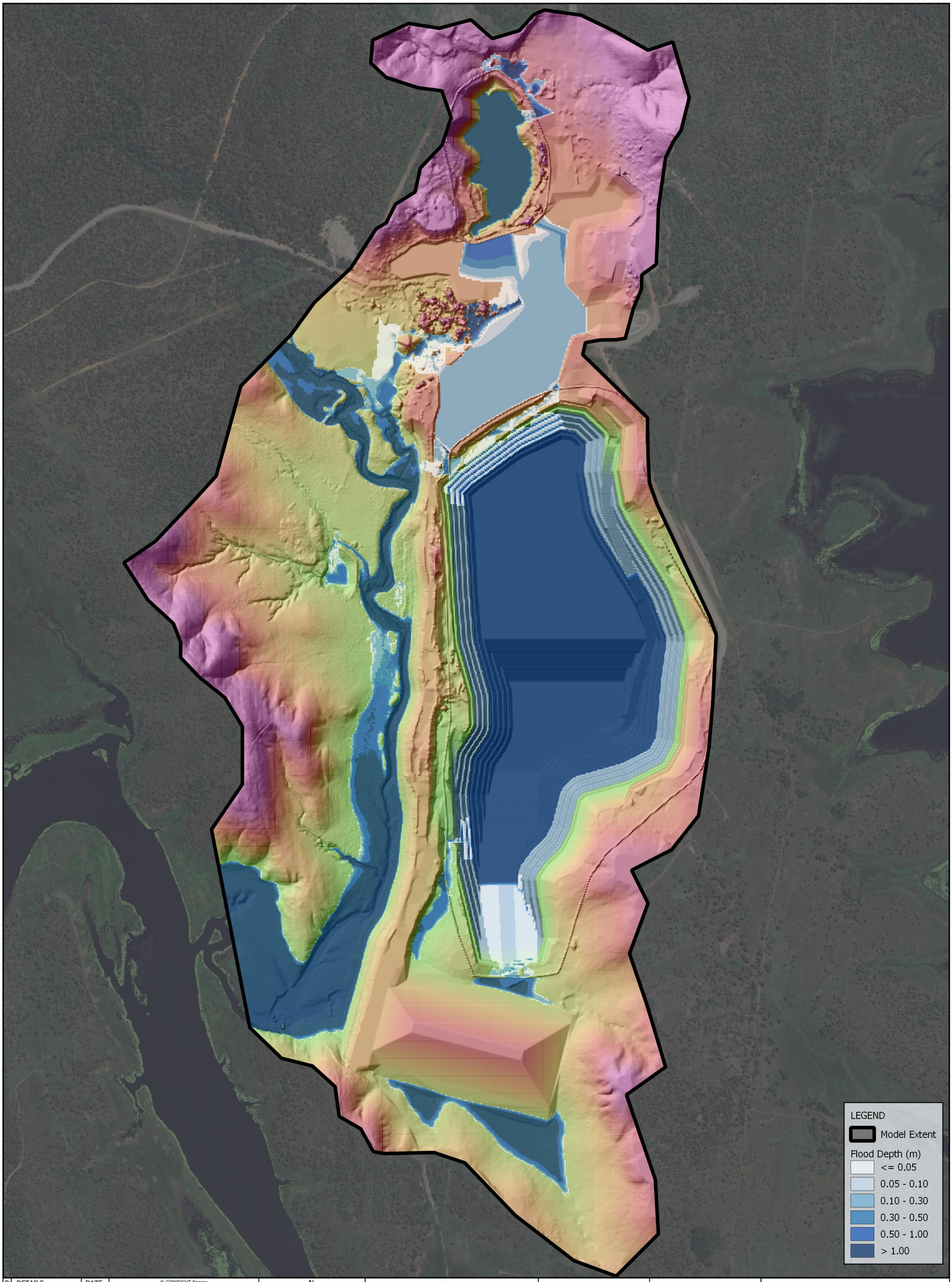
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Figure 3 - 100 Year Flood Depth

Epic Environmental
Calliope PRCP
Final Landform Flood Assessment

Drg Ref.

\\online.com\files\BNEManagement\Projects\QC4036 Epic Environmental\QC4036_004 Calliope PRCP Flooding\05 Design\QGIS\Workspaces\QC4036_004-WOR-002-A Figures.qgz



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N

0 0.1 0.2 km

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Figure 4 - 1000 Year Flood Depth

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Calliope PRCP
Final Landform Flood Assessment

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LEGEND

Model Extent

Flood Depth (m)

<= 0.05

0.05 - 0.10

0.10 - 0.30

0.30 - 0.50

0.50 - 1.00

> 1.00

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NOTES:

N

0 0.1 0.2 km

SCALE @ A3 - 1:10,000

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Figure 5 - 10000 Year Flood Depth

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Calliope PRCP
Final Landform Flood Assessment

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LEGEND

Model Extent

Flood Depth (m)

<= 0.05

0.05 - 0.10

0.10 - 0.30

0.30 - 0.50

0.50 - 1.00

> 1.00

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NOTES:

N

0 0.1 0.2 km

SCALE @ A3 - 1:10,000

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Figure 6 - PMP Flood Depth

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Calliope PRCP
Final Landform Flood Assessment

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LEGEND

Model Extent

Flood Velocity (m/s)

- <= 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1
- 1 - 1.5
- > 1.5

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NOTES:

N

0 0.1 0.2 km

SCALE @ A3 - 1:10,000
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Figure 7 - 100 Year Flood Velocity

Epic Environmental
Calliope PRCP
Final Landform Flood Assessment

Drg Ref.

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LEGEND

Model Extent

Flood Velocity (m/s)

<= 0.1

0.1 - 0.2

0.2 - 0.5

0.5 - 1

1 - 1.5

> 1.5

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NOTES:

N

0 0.1 0.2 km

SCALE @ A3 - 1:10,000

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Figure 8 - 1000 Year Flood Velocity

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Calliope PRCP
Final Landform Flood Assessment

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LEGEND

Model Extent

Flood Velocity (m/s)

- <= 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1
- 1 - 1.5
- > 1.5

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NOTES:

N

0 0.1 0.2 km

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GDA94 / MGA zone 56

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Figure 9 - 10000 Year Flood Velocity

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Calliope PRCP
Final Landform Flood Assessment

Drg Ref.

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LEGEND

Model Extent

Flood Velocity (m/s)

<= 0.1

0.1 - 0.2

0.2 - 0.5

0.5 - 1

1 - 1.5

> 1.5

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NOTES:

N

0 0.1 0.2 km

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GDA94 / MGA zone 56

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Figure 10 - PMP Flood Velocity

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Final Landform Flood Assessment

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Appendix J Mine Waste Characterisation Memo

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www.epicenvironmental.com.au

12 July 2026

Ref: BAA220011.01

Vicki Robins
HSEQ Specialist
Graymont (NSW) Pty Ltd
24 Taragoola Road
Calliope QLD 4680

Subject: Calliope Waste Rock Characterisation

1 INTRODUCTION

Epic Environmental Pty Ltd (Epic) has been engaged by Graymont (NSW) Pty Ltd (Graymont) for the continuation of environmental approvals support for their Calliope Limestone Quarry (the Project). The Project is located at Taragoola, Queensland (QLD).

The work has been undertaken to satisfy and information request from the QLD Department of Environment and Science and Innovation (DESI – previously Department of Environment and Science, DES) following submission of the Progressive Rehabilitation and Closure Plan (PRCP) for Calliope.

2 BACKGROUND

Graymont holds a site-specific Environmental Authority (EA) (reference: EPML00969013), enabling mining activities to be undertaken at their Calliope site.

The PRCP application was prepared in accordance with the Queensland Government's *Environment Protection Act 1994* (EP Act) and the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act). The application was initially submitted to DES on 16 March 2023 and determined to be *Not Properly Made*, with a subsequent submission on 27 June 2023 determined by the DES to be *Properly Made,* with an accompanying Information Request (IR) Notice received on 7 August 2023. The IR Notice identified information gaps or clarifications that need to be addressed for DES to approve the PRCP. In particular, DES identified gaps in waste rock characterisation.

A waste rock characterisation for the limestone quarry is therefore required to address the PRCP IR[1]. It would also be suitable to support an amendment to the EA. The submission date for the amended PRCP is 30 August 2024.

3 MATERIAL BEING CHARACTERISED

Waste rock from the mining operation has been placed on two (2) main waste rock dumps (WRDs), which have been labelled with the prefixes “northern” (NWRD) and “southern” (SWRD). The locations of the WRDs are shown on **Figure F1**.

Waste rock across the WRDs includes overburden, poor quality limestone (low specification, high clay fines content, such as that visible on the SWRD), andesite, greywacke (fault rock), and conglomerate. Of the sampled materials, andesite is considered to be the only rock exposed in the void wall to have any potential for acid generation and mixed andesite or andesite dominated waste was targeted during sampling.

Production bench blast drill chips have also collected from mining benches to characterise the main ‘ore’ exposed in the void walls. Similarly, samples of product stockpiled at the site were also analysed for mineralogy.

[1] The waste rock characterisation presented herein may also be used to support an EA amendment to reflect and expansion of mining activities at Calliope.

4 METHODOLOGY

The following section summarises the sampling methodology completed by staff from Graymont under the direction of Epic (refer **Section 4.1.1**) and the laboratory analysis undertaken.

4.1 Sampling

Sampling was completed for the northern and southern WRDs and production bench blast drill chips. Limestone (i.e., the rock which makes up a majority of the exposed void) was also sampled from blast drill holes on a production bench in the pit (refer **Section 4.1.2**).

4.1.1 Waste Rock Dumps

Graymont provided Epic with the current volumes of the WRDs which are summarised in **Table 1**. Given the low risk of acid generation, the sample density aimed to collect a minimum of one sample per 100,000 m^3 of waste rock.

Table 1. Waste rock dump volumes and samples

WRD ID	Estimated volume (m^3)	Number of bag samples collected	Number of jar samples collected	Sample IDs
NWRD	1,090,600	11	11	NW-S1-W NW-S2-W NW-S3-S NW-S4-S NW-S5-E NW-S6-E NW-S7-E NW-S8-TOP 1 NW-S9-TOP 2 NW-S10-TOP 3 NW-A (Andesite)
SWRD	850,100	10	10	SW-S1-S SW-S2-S SW-S3-S SW-S4-S SW-S5-S SW-S1-N SW-S2-N SW-S3-N SW-S4-N SW-F

The sampling methodology implemented by Graymont is provided in **Table 2**.

Table 2. Waste rock sampling methodology

Action	Description
Soil sampling	An excavator was used to obtain samples at various depths throughout the stockpiled material.
Sample collection	Samples of the material were collected directly from the excavator bucket using nitrile gloves. Material was screened using a 20 mm diameter sieve to obtain a homogenous sample and remove any large rock particles. Samples were placed into laboratory-supplied 150 mL glass jars (with Teflon-lined lids) for chemical analysis and 500 mL plastic zip-lock bags for acid-base accounting analysis. Samples were labelled and immediately stored on ice in eskies for transportation to the National Association of Testing Authorities (NATA) accredited laboratory (ALS Environmental Pty Ltd (ALS)).

Action	Description
Sample labelling, storage and transport	Samples were clearly labelled with unique sample identification numbers. Samples were kept chilled in an ice-filled esky prior to dispatch and during transport to the primary laboratory under chain-of-custody (COC) procedures.
Cross contamination	The excavator bucket was the only piece of equipment reused between sample points during the sampling. Samples were collected from the centre of the excavator bucket to minimise cross-contamination. A new pair of disposable nitrile gloves was worn for the collection of each sample.

4.1.2 Blast Drill Chips

A total of three (3) rock samples (DRILL-S1-S, DRILL-S2-N, DRILL-S3-M) were collected from a production bench associated with the drill cores/rock chips from the Project's exploration mining activities.

Samples were collected in the same containers and followed the same storage/transport methodology mentioned in **Table 2**.

4.1.3 Additional Product Samples

Petrographic (mineralogy and chemistry) analysis was previously commissioned by Graymont for product/stockpiled material including gabion rock, aggregate rock, and road base rock (Geochempet Services 2023, Groundwork Plus 2023, Groundwork Plus 2022, Superior Quarry Testing 2023). This data provides further evidence for the nature of the materials exposed in the pit walls and has been used in the assessment of acid mine drainage (AMD) potential.

4.1.4 Laboratory Analysis

Laboratory analysis for acid base accounting suite of static tests was completed by a NATA-accredited laboratory (ALS) to screen for AMD potential of the waste rock and void wall material. The following analysis was completed for each sample:

- Net Acid Producing Potential (NAPP), which includes Acid Neutralising Capacity (ANC) reported as $CaCO_3$ and H_2SO_4, fizz rating, and total sulfur (by LECO)
- Net Acid Generation (NAG)
- Chromium Reducible Sulfur (Scr) as a measure of sulfur present as sulfide
- Sulfate sulfur

Additional analysis on 19 selected samples was undertaken in January 2026 for metals and metalloids (As, Cd, Cr, Co, Cu, F, Hg, Mn, Pb, Ni, Se, Sb, Sn). Laboratory certificates are provided in **Appendix A**.

The petrographic analysis conducted on samples of product material included mineralogy, carbonate, sulfide and chloride content. The reports are attached in **Appendix B**.

5 DATA ANALYSIS AND INTERPRETATION OF RESULTS

5.1 Acid Mine Drainage Potential

Acid base accounting was undertaken to determine the potential for waste samples to be acid generating. A summary of the analytical results for the assessed acid base characteristics is provided in **Table** 3.

Table 3. Waste rock analytical results – acid-base accounting and sulfur characterisation

		ANC	Fizz rating	NAPP	NAG pH (Ox)	Max Potential Acidity (MPA)[2]	Net Potential Ratio (NPR)[3]	NAG (pH 4.5)	NAG (pH 7)	Total S	Scr	Sulfate (SO_4^{2-})
Location	**Laboratory ID**	kg H_2SO_4 /t	-	kg H_2SO_4/t	pH unit	kg H_2SO_4 /t	-	kg H_2SO_4/t	kg H_2SO_4/t	%	% S	mg/kg
Southern WRD	SW-S1-S	999	5	-998	11.5	0.61	1632	<0.1	<0.1	0.02	0.009	180
	SW-S2-S	564	5	-563	9.9	0.61	922	<0.1	<0.1	0.02	0.006	<100
	SW-S3-S	779	5	-778	9.5	0.61	1273	<0.1	<0.1	0.02	0.012	<100
	SW-S4-S	984	5	-983	11.5	0.61	1608	<0.1	<0.1	0.02	0.009	120
	SW-S5-S	575	5	-575	10	0.31	1879	<0.1	<0.1	0.01	0.009	<100
	SW-S1-N	821	5	-820	11.1	0.61	1342	<0.1	<0.1	0.02	<0.005	110
	SW-S2-N	897	5	-897	10.9	0.31	2931	<0.1	<0.1	0.01	0.008	100
	SW-S3-N	578	5	-578	10.5	0.31	1889	<0.1	<0.1	0.01	<0.005	<100
	SW-S4-N	746	5	-746	10.8	0.31	2438	<0.1	<0.1	0.01	0.006	<100
	SW-F	738	5	-738	11.2	0.31	2412	<0.1	<0.1	0.01	0.006	<100
Blast Drill Chips	DRILL-S1-S	1030	5	-1030	11.2	0.61	1683	<0.1	<0.1	0.02	0.008	<100
	DRILL-S2-N	1020	5	-1020	9.5	1.22	833	<0.1	<0.1	0.04	0.036	<100
	DRILL-S3-M	1020	5	-1020	11	2.14	476	<0.1	<0.1	0.07	0.074	<100
Northern WRD	NW-S1-W	1000	5	-1000	11.5	0.31	3268	<0.1	<0.1	0.01	0.008	<100
	NW-S2-W	986	5	-986	11.4	0.31	3222	<0.1	<0.1	0.01	0.005	210
	NW-S3-S	886	5	-885	11.4	0.61	1448	<0.1	<0.1	0.02	0.012	<100
	NW-S4-S	1010	5	-1010	11.3	0.61	1650	<0.1	<0.1	0.02	0.008	<100
	NW-S5-E	516	5	-515	11.7	0.61	843	<0.1	<0.1	0.02	0.016	<100
	NW-S6-E	942	5	-942	11.4	0.31	3078	<0.1	<0.1	0.01	<0.005	<100
	NW-S7-E	1030	5	-1030	11.4	0.61	1683	<0.1	<0.1	0.02	0.013	<100
	NW-S8-TOP 1	173	3	-173	10.2	0.15	1131	<0.1	<0.1	<0.01	<0.005	<100
	NW-S9-TOP 2	1000	5	-1000	11.2	0.31	3268	<0.1	<0.1	0.01	0.006	<100
	NW-S10-TOP 3	923	5	-922	11.5	0.61	1508	<0.1	<0.1	0.02	0.006	<100
	NW-A	996	5	-995	11.6	0.61	1627	<0.1	<0.1	0.02	0.008	140

[2] MPA = Total S% x .30.6
[3] NPR = ANC/MPA

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The results showed the following:

- Very low levels of total sulfur (<0.1%) across all three locations, which, from the SCr test, appeared to be in the form of sulfides
- Strongly negative NAPP values (markedly less than negative 20 kg H_2SO_4/t) across all three locations, indicating the material is acid consuming
- NAG pH values above 7 across all three locations
- NPRs markedly greater than 3 across all samples (INAP 2009)

Due to the very low total sulfur concentrations, there is no need to further account for the different forms of sulfur present (such as oxidised forms of sulfur; sulfates) to improve the assessment of AMD risk.

NAG pH and NAPP have been plotted on **Figure 1**. All of the data confirms that the waste rock and production (drill chip) material is classified as **non-acid forming (NAF)** (AMIRA, 2002).

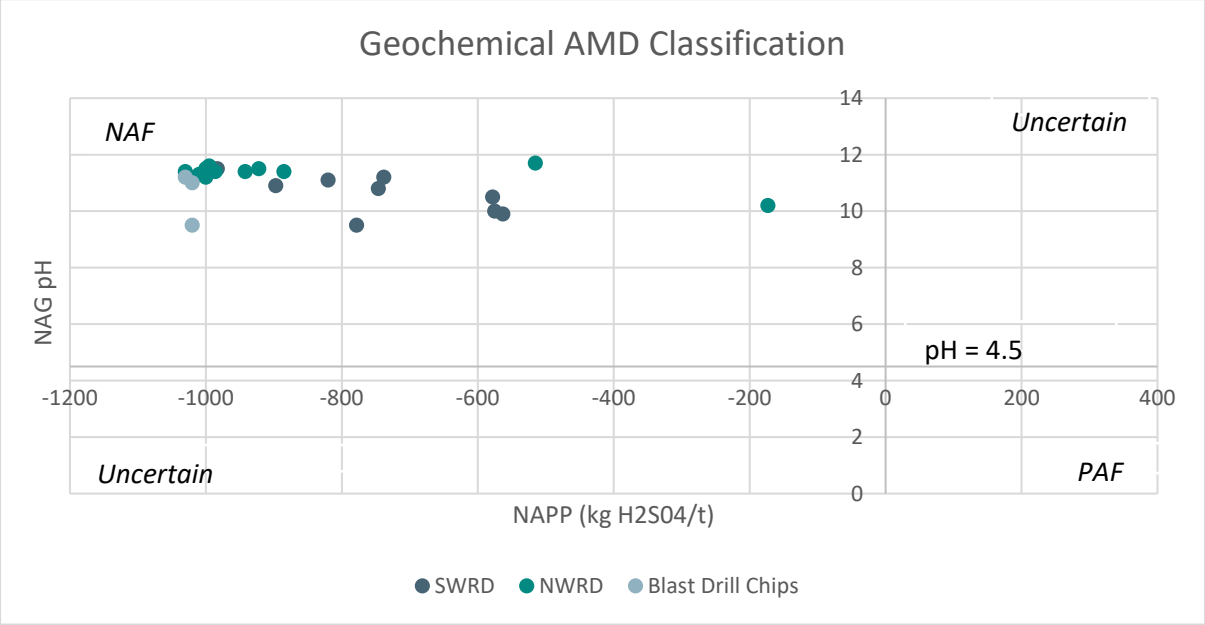


Figure 1. Geochemical AMD classification plot for the three locations based on NAG pH and NAPP (AMIRA, 2002)

5.2 Petrographic Analysis

The petrographic analysis completed in 2023 has shown that the limestone rock produced at Calliope is 93%-99% calcite (calcium carbonate) with the balance being goethite (iron oxide-hydroxide). The analysis also indicated that sulfides were not observed in the samples.

Given that carbonate mineralogy of the material and the lack of observable sulfides, there is no risk of AMD generation from exposed limestone in the void wall.

Additionally, the limestone contains negligible chloride. Together with the lack of AMD generation potential and the negligible risk of neutralisation salts formation, the results indicate a very low risk of saline mine drainage generation.

5.3 Metal and Metalloid Analysis

Concentrations of metals and metalloids were mostly below laboratory limits of reporting (LOR). Samples with concentrations greater than the LOR were below compared to the median crustal abundance for un-mineralised soils (refer GARD Guide, Bowen (1979)). Enrichment of metals and metalloids can be evaluated on a $\log_{10}$ scale and expressed in increments from 0 to 6, where:

- GAI 0 – less than 3-fold enrichment
- GAI 1 – 3-6 fold enrichment
- GAI 2 – 6-12 fold enrichment
- GAI 3 – 12-24 fold enrichment
- GAI 4 – 24-48 fold enrichment
- GAI 5 – 48-96 fold enrichment
- GAI 6 – greater than 96 fold enrichment.

Generally, where a sample reveals a concentration and GAI of 3 or greater, it warrants further assessment. Samples analysed reported concentrations below the average crustal abundance and with GAIs of 0 or 1, indicating the materials are not enriched in metals and metalloids.

6 CONCLUSION

The materials described in this letter are categorised as **non-acid forming**. There is negligible risk of acid generation from the WRDs or exposed rocks in the void wall. The results are consistent with the geology of the Project and the lack of acid pH values in water quality results from water that collects in the void presented in the PRCP. The results indicate the materials are not enriched in metals and metalloids.

No kinetic testing work is warranted.

If you have any questions, please do not hesitate to contact the undersigned.

Regards



Andrew Butler
Principal Environmental Scientist

Natalie Chandra
Project Environmental Engineer

Enclosures: Figure F1
Appendix A - Laboratory Certificates
Appendix B – Petrographic Analysis

7 REFERENCES

AMIRA, 2002. *Prediction & Kinetic Control of Acid Mine Drainage,* Melbourne: Environmental Geochemistry International.
INAP, 2019. *The GARD Guide,* Skelleftea: INAP.

APPENDIX A LABORATORY CERTIFICATES

CHAIN OF CUSTODY

ALS Laboratory: please tick →

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SMEDGE 1/21 Sydney Road Smeaton Grange NSW 2567 Ph: 02 4577 7499 E: AESEnviro.Smeaton@alsglobal.com
PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com
WOLLONGONG 4/19-21 Resolution Drive Port Kembla NSW 2505 Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT: Graymont Australia (GRAAUS)	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☐ Standard TAT (List due date):	FOR LABORATORY USE ONLY (Circle)
OFFICE: MS 24 Taragoola Rd Calliope Qld 4680		☐ Non Standard or urgent TAT (List due date):	Custody Seal Intact? Yes No N/A
PROJECT: Waste Dump Characteristics - Calliope PROJECT NO.:	ALS QUOTE NO.: BN/130/17 V2	COC SEQUENCE NUMBER (Circle) COC: (1) 2 3 4 5 6 7	Free ice / frozen ice bricks present upon receipt? Yes No N/A
PURCHASE ORDER NUMBER: 833739	COUNTRY OF ORIGIN: Australia	OF: 1 (2) 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Vicki Robins	CONTACT PH: (07) 4975 7144		Other comment:
SAMPLER: Vicki Robins	SAMPLER MOBILE: 0437 921211	RELINQUISHED BY: A. Jones	RECEIVED BY: GW 14:50
COC Emailed to ALS? (YES / NO)	EDD FORMAT (or default):	DATE/TIME: 30.04.24 14:50	DATE/TIME: 30.04.24
Email Reports to : vicki.robins@graymont.com		RELINQUISHED BY: GW 15:00	RECEIVED BY: DM
Email Invoice to : calliopesales@graymont.com		DATE/TIME: 30.4.24	DATE/TIME: 1020 25/4/24

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: ~~PLEASE LOG AS A PLANNED EVENT~~

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES + BAGS	Fluoride - Total	ICP/AES: 1st Metal (includes digestion) (Sb)	Mercury - Total Recoverable	- SCR (CRS)	NAPP (includes ANC, Total S)	Net Acid Generation (NAG)	Sulfate - Total as SO_4		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	SW-S1-S	30.04.2024 @ 8.25am	SOIL		2	X	X	X	X	X	X	X		
2	SW-S2-S	30.04.2024 @ 8.45am	SOIL		2	X	X	X	X	X	X	X		
3	SW-S3-S	30.04.2024 @ 8.39am	SOIL		2	X	X	X	X	X	X	X		
4	SW-S4-S	30.04.2024 @9.00am	SOIL		2	X	X	X	X	X	X	X		
5	SW-S5-S	30.04.2024 @9.00am	SOIL		2	X	X	X	X	X	X	X		
6	SW-S1-N	30.04.2024 @ 8.50am	SOIL		2	X	X	X	X	X	X	X		
7	SW-S2-N	30.04.2024 @ 9.10am	SOIL		2	X	X	X	X	X	X	X		
8	SW-S3-N	30.04.2024 @ 9.20am	SOIL		2	X	X	X	X	X	X	X		
9	SW-S4-N	30.04.2024 @ 9.40am	SOIL		2	X	X	X	X	X	X	X		
10	DRILL-S1-S	30.04.2024 @ 8.15am	SOIL		2	X	X	X	X	X	X	X		
11	DRILL-S2-N	30.04.2024 @ 8.15am	SOIL		2	X	X	X	X	X	X	X		
12	DRILL-S3-M	30.04.2024 @ 8.15am	SOIL		2	X	X	X	X	X	X	X		
				TOTAL	24									

Environmental Division
Brisbane
Work Order Reference
EB2414326

Telephone : + 61-7-3243 7222

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE: 21 Burma Road Pooraka SA 5095 Ph: 08 8162 5130 E: adelaide@alsglobal.com
BRISBANE: 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
CAIRNS: 48 Caltermoon Drive Gladstone QLD 4680 Ph: 07 4979 7544 E: AuSEnviro.Gladstone@alsglobal.com
LAUNCESTON: 27 Compigne Road Launceston TAS 7250 Ph: 03 6323 2800 E: launceston@alsglobal.com
MACKAY: Unit 2/20 Caldrail Drive Paget QLD 4740 Ph: 07 4952 5795 E: AUSEnviro.Mackay@alsglobal.com
MELBOURNE: 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com
NEWCASTLE: 5/585 Maitland Road Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com
ORANGE: 1/9 Hughes Place Orange NSW 2800 Ph: 02 6364 5990 E: AuSEnviro.Orange@alsglobal.com
PERTH: 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com
SYDNEY: 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com
TOWNSVILLE: 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: AuSEnviro.Townsville@alsglobal.com
WAGGA WAGGA: 4/13 Geary Place North Wagga NSW 2650 Ph: 02 6971 9696 E: wagga@alsglobal.com
WOLLONGONG: 4/19-21 Asquith Street Unanderra NSW 2526 Ph: 02 4271 1836 E: wollongong@alsglobal.com

CLIENT: Graymont Australia (GRAAUS)	TURNAROUND REQUIREMENTS : ☐ Standard TAT (List due date):	FOR LABORATORY USE ONLY (Circle)
OFFICE: MS 24 Taragoola Rd Calliope Qld 4680	(Standard TAT may be longer for some tests e.g., Ultra Trace Organics) ☐ Non Standard or urgent TAT (List due date):	Custody Seal Intact? Yes No N/A
PROJECT: Waste Dump Characteristics - Calliope PROJECT NO.:	ALS QUOTE NO.: BN/130/17 V2	Free ice / frozen ice bricks present upon receipt? Yes No N/A
PURCHASE ORDER NUMBER: 833739	COUNTRY OF ORIGIN: Australia	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Vicki Robins CONTACT PH: (07) 4975 7144	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7 OF: 1 2 3 4 5 6 7	Other comment:
SAMPLER: Vicki Robins SAMPLER MOBILE: 0437 921211	RELINQUISHED BY: R. Somes DATE/TIME: 30-04-24 14:50	RECEIVED BY: GW 14.50 DATE/TIME: 30.4.24
COC Emailed to ALS? (YES / NO) EDD FORMAT (or default):	RELINQUISHED BY: GW 15.00 DATE/TIME: 30.4.24	RECEIVED BY: DATE/TIME:
Email Reports to : vicki.robins@graymont.com		
Email Invoice to : calliopesales@graymont.com		

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: ~~PLEASE LOG AS A PLANNED EVENT~~

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES + BAGS	Fluoride - Total	ICP/AES: 1st Metal (includes digestion) (Sb)	Mercury - Total Recoverable	- SCR (CRS)	NAPP (includes ANC, Total S)	Net Acid Generation (NAG)	Sulfate - Total as SO_4		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
13	NW-S1-W	30.04.2025 @ 9.50am	SOIL		2	X	X	X	X	X	X	X		
14	NW-S2-W	30.04.2025 @ 10.00am	SOIL		2	X	X	X	X	X	X	X		
15	NW-S3-S	30.04.2024 @ 10.10am	SOIL		2	X	X	X	X	X	X	X		
16	NW-S4-S	30.04.2024 @ 10.20am	SOIL		2	X	X	X	X	X	X	X		
17	NW-S5-E	30.04.2024 @ 10.30am	SOIL		2	X	X	X	X	X	X	X		
18	NW-S6-E	30.04.2024 @ 10.40am	SOIL		2	X	X	X	X	X	X	X		
19	NW-S7-E	30.04.2024 @ 10.45am	SOIL		2	X	X	X	X	X	X	X		
20	NW-S8-TOP 1	30.04.2024 @ 10.55am	SOIL		2	X	X	X	X	X	X	X		
21	NW-S9-TOP 2	30.04.2024 @ 11.10am	SOIL		2	X	X	X	X	X	X	X		
22	NW-S10-TOP 3	30.04.2024 @ 11.15am	SOIL		2	X	X	X	X	X	X	X		
23	NW-A	30.04.2024 @ 11.25am	SOIL		2	X	X	X	X	X	X	X		
24	SW-F	30.4.24 @9.50	Soil		2	X	X	X	X	X	X	X		
				TOTAL	24									

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

CERTIFICATE OF ANALYSIS

Work Order	: **EB2414326**	Page	: 1 of 12
Client	: **GRAYMONT (AUSTRALIA) PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: Vicki Robins	Contact	: Customer Services EB
Address	: MS 24 TARAGOOLA ROAD CALLIOPE 4680	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: Waste Dump Characteristics - Calliope	Date Samples Received	: 02-May-2024 10:20
Order number	: 833739	Date Analysis Commenced	: 03-May-2024
C-O-C number	: ----	Issue Date	: 16-May-2024 17:54
Sampler	: Vicki Robins		
Site	: ----		
Quote number	: BN/130/17 V4		
No. of samples received	: 24		
No. of samples analysed	: 24		

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.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Soil Preparation, Stafford, QLD
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Jarwis Nheu	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Kim McCabe	Senior Inorganic 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.

- ASS: EA033 (CRS Suite): Analysis is performed as per the Acid Sulfate Soils Laboratory Methods Guidelines (2004) and the updated National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual, Department of Agriculture and Water Resources, Canberra, ACT (2018)
- ASS: EA033 (CRS Suite):Retained Acidity not required because pH KCl greater than or equal to 4.5
- EK040T: EB2414326 #002 Poor matrix spike recovery for Total Fluoride due to sample matrix. Confirmed by re-extraction and re-analysis.
- ASS: EA033 (CRS Suite): Laboratory determinations of ANC needs to be corroborated by effectiveness of the measured ANC in relation to incubation ANC. Unless corroborated, the results of ANC testing should be discounted when determining Net Acidity for comparison with action criteria, or for the determination of the acidity hazard and required liming amounts.
- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SW-S1-S	SW-S2-S	SW-S3-S	SW-S4-S	SW-S5-S
			Sampling date / time	30-Apr-2024 08:25	30-Apr-2024 08:45	30-Apr-2024 08:39	30-Apr-2024 09:00	30-Apr-2024 09:00
Compound	CAS Number	LOR	Unit	EB2414326-001	EB2414326-002	EB2414326-003	EB2414326-004	EB2414326-005
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-998**	**-563**	**-778**	**-983**	**-575**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**11.5**	**9.9**	**9.5**	**11.5**	**10.0**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**999**	**564**	**779**	**984**	**575**
ANC as CaCO3	----	0.1	% CaCO3	**102**	**57.6**	**79.5**	**100**	**58.7**
Fizz Rating	----	0	Fizz Unit	**5**	**5**	**5**	**5**	**5**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.4**	**8.8**	**9.0**	**9.4**	**8.8**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.009**	**0.006**	**0.012**	**0.009**	**0.009**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**101**	**49.0**	**74.5**	**100**	**49.5**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**20200**	**9790**	**14900**	**20100**	**9880**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**32.4**	**15.7**	**23.9**	**32.2**	**15.8**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	SW-S1-S	SW-S2-S	SW-S3-S	SW-S4-S	SW-S5-S
				Sampling date / time	30-Apr-2024 08:25	30-Apr-2024 08:45	30-Apr-2024 08:39	30-Apr-2024 09:00	30-Apr-2024 09:00
Compound	CAS Number	LOR	Unit		EB2414326-001	EB2414326-002	EB2414326-003	EB2414326-004	EB2414326-005
					Result	Result	Result	Result	Result
EA033-E: Acid Base Accounting - Continued									
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t		<1	<1	<1	<1	<1
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**4.5**	**0.5**	**7.7**	**9.8**	**8.9**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		**180**	<100	<100	**120**	<100
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.02**	**0.02**	**0.02**	**0.02**	**0.01**
EG005(ED093)T: Total Metals by ICP-AES									
Antimony	7440-36-0	5	mg/kg		<5	<5	<5	<5	<5
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	**0.1**
EK040T: Fluoride Total									
Fluoride	16984-48-8	40	mg/kg		<40	<40	<40	<40	<40

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SW-S1-N	SW-S2-N	SW-S3-N	SW-S4-N	DRILL-S1-S
			Sampling date / time	30-Apr-2024 08:50	30-Apr-2024 09:10	30-Apr-2024 09:20	30-Apr-2024 09:04	30-Apr-2024 08:15
Compound	CAS Number	LOR	Unit	EB2414326-006	EB2414326-007	EB2414326-008	EB2414326-009	EB2414326-010
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-820**	**-897**	**-578**	**-746**	**-1030**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**11.1**	**10.9**	**10.5**	**10.8**	**11.2**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**821**	**897**	**578**	**746**	**1030**
ANC as CaCO3	----	0.1	% CaCO3	**83.7**	**91.5**	**59.0**	**76.1**	**105**
Fizz Rating	----	0	Fizz Unit	**5**	**5**	**5**	**5**	**5**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.2**	**9.1**	**8.7**	**8.9**	**9.6**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	**0.008**	<0.005	**0.006**	**0.008**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**75.3**	**78.9**	**59.0**	**74.2**	**100**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**15000**	**15800**	**11800**	**14800**	**20000**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**24.1**	**25.2**	**18.9**	**23.8**	**32.0**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SW-S1-N	SW-S2-N	SW-S3-N	SW-S4-N	DRILL-S1-S
			Sampling date / time	30-Apr-2024 08:50	30-Apr-2024 09:10	30-Apr-2024 09:20	30-Apr-2024 09:04	30-Apr-2024 08:15
Compound	CAS Number	LOR	Unit	EB2414326-006	EB2414326-007	EB2414326-008	EB2414326-009	EB2414326-010
				Result	Result	Result	Result	Result
EA033-E: Acid Base Accounting - Continued								
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**3.1**	**3.5**	**6.7**	**3.7**	**0.7**
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	**110**	**100**	<100	<100	<100
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	**0.01**	**0.01**	**0.01**	**0.02**
EG005(ED093)T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	**0.4**	<0.1	<0.1	<0.1	<0.1
EK040T: Fluoride Total								
Fluoride	16984-48-8	40	mg/kg	<40	<40	<40	<40	<40

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	DRILL-S2-N	DRILL-S3-M	NW-S1-W	NW-S2-W	NW-S3-S
			Sampling date / time	30-Apr-2024 08:15	30-Apr-2024 08:15	30-Apr-2024 09:50	30-Apr-2024 10:00	30-Apr-2024 10:10
Compound	CAS Number	LOR	Unit	EB2414326-011	EB2414326-012	EB2414326-013	EB2414326-014	EB2414326-015
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-1020**	**-1020**	**-1000**	**-986**	**-885**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**9.5**	**11.0**	**11.5**	**11.4**	**11.4**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**1020**	**1020**	**1000**	**986**	**886**
ANC as CaCO3	----	0.1	% CaCO3	**104**	**104**	**102**	**100**	**90.4**
Fizz Rating	----	0	Fizz Unit	**5**	**5**	**5**	**5**	**5**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.6**	**9.6**	**9.6**	**9.6**	**9.3**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.036**	**0.074**	**0.008**	**0.005**	**0.012**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**23**	**46**	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**101**	**88.5**	**99.9**	**88.7**	**88.0**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**20100**	**17700**	**20000**	**17700**	**17600**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**32.3**	**28.4**	**32.0**	**28.4**	**28.2**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	DRILL-S2-N	DRILL-S3-M	NW-S1-W	NW-S2-W	NW-S3-S
			Sampling date / time	30-Apr-2024 08:15	30-Apr-2024 08:15	30-Apr-2024 09:50	30-Apr-2024 10:00	30-Apr-2024 10:10
Compound	CAS Number	LOR	Unit	EB2414326-011	EB2414326-012	EB2414326-013	EB2414326-014	EB2414326-015
				Result	Result	Result	Result	Result
EA033-E: Acid Base Accounting - Continued								
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.04**	**0.07**	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**23**	**46**	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	**2**	**3**	<1	<1	<1
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**0.5**	**0.5**	**2.7**	**4.1**	**1.5**
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	<100	<100	**210**	<100
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.04**	**0.07**	**0.01**	**0.01**	**0.02**
EG005(ED093)T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**0.1**
EK040T: Fluoride Total								
Fluoride	16984-48-8	40	mg/kg	<40	<40	**60**	<40	<40

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	NW-S4-S	NW-S5-E	NW-S6-E	NW-S7-E	NW-S8-TOP 1
			Sampling date / time	30-Apr-2024 10:20	30-Apr-2024 10:30	30-Apr-2024 10:40	30-Apr-2024 10:45	30-Apr-2024 10:55
Compound	CAS Number	LOR	Unit	EB2414326-016	EB2414326-017	EB2414326-018	EB2414326-019	EB2414326-020
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-1010**	**-515**	**-942**	**-1030**	**-173**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**11.3**	**11.7**	**11.4**	**11.4**	**10.2**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**1010**	**516**	**942**	**1030**	**173**
ANC as CaCO3	----	0.1	% CaCO3	**103**	**52.6**	**96.0**	**105**	**17.6**
Fizz Rating	----	0	Fizz Unit	**5**	**5**	**5**	**5**	**3**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.6**	**9.1**	**9.6**	**9.6**	**8.2**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.008**	**0.016**	<0.005	**0.013**	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**99.8**	**48.5**	**88.1**	**101**	**14.0**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**19900**	**9690**	**17600**	**20200**	**2800**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**32.0**	**15.5**	**28.2**	**32.4**	**4.50**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	NW-S4-S	NW-S5-E	NW-S6-E	NW-S7-E	NW-S8-TOP 1
				Sampling date / time	30-Apr-2024 10:20	30-Apr-2024 10:30	30-Apr-2024 10:40	30-Apr-2024 10:45	30-Apr-2024 10:55
Compound	CAS Number	LOR	Unit		EB2414326-016	EB2414326-017	EB2414326-018	EB2414326-019	EB2414326-020
					Result	Result	Result	Result	Result
EA033-E: Acid Base Accounting - Continued									
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t		<1	<1	<1	<1	<1
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**2.1**	**2.0**	**0.5**	**3.4**	**5.6**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		<100	<100	<100	<100	<100
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.02**	**0.02**	**0.01**	**0.02**	<0.01
EG005(ED093)T: Total Metals by ICP-AES									
Antimony	7440-36-0	5	mg/kg		<5	<5	<5	<5	<5
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		**0.1**	**0.1**	<0.1	<0.1	<0.1
EK040T: Fluoride Total									
Fluoride	16984-48-8	40	mg/kg		<40	**110**	**190**	**60**	**240**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	NW-S9-TOP 2	NW-S10-TOP 3	NW-A	SW-F	----
			Sampling date / time	30-Apr-2024 11:10	30-Apr-2024 11:15	30-Apr-2024 11:25	30-Apr-2024 09:50	----
Compound	CAS Number	LOR	Unit	EB2414326-021	EB2414326-022	EB2414326-023	EB2414326-024	--------
				Result	Result	Result	Result	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-1000**	**-922**	**-995**	**-738**	**----**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**11.2**	**11.5**	**11.6**	**11.2**	**----**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	**----**
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	**----**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**1000**	**923**	**996**	**738**	**----**
ANC as CaCO3	----	0.1	% CaCO3	**102**	**94.1**	**102**	**75.2**	**----**
Fizz Rating	----	0	Fizz Unit	**5**	**5**	**5**	**5**	**----**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.6**	**9.2**	**9.6**	**8.9**	**----**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	**----**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	**----**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.006**	**0.006**	**0.008**	**0.006**	**----**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	**----**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**102**	**89.0**	**102**	**73.6**	**----**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**20400**	**17800**	**20300**	**14700**	**----**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**32.7**	**28.5**	**32.6**	**23.6**	**----**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**----**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	**----**
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	**----**
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	**----**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	NW-S9-TOP 2	NW-S10-TOP 3	NW-A	SW-F	----
			Sampling date / time	30-Apr-2024 11:10	30-Apr-2024 11:15	30-Apr-2024 11:25	30-Apr-2024 09:50	----
Compound	CAS Number	LOR	Unit	EB2414326-021	EB2414326-022	EB2414326-023	EB2414326-024	--------
				Result	Result	Result	Result	----
EA033-E: Acid Base Accounting - Continued								
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**2.4**	**4.0**	**0.6**	**8.8**	----
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	<100	**140**	<100	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.01**	**0.02**	**0.02**	**0.01**	----
EG005(ED093)T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	**0.1**	<0.1	<0.1	----
EK040T: Fluoride Total								
Fluoride	16984-48-8	40	mg/kg	<40	**50**	**90**	<40	----

Inter-Laboratory Testing

Analysis conducted by ALS Melbourne, NATA accreditation no. 825, site no. 13778 (Chemistry).

(SOIL) EK040T: Fluoride Total

QUALITY CONTROL REPORT

Work Order	: **EB2414326**	Page	: 1 of 7
Client	: **GRAYMONT (AUSTRALIA) PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: Vicki Robins	Contact	: Customer Services EB
Address	: MS 24 TARAGOOLA ROAD CALLIOPE 4680	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: Waste Dump Characteristics - Calliope	Date Samples Received	: 02-May-2024
Order number	: 833739	Date Analysis Commenced	: 03-May-2024
C-O-C number	: ----	Issue Date	: 16-May-2024
Sampler	: Vicki Robins		
Site	: ----		
Quote number	: BN/130/17 V4		
No. of samples received	: 24		
No. of samples analysed	: 24		

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 Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

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.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Soil Preparation, Stafford, QLD
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Jarwis Nheu	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Kim McCabe	Senior Inorganic 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.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
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
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 5766984)									
EB2414326-001	SW-S1-S	EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.0	No Limit
EB2414326-011	DRILL-S2-N	EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.0	No Limit
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 5766986)									
EB2414326-021	NW-S9-TOP 2	EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.0	No Limit
EA011: Net Acid Generation (QC Lot: 5778773)									
EB2414326-001	SW-S1-S	EA011: NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.0	No Limit
		EA011: NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.0	No Limit
		EA011: pH (OX)	----	0.1	pH Unit	11.5	11.6	0.9	0% - 20%
EB2414326-011	DRILL-S2-N	EA011: NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.0	No Limit
		EA011: NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.0	No Limit
		EA011: pH (OX)	----	0.1	pH Unit	9.5	9.6	1.0	0% - 20%
EA011: Net Acid Generation (QC Lot: 5778776)									
EB2414326-021	NW-S9-TOP 2	EA011: NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.0	No Limit
		EA011: NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.0	No Limit
		EA011: pH (OX)	----	0.1	pH Unit	11.2	11.3	0.9	0% - 20%
EA013: Acid Neutralising Capacity (QC Lot: 5778772)									
EB2414326-001	SW-S1-S	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	999	1000	0.7	0% - 20%
EB2414326-011	DRILL-S2-N	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1020	1020	0.1	0% - 20%
EA013: Acid Neutralising Capacity (QC Lot: 5778775)									

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EA013: Acid Neutralising Capacity (QC Lot: 5778775) - continued									
EB2414326-021	NW-S9-TOP 2	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1000	1010	0.7	0% - 20%
EA033-A: Actual Acidity (QC Lot: 5778774)									
EB2414326-001	SW-S1-S	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	9.4	9.4	0.0	0% - 20%
EB2414326-011	DRILL-S2-N	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	9.6	9.6	0.0	0% - 20%
EA033-A: Actual Acidity (QC Lot: 5778777)									
EB2414326-021	NW-S9-TOP 2	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	9.6	9.6	0.0	0% - 20%
EA033-B: Potential Acidity (QC Lot: 5778774)									
EB2414326-001	SW-S1-S	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.009	0.012	21.6	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EB2414326-011	DRILL-S2-N	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.036	0.035	4.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	23	22	0.0	No Limit
EA033-B: Potential Acidity (QC Lot: 5778777)									
EB2414326-021	NW-S9-TOP 2	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.006	0.008	20.7	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-C: Acid Neutralising Capacity (QC Lot: 5778774)									
EB2414326-001	SW-S1-S	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	101	101	0.0	0% - 20%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	32.4	32.4	0.0	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	20200	20200	0.0	0% - 20%
EB2414326-011	DRILL-S2-N	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	101	101	0.0	0% - 20%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	32.3	32.3	0.0	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	20100	20200	0.0	0% - 20%
EA033-C: Acid Neutralising Capacity (QC Lot: 5778777)									
EB2414326-021	NW-S9-TOP 2	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	102	102	0.0	0% - 20%

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EA033-C: Acid Neutralising Capacity (QC Lot: 5778777) - continued									
EB2414326-021	NW-S9-TOP 2	EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	32.7	32.6	0.0	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	20400	20400	0.0	0% - 20%
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 5766995)									
EB2414326-001	SW-S1-S	EA055: Moisture Content	----	0.1	%	4.5	4.6	2.4	0% - 20%
EB2414326-011	DRILL-S2-N	EA055: Moisture Content	----	0.1	%	0.5	0.5	0.0	No Limit
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 5766996)									
EB2414326-021	NW-S9-TOP 2	EA055: Moisture Content	----	0.1	%	2.4	2.4	0.0	0% - 20%
ED040T : Total Sulfate by ICPAES (QC Lot: 5766993)									
EB2414326-001	SW-S1-S	ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	180	180	0.0	No Limit
EB2414326-010	DRILL-S1-S	ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	<100	0.0	No Limit
ED040T : Total Sulfate by ICPAES (QC Lot: 5766994)									
EB2414326-021	NW-S9-TOP 2	ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	<100	0.0	No Limit
ED042T: Total Sulfur by LECO (QC Lot: 5780614)									
EB2414326-001	SW-S1-S	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.0	No Limit
EB2414326-011	DRILL-S2-N	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.05	0.0	No Limit
ED042T: Total Sulfur by LECO (QC Lot: 5780615)									
EB2414326-021	NW-S9-TOP 2	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.01	0.01	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 5766985)									
EB2414326-001	SW-S1-S	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EB2414326-011	DRILL-S2-N	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 5766987)									
EB2414326-021	NW-S9-TOP 2	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EK040T: Fluoride Total (QC Lot: 5787232)									
EB2414326-001	SW-S1-S	EK040T: Fluoride	16984-48-8	40	mg/kg	<40	<40	0.0	No Limit
EB2414326-010	DRILL-S1-S	EK040T: Fluoride	16984-48-8	40	mg/kg	<40	50	0.0	No Limit
EK040T: Fluoride Total (QC Lot: 5787233)									
EB2414326-021	NW-S9-TOP 2	EK040T: Fluoride	16984-48-8	40	mg/kg	<40	<40	0.0	No Limit
EM2407337-011	Anonymous	EK040T: Fluoride	16984-48-8	40	mg/kg	50	50	0.0	No Limit

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 5766984)								
EG005T: Antimony	7440-36-0	5	mg/kg	<5	----	----	----	----
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 5766986)								
EG005T: Antimony	7440-36-0	5	mg/kg	<5	----	----	----	----
EA011: Net Acid Generation (QCLot: 5778773)								
EA011: NAG (pH 7.0)	----	----	kg H2SO4/t	----	22.83 kg H2SO4/t	94.2	70.0	130
EA011: Net Acid Generation (QCLot: 5778776)								
EA011: NAG (pH 7.0)	----	----	kg H2SO4/t	----	22.83 kg H2SO4/t	96.7	70.0	130
EA013: Acid Neutralising Capacity (QCLot: 5778772)								
EA013: ANC as H2SO4	----	----	kg H2SO4 equiv./t	----	196 kg H2SO4 equiv./t	104	82.0	120
EA013: Acid Neutralising Capacity (QCLot: 5778775)								
EA013: ANC as H2SO4	----	----	kg H2SO4 equiv./t	----	196 kg H2SO4 equiv./t	104	82.0	120
EA033-A: Actual Acidity (QCLot: 5778774)								
EA033: pH KCl (23A)	----	----	pH Unit	----	4.7 pH Unit	102	80.0	120
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	23.5 mole H+ / t	116	80.0	120
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-A: Actual Acidity (QCLot: 5778777)								
EA033: pH KCl (23A)	----	----	pH Unit	----	4.7 pH Unit	103	80.0	120
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	23.5 mole H+ / t	118	80.0	120
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-B: Potential Acidity (QCLot: 5778774)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	0.246 % S	88.0	77.0	121
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-B: Potential Acidity (QCLot: 5778777)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	0.246 % S	91.8	77.0	121
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-C: Acid Neutralising Capacity (QCLot: 5778774)								
EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	<0.01	10 % CaCO3	105	91.0	112
EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	<0.01	----	----	----	----
EA033-C: Acid Neutralising Capacity (QCLot: 5778777)								

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Acceptable Limits (%): Low	Acceptable Limits (%): High
EA033-C: Acid Neutralising Capacity (QCLot: 5778777) - continued								
EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	<0.01	10 % CaCO3	108	91.0	112
EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	<0.01	----	----	----	----
ED040T : Total Sulfate by ICPAES (QCLot: 5766993)								
ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	577.72262 mg/kg	88.5	79.0	121
ED040T : Total Sulfate by ICPAES (QCLot: 5766994)								
ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	577.72262 mg/kg	85.0	79.0	121
ED042T: Total Sulfur by LECO (QCLot: 5780614)								
ED042T: Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.51 %	99.9	70.0	130
ED042T: Total Sulfur by LECO (QCLot: 5780615)								
ED042T: Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.51 %	102	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 5766985)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.09199 mg/kg	111	70.0	125
EG035T: Total Recoverable Mercury by FIMS (QCLot: 5766987)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.09199 mg/kg	112	70.0	125
EK040T: Fluoride Total (QCLot: 5787232)								
EK040T: Fluoride	16984-48-8	40	mg/kg	<40	334 mg/kg	97.0	93.1	107
EK040T: Fluoride Total (QCLot: 5787233)								
EK040T: Fluoride	16984-48-8	40	mg/kg	<40	334 mg/kg	97.0	93.1	107

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Acceptable Limits (%): Low	Acceptable Limits (%): High
EG035T: Total Recoverable Mercury by FIMS (QCLot: 5766985)							
EB2414326-002	SW-S2-S	EG035T: Mercury	7439-97-6	0.5 mg/kg	88.9	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 5766987)							
EB2414326-022	NW-S10-TOP 3	EG035T: Mercury	7439-97-6	0.5 mg/kg	93.9	70.0	130
EK040T: Fluoride Total (QCLot: 5787232)							
EB2414326-002	SW-S2-S	EK040T: Fluoride	16984-48-8	400 mg/kg	# 67.0	70.0	130
EK040T: Fluoride Total (QCLot: 5787233)							
EB2414326-022	NW-S10-TOP 3	EK040T: Fluoride	16984-48-8	400 mg/kg	70.6	70.0	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB2414326**	Page	: 1 of 10
Client	: **GRAYMONT (AUSTRALIA) PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: Vicki Robins	Telephone	: +61-7-3243 7222
Project	: Waste Dump Characteristics - Calliope	Date Samples Received	: 02-May-2024
Site	: ----	Issue Date	: 16-May-2024
Sampler	: Vicki Robins	No. of samples received	: 24
Order number	: 833739	No. of samples analysed	: 24

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **SOIL**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EK040T: Fluoride Total	EB2414326--002	SW-S2-S	**Fluoride**	16984-48-8	67.0 %	70.0-130%	**Recovery less than lower data quality objective**

Outliers : Analysis Holding Time Compliance

Matrix: **SOIL**

Method / Container / Client Sample ID(s)		Extraction / Preparation: Date extracted	Due for extraction	Days overdue	Analysis: Date analysed	Due for analysis	Days overdue
ED040: Sulfur as SO4 2-							
Soil Glass Jar - Unpreserved							
SW-S1-S,	SW-S2-S,	09-May-2024	07-May-2024	**2**	----	----	----
SW-S3-S,	SW-S4-S,						
SW-S5-S,	SW-S1-N,						
SW-S2-N,	SW-S3-N,						
SW-S4-N,	DRILL-S1-S,						
DRILL-S2-N,	DRILL-S3-M,						
NW-S1-W,	NW-S2-W,						
NW-S3-S,	NW-S4-S,						
NW-S5-E,	NW-S6-E,						
NW-S7-E,	NW-S8-TOP 1,						
NW-S9-TOP 2,	NW-S10-TOP 3,						
NW-A,	SW-F						

Outliers : Frequency of Quality Control Samples

Matrix: **SOIL**

Quality Control Sample Type / Analytical Methods	Method	Count: QC	Count: Regular	Rate (%): Actual	Rate (%): Expected	Quality Control Specification
Laboratory Control Samples (LCS)						
Total Metals by ICP-AES	EG005T	0	24	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)						
Total Metals by ICP-AES	EG005T	0	24	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA011: Net Acid Generation								
Pulp Bag (EA011)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	30-Apr-2025	✓	**10-May-2024**	06-Nov-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
EA013: Acid Neutralising Capacity								
Pulp Bag (EA013)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	30-Apr-2025	✓	**10-May-2024**	06-Nov-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
EA033-A: Actual Acidity								
Pulp Bag (EA033)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	30-Apr-2025	✓	**10-May-2024**	08-Aug-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-B: Potential Acidity								
Pulp Bag (EA033)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	30-Apr-2025	✓	**10-May-2024**	08-Aug-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
EA033-C: Acid Neutralising Capacity								
Pulp Bag (EA033)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	30-Apr-2025	✓	**10-May-2024**	08-Aug-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
EA033-D: Retained Acidity								
Pulp Bag (EA033)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	30-Apr-2025	✓	**10-May-2024**	08-Aug-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-E: Acid Base Accounting								
Pulp Bag (EA033)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	30-Apr-2025	✓	**10-May-2024**	08-Aug-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
EA055: Moisture Content (Dried @ 105-110°C)								
Soil Glass Jar - Unpreserved (EA055)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**----**	----	----	**03-May-2024**	14-May-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
ED040: Sulfur as SO4 2-								
Soil Glass Jar - Unpreserved (ED040T)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**09-May-2024**	07-May-2024	×	**15-May-2024**	06-Jun-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED042T: Total Sulfur by LECO								
Pulp Bag (ED042T)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	27-Oct-2024	✓	**10-May-2024**	27-Oct-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
EG005(ED093)T: Total Metals by ICP-AES								
Soil Glass Jar - Unpreserved (EG005T)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**09-May-2024**	27-Oct-2024	✓	**15-May-2024**	27-Oct-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
EG035T: Total Recoverable Mercury by FIMS								
Soil Glass Jar - Unpreserved (EG035T)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**09-May-2024**	28-May-2024	✓	**15-May-2024**	28-May-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK040T: Fluoride Total								
Snap Lock Bag (EK040T)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**14-May-2024**	28-May-2024	✓	**15-May-2024**	28-May-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Acid Neutralising Capacity (ANC)	EA013	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chromium Suite for Acid Sulphate Soils	EA033	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Moisture Content	EA055	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Net Acid Generation	EA011	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfur - Total as S (LECO)	ED042T	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Fluoride	EK040T	4	29	**13.79**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Acid Neutralising Capacity (ANC)	EA013	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chromium Suite for Acid Sulphate Soils	EA033	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Net Acid Generation	EA011	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfur - Total as S (LECO)	ED042T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Fluoride	EK040T	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	0	24	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chromium Suite for Acid Sulphate Soils	EA033	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfur - Total as S (LECO)	ED042T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Fluoride	EK040T	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Total Fluoride	EK040T	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	0	24	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Net Acid Production Potential	EA009	SOIL	In house: Referenced to Coastech Research (Canada)(Mod.). NAPP = Acid Production Potential (APP or MAP-Maximum Acid Potential) minus Neutralising Capacity (ANC). NAPP may be +ve, zero or -ve.
Net Acid Generation	EA011	SOIL	In house: Referenced to Miller (1998) Titremetric procedure determines net acidity in a soil following peroxide oxidation. Titrations to both pH 4.5 and pH 7 are reported.
Acid Neutralising Capacity (ANC)	EA013	SOIL	In house: Referenced to USEPA 600/2-78-054, I. Miller (2000). A fizz test is done to semiquanititatively estimate the likely reactivity. The soil is then reacted with an known excess quanitity of an appropriate acid. Titration determines the acid remaining, and the ANC can be calculated from comparison with a blank titration.
Chromium Suite for Acid Sulphate Soils	EA033	SOIL	In house: Referenced to Ahern et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Moisture Content	EA055	SOIL	In house: A gravimetric procedure based on weight loss over a 12 hour drying period at 105-110 degrees C. This method is compliant with NEPM Schedule B(3).
Sulfate as SO4 2- Total	ED040T	SOIL	In house: Total Sulfate is determined off a HCl digestion by ICPAES as S , and reported as SO4
Sulfur - Total as S (LECO)	ED042T	SOIL	In house: Dried and pulverised sample is combusted in a high temperature furnace in the presence of strong oxidants / catalysts. The evolved S (as SO2) is measured by infra-red detector
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM Schedule B(3)
Total Mercury by FIMS	EG035T	SOIL	In house: Referenced to APHA 3112 Hg - B (Flow-injection (SnCl2) (Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM Schedule B(3)
Total Fluoride	EK040T	SOIL	(In-house) Total fluoride is determined by ion specific electrode (ISE) in a solution obtained after a Sodium Carbonate / Potassium Carbonate fusion dissolution.

Preparation Methods	Method	Matrix	Method Descriptions
Total Fluoride	EK040T-PR	SOIL	In house: Samples are fused with Sodium Carbonate / Potassium Carbonate flux.
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house
HCl Digest	EN24	SOIL	1g of soil is digested in 30 ml of 30% HCl and the resultant digest bulked and filtered for analysis by ICP.

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	In house: Referenced to USEPA 200.2. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM Schedule B(3).
Dry and Pulverise (up to 100g)	GEO30	SOIL	#

APPENDIX B PETROGRAPHIC ANALYSIS

Groundwork Plus Resources Environment Planning Laboratories
Phone: 1800 GW PLUS (1800 497 587)
Email: info@groundwork.com.au
Website: groundwork.com.au
ABN 13 609 422 791

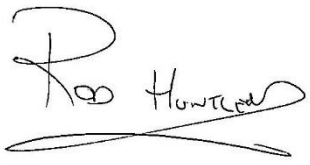
Petrographic Inspection Report

Prepared for:	Superior Quarry Testing
Purchase Order:	Not Provided
Material Source:	Graymont (Taragoola) Quarry, QLD
Sample Type:	Type 2.1 Roadbase
Sample Number:	SN 5459
Date Sampled:	Not Provided
Date of Inspection:	17/01/2022
Report Issued:	18/01/2022
Project/ File Ref.:	P2021_213_01

Author: 

Mathew Beddard (BSc)

Petrologist
Groundwork Plus

Reviewer: 

Rod Huntley (BSc, M.App.Sc, M.Eng)
Principal Resource Consultant
Groundwork Plus

Enquiries regarding the content of this report should be directed to Groundwork Plus 07 3871 0411*. Samples are disposed of after 3 months from the date of report. Thin sections will remain on site indefinitely. The analysis is based on a limited number of thin sections and sample provided by client, further investigation may be required. Interpretations are specific to the sample examined only.*

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Executive Summary

Classification: Limestone

For Engineering Purposes AS 2758.1: Roadbase derived from derived from carbonate sedimentary rock

Key Material Risk: Negligible risk

Table 1 – Summary of Sample's Compositional Characteristics

Compositional Features	%	Comments
Strong Phases	93	Calcite; *trace:* opaques
Weak Phases	7	Goethite
Clays	0	None observed
Micas	0	None observed
Sulphides	0	None observed
Carbonates	93	Calcite
Textural Features	**Yes/ No**	
Fracturing/Veins	Yes	Abundant diagenetic sparry calcite veins. Minor goethite veins. No fractures observed
Voids	No	None observed
Free Silica	**%**	
Unstrained quartz	0	None observed
Optically strained quartz	0	None observed
Microcrystalline quartz	0	None observed
Siliceous volcanic glass	0	None observed
Opaline/chalcedonic quartz	0	None observed
Total	0	

Table 2 – Risk Rating for Specific Applications and Source Rock Quality

Specific Application	Low	Mod	High	Comments
Coarse Aggregate in Concrete (MRTS70)	✓			Texturally isolated weak/secondary phases unlikely to cause deleterious reactions or significantly increase water demand in concrete
Manufactured Sand	✓			Considered suitable after processing to remove goethitic fines
Aggregate Unbound Pavements (MRTS05)	✓			Suitable hardness, strength, and durability (after processing to remove goethitic fines)
Cover Aggregate (MRTS22)	✓			Suitable hardness, strength, and durability (after processing to remove goethitic fines)
Graded Asphalt Aggregate (MRTS101)	✓			Suitable hardness, strength, and durability (after processing to remove goethitic fines)
Gabion/Revetment	✓			Mechanically suitable
Material Characteristics	**Low**	**Mod**	**High**	**Comments**
Hardness	✓			Hard
Strength	✓			Strong
Durability	✓			Durable
ACR in concrete	✓			Innocuous. No dolomite detected.
ASR in concrete	✓			Innocuous. No reactive silica detected.

Introduction

This report provides the results of a general petrographic assessment of a roadbase sample, which was submitted to the Groundwork Plus petrographic laboratory, and describes the method and standards used to assess the sample. The supplied sample was sampled by the client and sent to the Groundwork Plus petrographic facility. The thin section was prepared and analysed by Groundwork Plus with instructions from the client to conduct petrographic testing to ASTM C295 and recommend further testing if significant deleterious characteristics are identified pursuant to Clause 16.3 of this standard. The provided modal mineral percentages relate to the supplied sample which is understood to be representative of material on site. Assessment regarding the Alkali-Silica Reactivity (ASR) potential of the aggregate has been advised by SA HB 79-2015. Communication of findings are advised by AS 1726-2017 Geotechnical Site Investigations.

Methodology

The petrographic assessment of the slide is carried out using a Nikon polarising microscope equipped with a digital camera at the Groundwork Plus petrographic laboratory. Photographs of the hand specimen and thin section photomicrographs showing grain sizes and any particular aspects of the minerals are included as part of the report (**Plates 1** to **6**). Modal analysis is conducted on the sample using a MA945/10 Mechanical Point Counter on 600 points (**Table 3 – Modal Analysis of Minerals**).

The petrology assessment is based on:

- ASTM C 295 – 2019 Standard Guide for Petrographic Examination of Aggregates for Concrete.
- AS 2758.1 – 2014 Aggregates and Rock for Engineering Purposes Part 1: Concrete Aggregates (Appendix B).
- AS 2758.2 – 2014 Aggregates and Rock for Engineering Purposes Part 2: Aggregate for sprayed bituminous surfacing.
- AS 2758.4 – 2014 Aggregates and Rock for Engineering Purposes Part 4: Aggregate for gabion baskets and wire mattresses.
- AS 2758.5 – 2014 Aggregates and Rock for Engineering Purposes Part 5: Asphalt Aggregates.
- AS 2758.6 – 2014 Aggregates and Rock for Engineering Purposes Part 6: Guidelines for the specification of Armourstone.
- AS 1141.26 – 2019 Standard Guide for the Method for Sampling and Testing Aggregates – Secondary Minerals Content in Igneous Rocks.
- The accepted definition of free silica is set out in the Queensland Department of Transport and Main Roads Test Method Q188, and tested pursuant to guidelines set in Standards Australia HB 79-2015 Alkali-Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structure in Australia - Cement and Concrete Association of Australia and Standards Australia.

Hand Specimen Description

In hand specimen, the roadbase sample is identified as being derived from a **limestone**, a carbonate sedimentary rock.

The sample consists of variably sized, poorly sorted aggregate particles and abundant fines. Particles measure up to 20mm in size. Particles are angular to very angular, with variable sphericity. Prior to washing, the sample contains abundant goethitic fines and dust, giving it an overall light orangish-brown colour. Goethite dust coats most particles as well as forming liberated binder. Washing removes most dust to produce a turbid orangish-brown water. The washed particles show variable colour, with most being light to dark grey. Acid testing indicates the sample is composed of calcite. The shade of grey is dependent upon the texture of calcite that makes up the particle, with micrite being darker grey and sparry calcite being lighter. A minor abundance of particles show extensive internal staining of goethite, giving them an orange to reddish-brown colour.

The sample particles are regarded as strong and hard, with competent faces. No fractures or voids are observed. No sulphides are observed and the sample is not appreciably magnetic.



Plate 1: Photograph of the sample as provided, showing the poorly sorted, angular roadbase particles coated in abundant, light orangish-brown fines.



Plate 2: Photograph of sample when wetted, which removes the goethitic fines leaving the variably coloured limestone particles.

Thin Section Description

In thin section, the sample is conformed to derive from a limestone. The limestone shows textures consistent with classification as a mudstone with minor wackestone regions. Diagenetic alteration has seen replacement of micritic calcite with sparry calcite veins and bands. A mode base on a count of 600 widely spaced points is shown in **Table 3 - Modal Analysis of Minerals**. Robust minerals make up 93% of the rock and include calcite (split into micrite and sparry varieties) and trace opaques. Goethite is the only observed weak phase and accounts for 7% of the sample.

Table 3 - Modal Analysis of Minerals

Primary Minerals	Mode (%)	Comments
Calcite – micritic	41	Calcite showing massive, micritic texture. Also includes rare bioclastic/wackestone texture
Calcite – sparry	52	Calcite crystals showing sparry texture including twinning. Occurs as replacement of micrite.
Opaques	Trace	Trace, 0.05mm sized, rounded, opaque, magnetite crystals
Secondary Minerals		
Goethite	7	Abundant in the fines and dust as orange-coloured accretions. Minor staining within some particles. Minor veins and veinlets observed
Total	**100**	

Calcite forms most of the sample at 93% of the mineral count. Calcite is observed showing micritic texture (41% of the sample) and sparry texture (52%). The micritic calcite is regarded as the primary texture prior to replacement by sparry crystals during diagenesis. The micritic regions are typical of carbonate mudstones, with expansive regions of microcrystalline, massive calcite. In some areas, rare bioclasts are observed giving a more wackestone texture. Bioclasts include gastropods and bivalves. The distribution of sparry calcite is variable, with veinlets, veins, and large bands and patches observed. Some areas contain abundant crosscutting veins and veinlets; others are dominated by wide bands of sparry crystals. The remaining robust phase observed is trace opaque magnetite, which is disseminated throughout the sample as small, 0.05mm sized, rounded crystals.

The finer material in the sample is dominated by goethite (7%). Goethitic accretions coat most particles, with a minor abundance of particles having interior ferruginous staining. The goethitic fines are easily removed by washing the sample. Minor veins and veinlets of goethite are also observed crosscutting the calcite and indicating later weathering of the rock.

Overall, the sample is considered hard, strong, and durable, and considered suitable for use as a roadbase. The goethitic fines are expected to perform well as binder for the roadbase. After processing to remove fines, the sample is regarded as suitable for use as coarse aggregate in concrete, unbound pavements, cover aggregate, graded asphalt, and gabion/revetment. Extensive crushing is expected to produce a quality carbonate manufactured sand.

Free Silica Content

After conducting a modal analysis using the MA945-10 mechanical point counter on 600 points, the total free silica content was found to be 0%. The sample was found to contain **no reactive silica.**

According to Standards Australia HB 79-2015 and Department of Transport and Main Roads test method Q188, the provided aggregate is assessed as **innocuous in regard to ASR** in concrete.

Asbestiform Minerals

Asbestos can be defined mineralogically and by crystal habit. For the purposes of health screening asbestiform habit is relevant, which is defined as being hair-like (filiform) and flexible with a high aspect ratio. Based on the thin section constructed from the material supplied, the sample contains **no observable asbestiform minerals**.

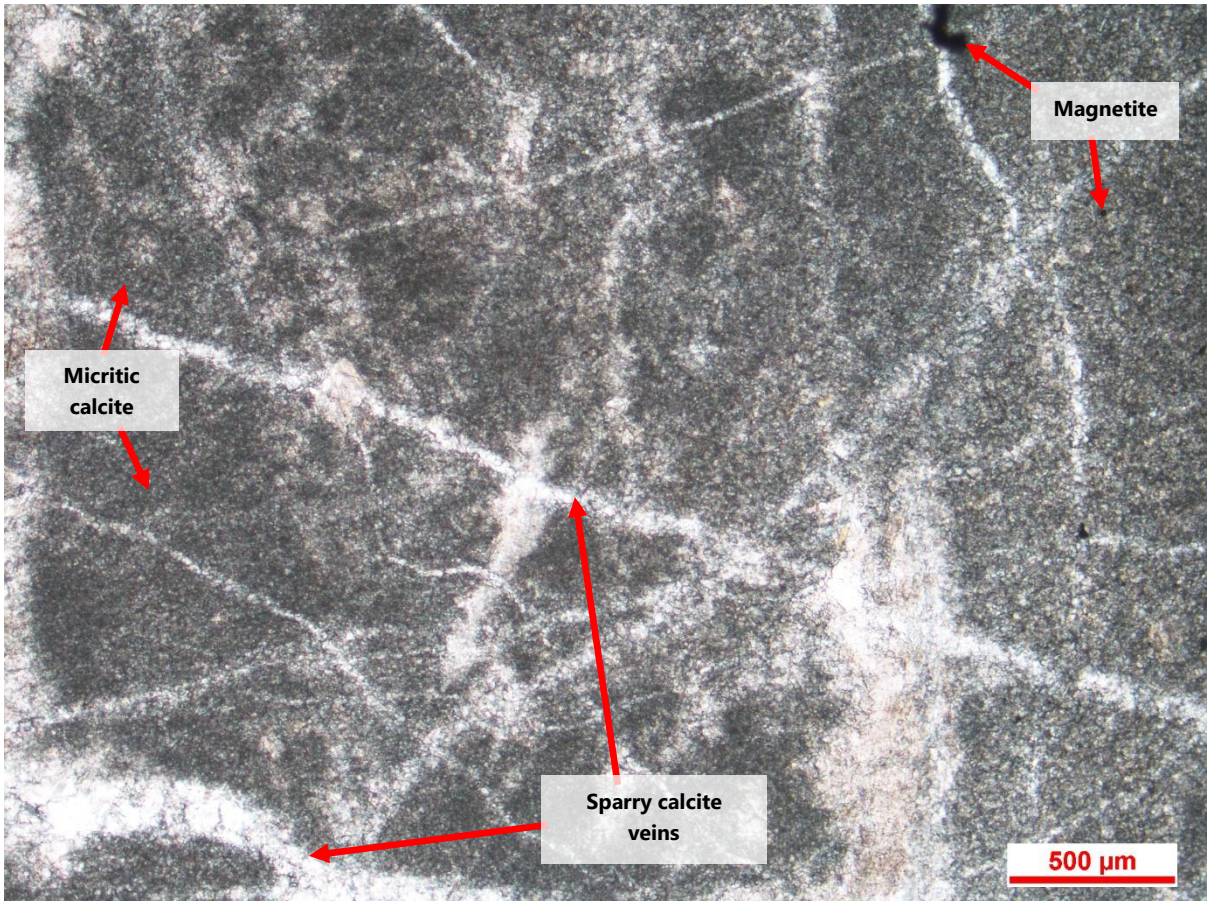


Plate 3: Microphotograph of the sample, showing abundant sparry calcite veins crosscutting the micritic calcite. Image shown in plane polarised light. Scale = 500µm x 40 magnification. F.O.V. 5.2mm.

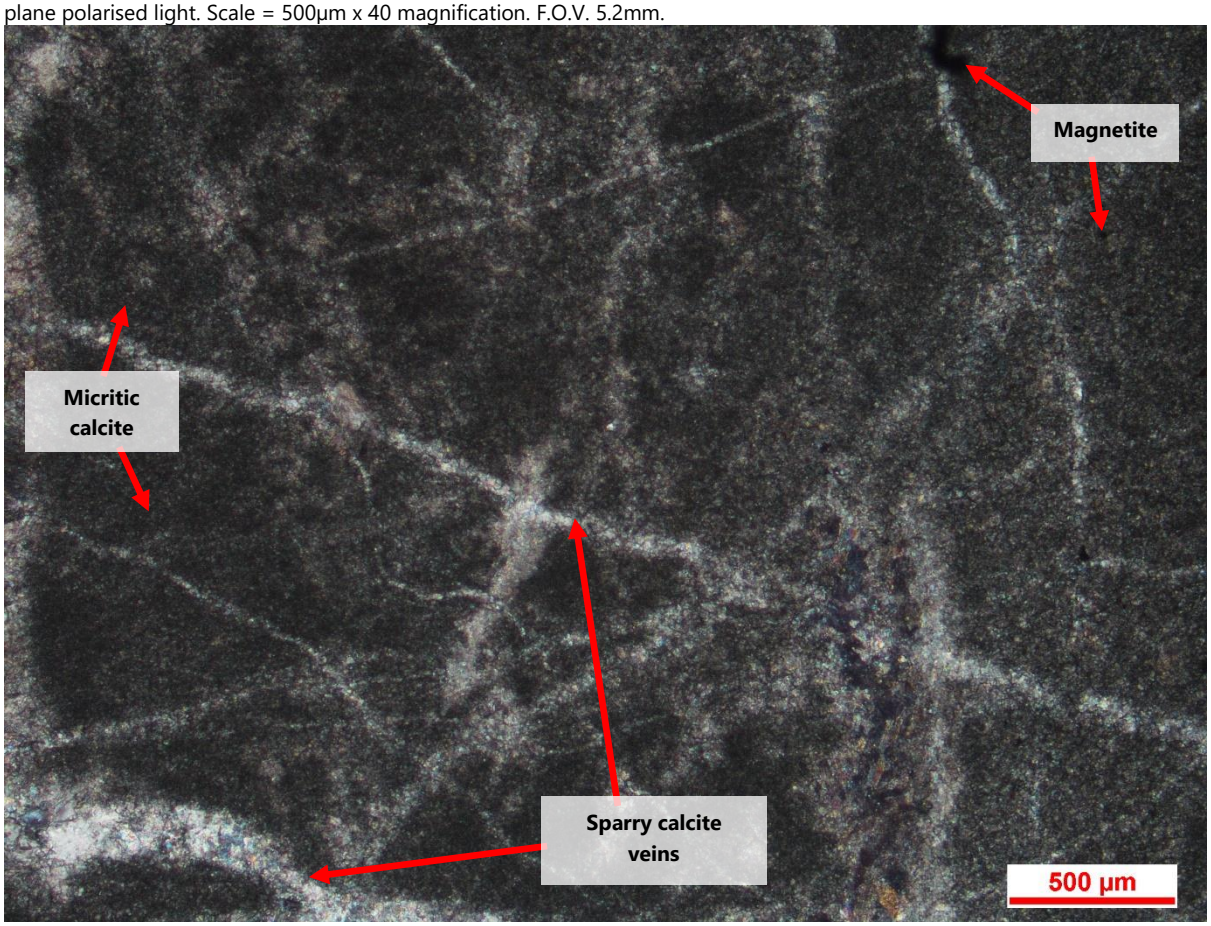


Plate 4: The same image from **Plate 3** under crossed polarised light. Scale = 500µm x 40 magnification. F.O.V. 5.2mm.

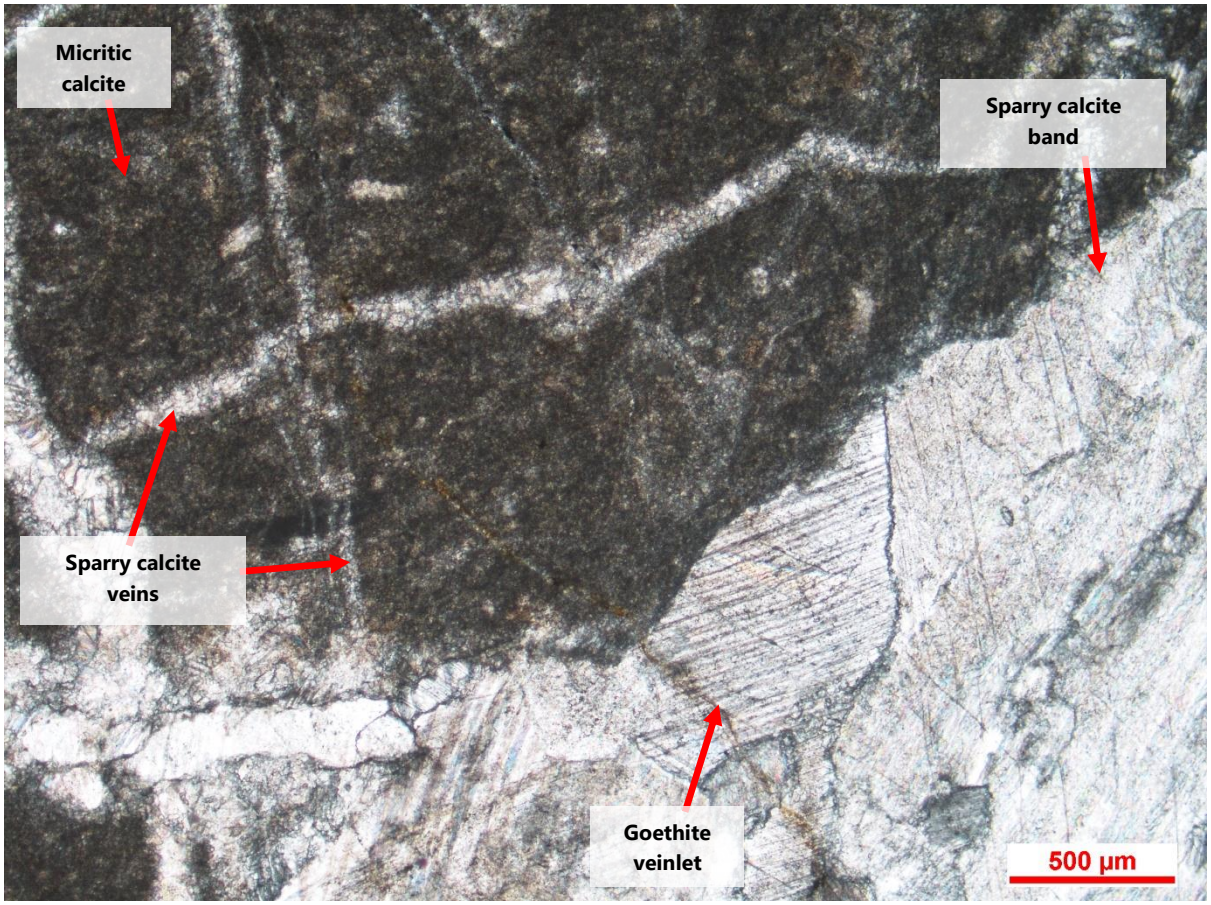


Plate 5: Microphotograph of the sample, showing sparry veins and a large sparry band crosscutting the micritic calcite. Image shown in plane polarised light. Scale = 500µm x 40 magnification. F.O.V. 5.2mm.

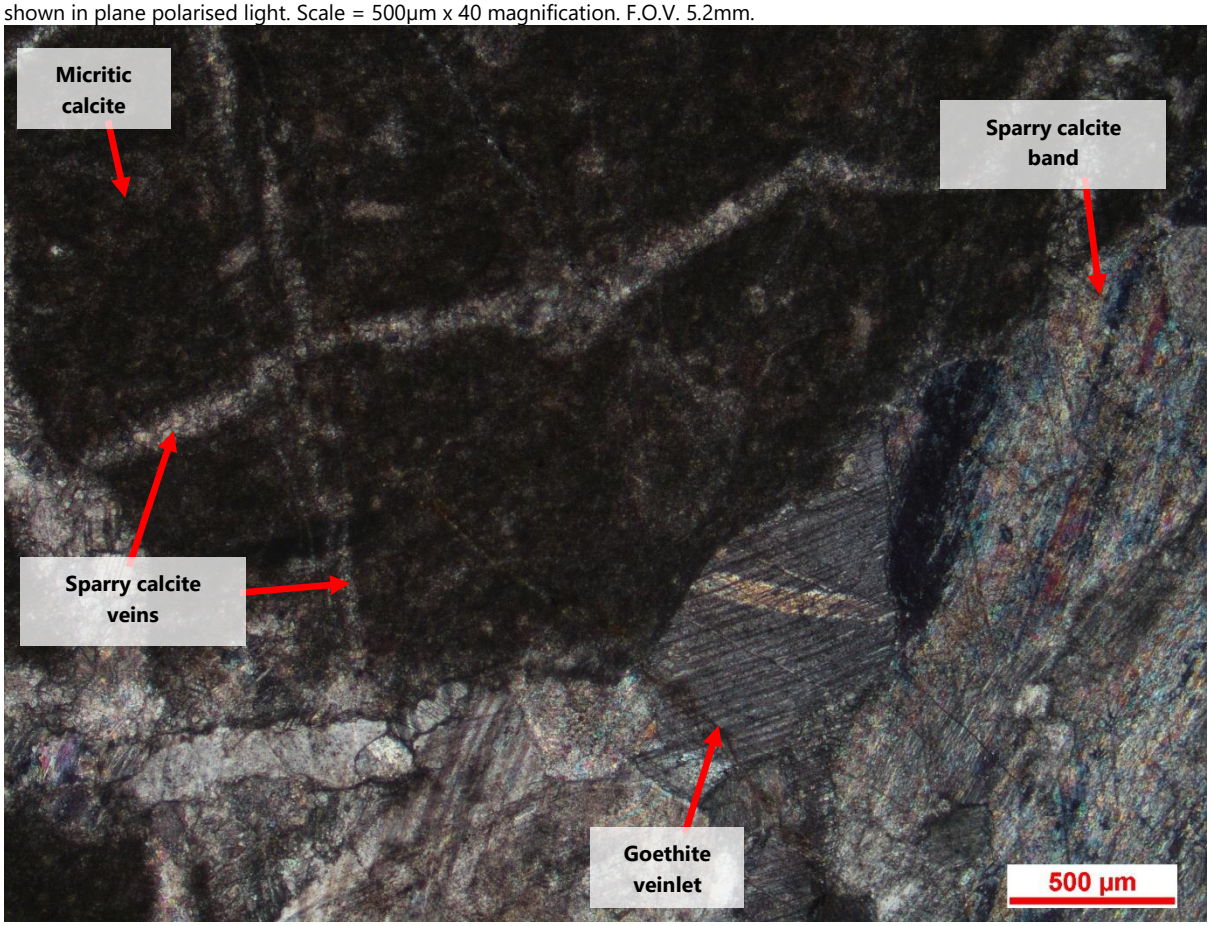


Plate 6: The same image from **Plate 5** under crossed polarised light. Scale = 500µm x 40 magnification. F.O.V. 5.2mm.

Summary

The roadbase sample is identified as being derived from a limestone source rock. The limestone is considered hard, strong, and is expected to be durable. Pending material testing, aggregate produced from this rock is regarded as suitable for use as coarse aggregate in concrete, unbound pavements, cover aggregate, graded asphalt and gabion/revetment. The sample is expected to perform well as roadbase. Extensive crushing to produce manufactured sand may submit elevated goethite particles but is otherwise considered suitable for use as fine aggregate in concrete.

For engineering purposes, the source rock may be summarised as:

- A **limestone**, a carbonate sedimentary rock.
- Slightly weathered with abundant goethitic fines, **non-porous** and without voids or extensive internal fracturing.
- Predominantly composed of **robust calcite (93%)**, with 7% weak goethite.
- Containing no free silica.
- Assessed as **innocuous in regard to ASR** in concrete.
- **Hard**, of predicted **high strength** and predicted to be **durable**.

Groundwork Plus Resources Environment Planning Laboratories
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ABN 13 609 422 791

Petrographic Inspection Report

Prepared for:	Superior Quarry Testing
Purchase Order:	329
Material Source:	Graymont (Australia) Pty Ltd – Calliope
Sample Type:	Source Rock – Coarse Aggregate
Sample Number:	7596
Date Sampled:	01/12/2022
Date of Inspection:	01/02/2023
Report Issued:	03/03/2023
Project/ File Ref.:	P2022_220_01

Author: **Mathew Beddard (BSc)**

Petrologist
Groundwork Plus

Reviewer: **Rod Huntley (BSc, M.App.Sc, M.Eng)**
Principal Resource Consultant
Groundwork Plus

Enquiries regarding the content of this report should be directed to Groundwork Plus 07 3871 0411*. Samples are disposed of after 3 months from the date of report. Thin sections will remain on site indefinitely. The analysis is based on a limited number of thin sections and sample provided by client, further investigation may be required. Interpretations are specific to the sample examined only.*

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Executive Summary

Classification: Limestone

For Engineering Purposes AS 2758.1: Coarse aggregate derived from carbonate sedimentary rock

Key Material Risk: Negligible risk

Table 1 – Summary of Sample's Compositional Characteristics

Compositional Features	%	Comments
Robust Phases	99	**Major (>20%):** calcite; **trace (<1%):** opaques
Weak Phases	1	**Minor (1-5%):** goethite
Clays	0	None observed
Micas	0	None observed
Sulphides	0	None observed
Carbonates	99	Calcite
Textural Features	**Yes/ No**	
Fracturing/veins	Yes	Abundant diagenetic sparry calcite veins. Minor goethite veins. No fractures observed
Voids	No	None observed
Free Silica	**%**	
Unstrained quartz	0	None observed
Optically strained quartz	0	None observed
Microcrystalline quartz	0	None observed
Siliceous volcanic glass	0	None observed
Opaline/chalcedonic quartz	0	None observed
Total	0	

Table 2 – Risk Rating for Specific Applications and Material Characteristics

Specific Application	Low	Mod	High	Comments
Coarse Aggregate in Concrete (MRTS70)	✓			Texturally isolated secondary/weak phases unlikely to cause deleterious reactions or significantly increase water demand in concrete
Manufactured Sand	✓			Expected to produce quality manufactured carbonate sand
Aggregate Unbound Pavements (MRTS05)	✓			Suitable hardness, strength, and durability
Cover Aggregate (MRTS22)	✓			Suitable hardness, strength, and durability
Graded Asphalt Aggregate (MRTS101)	✓			Suitable hardness, strength, and durability
Gabion/Revetment	✓			Suitable hardness, strength, and durability
Material Characteristics	**Low**	**Mod**	**High**	**Comments**
Hardness	✓			Hard
Strength	✓			Strong
Durability	✓			Durable
ACR in concrete	✓			Innocuous. No dolomite detected
ASR in concrete	✓			Innocuous. No reactive silica detected

Introduction

This report provides the results of a general petrographic assessment of an aggregate sample, which was submitted to the Groundwork Plus petrographic laboratory, and describes the method and standards used to assess the sample. The supplied sample was sampled by the client and sent to the Groundwork Plus petrographic facility. The thin section was prepared and analysed by Groundwork Plus with instructions from the client to conduct petrographic testing to ASTM C295 and recommend further testing if significant deleterious characteristics are identified pursuant to Clause 16.3 of this standard. The provided modal mineral percentages relate to the supplied sample which is understood to be representative of material on site. Assessment regarding the Alkali-Silica Reactivity (ASR) potential of the aggregate has been advised by SA HB 79-2015. Communication of findings are advised by AS 1726-2017 Geotechnical Site Investigations.

Methodology

The petrographic assessment of the slide is carried out using a Nikon polarising microscope equipped with a digital camera at the Groundwork Plus petrographic laboratory. Photographs of the hand specimen and thin section photomicrographs showing grain sizes and any particular aspects of the minerals are included as part of the report (**Plates 1** to **6**). Modal analysis is conducted on the sample using a Pelcon automatic point counter on at least 200 points (**Table 3 – Modal Analysis of Minerals**).

The petrology assessment is based on:

- ASTM C 295 – 2019 Standard Guide for Petrographic Examination of Aggregates for Concrete.
- AS 2758.1 – 2014 Aggregates and Rock for Engineering Purposes Part 1: Concrete Aggregates (Appendix B).
- AS 2758.2 – 2014 Aggregates and Rock for Engineering Purposes Part 2: Aggregate for sprayed bituminous surfacing.
- AS 2758.4 – 2014 Aggregates and Rock for Engineering Purposes Part 4: Aggregate for gabion baskets and wire mattresses.
- AS 2758.5 – 2014 Aggregates and Rock for Engineering Purposes Part 5: Asphalt Aggregates.
- AS 2758.6 – 2014 Aggregates and Rock for Engineering Purposes Part 6: Guidelines for the specification of Armourstone.
- The accepted definition of free silica is set out in the Queensland Department of Transport and Main Roads Test Method Q188, and tested pursuant to guidelines set in Standards Australia HB 79-2015 Alkali-Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structure in Australia - Cement and Concrete Association of Australia and Standards Australia.

Hand Specimen Description

In hand specimen, the sample is identified as a coarse aggregate derived from a **limestone**, a carbonate sedimentary rock.

The sample is composed of 5mm- to 20mm-sized particles. Particles are subangular to very angular, with low sphericity. The particles are an overall light to medium grey colour, with minimal variation. The shade of grey varies according to calcite texture, with micritic calcite being darker than sparry calcite. The particles react strongly with testing acid indicating a calcite composition. Rare ferruginous staining is observed on the faces of a minor abundance of particles.

The aggregate particles are regarded as strong and hard, with competent faces. No fractures or voids are observed. No sulphides are observed and the sample is not appreciably magnetic.



Plate 1: Photograph of the sample as provided.



Plate 2: Photograph of sample when wetted.

Thin Section Description

A mode base on a count of at least 200 widely spaced points is shown in **Table 3 - Modal Analysis of Minerals**. Robust minerals make up 99% of the sample and include calcite with trace opaques. Weak minerals make up 1% of the sample and include goethite.

The limestone shows textures consistent with classification as a mudstone with minor wackestone regions. Diagenetic alteration has seen replacement of micritic calcite with sparry calcite veins and bands.

Table 3 - Modal Analysis of Minerals

Robust Minerals	Mode (%)	Comments
Calcite (micritic)	51	Calcite showing massive, micritic texture. Also includes rare bioclastic/wackestone texture
Calcite (sparry)	48	Calcite crystals showing sparry texture including twinning. Occurs as replacement of micrite.
Opaques	Trace	Trace, 0.05mm sized, rounded, opaque, magnetite crystals
Weak Minerals		
Goethite	1	Minor veins and veinlets, and disseminated orange ferruginous staining
Total	**100**	

The sample is almost entirely composed of calcite at 99%. Approximately 51% of the limestone is composed of micritic calcite, with 48% being sparry. The micritic calcite is regarded as the primary texture prior to replacement by sparry crystals during diagenesis. The micritic regions are typical of carbonate mudstones, with expansive regions of microcrystalline, massive calcite. In some areas, rare bioclasts are observed giving a more wackestone texture. Bioclasts include gastropods and bivalves. The distribution of sparry calcite is variable, with veinlets, veins, and large bands and patches observed. Some areas contain abundant crosscutting veins and veinlets; others are dominated by wide bands of sparry crystals. The remaining robust phase observed is trace opaque magnetite, which is disseminated throughout the sample as small, 0.05mm sized, rounded crystals.

Goethite forms 1% of the sample and is the only observed weak phase. Goethite occurs as ferruginous veins and veinlets. Minor patches of ferruginous staining are also observed. No dolomitisation of the limestone is observed.

Overall, the sample is considered hard, strong, and durable, and considered suitable for use as a calcareous aggregate in all applications. The aggregate is regarded as suitable for use as coarse aggregate in concrete, unbound pavements, cover aggregate, graded asphalt, and gabion/revetment. Extensive crushing is expected to produce a quality carbonate manufactured sand.

Free Silica Content

After conducting a modal analysis using the Pelcon automatic point counter on at least 200 points, the total free silica content was found to be 0%. The sample was found to contain **no reactive silica.**

According to Standards Australia HB 79-2015 and Department of Transport and Main Roads test method Q188, the provided aggregate is assessed as **innocuous in regard to ASR** in concrete.

Table 4 – Calculation of Alkali-Silica Reactivity Value

Mineral Phase	Abundance	Critical concentration	ASR Value
Reactive silica phases	0%	3.0% to 5.0%	0
		Total	**0**

Asbestiform Minerals

Asbestos can be defined mineralogically and by crystal habit. For the purposes of health screening asbestiform habit is relevant, which is defined as being hair-like (filiform) and flexible with a high aspect ratio. Based on the thin section constructed from the material supplied, the sample contains **no observable asbestiform minerals**.

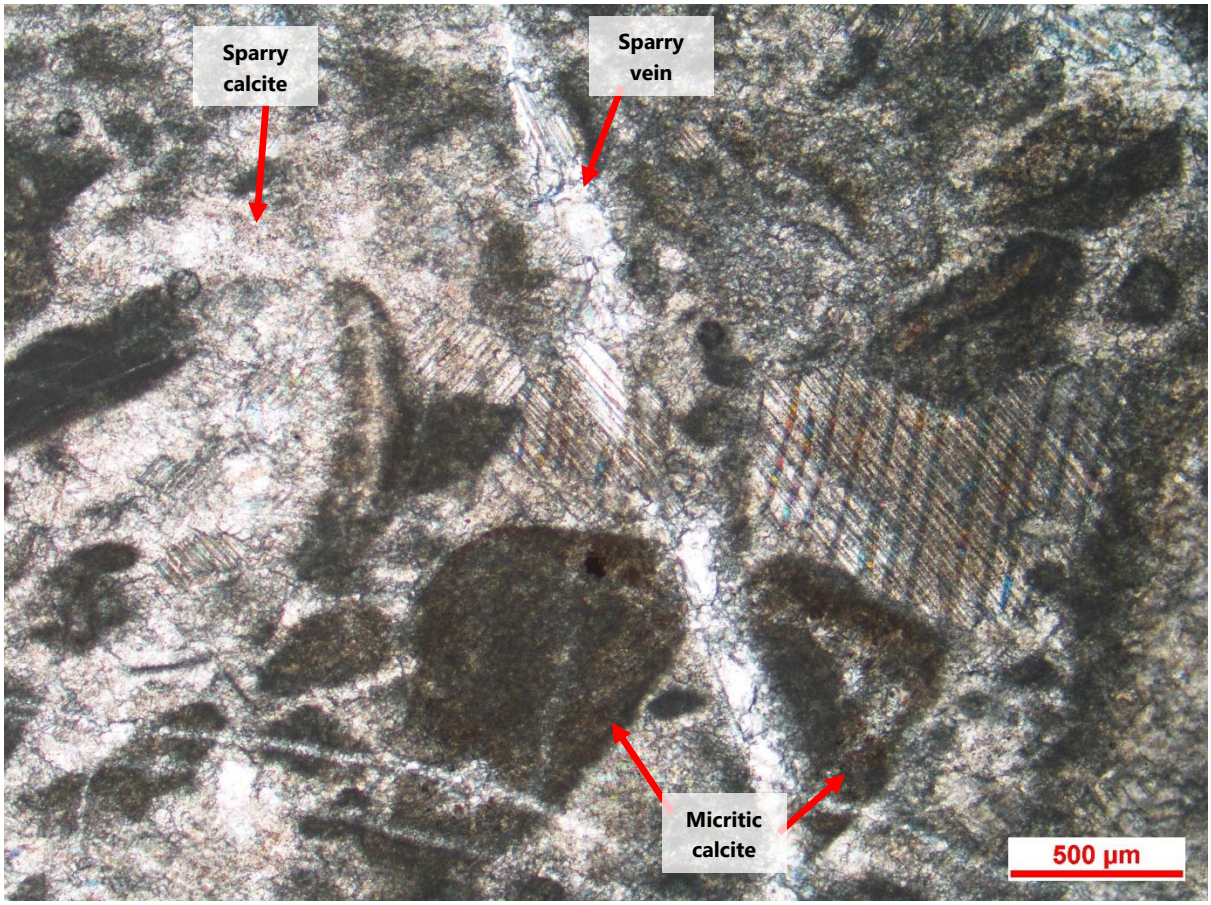


Plate 3: Microphotograph of the sample, showing remnant micritic bioclasts and regions surrounded by sparry calcite. Image shown in plane polarised light. Scale = 500µm x 40 magnification. F.O.V. 3.2mm.

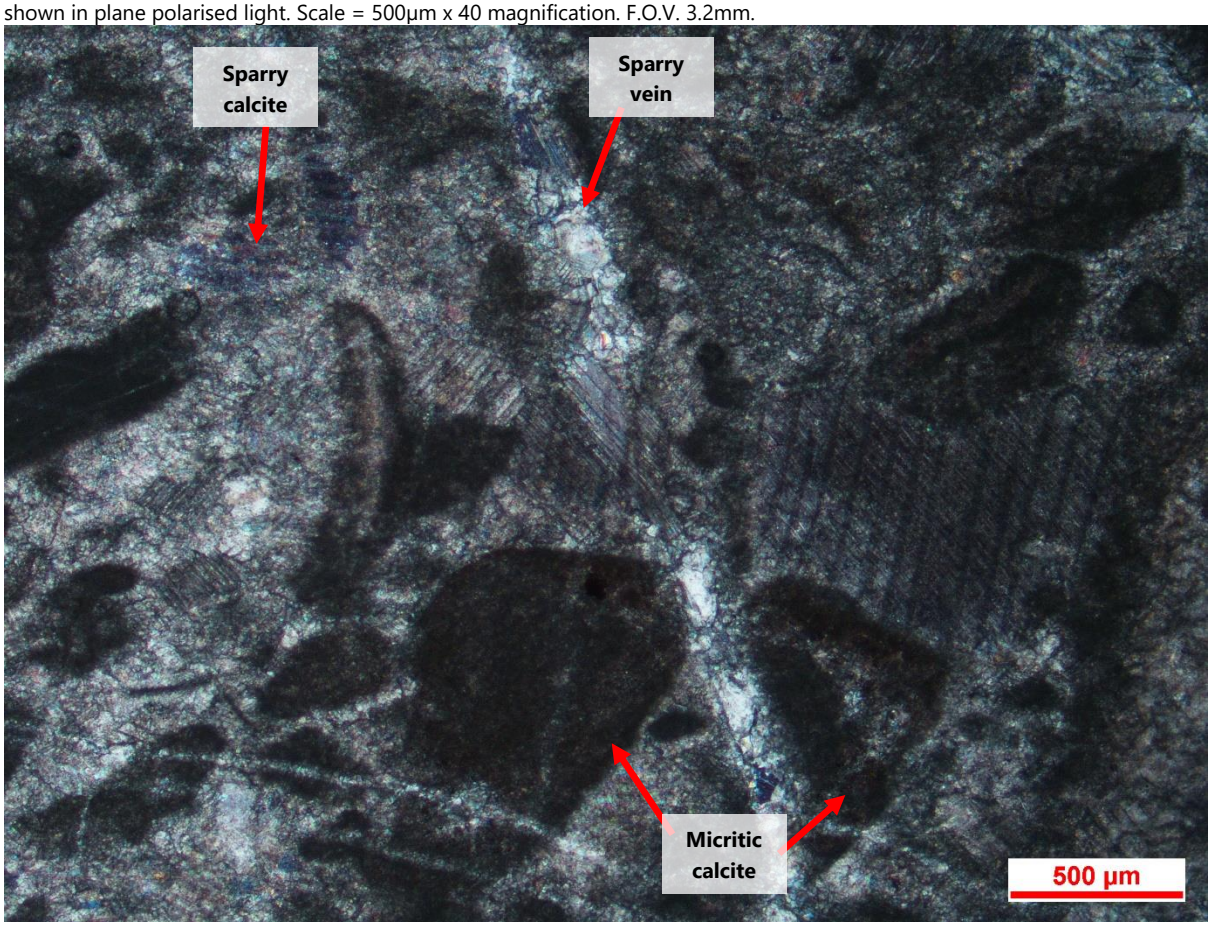


Plate 4: The same image from **Plate 3** under crossed polarised light. Scale = 500µm x 40 magnification. F.O.V. 3.2mm.

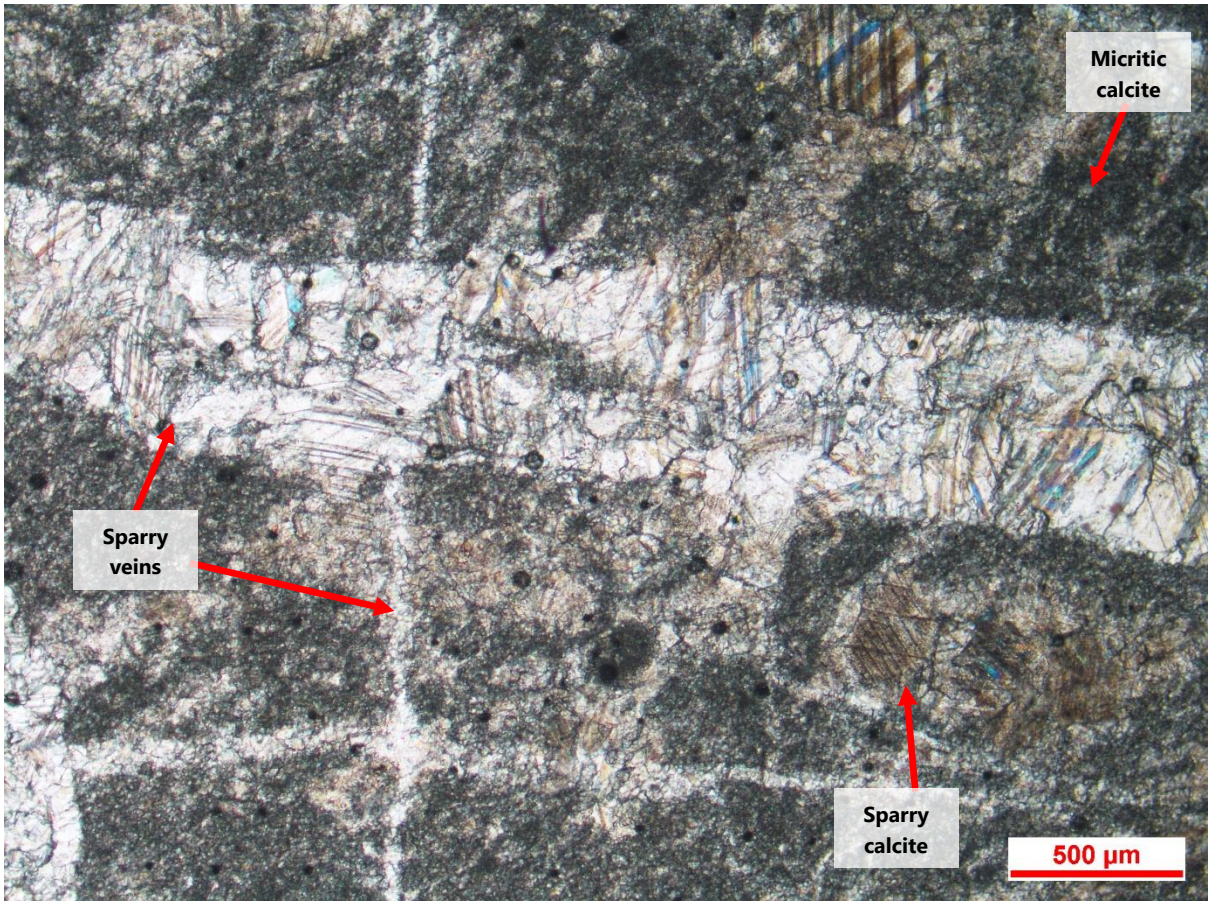


Plate 5: Microphotograph of the sample, showing crosscutting veins passing through micritic calcite. Image shown in plane polarised light. Scale = 500µm x 40 magnification. F.O.V. 3.2mm.

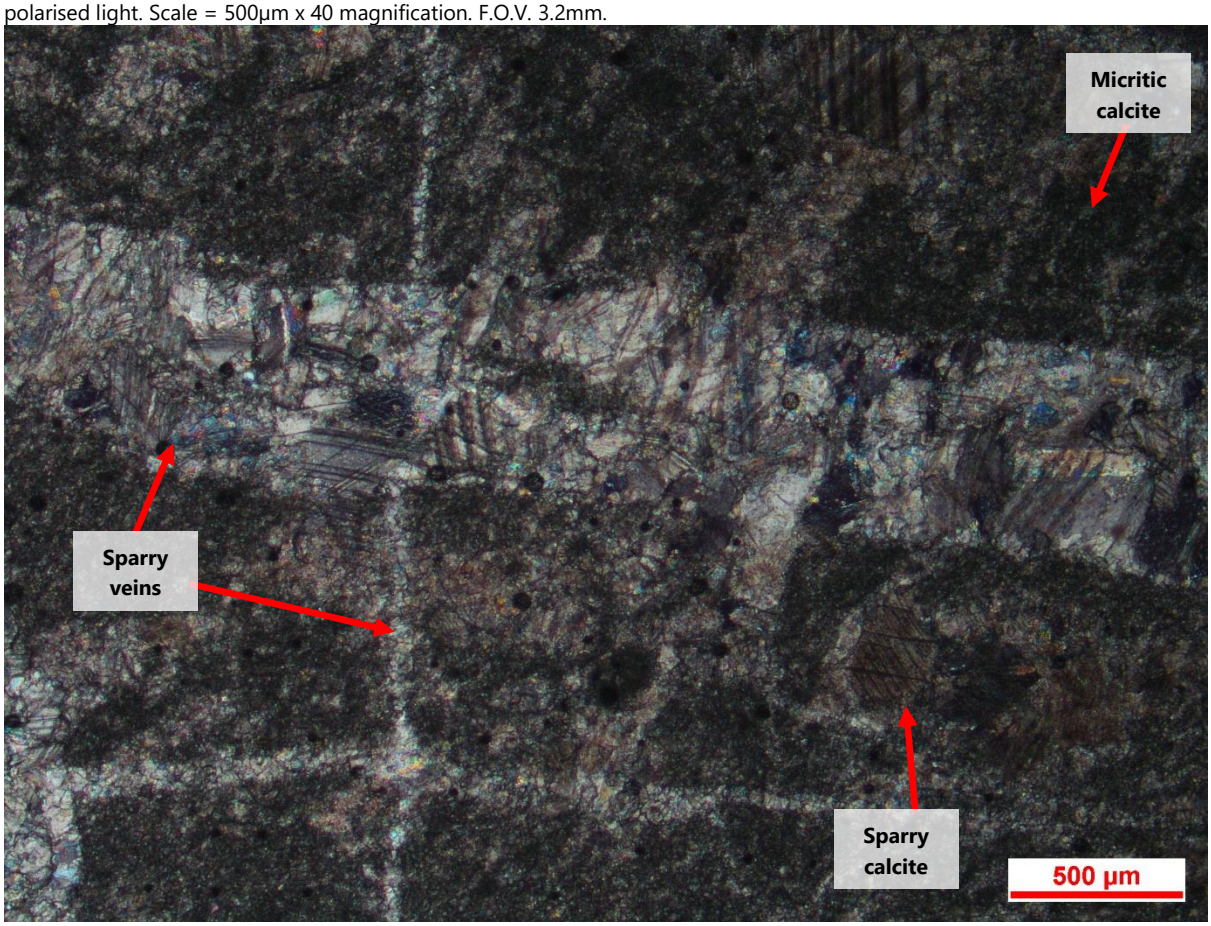


Plate 6: The same image from **Plate 5** under crossed polarised light. Scale = 500µm x 40 magnification. F.O.V. 3.2mm.

Summary

The sample is identified as a coarse aggregate derived from a limestone, a carbonate sedimentary rock type. The limestone is regarded as hard and strong, and is expected to be durable. Pending material testing, aggregate produced from this rock is regarded as suitable for use as coarse aggregate in concrete, unbound pavements, cover aggregate, graded asphalt, and gabion/revetment. Extensive crushing to produce manufactured sand is considered suitable for use as fine aggregate in concrete.

For engineering purposes, the rock may be summarised as:

- A **limestone**, a carbonate sedimentary rock.
- Mostly unweathered, **non-porous** and without voids or extensive internal fracturing.
- Predominantly composed of **robust calcite (99%)**, with 1% weak phases (goethite).
- Containing no free silica.
- Assessed as **innocuous in regard to ASR** in concrete.
- **Hard**, of predicted **high strength** and predicted to be **durable**.

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PETROGRAPHIC REPORT ON A 75-150 GABION ROCK (GL23-8830A) FROM GRAYMONT TARAGOOLA QUARRY

prepared for

BUTLER PARTNERS (REGIONAL)

Purchase Order: BPG4870

Invoice Number: G202307519

Client Ref: Simone Offord

Issued by

C. C. Angus
BSc, BA (Hons)
11 July 2023

Reviewed by

A.G. Christy
MA PhD FMinSoc
11 July 2023

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Sample ID: GL23-8830A **Date Sampled**: 17/05/2023

Geo Sample ID: G23050111 **Date Received**: 24/05/2023

Product Type: 75-150 Gabion Rock

Sample Location: Graymont Taragoola Quarry

Project: G19-121A – Quarry Quality Testing – MS24 Taragoola Rd, Calliope, QLD

Work Requested Petrographic analysis in relation to suitability for use as concrete aggregate; petrographic analysis in relation to potential for alkali-silica reactivity.

Methods Account taken of ASTM C 295 Standard Guide for *Petrographic Assessment of Aggregates for Concrete*, the AS2758.1 – 2014 *Aggregates and rock for engineering purposes part 1; Concrete aggregates (Appendix B)*, the AS1141 Standard Guide for the *Method for sampling and testing aggregates*, of the content of the 2015 joint publication of the Cement and Concrete Association of Australia and Standards Australia, entitled (HB 79-2015) *Alkali Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structures in Australia* and of the Queensland Transport and Main Roads Materials Testing Manual – Part 6 (September, 2020) *Test Method Q188: Petrographic assessment of aggregates.*

Identification Limestone

Description

The aggregate sample consisted of about 20 kg of angular and sub-angular, medium light-grey, finely crystalline limestone which is unweathered to less commonly slightly weathered (some fragments display brown limonitic and reddish hematitic staining), and apparently robust. A thin coating of white dust is easily removed by washing a small sub-sample.



Figure 1: Image of a washed subsample supplied aggregate.

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Mineralogy

A thin section was prepared to permit microscopic examination in transmitted polarized light of a fragment. An approximate composition, expressed in volume percent and based on a brief count of 100 widely spaced points falling within the sectioned random fragments, is:

96%	calcite (composed of 47% micritic calcite in the matrix and 49% sparry coarser calcite in veins)
<1%	quartz grains
4%	carbonaceous matter
<1%	sericite/illite
<1%	secondary iron oxide (limonite/goethite and hematite)

In thin section the rock fragments are seen to consist of abundantly veined, finely crystalline limestone; some of the fragments are fossiliferous.

The fragments display carbonate textures, now largely overprinted by fine mosaic recrystallization and cut by numerous veins of mobilized calcite; ghosted remnants of fossils are observed in some fragments. Matrix carbonate is of finely crystalline, micritic style (finer and slightly muddy), around 0.005 to 0.02 mm in grainsize. Numerous and irregular veins around 0.02 to several millimetres wide carry sparry calcite with a grainsize up to at least 2.5 mm associated with a little limonite/goethite and hematite. Some quite thin and complexly shaped stylolites are delineated by fine carbonaceous matter which is accompanied or replaced by limonite.

Normative Requirements

As per the Queensland Department of Main Roads Test Method Q188, the following normative requirements have been tabulated.

Requirement	Result
Quartz Content	<1%
Alkali Silica Reactivity (ASR) Potential[1]	Innocuous
Asbestos[2]	None observed
High sodium/potassium minerals	None observed
Sulphide content	None observed
Clays and moisture sensitive materials	4%
Carbonate Content	96%
Glass Content	None observed

[1] See ASR potential calculation below

[2] Not completed to the 2004 *Method for the Qualitative Identification of Asbestos in Bulk Samples*

Comments and Interpretations

This supplied 75-150 Gabion Rock sample (GL23-8830A) from Graymount Taragoola Quarry is interpreted to represent limestone, a biochemical sedimentary rock which has been indurated and rendered non-porous by diagenetic, fine recrystallization and by abundant veining by mobilized and coarsened calcite.

For engineering purposes, the rock in the supplied aggregate sample may be summarised as:

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- **limestone**, a biochemical sedimentary rock
- almost pure calcium carbonate (carrying 4% of other minerals)
- finely recrystallised
- abundantly veined
- non-porous
- unweathered and less commonly slightly weathered
- having a **hardness of only about 3** on the Mohs hardness scale (in contrast to a Mohs hardness of 7 for quartz) making it **moderately robust**.
- soluble in even dilute or weak, natural or synthetic acids

The product is interpreted to be **innocuous in relation to both alkali-silica**: it lacks the free silica necessary for deleterious alkali-silica reaction.

Optical differentiation between calcite and dolomite is inexact. The sample has the **potential to be reactive in relation to alkali-carbonate reactivity**. It is recommended that XRD analysis be carried out if detailed separation of carbonate species is required.

Thus, limestone equivalent to the supplied aggregate sample is predicted to be **suitable for use in concrete aggregate**, provided that it is not exposed to heavy abrasion and not exposed to attack by acids. It is also unsuitable for concrete intended for specialised high-temperature applications, since carbonates can decompose explosively under such conditions.

Free Silica Content

Apparently less than 1%.

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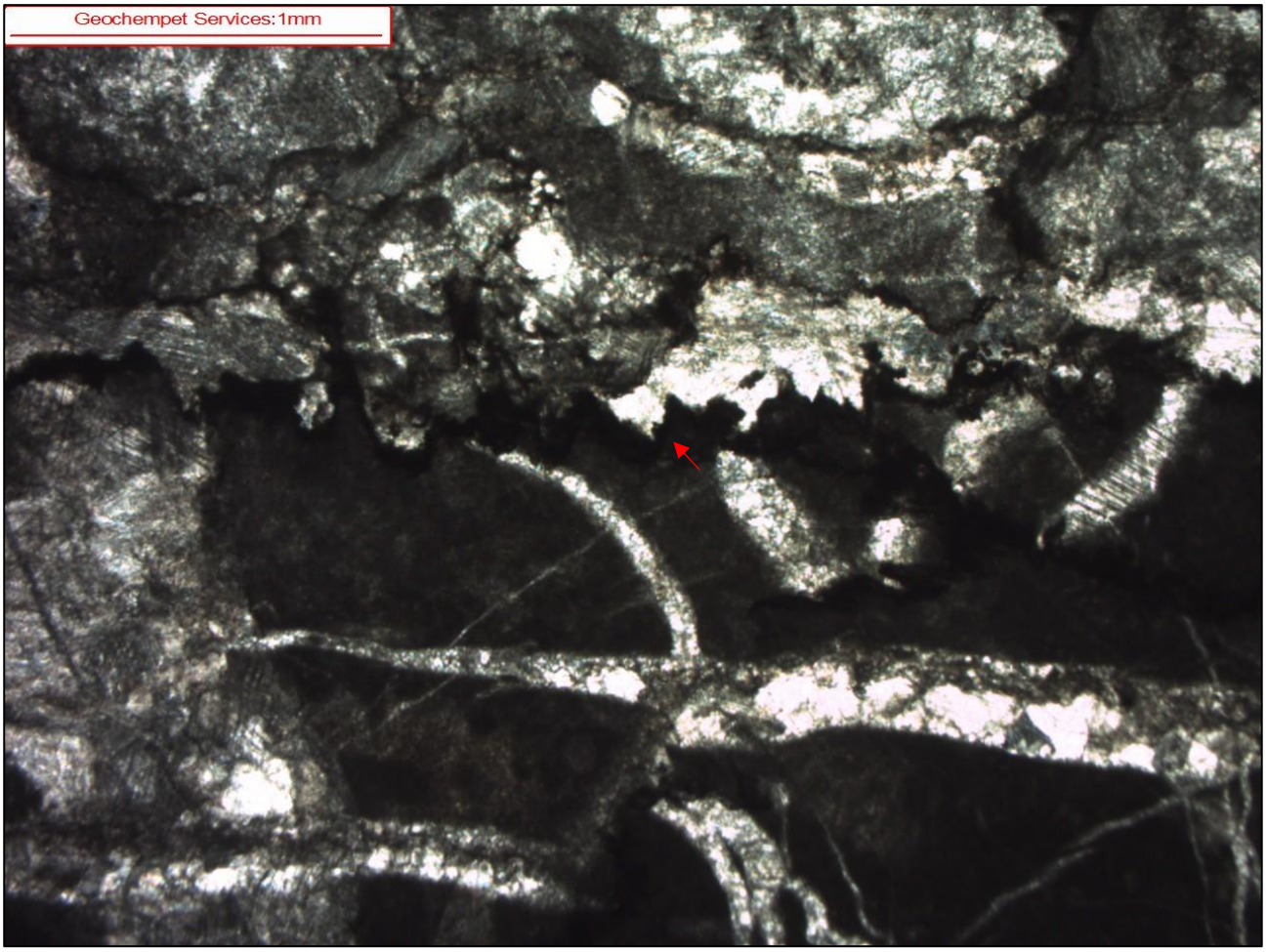


Figure 2: Micrograph taken at low magnification (2× objective) with transmitted cross-polarised light of a limestone fragment. Note the sparry calcite hosted within veins, the micritic calcite in the groundmass and stylolites carrying carbonaceous matter indicated by the red arrow.

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Material Test Report

Superior Quarry Testing Pty Ltd
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ACN: 614 194 900
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Toowoomba Qld 4350
Phone: 0412 694 063
Email: mal@superiorquarrytesting.com

Client:	Graymont (Australia) Pty Ltd
	MS 24 Taragoola Road
	Calliope Qld 4680
Project:	Compliance

Report No:	**9611**
Issue No:	**1**

Sample Details

Sample Number:	8704
Client Reference:	-
Date Sampled:	14/6/2023
Date Received:	22/06/202320/6
Material Source:	Calliope
Material Type:	Source Rock - Coarse Aggregate
Specification:	-
Sampling Method:	Tested as Received
Sampled From:	-
Location:	-
Lot No:	232006
Sampled By:	Submitted By Client

NATA Accredited Laboratory Number:20085

ACCREDITED FOR TECHNICAL COMPETENCE

Approved Signatory: Mal Nicholls

Date of Issue: 11/07/2023

Accredited for compliance with ISO/IEC 17025 - Testing

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Report Notes:

1. The results in this report relate only to the items tested.

2.The results in this test report apply to the sample as received. Sample information was provided by the client.

Testing Completed: 11/07/2023

Test Results

Test Method	Details	Results	Min	Max	Tar
AS1141.6.1	Particle Density Dry (t/m3)	**2.70**			
	Particle Density SSD (t/m3)	**2.71**			
	Apparent Particle Density (t/m3)	**2.72**			
	Water Absorption (%)	**0.2**			
AS1141.22	Nature of Bulk Sample	Crushed Rock			
	Nominal Size of Aggregate (mm)	20			
	Size Fraction of Test Portion (mm)	-13.2/+9.5			
	Dry Strength (kN)	**138**			
	Wet Strength (kN)	**133**			
	Wet/Dry Strength Variation (%)	**4**			
	Breakdown During Preparation	No			
	Size of Test Cylinder (mm)	150			
Q208B	Washington Degradation Factor	**34**			
AS1141.23	Los Angeles Value (%)	**26**			
	Selected Test Grading	B			
AS1141.24	Sodium Sulphate Soundness				
	Nature of Sample	Aggregate			
	19.0 - 13.2mm Loss (%)	0.2			
	13.2 - 9.5mm Loss (%)	0.3			
	9.5 - 4.75mm Loss (%)	0.5			
	Total Weighted Loss (%)	**0.2**			
AS1012.20.1	Qualitative Test- Positive/Negative	**Negative**			
	Chloride Content (%m/m)	**0.000**			
	Analysis Method	Volhard Titration			
AS1012.20.1	Qualitative Test- Positive/Negative	**Negative**			
	Sulfate Content - SO3 (%m/m)	**0.04**			
	Analysis Method	Gravimetric			

Comments:

Appendix K Pest and Weed Management Plan

Weed and Pest Management Plan
Calliope Limestone Operation

Operated by Graymont (Calliope) Pty Ltd

Rev	Date	Prepared By	Comments
1	21/02/11	W. Speirs (SKM)	First draft
2	10/03/11	W. Speirs (SKM)	Second draft
3	22/08/11	N. Ryan (Sibelco)	Third draft
4	15/08/12	N. Ryan (Sibelco)	Updated for new EA
5	29/10/14	E. Leech (Sibelco)	Review
6	08/10/15	E. Leech (Sibelco)	Review
7	13/06/18	C.Bax/C.Mann(Sibelco)	Review
8	20/02/2023	R. Lindner (pitt&sherry)	Review and update

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1 Introduction

Graymont (Calliope) Pty Ltd owns and operates the Calliope Limestone Operation (CLO), which is located approximately 30km south of Gladstone, and 10km southeast of the township of Calliope in Central Queensland.

1.1 Background

The Pest and Weed Management Plan (PWMP) aims to meet the conditions highlighted in the Environmental Authority Permit for site. Further, the PWMP aims to address issues relevant to the management and control of weeds and pests on site. The PWMP is designed to provide consistency with the Environmental Management Plan (EMP) and regulatory requirements.

1.2 Objectives

The objectives of this PWMP are as follows:

- To ensure the safety and health of personnel on the CLO;
- To comply with all relevant legislation;
- To preserve the integrity and structure of the bunds and dam walls;
- To maintain the current biodiversity on the CLO;
- To prevent new established weeds and pest species on the CLO; and
- To control and limit the spread of existing weeds and pests on the CLO

These objectives will provide the framework for evaluating the successfulness of the PWMP.

1.3 Authority / Legislative Details

Environmentally Relevant Activities (ERAs) are activities that will or have the potential to release contaminants into the environment that may cause environmental harm. It is a requirement of the *Environmental Protection Act 1994* (EP Act) and the *Environmental Protection Regulation 2008* (EP Regulations) that anyone who conducts an ERA must possess environmental authority.

The project is approved as a resource activity under Chapter 5, Section 195 of the EP Act.

Two Environmental Authority Permits are effective for this site:

- EA EPML00969013 for all mining leases, and
- EA EPPR00881913 (original permit # SPCE04023712 issued under the Sustainable Planning Act 2009) which covers all of the land held by Graymont including Mining leases and Freehold land.

The Environmental Authority EPML00969013 imposes specific conditions for the management of environmental impacts of the project including the following:

- A weed management plan must be developed and implemented. The weed management plan must describe how the weeds are to be managed in accordance with the Biosecurity Act 2014 and/or local government requirements for weeds not declared under the state legislation.

The Environmental Authority EPPR00881913 makes reference to weed management as it relates to rehabilitation activities only:

- C5: Maintenance of rehabilitated areas must take place to ensure: c) any weed infestations are removed and prevented from reoccurring.

1.4 Commonwealth Legislation

This Section describes the relevant Commonwealth and Queensland legislation that apply to the management and control of pests and weeds.

Agricultural and Veterinary Chemicals Code Act 1994

All pesticides supplied, used or distributed in Australia are registered under this Act by the Australian Pesticides and Veterinary Medicines Authority (APVMA). All APVMA approved chemicals or products have product labels, which contain the required specific information for the usage and application rates. Anyone found guilty of using these products in a way that does not comply with directions on the product label can be prosecuted under this Act.

1.5 Queensland Legislation

Environmental Protection Act 1994

Under the *Environmental Protection Act 1994* (EP Act) and the Environmental Protection Regulation 2008 (EP Regulation) certain environmental features are protected within mining lease areas. These are termed 'environmentally sensitive areas' and include such features as national parks, conservation reserves, wetlands of international importance, heritage places and Endangered Regional Ecosystems (EREs).

All mining and exploration activities in Queensland are conducted under an Environmental Authority (EA) as listed under section 183 of the EP Act. The EA sets out the means by which the activity can occur in order to mitigate impacts to the environment.

Biosecurity Act 2014

Under the *Biosecurity Act 2014*, there are seven categories of restricted matter (such as plants, animal diseases, invasive fish, insects, invasive animals and weeds).

Restricted invasive plants may fall into 1, a combination or all of Categories 2 to 5 (listed below). Under each Category the restricted invasive plant has listed restrictions. The specific restriction requirements also apply to a person when dealing with restricted invasive plants unless they have a restricted matter permit.

Restricted invasive plant categories and restrictions:

- Category 2: the invasive plant must be reported within 24 hours to Biosecurity Queensland on 13 25 23.
- Category 3: the invasive plant must not be distributed either by sale or gift, or released into the environment.
- Category 4: the invasive plant must not be moved.
- Category 5: the invasive plant must not be kept.

Under the Act, certain species of invasive animals are listed as 'restricted' matter. Invasive animals that are listed as restricted matter are already present in Queensland. They have an adverse impact and as a result, restrictions are placed on all dealings with these invasive animals to best manage the risks they pose.

Restricted invasive animal categories and restrictions:

- Category 2: The invasive animal must be reported within 24 hours to Biosecurity Queensland on 13 25 23. Your GBO requires you to take all reasonable and practical measures to minimise the risk of the animal escaping until they receive advice from an authorised officer.
- Category 3: The invasive animal must not be distributed either by sale or gift, or released into the environment.

- Category 4: The invasive animal must not be moved.
- Category 5: The invasive animal must not be kept.
- Category 6: The invasive animal must not be fed.

Nature Conservation Act 1992 and *Nature Conservation (Wildlife) Regulation 2006*

The *Nature Conservation Act 1992* (NC Act) provides for the conservation and management of Queensland's native flora and fauna. The NC Act prohibits the taking or destruction, without authorisation, of listed flora and fauna species.

The *Nature Conservation (Wildlife) Regulation 2006* (NC Regulation) lists the flora and fauna species considered extinct in the wild, endangered, vulnerable, near threatened, least concern, international and prohibited. It states the declared management intent and the principles to be observed in any taking of or destruction for each group.

Nature Conservation (Animals) Regulation 2020 (the Animals Regulation)

The Animals Regulation repeals the:

- Nature Conservation (Wildlife Management) Regulation 2006
- Nature Conservation (Wildlife) Regulation 2006
- Nature Conservation (Administration) Regulation 2017 (the Administration Regulation)

The regulation provides for the conservation and management of protected animals in Queensland.

Nature Conservation (Plants) Regulation 2020 (the Plants Regulation)

The three repealed regulations also contained provisions that applied to the conservation and management of protected plants and administrative requirements for protected area management. These are now contained within the Plants Regulation. The aim of the protected plants legislative framework under the Act is to ensure the survival of viable populations of protected plants in the wild, particularly threatened species or near threatened species, and to identify and reduce or remove the effects of threatening processes.

1.6 Related Documents

Environmental Management Plan

Water Management Plan

Land and Rehabilitation Plan

Ground Control Management Plan

Waste Management Plan

Erosion and Sediment Control Management Plan

1.7 Relevant Stakeholders

Relevant stakeholders are kept informed of activities at CLO as per the Community Engagement Plan. These stakeholders are listed below:

- Gladstone Area Water Board (GAWB);
- Queensland Department of Resources;
- Queensland Department of Environment and Science (DES);

- Resources Safety & Health Queensland (RSHQ);
- Gladstone Regional Council; and
- Nearby residences.

1.8 Management Roles and Responsibilities

The following people are the key Graymont personnel responsible for the implementation and review of this Management Plan.

Table 1: Environmental management responsibilities

Personnel	Summary of Responsibility
Environmental Advisor	• Facilitate and provide technical support for the development of this plan • Provide ongoing technical support for control and monitoring measures described in this plan. • Participate in the annual review of this plan
Regional Operations Manager	• Ensure performance targets specified in this plan are being met • Participate in the annual review of this plan
Operations Manager	• Ensure the implementation of all control, monitoring and reporting measures as specified in this plan • Ensure compliance with site specific requirements • Participate in the annual review of this plan
QSE Coordinator	• Put onsite systems in place to implement all control, monitoring and reporting requirements in this plan • Participate in the annual review of this plan

2 Site Description

2.1 Location

The CLO (site) is situated to the west of Lake Awoonga and allotments held by the Gladstone Area Water Board (GAWB) within the Gladstone Regional Council Local Government Area (LGA). The surrounding area is predominantly forested with some grazing activities. All mining leases are held by Graymont (Calliope) Pty Ltd.

2.2 Flora and Fauna

Prior to mining activities, the site area was used for low to moderate intensity grazing of native improved pasture. The original mixed Eucalypt woodland has been significantly altered by clearing, grazing and mine activities. Other regional changes have been brought about by agriculture and the extensive land inundation caused by Lake Awoonga.

In previous versions of this document, the vegetation communities, as categorised under the *Vegetation Management Act 1999*, present within the site were classified under the following subcategories;

- 11.11.15 least concern, sparse Eucalyptus crebra woodland to open woodland on deformed and metamorphosed sediments and interbedded volcanics.
- 11.11.14 endangered, mid dense Acacia harpophylla open forest on deformed and metamorphosed sediments and interbedded volcanics.
- 11.3.4 of concern, sparse Eucalyptus tereticornis and/or Eucalyptus spp. woodland on alluvial plains.
- 11.3.25 least concern, sparse Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines.

The *Vegetation Management Act 1999* regulates the clearing of vegetation in Queensland in a way that:

- conserves remnant vegetation;
- ensures clearing does not cause land degradation; and
- prevents loss of biodiversity.

The Queensland Government provides statistics on the extent of remnant regional ecosystem vegetation for the entire state of Queensland. The report is based on the detailed regional ecosystem survey and mapping Version 12.2 Regional Ecosystems (2022) and Version 5.0 Bioregions and subregions of Queensland. Derived from The QLD Globe Remnant BVG - 1:1 million layer, the following categories exist over the CLO:

- RVM category X- exempt clearing work on Freehold/Indigenous/leasehold land
- RVM category R- reef, re-growth watercourse vegetation
- RVM category B- remnant vegetation
- RVM category C- high-value regrowth vegetation

3 Environmental Risks and Controls

A summary of risks related to Pest and Weed Management is identified in Table 2 below:

Table 2: Pest and weed risk summary

Activity	Summary of Risk
Weed spread	• Vegetation removal encourages new weed growth • Vehicle movements spread weed seeds • Failure to actively manage weeds (through spraying or otherwise) leads to weed spread
Pest presence	• Inappropriate management of rubbish, recycling and landfill encourages activity by pest species • Failure to actively manage pests leads to increase in abundance

3.1 Potential Impacts

Weeds

Potential impacts of invasive weeds and pest species include safety hazards, loss of habitat for native plants and animals and subsequent loss of biodiversity. Abundant weeds could also impact long term rehabilitation goals. Specific impacts known to be associated with weed species previously recorded at CLO are listed in Table 3.

Table 3: Potential Impact of weeds identified

Common Name	Species Name	Potential Impacts	Status under Biosecurity Act 2014
Balloon Cotton Bush	*Gomphocarpus physocarpus*	Balloon Cotton Bush is known to be poisonous to livestock (DES, 2022).	Environmental Weed
Bellyache Bush	*Jatropha gossypiifolia*	The fruit of the Bellyache Bush is known to be poisonous to both humans and livestock. Can result in a reduction in native biodiversity and pasture growth through the smothering of native species (DAFF 2020).	Restricted (Category 3)
Castor oil Bush	*Ricinus communis*	The seeds of the Castor oil Bush are highly toxic to humans and livestock and the leaves are known to cause neuro-muscular disorders in livestock (DAFF 2020).	N/A
Chinee Apple	*Ziziphus mauritiana*	The species can cause reduction in biodiversity through competing with native plant species. Dense infestations can limit access to area for both native fauna and livestock (DAFF 2021).	Restricted (Category 3)

Common Thornapple	*Datura stramonium*	All parts of the Common Thornapple are poisonous to livestock and humans (NSW WeedWise, 2023).	N/A
Devil's Fig	*Solanum torvum*	Devil's Fig is known to be poisonous to humans, wildlife and livestock (WeedWise, 2023).	N/A
Giant Rat Tail Grass	*Sporobolus pyramidalis and S. natalensis*	Giant Rat's Tail Grass suppresses native grass species, causing loss of biodiversity. The abrasive nature of the leaves causes dental issues in livestock such as cattle and horses (DAFF 2021).	Restricted (Category 3)
Lantana	*Latana camara*	Lantana is known to be poisonous to livestock and some mild skin irriation can occur from contact with Lantana. Can suppress growth of native plants (DAFF, 2020).	Restricted (Category 3)
Leucaena	*Leucaena leucocephala*	Leucaena can reduce biodiversity by suppressing native plant growth (DAFF, 2020).	N/A
Noogoora Burr	*Zanthium pungens*	Seedlings of the Noogoora Burr are known to be poisonous to livestock (DAFF 2020).	N/A
Parthenium Weed	*Parthenium hysterophorus*	Parthenium Weed is known to dominate pastures and supress native species. The pollen from this plant is also a potential allergen that can cause dermatitis and hay fever in humans (DAFF 2022).	Restricted (Category 3)
Prickly Pear	*Opuntia spp.*	This species can reduce biodiversity by suppressing natve plant growth (DAFF 2020).	Restricted (Category 3)

Pests

Potential impacts of invasive pest species include erosion, safety hazards, loss of habitat for native plants and animals and subsequent loss of biodiversity. Specific impacts known to be associated with each species are listed in Table 4.

Table 4: Potential Impact of pests identified

Common Name	Species Name	Potential Impacts	QLD Government Classification
European Hare	*Lepus europeaus*	Hares are known to cause erosion through the depletion of vegetaion (Jarman & Stoft 2008).	Feral Animal
Feral Cats	*Felius catus*	Feral cats prey on local native fauna and provide a vector for ticks (DAFF 2020).	Restricted
Fox	*Vulpes vulpes*	Foxes prey on local native fauna (DAFF 2020).	Restricted
Dingo	*Canis lupus dingo*	Dingoes predate on local native fauna and local domestic stock. They also pose a safety risk in large numbers by signs of aggression through interactions with humans (DAFF 2020).	Restricted
Feral/Wild Dogs	*Canis lupus familiaris*	This species predates on local native fauna and local domestic stock. They also pose a safety risk in large numbers by signs of aggression through interactions with humans (DAFF 2016).	Restricted
Feral Pigs	*Sus scrofa*	Pigs wallowing behaviour destroys vegetation and allows for weed spread and erosion. Feral pigs have damaged the bunds located within the CLO though foraging and wallowing. They are also known carriers of Q-fever (DAFF 2011).	Restricted
Rabbits	*Oryctolagus cuniculus*	Rabbits cause erosion through vegetation loss and are also known to make hazardous conditions for livestock through warren systems within the bunds and stockpiles (DAFF 2021).	Restricted
Rats	*Rattus sp.*	Rats are a hygiene risk around amenity blocks and lunch rooms (BRC, 2019).	Nil
Mice	*Mus musculus*	Mice can cause a hygiene risk around amenity blocks and lunch rooms (BRC, 2019).	Disease Vector

4 Weed Inspection 2012

A site inspection was conducted on the 24 July 2012 by SKM's ecologist to record weed and pest species occurring in the CLO site.

4.1 Weeds

During the site inspection 12 weed species (Table 5) were identified on the CLO. For further information such as the basic ecology, impacts and other general information on the weed species refer to **Appendix A**. The abundance of the weeds present on site was based on field observation. The classification for the abundance is based on the following:

- Rare – isolated individuals located within the CLO;
- Limited – outbreak consisting of several individuals located within a couple of areas of the CLO; and
- Moderate – numerous outbreaks consisting of several individuals located at several locations throughout the CLO.

Table 5: Abundance of weeds on site

Common Name	Species Name	Biosecurity Act Status	Abundance on site
Balloon Cotton Bush	*Gomphocarpus physocarpus*	Non-declared	Limited
Bellyache Bush	*Jatropha gossypiifolia*	Restricted (Category 3)	Moderate
Castor oil Bush	*Ricinus communis*	Non-declared	Moderate
Chinee Apple	*Ziziphus mauritiana*	Restricted (Category 3)	Rare
Common Thornapple	*Datura stramonium*	Non-declared	Limited
Devil's Fig	*Solanum torvum*	Non-declared	Limited
Lantana	*Lantana camara*	Restricted (Category 3)	Moderate
Leucaena	*Leucaena leucocephala*	Non-declared	Moderate
Noogoora Burr	*Xanthium pungens*	Non-declared	Limited
Prickly Pear	*Opuntia spp.*	Restricted (Category 3)	Rare
Rubber vine	*Cryptostegia grandiflora*	Restricted (Category 3)	Moderate
Yellow Bells	*Tecoma stans*	Restricted (Category 3)	Moderate

The pest and weed officer for the Gladstone Regional Council identified an additional two weed species as occurring within the surrounding area, listed in Table 6. For further information on these species refer to **Appendix A.**

Table 6: Potential for weeds to occur in surrounding area

Common Name	Species Name	Biosecurity Act Status	Potential to occur on site
Giant Rat Tail Grass	*Sporobolus pyramidalis and S. natalensis*	Restricted (Category 3)	Moderate
Parthenium Weed	*Parthenium hysterophorus*	Restricted (Category 3)Class 2	Moderate

Giant Rat's Tail Grass and Parthenium Weed both have a moderate potential to occur on site.

These species are known to occur within the locality of the site. However, the vehicle movement throughout and on and off the CLO is on sealed and gravel roads. If these roads where not sealed and there was the requirement to traverse vegetated paddocks the potential to spread and establish on the CLO would be high.

4.2 Pests

During the site inspection, eight pest species (Table 7) were identified to occur within the CLO. For further information on these pest species refer to **Appendix A**. The abundance of the pest's presence on site was based from the field observation and discussion with site personnel. The classification for the abundance is based on the following:

- Rare – species has been known to occur on site but individuals are rarely observed;
- Limited – individuals known to occur on site but not noticed in any significant number; and
- Moderate – known to occur on site and observed on a intermediate basis throughout the Subject Site.

Table 7: Abundance of pests on site

Common Name	Species Name	Biosecurity Act Status	Abundance on site
European Hare	*Lepus europeaus*	Non-declared	Rare
Feral Cats	*Felius catus*	Restricted	Limited
Dingoes	*Canis lupus dingo*	Restricted	Limited
Feral Dogs	*Canis lupus familiaris*	Restricted	Limited
Feral Pigs	*Sus scrofa*	Restricted	Moderate
Rabbits	*Oryctolagus cuniculus*	Restricted	Rare
Rats	*Rattus sp.*	Non-declared	Moderate
Mice	*Mus musculus*	Non-declared	Moderate

The pest and weed officer for the Gladstone Regional Council identified an additional pest species as occurring within the surrounding area. Table 8 provides further details on the additional weed species that have the potential to occur on CLO. For further information on this species please refer to **Appendix A**.

Table 8: Pest species known to occur in the locality

Common Name	Species Name	Biosecurity Act Status	Abundance on site
Red Fox	*Vulpes vulpes*	Restricted	High

The Red Fox has high potential of occurring within the CLO due to the availability of suitable habitat, both within the CLO and adjacent land. The suitable habitat also provides ideal foraging habitat for the Red Fox, such as nesting water fowl and carrion that may result from deceased livestock.

5 Pest and Weed Management Actions

5.1 Roles and Responsibilities

Appendix B contains details of the schedule set for pest and weed management activites on site. Table 9 details the roles and responsibilities of the various stakeholders related to the management and actions of this PWMP.

Table 9: Roles and Responsiblities

Role	Responsibility
Graymont	Inspect the site regularly for declared plants and ensure weed control programs are implemented as necessary Manage independent pest and weed contractors and maintain site records Manage land disturbance to minimise the risk of weed spread
Independent consultant	Monitor and review the effectiveness of the PWMP
Pest Contractor	Implement pest control activities and ensure required specifications are met
Weed Contractor	Implement weed control activities and ensure required specifications are met

5.2 Weed Control Methods

Table 10 lists weed species known to occur on the CLO or in the locality and indicates their appropriate control method and the level of priority given to the need for control. The priority of control is based on the following:

- Low – Species not declared under the Biosecurity Act;
- Medium – Species that are Category 3 weeds or species under the Biosecurity Act that without controls have the potential to negatively impact on biodiversity of the CLO; and
- High – Category 2 declared weed species that are required to be controlled under the Biosecurity Act, and are known to be highly invasive and without controls will have a negative impact on the biodiversity of the CLO.

Table 10: Weed control methods

Weed Species	Priority	Herbicide Application	Controlled Burns	Manual Removal	Integrated Managment
Balloon Cotton Bush	*Low*	✓		✓	✓
Bellyache Bush	*High*	✓		✓	✓
Castor oil Bush	*Medium*	✓		✓	✓
Chinee Apple	*High*	✓		✓	✓
Common Thornapple	*Medium*	✓		✓	✓
Devil's Fig	*Medium*	✓		✓	✓

Giant Rat Tail Grass	*High**	✓		✓	✓
Lantana	*Medium*	✓		✓	✓
Leucaena	*Medium*	✓		✓	✓
Noogoora Burr	*Medium*	✓		✓	✓
Parthenium Weed	*High**	✓		✓	✓
Prickly Pear	*High*	✓	✓	✓	✓
Rubber vine	*High*	✓		✓	✓
Yellow Bells	*Medium*	✓		✓	✓

*Identified as occurring within surrounding area but not identified as occurring on the subject site

5.2.1 Integrated Management

Integrated weed management is a preferred method of controlling weeds within CLO. The idea of integrated management is to use a variety of control methods to accomplish the objectives of the PWMP. The integrated management method is ideal to use across a broad areas that may be constrained by a number or environmental, safety or other concerns that a single management option is insufficient to work effectively and address the concerns.

This method also prevents extensive environmental damage that may result from over use of herbicides or frequent fire control (DAFF 2010). Further this method can prevent the weeds from becoming resistant to herbicides and in some case can reduce the cost of controlling weeds within an area (DAFF 2010). It is recommended that an integrated management approach to weeds is utilised in Subject Site given the proximity of Lake Awoonga.

The EMP contains Land Use Management advice that pertains to the appropriate use of topsoil and land disturbance as it relates to weed management.

5.2.2 Controlled Burns

A controlled burn in areas of sufficient infestation of some weed species is one control measure that may be implemented across the Subject Site. Controlled burns are best commenced in the colder months of the year and have to be conducted in a manner that allows for adequate control of the fire to prevent unwanted damage to neighbouring properties. Controlled burns have a high weed control success when used in conjunction with the application of appropriate herbicides.

Prior to any controlled burns there is a requirement to obtain a Permit to Light from the Rural Fire Brigade and to follow all conditions that accompany the permit. Further to this it is recommended that neighbouring landowner and interested stakeholders such as agisting farmers be given at least 1 weeks' notice prior to the commencement of any controlled burns.

5.2.3 Manual Removal

Where feasible, in areas of infestation that involve isolated individuals, manual removal is an effective method of eradicating the infestation. The overall success of manual removal of weeds is based on the ability to remove any

material that may result in regeneration of the species; this includes but is not limited to root systems, branches, leaves, seeds and other reproductive material. This method has a high labour cost and also has the requirement for high skill- intensity, as there is a requirement to identify young plants and seedlings for removal.

This method is best applied to areas where the species have only recently started to occur or at the end of an intensive treatment regime where there is only isolated plants occurring. For the best results it is recommended that the treatment area is followed up with an appropriate herbicide treatment to ensure that seedlings and germinated seeds are controlled before they mature.

5.2.4 Herbicide Application

Herbicide application is the most commonly used control method for weed species. Herbicide application has proven effective at controlling major and minor infestations of weeds. Herbicide treatments are commonly used in conjunction with other control methods or repeat applications. Herbicide application requires trained, competent and qualified personnel to implement the method. Herbicide applications have several safety and environmental considerations that need to be addressed and therefore herbicides should only be used as directed by the product label and all safety procedures and warnings detailed in the Material Safety Data Sheet (MSDS) should be adhered throughout any application treatment. Further all herbicides to be used on site in weed management will adhere to the relevant requirements under the *Agricultural and Veterinary Chemicals Code Act 1994*. It is further recommended that consideration is given to the toxicity of any herbicide applied to site due to the proximity to Lake Awoonga, a drinking water supply. **Appendix C** provides details of herbacides used on site.

5.3 Pest Control Methods

Table 11 lists pest species known to occur in the locality and their appropriate control method and the level of priority given to the need for control. The priority of control is based on the following:

- Low – species not abundant or rarely have interactions with personnel. These species may have the potential for low health risks to personnel and without control will have a negative impact on the biodiversity of the CLO.
- Medium – species that are Class 2 pests that are not abundant on CLO however if not managed pose a significant risk to the health of personnel and livestock and the safety of bunds, equipment; and
- High – species that are abundant and are known to have interactions with personnel on the CLO. These species pose a significant health and safety risk to personnel, bunds, and equipment and environment.

Table 11: Pest control methods

Pest	Priority	Baiting	Trapping	Hunting	Integrated Managment
Hares	*Low*	✓	✓		✓
Cats	*Low*	✓	✓		✓
Dingo/Feral Dogs	*Medium*	✓	✓		✓
Feral Pigs	*High*	✓	✓	✓	✓
Fox	*Low*	✓	✓		✓
Rabbits	*Medium**	✓	✓		✓

Rats and Mice	*High*	✓	✓		✓

*Identified as occouring within surrounding area but not identified as occuring on the subject site

5.3.1 Integrated Pest Management

Integrated pest management is a preferred method of controlling pests within CLO. The idea of integrated management is to use a variety of control methods to accomplish the objectives of the PWMP. The integrated management method is ideal to use across a broad areas that may be constrained by a number or environmental, safety or other concerns that a single management option is insufficient to work effectively and address the concerns.

This method also prevents extensive environmental damage that may result from some control methods for species such as large scale baiting (DAFF 2010). Integrated management is ideal for pest species as many of these animals are highly mobile or have high fecundity rates (DAFF 2010). These traits allow for pest species to either develop immunity to baits or bio-controls or simply move to adjacent land until ideal conditions return (DAFF 2010). Integrated management is also a useful technique when there are safety concerns or restrictions that may limit the use of management techniques (DAFF 2010), for example fire arm restriction or use of poison near kitchen facilities.

It is also recommended that any integrated pest management is not commenced without consultation with relevant stakeholders. This will allow for a broad scale and co-ordinated approach to management of the target species to ensure successful management.

5.3.2 Baiting

Baiting for pest species is a cost effective and proven management control. Baiting requires trained and qualified personnel to utilise certain baits available for pest control. Pest baiting requires knowledge of what species are being targeted so that appropriate deployment and bait are utilised.

Baiting can also pose a safety risk to personnel, livestock and native wildlife, therefore these are considerations that need to be addressed when considering a baiting regime. Baiting programs work most effectively when population numbers are high and when followed up with alternative treatments or additional baiting.

It is recommended that baiting campaigns be organised through the Gladstone Regional Council. Should further baiting be required outside of the campaigns there will be the requirement to have a permit and the indemnity requirements that are mandatory for baits containing 1080, i.e. Doggone and Pigout. It is recommended that discussion about baiting treatments should be undertaken with neighbouring land owners, Gladstone Regional Council and interested stakeholders (agisting farmers) before undertaking a baiting program. Consultation with relevant stakeholders should allow for the optimisation of results through a co-ordinated approach to the management of the target species.

Appendix D contains Guidelines for Baiting.

5.3.3 Trapping

Trapping is a common alternative to baiting in areas where baiting poses a high risk to humans, livestock or native wildlife. Trapping can be used on a wide variety of species and can, to some degree, be designed to prevent catching non-target species. Trapping for small animals such as rats and mice provides all year management and is very low cost, low labour intensity and no training or qualification are required. In addition these traps provide a humane method of disposing of the pest animals. The traps commonly used form the management of rats and mice are considered humane because when used in accordance with instruction cause instant death without any prolonged suffering.

Trapping for the larger animals such as pigs, dogs, foxes and cats is a method that is best utilised when the objective is to manage low population numbers. This control method requires trained and skilled personnel. The other issue that is face with this method of control is the humane disposal of the pest animal. There are no approved traps for larger animals (cats and larger) that are not live capture and therefore the animals caught will require humane euthanasia through approved methods which would result in the requirement to transport the animal off site as fire arms are prohibited on the subject site.

5.3.4 Hunting

Within the Subject Site active hunting with dogs is used to control feral pigs. This method has proven successful in managing the pig population. This method is very labour and skill intensive but with the restriction of fire arms on the Subject Site this is the most acceptable method to control feral pigs. This method is target specific and does not pose a risk to native wildlife. This method has safety risks and as such should only be carried out by skilled, experienced personnel.

5.3.5 Waste Management

Unmanaged wastes have the potential to attract vermin. The EMP contains controls around waste management as it pertains to the control of pests on site.

5.4 Monitoring

It is recommended that an annual monitoring program is commissioned to determine the current presence of pest and weed species and their abundance within the CLO (Table 12). This should allow for identification of any new species or outbreak areas. This monitoring should further be able to determine the success or short comings of the management actions that have been implemented. It is recommended that any significant findings, such as new pest or weeds species, new outbreaks or any actions resulting from incidents, from the annual monitoring be incorporated into an annual review of the PWMP. This annual review should focus on the success of current management actions and, where required, evaluate the priority of species to be controlled or new species that require control.

Appendix E contains the monitoring schedule for site.

It is recommended that once every five years a major review of the PWMP is conducted to evaluate the currency and effectiveness of the PWMP. This review should incorporate a review of the current PWMP, review of records of management actions e.g. contractor records, past reviews and past mapping of pest and weed outbreaks. The annual monitoring of weed and pest species can be used to inform the major review. It is further recommended that this review is conducted by an independent consultant.

Table 12: Monitoring timing

Management Issue	Timing/Frequency	Description of Monitoring
Land – Weed and pest	Annually	Monitor the spread of declared weed species across the site. Monitor via visual inspection and photographic record. Incorporate weed species spread, type and condition monitoring into site wide vegetation survey as mentioned above.

5.5 Reporting

For the CLO, Graymont is required to record, compile and keep for a minimum of five years all monitoring results required by the relevant environmental authority and make available for inspection all or any of these records upon request.

Graymont use ORACLE by JD Edwards as a reporting system to record and manage incidents on site.

Records should be kept from all weed and pest control activities e.g. herbicide application, baiting and active hunting. These records should be kept in a central location on site for a minimum of five years so to allow for a comprehensive review of the PWMP. The minimum information to be recorded for the control events is:

- Date;
- Location of activity;
- Target species;
- Method utilised;
- Amount of herbicide/bait utilised;
- Area treated; and
- Numbers/area successfully controlled.

5.6 Weed and Pest Management Plan Review

This Plan will be reviewed every two years. The review shall be conducted with the QSE Coordinator, Environmental Advisor and the Operations Manager. The Regional Manager and Environment and Sustainability Manager may also review the Plan depending on the perceived risk of site operations.

The review will involve the review of all monitoring data, complaints and incidents and comparing this data and information to mandatory limits and internal KPI's.

Procedural changes or a review of targets and/or KPI's should be employed if targets are not met.

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Appendix A: Species Fact Sheets

Appendix B: Management Schedule

Appendix C: Site use Herbicides

Appendix D: Guidelines for Baiting

Appendix E: Monitoring Schedule

Appendix L Sediment and Erosion Management Plan

Sediment and Erosion Management Plan

Calliope Limestone Operation

Operated by Graymont (Calliope) Pty Ltd

Rev	Date	Prepared By	Comments
1	19/07/11	W. Speirs (SKM)	First draft
2	30/11/23	R. Lindner / A. Bishop (pitt&sherry)	Updated Draft

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1. Introduction

Graymont (Calliope) Pty Ltd owns and operates the Calliope Limestone Operation (CLO), which is located approximately 30km south of Gladstone, and 10km southeast of the township of Calliope in Central Queensland.

1.1. Background

The Erosion Sediment Management Plan (ESMP) aims to meet the conditions highlighted in the Environmental Authority Permit for site. Further, the ESMP aims to address issues relevant to the management and control of sediment and erosion on site. The ESMP is designed to provide consistency with the Environmental Management Plan (EMP) and regulatory requirements.

The nature of any open mining operation results in the disturbance of the natural ground cover through excavation, stockpiling and machine/vehicle movements. The purpose of the Erosion Sediment Management Plan (ESMP) is to prevent and/or manage sediment movement resulting from any land disturbance from water entering the receiving environment, as is relevant to the current mining operations.
There are a number of control measures that can be implemented on a site to reduce the risk of erosion and sediment movements off-site.

This plan outlines those techniques which best suit the operations of this site. The '*Best Practice Erosion and Sediment Control* (IECA 2008)' guideline has been used to design the required erosion and sediment control devices.

The magnitude of erosion problems experienced by a mine site, are similar to other construction type activities. They are proportional to the area of the site that is exposed / disturbed and the duration to which the area remains in this condition. As the duration of mining operations is generally longer than an average civil project, the implementation of a correct strategy is important. Focus is generally placed on site design, staged rehabilitation and minimising erosion, as opposed to temporary structures.

The management of these long periods of disturbance, and long operation of many erosion and sediment controls, requires a stronger emphasis on some management principles particularly:

- Erosion control, as a pollution prevention strategy,
- Runoff separation by diverting 'clean' stormwater runoff around the site or away from operational areas, and
- Management and maintenance of long-term controls.

1.1.1. Objectives

The objectives of this SEMP are as follows:

- To ensure the safety and health of personnel on the CLO;
- To comply with the relevant guidelines;
- To preserve the integrity and structure of the bunds and dam walls; and
- To maintain the current biodiversity on the CLO.
- To provide protection of receiving environment by eliminating or minimising the impacts of sediment laden water discharges from operations on the surrounding environment and meet community expectations regarding water quality. This can be done by:
    - Identifying, separating and controlling clean, dirty and contaminated water areas onsite;
    - Implementing appropriate erosion and sediment control techniques to suit the mining operations;
    - Ensuring the on-going maintenance and function of the implemented erosion and sediment controls.

These objectives will provide the framework for evaluating the successfulness of the SEMP.

1.1.2. Authority / Legislative Details

Environmentally Relevant Activities (ERAs) are activities that will or have the potential to release contaminants into the environment that may cause environmental harm. It is a requirement of the Environmental Protection Act 1994 (EP Act) and the Environmental Protection Regulation 2008 (EP Regs) that anyone who conducts an ERA must possess an environmental authority.

The project is approved as a resource activity under Chapter 5, Section 195 of the *Environmental Protection Act 1994* (EP Act). Under Section 608 of the EP Act.

Two Environmental Authority Permits are effective for this site:

- EA EPML00969013 for all mining leases, and
- EA EPPR00881913 (original permit # SPCE04023712 issued under the Sustainable Planning Act 2009) which covers all of the land held by Graymont including Mining leases and Freehold land.

The Environmental Authority EPML00969013 imposes specific conditions for the management of environmental impacts related to sediment and erosion:

- C14 Stormwater and water sediment controls
  An erosion and sediment control plan must be developed by an appropriately qualified person and implemented for all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and contamination of stormwater.

Environmental authority EPPR00881913 imposes specific conditions for the management of environmental impacts related to sediment and erosion:

- C1 Topsoil must be:
  a) removed, where practicable, from areas to be significantly disturbed prior to the commencement of extraction activities
  b) stockpiled in a manner that will preserve its biological and chemical integrity

c) used for onsite rehabilitation purposes revegetated when stockpiled, and prior to final use at end of quarry life, to minimise or prevent erosion.

- C5 Maintenance of rehabilitated areas must take place to ensure:
  a) erosion control measures remain effective;

- G4 Erosion protection measures and sediment control measures must be implemented and maintained to minimise:
  a) erosion of soils in areas disturbed by the activity;
  b) the release of sediment to any waters.

1.1.3. Guidelines

For the purpose of designing any required erosion and sediment control facilities, the '*Best Practice Erosion and Sediment Control* (IECA 2008)' guideline will be utilised.

1.1.4. Related Documents

Environmental Management Plan
Water Management Plan
Land and Rehabilitation Plan
Waste Management Plan
Ground Control Management Plan
Erosion and Sediment Control Management Plan

1.1.5. Project Ownership

The tenement mining leases are in the name of Graymont (Calliope) Pty Ltd.

1.2. Site Description

1.2.1. Site Topography, Geology, and Soils

The topography of the land is slightly undulating land that rises approximately 30m above the surface water level of Lake Awoonga Dam.

The site covers approximately 700ha, with approximately 685ha owned by Graymont Pty Ltd. The remainder is owned by the Gladstone Area Water Board (GAWB), who also own contiguous landholdings outside the operations area. With the exception of mining and quarrying activities, the land is put to no active use or is used for rural grazing activities.

The Taragoola limestone deposit comprises a large ore-body of steeply dipping, north-south, striking limestone. The limestone is fine grained to crystalline, light-grey with cream inclusions, very-high strength, fresh to slightly weathered, moderately-jointed to massive. Discontinuities are sharp and generally clean.

Dissolution of the upper surface has created some minor karst features; predominantly a slightly irregular surface, dilated joint apertures, small caverns, and shafts. These features are most obvious to a depth of ≈20m below surface. These features are likely to have negligible detrimental influences on the performances of the walls.

The limestone is overlain by red-brown clayey sand. The cover ranges in thickness from 0.5m to 5m. Where thickest, it contains boulders of limestone up to 1m diameter. Stripping of the upper bench involves stockpiling clean soil north of the pit for future use in rehabilitation and sending bouldery soil to the waste rock dump.

Basaltic to andesitic mafic volcanics have intruded around the site. The most obviously regions are centred north of the pit at 321000E 7333000N and south of the pit at 321500E 7333000N. There have not been many significant intrusions into the section of the ore body being mined; most notable are those on the north and south walls.

1.2.2. Hydrology and Water Storage

The CLO is bound by Lake Awoonga to the east, south and west. Lake Awoonga forms the drinking water supply dam from the surrounding catchment area for the GAWB. To the west of the site is a significant bund wall adjacent to Pit 3 and Pit 4. The water body adjacent to the bund wall is known as Raggote Creek, which is a tributary that flows into Lake Awoonga.

The eastern side of Pit 4 has another bund wall to prevent inundation of the mine site. GAWB has plans to increase the height of this bund wall in anticipation of raising the water level within Lake Awoonga.

Groundwater at the site is hosted by limestone as a variably connected, in places karstic aquifer.
The operation site has three main water storage areas:

- Pit 1 – a non-operational mining pit final void that is backfilled;
- Pit 2 - a water storage used for the supply of water to the wash plant; and
- Pit 3 - a final void pit used for water storage and stormwater capacity during periods of high rainfall. The final land use plan is to keep Pit 3 as a water storage dam for the local community.

2. Relevant Activities

2.1. Project Overview

The CLO conducts limestone mining and extraction to produce a range of agricultural and industrial limestone products for sale. Waste rock is also removed and either stockpiled on site or crushed for use as aggregate in a variety of applications such as road base construction.

Mining activities include topsoil stripping and removal of clay rich overburden and waste rock followed by extraction of limestone ore of appropriate grade and chemical properties suitable for quicklime, hydrate production and other end uses. Suitable limestone ore is then crushed, screened, and washed on site before being transported to customers off site for further downstream processing. Extractive activities are also conducted on site where limestone of different grades and suitable physical properties follow a similar process to mining for the production of road base and aggregates etc.

2.2. Environmental Values

Mining activities of the CLO are conducted within the catchment area for Lake Awoonga. The discharge of sediment laden water from the mining operation into the receiving environment has the potential to impact upon the environmental values of Raggote Creek and Lake Awoonga. Lake Awoonga is a freshwater dam which serves as the drinking water supply for the wider Gladstone Region. Implementation of appropriate erosion and sediment control measures is considered important in the protection of this receiving water body. Water quality is monitored at Monitoring Point C1 and F1 (downstream of sediment dam) to ensure the total suspended solids do not exceed a maximum 100 mg/L (and be less than 110% of the upstream reading at Monitoring Point C2).

2.3. Sources

Potential sources of pollutants relevant to erosion and sediment control include:

- Land clearing
- Topsoil and overburden stripping and stockpiling
- Shot rock loading
- Raw material hauling and tipping
- Crushing and Screening
- Conveying
- Stockpiling
- Rail loading (when being utilised)
- Wind acting on stockpiles and exposed areas

A risk assessment of these activities is provided in Table 1.

Table 1: Activities causing Sediment and Erosion risk

Activity	Location	Hazard	Risk	Likelihood	Consequence	Risk Rating
Blasting	On site	Generation of dust impacting local residences and surrounding land uses. Dust deposition affecting water quality	Complaints from local residences and surrounding land owners. Negative impacts on water quality. Graymont required to conduct complaint-based monitoring.	Unlikely	Moderate	6 - Medium
Movement and handling	On site			Unlikely	Moderate	6 - Medium
Crushing and screening	On site			Unlikely	Moderate	6 – Medium
Transportation of product	On site, Taragoola Road, near rail loading facility	Windblown dust generation impacting local residences and surrounding land uses. Dust deposition affecting water quality		Unlikely	Moderate	6 - Medium
Stockpiling	On site			Unlikely	Moderate	6 - Medium

2.3.1. Extraction

Open cut mining and quarrying are similar operations employing straight forward open cut mining/quarrying methods utilising a dedicated truck and excavator fleet. Vegetation, comprising mostly pasture grass, is removed together with an upper soil layer and stockpiled or used as a final surface layer on spoil embankments to facilitate revegetation. Underlying the surface soil/ clay layer is a clayey limestone strata. This layer is excavated by earthmoving equipment, usually following drill and blast. This material is either spoiled or, if appropriate, stockpiled for later separation of clay and limestone by a heavy duty rock screener.

Underlying the clayey limestone layer is dominantly homogeneous limestone which is drilled, blasted and loaded out by an excavator serviced by a number of ridged dump trucks. A second excavator is on site as a backup for the open cut operations. Drilling and blasting has been conducted at a rate of approximately one blast per week.

2.3.2. Material Handling

Material is hauled either to the Run-Of-Mine (ROM) pad for crushing, or to the stockpiles for screening or designated spoil dumps. Both a wet and dry plant are utilised. Via the ‘wet’ plant, material is washed with reclaimed water from Pit 2 whilst being crushed and screened into various sizes before being washed again. The washed, sized material is then stockpiled before being exported by truck to customers. Water discharged from this process is collected in a settling pond system before entering the wash plant dam.

The ‘dry’ plant sees material first screened by mobile rock screeners to separate oversized material and soils and scalping from the product. The material is then sent through the various crushers and stockpiled according to size.

2.3.3. Transport

Approximately 1.0 million tonnes per annum of limestone products are transported from site by road. The project used to also transport via rail, however this activity is not currently occurring at the project. All limestone products at the CLO site are loaded by wheeled loader into B-double road trucks. The trucks travel north on graded and paved roads to the town of Calliope where they connect to the Dawson Highway.

3. Control Measures

3.1. Planning and Design Strategy

The effectiveness of erosion and sediment controls during the operational and rehabilitation stages can be optimised through effective mine and quarry planning and design. Suitable strategies applicable to the CLO include:

- Designing any drainage systems operating for the life of the mine or quarry so that they do not cause erosion or increase sediment transport. This may involve scour protection of open drains and energy dissipaters located at drain outlets;
- Diverting runoff around the mine or quarry site where possible, to minimise external runoff flowing to operational areas;
- Separately considering sediment-contaminated stormwater from other sources of polluted water such as mine water, or runoff from stockpiles of coal or other mined or quarried product.
- Providing source controls to minimise the sediment load in stormwater, as well as “end of line” controls such as sediment basins to provide water quality improvement prior to offsite discharge
- The streams should be either separated to optimise their treatment prior to discharge or combined as part of an integrated water management strategy.
- Considering stormwater reuse as part of the overall water management strategy for the site to avoid or reduce discharge of polluted water. There are commonly a range of non-potable water uses on a mine or quarry site such as dust suppression and irrigation of revegetation areas. This may be more cost-effective than treatment of polluted runoff and will also reduce consumption from other water.

3.2. Operational Strategy

Whilst it is acknowledged that activities will vary throughout the life of a mine, it should also be accepted that erosion and sediment control measures will also evolve to suite. Erosion and sediment control strategies for mines should normally comprise the following:

- Minimisation of extent and duration of disturbed areas draining to waterways, and prompt revegetation of non-operational disturbed areas (using temporary revegetation if required);
- Ensuring both temporary earthworks and permanent land-shaping provide a landform whichminimises erosion hazard;
- Prompt stabilisation and rehabilitation of land following land-shaping (both temporary and permanent);
- Design of temporary surface-water collection, conveyance and disposal systems in a manner which minimises erosion.
- Ensuring dirty water catchments have appropriately designed and operated sediment basins at their downstream extremities

Where possible, stormwater should be diverted around any active or rehabilitated mine or quarry area. This will minimise both the flow rate and volume of runoff to be handled by on-site water management facilities and enable them to perform more effectively. Runoff from stable rehabilitated areas should also be diverted away from operational areas.

The site supervisor is responsible for maintaining erosion control due to mining operation, stockpiling, maintenance of roads, drains, sediment pits, and as a result of natural stormwater run-off or unseasonal high rainfall events. Sediment control devices such as silt fencing, bunding, berms, diversions and silt pits should be used to collect sediment from flowing outside of the mining lease area.

Stormwater drains, channels and diversions should be used to separate clean stormwater due to rainfall away from disturbed land areas. Disturbed or plant water should not be allowed to contaminate or mix with clean stormwater flow or storage.

3.2.1. Drainage and Diversions

Earth bunds and diversion drains are maintained around the perimeter of the site, particularly on the upslope of excavations, to prevent surface water entering these excavations and mixing clean with dirty water.

The majority of the disturbed catchments within the mining operation are controlled using appropriate drainage and a number of bund diversions. Runoff from the disturbed areas within the mining operation collects in one of the drainage channels. These drainage channels are then directed into either Pits 2, 3 or 4.

There are some bunds located around the site which prevent runoff from disturbed areas entering the receiving environment. In these locations, the bunds act to redirect runoff from disturbed areas back into one of the pits. Pit 3 is the only pit which has an external catchment. The farm dam catchment would have previously drained into Lake Awoonga. However, with the creation of the levee between Lake Awoonga and the mine, this catchment had no outlet. Waters from this catchment may rise and subsequently overtop into Pit 3 during high rainfall events. The only catchment which is not directed to a pit is the sediment basin catchment.

3.2.2. Sediment Basin

The basin located at the C1 discharge point has been sized for using the method for a C-type basin outlined in '*Best Practice Erosion and Sediment Control'* (IECA, 2008).

The following assumptions were made in the calculations in the absence of physical data:

- runoff for the Q-3 month (0.5 x 1 year ARI) was applied;
- approximately 90% of the sediment is larger than 0.05 mm diameter;
- bulk density of limestone used was 28 kN/m^3; and
- the Revised Universal Soil Loss Equation (RULSE) was used to estimate soil loss.
- Clean out frequency of basin is once per year.

The existing sediment basin located upstream of Release Point C2 presents the only possible uncontrolled release point from the site. The basin located at the C2 discharge point has been sized using the CALM method as outlined in 'Soil Erosion and Sediment Control – Engineering Guidelines for Queensland Construction Sites' (IEAUST, 1996).

The following assumptions were made in the calculations in the absence of physical data:

- the run-off co-efficient for the 1 in 10 year AEP event was 70%;
- approximately 70% of the sediment is larger than 0.2mm diameter;
- bulk density of limestone used was 28 kN/m3; and

The Revised Universal Soil Loss Equation (RULSE) was used to estimate soil loss.

The minimum required dimensions for the sediment basin above the discharge point C2 include:

- Dimensions Sediment Pond Surface Area (m2) 23.1
- Length (m) 8.3 Width (m) 2.8 Depth (m) 0.75
- Volume (m3) 17.2

The existing basin has measurements in excess of these recommendations, particularly if the 'Y-drain' which conveys water towards the final basin is included. However, it was observed that the sediment basin had become very full with deposited sediments, and it is recommended that it is cleaned out to provide the appropriate depth as soon as possible.

Releases of pumped void water to natural drainage system will be in accordance with water quality standards, monitoring locations and frequencies as nominated by EA conditions.

3.3. Minimising Land Disturbance

- Land disturbance will be restricted to that which is essential for mining purposes
- Disturbed land will be rehabilitated / revegetated as soon as is practicable to minimise erosionand sediment transport

3.4. Spill and Pollutant Containment

- Spill control equipment is stocked at specific locations around the site for spill response.
- Vehicles to be well maintained to avoid fuel and oil leakages
- Re-fuelling of trucks on site to take place away from drainage lines and in isolated/bunded areas to minimise the risk of environmental contamination and contain spills. Refueling will follow Refuelling Procedures
- Vehicle washdown to be carried out in a designated area so that washings (including concrete washings) will not enter waterways or storm drains
- Fuels, oils and chemicals required for construction and operation to be appropriately stored. Storage in open areas will be bunded to ensure any spills are contained
- Any spillages to be immediately contained and absorbed with a suitable material and disposed in an approved manner.
- Staff to be appropriately trained in procedures for the management of fuel and chemical spills and the location and use of spill kits

3.5. Emergencies

- In the event of imminent flooding, plant and equipment will be moved to the highest accessible points as per 4GN-P21- 12 Flood Emergency Plan
- If leaks are detected or an earthquake felt, 4GN-P21- 13 - Bund Wall Failure Emergency Plan will be implemented.
- If a contaminant release is observed this will be notified to the relevant authority immediately in line with the notification requirements of the EA.

3.6. Water Management and Reuse

To the extent practicable, all water pumped from mining/quarrying operational areas (except for water used for dust suppression) will be directed to the recycle water storage near the processing plant.

Water captured on site is used for dust suppression on haul roads, working benches, hardstands and stockpile areas. Water is applied at a controlled rate to prevent runoff. Water is also used for dust suppression at plant locations and for certain product washing, vehicle washdown, product moisture content control and product transportation. Excess water from product washing activities is directed to settling ponds essentially operating in a closed-circuit configuration.

Water entering Pit 1 and Pit 2 is not pumped offsite, but used for onsite purposes as follows:

- cool fog dust suppression units installed at the Hazemag Feeder and Main Screen House collection bays;
- washing down machinery at the wash down area;
- filling radiators;
- use in the main wash plant;
- dust suppression;
- mixing of wet road bases; and,
- hosing down and cleaning under conveyers.

The nature of this site lends itself to developing effective control measures to minimise the risk of sediment laden waters entering the receiving environment. Where the entrainment of sediments occur in surface water flows, sediment control measures will be necessary to prevent discharge from this site. The site currently does not have any external catchments entering disturbed parts of the sites. The majority of areas that are disturbed have been designed to flow back into the mining voids through appropriate drainage and bunds. A sediment dam is currently in

place to capture and treat runoff collected from the Process Area of the site. Waters from here discharges to Monitoring Point C1.

Table 2: Implementation of Erosion and Sediment Controls

Controls	Timing/ Frequency	Evidence of Implementation
Management of Air-Borne Dust on site	Ongoing	Review and audit of airborne dust emissions on site.
Vehicle operations on site follow Traffic Management Plan (speed, routes)	Ongoing	Review and audit of airborne dust emissions on site.
Deploy water carts to all unsealed roads to reduce the generation of dust from these areas	When required during dry days	Vehicle log detailing number of tank refills
Dust suppression devices installed on operating plant/crushers	When in use	Equipment equipped with dust collectors. Site supervisor daily inspection.
All trucks containing product must not leave the site without trailer covers	Ongoing	Weighbridge operator to report all instances of loads not securely covers to site supervisor.
Stockpiles to be located as far as practicable from residential areas	Ongoing	Site supervisor inspection report and environmental site audit report
Activities which have the potential to cause significant dust emissions should be modified or cease operation under adverse (high wind) weather conditions where sensitive receptors may be impacted.	When required	Start checklist includes details of weather conditions
Continuous visual surveillance of dust emissions to ensure effectiveness of control measures	Ongoing	Report any issue of excessive dust emissions into ORACLE incident and event reporting program
Mobile plant will be maintained to manufacturer's specifications to comply with dust and pollution emission control	Ongoing	Inspections to be recorded on vehicle pre-start inspection sheet
A continuous improvement program is actively undertaken on site to ensure that best work practices are implemented to avoid/or minimise generation of dust.	Ongoing	Regular internal audits of work practices, processes, and environmental objectives. Any corrective actions addressed in the audit are to be entered into ORACLE.
Installation of screens and windbreaks around areas of potential dust emissions	When required	Job start cards and JRAs are undertaken before commencing work to identify the need for screens or wind breaks to avoid excessive dust in work area.
Planting of trees and windbreaks to reduce wind corridors and create barriers to minimise dust emissions on site	As part of rehabilitation plan, or as part of continuous improvement process	Evidence of revegetation in areas that reduce dust emissions. Revegetation of areas will be reported in the Annual Return and Financial Assurance Audit report.

4. Monitoring

For the CLO, Graymont must ensure that a competent person conducts all monitoring where monitoring is a requirement of the relevant project permits.

Table 3 presents the routine monitoring conducted on site to meet OHS and environmental requirements.

Table 3: Care and Maintenance monitoring requirments

Management Issue	Timing/Frequency	Description of Monitoring	Monitoring Method
Erosion and Sediment	Quarterly	Visual inspection of sedimentation pond to ensure basin is free of weeds	Inspection by site supervisor
Erosion and Sediment	When required	Regular cleaning and removal of sediment from sediment collection devices, pits and dams	Following inspection report
Erosion and Sediment	Quarterly	Visual inspection of sediment control fencing to ensure its effectiveness	Inspection by site supervisor
Erosion and Sediment	Quarterly	Rehabilitated areas shall be monitored periodically to check for the possible onset of soil erosion	Inspection by site supervisor

Table 4: Monitoring Requirements when site is operational

Description of monitoring	Timing/ Frequency	Parameters	Monitoring method
Ambient air quality monitoring for TSP at monitoring sites N, SE, SW, and S.	Monthly	TSP (g/m2/month)	Dust deposition gauges using AS/NZS 3580
Monitoring of onsite weather conditions	Continuous	Rainfall, wind speed, wind direction	Onsite weather station
Visual inspection of wind speed and direction	Daily	Wind speed, wind direction	Beaufort wind scale and onsite weather vane. Observations documented in the onsite weather log
Visual inspection of dust suppression devices on equipment as part of prestart checklist	During activities	Device is correctly fitted	Inspections noted in vehicle prestart check logbook. Any defects are tagged out and/or reported to supervisor.
Visual inspection of dust emissions from the primary crushing and screening plant	Daily	Visible dust	Any defects are tagged out and/or reported to supervisor.
Visual inspection of dust emissions from drilling and blasting activities	During activities	Visible dust	Non-compliance with dust emissions will be entered into the incident and corrective action reporting: ORACLE
Visual inspection of dust control measures to ensure correct operation	During activities	Visible dust	Non-compliance with dust emissions will be entered into the incident and corrective action reporting, ORACLE
Site audit of operations by Graymont Advisory team	2 yearly	Audit checklist	Environmental audit procedure. Audit forms to be filed and any actions arising from audit will be entered into ORACLE

4.1. F1 Release Point

Controlled releases are permitted from release point F1. The discharge from F1 is released at a rate of approximately 200 litres per second (the pump capacity). The discharges from F1 are released directly into a rock lined channel. The gravel reduced the velocity and thereby reduces the risk of soil erosion and scour directly below the release point. Further downstream, the discharged water exhibits a laminar flow regime, at which point it enters Lake Awoonga.

The impacts of the mining operation on downstream water quality will be minimised by ensuring any release from the site do not exceed the criteria specified in the EA conditions as outlined below in Table 5.

Table 5: Water Quality Release Criteria

Quality Characteristic	Release Limits	Monitoring Frequency
Electrical conductivity (µS/cm)	900	Weekly during discharge
pH (pH unit)	6.5 (minimum) 8.5 (maximum)	Weekly during discharge
Total Suspended Solids (mg/L)	100 (maximum) Or when measured at C1, F2 or F1 not more than 110% of value at monitoring point C2	Weekly during discharge

4.2. Rail Lay Down Area

Approximately 1.5 km to the west of the CLO is the train lay down area, where pre-washed 40 mm stone is stock piled prior to loading on the trains. The lay down area currently consists of a number of stockpiles of pre-washed 40 mm stone, truck manoeuvring area, drainages and bunds. The truck manoeuvring area is covered in the 40 mm stone as to prevent dirt contamination of the stockpile when loading onto the trains occurs. This will limit the amount of erosion occurring from this surface.

To ensure the on-going compliance with the erosion and sediment control objectives the following is recommended:

- Develop a monitoring program of runoff and / or creek flows to ensure suspended solids are within the identified limits;
- Ensure cover of 40mm stone over truck manoeuvring area is maintained;
- Ensure bunding around lay down area is maintained; and
- Place dumped rock over drains flowing to waterway where scour has or may occur.

4.3. Inspection Requirements

Inspection and reporting requirements associated with the operation of erosion and sediment control measures is important in ensuring their on-going performance. An “Erosion and Sediment Control Inspection Checklist” is provided in **Appendix A**. Notifications of non-compliance will specify the type(s) of non-compliance, the corrective actions needed and a time schedule for achieving compliance.

Normally, routine inspections of the site will be performed on a monthly basis and after heavy rainfall events. A record of device failure / non-compliance and corrective actions taken to prevent recurrence will be maintained.

4.4. Maintenance Requirements

The erosion and sediment control devices will be maintained on a regular basis as directed by the Environmental Manager. Defective devices will be repaired or replaced as required. Maintenance may include replacing structures that are not functioning properly.

4.5. Targets and KPIs

This ESCP aims to minimise and where possible eliminate the potential impact erosion and sediment discharge from the site to the receiving environment. The targets and key performance indicators are outlined below in Table 6.

Table 6: KPIs

Target	Key Performance Indicator
To minimise the impact of construction and operational activities on erosion and the sedimentation of disturbed land, watercourses and water bodies	• Water quality readings in relation to Erosion and Sediment Control are not exceeded at Monitoring Point C1 and F1. • Disturbance is restricted to those areas identified as at risk • Surface water discharges from disturbed areas are captured by sediment control systems or directed to pit. • No active erosion is observable in stabalised areas. • There is no increase in erosion/siltation in downstream watercourses. • The water quality in downstream watercourses and water bodies is within acceptable limits.
To minimise the loss of soil from areas disturbed by mining activities	

5. Reporting

For the CLO, Graymont is required to record, compile and keep for a minimum of five years all monitoring results and make available for inspection all or any of these records upon request.

Table 7 presents the routine monitoring conducted on site to meet reporting requirements.

Table 7: Environmental management responsibilities

Management Issue	Frequency of Reporting	Description	Responsible Authority
Air Quality	Monthly	Dust deposition gauge results	Graymont central monitoring and reporting database
Air Quality	Quarterly	Air emission related environmental incidents	Corporate EHS team

Description of reporting	Frequency of reporting	Reporting tool	Reporting to:
Dust deposition gauge results	Monthly	Monitoring data form	Graymont central monitoring and reporting database
Air emission complaints	Quarterly	ORACLE	Corporate EHS team
Air emission related environmental incidents	Quarterly	ORACLE	Corporate EHS team
Complaint Based Dust Monitoring Report	Within 14 days of complaint	Written advice	Administering Authority
Complaint Based Odour Monitoring Report	Within 14 days of complaint	Written advice	Administering Authority

6. Audit and Review

6.1. Environmental Auditing

Graymont (Australia) PTY LTD is required to carry out third-party audit of the site's compliance with the conditions of the Development Approval. The audit is scheduled every 2 years as per condition A10 of the Environmental Authority (EPPR00881913).

An internal environmental audit program is in place for the existing mining operation at CLO. These audits are used to monitor environmental performance of operations against the risks identified and commitments made within this EM Plan.

6.2. Sediment and Erosion Control Management Plan Review

This Plan will be reviewed every two years. The review shall be conducted with the QSE Coordinator, Environmental Advisor, and the Operations Manager. The Regional Manager and Environment and Sustainability Manager may also review the Plan depending on the perceived risk of site operations.

The review will involve the review of all monitoring data, complaints and incidents and comparing this data and information to mandatory limits and internal KPI's.

Procedural changes or a review of targets and/or KPI's should be employed if targets are not met. Should it become necessary to revise the information and/or control measures described in this Plan because the measures are not adequate or in order to more effectively prevent erosion and sediment control or storm water pollution at the site, the Plan will be amended.

Environmental Inspection Reports (EIRs) will include details about the observations, the responsible party, and when the situation will be mitigated. Findings will be entered into an Action Tracking database maintained by the Environmental Manager or Environment Safety & Health Manager, and the status of open actions will be tracked.

7. Recommendations

Following the review and on-going planning of erosion and sediment control techniques employed on the site the following is recommended to ensure protection of the receiving environment in relation to sediment transport on the site:

1) Ensure drains and bunds around pits are maintained to ensure contaminated runoff is directed into pits, and not release from site.

2) Upgrade sediment basin to comply with the dimensions outlined in **Section 3.5.3**;

3) Ensure the rock lined drain is maintained to manage scour at release point F1; and

4) Ensure monitoring at the prescribed monitoring points C1, C2, F1 and F2 is maintain in order to demonstrate on-going compliance with the requirements of the EA conditions.

To ensure the on-going compliance of the erosion and sediment control objectives at the train lay down area it is recommended:

- Develop a monitoring program of runoff and / or creek flows to ensure suspended solids are within the identified limits;
- Ensure cover of 40mm stone over truck manoeuvring area is maintained;
- Ensure bunding around lay down area is maintained;
- Place dumped rock over drains flowing to waterway where scour has or may occur.

APPENDIX A: Erosion and Sediment Control Checklist

APPENDIX B: Sediment Basin Calculations

APPENDIX C: Site Images

Appendix M Final Landform Design Report

Calliope
PRCP
Final Landform Report

Author: Graymont

Date: 15th May 26

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1. INTRODUCTION

The Calliope Limestone Quarry is operated by Graymont (Calliope) Pty Ltd. The Project involves the operation of an open cut limestone quarry that produces approximately 0.8 million tonnes per annum (Mtpa) of limestone products. The Project commenced operations in 1967 and, noting potential future changes in reserves and yearly sales quantities, has a planned end of mine life (EOML) in 2100. The Project is located approximately 11 kilometres (km) south of the township of Calliope and 30 km south of Gladstone in Central Queensland within the Gladstone Local Government Area.

This report has been prepared to address the final landform design requirements of the Progressive Rehabilitation and Closure Plans Guideline (ESR/2019/4964) and appends to the Rehabilitation Planning Part prepared by Epic Environmental. This report includes discussion on the 3D design plan and methods for closure, limitations and assumptions, considerations for de-risking design and minimising footprint size, material balance, material available for landform rehabilitation, and the waste placement strategy.

2. 3D DESIGN AND METHODS FOR CLOSURE

There are approximately 30 landholders within a 5 km radius of the site; however, based on the topography and the rural location of the quarry, no visual impact from rehabilitation is expected at these sensitive receptors. The quarry is surrounded by grazing land to the north, west, and south, and Lake Awoonga to the east. No feedback was received during community consultation undertaken at the Quarry Open Day on 4 March 2023 that would influence the final landform design.

The long-term stability of the landforms has been considered within design and described further in the Geotechnical Assessment (GA) prepared by Rocktest for the Progressive Rehabilitation and Closure Plan (PRCP) and an erosion assessment included in the Rehabilitation Planning Part. Hydrological and hydrogeological assessments have informed the final landform design. Further discussion is provided in the hydrogeological assessment prepared by Graymont.

2.1 PIT 3-4

Pit 3-4 is the main pit being currently mined at Calliope and will make up the largest void at closure. A mine optimisation study was completed to define the size of the economic pit limits. As the modelled ore body is massive and extends beyond mining leases and other surface constraints, the pit is planned to be mined to the full extent that these constraints allow. For this reason, the final void cannot be reduced in surface area without sterilising viable reserves.

Pit 3-4 is planned to be mined in four stages, with indicative timeframes as follows:

Stage 1- 2027 - 2060

Stage 2- 2050 – 2070

Stage 3- 2060 - 2090

Stage 4- 2080 - 2100

Conceptual plans for the 4 stages are shown in Section 7 - Waste Placement Strategy of this report.

As the quarry produces between 10% and 20% waste material during mining and processing operations, full backfilling of the pit is not considered feasible. Furthermore, due to the depth of the limestone reserve, a minimum volume of rock is required to be mined before access to in-pit backfill room becomes available. Due to limited waste dump capacity in the final Southern Waste Rock Dump (WRD)—resulting from the final 12% slopes—the dump will be temporarily constructed with steeper slopes and regraded at the end-of-mine life.

Excess material placed into the pit void will improve the stability of the pit walls. **Figure 2** shows how the pit is planned to be mined in such a way as to provide in-pit backfill room as soon as practicable to minimise the quantity of waste material required to be spoiled outside the void.

Stage 1 and 2 will occur over 35 years focusing on the northern extent of the Pit. To provide in-pit backfill room at final pit floor level, a large portion of the full pit surface extent will need to be disturbed during Stage 1. Stage 3 will commence approximately 10 years prior to Stage 1 and 2 being finalised. During Stage 3, Pit 3-4 will become one pit, with the eastern and western walls of the central Pit being pushed out to the maximum disturbance extent. Similarly, Stage 4 will commence approximately 10 years prior to Stage 3 being finalised and will involve final mining operations in the southern extent of the Pit.

Vertical and lateral expansion of Pit 4 is projected to occur through a range of cutbacks using conventional drilling and blasting methods on the existing pit. Blasting occurs approximately once a month within the confines of ML3594, ML3604, ML3608 and ML80190, and trucks transport loose material from Pit 4 to the ROM pad for processing. To efficiently mine Pit 3-4, access roads must be maintained above the eastern and western sides of the pit for the life of mine. Expansion of Pit 4 is proposed to occur in four stages from north to south, over a period of approximately 68 years. Expansion will involve widening Pit 4 to the final east and west limits and progressing to the south, with Pit 3 being amalgamated with Pit 4 to form the final pit shell. A south-to-north mining approach has also been considered in the final landform design report.

As mining progresses, undisturbed areas will need to be stripped, and topsoil stockpiled in zones adjacent to mining. Stockpiling areas will be spread out around the pit limit to allow for efficient rehabilitation.

The final Pit 3-4 void dimensions will be approximately 1,700m long, an average of 650m wide, and up to 117m deep. Following further pit optimisation, it is possible that an updated design will propose to mine deeper than the current pit limit of -56mRL, as ore exists below this level. Overall toe-to-toe slope angles are designed to be less than 38 degrees to comply with the GA. This void will be largely filled with water following closure.

Backfill in the Pit 3–4 void will be mostly constructed using waste material from mining, processing, removal of the Northern Waste Rock Dump, and reprofiling of the Southern WRD at the EOML. Backfill is not required to provide stability of the final pit slopes; however, it will generally be placed in layers less than 10 m thick and either tracked with dozers or wheel-rolled with trucks to provide a level of compaction. Consideration will be given to spreading the backfill over a larger surface area to provide broader toe support for the final pit slopes.

Pit structures will not require a lining to prevent water or air ingress, as the pit is planned to be flooded and there is no contaminated or acid generating mine waste material within the pit void (refer to the Waste Characterisation report appended to the PRCP).

An abandonment bund has been allowed for as close to the final pit crest as practicable, considering geotechnical setback recommendations. These bunds are designed to be constructed out of well graded coarse limestone in accordance with GA recommendations and will help to prevent inadvertent access to the void following closure.

As described in the GA, some of the strategies employed in the closure plan to de-risk the final landform are:

- Installing abandonment bunds behind the crests of each pit.
- Reducing batter angles on sections of the upper benches comprising extremely weathered rock and soil.
- Installing a lockable gate to prevent unauthorised access to the void.
- Filling karst caverns and covering stripped ground with broken rock.
- Installing warning signs around the pits and restricting public access to the site.

2.2 PITS 1 AND 2

Pit 1 was a small void located to the northeast of Pit 3–4 and has been backfilled with waste material from operations. The final landform of this area will be flat to gently inclined to make it suitable for grazing as the post-mine land use.

Pit 2 is an historic void mined from the mid-1960s until the mid-1970s. The pit is used to store water for operation of plant and facilities and therefore will be required to remain as a void until EOML. The pit is 435 m long, 235 m wide and approximately 37 m deep. At the end of operations, the upper slopes will be regraded in accordance with the GA recommendations, and the pit will be allowed to fill with water.

2.3 SOUTHERN WRD

The Southern WRD will be constructed initially up to a maximum height of 100mRL. This will provide temporary capacity for excess pit waste while in-pit dump capacity is being developed. Dump construction will generally be undertaken using a bottom-up approach in layers. The temporary footprint will partially overlap with the Pit disturbance area at the southern end of the pit, but before this area is mined, the overlapping material will be backfilled into the pit, as the pit floor will be established by that stage. A drain will be constructed at the toe of the dump to allow water from the south and east to drain to the north into the Pit3-4 void, to manage the risk of ponding. An indicative cross section of the drain is shown in **Figure *1***. At the EOML, the Southern WRD will be reprofiled to a maximum height of 25m (63mRL) and will have slopes less than 12 percent. Stability of the final landform will be achieved in accordance with the recommendations in the GA.

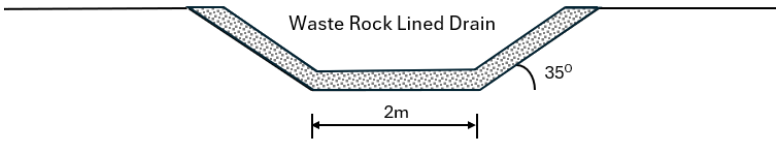


Figure 1. Indicative Southern WRD toe drain

The final Southern WRD footprint within the mining lease is 15.8 ha. Access tracks around the base of the dump have been included to provide access to the drainage infrastructure for maintenance, as well as to other parts of the site, primarily for monitoring purposes. There is also a progressing topsoil storage area adjacent to this footprint, so the material is readily available for rehabilitation of this area.

The cores of the outer slopes of the dump will be constructed in a series of lifts from the bottom up, beginning on the natural surface. The procedure will compact the materials, so they achieve their greatest practical strength and lowest practical permeability, as follows:

1. Strip topsoil and vegetation from the natural surface.
2. Dump waste materials from trucks into piles.
3. Spread the material in a near-horizontal layer as thin as practical.
4. Moisture-condition the material (i.e., dampen it).
5. Compact the material using repeated passes of equipment until no further compaction occurs.
6. Repeat steps 2 to 5 for subsequent lifts.

The slopes are advanced in the same direction as the topography. No major drainage paths are blocked by the toes of the dump. As the Southern WRD is designed for grazing, the slopes have very high factors of safety, as indicated in the GA.

After the EOML, the principal strategies to reduce the risks applicable to the Southern WRD will be:

- Ensuring all slopes have acceptable stability and that the toe of the northern slope is sufficiently distant from the crest of the south wall of Pit 4.
- Visually monitoring the performance of the dump over the medium to long term to confirm that the design continues to perform acceptably.
- Being prepared to modify plans, designs and/or site works if the dump deviates from the design or its performance does not comply with the completion criteria.

Other completion criteria for the Southern WRD are shown in tables 9 and 10 of the GA.

2.4 VOID CLOSURE PLAN

Geotechnical requirements for void closure are considered in the GA.

3. DOCUMENTED TESTING REGIME

The documented monitoring regime is described in the GA and is shown in **Table *1*** below.

Landform	Rehabilitation milestone reference	Rehabilitation milestone reference	Milestone criteria
Residual voids (Pit 2 and Pit 3-4)	RM3	Landform development and reshaping / re-profiling of residual void	• An Appropriately Qualified Person (AQP) has confirmed that geotechnical stability of the residual void walls (i.e., a factor of safety value of ≥1.2) has been achieved. • Pit 3-4 batter slopes meet final design specifications (18° in weathered rock, 65° in unweathered rock) • Pit 2 maximum overall slope angle meets final design specifications (34°) • Perimeter abandonment bund and safety signage installed offset, as specified by an AQP, from the crest of the voids • Locked gates and signage installed at access points to the residual voids to prevent unauthorised access • AQP certifies that void final landform design intent has been achieved
	RM10	Achievement of post-mining land use to stable condition (water storage)	• Visual inspection by an AQP provides evidence that the stabilities of the residual void crests and walls have remained constant or increased following cessation of mining and rehabilitation activities
Southern WRD	RM4	Landform development and reshaping / re-profiling of waste rock dump	• As built inspection by an AQP confirms that the final landform design intent has been achieved, and batter slopes do not exceed 12%
	RM11	Achievement of post-mining land use to stable condition (grazing)	• Visual inspection by an AQP provides evidence that the geotechnical stability of the Southern WRD has remained constant or increased following completion of rehabilitation activities

Table 1: Proposed geotechnical rehabilitation milestone criteria for the residual voids and Southern WRD at Calliope

4. LIMITATIONS AND ASSUMPTIONS OF THE FINAL LANDFORM DESIGN

Quarrying activities in Future Pit 3-4 will continue for approximately 80 years until the EOML in 2100. Therefore, waste percentages and calculations for available reserve volumes including identifying further reserves, will be updated periodically over the LOM. A detailed mine plan is prepared for Calliope for a five-to-ten-year period, and it is likely that future mine plans and unforeseen mine parameters might delay or change intended schedules for Future Pit 3-4.

Assumptions have been made about these mine parameters, including the extent of known reserves, future changes in saleable product quantities, and other variables that may impact operational mine scheduling and, consequently, rehabilitation scheduling, for the purposes of providing the required information for the Calliope Limestone Quarry PRC Plan. It is noted that conservative estimates of the LOM, with an EOML of 2100, have been prepared based on the material balance and final landform design. However, if refinements from future calculations affect when Pit 3–4 can cease quarrying activities, an amendment to this PRC Plan will be required to ensure consistency with mine planning.

5. MATERIAL BALANCE

The material balance for the current LOM design as of the 21 Nov 25 survey is shown in **Table 2**. The total waste quantity has been calculated from the 2025 geological block model. It is noted that the actual waste generated over time may vary from that predicted in this model based on geological uncertainty, ore recovery and markets for ore and waste products.

The material balance shows that the full Interim Southern WRD volume of 3.5 Mm3 is required to provide time to create in-pit backfill room. Depending on actual waste volumes the final interim WRD volume may be smaller than shown in **Figure 3**. It is assumed that some in-pit backfill room will be available prior to completing each cut stage as shown in **Table 2**.

Calliope LOM Plan Cut vs Fill Material Balance							
Cut			Waste Rock Dump Capacity				
Location	Description	Waste lcm	Southern WRD Interim m3	Stage 1 Floor m3	Stage 2 Floor m3	Stage 3 Floor m3	In-Pit North & In-Pit South Dump m3
			3,461,700	**653,185**	**1,593,267**	**2,446,138**	**5,280,430**
Stage 1	Stage 1 cut to Southern WRD	3,626,388	3,461,700	164,688			
Stage 2	Stage 2 cut to Stage 1 floor	713,715		488,497	225,218		
Stage 3	Stage 3 cut to Stage 2 floor	1,684,456			1,368,049	316,407	
Stage 4	Stage 4 cut to Stage 3 floor	3,482,260				2,129,731	1,352,529
Northern out-of-pit WRD	Northern out-of-pit WRD to Stage 4 floor	1,081,159					1,081,159
Southern WRD reprofile	SWRD to Southern in-pit dump	2,732,709					2,732,709
	Dump balance remaining room		-	-	-	-	**114,033**

Table 2: Calliope Material Balance

6. MATERIAL AVAILABLE FOR LANDFORM REHABILITATION

Material available for landform rehabilitation is overburden from the upper 5-30m and waste material from the processing of the limestone. Total waste is expected to be in the vicinity of 10 to 20 percent of the total mined quantity. The approximate waste produced from the site including existing waste that needs to be relocated from 2026 to the EOML is shown in **Table 2**.

No material will be required to complete rehabilitation of Pit 2 and Pit 3-4. The Interim Southern WRD will be formed by truck and excavator using a series of fill tip heads and benches with overall toe to toe slopes less

than 35 percent. At the EOML once the Pit 3-4 floor has been achieved the dump will be reprofiled to 12 percent. As the overburden rock in this area will be used to form the final landform, no other additional material is required. Topsoil quality is considered further in the main PRCP document.

7. WASTE PLACEMENT STRATEGY

The conceptual LOM quarry and dump staging is shown in figures 1 to 7 below.

7.1 PIT 4N CUT STAGE 1 AND SOUTHERN WASTE ROCK DUMP

Pit 4N Cut Stage 1 focuses on the northern end of Pit 4 to provide a void for the placement of in-pit backfill, as shown in **Figure 2**. During this stage, backfill will be placed in the Southern WRD to the full dump footprint extent, as shown in ***Figure 3***. It is possible that a small amount of material may be able to be placed in the pit prior to mining the full Stage 1 block.

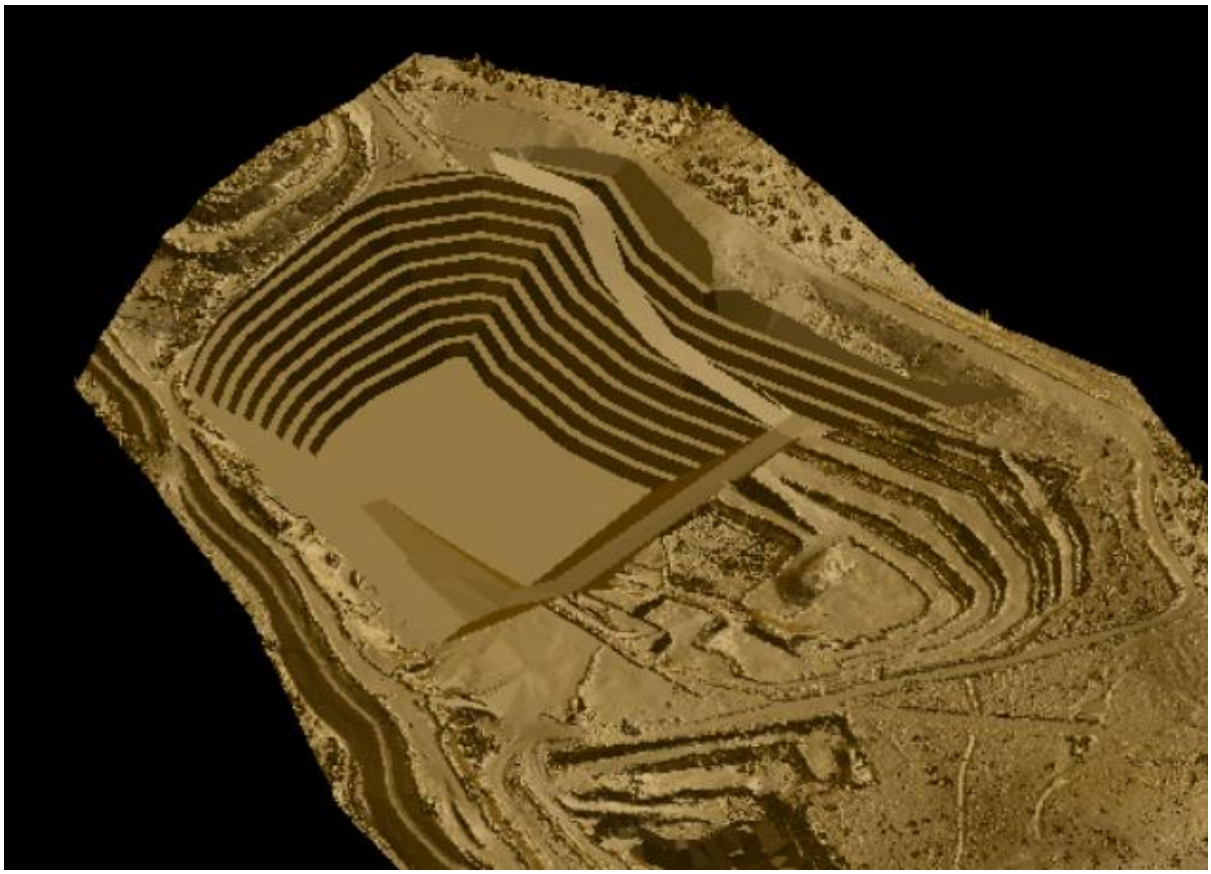


Figure 2. Pit 4 Cut Stage 1



Figure 3. Southern Interim Waste Rock Dump

7.2 PIT 4N CUT STAGE 2 / INPIT BACKFILL STAGE 1

Pit 4N Cut Stage 2 expands the Stage 1 cut to the south. This material is placed in the void that was created during Cut Stage 1 as shown in **Figure 4**.

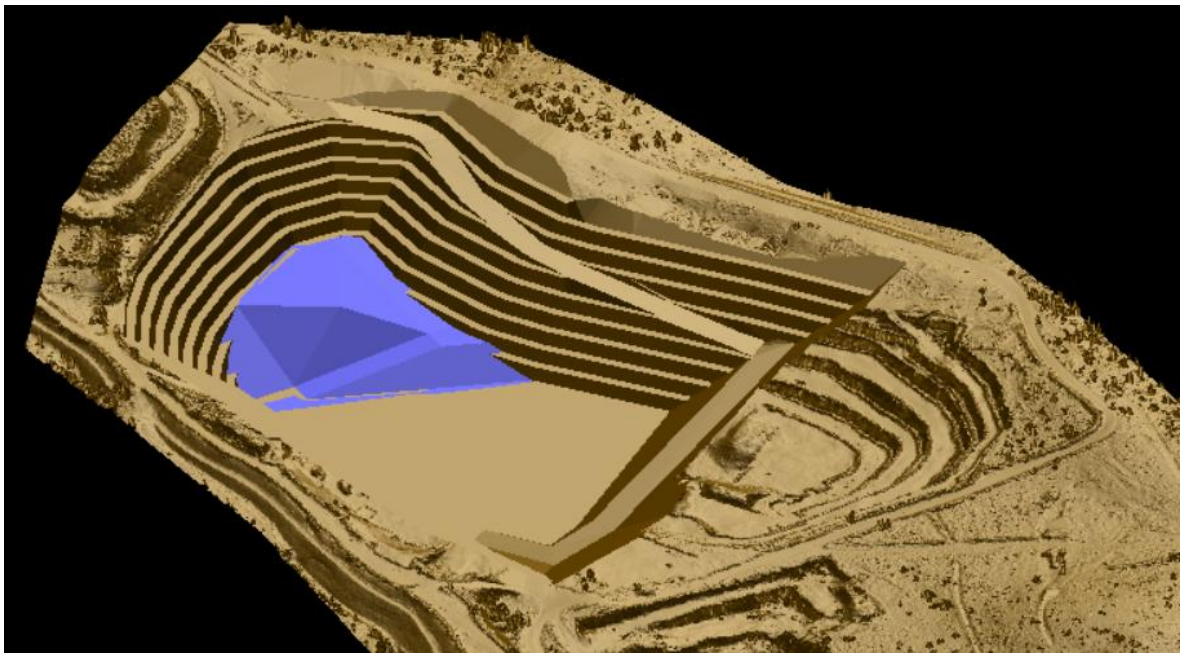


Figure 4. In-pit backfill after Pit 4N Cut Stage 2.

7.3 PIT 4N CUT STAGE 3 / INPIT BACKFILL STAGE 2

Pit 4N Cut Stage 3 widens the Stage 2 cut to the south. This material is placed in the void create during Stage 1 and 2 Cuts as shown in **Figure *5***. Access is maintained to the southern upper benches with a south-eastern ramp.

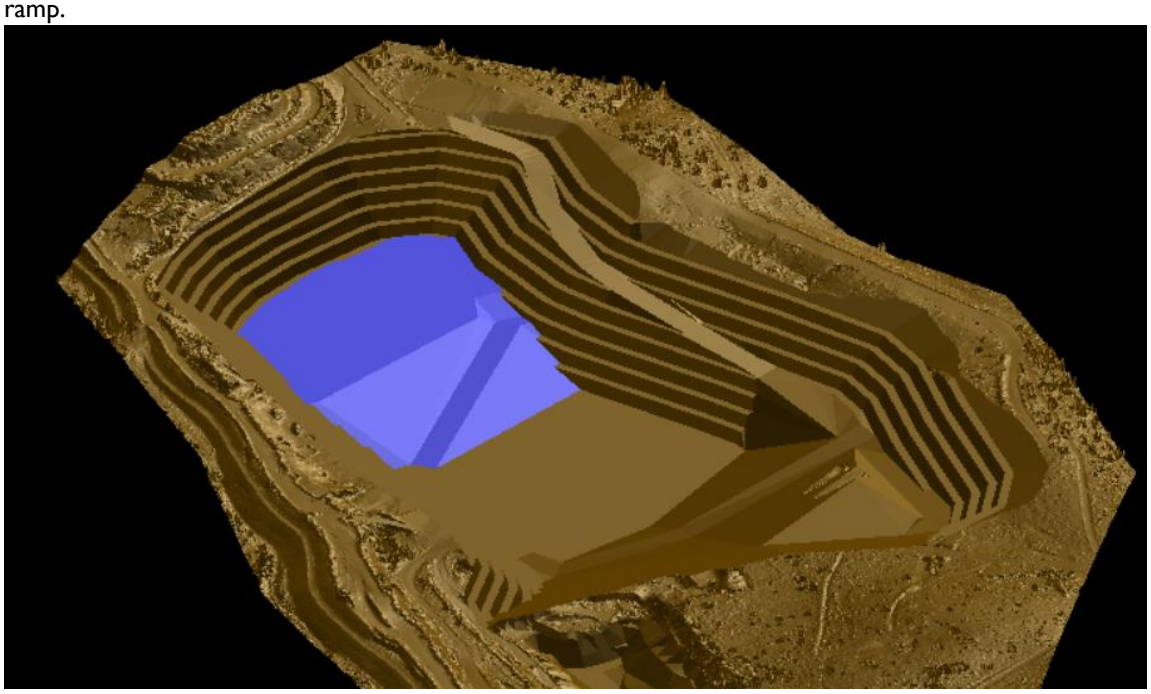


Figure 5. In-pit backfill after Pit 4N Cut Stage 3

7.4 PIT 4N CUT STAGE 4 / INPIT BACKFILL STAGE 3

Pit 4N Cut Stage 4 removes the highwall between Pit 4 and Pit 3 and completes mining of the combined pit to full extent. This material is placed in the void created during Cut Stage 3, as shown in **Figure 6**.

A void will remain in the southern end of the pit down to -56mRL as backfill cannot be placed on the floor while mining is still occurring during Cut Stage 4.

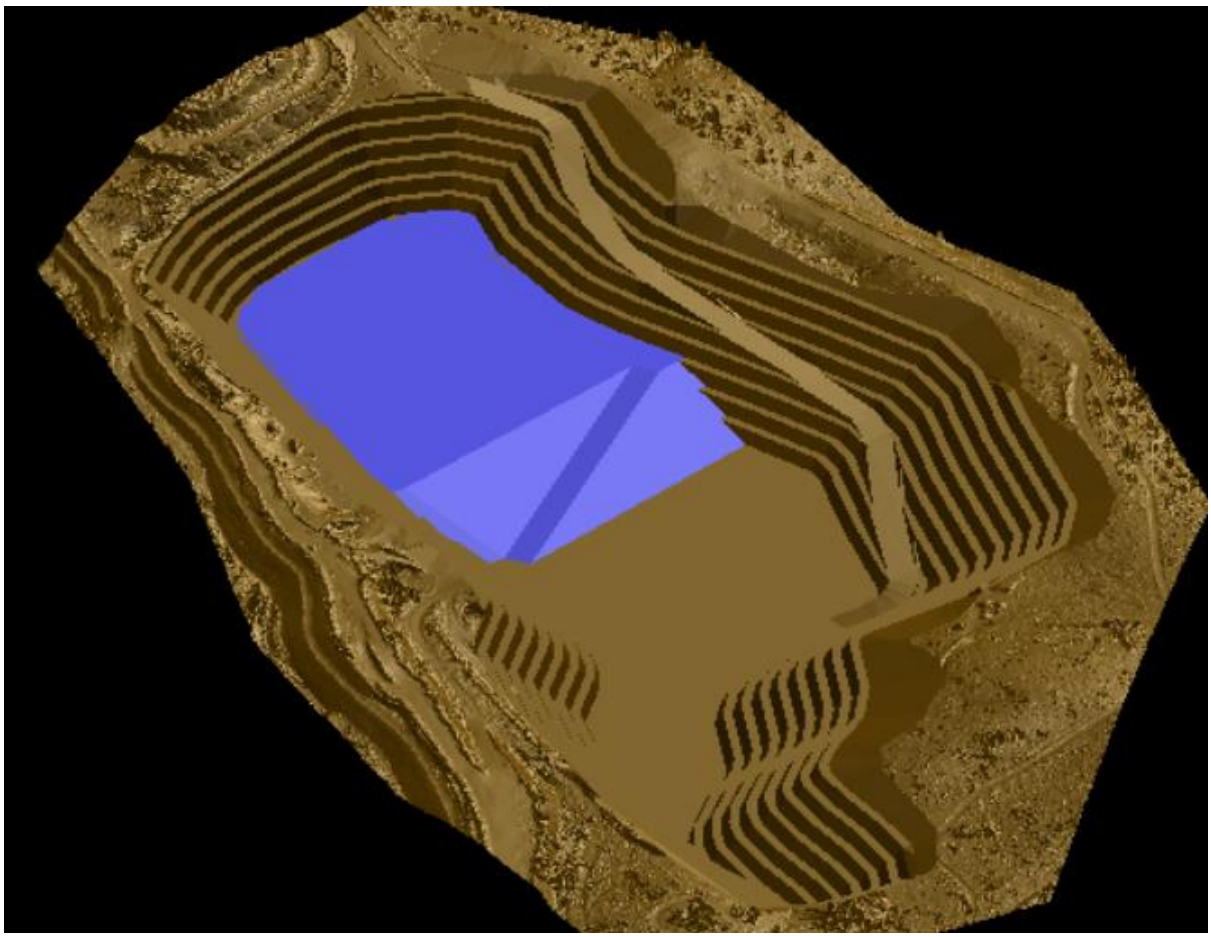


Figure 6. In-pit backfill after Pit 4N Cut Stage 4

7.5 NORTHERN OUT OF PIT DUMP, LAYDOWN AND ABANDONMENT BUND

During the final stages of mining, the northern out of pit dump and northeastern face of the Interim Southern WRD is backfilled into the northern end of Pit 4, the laydown area is levelled and abandonment bund construction commenced as shown in **Figure 7**.

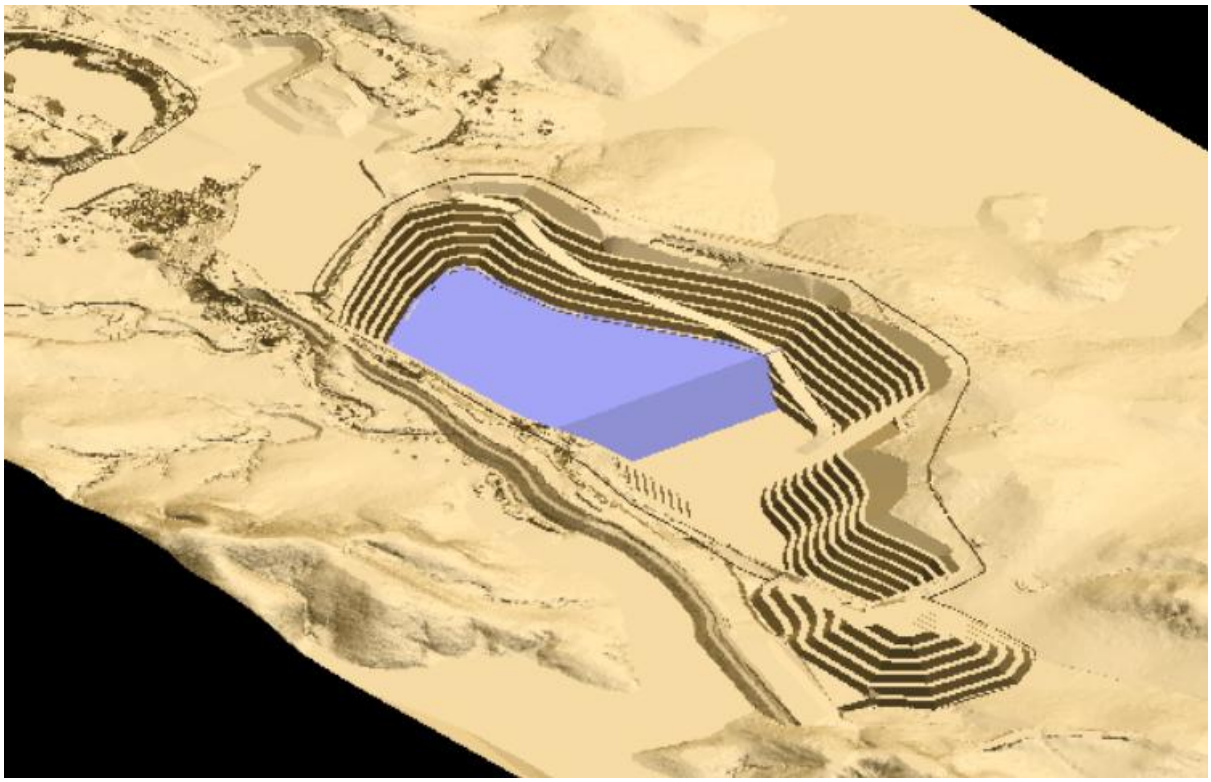


Figure 7. In-pit backfill at EOML, removal of the northern out of pit dump and interim northeastern Southern WRD face, and levelling laydown area

7.6 REPROFILING SOUTHERN WASTE ROCK DUMP

At the EOML the Southern WRD is reprofiled, so the slopes are less than 12 percent. Any excess material will be placed in the Pit 3-4 void. The amount of excess material and size of the southern in-pit dump will vary depending on the actual quantity of waste produced during operations. Finally, an abandonment bund will be constructed around the top of Pit 2 and Pit 3-4 as shown in **Figure *8***.

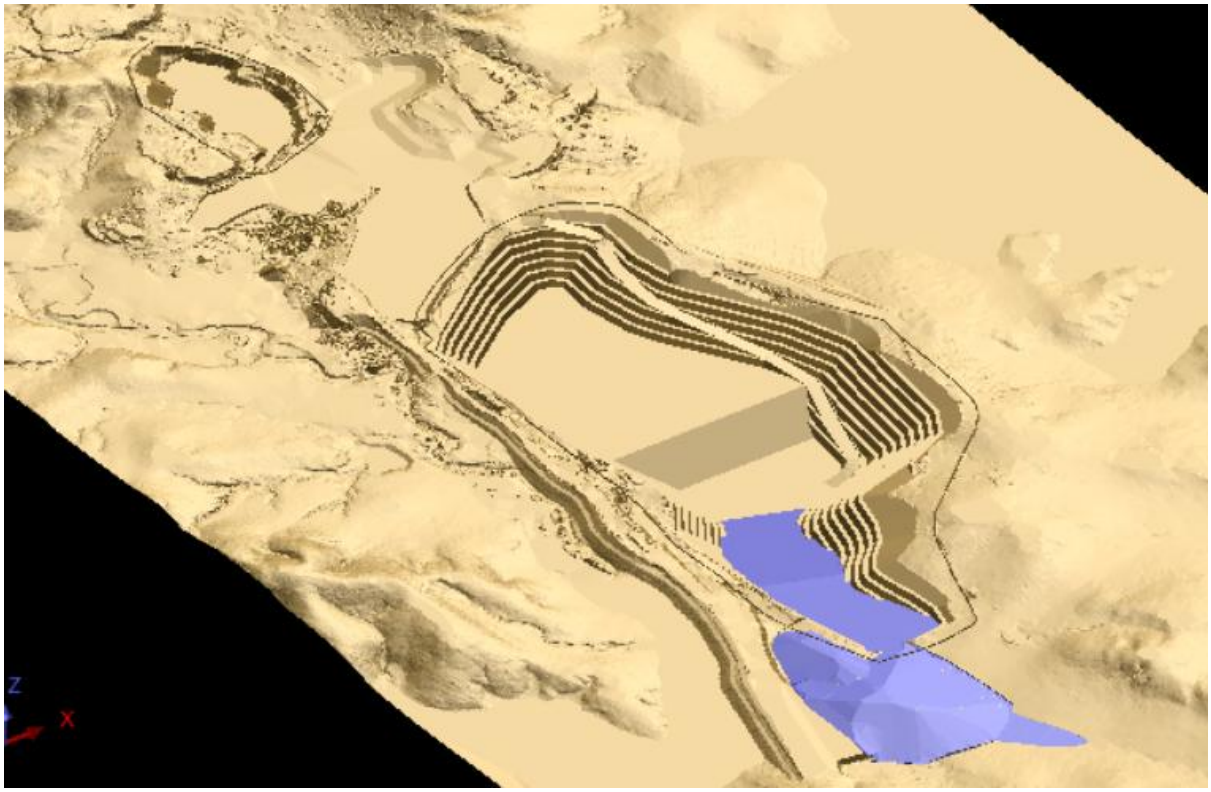


Figure 8 Reprofile Southern WRD, southern in-pit fill and abandonment bund

7.7 OPTION 2 WORKING THE PIT FROM SOUTH TO NORTH

Pit 3-4 may also be worked from south to north rather than north to south. To determine the best direction to mine the pit further consideration will be given to potential added limestone reserves in the area, water management of Pit 2 and further economic assessment of N-S and S-N scenarios.

A south to north mining direction will follow a similar strategy as described in figures 1 to 6 but in reverse. The southern end of the pit will be mined first to establish in-pit backfill room. Waste generated during this phase will be placed in the Southern WRD.

8. FINAL LANDFORM

The proposed final landform at closure is shown in **Figure 9**.

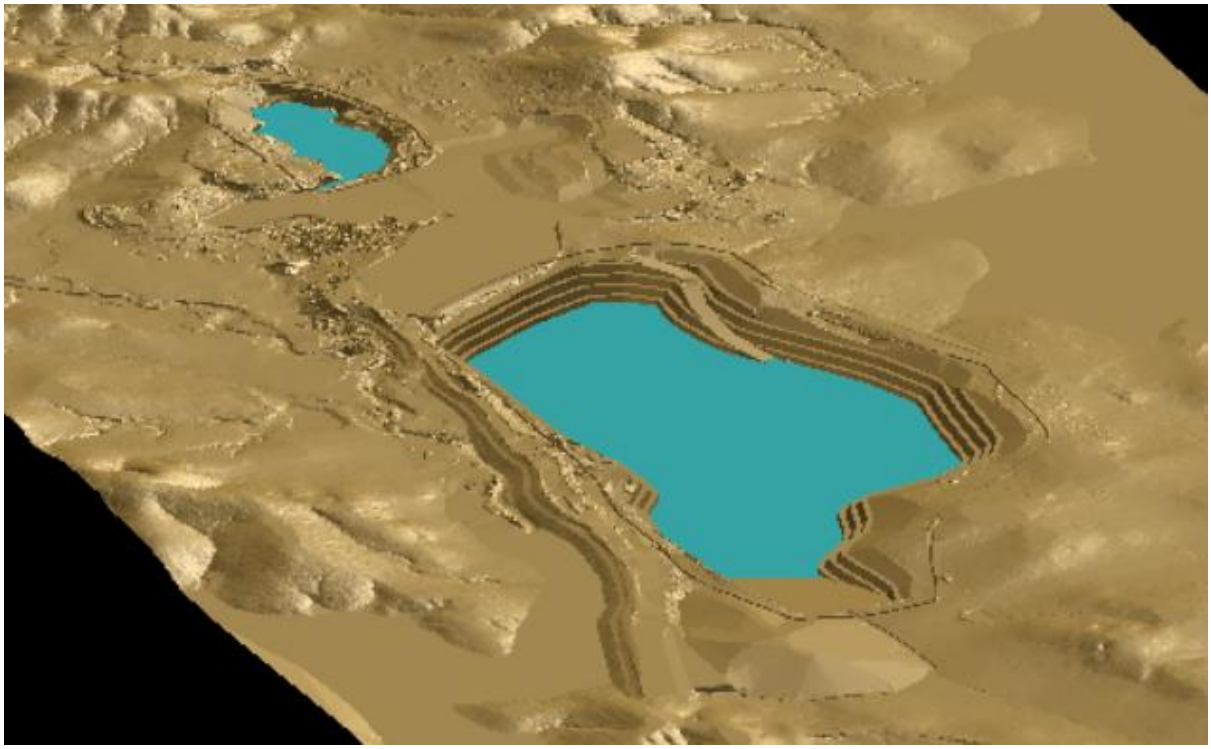


Figure 9. Final Landform

Appendix N Ecological Assessment



Ecology Field Report

Graymont
Calliope Limestone Quarry
Calliope
BAA220009.01
9 June 2025

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1 INTRODUCTION

This Ecology Field Report has been prepared on behalf of Graymont (Australia) Pty Ltd (Graymont) to support the legislated environmental approvals process for the Calliope Limestone Quarry (the Project), located in Central Queensland. The Project involves the operation of an open cut limestone quarry that produces approximately 0.8 million tonnes per annum (Mtpa) of limestone products annually. The Project commenced operations in 1967 and, noting potential future changes in reserves and yearly sales quantities, has a planned end of mine life (EOML) in 2100.

1.1 Project Location

The Project is located approximately 11 kilometres (km) south of the township of Calliope and 30 km south of Gladstone within the Gladstone Local Government Area (LGA) (refer **Figure 1**). The current and proposed disturbance areas are displayed in **Figure 2** and **Figure 3**.

The Project has approval under Environmental Authority (EA) EPML00969013 which covers the following Mining Leases (ML): ML3594, ML3595, ML3596, ML3597, ML3598, ML3599, ML3600, ML3602, ML3603, ML3604, ML3605, ML3606, ML3608, ML3609, ML80036, ML80189, ML80190, ML80191, ML80192 (the Project area). The Project also has approval under EPPR00881913 for the following Environmentally Relevant Activities (ERAs):

- ERA 8 (3a) - Chemical storage >10m^3 but 1,000,000 tonnes (t) of material
- ERA 16(2)(d) – Extracting, in a year >1,000,000 t of material
- ERA 16 (3c) – Screening in a year >1,000,000 t of material
- ERA 50 (2) - Bulk material handling >100 t day

1.2 Scope and Purpose of Assessment

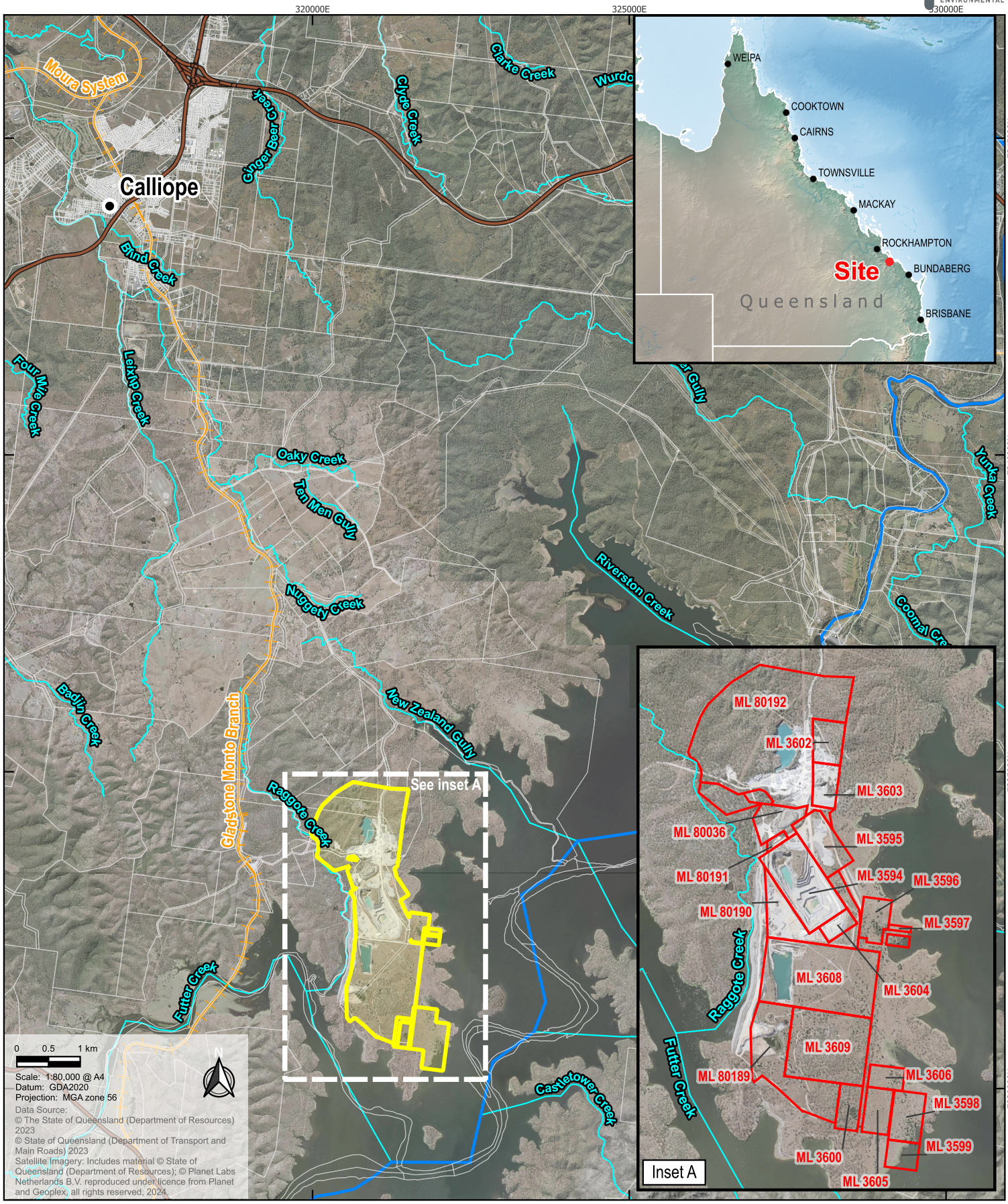
The purpose of this report is to document the baseline terrestrial ecological values of the Project area and provide avoidance, mitigation and management measures to adequately address impacts associated with the Project. The scope is defined as including the MLs listed in **Section 1.1**.

The description of baseline ecological values has been documented to support an application for an amendment to an existing Environmental Authority. Graymont are seeking to amend EA EPML00969013 for the Project via a major EA Amendment under the *Environmental Protection Act 1994* (EP Act), to address the discrepancies in disturbance areas and activity types for the mine until end of mine life (EOML).

Epic was engaged by Graymont to undertake terrestrial ecological surveys for the Project. The scope of this report includes a description of the terrestrial fauna and flora species and habitats within the Project area. The assessment includes an analysis under relevant State guidelines of the potential for significant residual impacts to the following:

- Matters of State Environmental Significance (MSES) as identified as Prescribed Environmental Matters (PEMs) under Schedule 2 of the *Environmental Offsets Regulation 2014* including conservation significant species and identified species habitat areas, listed vegetation communities, waterways and wetlands

The potential requirements for environmental offsets will be identified where significant residual impacts are identified as likely occurring to identified environmental matters as a result of the Project's activities.



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Legend

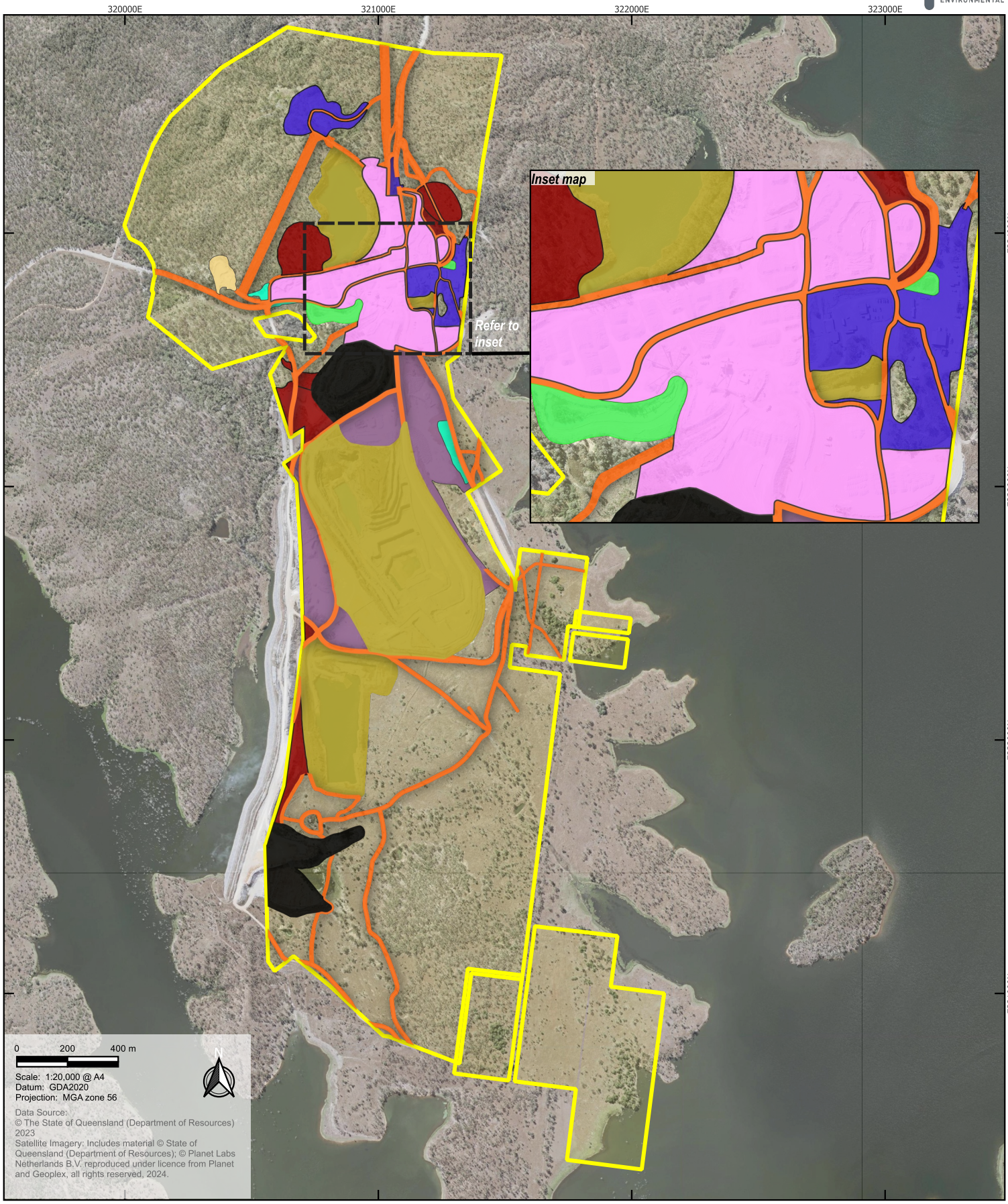
- Site boundary
- Mining leases
- Cadastre (DCDB)
- State controlled roads
- Railways

Watercourses

- Major
- Minor

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Calliope Limestone Quarry
Ecology Field Report

Figure 1
Site location



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Legend

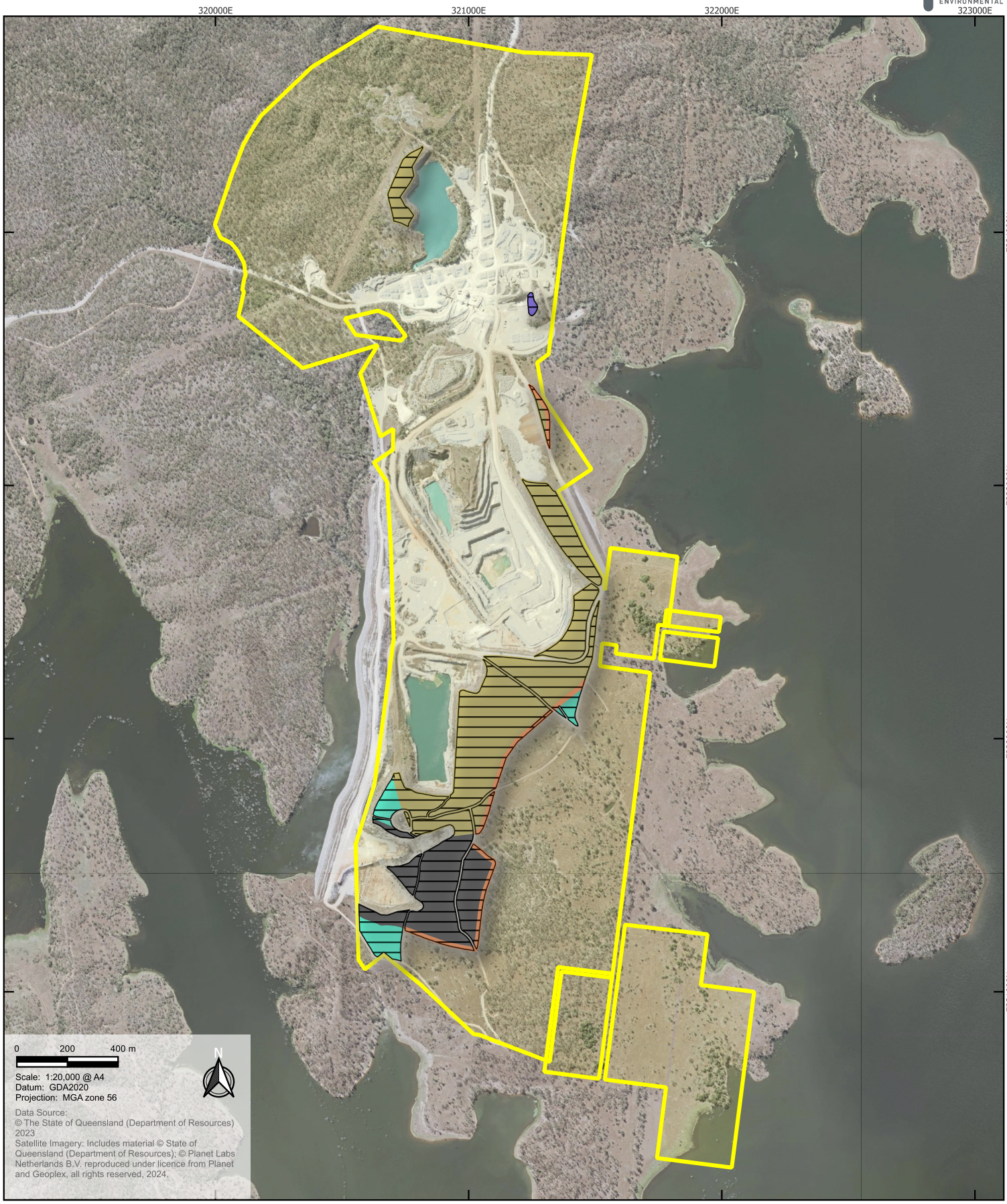
- Site boundary

Current disturbance area

- Access tracks
- Cleared areas and laydowns
- Infrastructure and plant
- Sediment pond
- Pit
- ROM processing area
- Silt dump
- Temporary spoil storage area
- Topsoil stockpile
- Waste rock dump

Graymont
Calliope Limestone Quarry
Ecology Field Report

Figure 2
Current disturbance area



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Legend

- Site boundary
- Proposed disturbance expansion

Proposed disturbance expansion (by activity type)

- Access tracks
- Infrastructure and plant
- Pit
- Topsoil stockpile
- Waste rock dump

Graymont
Calliope Limestone Quarry
Ecology Field Report

Figure 3
Proposed disturbance area

2 PROJECT DESCRIPTION AND ACTIVITIES

Limestone mining has been ongoing at Calliope since 1967, with Graymont managing operations since 2019. Situated just west of Lake Awoonga, the Project produces approximately 0.8 million tonnes per annum of limestone products and intersects 19 MLs. The Project area covers 429.6 hectares (ha) and includes four open cut pits (**Figure 2**). The Project area includes 152.9 ha of existing disturbance (i.e. operational areas, pits etc) and 211.9 ha of proposed disturbance areas. Two non-operational pits (former Pit 1 and Pit 2) are located in the northern end of the ML. Pit 1 was completely back filled with waste rock in 2024 and is now utilised for ag-lime production, and Pit 2 is utilised for onsite water storage. Water from Pit 2 is primarily utilised for the wash plant. Pit 3 and Pit 4 are located to the southern extent of the ML. The Project adjoins land owned and operated by the Gladstone Area Water Board (GAWB), with some shared access tracks in the area used by both Graymont and the GAWB.

Other infrastructure located onsite includes the main office, weighbridge, run of mine (ROM) stockpile, access roads, crushing and screening plant, wash plant, main stockpile area of final product, silt ponds and spoil areas located in the northern portion of the Project (**Figure 2**).

Mining operations have remained consistent throughout the life of mine (LOM) and consists of conventional open cut benching methods and begins with topsoil stripping and removal of clay rich overburden and waste rock. Based on the Plan of Operations for the Project for July 2018 – June 2023, an estimated 142,000 t of overburden and waste rock will be shifted annually (Sibelco 2018).

Limestone ore is extracted by drilling and blasting, then crushed, screened and washed onsite before being loaded by a 120 tonne (t) excavator serviced by two 100 t and one 85 t off road dump trucks. Material is hauled either to the ROM pad for crushing, or to the stockpiles for screening or placement in the designated spoil dumps. There is a second 75 t excavator onsite which is utilised as a backup for the open cut operations.

Extractive activities are also conducted onsite where limestone of different grades and suitable physical properties follow a similar process to mining for the production of road base and aggregates. Extractive activities are authorised and conducted under ERA 16(2)(d) and EA EPPR00881913 (original permit # SPCE04023712 issued under the *Sustainable Planning Act 2009*).

The current Project schedule includes limestone ore to be mined exclusively from the existing open cut mining pit (Pit 4), which is located centrally within the Project area. Lateral and vertical expansion of Pit 4 is projected over the next 70 years, with amalgamation of Pit 3 expected to occur during southern expansion (**Figure 3**). All future disturbance until EOML will be authorised by, and undertaken in accordance with, the amended EA. Mine closure is scheduled for 2100. Limestone ore will continue to be processed onsite utilising pre-existing purpose-built infrastructure in the crushing and screening plant and wash plant, with a rate of production of 10-20,000 t a week.

3 LEGISLATIVE CONTEXT

3.1 Queensland State Legislation

3.1.1 Environmental Protection Act 1994

The objective of the *Environmental Protection Act 1994* (EP Act) is to protect Queensland's environment and to promote ecologically sustainable development. The EP Act defines a General Environmental Duty under which all persons in Queensland have a responsibility not to carry out an activity that causes or is likely to cause environmental harm, and to take all reasonable and practicable measures to prevent or minimise the harm.

The EP Act provides the key legislative framework for environmental management and protection in Queensland. The objective of the EP Act is to: "*Protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains ecological processes on which life depends*" (Section 3 of the EP Act).

Under the EP Act, Graymont must comply with the general environmental duty not to undertake an: "*Activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm are taken*" (Section 319 of the EP Act).

The Project has approval under Environmental Authority EPML00969013 which authorises activities within the MLs. The Project also has approval under EA EPPR00881913 for the following Environmentally Relevant Activities (ERAs):

1. ERA 8 (3a) - Chemical storage >10m^3 but 1,000,000 t of material
2. ERA 16 (3c) – Screening in a year >1,000,000 t of material
3. ERA 50 (2) - Bulk material handling >100 t day

Extractive activities are authorised and conducted under ERA 16(2)(d) and EA EPPR00881913 (original permit # SPCE04023712 issued under the *Sustainable Planning Act 2009*).

3.1.2 Nature Conservation Act 1992

The *Nature Conservation Act 1992* (NC Act) regulates environmental impacts of development through the requirement for vegetation clearing permits, species management programs and other permits.

A clearing permit is required to clear protected plants unless an exemption applies. In general, clearing of Critically Endangered, Endangered, Vulnerable or Near Threatened protected plants will require a clearing permit. Clearing permit applications are assessed on a case-by-case basis and approvals will be subject to conditions.

Where activities involve tampering with 'animal breeding places', the tampering may be authorised by application to the Department of Environment, Tourism, Science and Innovation (DETSI) through an approved species management program.

3.1.3 Environmental Offsets Act 2014

Under the *Environmental Offsets Act 2014* (Offsets Act) an environmental offset is defined as 'an activity undertaken to counterbalance a significant residual impact of a prescribed activity on a PEM.' PEMs are described as MSES and defined under Schedule 2 of the *Environmental Offsets Regulation 2014*. Where a significant residual impact is assessed as occurring on a PEM there may be a requirement for environmental offsets to compensate for the impact. The Queensland Environmental Offsets Policy Significant Residual Impact Guideline (QEOIP Guidelines) (DEHP 2014) provides the framework for assessing the potential for significant residual impacts to MSES from a Project's activities.

3.1.4 Fisheries Act 1994

The *Fisheries Act 1994* (Fisheries Act) provides for the management, use, development and protection of fish habitats and resources. This includes waterways potentially used for 'fish passage' (considered as a MSES) as mapped within waterways for waterway barrier works mapping administered by the Department of

Agriculture and Fisheries (DAF). Environmental offsets may be required where significant residual impact to waterways for fish passage are identified (including permanent, partial and temporary barriers).

3.1.5 Biosecurity Act 2014

The *Biosecurity Act 2014* (Biosecurity Act) ensures a consistent, modern, risk-based and less prescriptive approach to biosecurity in Queensland. The Biosecurity Act provides comprehensive biosecurity measures to safeguard the economy, agricultural and tourism industries, environment and way of life from pests, diseases and contaminants. Decisions made under the Biosecurity Act will depend on the likelihood and consequences of risk, allowing for more appropriate management of risks.

Graymont have a statutory duty of care ("general biosecurity obligation (GBO)") under the Act (s23). Under the GBO, Graymont must:

- Take all reasonable and practical steps to prevent or minimise each biosecurity risk
- Minimise the likelihood of causing a 'biosecurity event', and limit the consequences if such an event is caused
- Prevent or minimise the harmful effects a risk could have, and not do anything that might make any harmful effects worse

Under the Biosecurity Act there are seven categories of 'restricted matter' with associated restrictions (under the Biosecurity Act). Several categories may apply to a single 'restricted matter' and include the following (as relevant to the Project):

- Category 3: You must not distribute this restricted matter. This means it must not be given as a gift, sold, traded or released into the environment unless the distribution or disposal is authorised in a regulation or under a permit
- Category 4: You must not move this restricted matter to ensure that it does not spread into other areas of the State
- Category 5: You must not keep in your possession this category of restricted matter
- Category 6: You must not feed this category of restricted matter. Feeding for the purpose of preparing for or undertaking a control program is exempted

4 ASSESSMENT METHODS

The ecological assessment for the Project consisted of a desktop review of publicly available ecological data sources and information. The desktop review was followed by a field survey carried out within the Project area to describe the ecological values present and to aid the evaluation of the potential impacts of the Project to values considered important to MSES. A summary of the assessment methods is provided in the following sections.

4.1 Desktop Assessment

Prior to commencing the field survey, desktop assessments were carried out to identify species and ecological communities of conservation significance (MSES) that potentially occur within the assessment Project area. Flora and fauna values of conservation significance in this report refer to:

- Flora and fauna species listed as Critically Endangered, Endangered or Vulnerable under the NC Act
- Regional Ecosystems (RE) listed as Endangered or Of Concern under the EP Act

The desktop assessment also aimed to identify other environmental values relevant to the Project area including Environmentally Sensitive Areas (ESAs) and MSES.

4.1.1 Data Sources

Flora and fauna records listed in publicly available databases and other resources were investigated to identify ecological matters relevant to the Project area. These resources included the following:

- Queensland Government Wildlife Online (WildNet) database (records within a 25 km radius around the point -24.1043, 151.2392) (**Appendix A**)
- Species Profile and Threats Database maintained by the Department of Climate Change, Energy, Environment and Water (DCCEEW) (DCCEEW 2023)
- Atlas of Living Australia (ALA), a web-based search tool that is a partnership between CSIRO, Australian museums, herbaria and other biological collections, and the Australian Government (ALA 2025)
- DETSI Matters of State Environmental Significance (MSES) mapping
- DETSI Map of ESAs
- Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development (DNRMMRRD)Regulated Vegetation Management Map and Vegetation Management Supporting Map, including REs, essential habitat, watercourse and wetland mapping
- DETSI certified RE mapping (Version 13).

4.1.2 Previous Studies

During an ecological assessment (flora and fauna) undertaken by Ansar Environmental in 1997, no rare, vulnerable, or endangered species or ecological communities were found in the Project area (Ansar Environmental 1997).

4.2 Field Assessment Methods

4.2.1 Survey Timing and Conditions

A field survey of the Project area was completed during 27 February to 1 March 2023. The survey included a baseline flora and fauna assessment, ground-truthing of REs, and assessment of habitat suitability for conservation significant species.

The nearest weather station providing continuous temperature and rainfall data is Gladstone Airport (39326), located approximately 25 km north of the Project area. During the field survey temperatures ranged between 19.4 and 30.5°C (BoM 2023). No rainfall occurred during the field survey. The region recorded slightly below average rainfall during the three months prior to the field survey, with a total of 300.6 millimetres (mm) during December to February (BoM 2023).

4.2.2 Flora

Native vegetation within the Project area was assessed and mapped into analogous REs. The survey and mapping of REs was in accordance with the *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland V6.0* (Neldner et al. 2022). A combination of tertiary and quaternary RE sites were used to verify the on-ground vegetation communities present. Quaternary assessments were carried out where simple confirmation of the RE present was considered based on the results of the more detailed quaternary assessments carried out elsewhere at the Project area.

Tertiary sites were used to identify REs with the quantification of vegetation community condition and floristic species composition. At a minimum the following data were recorded at each quaternary survey site:

- RE type
- Vegetation condition
- Dominant, co-dominant, sub-dominant and associated flora species, median height and cover for each strata level
- Ecologically dominant layer (EDL)
- Structural classification (Specht and Specht 2000) (i.e. grassland, open-woodland, woodland etc)
- Structure category (i.e. dense, mid-dense, sparse, very sparse)
- Landform
- Soil type
- Weed species and density
- Disturbance.

Quaternary were used to ground-truth the extent, classification and condition of vegetation communities within the Project area. At each quaternary site the following data were recorded:

- RE type
- Condition (i.e. remnant, regrowth, non-remnant)
- Dominant flora species at each strata level
- EDL strata
- EDL cover and median height
- Structural classification (Specht & Specht 2000) (i.e. grassland, open-woodland, woodland etc).

In addition to RE mapping, incidental observations of all native and non-native flora species observed within the Project area were recorded.

BioCondition assessments were also completed in accordance with *BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland* (Eyre et al 2015) to provide a reference for future planned rehabilitation works.

4.2.3 Fauna

Fauna surveys comprised non-invasive methods and included the following:

- Diurnal bird surveys
- Habitat searches for herpetofauna
- Opportunistic observations throughout the survey.

4.2.4 Fauna Habitat

Fauna habitat assessments were conducted at sites across the Project area to ascertain the quality and availability of habitat, particularly for the potential presence of Koala (*Phascolarctos cinereus*), Squatter Pigeon (southern) (*Geophaps scripta scripta*) and Greater Glider (southern and central) (*Petauroides volans*). Habitat assessment sites were selected during the fauna surveys and assessed for the following features:

- Ground cover
  - Grass cover
  - Bare ground

  - Non-native cover
- Presence of tree hollows
- Rocky habitat
- Nearby water source
- Woody debris
- Recent fire
- Level of cattle disturbance (lack of grass cover and surface soil trampling)

4.2.5 Suitably Qualified Personnel

The field surveys were led by Senior Environmental Scientist Oliver Robertson.

Oliver Robertson

With almost 9 years in the industry, Oliver has extensive experience in undertaking surveys for listed weeds and conservation significant fauna and flora species as part of environmental monitoring and compliance programs for projects throughout Queensland for a broad range of industries and government sectors including road and rail transport, energy, communications, and defence. He is familiar with environmental legislative requirements in Queensland and NSW. Oliver is suitably qualified to complete Protected Plant Flora Surveys under the Queensland Department of Environment and Science Protected Plants Flora Survey Guidelines (DES 2020) Oliver holds a PhD in Ecology from University of Queensland as well as a Bachelor of Environmental Science and a Bachelor of Science (Zoology) from Deakin University and University of Melbourne respectively.

4.2.6 Permits and Ethics Approval

The field surveys were conducted in accordance with the following Queensland government permits and approvals:

- Scientific Use Registration Certificate (DAF) – Registration No. SUR001535)
- Animal Ethics Approval (DAF) – (Reference No. CA 2020/06/1377)
- Research Permit (DETSI) – Permit No. WA0027840

4.2.7 Limitations

In accordance with the *Terrestrial vertebrate fauna survey guidelines for Queensland* (Eyre et al. 2022) surveys in the Brigalow Belt Bioregion should be carried out in spring to early summer (September to mid-November) and autumn (March-mid-May). The field survey was completed during late summer.

4.3 Likelihood of Occurrence Assessment

Following the field survey, a likelihood of occurrence assessment was completed to categorise the potential for conservation significant flora and fauna to occur based on the habitat observed within the Project area and surrounds (refer **Section 6.1.3** and **Section 6.2.3**). The assessment provides the following criteria:

- Known to occur
  - Observed onsite during surveys
- Likely to occur
  - Observed close to the Project area during surveys and suitable habitat occurs within the Project area
  - Database records occurring close to the Project area (within 5 km) and suitable habitat occurs within the Project area
- Potential to occur
  - Database records occurring in wider area (>5 km and <25 km) and suitable habitat occurs within the Project area

  - Database records occurring close to the Project area (within 5 km) and marginally suitable habitat occurs although remain relatively isolated (due to vegetation clearing)
- Unlikely to occur
  - No database records in wider area and/or
  - Habitat present in generally unsuitable and/or
  - Project area generally outside of known distribution of species

4.4 Nomenclature and Taxonomy

The common names of many flora and fauna species frequently vary between regions, and many species lack them altogether. Taxonomy of flora presented in this report follows that currently endorsed by the Queensland Herbarium in the *Census of Queensland Flora and Fungi 2023* (Bean 2024)The taxonomy of fauna follows the Australian Faunal Directory (ABRS 2023). In this report, flora and fauna species are referred to initially by both their common and scientific names and then for ease of reading, only by their common name (where the species has a common name).

5 DESKTOP ASSESSMENT RESULTS

5.1 Existing Environment

The Project is located within the Brigalow Belt South Bioregion (BBSB). Within the BBSB the Project area lies within the Mount Morgan subregion. Large areas of the Brigalow Belt have been cleared of remnant native vegetation for grazing, agriculture and mining. Remaining vegetation is often confined to rockier hilly areas, linear strips of roadside vegetation, riparian vegetation and relatively small, isolated pockets of remnant vegetation.

5.1.1 Topography, Geology and Soils

The topography in the vicinity of the Project area is hilly with considerable height variance between 100 and 40 metres Australian Height Datum (mAHD). It falls to the east, south, and west to Lake Awoonga.

The Taragoola limestone deposits occur within the Early Devonian age (419-Ma) Calliope Beds. The Beds occupy a north-northwest striking belt about 40 km long and 3-4 km wide. They comprise predominantly volcanic rocks with relatively minor inter-bedded sedimentary rocks, including limestone. The rocks have been subjected to folding and faulting. Overburden consists of a shallow cover of soil. Boulders and cobbles of limestone and volcanics occur in much of the layer.

Underlying the overburden is predominantly limestone. Discontinuities within the limestone are clay filled and karst features are prevalent to a depth up to approximately 15 mBGL. Below this depth, karst and infill becomes less prevalent and apertures become tight. Bedding surfaces within the limestone generally dip very steeply towards the west. The major axes of the pits are parallel to the strikes of the beds. This characteristic is consistent with the regional structure.

The volcanics exposed in the walls of the pits include predominantly basic basalt and intermediate olive green andesite. The basalt occurs as lava flows. It is exposed primarily in the upper benches of the east and south walls of Pit 4. It is dark grey, has high to very high strength and is slightly weathered. The andesite generally occurs as steep dipping dykes following vertical to sub-vertical bedding and joints within the limestone. Two dominant systems strike north-north-west and east. Their widths range from stringers to a few meters. Reduced vertical stresses at shallower depths have allowed the andesite to extrude along shallow dipping joints. It has high to very high strength and is moderately to slightly weathered. A summary of the dominant surface geology of the Project area is provided below in **Table 1**.

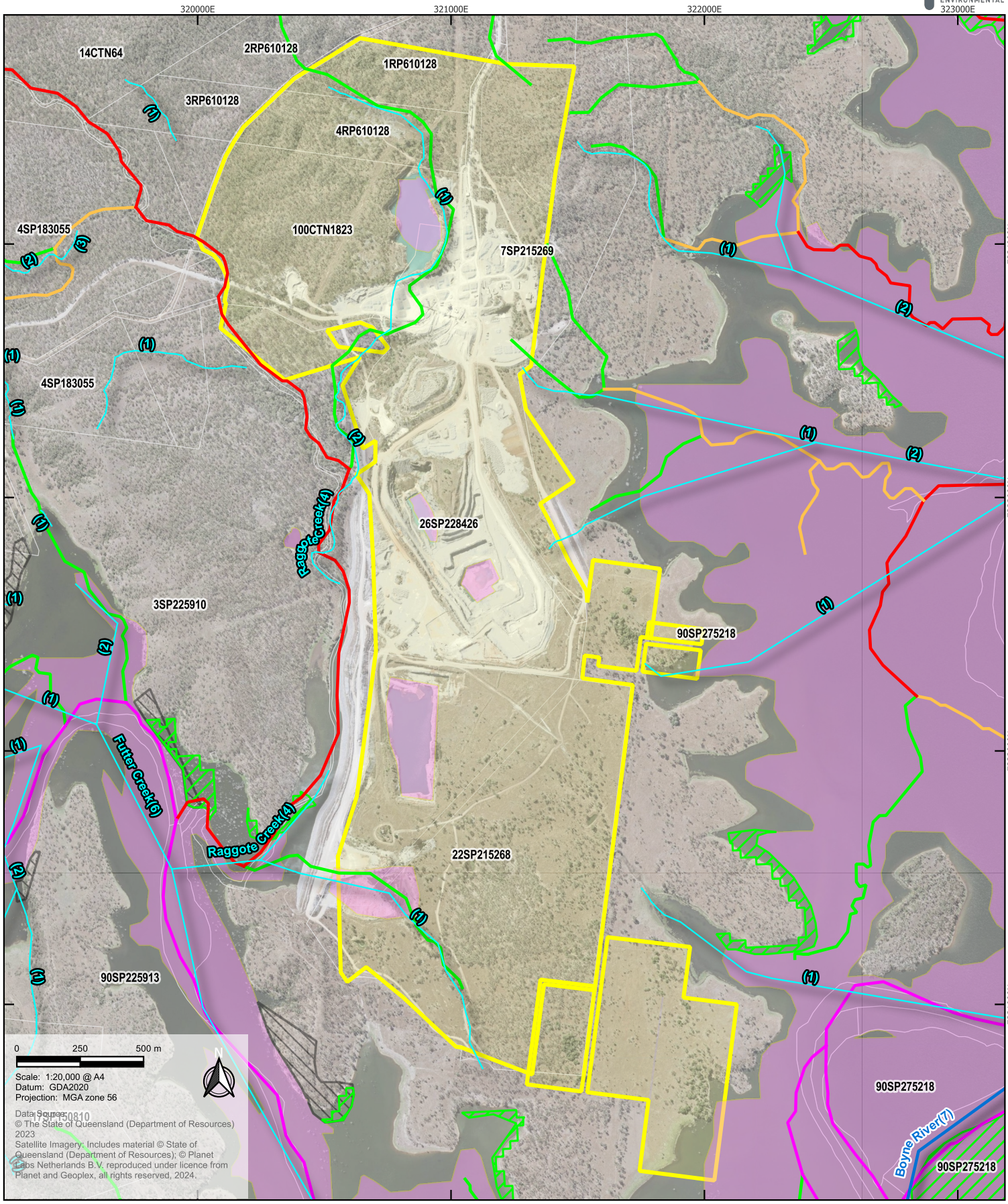
Table 1. Project area surface geology (QGlobe 2023)

Rock unit name	Lithological summary	Dominant rock	Age
SDa	Basaltic to andesitic (rarely dacitic and rhyolitic) volcaniclastic sandstone and conglomerate, limestone, siltstone, andesite	Stratified unit (including volcanic and metamorphic)	Silurian - early Devonian
DSa/l	Fossiliferous limestone, marble	Carbonates (limestone or dolomite)	Silurian - early Devonian

5.1.2 Wetland and Watercourse Mapping

The Project area is within the Boyne River drainage sub-basin. The Project area is intersected by nine stream order 1 watercourses and one stream order 2 watercourse (**Figure 4**). No wetlands of high ecological significance (HES) are mapped within the Project area. East of the Project area, the Boyne River, a stream order 7 watercourse flows into Awoonga Lake. Awoonga Lake is an artificial reservoir maintained by the Awoonga Dam wall. The farm dam is a mapped hydrologically modified or artificial wetland.

A total of six low-risk waterways for waterway barrier works are mapped within the Project area (**Figure 4**).



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA220009.01 EA Amendment\2. Ecology Field Report\Rev 0\Figure 4 Watercourse and waterways.qgz

Legend

- Site boundary
- Cadastre (DCDB)
- Vegetation management wetlands map v8.01

Wetland areas (Qld Wetland Mapping v6.0)

- Lacustrine Wetlands (hydrologically modified or artificial)
- Contains Wetlands (1 - 50%)

QLD waterways for waterway barrier works

- Low
- Moderate
- High
- Major

Vegetation management watercourses and drainage features v7 (stream order)

- Major
- Minor

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Figure 4
Wetlands, waterways and watercourses

5.2 Matters of State Environmental Significance

The Offsets Act is supported by the *Environmental Offsets Regulation 2014* (Offsets Regulation) which provides detail on prescribed activities and environmental matters (i.e. MSES) to which the Act applies. MSES include environmental values that are protected under Queensland legislation. The Queensland Government Environmental Reports Online portal identified five MSES as present within the Project area (as summarised in **Table 2**).

Table 2. Matters of State Environmental Significance relevant to the Project area

Matters of State Environmental Significance	Relevance to Project
Protected wildlife habitat under the NC Act:	
Conservation significant flora and fauna	A total of 26 fauna species and 18 flora species listed as threatened or near threatened under the NC Act were identified as potentially occurring within the Project area
Regulated vegetation under the *Vegetation Management Act 1999* (VM Act):	
Endangered/Of concern in Category B	**Not relevant**. Remnant RE 11.3.4/11.3.25 is mapped outside of the Project area to the south-west along the banks of Futter Creek.
Endangered/Of concern in Category C	**Not relevant**. Regrowth RE 11.3.4/11.3.25 is mapped outside of the Project area to the west along the banks of Futter Creek.
Category R (Great Barrier Reef (GBR) riverine regrowth)	Small patches of riverine regrowth vegetation are mapped within the Project area in association with tributaries of Raggote Creek close to Pit 2 and along the eastern boundary of the Project area in association with gullies draining into Awoonga Lake.
Intersecting a watercourse	Regulated vegetation intersecting a watercourse identified on the VM Act watercourse map occur in the far northern and southern portions of the Project area.
Within 100 m of a Vegetation Management Wetland	**Not relevant**. Regulated vegetation within 100 m of a Vegetation Management Wetland is mapped outside of the Project area adjacent to the western boundary and to the south and east of the Project area.
Connectivity areas:	
Remnant vegetation	Remnant vegetation providing connectivity is mapped within the Project areas
Wetlands and watercourses under the EP Act:	
Waterway providing fish passage	Waterways mapped as low risk Queensland waterways for waterway barrier works occur within the Project area

5.3 Environmentally Sensitive Areas

No Environmentally Sensitive Areas (ESAs) are mapped within the Project area. The nearest ESA is Category C ESA Boyne Range State Forest, located 3 km to the west of the Project area.

5.4 Flora

5.4.1 Vegetation Communities

Current Queensland regulated vegetation mapping indicates the majority of the Project area is Category X non-remnant vegetation. Areas of Category B, C and R vegetation are mapped in the far northern and southern portions of the Project area (**Appendix A**). The extent of this mapping within the Project area is detailed in **Table 3**. Current DNRMMRRD vegetation community mapping identified three REs within the Project area mapped as a mix of homogenous and heterogenous polygons. The REs are described in **Table 4** and depicted in **Figure 5**.

Table 3. Regulated vegetation mapped within the Project area

Regulated vegetation category	Extent (ha)
Category X (non-remnant)	278.50
Category B (remnant)	103.50
Category C (high-value regrowth)	28.60
Category R (riverine regrowth)	18.90

Table 4. Regional Ecosystems currently mapped within Project area

RE	Short description (Queensland Herbarium 2021)	VM Act status	EP Act status
11.11.15	*Eucalyptus crebra* woodland to open woodland on deformed and metamorphosed sediments and interbedded volcanics	Least concern	No concern at present
11.11.4	*Eucalyptus crebra* woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges	Least concern	No concern at present
11.11.4a	*Eucalyptus tereticornis* dominated woodland. Other tree species listed above may occur as sub or co-dominant species. Not a wetland	Least concern	No concern at present

5.4.2 Conservation Significant Flora

The desktop assessment revealed there are no areas mapped as 'high risk' on the Queensland Flora Survey Trigger Map within the Project area (refer DNRMMRRD Vegetation Management Report in **Appendix A**).

The Wildlife Online database search results identified 18 flora species listed as threatened or near threatened under the NC Act, including five Near Threatened, four Critically Endangered, three Endangered and six Vulnerable species.

Historical database records from ALA (2025) identified 15 threatened or near threatened flora species within 25 km of the assessment area including the following (refer **Figure 6**):

- *Scleromitrion gibsonii* (Critically Endangered – NC Act) - 14 records 18 km south south-west of the Project area within Wietalaba National Park
- *Rhodamnia glabrescens* (Critically Endangered – NC Act) - 11 occurrence records 20 km southeast of the Project area
- Narrow-leaved Malletwood (*Rhodamnia angustifolia*) (Critically Endangered – NC Act) - 21 records 18 km south-southwest of the Project area
- Discolorous-leaved Ironbark (*Eucalyptus decolor*) (Near Threatened – NC Act) - 11 records 6-15 km southeast of the Project area
- *Acacia* sp. (Castletower N.Gibson TOI345) (Vulnerable – NC Act) - one record 9 km southeast of the Project area
- Cudgerie (*Hernandia bivalvis*) (Near Threatened – NC Act) - one record 21 km southeast of the Project area
- Scarlet Fuchsia (*Graptophyllum excelsum*) (Near Threatened – NC Act) - one record 16 km north of the Project area and one record 18 km south southwest of the Project area
- *Parsonsia kroombitensis* (Vulnerable – NC Act) - two records 3-5 km west of the Project area
- *Cassinia collina* (Vulnerable – NC Act) - one record 14 km southeast of the Project area
- Many Peaks Apatophyllum (*Apatophyllum olsenii*) (Endangered - NC Act) – four records 6.5-9 km southeast of the Project area
- *Macropteranthes leiocaulis* (Near Threatened NC Act) - one record 19 km north-northeast of the Project area and two records 22 km southeast of the Project area
- *Cycas megacarpa* (Endangered NC Act) - one record 24 km southwest of the Project area and one record 20 km northeast of the Project area
- *Bergera crenulata* (Critically Endangered – NC Act) - one record 15 km south-southeast of the Project area

- Grevillea (*Grevillea venusta*) (Vulnerable – NC Act) -20 occurrence records within 25 km of the Project area with the nearest record located 6 km southeast of the Project area
- Scrub Ironbark (*Rhodamnia spongiosa*) (Critically Endangered – NC Act) – one record 20 km northeast of the Project area and one record 25 km northwest of the Project area

5.5 Fauna

5.5.1 Conservation Significant Fauna

The desktop review identified 27 fauna species listed as conservation significant under the NC Act as potentially occurring within the wider area surrounding the Project area (refer **Appendix A** for database search results).

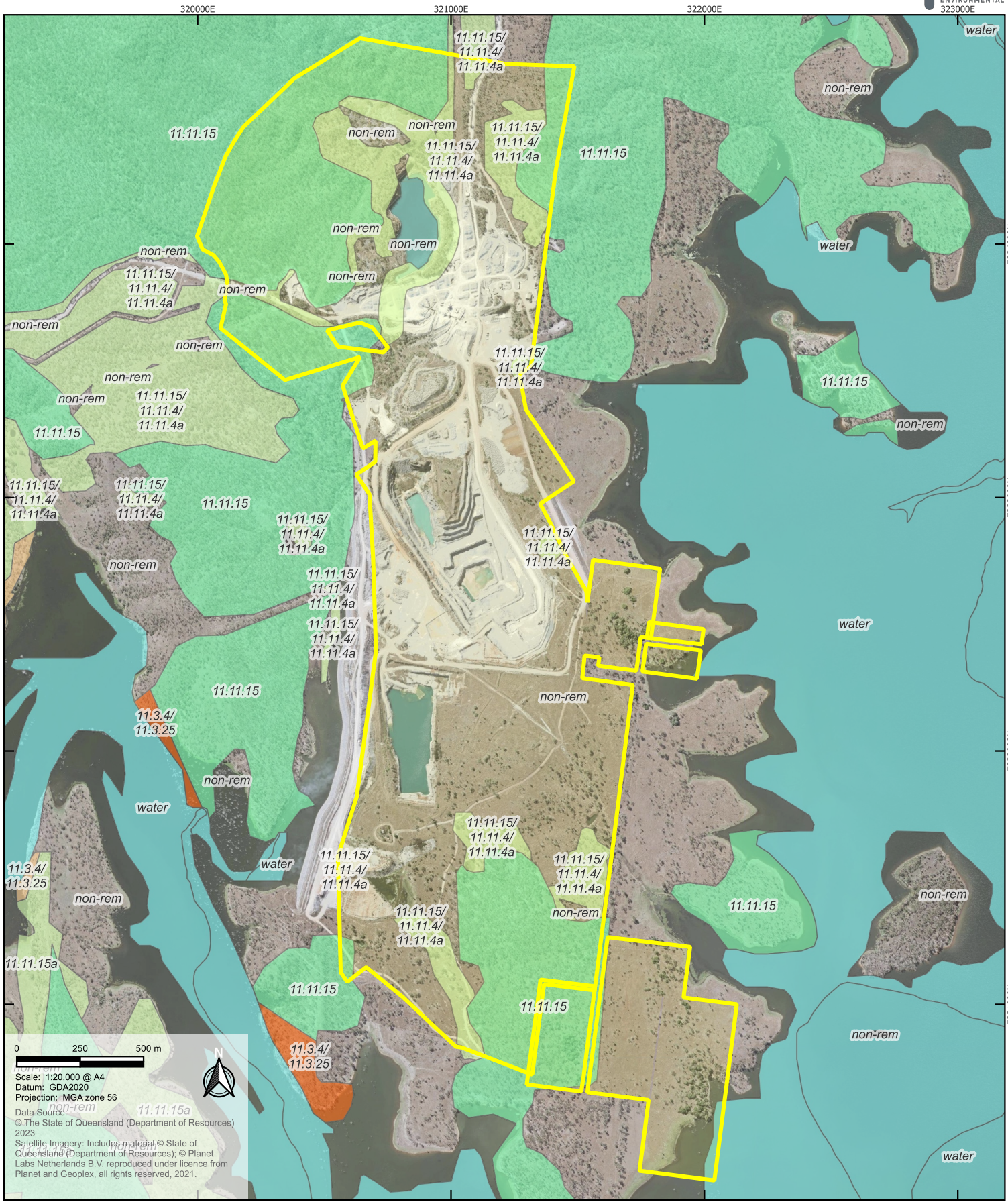
Conservation significant fauna species identified as occurring within 25 km of the Project area from the ALA (2025) database include the following (refer **Figure 6** for locations):

- White-throated Needletail (*Hirundapus caudacutus*) (Vulnerable - NC Act) – 19 occurrence records within 25 km with the nearest record 1.5 km northeast of the Project area
- Curlew Sandpiper (*Calidris ferruginea*) (Critically Endangered - NC Act) – 23 occurrence records within 25 km with the nearest record 1.5 km northeast of the Project area
- Greater Sand Plover (*Charadrius leschenaultii*) (Vulnerable - NC Act) – six occurrence records with 25 km of the Project area with the nearest record located 16 km east of the Project area
- Red Goshawk (*Erythrotriorchis radiatus*) (Endangered - NC Act) – one record from Boyne Island 20 km north-northeast of the Project area
- Squatter Pigeon (*Geophaps scripta scripta*) (Vulnerable - NC Act) – 24 occurrence records with 25 km of the Project area with the nearest record located 3.5 km west of the Project area
- Western Alaskan Bar-tailed Godwit (*Limosa lapponica baueri*) (Endangered - NC Act) – three occurrence records within 25 km of the Project area at Boyne Island with the nearest record located 20 km to the north-northeast of the Project area
- Eastern Curlew (*Numenius madagascariensis*) (Critically Endangered - NC Act) – 88 occurrence records within 25 km of the Project area
- Yellow-bellied Glider (*Petaurus australis australis*) (Vulnerable - NC Act) – f occurrence records within 25 km of the Project area with the nearest record located 11 km south southeast of the Project area
- Koala (*Phascolarctos cinereus*) (Endangered - NC Act) – 17 occurrence records within 25 km of the Project with the nearest record located 3.5 km west-southwest of the Project area
- Beach Stone-curlew (*Esacus magnirostris*) (Vulnerable - NC Act) – 20 occurrence records within 25 km of the Project area with the nearest record located 17 km east of the Project area
- Lesser Sand Plover (*Charadrius mongolus*) (Endangered - NC Act) – 19 occurrence records within 25 km of the Project area with the nearest record located 17 km east of the Project area
- Great Knot (*Calidris tenuirostris*) (Critically Endangered - NC Act) – two occurrence records within 25 km of the Project area with the nearest record located 20 km north-north-east of the Project area
- Powerful Owl (*Ninox strenua*) (Vulnerable - NC Act) – seven occurrence records within 25 km of the Project area with the nearest record located 11 km south-southeast of the Project area
- Black-breasted Button-quail (*Turnix melanogaster*) (Vulnerable - NC Act) – eight occurrence records within 25 km of the Project area with the nearest record located 20 km northeast of the Project area on Boyne Island
- Australian Humpback Dolphin (*Sousa sahulensis*) (Vulnerable - NC Act) – one record within 25 km of the Project area located 20 km northeast of the Project area
- Greater Glider (southern and central) (*Petauroides volans*) (Endangered – NC Act) – six occurrence records within 25 km of the Project area with the nearest record located 11 km south-southeast of the Project area
- Red Knot (*Calidris canutus*) (Endangered - NC Act) - Three occurrence records within 25 km of the Project area with the nearest record located 1.5 northeast of the Project area

- Flatback Turtle (*Natator depressus*) (Vulnerable – NC Act) – one record 18 km northeast of the Project area, numerous additional records within Wild Cattle Island National Park
- Glossy Black-cockatoo (northern) (*Calyptorhynchus lathami erebus*) (Vulnerable – NC Act) – numerous records within 25 km of the Project area, the closest record located 19 km northeast of the Project area
- Grey Plover (*Pluvialis squatarola*) (Vulnerable – NC Act) – Two records within 25 km of the Project area, with the closest record 21 km to the north northeast of the Project area
- Ruddy Turnstone (*Arenaria interpres*) (Vulnerable – NC Act) – Two records 22 km northeast of the Project area
- Sharp-tailed Sandpiper (*Calidris acuminata*) (Vulnerable – NC Act) – 10 records within 25 km of the Project area, the closest of which is located 6.5 km northeast of the Project area
- Latham's Snipe (*Gallinago hardwickii*) (Vulnerable – NC Act) – seven records within 25 km of the Project area, the closest of which is located 1.9 km north-northeast of the Project area
- Common Greenshank (*Tringa nebularia*) (Vulnerable – NC Act) – three records within 25 km of the Project area, the closest record, located 1.9 km northeast of the Project area
- Terek Sandpiper (*Xenus cinereus*) (Vulnerable – NC Act) – four records within 25 km of the Project area, the closest record, 17 km east of the Project area

5.5.2 Habitat Mapping

Assessment of DETSI threatened wildlife habitat suitability models determined that habitat for conservation significant fauna species is absent from the Project area (**Appendix A**).



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA220009.01 EA Amendment\2. Ecology Field Report\Rev 0\Figure 5 Queensland Herbarium RE mapping.qgz

Legend

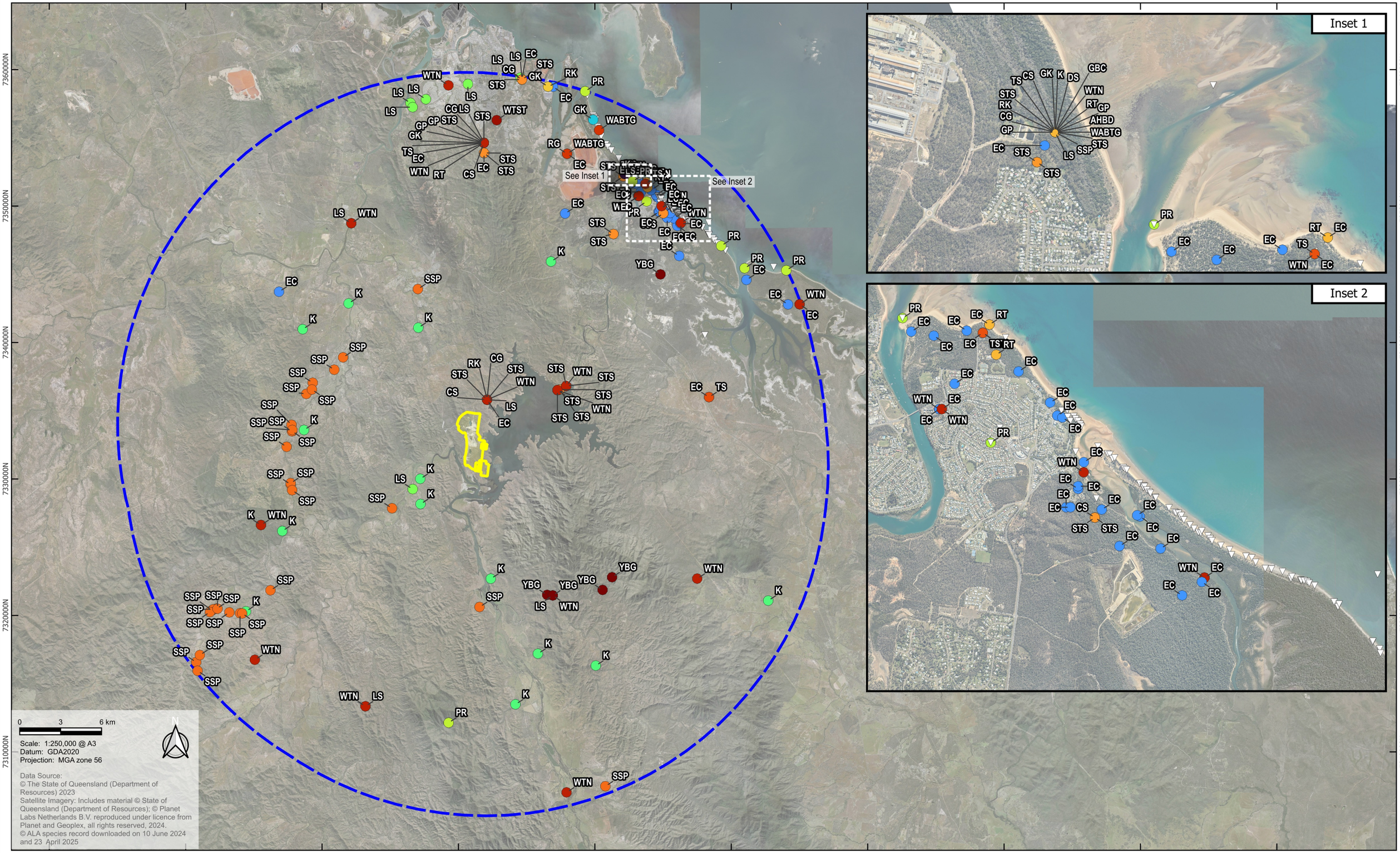
- Site boundary

Regional Ecosystems v13.00

- Category A or B area containing of concern
- Category A or B area that is least concern
- Category C or R area containing of concern
- Category C or R area that is of least concern
- water
- Non-remnant

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Figure 5
Queensland herbarium RE mapping



Filepath: ...BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA220009.01 EA Amendment\2. Ecology Field Report\Rev 0\Figure 6 ALA record of threatened species and Migratory within 25 km.qgz

Legend

- Site boundary
- 25 km buffer of site boundary

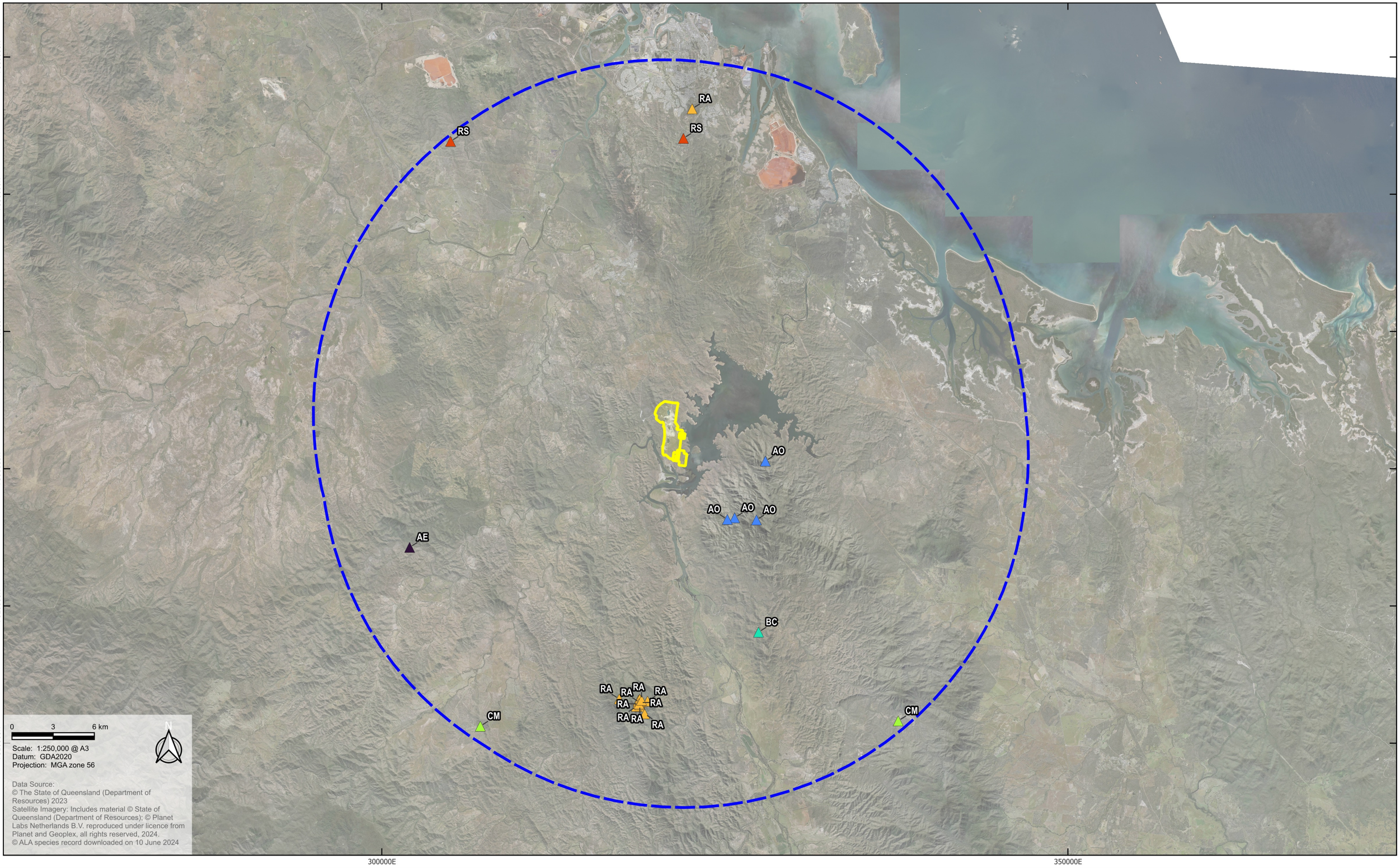
Threatened fauna

- Australian Hump-backed Dolphin (AHBD)
- Common Greenshank (CG)
- Curlew Sandpiper (CS)
- Dunmall's Snake (DS)
- Eastern Curlew (EC)
- Flatback Turtle (FT)
- Great Knot (GK)
- Grey Plover (GP)
- Koala (K)
- Latham's Snipe (LS)
- Pacific Ridley (PR)
- Red Goshawk (RG)
- Red Knot (RK)
- Ruddy Turnstone (RT)
- Sharp-tailed Sandpiper (STS)
- Southern Squatter Pigeon (SSP)
- Terek Sandpiper (TS)
- Western Alaskan Bar-tailed Godwit (WABTG)
- White-throated Needletail (WTN)
- White-throated Snapping Turtle (WTST)
- Yellow-bellied Glider (YBG)

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Significant Impact Assessment (MNES) Report

Figure 6a
Conservation significant flora and fauna species records within 25 km of the project area - Threatened fauna species



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA220009.01 EA Amendment\2. Ecology Field Report\Rev 0\Figure 6 ALA record of threatened species and Migratory within 25 km.qgz

Legend

- Site boundary
- 25 km buffer of site boundary

Threatened flora

- Acacia eremophiloides (AE)
- Apatophyllum olsenii (AO)
- Bergera crenulata (BC)
- Cycas megacarpa (CM)
- Rhodamnia angustifolia (RA)
- Rhodamnia spongiosa (RS)

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Figure 6b
Conservation significant flora and fauna species records within 25 km of the project area - Threatened flora species

6 FIELD ASSESSMENT RESULTS

6.1 Flora Survey Results

6.1.1 Flora Diversity

A total of 85 flora species were identified within the Project area, including 26 non-native flora species. The floral assemblage is dominated by eucalypts with an understorey of native woody shrubs, herbs and tussock grasses. Narrow-leaved Ironbark (*Eucalyptus crebra*) was the dominant eucalypt within the Project area. A full list of recorded flora species is provided in **Appendix B**.

6.1.2 Ground-truthed Regional Ecosystems

A total of 10 tertiary RE assessments and six quaternary RE assessments were completed across the Project area (refer **Figure 7**). Ground-truthing of current RE mapping confirmed the presence of four vegetation communities analogous to two RE types. Large portions of the Project area currently mapped as a mixed polygon of multiple RE types was confirmed as remnant RE 11.11.15 *Eucalyptus crebra* woodland. Some areas currently mapped as non-remnant or regrowth vegetation on the regulated vegetation map meet the definition of remnant vegetation analogous to RE 11.11.15. Water bodies and non-remnant areas impacted by vegetation clearing were also mapped. The description, status and area of each RE is provided in **Table 5**, and the extent illustrated in **Figure 7**. Further detail regarding vegetation community floristics, structure and representative photos is provided in the following sections. Tertiary and quaternary RE assessment data is provided in **Appendix B**.

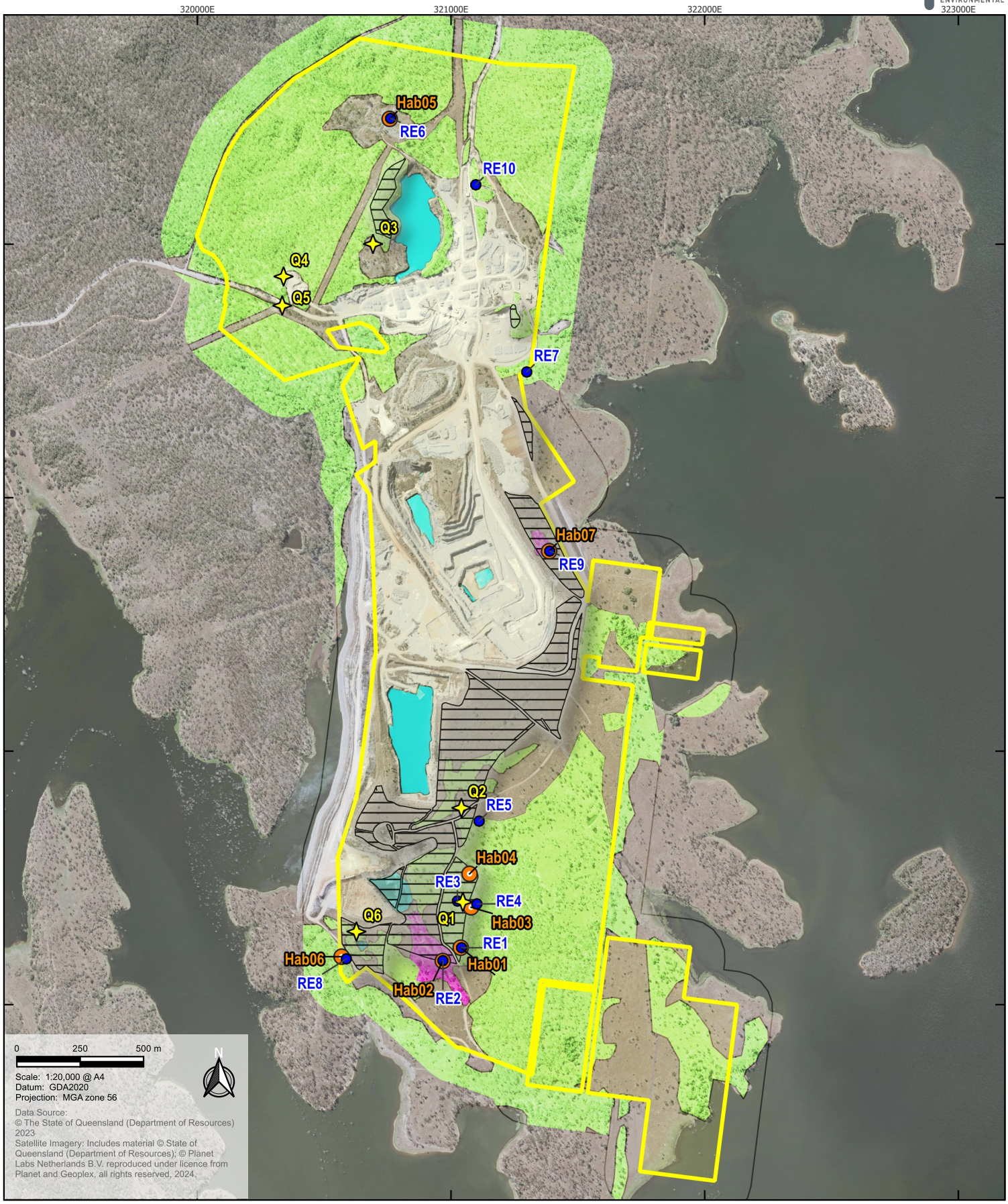
Table 5. Ground-truthed REs within the Project area

Vegetation community	RE	Regulated vegetation category	EP Act (biodiversity)	Extent within Project area (ha)
1. Remnant *Eucalyptus crebra* woodland	11.11.15	B	No concern at present	115.2
2. Regrowth *Eucalyptus crebra* woodland	11.11.15	C	No concern at present	65.8
3. Remnant *Eucalyptus tereticornis* fringing woodland	11.3.25	B	Of concern	4.1
4. Disturbed non-remnant vegetation	N/A	X	N/A	230.1

6.1.2.1 Remnant *Eucalyptus crebra* Woodland

This vegetation community occurs on deformed and metamorphosed sediments with interbedded volcanics. The structure of the vegetation community varies from woodland to open-forest (**Plate 1**). The vegetation community is dominated by Narrow-leaved Ironbark with associated Variable-barked Bloodwood (*Corymbia erythrophloia*) and sub-dominant Moreton Bay Ash (*Corymbia tessellaris*). With a median canopy height range of 14-17 m and a canopy cover range of 18-36 %. A sparse sub-canopy always occurred and included Narrow-leaved Ironbark, Variable-barked Bloodwood, Moreton Bay Ash, and Queensland Bluegum (*Eucalyptus tereticornis*) with a median height range of 7-8.5 m and a median cover range of 3-6%.

A very-sparse to mid-dense shrub layer typically occurred and included Dogs Balls (*Grewia retusifolia*), Spiked Sida (*Sida subspicata*), Glycine Pea (*Glycine tabacina*), Narrow-leaved Ironbark, Pretty Wattle (*Acacia decora*), Catkin Wattle (*Acacia julifera*), Cockatoo Wattle (*Planchonia careya*), Dysentery Plant (*Grewia latifolia*), (*Capparis canescens*), Queensland Bluegum, and Green Wattle (*Acacia deanei*) with a median height range of 0.9-2.5 m and a median canopy cover range of 5-30%.



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA220009.01 EA Amendment\2. Ecology Field Report\Rev 0\Figure 7 Field-verified regional ecosystems, survey sites and proposed impacts.qgz

Legend

- Site boundary
- Proposed disturbance expansion

Ground-truthed regional ecosystems

- 11.11.15
- 11.3.25
- Non-remnant
- Water

- Quaternary RE
- Secondary RE
- Habitat assessment sites

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Figure 7
Field-verified regional ecosystems, survey sites and proposed impacts

Groundcover was dense and dominated by native tussock grasses and herbs including Dark Wiregrass (*Aristida calycina*), Cotton Panic (*Digitaria brownii*), Queensland Bluegrass (*Dichanthium sericeum*), Pitted Bluegrass (*Bothriochloa decipiens*), Black Speargrass (*Heteropogon contortus*), Slender Bamboo Grass (*Austrostipa verticillata*), Kangaroo Grass (*Themeda triandra*), Fuzzweed (*Peripleura hispidula*), Barbed-wire Grass (*Cymbopogon refractus*), White Speargrass (*Aristida leptopoda*), Slender Sedge (*Cyperus gracilis*), High Sida (*Sida trichopoda*),Rusty Glycine (*Glycine tomentella*), Hairy Panic (*Panicum effusum*), Birdsville Indigo (*Indigofera linnaei*), Australian Millet (*Panicum decompositum*), Wiregrass (*Aristida queenslandica*), Nine-awn Grass (*Enneapogon lindleyanus*), Fairy Grass(*Sporobolus caroli*), Desert Bluegrass (*Bothriochloa ewartiana*), Chaff Flower (*Achyranthes aspera*), Spurge (*Phyllanthus maderaspatensis*), and Asthma Plant (*Euphorbia hirta*) with a median height range of 0.2-1.5 m and a median cover range of 80-90%.

Non-native plant cover ranged from 10% to 45% and included African Lovegrass (*Eragrostis curvula*), Cobbler's Pegs (*Bidens pilosa*), Flannel Weed (*Sida cordifolia*), Shrubby Stylo (*Stylosanthes scabra*), Creeping Lantana (*Lantana montevidensis*), Cayenne Snake Weed (*Stachytarpheta cayennensis*), Dwarf Poinsettia (*Euphorbia cyathophora*), Corky Passion Flower (*Passiflora suberosa*), Rubber Vine (*Cryptostegia grandiflora*), Siratro (*Macroptilium atropurpureum*), Canadian Fleabane (*Conyza bonariensis*), American Rat's Tail Grass (*Sporobolus jacquemontii*), Woolly Rattlepod (*Crotalaria incana*), and Lantana (*Lantana camara*). This vegetation community was subject to low cattle disturbance and edge effects from adjacent access tracks.



Plate 1. Remnant *Eucalyptus crebra* woodland

6.1.2.2 Regrowth Eucalyptus crebra Woodland

This vegetation community occurs on deformed and metamorphosed sediments with interbedded volcanics and occurs as woodland (**Plate 2**). The vegetation community is dominated by Narrow-leaved Ironbark with sub-dominant Moreton Bay Ash and Queensland Bluegum with a median canopy height range of 17-17.5 m and a canopy cover range of 11-12%. A very-sparse sub-canopy always occurred and included Narrow-leaved

Ironbark, Moreton Bay Ash, and Queensland Bluegum with a median height range of 6-7 m and a median cover range of 4-5%.

A very-sparse to sparse shrub layer always occurred and included Spiked Sida and Catkin Wattle with a median height range of 1.2-2.4 m and a median canopy cover range of 2-20%.

A dense ground layer was dominated by native tussock grasses with sub-dominant native forbs and was comprised of Pitted Bluegrass, Hairy Panic, Barbed-wire Grass, Wiregrass, Black Spear Grass, Slender Bamboo Grass, Kangaroo Grass, Fuzzweed, Rusty Glycine, and Rycho (*Rhynchosia minima*) with a median height range of 0.7-1.1 m and a median cover range of 90-95%.

Non-native plant cover occurred at 5% and included Shrubby Stylo, Cobbler's Pegs, Canadian Fleabane, Balloon Cotton Bush (*Gomphocarpus physocarpus*). The vegetation community was subject to disturbance resulting from historical land clearing.



Plate 2. Regrowth *Eucalyptus crebra* woodland

6.1.2.3 Remnant *Eucalyptus tereticornis* Fringing Woodland

This vegetation community occurs along alluvial drainage line and varies from woodland to open-forest (**Plate 3**). The vegetation community is dominated by Queensland Bluegum with sub-dominant Moreton Bay Ash and Narrow-leaved Ironbark with a mean height range of 20-21 m and a median canopy cover range of 24-40%. A very-sparse sub-canopy always occurred and included Queensland Bluegum and Moreton Bay Ash with a median height range of 5-9 m and a median cover range of 1-10%.

A very-sparse shrub layer always occurred and was comprised of Tuckeroo (*Cupaniopsis anacardioides*), Currantbush (*Carissa ovata*) and Dysentery Plant with a median height range of 1.2-1.8 m and a median cover of 1%. A secondary low-shrub layer sometimes occurred and was comprised of Dysentery Plant.

A mid-dense to dense ground layer was dominated by native tussock grasses and herbs including Slender Bamboo Grass, Pitted Bluegrass, Black Speargrass, Reedgrass (*Arundinella nepalensis*), Fuzzweed, High Sida, Common Rush (*Juncus usitatus*), Slender Sedge and Woolly Rattlepod with a median height range of 0.5-1.5m and a median cover range of 60-80%.

Non-native plant cover was sparse and comprised of Shrubby Stylo, Lantana, Canadian Fleabane, Corky Passion Flower, Siratro, Cayenne Snake Weed, Noogoora Burr (*Xanthium occidentale*), Argentine Peppercress (*Lepidium bonariense*), and Castor Oil Bush (*Ricinus communis*) with a median cover of 10%. This vegetation community was subject to disturbance from wash-out erosion and Feral Pig (*Sus scrofa*) rooting and wallowing.



Plate 3. Remnant *Eucalyptus tereticornis* fringing woodland

6.1.2.4 Disturbed Non-remnant Vegetation

This vegetation community occurs as a grassland dominated by native tussock grasses although it is not considered analogous to any RE type (**Plate 4**). A sparse, low, emergent shrub layer is comprised of Australian Indigo (*Indigofera australis*) with a median height of 0.6 m and a median cover of 2%. A sparse ground layer was dominated by native tussock grasses including Pitted Blue Grass, Black Speargrass, Queensland Wiregrass, Hairy Panic, and Narrow-leaved Indigo (*Indigofera linifolia*) with a median height of 0.3 m and a median cover of 20%.

Non-native plant cover was sparse and comprised of Cayenne Snake Weed, Shrubby Stylo, and Blue Billygoat Weed (*Ageratum houstonianum*) with a median cover of 25%.

This vegetation community was subject to very high level of current and historical disturbance including cattle grazing, land clearing, and mining operations (i.e. stock piles and laydowns).



Plate 4. Disturbed non-remnant vegetation

6.1.3 Conservation Significant Flora

The likelihood of occurrence assessment for conservation significant flora species identified in database searches determined that no conservation significant flora species are considered likely to occur within the Project area (**Table 6**). Two flora species area considered a possible occurrence within the Project area:

- *Cassinia collina*
- *Cycas megacarpa*

The remaining flora species area considered unlikely to occur within the Project area and are not considered further in the report.

Table 6. Likelihood of occurrence assessment of conservation significant flora species

Species	Distribution and habitat	Likelihood of occurrence
Acacia sp. (Castletower N. Gibson TO1345) NC Act: V	The species is endemic to Queensland and in restricted to a single known population in the Mt Castletower area along a stream order 3 waterway (Queensland Herbarium 2011a). The single known population occurs in riverine vegetation at 45 m ASL (Halford 2011).	**Unlikely**. Suitable riverine habitat does not occur within the Project area. The nearest historical record of the species is located 9 km southeast of the Project area (ALA 2025).
Acacia eremophiloides NC Act: V	This species is a resinous shrub which grows in shallow well-drained sandy soils on exposed granite ridges at altitudes between 460-550 m. The species occurs in a small isolated population restricted to a distribution range of less than 10 km, in the Burnett Pastoral District of south-eastern Queensland, located 46 km south southwest of Gayndah (DCCEWW 2025).	**Unlikely.** The species has a highly restricted range located over 200 km southwest of the Project area (ALA 2025). The nearest unverified record is located 20 km southwest of the Project area which does not align with its known distribution and is likely incorrectly recorded (ALA 2025).
Bergera crenulata (Turcz.) F.J.Mou NC Act – CR	The species is in the *Rutaceae* family and is a small shrub or tree. The species distribution in Australia is restricted to isolated and scattered records recorded as far north as Goodedulla National Park northwest of Rockhampton and as far south as Gatton in southeast Queensland.	**Unlikely.** The species only occurs in scattered and isolated locations, the closest record is located 15 km south-southeast of the Project area (ALA 2025).
Cassinia collina NC Act: V	The species occurs three locations including Mount Walsh NP, Wongi SF and Mt Stanley (Queensland Herbarium 2011b). Suitable habitat for the species includes open forest on stony soils or sandy loams, along rocky creek banks in fine-grained granite, tall woodland with *Eucalyptus dura, Corymbia trachyphloia* and *Acacia blakei*, and woodland dominated by *Corymbia citriodora, E, acmenoides, C. trachyphloia* and *E. crebra* on shallow sandy soils (Queensland Herbarium 2011b).	**Possible**. Suitable habitat occurs within the Project area in the form of remnant woodland on stony granite soils, however the nearest historical record occurs 14 km southeast of the Project area (ALA 2025).
Cudgerie (*Hernandia bivalvis*) NC Act: NT	This species is restricted to the central coastal and south-east Queensland, between Dryander Creek south to Mt Tamborine. It has also been recorded from Mt Colosseum National Park (DESI 2024). This species grows in vine thicket, microphyll vine forest, or rainforests on rock pavements and outcrops with shallow soils. It occurs up to 620 m altitude (DESI 2024).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. The nearest historical record of the species is located 21 km southeast of the Project area (ALA 2025).
Cycas megacarpa NC Act: E	This species is endemic to south-east Queensland. It is found from as far south as Woolooga to Bouldercombe in the north (Queensland Herbarium 2007). This species is found in woodland, open woodland and open forests, often in conjunction with a grassy understory, as well as on the edge of rainforest habitat. Associated species included *Eucalyptus crebra* and *Corymbia citriodora* as well as *Corymbia erythrophloia*, *Eucalyptus melanophloia* and *Lophostemon confertus* (Queensland Herbarium 2007).	**Possible**. Suitable habitat for the species occurs within the Project area in the form of remnant woodland and open-forest with a grassy understorey. The nearest historical record of the species is located 24 km southwest of the Project area (ALA 2025).
Dansiea elliptica NC Act: NT	The species is known to occur across two disjunct regions including the Wet Tropic of NE Qld and central Queensland (Queensland Herbarium 2012a). Suitable habitat for the species includes lowland dry rainforest and vine thicket communities (Queensland Herbarium 2012a).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. No historical records of the species occur within 25 km of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Discolorous-leaved Ironbark (*Eucalyptus decolor*) NC Act: NT	This species is restricted to Queensland. It is distributed as far north as Castle Tower National Park (north west of Miriam Vale) to south to the ranges south of Biggenden (Mount Walsh National Park). The species occurs within Castle Tower National Park; Many Peaks Range; Eurimbula National Park; Gongiberoo Range; and Mt Walsh National Park, near Biggenden (DESI 2024). This species grows in open forest or open tall woodland on ridges, crest or steep slopes on grey loams or shallow soils derived from granite or sandstone from 160 to 550 metres above sea-level. Associated species include: C*orymbia citriodora, C. trachyphloia subsp. trachyphloia, Eucalyptus major, E. moluccana, E. acmenoides, E. montivaga, E. exserta, Allocasuarina littoralis, Lophostemon confertus, Leptospermum neglectum, Pomaderris argyrophylla, Arundinella nepalensis* and *Eremochloa bimaculata*, and *E. montivaga.*	**Unlikely**. The Project area is beyond the known distribution of the species and suitable habitat in the form of open forest or open tall woodland on ridges, crest or steep slopes does not occur within the Project area. The nearest historical record of the species is located 6 km southeast of the Project area (ALA 2025).
Graptophyllum excelsum	The species occurs across the coastal regions of northern and southern Queensland (Queensland Herbarium 2012b). Suitable habitat for the species includes semi-evergreen vine thickets and grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* (Queensland Herbarium 2012b).	**Unlikely**. Suitable habitat for the species in the form of semi-evergreen vine thickets or grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* do not occur within the Project area. The nearest historical record of the species is located 16 km north of the Project area (ALA 2025).
Grevillea (*Grevillea venusta*)	The species is restricted to central eastern Queensland, where it occurs in coastal areas from Many Peaks Range to Shoalwater Bay (Makinson, 2000). Suitable habitat for the species includes rocky areas at the foot of mountains, along drainage lines in sandy soil, and forests and woodlands on granite. Suitable vegetation communities include *Eucalyptus acmenoides*, *Corymbia trachyphloia*, *Eucalyptus exserta* open forest on shallow rocky soil with granite, and open forest with *Corymbia intermedia*, *Syncarpia glomulifera* and *Eucalyptus acmenoides*.	**Unlikely**. Habitat with suitable vegetation communities does not occur within the Project area. Historical records include 17 occurrence records within 25 km of the Project area with the nearest record located 6 km southeast of the Project area (ALA 2025).
Macropteranthes leiocaulis NC Act: NT	*Macropteranthes leiocaulis* grows in vine thickets and dry rainforest from approximately Gayndah to Townsville (Harden et al 2018).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. The nearest historical record occurs 19 km north north-east of the Project area (ALAL 2025).
Many Peaks Apatophyllum (*Apatophyllum olsenii*) NC Act: E	This species is known from three localities in the Many Peak Range, south of Gladstone, Queensland. Two populations occur in the vicinity of Castle Tower National Park (NP). One population occurs in the NP on the east slopes of Many Peaks Range and contains six plants. The other population occurs just out of the Park, west of Castletower Mountain, and is described as small. The third population occurs about 40 km to the south of Castle Tower NP (DEWHA, 2008). This species inhabits granite ridges and granite boulder outcrops in open forest or tall shrubland with *Eucalyptus exserta, Lophostemon confertus, and Xanthorrhoea johnsonii* (DEWHA, 2008a).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. Historical records of the species include four records 6.5-9 km southeast of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Narrow-leaved Mallettwood (*Rhodamnia angustifolia*) NC Act: CR	The species is known from a single location at the head of Cedar Creek along a single ridgetop and subtending slopes in the Wietalaba National Park, 45 km south of Gladstone (Queensland Herbarium 2012c). Suitable habitat for the species includes microphyll vineforest with *Backhousia subargentea, Barklya syringifolia, Archidendropsis thozetiana, Backhousia kingii, Sterculia quadrifida, Mallotus philippensis, Croton stigmatosus* and *Araucaria cunninghamii* as the dominant tree species. The substrate is reddish or brown loam from mudstones of Muncon volcanics. The elevation range is from 200 to 560 metres (Snow and Guymer, 1999).	**Unlikely**. Suitable habitat for the species in the form of microphyll vine forest does not occur within the Project area. The nearest historical record is located 18 km south-southwest of the Project area (ALA 2025).
Parsonsia kroombitensis NC Act: V	The species occurs in central east Queensland at Kroombit Tops NP, Boyne Range SF and Cania Gorge NP north-west of Monto (Wang 1998, William 1996). Suitable habitat for the species includes low shrubby woodland and open shrubland along the escarpments of deep valleys, outcrops of acidic volcanic rocks and on skeletal soils derived from sandstone (Queensland Herbarium 2011c).	**Unlikely**. Suitable habitat for the species in the form of low shrubby woodland or open shrubland does not occur within the Project area. The nearest historical record is located 3 km west of the Project area (ALA 2025).
Rib-fruited Malletwood (*Rhodamnia dumicola*) NC Act: E	Occurs in sub-coastal dry rainforest communities from Beenleigh north to the Gladstone area (Leiper et al. 2014, ALA 2022).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. The nearest record of the species is 20 km northeast of the Project area (ALA 2025)
Scarlet Fuchsia (*Graptophyllum excelsum*) NC Act: NT	The species occurs across the coastal regions of northern and southern Queensland (Queensland Herbarium 2012c). Suitable habitat for the species includes semi-evergreen vine thickets and grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* (Queensland Herbarium 2012c).	**Unlikely**. Suitable habitat for the species in the form of semi-evergreen vine thickets or grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* do not occur within the Project area. The nearest historical record of the specie is located 16 km north of the Project area (ALA 2025).
Scleromitrion gibsonii NC Act: E	The species is restricted to an area west of Miriam Vale in central Queensland where it is known to occur in Araucarian microphyll vineforest and dry rainforest (DES 2023).	**Unlikely**. Suitable habitat for the species in the form of *Araucarian* microphyll vine forest and dry rainforest do not occur within the Project area. The nearest historical record of the species is located 18 km south-southwest of the Project area (ALA 2025).
Scrub Ironbark (*Rhodamnia spongiosa*) NC Act: CR	The species is a rainforest tree or shrub which occurs in North and Central east Queensland as well as the Cape York Peninsula. Scrub Ironbark occurs as an understory tree in a variety of established drier rainforest environments and is commonly associated with Kauri Pine (*Agathis robusta)* (Zich et al 2020).	**Unlikely**. Suitable habitat for the species in the form of dry rainforest and Kauri Pine do not occur within the Project area. The nearest record of the species is located 20 km northeast of the Project area (ALA 2025).
Smooth Malletwood (*Rhodamnia glabrescens*) NC Act: NT	The species is known to occur around the districted of Miriam Vale, Mt Boogooramunya and Proserpine (Harden et al 2018). Suitable habitat for the species includes dry rainforest and subtropical rainforest (Harden et al 2018).	**Unlikely**. Suitable habitat for the species in the form of rainforest does not occur within the Project area. The nearest historical record of the species is located 20 km southeast of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Southern Penda (*Xanthostemon oppositifolius*)	The species is distributed from Miriam Vale in the north to Noosa Heads in the south (ALA 2024). Suitable habitat for the species includes notophyll and microphyll vineforest and wet sclerophyll forest (DESI 2024).	**Unlikely**. Suitable vineforest habitat does not occur within the Project area. There are no historical records within 25 km with the nearest record located 57 km southeast of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Acacia sp. (Castletower N. Gibson TO1345) NC Act: V	The species is endemic to Queensland and in restricted to a single known population in the Mt Castletower area along a stream order 3 waterway (Queensland Herbarium 2011a). The single known population occurs in riverine vegetation at 45 m ASL (Halford 2011).	**Unlikely**. Suitable riverine habitat does not occur within the Project area. The nearest historical record of the species is located 9 km southeast of the Project area (ALA 2025).
Acacia eremophiloides NC Act: V	This species is a resinous shrub which grows in shallow well-drained sandy soils on exposed granite ridges at altitudes between 460-550 m. The species occurs in a small isolated population restricted to a distribution range of less than 10 km, in the Burnett Pastoral District of south-eastern Queensland, located 46 km south southwest of Gayndah (DCCEWW 2025).	**Unlikely.** The species has a highly restricted range located over 200 km southwest of the Project area (ALA 2025). The nearest unverified record is located 20 km southwest of the Project area which does not align with its known distribution and is likely incorrectly recorded (ALA 2025).
Bergera crenulata (Turcz.) F.J.Mou NC Act – CR	The species is in the *Rutaceae* family and is a small shrub or tree. The species distribution in Australia is restricted to isolated and scattered records recorded as far north as Goodedulla National Park northwest of Rockhampton and as far south as Gatton in southeast Queensland.	**Unlikely.** The species only occurs in scattered and isolated locations, the closest record is located 15 km south-southeast of the Project area (ALA 2025).
Cassinia collina NC Act: V	The species occurs three locations including Mount Walsh NP, Wongi SF and Mt Stanley (Queensland Herbarium 2011b). Suitable habitat for the species includes open forest on stony soils or sandy loams, along rocky creek banks in fine-grained granite, tall woodland with *Eucalyptus dura, Corymbia trachyphloia* and *Acacia blakei*, and woodland dominated by *Corymbia citriodora, E, acmenoides, C. trachyphloia* and *E. crebra* on shallow sandy soils (Queensland Herbarium 2011b).	**Possible**. Suitable habitat occurs within the Project area in the form of remnant woodland on stony granite soils, however the nearest historical record occurs 14 km southeast of the Project area (ALA 2025).
Cudgerie (*Hernandia bivalvis*) NC Act: NT	This species is restricted to the central coastal and south-east Queensland, between Dryander Creek south to Mt Tamborine. It has also been recorded from Mt Colosseum National Park (DESI 2024). This species grows in vine thicket, microphyll vine forest, or rainforests on rock pavements and outcrops with shallow soils. It occurs up to 620 m altitude (DESI 2024).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. The nearest historical record of the species is located 21 km southeast of the Project area (ALA 2025).
Cycas megacarpa NC Act: E	This species is endemic to south-east Queensland. It is found from as far south as Woolooga to Bouldercombe in the north (Queensland Herbarium 2007). This species is found in woodland, open woodland and open forests, often in conjunction with a grassy understory, as well as on the edge of rainforest habitat. Associated species included *Eucalyptus crebra* and *Corymbia citriodora* as well as *Corymbia erythrophloia*, *Eucalyptus melanophloia* and *Lophostemon confertus* (Queensland Herbarium 2007).	**Possible**. Suitable habitat for the species occurs within the Project area in the form of remnant woodland and open-forest with a grassy understorey. The nearest historical record of the species is located 24 km southwest of the Project area (ALA 2025).
Dansiea elliptica NC Act: NT	The species is known to occur across two disjunct regions including the Wet Tropic of NE Qld and central Queensland (Queensland Herbarium 2012a). Suitable habitat for the species includes lowland dry rainforest and vine thicket communities (Queensland Herbarium 2012a).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. No historical records of the species occur within 25 km of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Discolorous-leaved Ironbark (*Eucalyptus decolor*) NC Act: NT	This species is restricted to Queensland. It is distributed as far north as Castle Tower National Park (north west of Miriam Vale) to south to the ranges south of Biggenden (Mount Walsh National Park). The species occurs within Castle Tower National Park; Many Peaks Range; Eurimbula National Park; Gongiberoo Range; and Mt Walsh National Park, near Biggenden (DESI 2024). This species grows in open forest or open tall woodland on ridges, crest or steep slopes on grey loams or shallow soils derived from granite or sandstone from 160 to 550 metres above sea-level. Associated species include: C*orymbia citriodora, C. trachyphloia subsp. trachyphloia, Eucalyptus major, E. moluccana, E. acmenoides, E. montivaga, E. exserta, Allocasuarina littoralis, Lophostemon confertus, Leptospermum neglectum, Pomaderris argyrophylla, Arundinella nepalensis* and *Eremochloa bimaculata*, and *E. montivaga.*	**Unlikely**. The Project area is beyond the known distribution of the species and suitable habitat in the form of open forest or open tall woodland on ridges, crest or steep slopes does not occur within the Project area. The nearest historical record of the species is located 6 km southeast of the Project area (ALA 2025).
Graptophyllum excelsum	The species occurs across the coastal regions of northern and southern Queensland (Queensland Herbarium 2012b). Suitable habitat for the species includes semi-evergreen vine thickets and grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* (Queensland Herbarium 2012b).	**Unlikely**. Suitable habitat for the species in the form of semi-evergreen vine thickets or grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* do not occur within the Project area. The nearest historical record of the species is located 16 km north of the Project area (ALA 2025).
Grevillea (*Grevillea venusta*)	The species is restricted to central eastern Queensland, where it occurs in coastal areas from Many Peaks Range to Shoalwater Bay (Makinson, 2000). Suitable habitat for the species includes rocky areas at the foot of mountains, along drainage lines in sandy soil, and forests and woodlands on granite. Suitable vegetation communities include *Eucalyptus acmenoides*, *Corymbia trachyphloia*, *Eucalyptus exserta* open forest on shallow rocky soil with granite, and open forest with *Corymbia intermedia*, *Syncarpia glomulifera* and *Eucalyptus acmenoides*.	**Unlikely**. Habitat with suitable vegetation communities does not occur within the Project area. Historical records include 17 occurrence records within 25 km of the Project area with the nearest record located 6 km southeast of the Project area (ALA 2025).
Macropteranthes leiocaulis NC Act: NT	*Macropteranthes leiocaulis* grows in vine thickets and dry rainforest from approximately Gayndah to Townsville (Harden et al 2018).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. The nearest historical record occurs 19 km north north-east of the Project area (ALAL 2025).
Many Peaks Apatophyllum (*Apatophyllum olsenii*) NC Act: E	This species is known from three localities in the Many Peak Range, south of Gladstone, Queensland. Two populations occur in the vicinity of Castle Tower National Park (NP). One population occurs in the NP on the east slopes of Many Peaks Range and contains six plants. The other population occurs just out of the Park, west of Castletower Mountain, and is described as small. The third population occurs about 40 km to the south of Castle Tower NP (DEWHA, 2008). This species inhabits granite ridges and granite boulder outcrops in open forest or tall shrubland with *Eucalyptus exserta, Lophostemon confertus, and Xanthorrhoea johnsonii* (DEWHA, 2008a).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. Historical records of the species include four records 6.5-9 km southeast of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Narrow-leaved Mallettwood (*Rhodamnia angustifolia*) NC Act: CR	The species is known from a single location at the head of Cedar Creek along a single ridgetop and subtending slopes in the Wietalaba National Park, 45 km south of Gladstone (Queensland Herbarium 2012c). Suitable habitat for the species includes microphyll vineforest with *Backhousia subargentea, Barklya syringifolia, Archidendropsis thozetiana, Backhousia kingii, Sterculia quadrifida, Mallotus philippensis, Croton stigmatosus* and *Araucaria cunninghamii* as the dominant tree species. The substrate is reddish or brown loam from mudstones of Muncon volcanics. The elevation range is from 200 to 560 metres (Snow and Guymer, 1999).	**Unlikely**. Suitable habitat for the species in the form of microphyll vine forest does not occur within the Project area. The nearest historical record is located 18 km south-southwest of the Project area (ALA 2025).
Parsonsia kroombitensis NC Act: V	The species occurs in central east Queensland at Kroombit Tops NP, Boyne Range SF and Cania Gorge NP north-west of Monto (Wang 1998, William 1996). Suitable habitat for the species includes low shrubby woodland and open shrubland along the escarpments of deep valleys, outcrops of acidic volcanic rocks and on skeletal soils derived from sandstone (Queensland Herbarium 2011c).	**Unlikely**. Suitable habitat for the species in the form of low shrubby woodland or open shrubland does not occur within the Project area. The nearest historical record is located 3 km west of the Project area (ALA 2025).
Rib-fruited Malletwood (*Rhodamnia dumicola*) NC Act: E	Occurs in sub-coastal dry rainforest communities from Beenleigh north to the Gladstone area (Leiper et al. 2014, ALA 2022).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. The nearest record of the species is 20 km northeast of the Project area (ALA 2025)
Scarlet Fuchsia (*Graptophyllum excelsum*) NC Act: NT	The species occurs across the coastal regions of northern and southern Queensland (Queensland Herbarium 2012c). Suitable habitat for the species includes semi-evergreen vine thickets and grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* (Queensland Herbarium 2012c).	**Unlikely**. Suitable habitat for the species in the form of semi-evergreen vine thickets or grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* do not occur within the Project area. The nearest historical record of the specie is located 16 km north of the Project area (ALA 2025).
Scleromitrion gibsonii NC Act: E	The species is restricted to an area west of Miriam Vale in central Queensland where it is known to occur in Araucarian microphyll vineforest and dry rainforest (DES 2023).	**Unlikely**. Suitable habitat for the species in the form of *Araucarian* microphyll vine forest and dry rainforest do not occur within the Project area. The nearest historical record of the species is located 18 km south-southwest of the Project area (ALA 2025).
Scrub Ironbark (*Rhodamnia spongiosa*) NC Act: CR	The species is a rainforest tree or shrub which occurs in North and Central east Queensland as well as the Cape York Peninsula. Scrub Ironbark occurs as an understory tree in a variety of established drier rainforest environments and is commonly associated with Kauri Pine (*Agathis robusta)* (Zich et al 2020).	**Unlikely**. Suitable habitat for the species in the form of dry rainforest and Kauri Pine do not occur within the Project area. The nearest record of the species is located 20 km northeast of the Project area (ALA 2025).
Smooth Malletwood (*Rhodamnia glabrescens*) NC Act: NT	The species is known to occur around the districted of Miriam Vale, Mt Boogooramunya and Proserpine (Harden et al 2018). Suitable habitat for the species includes dry rainforest and subtropical rainforest (Harden et al 2018).	**Unlikely**. Suitable habitat for the species in the form of rainforest does not occur within the Project area. The nearest historical record of the species is located 20 km southeast of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Southern Penda (*Xanthostemon oppositifolius*)	The species is distributed from Miriam Vale in the north to Noosa Heads in the south (ALA 2024). Suitable habitat for the species includes notophyll and microphyll vineforest and wet sclerophyll forest (DESI 2024).	**Unlikely**. Suitable vineforest habitat does not occur within the Project area. There are no historical records within 25 km with the nearest record located 57 km southeast of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Acacia sp. (Castletower N. Gibson TO1345) NC Act: V	The species is endemic to Queensland and in restricted to a single known population in the Mt Castletower area along a stream order 3 waterway (Queensland Herbarium 2011a). The single known population occurs in riverine vegetation at 45 m ASL (Halford 2011).	**Unlikely**. Suitable riverine habitat does not occur within the Project area. The nearest historical record of the species is located 9 km southeast of the Project area (ALA 2025).
Acacia eremophiloides NC Act: V	This species is a resinous shrub which grows in shallow well-drained sandy soils on exposed granite ridges at altitudes between 460-550 m. The species occurs in a small isolated population restricted to a distribution range of less than 10 km, in the Burnett Pastoral District of south-eastern Queensland, located 46 km south southwest of Gayndah (DCCEWW 2025).	**Unlikely.** The species has a highly restricted range located over 200 km southwest of the Project area (ALA 2025). The nearest unverified record is located 20 km southwest of the Project area which does not align with its known distribution and is likely incorrectly recorded (ALA 2025).
Bergera crenulata (Turcz.) F.J.Mou NC Act – CR	The species is in the *Rutaceae* family and is a small shrub or tree. The species distribution in Australia is restricted to isolated and scattered records recorded as far north as Goodedulla National Park northwest of Rockhampton and as far south as Gatton in southeast Queensland.	**Unlikely.** The species only occurs in scattered and isolated locations, the closest record is located 15 km south-southeast of the Project area (ALA 2025).
Cassinia collina NC Act: V	The species occurs three locations including Mount Walsh NP, Wongi SF and Mt Stanley (Queensland Herbarium 2011b). Suitable habitat for the species includes open forest on stony soils or sandy loams, along rocky creek banks in fine-grained granite, tall woodland with *Eucalyptus dura, Corymbia trachyphloia* and *Acacia blakei*, and woodland dominated by *Corymbia citriodora, E, acmenoides, C. trachyphloia* and *E. crebra* on shallow sandy soils (Queensland Herbarium 2011b).	**Possible**. Suitable habitat occurs within the Project area in the form of remnant woodland on stony granite soils, however the nearest historical record occurs 14 km southeast of the Project area (ALA 2025).
Cudgerie (*Hernandia bivalvis*) NC Act: NT	This species is restricted to the central coastal and south-east Queensland, between Dryander Creek south to Mt Tamborine. It has also been recorded from Mt Colosseum National Park (DESI 2024). This species grows in vine thicket, microphyll vine forest, or rainforests on rock pavements and outcrops with shallow soils. It occurs up to 620 m altitude (DESI 2024).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. The nearest historical record of the species is located 21 km southeast of the Project area (ALA 2025).
Cycas megacarpa NC Act: E	This species is endemic to south-east Queensland. It is found from as far south as Woolooga to Bouldercombe in the north (Queensland Herbarium 2007). This species is found in woodland, open woodland and open forests, often in conjunction with a grassy understory, as well as on the edge of rainforest habitat. Associated species included *Eucalyptus crebra* and *Corymbia citriodora* as well as *Corymbia erythrophloia*, *Eucalyptus melanophloia* and *Lophostemon confertus* (Queensland Herbarium 2007).	**Possible**. Suitable habitat for the species occurs within the Project area in the form of remnant woodland and open-forest with a grassy understorey. The nearest historical record of the species is located 24 km southwest of the Project area (ALA 2025).
Dansiea elliptica NC Act: NT	The species is known to occur across two disjunct regions including the Wet Tropic of NE Qld and central Queensland (Queensland Herbarium 2012a). Suitable habitat for the species includes lowland dry rainforest and vine thicket communities (Queensland Herbarium 2012a).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. No historical records of the species occur within 25 km of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Discolorous-leaved Ironbark (*Eucalyptus decolor*) NC Act: NT	This species is restricted to Queensland. It is distributed as far north as Castle Tower National Park (north west of Miriam Vale) to south to the ranges south of Biggenden (Mount Walsh National Park). The species occurs within Castle Tower National Park; Many Peaks Range; Eurimbula National Park; Gongiberoo Range; and Mt Walsh National Park, near Biggenden (DESI 2024). This species grows in open forest or open tall woodland on ridges, crest or steep slopes on grey loams or shallow soils derived from granite or sandstone from 160 to 550 metres above sea-level. Associated species include: C*orymbia citriodora, C. trachyphloia subsp. trachyphloia, Eucalyptus major, E. moluccana, E. acmenoides, E. montivaga, E. exserta, Allocasuarina littoralis, Lophostemon confertus, Leptospermum neglectum, Pomaderris argyrophylla, Arundinella nepalensis* and *Eremochloa bimaculata*, and *E. montivaga.*	**Unlikely**. The Project area is beyond the known distribution of the species and suitable habitat in the form of open forest or open tall woodland on ridges, crest or steep slopes does not occur within the Project area. The nearest historical record of the species is located 6 km southeast of the Project area (ALA 2025).
Graptophyllum excelsum	The species occurs across the coastal regions of northern and southern Queensland (Queensland Herbarium 2012b). Suitable habitat for the species includes semi-evergreen vine thickets and grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* (Queensland Herbarium 2012b).	**Unlikely**. Suitable habitat for the species in the form of semi-evergreen vine thickets or grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* do not occur within the Project area. The nearest historical record of the species is located 16 km north of the Project area (ALA 2025).
Grevillea (*Grevillea venusta*)	The species is restricted to central eastern Queensland, where it occurs in coastal areas from Many Peaks Range to Shoalwater Bay (Makinson, 2000). Suitable habitat for the species includes rocky areas at the foot of mountains, along drainage lines in sandy soil, and forests and woodlands on granite. Suitable vegetation communities include *Eucalyptus acmenoides*, *Corymbia trachyphloia*, *Eucalyptus exserta* open forest on shallow rocky soil with granite, and open forest with *Corymbia intermedia*, *Syncarpia glomulifera* and *Eucalyptus acmenoides*.	**Unlikely**. Habitat with suitable vegetation communities does not occur within the Project area. Historical records include 17 occurrence records within 25 km of the Project area with the nearest record located 6 km southeast of the Project area (ALA 2025).
Macropteranthes leiocaulis NC Act: NT	*Macropteranthes leiocaulis* grows in vine thickets and dry rainforest from approximately Gayndah to Townsville (Harden et al 2018).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. The nearest historical record occurs 19 km north north-east of the Project area (ALAL 2025).
Many Peaks Apatophyllum (*Apatophyllum olsenii*) NC Act: E	This species is known from three localities in the Many Peak Range, south of Gladstone, Queensland. Two populations occur in the vicinity of Castle Tower National Park (NP). One population occurs in the NP on the east slopes of Many Peaks Range and contains six plants. The other population occurs just out of the Park, west of Castletower Mountain, and is described as small. The third population occurs about 40 km to the south of Castle Tower NP (DEWHA, 2008). This species inhabits granite ridges and granite boulder outcrops in open forest or tall shrubland with *Eucalyptus exserta, Lophostemon confertus, and Xanthorrhoea johnsonii* (DEWHA, 2008a).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. Historical records of the species include four records 6.5-9 km southeast of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Narrow-leaved Mallettwood (*Rhodamnia angustifolia*) NC Act: CR	The species is known from a single location at the head of Cedar Creek along a single ridgetop and subtending slopes in the Wietalaba National Park, 45 km south of Gladstone (Queensland Herbarium 2012c). Suitable habitat for the species includes microphyll vineforest with *Backhousia subargentea, Barklya syringifolia, Archidendropsis thozetiana, Backhousia kingii, Sterculia quadrifida, Mallotus philippensis, Croton stigmatosus* and *Araucaria cunninghamii* as the dominant tree species. The substrate is reddish or brown loam from mudstones of Muncon volcanics. The elevation range is from 200 to 560 metres (Snow and Guymer, 1999).	**Unlikely**. Suitable habitat for the species in the form of microphyll vine forest does not occur within the Project area. The nearest historical record is located 18 km south-southwest of the Project area (ALA 2025).
Parsonsia kroombitensis NC Act: V	The species occurs in central east Queensland at Kroombit Tops NP, Boyne Range SF and Cania Gorge NP north-west of Monto (Wang 1998, William 1996). Suitable habitat for the species includes low shrubby woodland and open shrubland along the escarpments of deep valleys, outcrops of acidic volcanic rocks and on skeletal soils derived from sandstone (Queensland Herbarium 2011c).	**Unlikely**. Suitable habitat for the species in the form of low shrubby woodland or open shrubland does not occur within the Project area. The nearest historical record is located 3 km west of the Project area (ALA 2025).
Rib-fruited Malletwood (*Rhodamnia dumicola*) NC Act: E	Occurs in sub-coastal dry rainforest communities from Beenleigh north to the Gladstone area (Leiper et al. 2014, ALA 2022).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. The nearest record of the species is 20 km northeast of the Project area (ALA 2025)
Scarlet Fuchsia (*Graptophyllum excelsum*) NC Act: NT	The species occurs across the coastal regions of northern and southern Queensland (Queensland Herbarium 2012c). Suitable habitat for the species includes semi-evergreen vine thickets and grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* (Queensland Herbarium 2012c).	**Unlikely**. Suitable habitat for the species in the form of semi-evergreen vine thickets or grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* do not occur within the Project area. The nearest historical record of the specie is located 16 km north of the Project area (ALA 2025).
Scleromitrion gibsonii NC Act: E	The species is restricted to an area west of Miriam Vale in central Queensland where it is known to occur in Araucarian microphyll vineforest and dry rainforest (DES 2023).	**Unlikely**. Suitable habitat for the species in the form of *Araucarian* microphyll vine forest and dry rainforest do not occur within the Project area. The nearest historical record of the species is located 18 km south-southwest of the Project area (ALA 2025).
Scrub Ironbark (*Rhodamnia spongiosa*) NC Act: CR	The species is a rainforest tree or shrub which occurs in North and Central east Queensland as well as the Cape York Peninsula. Scrub Ironbark occurs as an understory tree in a variety of established drier rainforest environments and is commonly associated with Kauri Pine (*Agathis robusta)* (Zich et al 2020).	**Unlikely**. Suitable habitat for the species in the form of dry rainforest and Kauri Pine do not occur within the Project area. The nearest record of the species is located 20 km northeast of the Project area (ALA 2025).
Smooth Malletwood (*Rhodamnia glabrescens*) NC Act: NT	The species is known to occur around the districted of Miriam Vale, Mt Boogooramunya and Proserpine (Harden et al 2018). Suitable habitat for the species includes dry rainforest and subtropical rainforest (Harden et al 2018).	**Unlikely**. Suitable habitat for the species in the form of rainforest does not occur within the Project area. The nearest historical record of the species is located 20 km southeast of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Southern Penda (*Xanthostemon oppositifolius*)	The species is distributed from Miriam Vale in the north to Noosa Heads in the south (ALA 2024). Suitable habitat for the species includes notophyll and microphyll vineforest and wet sclerophyll forest (DESI 2024).	**Unlikely**. Suitable vineforest habitat does not occur within the Project area. There are no historical records within 25 km with the nearest record located 57 km southeast of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Acacia sp. (Castletower N. Gibson TO1345) NC Act: V	The species is endemic to Queensland and in restricted to a single known population in the Mt Castletower area along a stream order 3 waterway (Queensland Herbarium 2011a). The single known population occurs in riverine vegetation at 45 m ASL (Halford 2011).	**Unlikely**. Suitable riverine habitat does not occur within the Project area. The nearest historical record of the species is located 9 km southeast of the Project area (ALA 2025).
Acacia eremophiloides NC Act: V	This species is a resinous shrub which grows in shallow well-drained sandy soils on exposed granite ridges at altitudes between 460-550 m. The species occurs in a small isolated population restricted to a distribution range of less than 10 km, in the Burnett Pastoral District of south-eastern Queensland, located 46 km south southwest of Gayndah (DCCEWW 2025).	**Unlikely.** The species has a highly restricted range located over 200 km southwest of the Project area (ALA 2025). The nearest unverified record is located 20 km southwest of the Project area which does not align with its known distribution and is likely incorrectly recorded (ALA 2025).
Bergera crenulata (Turcz.) F.J.Mou NC Act – CR	The species is in the *Rutaceae* family and is a small shrub or tree. The species distribution in Australia is restricted to isolated and scattered records recorded as far north as Goodedulla National Park northwest of Rockhampton and as far south as Gatton in southeast Queensland.	**Unlikely.** The species only occurs in scattered and isolated locations, the closest record is located 15 km south-southeast of the Project area (ALA 2025).
Cassinia collina NC Act: V	The species occurs three locations including Mount Walsh NP, Wongi SF and Mt Stanley (Queensland Herbarium 2011b). Suitable habitat for the species includes open forest on stony soils or sandy loams, along rocky creek banks in fine-grained granite, tall woodland with *Eucalyptus dura, Corymbia trachyphloia* and *Acacia blakei*, and woodland dominated by *Corymbia citriodora, E, acmenoides, C. trachyphloia* and *E. crebra* on shallow sandy soils (Queensland Herbarium 2011b).	**Possible**. Suitable habitat occurs within the Project area in the form of remnant woodland on stony granite soils, however the nearest historical record occurs 14 km southeast of the Project area (ALA 2025).
Cudgerie (*Hernandia bivalvis*) NC Act: NT	This species is restricted to the central coastal and south-east Queensland, between Dryander Creek south to Mt Tamborine. It has also been recorded from Mt Colosseum National Park (DESI 2024). This species grows in vine thicket, microphyll vine forest, or rainforests on rock pavements and outcrops with shallow soils. It occurs up to 620 m altitude (DESI 2024).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. The nearest historical record of the species is located 21 km southeast of the Project area (ALA 2025).
Cycas megacarpa NC Act: E	This species is endemic to south-east Queensland. It is found from as far south as Woolooga to Bouldercombe in the north (Queensland Herbarium 2007). This species is found in woodland, open woodland and open forests, often in conjunction with a grassy understory, as well as on the edge of rainforest habitat. Associated species included *Eucalyptus crebra* and *Corymbia citriodora* as well as *Corymbia erythrophloia*, *Eucalyptus melanophloia* and *Lophostemon confertus* (Queensland Herbarium 2007).	**Possible**. Suitable habitat for the species occurs within the Project area in the form of remnant woodland and open-forest with a grassy understorey. The nearest historical record of the species is located 24 km southwest of the Project area (ALA 2025).
Dansiea elliptica NC Act: NT	The species is known to occur across two disjunct regions including the Wet Tropic of NE Qld and central Queensland (Queensland Herbarium 2012a). Suitable habitat for the species includes lowland dry rainforest and vine thicket communities (Queensland Herbarium 2012a).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. No historical records of the species occur within 25 km of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Discolorous-leaved Ironbark (*Eucalyptus decolor*) NC Act: NT	This species is restricted to Queensland. It is distributed as far north as Castle Tower National Park (north west of Miriam Vale) to south to the ranges south of Biggenden (Mount Walsh National Park). The species occurs within Castle Tower National Park; Many Peaks Range; Eurimbula National Park; Gongiberoo Range; and Mt Walsh National Park, near Biggenden (DESI 2024). This species grows in open forest or open tall woodland on ridges, crest or steep slopes on grey loams or shallow soils derived from granite or sandstone from 160 to 550 metres above sea-level. Associated species include: C*orymbia citriodora, C. trachyphloia subsp. trachyphloia, Eucalyptus major, E. moluccana, E. acmenoides, E. montivaga, E. exserta, Allocasuarina littoralis, Lophostemon confertus, Leptospermum neglectum, Pomaderris argyrophylla, Arundinella nepalensis* and *Eremochloa bimaculata*, and *E. montivaga.*	**Unlikely**. The Project area is beyond the known distribution of the species and suitable habitat in the form of open forest or open tall woodland on ridges, crest or steep slopes does not occur within the Project area. The nearest historical record of the species is located 6 km southeast of the Project area (ALA 2025).
Graptophyllum excelsum	The species occurs across the coastal regions of northern and southern Queensland (Queensland Herbarium 2012b). Suitable habitat for the species includes semi-evergreen vine thickets and grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* (Queensland Herbarium 2012b).	**Unlikely**. Suitable habitat for the species in the form of semi-evergreen vine thickets or grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* do not occur within the Project area. The nearest historical record of the species is located 16 km north of the Project area (ALA 2025).
Grevillea (*Grevillea venusta*)	The species is restricted to central eastern Queensland, where it occurs in coastal areas from Many Peaks Range to Shoalwater Bay (Makinson, 2000). Suitable habitat for the species includes rocky areas at the foot of mountains, along drainage lines in sandy soil, and forests and woodlands on granite. Suitable vegetation communities include *Eucalyptus acmenoides*, *Corymbia trachyphloia*, *Eucalyptus exserta* open forest on shallow rocky soil with granite, and open forest with *Corymbia intermedia*, *Syncarpia glomulifera* and *Eucalyptus acmenoides*.	**Unlikely**. Habitat with suitable vegetation communities does not occur within the Project area. Historical records include 17 occurrence records within 25 km of the Project area with the nearest record located 6 km southeast of the Project area (ALA 2025).
Macropteranthes leiocaulis NC Act: NT	*Macropteranthes leiocaulis* grows in vine thickets and dry rainforest from approximately Gayndah to Townsville (Harden et al 2018).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. The nearest historical record occurs 19 km north north-east of the Project area (ALAL 2025).
Many Peaks Apatophyllum (*Apatophyllum olsenii*) NC Act: E	This species is known from three localities in the Many Peak Range, south of Gladstone, Queensland. Two populations occur in the vicinity of Castle Tower National Park (NP). One population occurs in the NP on the east slopes of Many Peaks Range and contains six plants. The other population occurs just out of the Park, west of Castletower Mountain, and is described as small. The third population occurs about 40 km to the south of Castle Tower NP (DEWHA, 2008). This species inhabits granite ridges and granite boulder outcrops in open forest or tall shrubland with *Eucalyptus exserta, Lophostemon confertus, and Xanthorrhoea johnsonii* (DEWHA, 2008a).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. Historical records of the species include four records 6.5-9 km southeast of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Narrow-leaved Mallettwood (*Rhodamnia angustifolia*) NC Act: CR	The species is known from a single location at the head of Cedar Creek along a single ridgetop and subtending slopes in the Wietalaba National Park, 45 km south of Gladstone (Queensland Herbarium 2012c). Suitable habitat for the species includes microphyll vineforest with *Backhousia subargentea, Barklya syringifolia, Archidendropsis thozetiana, Backhousia kingii, Sterculia quadrifida, Mallotus philippensis, Croton stigmatosus* and *Araucaria cunninghamii* as the dominant tree species. The substrate is reddish or brown loam from mudstones of Muncon volcanics. The elevation range is from 200 to 560 metres (Snow and Guymer, 1999).	**Unlikely**. Suitable habitat for the species in the form of microphyll vine forest does not occur within the Project area. The nearest historical record is located 18 km south-southwest of the Project area (ALA 2025).
Parsonsia kroombitensis NC Act: V	The species occurs in central east Queensland at Kroombit Tops NP, Boyne Range SF and Cania Gorge NP north-west of Monto (Wang 1998, William 1996). Suitable habitat for the species includes low shrubby woodland and open shrubland along the escarpments of deep valleys, outcrops of acidic volcanic rocks and on skeletal soils derived from sandstone (Queensland Herbarium 2011c).	**Unlikely**. Suitable habitat for the species in the form of low shrubby woodland or open shrubland does not occur within the Project area. The nearest historical record is located 3 km west of the Project area (ALA 2025).
Rib-fruited Malletwood (*Rhodamnia dumicola*) NC Act: E	Occurs in sub-coastal dry rainforest communities from Beenleigh north to the Gladstone area (Leiper et al. 2014, ALA 2022).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. The nearest record of the species is 20 km northeast of the Project area (ALA 2025)
Scarlet Fuchsia (*Graptophyllum excelsum*) NC Act: NT	The species occurs across the coastal regions of northern and southern Queensland (Queensland Herbarium 2012c). Suitable habitat for the species includes semi-evergreen vine thickets and grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* (Queensland Herbarium 2012c).	**Unlikely**. Suitable habitat for the species in the form of semi-evergreen vine thickets or grassy woodland dominated by *Eucalyptus cullenii* and *Corymbia erythrophloia* do not occur within the Project area. The nearest historical record of the specie is located 16 km north of the Project area (ALA 2025).
Scleromitrion gibsonii NC Act: E	The species is restricted to an area west of Miriam Vale in central Queensland where it is known to occur in Araucarian microphyll vineforest and dry rainforest (DES 2023).	**Unlikely**. Suitable habitat for the species in the form of *Araucarian* microphyll vine forest and dry rainforest do not occur within the Project area. The nearest historical record of the species is located 18 km south-southwest of the Project area (ALA 2025).
Scrub Ironbark (*Rhodamnia spongiosa*) NC Act: CR	The species is a rainforest tree or shrub which occurs in North and Central east Queensland as well as the Cape York Peninsula. Scrub Ironbark occurs as an understory tree in a variety of established drier rainforest environments and is commonly associated with Kauri Pine (*Agathis robusta)* (Zich et al 2020).	**Unlikely**. Suitable habitat for the species in the form of dry rainforest and Kauri Pine do not occur within the Project area. The nearest record of the species is located 20 km northeast of the Project area (ALA 2025).
Smooth Malletwood (*Rhodamnia glabrescens*) NC Act: NT	The species is known to occur around the districted of Miriam Vale, Mt Boogooramunya and Proserpine (Harden et al 2018). Suitable habitat for the species includes dry rainforest and subtropical rainforest (Harden et al 2018).	**Unlikely**. Suitable habitat for the species in the form of rainforest does not occur within the Project area. The nearest historical record of the species is located 20 km southeast of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Southern Penda (*Xanthostemon oppositifolius*)	The species is distributed from Miriam Vale in the north to Noosa Heads in the south (ALA 2024). Suitable habitat for the species includes notophyll and microphyll vineforest and wet sclerophyll forest (DESI 2024).	**Unlikely**. Suitable vineforest habitat does not occur within the Project area. There are no historical records within 25 km with the nearest record located 57 km southeast of the Project area (ALA 2025).

6.1.4 Weed Species

A total of 26 non-native flora species were identified within the Project area and included invasive grasses, shrubs, vines, herbs and cactus (**Table 7**). A total of six category 3 Biosecurity matters and four WoNS were identified within the Project area with Lantana and Creeping Lantana the most common. Rubber Vine was also relative common in disturbed areas (i.e. rock dumps, residual voids, and adjacent to access tracks) (**Plate 5**). Non-native plant cover ranged from 5% to 45%.

Large infestation of White Cedar (*Melia azedarach*) occurred in rock dump areas (**Plate 6**). The species is technically native to the state of Queensland, however it is not considered a natural component of local vegetation communities and appears to be responding to anthropological disturbance resulting in a novel vegetation community.

Table 7. Non-native flora species identified within the Project area

Common name (Species name)	Species name	Biosecurity status	WoNS
African Lovegrass	*Eragrostis curvula*	-	-
American Ratstail Grass	*Sporobolus jacquemontii*	3	Yes
Argentine Peppercress	*Lepidium bonariense*	-	-
Balloon Cottonbush	*Gomphocarpus physocarpus*	-	-
Blue Billygoat Weed	*Ageratum houstonianum*	-	-
Canadian Fleabane	*Conyza bonariensis*	-	-
Castor Oil Bush	*Ricinus communis*	-	-
Cobbler's Pegs	*Bidens pilosa*	-	-
Corky Passion Flower	*Passiflora suberosa*	-	-
Creeping Lantana	*Lantana montevidensis*	3	-
Dwarf Poinsettia	*Euphorbia cyathophora*	-	-
Flannel Weed	*Sida cordifolia*	-	-
Lantana	*Lantana camara*	3	Yes
Lippia	*Phyla canescens*	-	-
Maynes pest	*Glandularia aristigera*	-	-
Mimosa Bush	*Vachellia farnesiana*	3	-
Noogoora Burr	*Xanthium occidentale*	-	-
Prickly Pear	*Opuntia stricta*	3	Yes
Red Natal Grass	*Melinis repens*	-	-
Rubber vine	*Cryptostegia grandiflora*	3	Yes
Shrubby Stylo	*Stylosanthes scabra*	-	-
Siratro	*Macroptilium atropurpureum*	-	-
Snake Weed	*Stachytarpheta cayennensis*	-	-
Urena Weed	*Urena lobata*	-	-
Verbena	*Verbena littoralis*	-	-
Woolly Rattlepod	*Crotalaria incana*	-	-



Plate 5. Rubber Vine infestation



Plate 6. White Cedar infestation

6.1.5 BioCondition

Two BioCondition assessments were completed, one in remnant RE 11.11.15 in the far north of the Project area, and a second within a derived native grassland in the south of the Project area (**Figure 7**).

BioCondition assessment data is provided in **Appendix B**.

6.2 Fauna Survey Results

6.2.1 Fauna Diversity

A total of 23 fauna species (or evidence of) were observed within the Project area during the field survey, including three non-native species. The faunal assemblage was dominated by common diurnal birds, particularly those species that are tolerant of disturbance and able to utilise cleared open areas. A full list of fauna species recorded during the field survey is provided in **Table 8**.

Table 8. Fauna species observed within the Project area

Common name	Species name	Non-native	Biosecurity status
Agile Wallaby	*Notamacropus agilis*	-	-
Bearded Dragon	*Pogona barbata*	-	-
Black Cormorant	*Phalacrocorax sulcirostris*	-	-

Common name	Species name	Non-native	Biosecurity status
Brown Goshawk	*Accipiter fasciatus*	-	-
Brown Quail	*Coturnix ypsilophora*	-	-
Dragon species	*Diporiphora sp.*	-	-
Eastern Grey Kangaroo	*Macropus giganteus*	-	-
Eastern Sedge Frog	*Litoria fallax*	-	-
Feral Pig	*Sus scrofa*	*	3,4,6
Grey Butcherbird	*Cracticus torquatus*	-	-
Kestrel	*Falco cenchroides*	-	-
Magpie	*Gymnorhina tibicen*	-	-
Noisy Friarbird	*Philemon corniculatus*	-	-
Noisy Miner	*Manorina melanocephala*	-	-
Pacific Black Duck	*Anas superciliosa*	-	-
Pied Butcherbird	*Cracticus nigrogularis*	-	-
European Rabbit (scat)	*Oryctolagus cuniculus*	*	3,4,5,6
Red-backed Fairy-wren	*Malurus melanocephalus*	-	-
Striated Pardalote	*Pardalotus striatus*	-	-
Wedge-tailed Eagle	*Audax aquila*	-	-
White-Faced Heron	*Egretta novaehollandiae*	-	-
White-throated Honeyeater	*Melithreptus albogularis*	-	-
Wild Dog/dingo (scat)	*Canis sp.*	*	3,4,6

6.2.2 Fauna Habitats

A total of seven habitat assessments were completed within the Project area (**Figure 7**). Fauna habitat within the Project is limited relative to the broader landscape. Remnant open-forests and woodland provide suitable habitat for birds, reptiles and mammals. Mature trees (i.e. Narrow-leaved Ironbark) within the Project area provided very few hollows and no large tree hollows were observed within the Project area. The Project area is unlikely to provide habitat for hollow-dependent arboreal mammals.

Fauna abundance and diversity generally declined from remnant to regrowth vegetation, and was poorest in cleared areas, with the exception of Agile Wallabies, which were in high abundance in disturbed areas such as cleared areas, easements and access tracks.

A range of microhabitats suitable for a various fauna occurred onsite. Rock piles were common and likely provide suitable habitat for reptiles and small mammals. Several small farm dams also occur within the southern portion of the Project area, and likely provide drinking water for a range of mammals and birds. Fauna habitat assessment data is provided in **Appendix B**.

6.2.3 Conservation Significant Fauna

The likelihood of occurrence assessment for conservation significant fauna species identified in database searches determined that three conservation significant fauna species, Koala, Squatter Pigeon and White-throated Needletail, are considered likely to occur within the Project area (**Table 10**). An additional conservation significant fauna species is considered a possible occurrence and listed below:

- Powerful Owl

Marine species such as marine mammals and turtles were excluded from the assessment due to the absence of marine environments from the Project area or adjacent areas and not considered in this report.

The remaining conservation significant fauna species area considered unlikely to occur within the Project area and are not considered further in the report.

6.2.4 Pest Species

Three non-native fauna species were observed during the field survey within the Project area, either directly or indirectly through evidence of occurrence (i.e. scats) (**Table 9**).

Table 9. Pest species identified within the Project area

Common name	Species name	Biosecurity Act categories
Feral Pig	*Sus scrofa*	3,4,6
European Rabbit (scat)	*Oryctolagus cuniculus*	3,4,5,6
Wild Dog/dingo (scat)	*Canis sp.*	3,4,6

Table 10. Likelihood of occurrence assessment of conservation significant fauna species

Species	Distribution and habitat	Likelihood of occurrence
Beach-stone Curlew (*Esacus magnirostris*) NC Act: V	The species is distributed along the coast of northern and eastern Australia (ALA 2024). Suitable habitat for the species includes beaches, foredunes, mangroves, tidal flats and offshore islands (Menkhorst et al 2017).	**Unlikely**. Suitable coastal habitat for the species does not occur within the Project area. Historical records include 20 occurrence records within 25 km of the Project area with the nearest record located 17 km east of the Project area (ALA 2025).
Black-breasted Button-quail (*Turnix melanogaster*) NC Act: V	Has been recorded from the Byfield region in the north to at least the Border Ranges rainforests, generally east of the Great Dividing Range, although some observations have been made on its western slopes, up to 300 km inland at locations such as Palm Grove National Park and Barakula State Forest in Queensland (Marchant & Higgins 1993; Smyth & Pavey 2001; Garnett et al. 2011). Habitat considered critical to the survival of the black-breasted button-quail includes: Vine thickets and rainforest vegetation types, particularly semi-evergreen vine thicket, low microphyll vine forest, *Araucarian* microphyll vine forest, *Araucarian* notophyll vine forest and *Brachychiton* scrubs; Low thickets or woodlands with a dense understorey but little ground cover, typically dominated by Acacia spp.; and in littoral situations, dry vine scrubs, acacia thickets and areas densely covered in shrubs, particularly *Austromyrtus dulcis* and Lantana (DEECCW 2022).	**Unlikely**. Suitable rainforest/thicket vegetation does not occur within the Project area. The species was not observed within the Project area during field surveys. The nearest record of the species is located 20 km northeast of the Project area on Boyne Island (ALA 2025).
Common Greenshank (*Tringa nebularia*) NC Act: E	Recorded in most coastal regions. Inland, there have been a few records south of a line from near Dalby to Mt Guide, and sparsely scattered records elsewhere. Sites of international importance in Queensland include the south-east Gulf of Carpentaria and the Great Sandy Strait (DotE 2015a). The species occurs in all types of wetlands. This species inhabits a wide variety of inland wetlands and sheltered coastal habitats of varying salinity, including sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass, both permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats (DotE 2015a).	**Unlikely** - Suitable coastal and wetland habitats are not present within the Project area. The closest occurrence record for the species was recorded 1.9 km northeast of the Project area (ALA 2025)**.**
Curlew Sandpiper (*Calidris ferruginea*) NC Act: CR	The species migrates to coastal regions of Australia with scattered location inland (DE 2015a). This species usually forages and roosts in intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms (DE 2015a).	**Unlikely**. Suitable wetland habitat for the species does not occur within the Project area. Historical records of the species include 23 occurrence records within 25 km with the nearest record 1.5 km northeast of the Project area (ALA 2025).
Eastern Curlew (*Numenius madagascariensis*) NC Act: E	Coastal distribution in all states. Rarely recorded inland. Continuous distribution along the Qld coast. Internationally important sites occur in Great Sandy Strait, Moreton Bay, Shoalwater Bay and Broad Sound, Notch Point (Ilbilbie), SE Gulf of Carpentaria and Mackay Town Beach (DCCEEW 2023). Typically inhabit sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets.	**Unlikely**. Suitable habitat for the species does not occur within the Project area. Historical records of the species include 88 occurrence records within 25 km of the Project area (ALA 2025).

Species	Distribution and habitat	Likelihood of occurrence
Glossy Black-cockatoo (northern) (*Calyptorhynchus lathami erebus*) NC Act: V	This species is widespread across the north and central east coast of Queensland and is found north of the Dawes and Many Peaks ranges to north of the Connors-Clarke Ranges and as far west as the Denham Ranges. The Glossy Black-cockatoo (northern) has a similar preferred habitat to the Glossy Black-cockatoo (south-eastern) preferring woodlands dominated by casuarina and Allocasuarina species (Horigan 2012). The species is visually similar to the Glossy Black-cockatoo (south-eastern) and can be distinguished by the smaller size of its bill (DCCEEW 2022).	**Unlikely.** Suitable habitat for the species was not recorded within the Project area, and no Casuarina or Allocasuarina species were identified. The closest occurrence record for the species is located approximately 19 km northeast of the Project area (ALA 2025)**.**
Great Knot (*Calidris tenuirostris*) NC Act: CR	The species is known to occur along the entire Australian coastline (DCCEEW 2023). Suitable habitat for the species includes sheltered coastal habitats, with large intertidal mudflats or sandflats, inlets, bays, harbours, estuaries and lagoons, exposed reefs or rock platforms, shorelines with mangrove vegetation, ponds in saltworks, at swamps near the coast, saltlakes and non-tidal lagoons (DCCEEW 2023).	**Unlikely**. Suitable wetland or coastal habitats do not occur within the Project. Historical records of the species include two occurrence records within 25 km of the Project area with the neatest record located 20 km north-northeast of the Project area (ALA 2025).
Greater Sand Plover (*Charadrius leschenaultii*) NC Act: V	Greater Sand Plovers occur along most of the coastline but are more widespread in northern Australia (DCCEEW 2022). There are 5 sites in Australia of international importance including the south-eastern corner of Gulf of Carpentaria, Queensland (Bamford et al. 2008). The species forages on intertidal mudflats and sandflats, usually in sheltered bays and estuaries but also on ocean beaches, coral reefs and rock platforms. It roosts on beaches, sandbars and estuarine lagoons and occasionally rocky islets and reefs (Marchant & Higgins 1993).	**Unlikely**. Suitable wetland or coastal habitats do not occur within the Project. Historical records of the species include six occurrence records with 25 km of the Project area with the nearest record located 16 km east of the Project area (ALA 2025).
Grey plover (*Pluvialis squatarola*) NC Act: V	The Grey Plover is a migratory shorebird which breeds in Alaska, northern Siberia and northern Canada, migrating during the non-breeding season (austral summer). The Australian distribution of the species is located primarily along the west and south coasts; however, they can be found in all States. The species distribution in Queensland is most recorded around the south-eastern Gulf of Carpentaria. The Grey Plover feeds within the whole tidal range, feeding diurnally on polychaete worms, marine molluscs and crustaceans, and to a lesser extent, insects. The species roosts in sandy areas such as unvegetated sandbanks and sheltered habitats such as estuaries, lagoons or sheltered beaches (DCCEEW 2024a).	**Unlikely –** Suitable coastal habitat for the species does not occur within the Project area. The closes record for the species is approximately 22 km northeast of the Project area along the coast (ALA 2025).
Koala (*Phascolarctos cinereus*) NC Act: LC	In Queensland, the species contains scattered populations throughout moist forests along the coastline, subhumid woodlands in central and southern regions and within eucalypt woodlands along watercourses within semi-arid areas further west. Koalas occur in a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by *Eucalyptus* species (preference varying regionally). Diet is thought to be a major determinant of habitat selection, with the use small remnants of original vegetation where suitable habitat is present. Koalas are also known to occur in modified or regenerating native vegetation communities, as well as urban and rural landscapes where food trees or shelter trees may be highly scattered (DE 2014).	**Likely**. Suitable habitat for the species occurs within the Project area in the form of eucalypt woodland. Historical records of the species include 17 occurrence records within 25 km of the Project with the nearest record located 3.5 km west-southwest of the Project area (ALA 2024).

Species	Distribution and habitat	Likelihood of occurrence
Latham's Snipe (*Gallinago hardwickii*) NC Act: V	Widespread although scattered occurrence in both coastal and inland areas. Extends inland over the eastern tablelands in south-eastern Queensland (and occasionally from Rockhampton in the north), and to west of the Great Dividing Range in New South Wales (Barrett et al. 2003; Blakers et al. 1984; Frith et al. 1977). Occasionally recorded in south-western Queensland. They usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies). However, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity. Various other freshwater habitats can be used including bogs, waterholes, billabongs, lagoons, lakes, creek or river margins, river pools and floodplains (DotE 2015b).	**Unlikely** - Suitable wetland habitat is not present within the Project area. The closest occurrence record for the species was recorded 1.9 km northeast of the Project area (ALA 2025)**.**
Lesser Sand Plover (*Charadrius mongolus*) NC Act: E	The species is known to occur along the Australian coastline. Suitable habitat for the species includes coastal littoral and estuarine environments (DCCEEW 2023).	**Unlikely**. Suitable coastal or estuarine habitat for the species does not occur within the Project area. Historical records of the species include 19 occurrence records within 25 km of the Project area with the nearest record located 17 km east of the Project area (ALA 2024).
Powerful Owl (*Ninox strenua*) NC Act: V	In Queensland, Powerful Owl occurs as far north as the Eungella area and west to Carnarvon Gorge (Debus 2012). This species lives in open forests and woodlands, sometimes with dense forest nearby. It is often found in tall open wet sclerophyll forest, mainly in sheltered gullies containing old-growth forest with dense understorey and often near permanent streams (Higgins 1999). Roost and nest sites are usually in gullies (Debus 2012). It nests in hollows in large old trees (Higgins 1999; Kavanagh 2002), usually a living eucalypt, often in trees near creeks. Roost sites are mostly in closed forest but occasionally in open forest and woodland (Higgins 1999). The species also occurs in large areas of urban bushland and large botanic gardens in cities (Debus 2012)	**Possible**. Marginal habitat for the species exists within the Project area in the form of eucalypt woodland and open forest, although no suitably large hollows were observed. Historical records of the species include seven occurrence records within 25 km of the Project area with the nearest record located 11 km south-southeast of the Project area (ALA 2024).
Red Goshawk (*Erythrotriorchis radiatus*) NC Act: E	Sparsely dispersed across 15% of coastal and sub-coastal Australia, from the Kimberley in Western Australia to north-eastern New South Wales (DCCEEEW 2023). Also recorded along major rivers in central Australia, most likely to be transient birds (DCCEEEW 2023). Recent records in Queensland suggest that both southern and northern Queensland birds are in existing national parks or state forests with a strongholds in north-east Queensland and eastern Cape York Peninsula (DERM 2012). The species prefers landscapes containing a mosaic of habitats including coastal and sub-coastal tall open forest, woodland and rainforest edges. Forests of intermediate density are particularly favoured, as are ecotones between variably dense habitats. Habitat utilisation is influenced by the location of large populations of birds (primary prey). It is rarely encountered over agricultural land as it avoids open habitats. Nesting occurs in tall trees within 1 km of permanent water, generally in open, biologically rich forest or woodland (TSSC 2015a).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. Historical records of the species include one record from 2016 taken from Boyne Island 20 km northeast of the Project area. It should be noted that this record is highly dubious due to the lack of suitable habitat in this area and that the population of this species has largely disappeared from southeast Queensland (DCCEEW 2023b).

Species	Distribution and habitat	Likelihood of occurrence
Ruddy Turnstone (*Arenaria interpres*) NC Act: V	The Ruddy Turnstone is a shorebird which migrates to Australia from Europe, Asia and North America during the non-breeding season (austral summer). The species is found across Australia in coastal regions, with occasional inland records. In Queensland, the species distribution extends the entire east coast and the north coast. A carnivorous species, the Ruddy Turnstone feeds diurnally and nocturnally on insects, crustaceans, molluscs arachnids and worms in the tidal range, with a preference for upper tidal flats. The species prefers to roost on platforms, rock shelves or shingle coral and gravel beaches, adjacent to shallow pools and are occasionally observed in estuaries, coastal lagoons, harbours, bays, sewage ponds and mudflats (DCCEEW 2024c).	**Unlikely** - Suitable coastal habitat is not present within the Project area. The closest occurrence record for the species was recorded 22 km northeast of the Project area (ALA 2025).
Southern Greater Glider (*Petauroides volans volans*) NC Act: E	This species occurs in Eastern Australia with a broad distribution from around Proserpine in Qld, south through NSW and the ACT, to Wombat State Forest in central Vic. The species is generally restricted to eucalypt forests and woodlands, particularly favouring forest with a diversity of eucalypt species. During the day the species shelters in tree hollows, with a particular selection for large hollows in large, old trees (DCCEEW 2023). Modelling suggests they require native forest patches of at least 160 km^2 to maintain viable populations (Eyre 2002).	**Unlikely**. Eucalypt woodland does occur within the although field surveys determined that suitably large hollows where absent for the Project area. The species was not observed during field surveys within the Project area. Historical records of the species include six occurrence records within 25 km of the Project area with the nearest record located 11 km south-southeast of the Project area (ALA 2025).
Sharptailed Sandpiper (*Calidris acuminata*) NC Act: V	This species is recorded in most regions of Queensland and their distribution is widespread along much of the coast and very sparsely scattered inland, particularly in central and south-western regions (Higgins & Davies 1996). The Sharptailed Sandpiper typically inhabits muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline salt lakes inland. The species may use flooded paddocks, sedgelands and other ephemeral wetlands, but vacate these habitats during dry conditions. Marine habitats for the species include intertidal mudflats in sheltered bays, inlets, estuaries or seashores, and also swamps and creeks lined with mangroves. Sometimes occur on rocky shores and rarely on exposed reefs (DotE 2015b).	**Unlikely –** Suitable wetland habitat is not present within the Project area. The closest occurrence record for the species was recorded 1.9 km northeast of the Project area (ALA 2025)
Squatter Pigeon (southern) (*Geophaps scripta scripta*) NC Act: V	Squatter Pigeon is now largely restricted to Queensland, where the southern subspecies occurs north to the Burdekin River (Frith 1982). The species extends west to Longreach and Charleville. There is a subpopulation from Warwick to Texas. A small population may persist in the upper Brisbane valley, where the last Bird data record is from 2014 (Ward et al. 2021). Squatter Pigeon does not appear to undertake any large-scale seasonal movement and is probably locally nomadic, or perhaps sedentary (Frith 1982; Blakers et al. 1984). The southern subspecies of the Squatter Pigeon occurs mainly in dry grassy woodlands and open forests (Frith 1982; Crome & Shields 1992).	**Likely**. Suitable habitat for the species occurs within the Project area in the form of grassy woodlands. Historical records of the species include 24 occurrence records with 25 km of the Project area with the nearest record located 3.5 km west of the Project area (ALA 2025), although the occurrence record is generalised to 10km and

Species	Distribution and habitat	Likelihood of occurrence
		undated. Numerous records to the west are dated 2003-2018 (ALA 2025).
Terek Sandpiper (*Xenus cinereus*) NC Act: V	This migratory shorebird migrates from Russia during non-breeding periods to coastal, western and central Africa, South Africa, throughout Asia including but not limited to the Persian Gulf, the Indian subcontinent and southeast Asia and as far south as New Guinea, Australia and New Zealand. The species distribution within Australia is primarily restricted to coastal distributions in all Australian States and Territories (with the exception of the ACT) and will occasionally be recorded inland. In Queensland, the species is commonly recorded along the coast from the southeast of the Gulf of Carpentaria and extends as far north as the Torres Strait. This species is carnivorous, and its primary diet comprises crustaceans and insects and feed within the supralittoral or upper littoral zone of mudflats in estuaries. The species prefers to roost in mudflats and mangrove swamps (DCCEEW 2024b)	**Unlikely** – Suitable coastal and estuarine mudflats are not present within the Project area. The closest record for the species is located 17 km east of the Project area (ALA 2025).
Western Alaskan Bar-tailed Godwit (*Limosa lapponica baurei*) NC Act: V	The species is known to occur along the coast of northern, southern, and eastern Australia (with the exception of the WA) (DCCEEW 2023). Suitable habitat for the species includes intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays (DCCEEW 2023).	**Unlikely**. Suitable habitat for the species does not occur within the Project area. The species was not detected during recent field surveys within the Project area. Historical records of the species include three occurrence records within 25 km of the Project area at Boyne Island with the nearest record located 20 km to the north-northwest of the Project area (ALA 2025).
White-throated Needletail (*Hirundapus caudacutus*) NC Act: V	In Australia, White-throated Needletail is almost completely an aerial species, possibly even sleeping on the wing. The species is sometimes found roosting in trees and may on rare occasions rest in trees and on the ground during the day (Higgins 1999). White-throated Needletail is found over a wide variety of habitat, including open areas, modified land and the ocean but is most often recorded over wooded areas (Higgins 1999). They sometimes forage over recently disturbed areas, such as forest that has been cleared or burnt (Blakers et al. 1984).	**Likely**. Suitable habitat for the species occurs within the Project area. Historical records of the species include 19 occurrence records within 25 km with the nearest record 1.5 km northeast of the Project area (ALA 2025).
White-throated Snapping Turtle (*Elseya albagula*) NC Act – CE	Found only in Queensland in the Fitzroy, Mary and Burnett Rivers and associated smaller drainages in southeastern Queensland. The Fitzroy catchment population has been separated from the Mary and Burnett catchments for an extended period. It has been suggested that the two lineages can be considered to be Evolutionarily Significant Units (Todd et al. 2013). Prefers clear, flowing, well-oxygenated waters. The species does occur in non-flowing waters, but typically at much reduced densities (DE 2014a).	**Unlikely** – Suitable habitat for the species is not located within the Project area. The closest verified occurrence record for the species is located approximately 49 km northeast of the Project area (ALA 2025).
Yellow-bellied Glider (*Petaurus australis australis*) NC Act: V	The species has a widespread but patchy distribution from south-eastern Queensland (Qld) to far south-eastern SA, near the SA-Vic border in found at altitudes ranging from sea level to 1400 m above sea level (DAWE 2022). The species occurs in tall mature eucalypt forest in areas with high	**Unlikely**. Suitable habitat for the species does not occur within the Project area. Soils within the Project area low in fertility and woodlands are low

Species	Distribution and habitat	Likelihood of occurrence
	rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forest in the north; moist coastal gullies and creek flats to tall mountain forests in the south (OEH 2017).	without suitable hollows. Historical records of the species include five occurrence records within 25 km of the Project area with the nearest record located 11 km south-southeast of the Project area (ALA 2025).

7 POTENTIAL PROJECT IMPACT AND MITIGATION MEASURES

The majority of impacts within the Project area are pre-existing. The proposed extensions to the extent of current mining impact areas area, includes increases in the size of open pits and stockpiles, in addition to new access tracks and other operational areas (hereby referred to as proposed impacts). Proposed impacts areas are shown in **Figure 7** overlaid on the field-verified vegetation mapping. For conservation significant species considered as potentially occurring, impacts were assessed for loss of habitat by the construction of proposed impacts.

7.1 Potential Project Impacts

The proposed impacts have the potential to directly and indirectly impact a range of ecological values, including vegetation communities and habitat for conservation significant flora and fauna. The proposed impacts will occur incrementally, as open pits and stockpiles increase in size over time. Proposed impacts include the following:

- Access tracks – 1.73 ha
- Infrastructure and plant – 0.24 ha
- Pit – 27.77 ha
- Topsoil stockpile – 3.66 ha
- Waste rock dump – 11.78 ha

7.1.1 Clearing Vegetation

The clearing of vegetation is the most significant and direct impact of the Project on ecological values of the Project area. The removal of habitat reduces the size of local populations of flora and fauna dependent on that habitat. These impacts are immediate and significant in the short-term. Impacts may persist in the long-term if habitat created during rehabilitation does not closely resemble pre-disturbance ecosystems. In addition, if sufficient habitat refuges are not maintained locally, prior to the maturation of rehabilitated land, local extinction of certain species may occur.

The predicted extent of overall impact to vegetation communities and habitat for conservation significant species is provided in **Table 11**. The extent of impact is based on the results of the ground-truthed vegetation mapping, analysis of aerial imagery, and onsite habitat assessments. The proposed impacts of the Project area are predicted to impact 5.57 ha of remnant vegetation and 9.86 ha of regrowth habitat under the current layout. The primary potential impact to conservation significant fauna species is on remnant woodland vegetation suitable Koala, which is considered likely to occur within the Project area.

Table 11. Predicted vegetation clearing resulting from Project proposed impacts

GTRE	Biodiversity (EP Act) status	Potential habitat	Proposed impact area (ha)
11.11.15 remnant	No concern at present	Koala, Powerful Owl, Squatter Pigeon, *Cycas megacarpa, Cassinia collina*.	3.27
11.11.15 regrowth	No concern at present	Koala, Squatter Pigeon.	9.86
11.3.25 remnant	Of concern	Koala, Powerful Owl, Squatter Pigeon, *Cassinia collina*.	2.30
		Overall area	15.43

7.1.2 Habitat Fragmentation and Connectivity

Highly fragmented habitats support fewer species than connected blocks of habitat of the same size. This is because fragmentation restricts dispersal of fauna and plant seeds between available habitat. The impacts of habitat fragmentation depend on the degree to which dispersal is inhibited by habitat gaps., the size of the remaining habitat fragments, and ecological attributes of the species.

The landscape associated with the Project has been heavily impacted by tree clearing for pastoralism and open cut mining. Remnant and regrowth vegetation communities within the Project area are largely consolidated, although in the southern portion of the Project area vegetation is isolated by the dam impoundment and mining activities. Vegetation communities in the northern portion of the Project area are connected to a large expanse of remnant vegetation to the north of the Project area, although the proposed impacts of the expansion are largely concentrated in the south of the Project area. The proposed impacts of the Project will not further fragment remnant and regrowth vegetation communities within the Project area, with negligible impacts to connectivity.

The farm dam within the southern portion of the Project area likely provides drinking water for a range of mammals and birds. It may also support native and exotic aquatic fauna species. The removal of the farm dam is not considered to be a significant impact to terrestrial and aquatic ecology due to the proximity of the farm dam to Lake Awoonga which provides similar, yet more extensive habitat suitable for these species.

7.1.3 Fauna Mortality

Clearing of vegetation for the Project presents a risk of direct mortality or injury to fauna. Fauna of low mobility are at risk to injury or death from heavy machinery and vehicular movements during the construction and operational phases of the Project.

Clearing will only occur within designated areas and only during designated time periods. The presence of qualified Wildlife Spotter-Catcher/s to assist with vegetation clearing will decrease incidences of fauna mortality. Educating employees and contractors with regard to fauna and flora will further reduce direct mortality as part of the Project.

7.1.4 Airborne Dust

Earthworks, vehicular traffic, mobile plant movements and mining activities associated with construction and operation can generate substantial amounts of dust during dry weather (Field et al. 2010). Dust can have both a physical and chemical impact on plants, either through the smothering of leaves, whereupon the rate of deposition is important, or through chemical changes to the soil or directly to the plant surface. Changes in soil properties, such as pH, can ultimately impact plant species assemblages. Dust can form a hard crust on plant photosynthesis, respiration transpiration and productivity (Farmer 1993; Chaston & Dooley 2006). Evidence of potential impacts on entire vegetation communities is scarce. Many studies focus on specific impacts to single species and findings may not be conclusive. Because a limestone quarry is already operating within the Project area, additional impacts to airborne dust resulting from the proposed expansion area considered negligible.

7.1.5 Noise and Lighting

Understanding of the impacts of noise on fauna is limited. There are no current government policies or guidelines that recommend noise thresholds or limits for development activities to mitigate potential harm to fauna. Noise may affect wildlife through a variety of impacts such as: interfering with communication calls; interfering with foraging/defence through cloaking the sound of predators and prey; causing general stress or avoidance reactions; or changes in reproductive or nesting behaviours. Excessive noise may lead some species to avoid noisy areas, which could result in the localised fragmentation of habitat at the specie or individual territory level. Radle (2007) states the consensus that terrestrial fauna will avoid any industrial plant or construction area where noise or vibration presents an annoyance to them. Nevertheless, many animals may interpret a new noise as a potential danger at first, but rapidly understand the noise is not associated with any threats (Radle 2007).

Artificial lighting may have a range of impacts across different groups of taxa and between species within these groups. Some taxa such as rodents may avoid brightly lit areas at night. Alternatively, nocturnal fauna such as many microbat species, frogs and some reptiles may congregate at artificial lights to feed on insects attracted to light (Perry et al. 2008; Rich and Longcore 2006). Although, other microbat species may avoid well-lit areas (Threlfall et al. 2013). Artificial light can alter foraging and calling by frogs and probably impairs their vision (Buchanan 1993) and may lead to individuals being killed by vehicles when attracted to lights for feeding on invertebrates. The Project area is already subject to artificial lighting and noise from the existing limestone quarry and further increases from the proposed expansion area are considered negligible.

7.1.6 Weeds and Pest Animals

Introduced weeds have the potential to impact on terrestrial and aquatic ecological values as native flora can become displaced through competition with weed species, and adversely affected by browsing and soil trampling caused by feral herbivores. Native fauna populations, particularly small to medium sized species, may be impacted by predation from introduced carnivores such as feral cats (*Felis catus*) and Red Fox (*Vulpes vulpes*). These are indirect impacts which may not manifest themselves in the short-term and are likely to be exacerbated by proposed cattle grazing activities within the Project area. Introduced weed species are already present throughout the Project area including six Category 3 Biosecurity matters and four WoNS with Lantana and Creeping Lantana the most common. Rubber Vine was common in heavily disturbed areas such as rock-dumps, roadsides and topsoil stockpiles.

The following activities associated with the Project have the potential to promote the proliferation of weeds and pests within the Project area, or introduce new weeds and pests from surrounding areas:

- The use of construction machinery, plant and materials sourced from outside the region and increased vehicular traffic in general may introduce and spread weed seeds if biosecurity hygiene measures are not in place
- Land clearance favours the establishment of weeds due to increased light and soil disturbance
- Inappropriate disposal and storage of putrescible wastes may attract feral animals

Mobile plant and vehicular movements have association with future Project activities have a very high potential to further the spread of American Ratstail Grass (*Sporobolus jacquemontii*) within the Project area, with adverse impacts on proposed post-mining pastoralism.

7.1.7 Fire

The Project area is comprised of operational mining areas, cleared areas, and woodland/open-forest vegetation to the north and south. Woodland/open-forest areas have potential to be severely impacted by accidental high-intensity fires caused by Project activities. Fire hazard mapping indicates the majority of woodland and open-forests within the Project area as having a medium potential bushfire intensity with a small patch of high and very-high potential bushfire intensity bordering the northern pit.

7.1.8 Surface Water

7.1.8.1 Construction Impacts

The Project has potential to impact surface water and associated aquatic ecology values through a variety of processes:

- During construction disturbance, uncontrolled sedimentation of watercourses (particularly during and following heavy rainfall events) can impact aquatic ecology by smothering stream beds with fine material, and decreasing bed roughness and reducing habitat diversity
- Similarly, uncontrolled sedimentation movements associated with construction disturbance may lead to localised increased turbidity and suspended solids which may negatively impact fish and macroinvertebrates (through reduced respiratory and feeding efficiency), and adversely affect submerged aquatic plants as light penetration (required for photosynthesis) is reduced
- Poorly designed and constructed waterway crossings may create waterway barriers that prevent or impede movements of aquatic fauna
- Waterway crossings may cause bank instability if remediation works are not adequately designed and implemented. This may lead to bank erosion (causing impacts to instream sedimentation and turbidity) and adverse impacts to riparian vegetation

The Project area is intersected by six stream order 1 watercourses (**Figure 4**). A total of six low-risk waterways for waterway barrier works are mapped within the Project area and three of these waterways will be impacted by the proposed impact area. Waterways within the Project area are ephemeral and were dry at the time of the field survey. Furthermore, the environmental values of the potentially impacted waterways are very low as all are artificially impounded. The potentially impacted stream in the north flows directly into Pit 2, and a

potentially impacted stream in the east is impounded by a steep embankment. The potentially impacted stream in the south is impounded by the existing waste rock stockpile and mine longwall.

7.1.8.2 Waterway Barrier Works

The Project is expected to impact 3 low risk waterways with barrier works. Barrier works (i.e. maintenance or upgrade of existing culvert crossings) should be completed in accordance with *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF 2018). All low risk waterways impacted by the Project are subject to artificial impoundment and no longer connected to the wider catchment.

7.1.8.3 Aquatic Pollutant Release

The accidental release of pollutants from Project activities has the potential to degrade the surrounding environment and local waterways within and downstream of the Project area. Potential sources of contaminants may include runoff from chemical and fuel/oil storage areas and general wastewater from vehicle/machinery washdown areas. In the event of a significant fuel spill (>200 litres) (L) to waterways there is potential to have a local impact on both flora and fauna. The extent of impact will of course be dependent on the size of the spill and the volume of water in the waterway (including whether there is flow), thereby influencing the length of stream potentially impacted.

Waterways in the Project area are ephemeral (no flows occurring the majority of the time) and are predominantly likely to be considered to be of low value.

7.2 Proposed Mitigation Measures

The proponent will commit to a range of measures to minimise impacts to MSES and general ecological values associated with Project area. Avoidance is largely not possible as the majority of Project impacts have already occurred. A range of mitigation strategies will be implemented under an overarching Environmental Management Plan (EMP). The current EMP for the existing EA for the Project will be amended to reflect the proposed amendments to the EA. The EMP is informed by a number of updated management plans relevant to ecological impacts including (but not limited to):

- Water Management Plan
- PRC Plan
- Erosion and Sediment Control Plan (ESCP)
- Pest and Weed Management Plan

The EMP and various sub-plans comprise a range of measures that will mitigate the potential impact to ecological values as detailed in **Table 12**.

Table 12. Recommended mitigation measures proposed for general impacts resulting from proposed impacts

Impact	Management measure
Vegetation clearing	The Project has an EMP in place. Vegetation clearing protocols are established within the EMP and will be updated to include the following mitigation measures below at a minimum.
	A PRCP including rehabilitation measures following mine closure
	Project employees and contractors should be made aware of environmental obligations and compliance requirements through the induction program.
	Vegetation clearing extents will be clearly demarcated with flagging or bunting prior to clearing to limited the area safely and reasonably required for permanent and temporary works
	Targeted pre-clearance surveys will be carried out prior to vegetation clearing and will incorporate searches for conservation significant plants that potentially occur, including: • *Cassinia collina* • *Cycas megacarpa.* Pre-clearance surveys will be carried out by suitable qualified ecologists prior to vegetation clearing.

Impact	Management measure
	Topsoil should be stockpiled in designated areas and used for rehabilitation.
	Disturbed areas that are no longer required will be immediately reinstated to a non-polluting and stable landform.
Conservation significant flora and fauna	Fauna and Flora Management Plan will be in place prior to construction works being carried out. Plan will establish species-specific management procedures for conservation significant species considered to be potentially or likely to be present in this report.
	Searches for conservation significant flora and fauna species will be carried out by a suitably qualified ecologist as part of pre-clearance surveys.
	Procedures will be in place where injured fauna are encountered during clearing works. Local wildlife carer and/or veterinarian will be identified prior to works being carried out and be notified that clearing works are being carried out (prior to clearing).
	Project inductions will outline species of significance that may occur on the project area.
	Project employees will be required to notify fauna spotter/catchers when a species of significance is observed in the Project area. All encounters with a conservation significant species will recorded in the project fauna register maintained by the designated Environmental Officer.
	Fauna spotter-catchers (licensed) will inspect sites prior to vegetation clearing. Fauna habitat shelter features (large hollows) will be clearly marked where they are unable to be accessed/inspected prior to tree felling.
	EMP will incorporate procedures for tree felling that will minimise potential impacts on resident fauna where habitat shelter features are identified.
	Procedures will be in place where injured fauna are encountered during clearing works. Local wildlife carer and/or veterinarian will be identified prior to works being carried out and be notified that clearing works are being carried out (prior to clearing).
	Onsite speed limits will be established throughout Project area to limit the potential for road collisions.
Noise and lighting	The final Project design process will incorporate the use of low light spill lighting components and directional lighting (away from adjacent fauna habitat) where night lighting is considered necessary.
	All Project-associated construction/operational machinery will be maintained as per manufacturer design specifications to ensure project noise is minimised.
	Onsite speed limits will be established throughout Project area to limit noise levels as a result of vehicle movements.
Airborne dust	Monitoring of weather conditions will be carried out to inform Project activities and planning during high-wind weather conditions.
	Ensure employees made aware of potential dust generating activities and mitigation and management measures to prevent nuisance
	Monitoring of air/dust emissions will be carried out in accordance with regulatory requirements.
	Dust from areas likely to be a source of airborne dust (such as tracks and topsoil stockpiles) will be suppressed during construction using water trucks/wetting to keep dust related impacts to a minimum. Water used for dust suppression will be obtained from Pit 2 and onsite water tanks.
	Onsite speed limits will be established to minimise dust caused by vehicle movements
	Areas subject to vegetation clearing and no longer required for construction will be subject to vegetation reinstatement as soon as is practicable as per the assigned post-mining land-use.
Weeds and pest	Pest and Weed Management Plan is in place prior to construction works being carried out. Plan will detail all required management measures and monitoring procedures.
	Mapping of the extent of weed/pest occurrence within the Project footprint will be recorded during pre-clearance surveys.
	Vehicle wash-downs will be required for all new vehicles (including earthmoving and other construction machinery) entering the Project area.
	Disposal and storage of putrescible wastes must be undertaken appropriately to ensure feral animals aren't attracted to the Project area.
	Storage of construction/operation materials carried out in a manner so as to not encourage the establishment of resident pest fauna.
	Regular monitoring of weed and pest occurrence in association with Project works areas and in response to complaints from adjacent landowners.

Impact	Management measure
Fire	Monitoring of weather conditions will be carried out to inform Project activities and planning during high fire-risk weather conditions.
	The Project will maintain communications with local representatives for the Queensland Fire and Emergency Services (QFES) regarding Project activities and bushfire hazard conditions.
	Appropriate fire breaks will be maintained around above ground Project infrastructure.
	Site will include designated smoking areas.
	Onsite fire-fighting equipment will be regularly maintained and staff training will be developed and implemented.
Surface water	An ESCP will be developed and implemented prior to construction commencing. The ESCP will be developed by a Certified Professional in Erosion and Sediment Control.
	Access track crossings of watercourses will be designed and constructed in accordance with the accepted development requirements for waterway barrier works (DAF 2018) to minimise impacts to fish passage.
	Earth bunds and diversion drains are maintained around the perimeter of the site, particularly on the upslope, of excavations to prevent surface water entering these areas.
	Stabilised diversion drains are maintained to direct dirty water to sediment traps (e.g. straw bale filter, sandbag filter, sediment dams).
	Applicable Project materials/chemicals will be stored and handled in accordance with relevant legislative requirements and Australian Standards (AS) including: • AS 3780:2008 – The storage and handling of corrosive substances • AS 1940:2004 – The storage and handling of flammable and combustible liquids • AS 3833:2007 – Storage and handling of mixed classes of dangerous goods in packaged and intermediate bulk containers
	All storage of chemicals associated with Project works will be stored away from watercourse and in bunded areas
	Refuelling will be in designated bunded areas away from watercourses. Or in accordance with the existing refuelling procedures – 620-P8.200.213 Main Hardstand Refuelling.
	Spill response equipment (e.g. booms and absorbent materials) will be available at refuelling areas and other sites (where relevant). Staff will be trained in the appropriate use of spill response equipment.
	Onsite washdown areas for Project vehicles/machinery will be located and clearly demarcated to prevent contaminated run-off from entering waterways.

8 MSES SIGNIFICANT RESIDUAL IMPACT ASSESSMENT

An assessment of the potential for significant impacts resulting from the proposed Project has been carried out only on those MSES considered as potentially subject to substantial impacts. The assessments have been carried out in accordance with the *Queensland Environmental Offsets Policy Significant Residual Impact Guideline* (MSES Guideline) (DEHP 2014) to determine if offsets under the Offsets Act are not required for the proposed Project. The assessment is focused on MSES identified in **Section 5.2** as potentially occurring within the Project area, including:

- Listed conservation significant species
- Category R (GBR) Riverine Regulated Vegetation
- MSES regulated vegetation (defined watercourse)
- Waterways providing fish passage

8.1 Conservation Significant Species

The likelihood of occurrence assessment in **Section 4.3** has determined the following listed conservation significant species to be relevant for the significant residual impact assessment:

- Likely to occur:
  - Koala (*Phascolarctos cinereus*) – Endangered
  - Squatter Pigeon (Southern) (*Geophaps scripta scripta*) – Vulnerable
- Possibly occurs:
  - *Cycas megacarpa* – Endangered
  - Powerful Owl - Vulnerable
  - *Cassinia collina* - Vulnerable

White-throated Needletail is an aerial species that may occur over any habitat including inland, coastal and marine areas and disturbed habitat such as urban areas. The species is only occasionally recorded as landing in Australia. The species is highly mobile and may forage anywhere up to 100s of metres above ground (Higgins 1999; DCCEEW 2023). Given the species' aerial habits it is inconceivable the Project area would support an important population or represent important habitat (as defined in DE 2013a) for the species and the proposed impacts would be highly unlikely to impact the species in any way. Therefore, it has not been considered in the significant residual impact assessment.

8.1.1.1 Koala – Endangered

Ecology

Koalas have a distinct association with eucalypt woodland and forest habitats comprising suitable food trees, mainly of the following genus: Eucalyptus, Corymbia, Angophora and Melaleuca (Moore and Foley, 2000; and Martin et al. 2008). They are not necessarily restricted to bushland areas and are known to occur and breed where suitable tree species occur within farmland and the urban environment (Dique et al. 2004). Similarly, movement is not confined to vegetated corridors, as they also move across cleared rural land and through suburbs (Martin et al. 2008). They may use a variety of trees, including many non-eucalypts, for feeding, shelter and breeding purposes (Dique et al. 2004; Martin et al. 2008).

They are known to have localised and variable preferences throughout their range, favouring some tree species over others (Pahl and Hume 1990). At the local level they are known to prefer individual trees. It has been suggested this could be a response to a number of factors such as high leaf moisture and/or nitrogen content, and low levels of toxic chemical compounds which are expressed by eucalypts as a result of herbivory (Pahl and Hume 1990; Hume and Esson 1993; Moore and Foley 2000).

Breeding occurs in spring / summer when males become territorial. Young permanently leave the pouch after seven months but may continue to ride on the mothers back until approximately 12 months. After this time adolescent females may remain in the natal habitat. Males generally disperse to new territories from one to three years of age (Dique et al. 2003; Martin et al. 2008).

Association with the Project area

The species was not observed during field surveys within the Project area. Numerous records of the species occur in the wider landscape include 17 occurrence records within 25 km of the Project with the nearest record from 1987 located 3.5 km west-southwest of the Project area (ALA 2025). The majority of Koala records in the wider landscape are from 1987 or earlier. More recent records from 1992 and 1997 occur further west at Dan Dan National Park located 15 km southwest of the Project area (ALA 2025).

Suitable habitat for Koala within the Project area is provided by remnant and regrowth RE 11.11.15 and remnant RE 11.3.25 with a total area of 168.7 ha of which, 15.43 ha is proposed to be disturbance by the Project.

Government approved species documents

The *National recovery plan for the Koala* Phascolarctos cinereus *combined populations of Queensland, New South Wales and the Australian Capital Territory* (the Koala recovery plan) (DAWE 2022b) was approved on 8 April 2022. The Koala Recovery plan notes the following threats to the species:

- Habitat loss, fragmentation and modification including the impact of native forestry activities
- Drought, extreme heat events including associated with climate change
- Altered fire regimes
- Mortality from dog attack and vehicle collisions
- Diseases including Chlamydia and Koala retrovirus
- Plant pathogens impacting Koala habitat such as Myrtle Rust

The *Conservation Advice for* Phascolarctos cinereus *(Koala) combined populations of Queensland, New South Wales and the Australian Capital Territory* (DAWE 2022c) notes (with relevance to Queensland) the priority management actions associated with the south-east Queensland population and that sub-populations on the western edge of the species range may be 'climate-sensitive' and comprise genes adapted to environmental extremes which may prove critical to populations elsewhere in the future through translocation programs.

The Koala recovery plan does not specifically identify any areas comprising 'valued populations' of Koala but does note an imperative to conserve populations:

- That may act as source populations to adjacent areas
- Occur in areas of climatic refugia (specifically from droughts and heat waves)
- Genetically diverse
- Contain adaptive genes to potential environmental stressors or
- Are geographical or environmental outliers

The Koala recovery plan identified the following objectives:

- The area of occupancy and estimated size of populations that are declining, suspected to be declining, or predicted to decline are instead stabilised then increased
- The area of occupancy and estimated size of populations that are suspected and predicted to be stable are maintained or increased
- Metapopulation processes are maintained or improved
- Partners, communities and individuals have a greater role and capability in listed Koala monitoring, conservation and management.

Table 13 provides as assessment of the potential for significant residual impacts on Koala from the Project using the assessment criteria for Endangered and Vulnerable wildlife habitat outlined in the Guideline. It is important to note that Koala is also listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and will also need to be assessed as a Matter of National Environmental Significance (MNES) as per the EPBC Act.

Table 13. Significant residual impact criteria assessment: Koala

Criteria	Endangered species assessment
Lead to long-term decrease in the size	The species was not observed during the recent field survey within the Project area although the species is considered likely to occur. Historical records of the species include 17 occurrence records within 25 km of the Project area with the nearest record from 1987 located 3.5 km west-

Criteria	Endangered species assessment
of a local population	southwest of the Project area (ALA 2025). Pre-clearance surveys will be completed prior to clearing and a licenced Wildlife spotter-catcher will be present during clearing. The Project will result in the clearing of 15.43 ha of suitable habitat for Koala. Suitable habitat for Koala within the Project area is adjacent to areas of existing disturbance. The majority of suitable Koala habitat proposed for clearing is in a highly isolated location between the existing mine and Awoonga Reservoir. Significant areas of continuous and undisturbed Koala habitat occurs to the north and west of the Project area. Whilst the species is likely to occur, there is no evidence to suggest that a local population occurs within the Project area. The Project is considered unlikely to lead to a long-term decrease in the size of a local population.
Reduce the extent of occurrence of the species	The extent of occurrence (EOO) of the species is estimated at 1,665,850 km^2 (DAWE 2022). The Project will result in the clearing of 15.43 ha of suitable habitat for Koala. The Project area is not near the limit of the species distribution. The Project is considered unlikely to reduce the extent of occurrence of the species.
Fragment an existing population	The species was not observed during recent field surveys within the Project area although the species is considered likely to occur. Whilst the species is likely to occur, there is no evidence to suggest that a local population occurs within the Project area. Although operational mining areas will be unsuitable for Koala movements, Koalas will be able to move freely to the north along the eastern boundary of the Project area. In addition, the extent of the proposed impacts relatively minor in relation to the extent of existing operation mining areas within the Project area.
Result in genetically distinct populations forming as a result of habitat isolation	The species was not observed during recent field surveys within the Project area although the species is considered likely to occur. Whilst the species is likely to occur, there is no evidence to suggest that a local population occurs within the Project area. Although operational mining areas will be unsuitable for Koala movements, Koalas will be able to move freely to the north via the eastern boundary of the Project area. Remnant vegetation to the north and south of the operational areas will remain consolidated. The Project is considered unlikely to result in genetically distinct populations forming as a result of habitat isolation.
Result in invasive species that area harmful to an endangered to vulnerable species becoming established in the endangered or vulnerable species habitat	The species is vulnerable to predation from Wild Dogs. A Pest and Weed Management Plan will be in place prior to construction works being carried out. The Project is considered unlikely to result in invasive species that are harmful to an endangered species becoming established in the endangered species habitat.
Introduce disease that may cause the population to decline	Koala retrovirus (KoRV) and Chlamydia (*Chlamydia percorum*) are known threats to the species. It is inconceivable the Project activities will result in the introduction of these diseases into the Project area. The Project is considered unlikely to introduce disease that may cause the population to decline.
Interfere with the recovery of the species	The Koala recovery plan identified the following objectives: • The area of occupancy and estimated size of populations that are declining, suspected to be declining, or predicted to decline are instead stabilised then increased • The area of occupancy and estimated size of populations that are suspected and predicted to be stable are maintained or increased • Metapopulation processes are maintained or improved • Partners, communities and individuals have a greater role and capability in listed Koala monitoring, conservation and management. There is no evidence to suggest a Koala population occurs within the Project area and is therefore not a known area of occupancy. The Project is not expected to significantly increase he isolation of habitat suitable for Koala. The Project is unlikely to interfere with any of the recovery actions identified in the Koala recovery plan.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration	The species was not observed during recent field surveys within the Project area although the species is considered likely to occur. Whilst the species is likely to occur, there is no evidence to suggest that a local population occurs within the Project area. The Project area is not considered an ecologically significant location for Koala. The proposed impacts are considered unlikely to cause disruptions to ecologically significant locations of a species.

Criteria	Endangered species assessment
or resting sites) of a species	
Assessment result	Significant residual impacts to Koala resulting from the proposed impacts are considered unlikely to occur in accordance with the Guideline. Offsets for impacts to Koala habitat under the *Queensland Environmental Offsets Policy* are not required.

8.1.1.2 *Cycas megacarpa* – Endangered

Ecology

The species is a small to medium sized cycad reaching a maximum height of 8 m with green new growth and eggs shaped seeds (DESI 2024). Suitable habitat for the species is described as Spotted Gum and Narrow-leaved Ironbark woodland or open-forest on hill tops and steep slopes with stony sandy loams or stony shallow clay loams. The species typically occurs at 40-600 m above sea level (ASL). Fruiting occurs during May to February and ripen from March. Seeds remain infertile for a minimum of nine months (DES1 2024).

Relationship with the Project area

The species was not observed during recent field surveys within the Project area. No Cycad species were identified within the Project area during the field survey. Cycad species are highly distinctive and easily located in the field. The nearest historical record of the species is located 24 km south-west of the Project area from 2003. Numerous records of the species occur further south and west. Suitable habitat for the species within the Project area is provided by remnant RE 11.11.15 with an area of 115.2 ha of which 3.27 ha is proposed to be impacted by the Project.

Government documents species documents

There is no approved conservation advice or listing advice for the species. The *National Multi-species Recovery Plan for the cycads*, Cycas megacarpa, Cycas ophiolitica, Macrozamia cranei, Macrozamia lomandroides, Macrozamia pauli-guilielmi *and* Macrozamia platyrhachis (Queensland Herbarium 2007) identifies the following threats relevant to the species:

- Land clearing
- Illegal harvesting
- Loss of genetic variation and insect pollinators
- Timber harvesting
- Fire.

The recovery plan also identifies the following recovery objectives relevant to the species:

- Protect existing populations
- Prevent loss of individuals and populations from legal harvesting and salvage
- Prevent loss of individuals, plant parts and seeds to illegal harvesting and destruction
- Determine habitat, ecological and reproductive needs
- Populations managed according to the best available knowledge
- Recovery of populations

Table 14 provides as assessment of the potential for significant residual impacts on *Cycas megacarpa* from the proposed impacts using the assessment criteria for Endangered and Vulnerable wildlife habitat outlined in the Guideline.

Table 14. Significant residual impact criteria assessment: *Cycas megacarpa*

Criteria	Endangered species assessment
Lead to long-term decrease in the size of a local population	The species was not observed during field surveys within the Project area although its occurrence is considered possible. The nearest historical record of the species is located 24 km south-west of the Project area from 2003 (ALA 2025). The proposed impacts will result in the clearing of 3.27 ha of suitable habitat for the species, although there is no evidence to suggest a

Criteria	Endangered species assessment
	population of Cycas megacarpa occurs within the Project area. The proposed impacts area considered unlikely to lead to a long-term decrease in the size of a local population.
Reduce the extent of occurrence of the species	The EOO of the species is estimated at 18,726 km^2 (DCCEEW 2023). The species was not observed during field surveys within the Project area and there is no evidence to suggest a population occurs within the Project area. The proposed impacts are considered unlikely to reduce the EOO of the species.
Fragment an existing population	The species was not observed during field surveys within the Project area and there is no evidence to suggest a population occurs within the Project area. The proposed clearing areas are adjacent to areas of existing disturbance. The proposed impacts are considered unlikely to fragment an existing population.
Result in genetically distinct populations forming as a result of habitat isolation	The species was not observed during field surveys within the Project area and there is no evidence to suggest a population occurs within the Project area. The proposed impacts areas area consolidated with the existing Project area and will not increase the current degree of habitat isolation within the Project area (i.e. suitable habitat in the southern portion of the Project area). The proposed impacts are unlikely to result in genetically distinct populations forming as a result of habitat isolation.
Result in invasive species that area harmful to an endangered to vulnerable species becoming established in the endangered or vulnerable species habitat	There are no invasive species known to be harmful to the species, although dense weed infestation may adversely impact recruitment. A large number of non-native plant species are already established within the Project area. A Pest and Weed Management Plan will be in place prior to construction works being carried out. The proposed impacts area considered unlikely to result in invasive species that are harmful to an endangered species becoming established in the endangered species habitat.
Introduce disease that may cause the population to decline	The species was not observed during field surveys within the Project area and there is no evidence to suggest a population occurs within the Project area. The species is not known to be vulnerable to any diseases. The Project is considered unlikely to introduce disease that may cause the population to decline.
Interfere with the recovery of the species	The species was not observed during field surveys within the Project area and there is no evidence to suggest a population occurs within the Project area. The proposed impacts will not interfere with any of the recovery objectives identified in the recovery plan for the species.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	The following important populations of the species have been identified in the recovery plan for the species: • Population 8 (Biloela) • Population 19 (Kroombit) • Population 30 (Woonbah) • Population 2 (Bouldercombe) • Population 3 (Mt Morgan) • Population 5 (Dee Range) • Population 14 (Biloela). The proposed impacts will not impact any of the locations listed above. The proposed impacts are unlikely to cause disruptions to ecological significant locations of the species.
Assessment result	Significant residual impact to *Cycas megacarpa* resulting from the proposed impacts are considered unlikely to occur.

8.1.1.3 Squatter Pigeon – Vulnerable

Ecology

Largely terrestrial pigeon species, foraging and breeding on the ground. Mainly occurs in dry grassy eucalypt woodlands and open forests (Frith 1982; Crome and Shields 1992). May also inhabit *Callitris*/*Acacia* dominated woodlands. Reported from open plains in its historical southern range (Frith 1982). Most birds live in sandy sites within 3 km of a permanent water source (Blakers et al. 1984). They remain common in heavily grazed country in tropical Queensland (Reis 2012) but they are typically more common in ungrazed lands (Woinarski and Ash 2002; Reis 2012). This species mainly feeds on grass seed although insects are seasonally important in the diet (Reis 2012).

The species may breed throughout the year but this appears to be greatly influenced by rainfall and abundance of foraging resources. Peak breeding is likely to occur during the dry season (April to October) (Squatter Pigeon Workshop 2011; DCCEEW 2023). The nest is a shallow depression on the ground usually sheltered by a bush or log (Reis 2012). The total population size is estimated at 40,000 breeding birds and is thought to occur as a single continuous interbreeding population (DCCEEW 2023).

The subspecies was historically found from the Dubbo region in New South Wales north to the Burdekin River area in in Queensland. There have been no official records in New South Wales since the 1970s. Although the species has declined greatly in southern Queensland in the past it appears this decline has slowed, and the species now persists over a wide area and can be locally abundant in central Queensland (Garnett et al. 2011) where groups of up to 30 individuals can still be seen (Reis 2012). South of the Carnarvon Range the species appears to occur only in scattered areas.

Association with Project area

The species was not detected during field surveys within the Project area. Historical records of the species include 24 occurrence records with 25 km of the Project area with the nearest record located 3.5 km west of the Project area. Suitable habitat for the species includes remnant and regrowth RE 11.11.15 and remnant RE 11.3.25 with a total area of 168.7 ha of which 15.43 ha is proposed to be impacted by the Project. The entire Project area is within 3 km of permanent water provided by Awoonga Reservoir.

Government approved species documents

There is no approved recovery plan for the species. The Approved Conservation Advice for the species (TSSC 2015b) notes the following threats to the species:

- Habitat loss through land clearing, particularly for livestock grazing which decreases foraging resources
- Overgrazing by livestock and feral herbivores
- Unsuitable fire regimes
- Changes to habitats caused by invasive weeds and/or thickening of understorey vegetation (Higgins & Davies 1996; Garnett et al 2011)

Relevant threat abatement plans considered applicable to the species include:

- *Threat abatement plan for competition and land degradation by rabbits* (DEE 2016)
- *Threat abatement plan for predation by feral cats* (DE 2015b)
- *Threat abatement plan for predation by the European red fox* (DEWHA 2008c)

The Approved Conservation Advice for the species also identifies the following primary conservation actions:

- Identify sub-populations of high conservation priority, especially in the southern part of the Squatter Pigeon's (southern) range.
- Protect and rehabilitate areas of vegetation that support important sub-populations
- Protect sub-populations of the listed subspecies through the development of covenants, conservation agreements or inclusion in reserve tenure
- Develop and implement a stock management plan for key sites
- Develop and implement a management plan, or nominate an existing plan to be implemented, for the control and eradication of feral herbivores in areas inhabited by the squatter pigeon (southern)
- Raise awareness of the squatter pigeon (southern) within the local community, particularly among land managers.

All of the small, isolated and sparsely distributed populations south of the Carnarvon Range area are considered as important subpopulations of Squatter Pigeon (southern) including:

- Populations occurring in the Condamine River catchment and Darling Downs
- Populations known to occur in the Warwick-Inglewood-Texas area
- Populations potentially occurring in northern NSW (Squatter Pigeon Workshop 2011; DCCEEW 2023).

An important sub-population of the species is not known to occur within the Project area. There is no definition of habitat critical to the survival of the species is the available literature. This is likely due to the relatively broad habitat requirements of the species and the abundance of similar habitat across the wider landscape.

Table 15 provides an assessment of the potential for significant impacts to Squatter Pigeon from the proposed impacts using the assessment criteria for Vulnerable species outlined in the Guideline.

Table 15. Significant residual impact criteria assessment: Squatter Pigeon

Criteria	Vulnerable species assessments
Lead to long-term decrease in the size of a local population	The species was not detected during the recent field survey within the Project area, although the species is considered a likely occurrence. There is no evidence to suggest that a local population occurs within the Project area. The proposed impacts will result in the clearing of 15.43 ha of suitable habitat for the species. The habitat proposed for clearing is adjacent to areas of existing disturbance and is partially isolated by the existing mine and Awoonga Reservoir. Ther species has limited dispersal abilities and required woodland or forest habitat to move between areas of suitable breeding or foraging habitat (Squatter Pigeon Workshop 2011). Extensive areas of suitable habitat for the species occurs to the north and west of the Project area. Pre-clearance surveys will be completed prior to clearing to survey for any breeding places for the species, however individual birds are likely to fly away from any disturbance during the construction phase. The proposed impacts are considered unlikely to lead to a long-term decrease in the size of local population of the species.
Reduce the extent of occurrence of the species	The species was not detected during field surveys within the Project area, although the species is considered a likely occurrence. There is no evidence to suggest that a population occurs within the Project area. The current EOO of the species is estimated at 440,000km^2 (DCCEEW 2023). The Project area is not at the limit of the species distribution. The proposed impacts will result in the clearing of 15.43 ha of suitable foraging habitat for the species. The proposed impacts are considered unlikely to reduce the EOO of the species.
Fragment an existing population	The species was not detected during field surveys within the Project area, although the species is considered a likely occurrence. There is no evidence to suggest that a population occurs within the Project area. The species is highly mobile and able to fly, the Project will not form a barrier to the species. The proposed impacts are considered unlikely to fragment an existing population into two or more populations.
Result in genetically distinct populations forming as a result of habitat isolation	The species was not detected during field surveys within the Project area, although the species is considered a likely occurrence. There is no evidence to suggest that a population occurs within the Project area. The species is highly mobile and able to fly, the Project will not form a barrier to the species. The proposed impacts will not increase the existing degree of habitat isolation within the Project area. The proposed impacts area considered unlikely to result in genetically distinct populations forming as a result of habitat isolation.
Result in invasive species that area harmful to an endangered to vulnerable species becoming established in the endangered or vulnerable species habitat	Predation by feral Cats (*Felis catus*) and Foxes (*Vulpes vulpes*) is a known threatening process for the species, as is habitat degradation resulting from Buffel Grass (*Cenchrus ciliaris*) invasion. Cats and foxes area expected to be common within the Project and wider landscape. Buffel Grass was not observed within the Project area. The Project is unlikely to introduce Buffel Grass into the Project area. A Pest and Weed Management Plan will be in place prior to construction works being carried out. The proposed impacts are considered unlikely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.
Introduce disease that may cause the population to decline	The species may be susceptible to avian bird flu. The Project is unlikely to introduce avian bird flu into the Project area. Machinery imported from outside the region for Project earthworks, transportation and other construction activities will be required to be certified free of weed seeds and soil matter prior to entry onsite. It is inconceivable the proposed impacts will result in the introduction of a disease causing the species to decline.
Interfere with the recovery of the species	The Project will not interfere with any recovery strategies identified in the Approved Conservation Advice for the species.
Cause disruption to ecologically significant locations (breeding,	The species was not observed during recent field surveys within the Project area although the species is considered likely to occur. Historical records of the species include 24 occurrence records with 25 km of the Project area with the nearest record located 3.5 km

feeding, nesting, migration or resting sites) of a species	west of the Project area from 2003 (ALA 2024). There is no evidence to suggest that a local population occurs within the Project area. The Project area is not considered an ecologically significant location for the species. The proposed impacts are considered unlikely to cause disruptions to ecologically significant locations of a species.
Assessment result	Significant impacts to Squatter Pigeon are considered unlikely to occur.

8.1.1.4 Powerful Owl – Vulnerable

Ecology

The Powerful Owl is a large hawk-owl with no facial disc and yellow eyes. Suitable habitat for the species includes open forests and woodlands, and sheltered gullies in wet forests with abundant tree hollows to provide habitat for their preferred prey (Birdlife Australia 2023). The species prey primarily on arboreal mammals such as Common Ring-tail Possum (*Pseudocheirus peregrinus*) and Greater Glider. Nesting occurs in large vertical tree hollows provided by old-growth eucalypt vegetation communities. Breeding pairs of Powerful Owls defend home ranges of 400-4,000 ha, depending on habitat quality (NSW Scientific Committee 2008). The species is distributed from Mackay in the north to western Victoria in the south across a band along the coast and up to 200 km inland, with the exception of the Carnarvon Ranges and the Pilliga (ALA 2024).

Association with the Project area

The species was not observed during the field surveys within the Project area. Historical records of the species include seven occurrence records within 25 km of the Project area with the nearest record located 11 km SSE of the Project area. Marginal habitat for the species within the Project area is provided by remnant RE 11.11.15 and remnant RE 11.3.25 with a total area of 5.57 ha. The habitat is considered marginal due to the absence of suitably large hollows required for nesting and scarcity of smaller hollows to support prey species (I.e. arboreal mammals). Powerful owls may intermittently use the habitat as part of a wider home range.

Government documents

There are no Commonwealth or Queensland Government documents relevant to the species. The NSW Government Saving Our Species Program identifies the following critical actions for the species:

- Consolidate all available information, knowledge and assessment protocols to create a consensus of best practice guidelines, providing a single point source to advise land managers about powerful owl conservation
- Negotiate with relevant landholders to enter into agreements, particularly in-perpetuity covenants or stewardship agreements, that promote the retention of large old trees, riparian habitat, owl roost sites and other high value habitat
- In regions where high priority powerful owl populations can be increased and stabilised, improve habitat quality and reconstruct connectivity
- At sites where tree hollows are few or declining within high priority powerful owl populations, trial the installation of nest boxes to increase mammalian prey densities
- Encourage development of citizen science programs in urban areas where an increase in community engagement is likely to create broader conservation awareness of powerful owls
- Document and protect known nests.

Table 16 provides an assessment of the potential for significant impacts to Powerful Owl from the Proposed impacts using the assessment criteria for Vulnerable species outlined in the Guideline.

Table 16. Significant residual impact criteria assessment: Powerful Owl

Criteria	Vulnerable species assessments
Lead to long-term decrease in the size of a local population	The species was not observed during recent field surveys within the Project area. Historical records of the species include seven occurrence records within 25 km of the Project area with the nearest record located 11 km south southeast of the Project area from 2003 (ALA 2025). There is no evidence to suggest that a local population occurs within the Project area. The proposed impacts will result in the clearance of 18.0 ha of

Criteria	Vulnerable species assessments
	marginal habitat for the species. The habitat proposed for clearing is adjacent to areas of existing disturbance and is partially isolated by the existing mine and Awoonga Reservoir. The proposed impacts are considered unlikely to lead to a long-term decrease in the size of a local population.
Reduce the extent of occurrence of the species	The EOO of the species is estimated at 1,290,000 km^2 (Garnet & Baker 2020). The Project area is not at the limit of the species distribution. The proposed impacts will result in the clearance of 18.0 ha of marginal habitat for the species. The proposed impacts are considered unlikely to reduce the EOO of the species.
Fragment an existing population	The species was not observed during recent field surveys within the Project area. There is no evidence to suggest that a population exists within the Project area. The proposed impact area of 18.0 ha of marginal habitat for the species is relatively minor compared to the existing operational areas within the Project area. The majority of marginal habitat for the species proposed to be impacted is currently isolated to the south of the existing mine. The proposed impacts will not further the current degree of habitat fragmentation within the Project area. The proposed impacts are considered unlikely to fragment an existing population.
Result in genetically distinct populations forming as a result of habitat isolation	The species was not observed during recent field surveys within the Project area. There is no evidence to suggest that a population exists within the Project area. The proposed impact area of 18.0 ha of marginal habitat for the species is relatively minor compared to the existing operational areas within the Project area. The proposed impacts will increase the degree of habitat fragmentation within the Project area. The proposed impacts are considered unlikely to fragment an existing population.
Result in invasive species that area harmful to an endangered to vulnerable species becoming established in the endangered or vulnerable species habitat	There are no invasive species that area a known threat to the species. A Pest and Weed Management Plan will be in place prior to construction works being carried out. The proposed impacts are considered unlikely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.
Introduce disease that may cause the population to decline	The species may be susceptible to avian bird flu. The Project is unlikely to introduce avian bird flu into the Project area. Machinery imported from outside the region for Project earthworks, transportation and other construction activities will be required to be certified free of weed seeds and soil matter prior to entry onsite. It is inconceivable the proposed impacts will result in the introduction of a disease causing the species to decline.
Interfere with the recovery of the species	The Project will not interfere with any critical actions identified for the species.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	The species was not observed during recent field surveys within the Project area although the species is considered likely to occur. There is no evidence to suggest that a local population occurs within the Project area. The Project area is not considered an ecologically significant location for the species. The proposed impacts are considered unlikely to cause disruptions to ecologically significant locations of a species.
Assessment result	Significant impacts to Powerful Owl are considered unlikely to occur.

8.1.1.5 Cassinia collina – Vulnerable

Ecology

Cassinia collina is a shrub reaching 2 m in height, with brown branches and leaves 3 to 7 cm in length. Inflorescences are up to 16 cm long (DESI 2024). Flowering has been observed during April-June and also September-October (Wang 1999; Queensland Herbarium 2011b). Suitable habitat for the species includes tall woodland and open forest on stony soils and sandy loams, including fine-grained granite soils (DESI 2024). The species is restricted to eight populations, including six within Mount Walsh National Park, one within Wongi State Forest and one near Mount Stanley in the Many Peaks Range.

Association with the Project area

The species was not observed within the Project area during the recent field survey. A single record of the species occurs within 25 km of the Project area, located 14 km to the southeast (ALA 2025). Suitable habitat for the species within the Project area is provided by remnant RE 11.11.15 and 11.3.25 with a total area of 5.57 ha.

Government approved documents

There are no government documents relevant to the species. The DETSI species profile for the species identifies the following threat as relevant to the species:

- Habitat clearing on private land

The following management recommendations are also identified:

- Establishment of protective buffers that exclude clearing in areas where the species occurs
- Adaptive management techniques to be implemented during timber harvesting.

Table 17 provides an assessment of the potential for significant impacts to *Cassinia collina* from the proposed impacts using the assessment criteria for Vulnerable species outlined in the Guideline.

Table 17. Significant residual impact criteria assessment: *Cassinia collina*

Criteria	Vulnerable species assessments
Lead to long-term decrease in the size of a local population	The species was not recorded during the recent ecology field survey within the Project area, although a formal protected plant survey was not completed. Known populations occur at Mount Walsh National Park, Wongi State Forest and near Mount Stanley. A single record of the species occurs within 25 km of the Project area, located 14 km to the southeast (ALA 2025). There is no evidence to suggest a local population of the species occurs within the Project area. The proposed impacts will result in the clearance of 18 ha of suitable habitat for the species. The habitat proposed for clearing is adjacent to areas of existing disturbance and is partially isolated by the existing mine and Awoonga Reservoir. A pre-clearance survey targeting the species will be completed within areas of suitable habitat prior to clearing. In the event that a population is discovered within the proposed disturbance areas, further mitigation measures including avoidance will be required to prevent a significant impact. The proposed impacts are considered unlikely to result in a long-term decrease in the size of a local population.
Reduce the extent of occurrence of the species	The species was not recorded during recent surveys within the Project area. The Project area is likely to be outside of the known EOO of the species. A pre-clearance survey targeting the species will be completed within areas of suitable habitat prior to clearing. In the event that a population is discovered within the proposed disturbance areas, further mitigation measures including avoidance will be required to prevent a significant impact. The proposed impacts area considered unlikely to reduce the extent of occurrence of the species.
Fragment an existing population	The species was not recorded during recent surveys within the Project area. There is no evidence to suggest a local population of the species occurs within the Project area. The proposed impacts will not increase the degree of fragmentation of suitable habitat for the species within the Project area. A pre-clearance survey targeting the species will be completed within areas of suitable habitat prior to clearing. In the event that a population is discovered within the proposed disturbance areas, further mitigation measures including avoidance will be required to prevent a significant impact. The proposed impacts are considered unlikely to fragment an existing population.
Result in genetically distinct populations forming as a result of habitat isolation	The species was not recorded during recent surveys within the Project area. There is no evidence to suggest a local population of the species occurs within the Project area. The proposed impacts will not increase the isolation of suitable habitat for the species within the Project area. The proposed impacts are considered unlikely to result in genetically distinct populations forming as a result of habitat isolation.
Result in invasive species that area harmful to an endangered to	There are no invasive species that are known threats to the species, although the species may be vulnerable to herbivory from non-native fauna and habitat degradation from invasive plants. A Pest and Weed Management Plan will be in place prior to construction works being carried out. The proposed impacts are considered unlikely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.

Criteria	Vulnerable species assessments
vulnerable species becoming established in the endangered or vulnerable species habitat	
Introduce disease that may cause the population to decline	There are no diseases that are known to adversely impact the species. A Pest and Weed Management Plan will be in place prior to construction works being carried out. The proposed impacts are considered unlikely to introduce disease that may cause the population to decline.
Interfere with the recovery of the species	The proposed impacts are considered unlikely to interfere with the management recommendation for the species. Flora surveys associated with the Project may increase understanding of the species.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	The species was not recorded during recent surveys within the Project area. There is no evidence to suggest a local population of the species occurs within the Project area. The only known location of the species near Mt Castletower is considered an ecologically significant location for the species. A pre-clearance survey targeting the species will be completed within areas of suitable habitat prior to clearing. In the event that a population is discovered within the proposed disturbance areas, it may be considered an ecologically significant location for the species and further mitigation measures including avoidance will be required to prevent a significant impact. The proposed impacts are considered unlikely to cause disruption to ecological significant locations of a species.
Assessment result	Significant impacts to *Cassinia collina* are considered unlikely to occur.

8.2 Category R (GBR Riverine regrowth) Regulated Vegetation

The Project is mapped as a key resource area (KRA) (State of Queensland 2024a). KRAs are a planning tool designed to protect resources from being rendered inaccessible by urban expansion. Further, they are designed to maintain adequate separation distances between sensitive uses and any future extractive industry (State of Queensland 2024b).

Category A, B, and C regulated vegetation has been completely avoided in developing the proposed future mine plan for the Project. However, the proposed expansion of the Southern WRD to the east will impact 2.95 ha of mapped MSES category R (GBR riverine) least concern vegetation. This area is specifically within the separation area of KRA19 (Taragoola- hard rock operation). The *Accepted Development Clearing Code- Clearing for an Extractive Industry* (DoR 2020) and *List of exempt clearing work* (State of Queensland 2019) notes that clearing in a category C area or category R area within a KRA is exempt clearing work. Therefore, an approval or notification prior to clearing this area is not required.

Under the Offsets Regulation, offsets may be required for any significant residual impact on prescribed environmental matters defined in Schedule 2, Section 1. A prescribed RE is defined as a RE, other than a RE mentioned in the VM Act, section 8(b), located in a category B area on the regulated vegetation management map, to the extent the ecosystem contains remnant vegetation. Therefore, the Category R area is not considered a prescribed environmental matter for offsets under the Offsets Regulation as it is regrowth vegetation. Therefore, there are no significant residual impacts to Category R regulated vegetation considered applicable for the Project.

8.3 Clearing in a RE that is within the Defined Distance of a Watercourse

The Project will require clearing of two areas of mapped regulated vegetation within the defined distance from the defining bank of a relevant watercourse for both linear (access track) and non-linear infrastructure (Southern WRD and future Pit 3-4). The mapping of the MSES regulated vegetation (defined watercourse) is considered to be inconsistent with ground conditions as it partially overlaps existing Project disturbance areas authorised under the Project's EA. The alignment does not reflect the topography of the area, as in both instances the MSES regulated vegetation (defined watercourses) mapping crosses the eastern and western levees at a perpendicular angle, despite being a nominal 15 m taller than the adjacent land.

The MSES defined watercourse mapping follows the same alignment as 'unmapped' watercourse mapping under the *Water Act 2000* and are labelled as stream order 1. Both areas are also mapped low risk (green) waterways for waterway barrier works. Based on the satellite imagery and field surveys undertaken by Epic in March 2023, these waterways are ephemeral, short-in length, and do not provide fish habitat as they are either totally (artificially) impounded and isolated from downstream waterways, or significantly modified by earthworks and/or mining operations. In this context the waterways do not function as mapped and would be heavily altered by historic mining activities. Irrespective of this, an assessment of potential significant residual impact to prescribed REs within the defined distance of a watercourse has been considered in **Table 18,** in relation to Section 2.1 of the SRI Guideline (DEHP 2014).

Under Schedule 2 Section 2 of the Offsets Act, a prescribed RE is a matter of state environmental significance to the extent the ecosystem is located within a defined distance from the defining banks of a relevant watercourse or relevant drainage feature. In Schedule 2, Section 2 (6) of the Offsets Regulation, the 'defined distance' for RE is defined as a distance identified in the *Queensland Environmental Offsets Policy 2023* (Appendix 3, V1.15) as the relevant distance from the defining banks of a relevant watercourse or relevant drainage feature. For stream order 1 watercourses in a non-coastal bioregion, the defined distance is 25 metres. Excluding the existing disturbance, the RE within the proposed disturbance areas is RE 11.3.25 which has a woodland structure code. Therefore, criteria for the 'sparse' structural category applies.

Table 18. Significant residual impact test for MSES regulated vegetation (defined watercourse)

Ref.	Vegetation Clearing Type	Trigger specified in Section 2.1 of guideline	Proposed Project disturbance
1	Clearing for linear infrastructure in a sparse RE	Greater than 20 m wide	Nil- all tracks are no more than 10 m wide
	Clearing other than for linear infrastructure in a sparse RE	Area greater than 2 ha	1.86 ha
2	Clearing within 50 m of the defining bank	N/A	N/A
3	Clearing within 5 m of the [25 m] defining bank	Any clearing	0.42 ha

For a prescribed activity to have a significant residual impact on a RE that is within the defined distance of watercourses, criteria 1 and 3 must be exceeded. Significant impacts are unlikely based on the SRI Guideline (DEHP 2014), however the watercourse does not exist as mapped and therefore there is no potential impact. No offsets under Queensland's *Environmental Offsets Act 2014* are required.

8.4 Waterways Providing for Fish Passage

The Project is expected to impact 3 low risk waterways with barrier works. An environmental offset may be required for any part of a waterway that provides for passage of fish if the construction, installation or modification of waterway barrier works caried out under an authority will limit the passage of fish along the waterway. An assessment of the potential for significant residual impacts to a waterway providing fish passage against the criteria provided in the Guideline is provided below in **Table 19**.

Table 19. Significant residual impact criteria assessment: waterway providing for fish passage

Criteria	Waterway providing fish passage assessment
A permanent modification to the volume, depth, timing, duration or flow frequency on the waterway	Two of the low risk waterways will be impacted by the proposed expansion of Pit 2 and Pit 3-4. A third low risk waterway will be impacted by the proposed waste rock dump. All three waterways and ephemeral, short in length and already subject to artificial impoundment. The expected flow volume and duration is expected to be zero except during very high rainfall event triggering surface flow across the wider area. Expansion of the pits and waste rock dump is not expected to reduce flow the flow of the waterways. The proposed Project is considered unlikely to result in a permanent modification to the volume, depth, timing, duration or flow frequency on the waterway.

Criteria	Waterway providing fish passage assessment
Permanent modification or fragmentation of fish habitat including but not limited to in stream vegetation, snags or woody debris, substrate, bank or riffle formation necessary for breeding and/or survival of native fish	The expected impact areas of all three waterways do not provide fish habitat as they are either totally impounded and isolated from downstream waterways or significantly modified by earthworks and/or mining operations. The proposed Project in considered unlikely to result in permanent modification or fragmentation of fish habitat including but not limited to in stream vegetation, snags or woody debris, substrate, bank or riffle formation necessary for breeding and/or survival of native fish.
The mortality or injury of fish species	Native fish are considered highly unlikely to occur within any of the proposed impact areas. The proposed Project is considered unlikely to result in the mortality or injury of fish.
Works that permanently reduce the level of fish passage provided in a tidal waterway or a waterway identified as a major high risk waterway for waterway barrier works, to a level that would increase stress on fish populations	The waterways or not tidal or major risk. The proposed Project is considered unlikely to result in works that permanently reduce the level of fish passage provided in a tidal waterway or a waterway identified as a major high risk waterway for waterway barrier works, to a level that would increase stress on fish populations.
Assessment result	Significant residual impacts to waterways providing fish passage resulting from the Project are considered unlikely to occur.

8.5 Significant Residual Impacts – Environmental Offsets

Under the Offsets Act, environmental offsets may be required for significant residual impacts to MSES from the proposed Project. As described in **Section 0** and in accordance with the MSES Guideline, significant residual impacts to the following MSES are not expected to be likely:

- Listed conservation significant species
- Regulated vegetation (prescribed RE within the defined distance from the defining banks of a watercourse identified on the vegetation management watercourse map)
- Category R (GBR riverine regrowth) regulated vegetation
- Waterways providing for fish passage

Therefore, no offsets under the Offsets Act are required.

9 SUMMARY AND CONCLUSION

A field survey of the Project area was completed during 27 February to 1 March 2023. The survey included a baseline flora and fauna assessment, verification of REs and regulated vegetation, and assessment of habitat suitability for conservation significant species.

A total of two different RE types were verified within the Project area, including remnant and regrowth vegetation analogous to Category B and Category C regulated vegetation.

The likelihood of occurrence assessment for conservation significant flora species determined that no conservation significant flora species are likely to occur within the Project area (**Table 6**), although two flora species area considered a possible occurrence within the Project area:

- *Cassinia collina*
- *Cycas megacarpa*

The likelihood of occurrence assessment for conservation significant fauna species determined that three conservation significant fauna species, Koala, Squatter Pigeon (southern) and White-throated Needletail, are considered likely to occur within the Project area (**Table 10**), whilst Powerful Owl is considered a possible occurrence within the Project area.

Significant residual impacts from the proposed Project were considered for these listed species considered likely to occur, as well as for regulated vegetation (prescribed RE within the defined distance from the defining banks of a watercourse identified on the vegetation management watercourse map), Category R (GBR riverine) regulated vegetation, and waterways providing for fish passage. It was determined that no significant impact is expected from the proposed Project and therefore, no offsets under the Queensland *Environmental Offsets Act 2014* are required.

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11 ACRONYMS

Acronym	Description
ALA	Atlas of Living Australia
AS	Australian Standards
ASL	Above sea level
BBSB	Brigalow Belt South Bioregion
Biosecurity Act	*Biosecurity Act 2014*
BoM	Bureau of Meteorology
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAF	Department of Agriculture and Fisheries
DAWE	Department of Agriculture, Water, and the Environment
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEHP	Department of Environment and Heritage Protection
DNRMMRRD	Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development
DESI	Department of Environment, Science and Innovation (formerly DES)
DETSI	Department of Environment, Tourism, Science and Innovation (formerly DESI)
DoR	Department of Resources
EA	Environmental Authority
EDL	Ecologically dominant layer
EMP	Environmental Management Plan
EOML	End of mine life
EOO	Extent of occurrence
EP Act	*Environmental Protection Act 1994*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EP Regulation	*Environmental Protection Regulation 2019*
ERAs	Environmentally Relevant Activities
ESAs	Environmentally Sensitive Areas
ESCP	Erosion and Sediment Control Plan
Fisheries Act	*Fisheries Act 1994*
GAWB	Gladstone Area Water Board
GBO	General biosecurity obligation
GBR	Great Barrier Reef
ha	hectares
HES	High ecological significance
km	kilometres
KRA	Key resource area
L	Litres
LGA	Local Government Area
LOM	Life of mine
ML	Mining Leases
m	metre
mAHD	Metres Australian Height Datum
mBGL	Metres below ground level
mm	millimetre
MNES	Matter of national environmental significance
MSES	Matter of state environmental significance
Mtpa	Million tonnes per annum
NC Act	*Nature Conservation Act 1992*
NSW	New South Wales
Offsets Act	*Environmental Offsets Act 2014*
Offsets Regulation	*Environmental Offsets Regulation 2014*
PEM	Prescribed environmental matter
PMLU	Post mining land use
PRC Plan	Progressive Rehabilitation and Closure Plan
QFES	Queensland Fire and Emergency Services
RE	Regional ecosystem

Acronym	Description
ROM	Run of mine
t	tonne
VM Act	*Vegetation Management Act 1999*
WildNet	Wildlife Online
°C	Degrees Celsius
%	Percent

APPENDIX A DESKTOP SEARCH RESULTS

Queensland Government

Department of the Environment, Tourism, Science and Innovation

Environmental Reports

Matters of State Environmental Significance

For the selected area of interest

Longitude: 151.2392 Latitude: -24.1043 with 2 kilometre radius

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 2020). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and a field survey may be required to validate values on the ground.

Please direct queries about these reports to: Planning.Support@des.qld.gov.au

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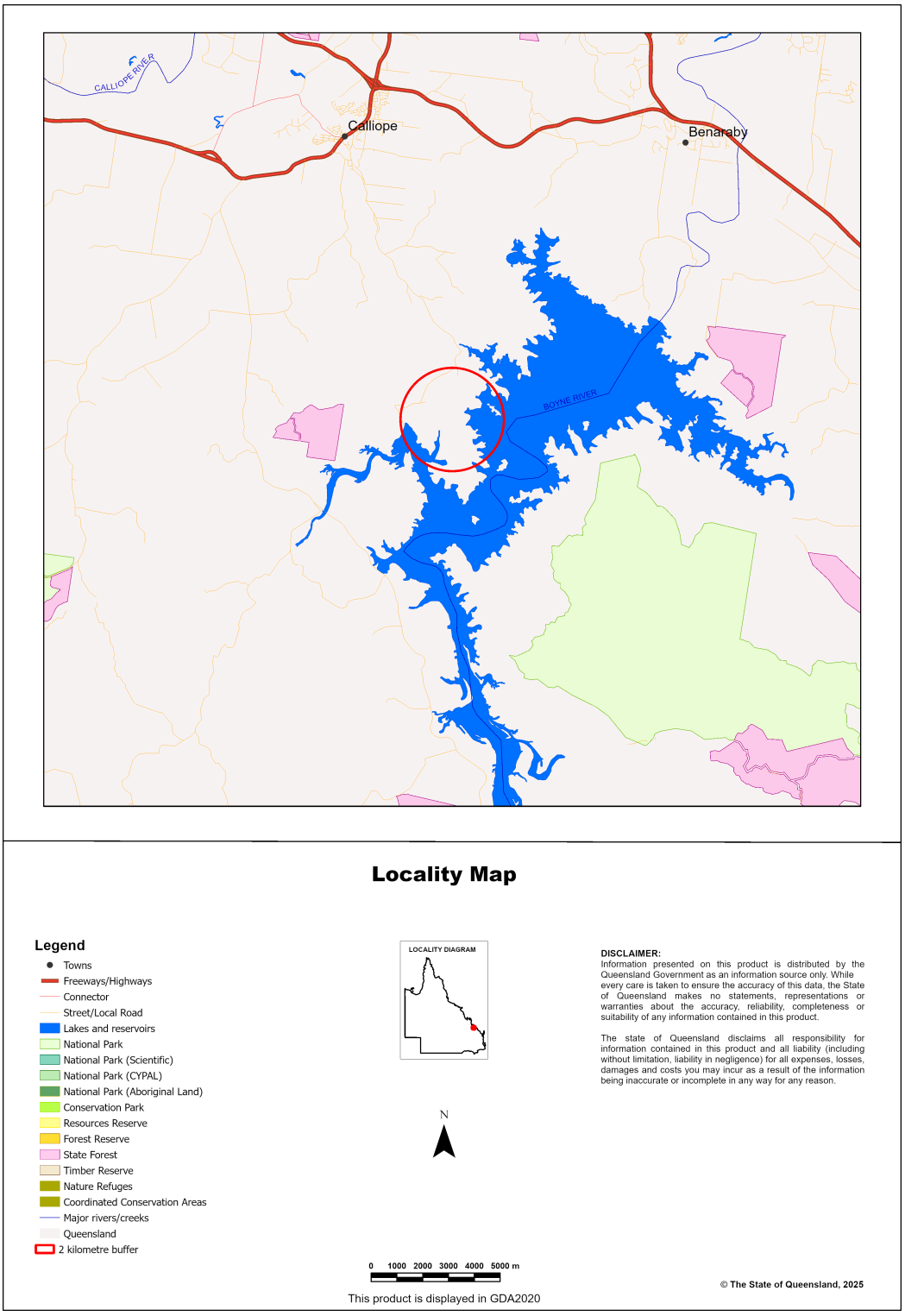
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Assessment Area Details

The following table provides an overview of the area of interest (AOI) with respect to selected topographic and environmental values.

Table 1: Summary table, details for AOI: Longitude: 151.2392 Latitude: -24.1043 with 2 kilometre radius, with area 1256.64 ha

Local Government(s)	Catchment(s)	Bioregion(s)	Subregion(s)
Gladstone Regional	Boyne	Brigalow Belt	Mount Morgan Ranges



Matters of State Environmental Significance (MSES)

MSES Categories

Queensland's State Planning Policy (SPP) includes a biodiversity State interest that states:

'The sustainable, long-term conservation of biodiversity is supported. Significant impacts on matters of national or state environmental significance are avoided, or where this cannot be reasonably achieved; impacts are minimised and residual impacts offset.'

The MSES mapping product is a guide to assist implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations.

The SPP defines matters of state environmental significance as:

- Protected areas (including all classes of protected area except coordinated conservation areas) under the *Nature Conservation Act 1992;*

- Marine parks and land within a 'marine national park', 'conservation park', 'scientific research', 'preservation' or 'buffer' zone under the Marine Parks Act 2004 ;

- Areas within declared fish habitat areas that are management A areas or management B areas under the Fisheries Regulation 2008;

- *Threatened wildlife under the Nature Conservation Act 1992* and special least concern animals under the Nature Conservation (Wildlife) Regulation 2006;

- Regulated vegetation under the *Vegetation Management Act 1999* that is:

  - Category B areas on the regulated vegetation management map, that are 'endangered' or 'of concern' regional ecosystems;
  - Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;
  - Category R areas on the regulated vegetation management map;
  - Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse and drainage feature map;
  - Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map;

- Strategic Environmental Areas under the *Regional Planning Interests Act 2014* ;

- Wetlands in a wetland protection area of wetlands of high ecological significance shown on the Map of Queensland Wetland Environmental Values under the Environment Protection Regulation 2019;

- Wetlands and watercourses in high ecological value waters defined in the Environmental Protection (Water) Policy 2009, schedule 2;
- Legally secured offset areas.

MSES Values Present

The MSES values that are present in the area of interest are summarised in the table below:

Table 2: Summary of MSES present within the AOI

1a Protected Areas- estates	0 ha	0.0%
1b Protected Areas- nature refuges	0 ha	0.0%
1c Protected Areas- special wildlife reserves	0 ha	0.0%
2 State Marine Parks- highly protected zones	0 ha	0.0%
3 Fish habitat areas (A and B areas)	0 ha	0.0%
4 Strategic Environmental Areas (SEA)	0 ha	0.0%
5 High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values	0 ha	0.0%
6a High Ecological Value (HEV) wetlands	0 ha	0.0%
6b High Ecological Value (HEV) waterways	0 km	Not applicable
7a Threatened (endangered or vulnerable) wildlife	0 ha	0.0%
7b Special least concern animals	0 ha	0.0%
7c i Koala habitat area - core (SEQ)	0 ha	0.0%
7c ii Koala habitat area - locally refined (SEQ)	0 ha	0.0%
7d Sea turtle nesting areas	0 km	Not applicable
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	2.07 ha	0.2%
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	1.79 ha	0.1%
8c Regulated Vegetation - Category R (GBR riverine regrowth)	28.33 ha	2.3%
8d Regulated Vegetation - Essential habitat	0 ha	0.0%
8e Regulated Vegetation - intersecting a watercourse	26.5 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	0 ha	0.0%
9a Legally secured offset areas- offset register areas	0 ha	0.0%
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0 ha	0.0%

Additional Information with Respect to MSES Values Present

MSES - State Conservation Areas

1a. Protected Areas - estates

(No results)

1b. Protected Areas - nature refuges

(No results)

1c. Protected Areas - special wildlife reserves

(No results)

2. State Marine Parks - highly protected zones

(No results)

3. Fish habitat areas (A and B areas)

(No results)

Refer to **Map 1 - MSES - State Conservation Areas** for an overview of the relevant MSES.

MSES - Wetlands and Waterways

4. Strategic Environmental Areas (SEA)

(No results)

5. High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values

(no results)

6a. Wetlands in High Ecological Value (HEV) waters

(no results)

6b. Waterways in High Ecological Value (HEV) waters

(no results)

Refer to **Map 2 - MSES - Wetlands and Waterways** for an overview of the relevant MSES.

MSES - Species

7a. Threatened (endangered or vulnerable) wildlife

Not applicable

7b. Special least concern animals

Not applicable

7c i. Koala habitat area - core (SEQ)

Not applicable

7c ii. Koala habitat area - locally refined (SEQ)

Not applicable

7d. Wildlife habitat (sea turtle nesting areas)

Not applicable

Threatened (endangered or vulnerable) wildlife habitat suitability models

Species	Common name	NCA status	Presence
Boronia keysii	Keys boronia	V	None
Calyptorhynchus lathami	Glossy black cockatoo	V	None
Casuarius casuarius johnsonii	Sthn population cassowary	E	None
Crinia tinnula	Wallum froglet	V	None
Denisonia maculata	Ornamental snake	V	None
Euastacus bindal	Mount Elliot crayfish	CR	None
Euastacus binzayedi		CR	None
Euastacus eungella		E	None
Euastacus hystricosus		E	None
Euastacus jagara	Jagara hairy crayfish	CR	None
Euastacus maidae		CR	None
Euastacus monteithorum		E	None
Euastacus robertsi		E	None
Taudactylus pleione	Kroombit tinkerfrog	E	None
Litoria freycineti	Wallum rocketfrog	V	None
Litoria olongburensis	Wallum sedgefrog	V	None
Macadamia integrifolia		V	None
Melaleuca irbyana	swamp tea-tree	E	None
Macadamia ternifolia		V	None
Macadamia tetraphylla	bopple nut	V	None
Petrogale penicillata	brush-tailed rock-wallaby	V	None
Petrogale coenensis	Cape York rock-wallaby	E	None
Petrogale purpureicollis	purple-necked rock-wallaby	V	None
Petrogale sharmani	Sharmans rock-wallaby	V	None
Petrogale xanthopus celeris	yellow-footed rock-wallaby (Qld subspecies)	V	None
Petaurus gracilis	Mahogany Glider	E	None
Petrogale persephone	Proserpine rock-wallaby	E	None
Phascolarctos cinereus	Koala - outside SEQ*	E	None
Pezoporus wallicus wallicus	Eastern ground parrot	V	None
Xeromys myoides	Water Mouse	V	None

*For koala model, this includes areas outside SEQ. Check 7c SEQ koala habitat for presence/absence.

Threatened (endangered or vulnerable) wildlife species records

(No results)

Special least concern animal species records

(No results)

Shorebird habitat (critically endangered/endangered/vulnerable)

Not applicable

Shorebird habitat (special least concern)

Not applicable

**Nature Conservation Act 1992 (NCA) Status- Endangered (E), Vulnerable (V) or Special Least Concern Animal (SL). Environment Protection and Biodiversity Conservation Act 1999 (EPBC) status: Critically Endangered (CE) Endangered (E), Vulnerable (V)*

Migratory status (M) - China and Australia Migratory Bird Agreement (C), Japan and Australia Migratory Bird Agreement (J), Republic of Korea and Australia Migratory Bird Agreement (R), Bonn Migratory Convention (B), Eastern Flyway (E)

To request a species list for an area, or search for a species profile, access Wildlife Online at:

https://www.qld.gov.au/environment/plants-animals/species-list/

Refer to **Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals** and **Map 3b - MSES - Species - Koala habitat area (SEQ)** and **Map 3c - MSES - Wildlife habitat (sea turtle nesting areas)** for an overview of the relevant MSES.

MSES - Regulated Vegetation

For further information relating to regional ecosystems in general, go to:

https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/

For a more detailed description of a particular regional ecosystem, access the regional ecosystem search page at:

https://environment.ehp.qld.gov.au/regional-ecosystems/

8a. Regulated Vegetation - Endangered/Of concern in Category B (remnant)

Regional ecosystem	Vegetation management polygon	Vegetation management status
11.3.4/11.3.25	O-dom	rem_oc

8b. Regulated Vegetation - Endangered/Of concern in Category C (regrowth)

Regional ecosystem	Vegetation management polygon	Vegetation management status
11.3.4/11.3.25	O-dom	hvr_oc

8c. Regulated Vegetation - Category R (GBR riverine regrowth)

Regulated vegetation map category	Map number
R	9149

8d. Regulated Vegetation - Essential habitat

Not applicable

8e. Regulated Vegetation - intersecting a watercourse**

A vegetation management watercourse is mapped as present

8f. Regulated Vegetation - within 100m of a Vegetation Management wetland

Not applicable

Refer to **Map 4 - MSES - Regulated Vegetation** for an overview of the relevant MSES.

MSES - Offsets

9a. Legally secured offset areas - offset register areas

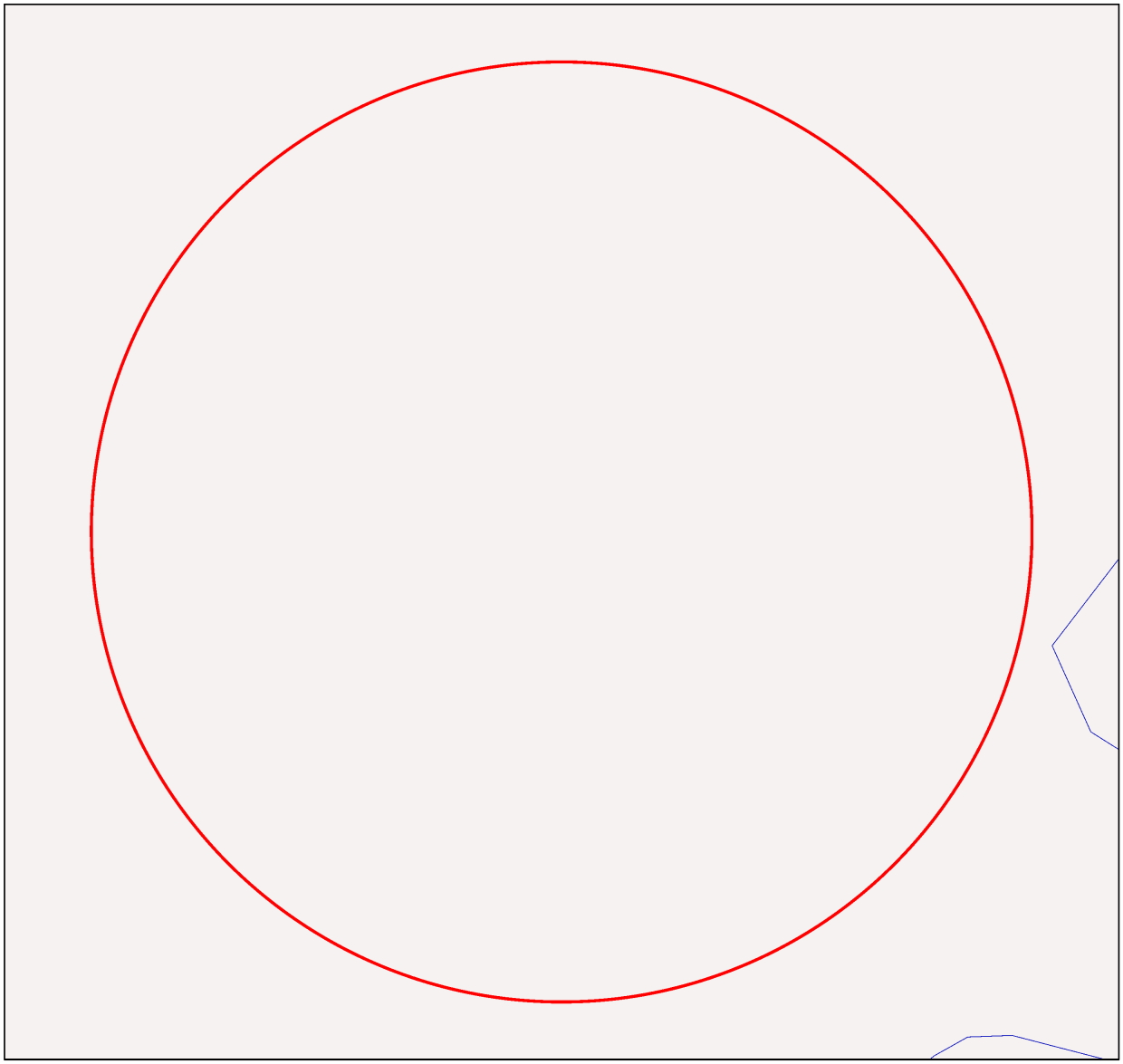
(No results)

9b. Legally secured offset areas - vegetation offsets through a Property Map of Assessable Vegetation

(No results)

Refer to **Map 5 - MSES - Offset Areas** for an overview of the relevant MSES.

Map 1 - MSES - State Conservation Areas



MSES - State Conservation Areas

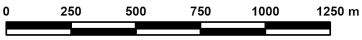
- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Protected area (estates, nature refuges, special wildlife reserves)
- Declared fish habitat area (A and B areas)
- Marine park (highly protected)
- 2 kilometre buffer



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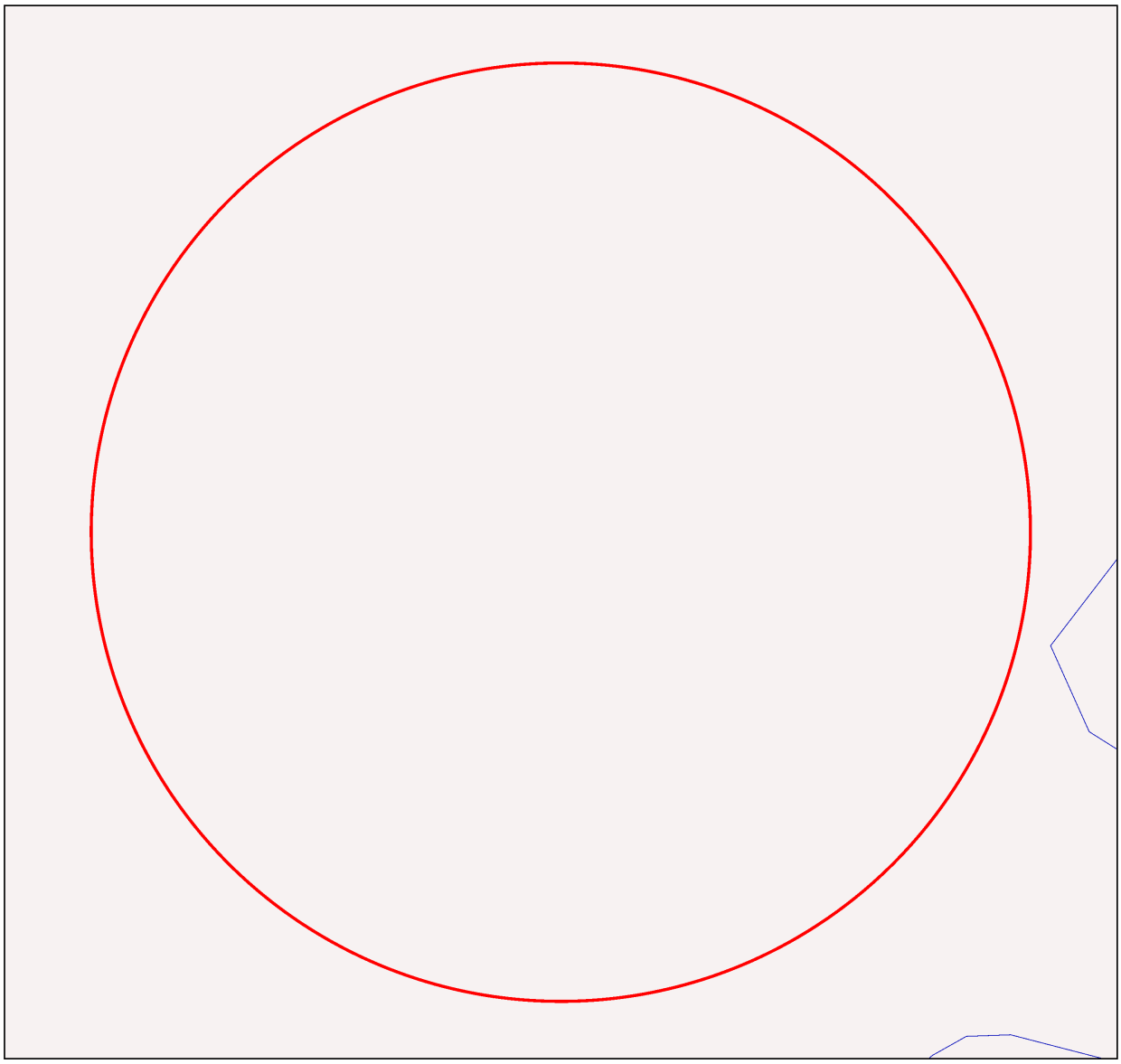




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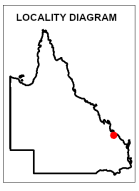
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Map 2 - MSES - Wetlands and Waterways



MSES - Wetlands and Waterways

- ▲ Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Declared high ecological value waters (watercourse)
- Strategic environmental area (designated precinct)
- Declared high ecological value waters (wetland)
- High ecological significance wetlands
- 2 kilometre buffer



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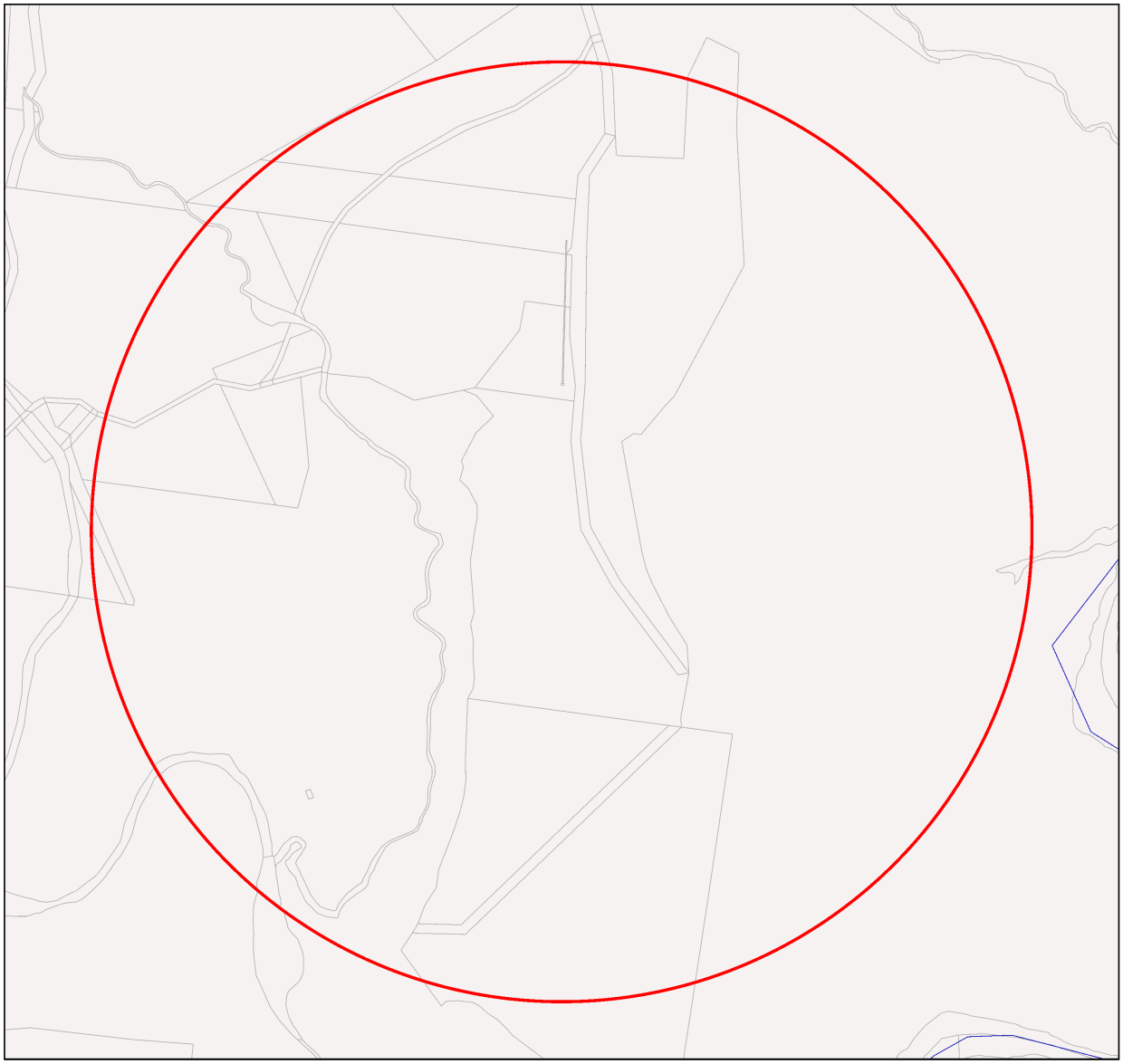
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Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals



MSES - Species
Threatened (endangered or vulnerable) wildlife and special least concern animals

- ▲ Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Wildlife habitat (special least concern)
- Wildlife habitat (endangered or vulnerable)
- 2 kilometre buffer



N

0 250 500 750 1000 1250 m

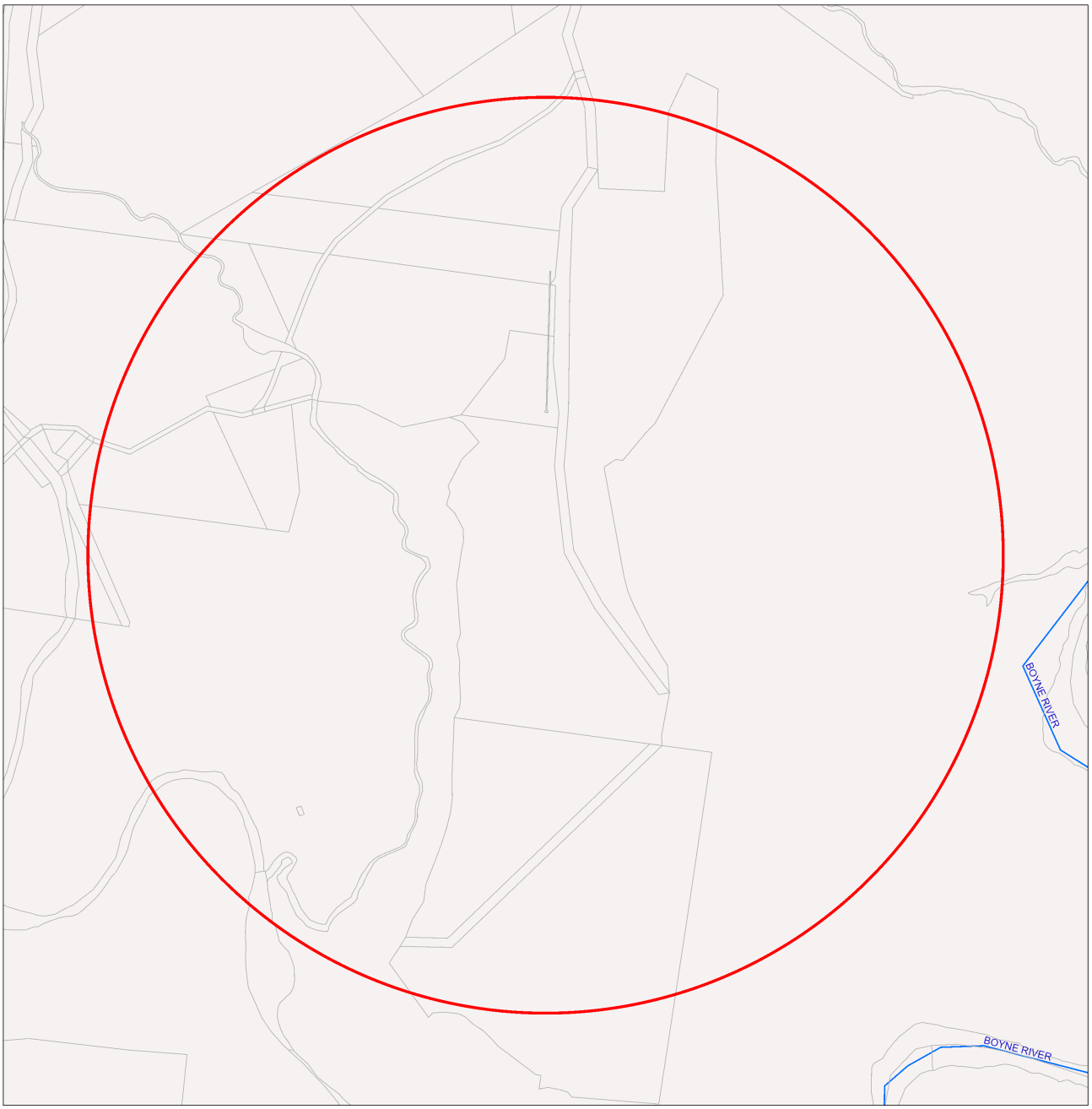
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Map 3b - MSES - Species - Koala habitat area (SEQ)



MSES - Species
Koala habitat area (SEQ)

- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Koala habitat area (core)
- Koala habitat area (locally refined)
- 2 kilometre buffer

LOCALITY DIAGRAM



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The represented layers for SEQ 'koala habitat area-core' and 'koala habitat area- locally refined' in MSES are sourced directly from the regulatory mapping under the Nature Conservation (Koala) Conservation Plan 2017. Whilst every effort is made to ensure the information remains current, there may be delays between updating versions. Please refer to the original mapping for the most recent version. See https://environment.des.qld.gov.au/wildlife/animals/living-with/koalas/mapping

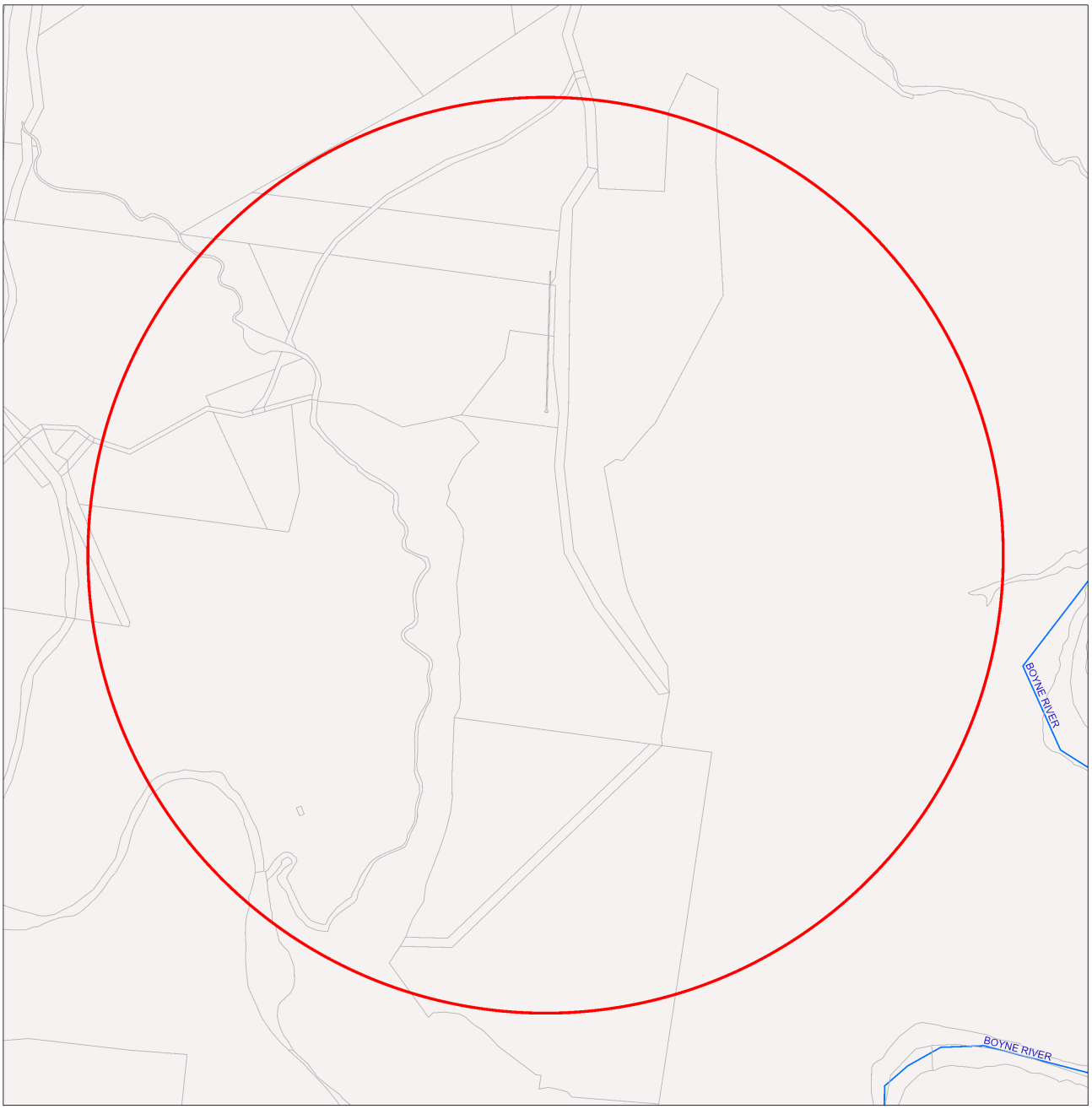
The koala habitat mapping within South East Queensland uses regional ecosystem linework compiled at a scale varying from 1:25,000 to 1:100,000. Linework should be used as a guide only. The positional accuracy of regional ecosystem data mapped at a scale of 1:100,000 is +/- 100 metres.

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Map 3c - MSES - Species - Wildlife habitat (sea turtle nesting areas)



MSES - Wildlife habitat (sea turtle nesting areas)

- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Wildlife habitat (sea turtle nesting areas)
- 2 kilometre buffer

LOCALITY DIAGRAM



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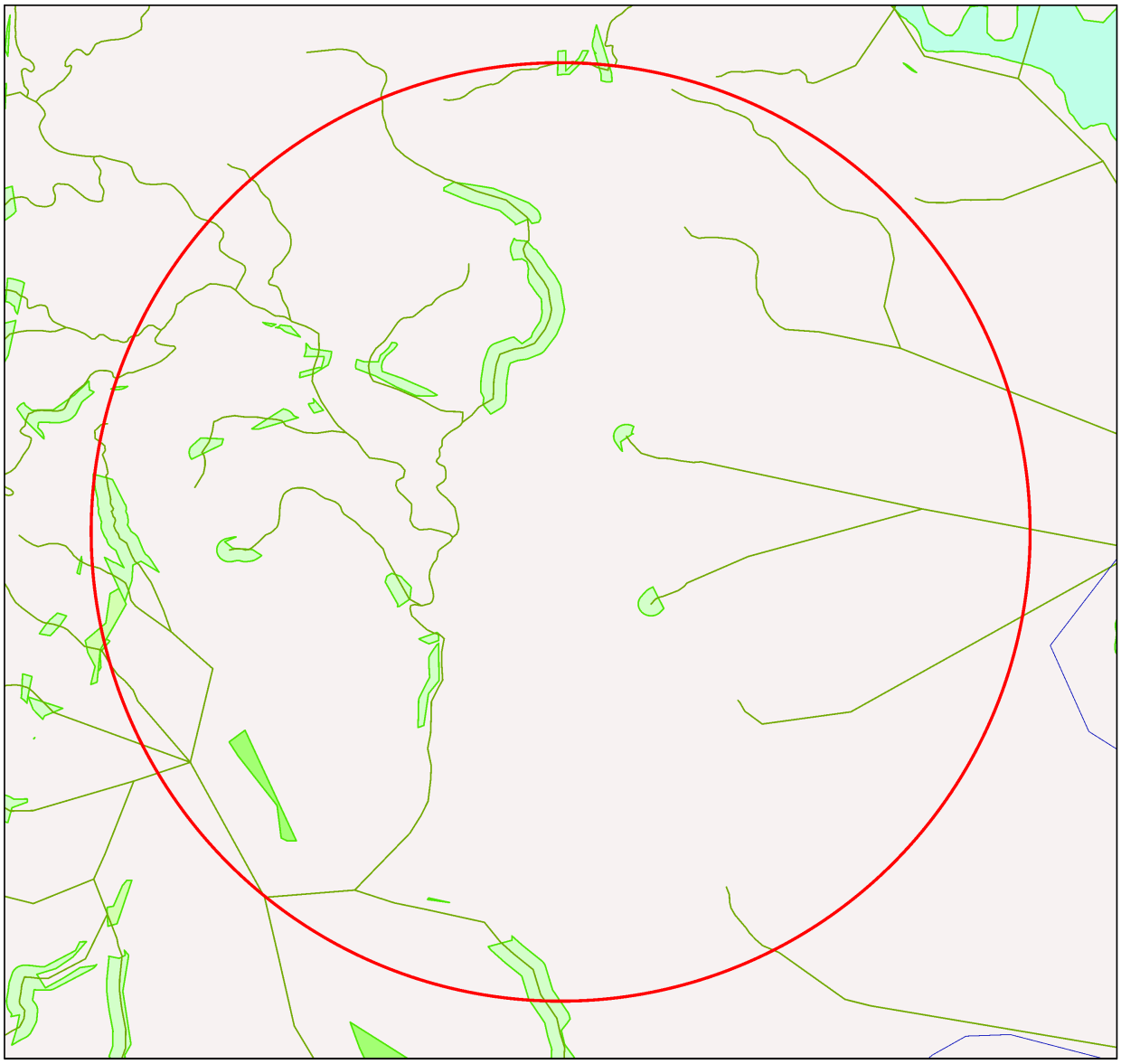
MSES mapping of sea turtle nesting areas identifies beaches where the recorded number of turtle nests are over 1% of the turtle species or genetic stock. The linework is also deliberately extended along nearby rocky coastlines and headlands to recognise that significant numbers of nesting adults and hatchlings can become disoriented by light pollution from development on rocky coastlines and headlands while navigating offshore from nesting beaches.

0 240 480 720 960 1,200 m

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Map 4 - MSES - Regulated Vegetation



MSES - Regulated Vegetation

- ▲ Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Regulated vegetation (intersecting a watercourse)
- Regulated vegetation (100m from wetland)
- Regulated vegetation (category B - endangered or of concern)
- Regulated vegetation (category C - endangered or of concern)
- Regulated vegetation (category R - GBR riverine)
- Regulated vegetation (essential habitat)
- 2 kilometre buffer



N

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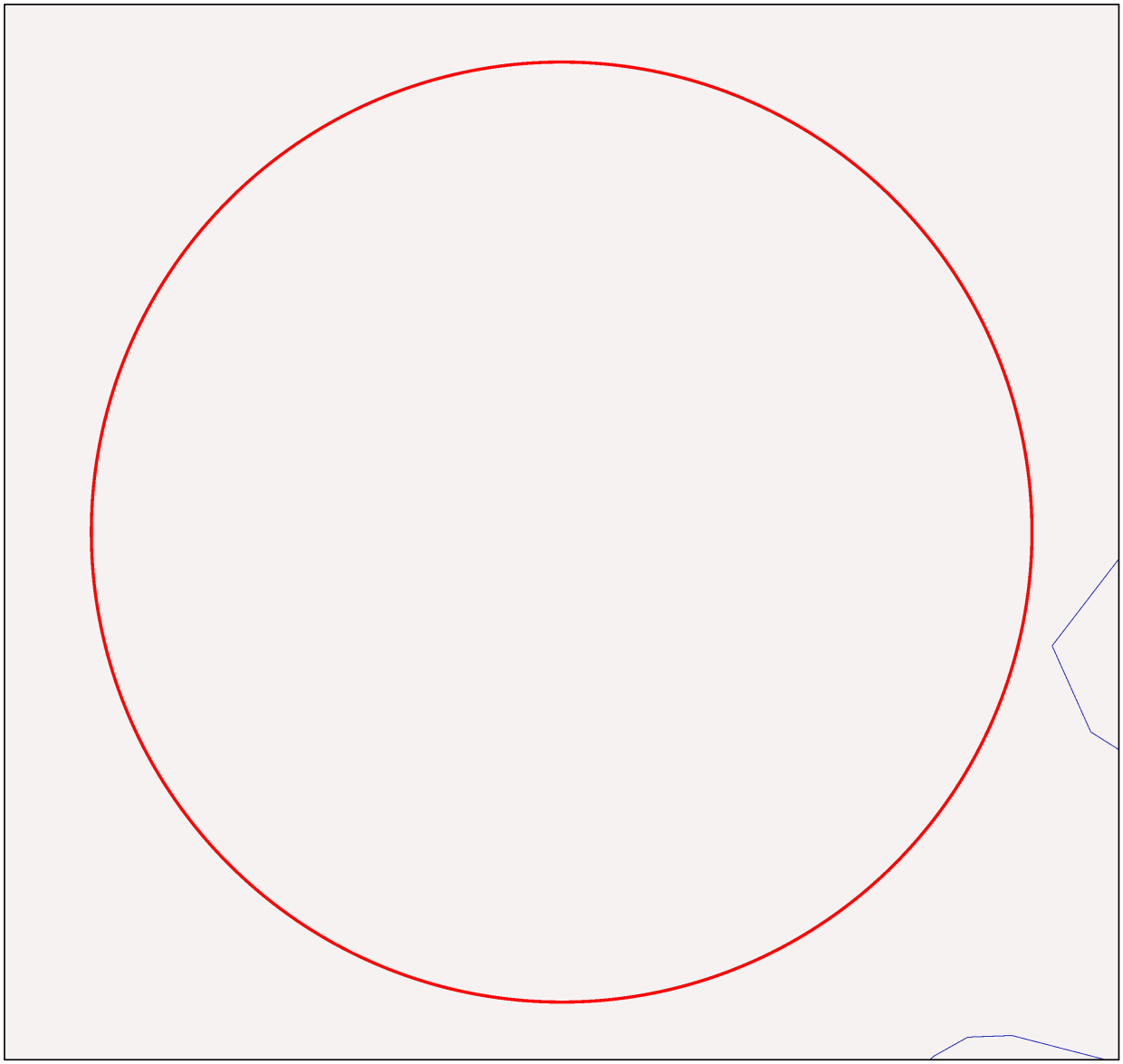
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Map 5 - MSES - Offset Areas



MSES - Offsets

- ▲ Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Legally secured offset area (offset register)
- Legally secured offset area (vegetation offsets)
- 2 kilometre buffer



N

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Appendices

Appendix 1 - Matters of State Environmental Significance (MSES) methodology

MSES mapping is a regional-scale representation of the definition for MSES under the State Planning Policy (SPP). Its primary purpose is to support implementation of the SPP biodiversity policy.

MSES mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations.

MSES mapping does not determine whether state or local development assessment is required. For state assessment triggers refer to the Development Assessment Mapping System (DAMS). For local assessment triggers, refer to the relevant local planning scheme.

The Queensland Government's "Method for mapping - matters of state environmental significance can be downloaded from:

http://www.ehp.qld.gov.au/land/natural-resource/method-mapping-mses.html .

Appendix 2 - Source Data

The datasets listed below are available on request from:

http://qldspatial.information.qld.gov.au/catalogue/custom/index.page

- Matters of State environmental significance

Note: MSES mapping is not based on new or unique data. The primary mapping product draws data from a number of underlying environment databases and geo-referenced information sources. MSES mapping is a versioned product that is updated generally on a twice-yearly basis to incorporate the changes to underlying data sources. Several components of MSES mapping made for the current version may differ from the current underlying data sources. To ensure accuracy, or proper representation of MSES values, it is strongly recommended that users refer to the underlying data sources and review the current definition of MSES in the State Planning Policy, before applying the MSES mapping.

Individual MSES layers can be attributed to the following source data available at QSpatial:

MSES layers	**current QSpatial data (http://qspatial.information.qld.gov.au)**
Protected Areas-Estates, Nature Refuges, Special Wildlife Reserves	- Protected areas of Queensland - Nature Refuges - Queensland - Special Wildlife Reserves- Queensland
Marine Park-Highly Protected Zones	Moreton Bay marine park zoning 2008
Fish Habitat Areas	Queensland fish habitat areas
Strategic Environmental Areas-designated	Regional Planning Interests Act - Strategic Environmental Areas
HES wetlands	Map of Queensland Wetland Environmental Values
Wetlands in HEV waters	HEV waters: - EPP Water intent for waters Source Wetlands: - Queensland Wetland Mapping (Current version 5) Source Watercourses: - Vegetation management watercourse and drainage feature map (1:100000 and 1:250000)
Wildlife habitat (threatened and special least concern)	-WildNet database species records - habitat suitability models (various) - SEQ koala habitat areas under the Koala Conservation Plan 2019
VMA regulated regional ecosystems	Vegetation management regional ecosystem and remnant map
VMA Essential Habitat	Vegetation management - essential habitat map
VMA Wetlands	Vegetation management wetlands map
Legally secured offsets	Vegetation Management Act property maps of assessable vegetation. For offset register data-contact DETSI
Regulated Vegetation Map	Vegetation management - regulated vegetation management map

Appendix 3 - Acronyms and Abbreviations

AOI	- Area of Interest
DETSI	- Department of the Environment, Tourism, Science and Innovation
EP Act	- Environmental Protection Act 1994
EPP	- Environmental Protection Policy
GDA2020	- Geocentric Datum of Australia 2020
GEM	- General Environmental Matters
GIS	- Geographic Information System
MSES	- Matters of State Environmental Significance
NCA	- Nature Conservation Act 1992
RE	- Regional Ecosystem
SPP	- State Planning Policy
VMA	- Vegetation Management Act 1999

Queensland Government

Department of the Environment, Tourism, Science and Innovation

Environmental Reports

Regional Ecosystems

Biodiversity Status

For the selected area of interest
Longitude: 151.2392 Latitude: -24.1043 with 2 kilometre buffer

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the input coordinates.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 2020). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Important Note to User

Information presented in this report is based upon the Queensland Herbarium & Biodiversity Science's Regional Ecosystem framework. The Biodiversity Status has been used to depict the extent of "Endangered", "Of Concern" and "No Concern at Present" regional ecosystems in all cases, rather than the classes used for the purposes of the *Vegetation Management Act 1999* (VMA). Mapping and figures presented in this document reflect the Queensland Herbarium & Biodiversity Science's Remnant and Pre-clearing Regional Ecosystem Datasets, and not the certified mapping used for the purpose of the VMA.

For matters relevant to vegetation management under the VMA, please refer to the Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development website https://www.nrmmrrd.qld.gov.au/

Please direct queries about these reports to: Queensland.Herbarium@qld.gov.au

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Summary Information

The following table provides an overview of the AOI with respect to selected topographic and environmental themes. Refer to **Map 1** for locality information.

Table 1: Details for area of interest:
Longitude: 151.2392 Latitude: -24.1043 with 2 kilometre buffer, with area 1256.64 ha

Local Government(s)	Catchment(s)	Bioregion(s)	Subregion(s)
Gladstone Regional	Boyne	Brigalow Belt	Mount Morgan Ranges

The table below summarizes the extent of remnant vegetation classed as "Endangered", "Of concern" and "No concern at present" regional ecosystems classified by Biodiversity Status within the area of interest (AOI).

Table 2: Summary table, biodiversity status of regional ecosystems within the AOI

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.00	0.00
Of concern	2.07	0.16
No concern at present	393.81	31.34
Total remnant vegetation	395.87	31.50

Refer to **Map 2** for further information.

Regional Ecosystems

1. Introduction

Regional ecosystems are vegetation communities in a bioregion that are consistently associated with particular combinations of geology, landform and soil (Sattler and Williams 1999). Descriptions of Queensland's Regional ecosystems are available online from the Regional Ecosystem Description Database (REDD). Descriptions are compiled from a broad range of information sources including vegetation, land system and geology survey and mapping and detailed vegetation site data. The regional ecosystem classification and descriptions are reviewed as new information becomes available. A number of vegetation communities may form a single regional ecosystem and may be distinguished by differences in structure or sub-dominant species in the ecologically dominant layer. Vegetation communities with different dominant species in the ecologically dominant layer may be amalgamated in to a regional ecosystem if they are not mappable and predictable in the landscape at 1:100 000 scale. Vegetation communities may be mappable at a scale larger than 1:100 000. Vegetation communities within a regional ecosystem are denoted by a letter following the regional ecosystem code (e.g. a, b, c). Vegetation communities and regional ecosystems are amalgamated into a higher level classification of broad vegetation groups (BVGs).

A published methodology for survey and mapping of regional ecosystems across Queensland (Neldner et al 2023) provides further details on regional ecosystem concepts and terminology.

This report provides information on the type, status, and extent of vegetation communities, regional ecosystems and broad vegetation groups present within a user specified area of interest. Please note, for the purpose of this report, the Biodiversity Status is used. This report has not been developed for application of the *Vegetation Management Act 1999* (VMA). Additionally, information generated in this report has been derived from the Queensland Herbarium & Biodiversity Science's Regional Ecosystem Mapping, and not the regulated mapping certified for the purposes of the VMA. If your interest/matter relates to regional ecosystems and the VMA, users should refer to the Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development website https://www.nrmmrrd.qld.gov.au/.

With respect to the Queensland Biodiversity Status,

"Endangered" regional ecosystems are described as those where:

- remnant vegetation is less than 10 per cent of its pre-clearing extent across the bioregion; or 10-30% of its pre-clearing extent remains and the remnant vegetation is less than 10,000 hectares, or
- less than 10 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss*, or
- 10-30 percent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 hectares; or
- it is a rare** regional ecosystem subject to a threatening process.***

"Of concern" regional ecosystems are described as those where:

- the degradation criteria listed above for 'Endangered' regional ecosystems are not met and,
- remnant vegetation is 10-30 per cent of its pre-clearing extent across the bioregion; or more than 20 per cent of its pre-clearing extent remains and the remnant extent is less than 10,000 hectares, or
- 10-30 percent of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss.****

and "No concern at present" regional ecosystems are described as those where:

- remnant vegetation is over 30 percent of its pre-clearing extent across the bioregion, and the remnant area is greater than 10,000 hectares, and
- the degradation criteria listed above for 'Endangered' or 'Of concern' regional ecosystems are not met.

**Severe degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 50 years even with the removal of threatening processes; or soil surface is severely degraded, for example, by loss of A horizon, surface expression of salinity; surface compaction, loss of organic matter or sheet erosion.*

***Rare regional ecosystem: pre-clearing extent (<1000 ha); or patch size (<100 ha and of limited total extent across its range).*

****Threatening processes are those that are reducing or will reduce the biodiversity and ecological integrity of a regional ecosystem. For example, clearing, weed invasion, fragmentation, inappropriate fire regime or grazing pressure, or infrastructure development.*

*****Moderate degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 20 years even with the removal of threatening processes; or soil surface is moderately degraded.*

2. Remnant Regional Ecosystems

The following table identifies the remnant regional ecosystems and vegetation communities mapped within the AOI and provides their short descriptions, Biodiversity Status, and remnant extent within the selected AOI. Please note, where heterogeneous vegetated patches (mixed patches of remnant vegetation mapped as containing multiple regional ecosystems) occur within the AOI, they have been split and listed as individual regional ecosystems (or vegetation communities where present) for the purposes of the table below. In such instances, associated area figures have been generated based upon the estimated proportion of each regional ecosystem (or vegetation community) predicted to be present within the larger mixed patch.

Table 3: Remnant regional ecosystems, description and status within the AOI

Regional Ecosystem	Short Description	BD Status	Area (Ha)	% of AOI
11.11.15	Eucalyptus crebra woodland to open woodland on deformed and metamorphosed sediments and interbedded volcanics	No concern at present	393.81	31.34
11.3.25	Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines	Of concern	0.31	0.02
11.3.4	Eucalyptus tereticornis and/or Eucalyptus spp. woodland on alluvial plains	Of concern	1.76	0.14
non-remnant	None	None	645.45	51.36
water	None	None	214.49	17.07

Refer to **Map 2** for further information. **Map 3** also provides a visual estimate of the distribution of regional ecosystems present before clearing.

Table 4 provides further information in regards to the remnant regional ecosystems present within the AOI. Specifically, the extent of remnant vegetation remaining within the bioregion, the 1:1,000,000 broad vegetation group (BVG) classification, whether the regional ecosystem is identified as a wetland, and extent of representation in Queensland's Protected Area Estate. For a description of the vegetation communities within the AOI and classified according to the 1:1,000,000 BVG, refer to **Table 6**.

Table 4: Remnant regional ecosystems within the AOI, additional information

Regional Ecosystem	Remnant Extent	BVG (1 Million)	Wetland	Representation in protected estate
11.11.15	Pre-clearing 892000 ha; Remnant 2021 519000 ha	13c	Not a Wetland	Low
11.3.25	Pre-clearing 813000 ha; Remnant 2021 531000 ha	16a	Riverine	Low
11.3.4	Pre-clearing 684000 ha; Remnant 2021 178000 ha	16c	Not a Wetland	Low

Regional Ecosystem	Remnant Extent	BVG (1 Million)	Wetland	Representation in protected estate
non-remnant	None	None	None	None
water	None	None	None	None

Representation in Protected Area Estate: High greater than 10% of pre-clearing extent is represented; Medium 4 - 10% is represented; Low less than 4% is represented, No representation.

The distribution of mapped wetland systems within the area of interest is displayed in **Map 6**.

The following table lists known special values associated with a regional ecosystem type.

Table 5: Remnant regional ecosystems within the AOI, special values

Regional Ecosystem	Special Values
11.11.15	11.11.15: Potential habitat for NCA listed species: Capparis humistrata, Corymbia clandestina, Corymbia xanthope, Cycas megacarpa, Cycas ophiolitica.
11.3.25	11.3.25: Shown to be associated with a high fauna species richness in the Taroom area (Venz et al. 2002). Within parts of the Fitzroy catchment, this RE is known habitat for the threatened freshwater turtle Rheodytes leukops. Known to be important habitat for other riparian freshwater turtle species. This ecosystem is also known to provide suitable habitat for koalas (Phascolarctos cinereus).
11.3.4	11.3.4: Potential habitat for NCA listed species: Acacia pedleyi, Callicarpa thozetii, Cycas megacarpa, Cycas ophiolitica, Digitaria porrecta, Eriocaulon carsonii subsp. orientale, Livistona nitida, Rhaponticum australe, Samadera bidwillii, Sannantha brachypoda. This ecosystem is also known to provide suitable habitat for koalas (Phascolarctos cinereus).
non-remnant	None
water	None

3. Remnant Regional Ecosystems by Broad Vegetation Group

BVGs are a higher-level grouping of vegetation communities. Queensland encompasses a wide variety of landscapes across temperate, wet and dry tropics and semi-arid climatic zones. BVGs provide an overview of vegetation communities across the state or a bioregion and allow comparison with other states. There are three levels of BVGs which reflect the approximate scale at which they are designed to be used: the 1:5,000,000 (national), 1:2,000,000 (state) and 1:1,000,000 (regional) scales.

A comprehensive description of BVGs is available at: https://publications.qld.gov.au/dataset/redd/resource/

The following table provides a description of the 1:1,000,000 BVGs present and their associated extent within the AOI.

Table 6: Broad vegetation groups (1 million) within the AOI

BVG (1 Million)	Description	Area (Ha)	% of AOI
None	None	859.94	68.43

BVG (1 Million)	Description	Area (Ha)	% of AOI
13c	Woodlands of Eucalyptus crebra (sens. lat.) (narrow-leaved red ironbark), E. drepanophylla (grey ironbark), E. fibrosa (dusky-leaved ironbark), E. shirleyi (shirley's silver-leaved ironbark) on granitic and metamorphic ranges.	393.81	31.34
16a	Open forest and woodlands dominated by Eucalyptus camaldulensis (river red gum) (or E. tereticornis (blue gum)) and/or E. coolabah (coolabah) (or E. microtheca (coolabah)) fringing drainage lines. Associated species may include Melaleuca spp., Corymbia tessellaris (carbeen), Angophora spp., Casuarina cunninghamiana (riveroak). Does not include alluvial areas dominated by herb and grasslands or alluvial plains that are not flooded.	0.31	0.02
16c	Woodlands and open woodlands dominated by Eucalyptus coolabah (coolabah) or E. microtheca (coolabah) or E. largiflorens (black box) or E. tereticornis (blue gum) or E. chlorophylla on floodplains. Does not include alluvial areas dominated by herb and grasslands or alluvial plains that are not flooded.	1.76	0.14

Refer to **Map 4** for further information. **Map 5** also provides a representation of the distribution of vegetation communities as per the 1:5,000,000 BVG believed to be present prior to European settlement.

4. Technical and BioCondition Benchmark Descriptions

Technical descriptions provide a detailed description of the full range in structure and floristic composition of regional ecosystems (e.g. 11.3.1) and their component vegetation communities (e.g. 11.3.1a, 11.3.1b). See: http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

The descriptions are compiled using site survey data from the Queensland Herbarium & Biodiversity Science's QBEIS database. Distribution maps, representative images (if available) and the pre-clearing and remnant extent (hectares) of each vegetation community derived from the regional ecosystem mapping data are included. The technical descriptions should be used in conjunction with the fields from the regional ecosystem description database (REDD) for a full description of the regional ecosystem.

Technical descriptions include data on canopy height, canopy cover and native plant species composition of the predominant layer, which are attributes relevant to assessment of the remnant status of vegetation under the *Vegetation Management Act 1999*. However, as technical descriptions reflect the full range in structure and floristic composition across the climatic, natural disturbance and geographic range of the regional ecosystem, local reference sites should be used for remnant assessment where possible (Neldner et al. 2023 (PDF)* section 3.3 of: https://www.qld.gov.au/__data/assets/pdf_file/0033/459186/methodology-mapping-surveying-v7.pdf

The technical descriptions are subject to review and are updated as additional data becomes available.

When conducting a BioCondition assessment, these technical descriptions should be used in conjunction with BioCondition benchmarks for the specific regional ecosystem, or component vegetation community. http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

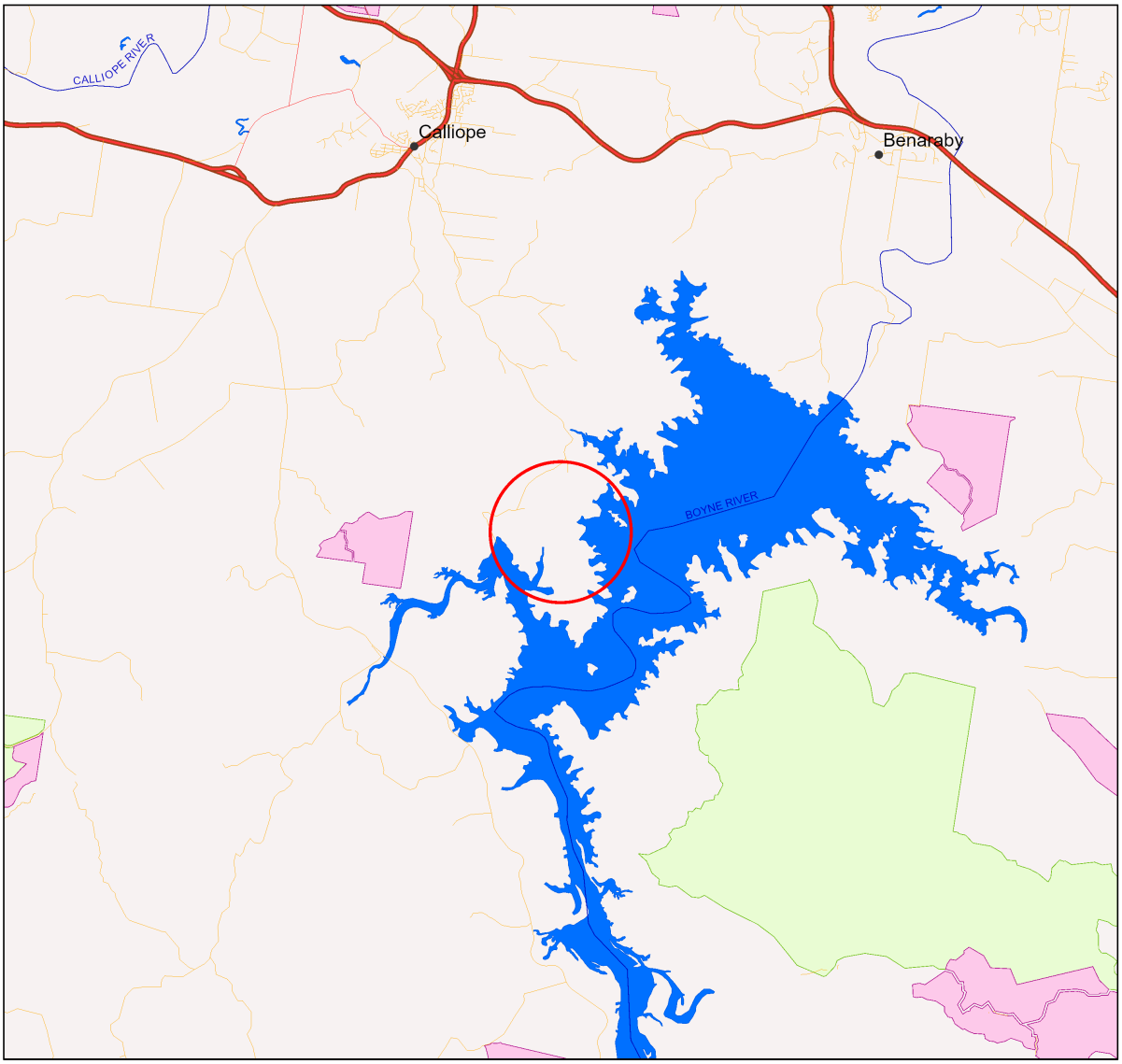
Benchmarks are based on a combination of quantitative and qualitative information and should be used as a guide only. Benchmarks are specific to one regional ecosystem vegetation community, however, the natural variability in structure and floristic composition under a range of climatic and natural disturbance regimes has been considered throughout the geographic extent of the regional ecosystem. Local reference sites should be used for this spatial and temporal (seasonal and annual) variability.

Table 7: List of remnant regional ecosystems within the AOI for which technical and biocondition benchmark descriptions are available

Regional ecosystems mapped as within the AOI	Technical Descriptions	Biocondition Benchmarks
11.11.15	Available	Available
11.3.25	Available	Available
11.3.4	Available	Available
non-remnant	Not currently available	Not currently available
water	Not currently available	Not currently available

Maps

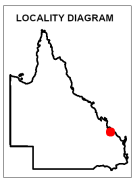
Map 1 - Location



Locality Map

Legend

- Towns
- Freeways/Highways
- Connector
- Street/Local Road
- Lakes and reservoirs
- National Park
- National Park (Scientific)
- National Park (CYPAL)
- National Park (Aboriginal Land)
- Conservation Park
- Resources Reserve
- Forest Reserve
- State Forest
- Timber Reserve
- Nature Refuges
- Coordinated Conservation Areas
- Major rivers/creeks
- Queensland
- 2 kilometre buffer



N

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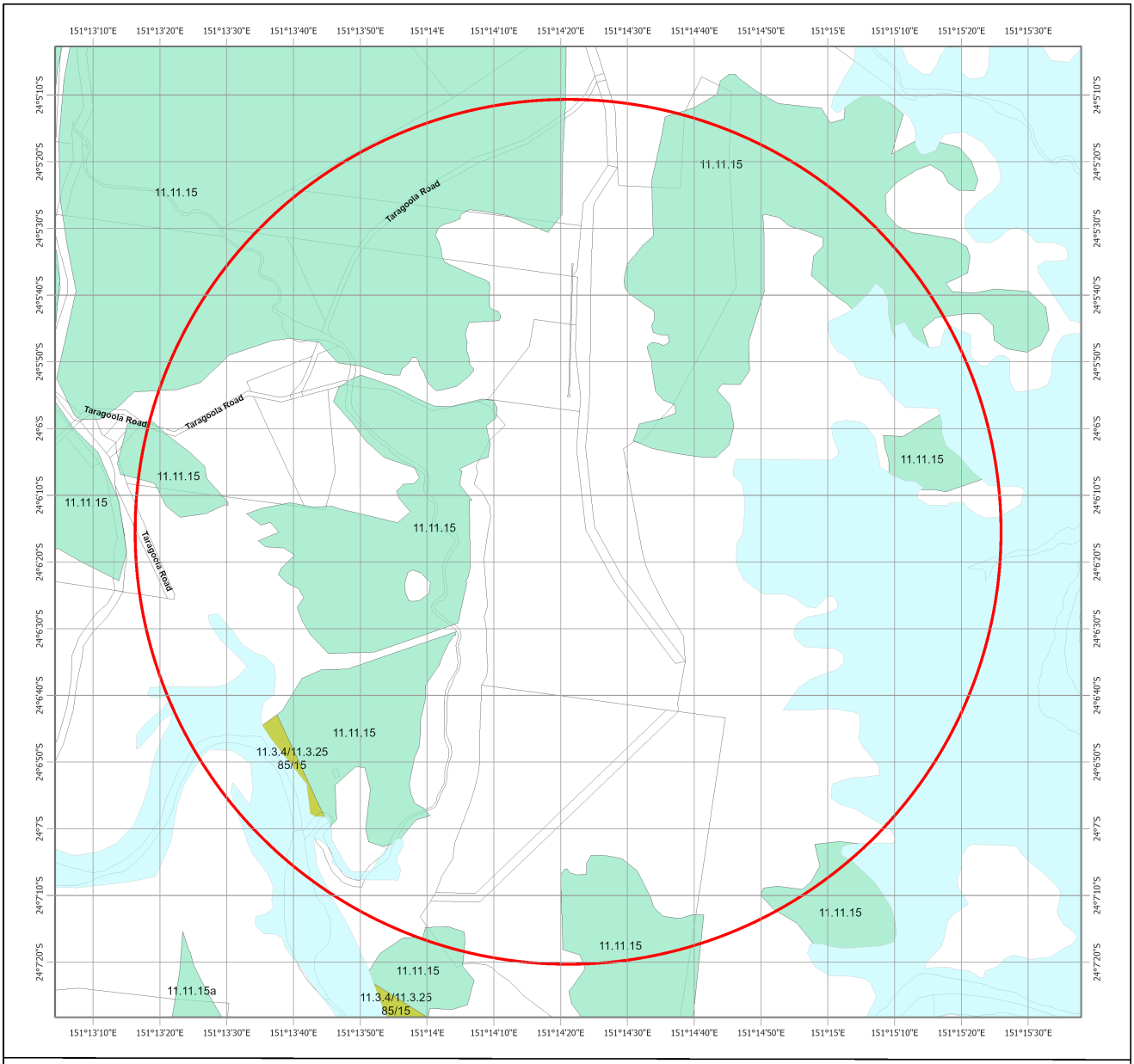
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Map 2 - Remnant 2021 regional ecosystems

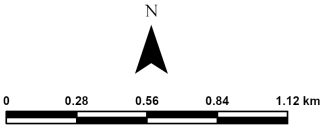


Remnant 2021 Regional Ecosystems

Biodiversity Status

- Endangered - Dominant vegetation
- Endangered - Sub-dominant
- Of Concern - Dominant
- Of Concern - Sub-dominant
- No concern at present
- Non-remnant vegetation, cultivated or built environment
- Plantation
- Water
- Cadastral Boundaries
- 2 kilometre buffer



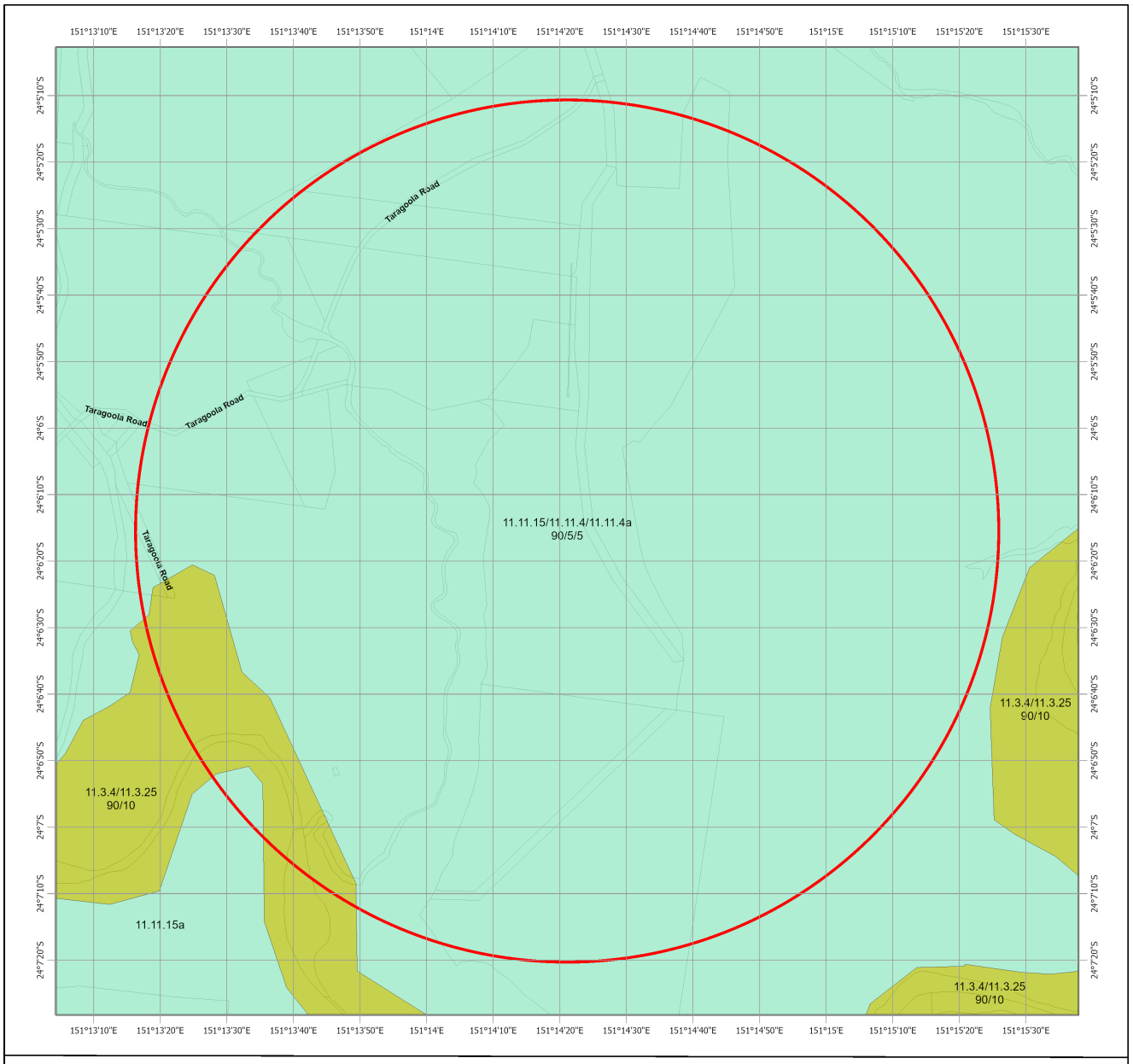


This product is projected into GDA2020

Regional ecosystem mapping over the majority of Queensland is produced at a scale of 1:100,000. At this scale, the minimum remnant polygon area is 5 hectares or minimum remnant width of 75 metres. Regional ecosystem linework reproduced at a scale greater than 1:100,000, except in designated areas, should be used as a guide only. The precision of polygon boundaries or positional accuracy of linework is 100 metres.
Regional ecosystems are defined as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil. The polygons are labelled by regional ecosystem (RE); where more than one RE occurs, the percentage of each is labelled. The label consists of 3 components: bioregion, land zone, and vegetation community – the dominant canopy species. e.g.: RE 12.3.3. Descriptions of REs are found online. Use the search term "Regional Ecosystem Framework".
Regional ecosystem mapping at 1:100,000 map scale is derived from the following sources: 1:80,000 B&W 1960's aerial photography, Landsat TM imagery, geology, soils, land systems data, field survey and historical records.

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Map 3 - Pre-clearing regional ecosystems



Pre-clearing Regional Ecosystems

Biodiversity Status

- Endangered - Dominant vegetation
- Endangered - Sub-dominant
- Of Concern - Dominant
- Of Concern - Sub-dominant
- No concern at present
- Water
- Cadastral Boundaries
- 2 kilometre buffer



N

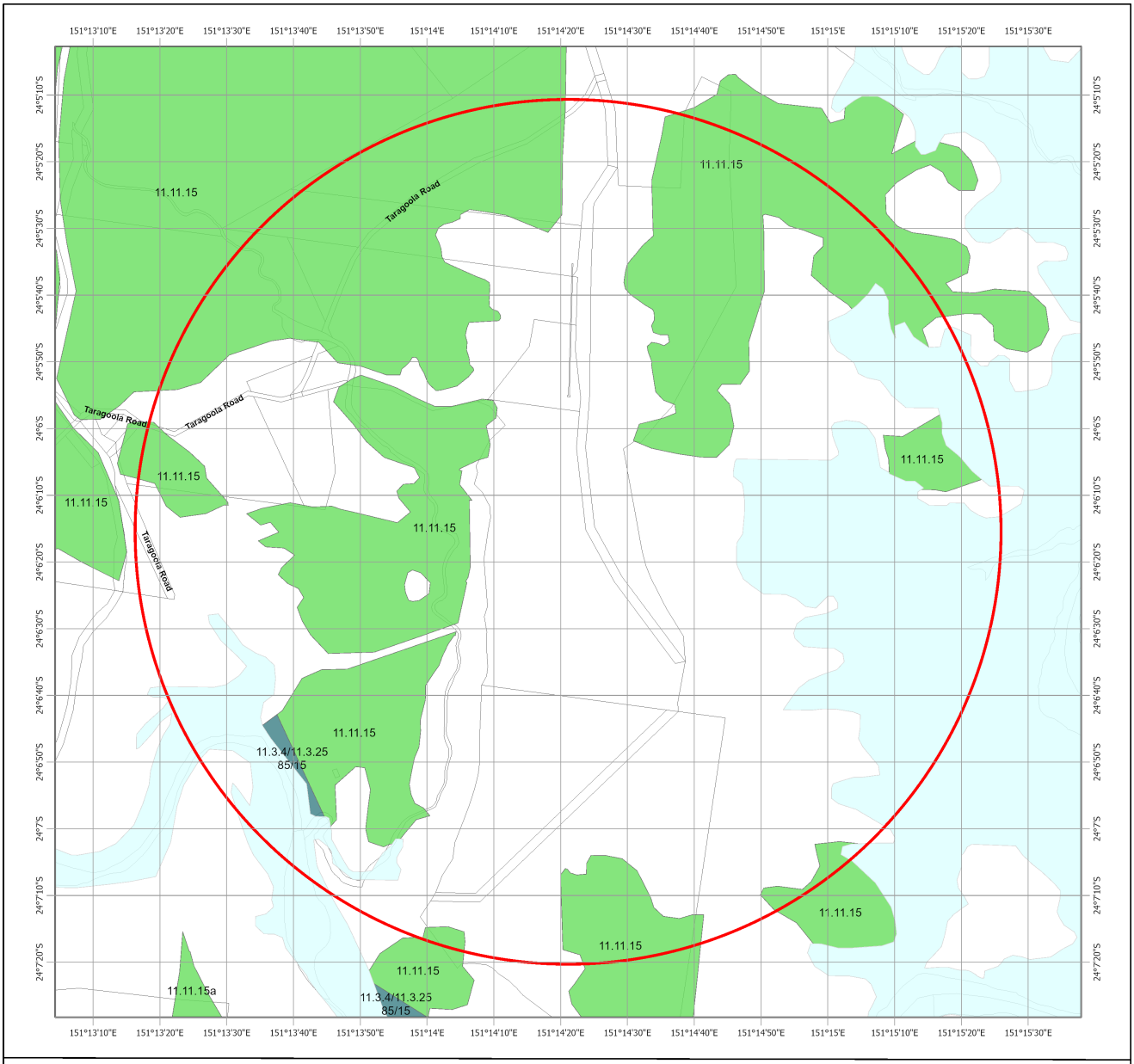
0 0.28 0.57 0.85 1.14 km

This product is displayed in GDA2020

Regional ecosystem mapping over the majority of Queensland is produced at a scale of 1:100,000. At this scale, the minimum remnant polygon area is 5 hectares or minimum remnant width of 75 metres. Regional ecosystem linework reproduced at a scale greater than 1:100,000, except in designated areas, should be used as a guide only. The precision of polygon boundaries or positional accuracy of linework is 100 metres.
Regional ecosystems are defined as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil. The polygons are labelled by regional ecosystem (RE); where more than one RE occurs, the percentage of each is labelled. The label consists of 3 components: bioregion, land zone, and vegetation community – the dominant canopy species. e.g.: RE 12.3.3. Descriptions of REs are found online. Use the search term "Regional Ecosystem Framework".
Regional ecosystem mapping at 1:100,000 map scale is derived from the following sources: 1:80,000 B&W 1960's aerial photography, Landsat TM imagery, geology, soils, land systems data, field survey and historical records.

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Map 4 - Remnant 2021 regional ecosystems by BVG (5M)



Remnant 2021 Regional Ecosystems coloured by Broad Vegetation Groups

Broad Vegetation Groups
BVG5M Description (BVG1M codes)

- 1. Rainforests and scrubs (1-7b)
- 2. Wet eucalypt open forests (8-8b)
- 3. Eucalypt woodlands to open forests (mainly eastern Qld) (9-15b)
- 4. Eucalypt open forests to woodlands on floodplains (16-16d)
- 5. Eucalypt dry woodlands on inland depositional plains (17-18d)
- 6. Eucalypt low open woodlands usually with spinifex understorey (19-19d)
- 7. Callitris woodland - open forests (20a)
- 8. Melaleuca open woodlands on depositional plains (21-22c)
- 9. Acacia aneura (mulga) dominated open forests, woodlands and shrublands (23-23b)
- 10. Other acacia dominated open forests, woodlands and shrublands (24-26a)
- 11. Mixed species woodlands, open woodland - (inland bioregions) includes wooded downs (27-27c)
- 12. Other coastal communities or heaths (28-29b)
- 13. Tussock grasslands, forblands (30-32b)
- 14. Hummock grasslands (33-33b)
- 15. Wetlands (swamps and lakes) (34-34g)
- 16. Mangroves and saltmarshes (35-35b)
- Non-remnant vegetation, cultivated or built environment
- Water
- Cadastral Boundaries
- 2 kilometre buffer



N

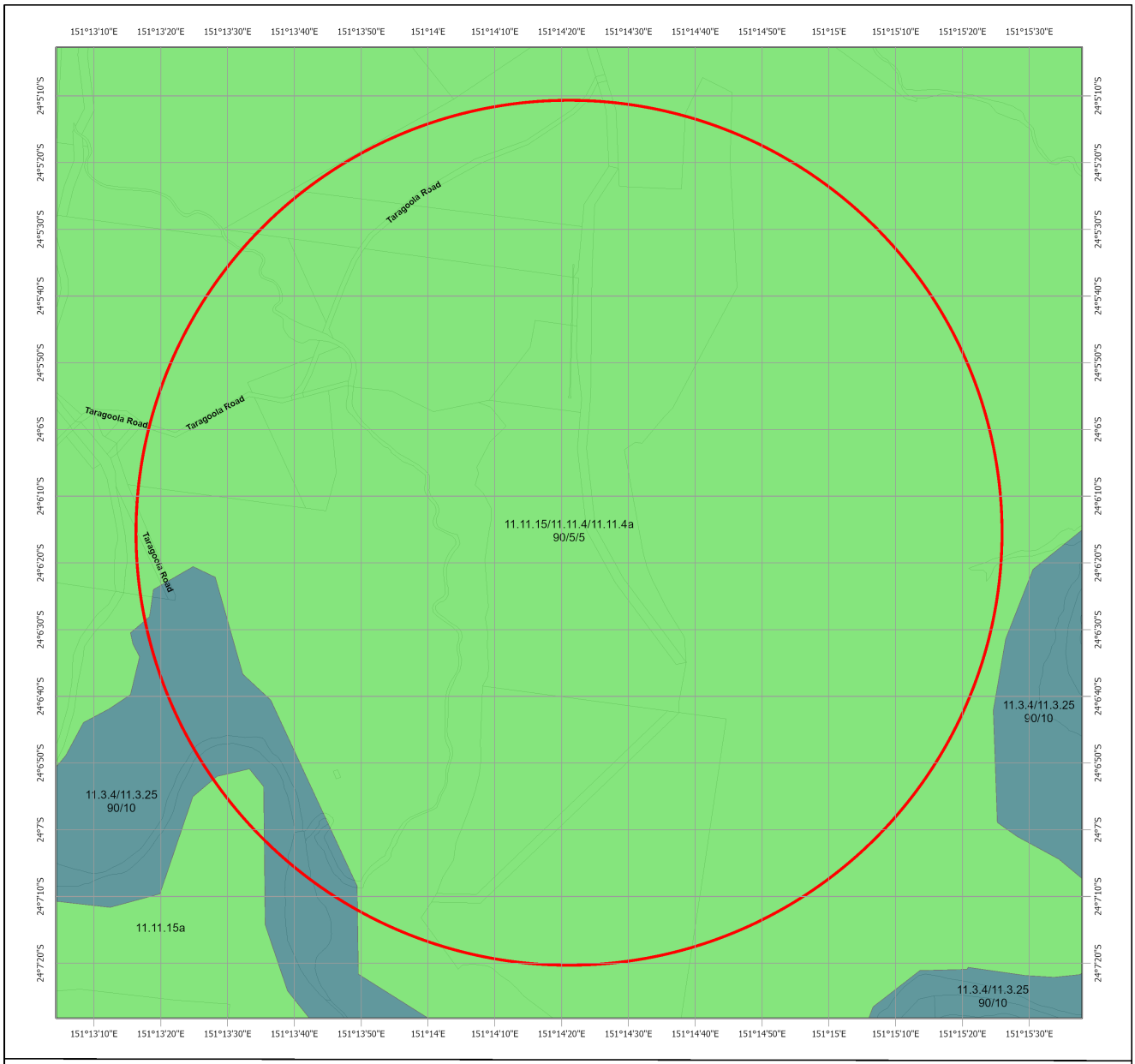
0 0.28 0.56 0.84 1.12 km

This product is displayed in GDA2020

Broad Vegetation Groups (BVG) of Queensland are applied by look up table to the regional ecosystem vegetation communities. Each polygon is coloured by the dominant BVG5M and the component regional ecosystems labelled. Where more than one regional ecosystem occurs, the percentage of each is labelled. Regional ecosystem mapping over the majority of Queensland is produced at a scale of 1:100,000. At this scale, the minimum remnant polygon area is 5 hectares or minimum remnant width of 75 metres. Regional ecosystem linework reproduced at a scale greater than 1:100,000, except in designated areas, should be used as a guide only. The precision of polygon boundaries or positional accuracy of linework is 100 metres.
Regional ecosystems are defined as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil.
The label consists of 3 components: bioregion, land zone, and vegetation community – the dominant canopy species. e.g.: RE 12.3.3. Descriptions of REs are found online. Use the search term "Regional Ecosystem Framework".
Regional ecosystem mapping at 1:100,000 map scale is derived from the following sources: 1:80,000 B&W 1960's aerial photography, Landsat TM imagery, geology, soils, land systems data, field survey and historical records.
Remnant woody vegetation is defined as vegetation that has not been cleared or vegetation that has been cleared but where the dominant canopy has >70% of the height and >50% of the cover relative to the undisturbed height and cover of that stratum and is dominated by species characteristic of the vegetation's undisturbed canopy.
Non-remnant vegetation includes regrowth and disturbed native vegetation.

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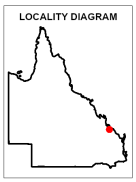
Map 5 - Pre-clearing regional ecosystems by BVG (5M)

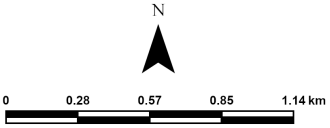


Pre-clearing Regional Ecosystems coloured by Broad Vegetation Groups

Broad Vegetation Groups
BVG5M Description (BVG1M codes)

- 1. Rainforests and scrubs (1-7b)
- 2. Wet eucalypt open forests (8-8b)
- 3. Eucalypt woodlands to open forests (mainly eastern Qld) (9-15b)
- 4. Eucalypt open forests to woodlands on floodplains (16-16d)
- 5. Eucalypt dry woodlands on inland depositional plains (17-18d)
- 6. Eucalypt low open woodlands usually with spinifex understorey (19-19d)
- 7. Callitris woodland - open forests (20a)
- 8. Melaleuca open woodlands on depositional plains (21-22c)
- 9. Acacia aneura (mulga) dominated open forests, woodlands and shrublands (23-23b)
- 10. Other acacia dominated open forests, woodlands and shrublands (24-26a)
- 11. Mixed species woodlands, open woodland - (inland bioregions) includes wooded downs (27-27c)
- 12. Other coastal communities or heaths (28-29b)
- 13. Tussock grasslands, forblands (30-32b)
- 14. Hummock grasslands (33-33b)
- 15. Wetlands (swamps and lakes) (34-34g)
- 16. Mangroves and saltmarshes (35-35b)
- Water
- Cadastral Boundaries
- 2 kilometre buffer



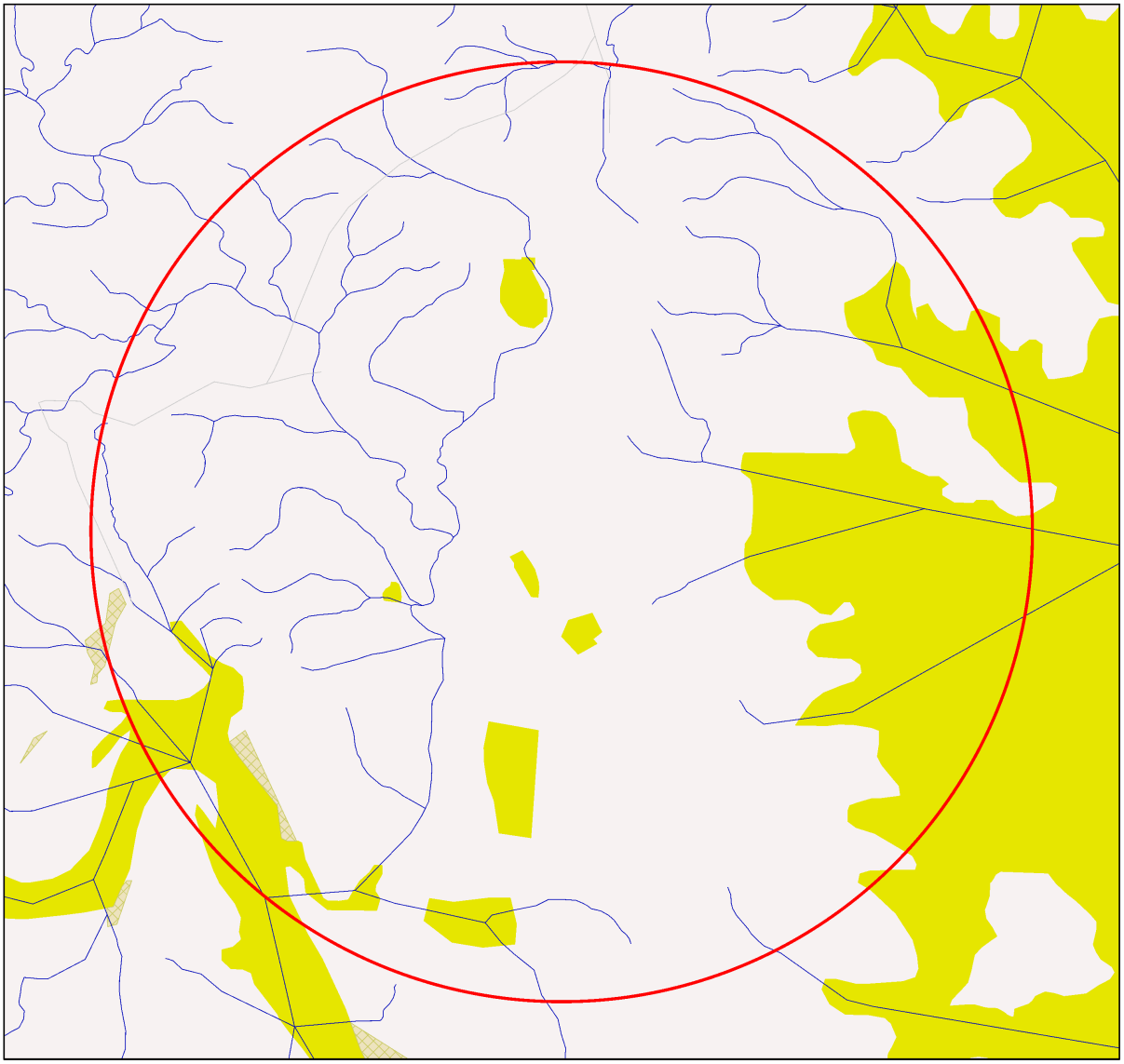


This product is displayed in GDA2020

Broad Vegetation Groups (BVG) of Queensland are applied by look up table to the regional ecosystem vegetation communities. Each polygon is coloured by the dominant BVG5M and the component regional ecosystems labelled. Where more than one regional ecosystem occurs, the percentage of each is labelled.
Regional ecosystem mapping over the majority of Queensland is produced at a scale of 1:100,000. At this scale, the minimum remnant polygon area is 5 hectares or minimum remnant width of 75 metres. Regional ecosystem linework reproduced at a scale greater than 1:100,000, except in designated areas, should be used as a guide only. The precision of polygon boundaries or positional accuracy of linework is 100 metres.
Regional ecosystems are defined as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil. The label consists of 3 components: bioregion, land zone, and vegetation community – the dominant canopy species. e.g.: RE 12.3.3. Descriptions of REs are found online. Use the search term "Regional Ecosystem Framework".
Regional ecosystem mapping at 1:100,000 map scale is derived from the following sources: 1:80,000 B&W 1960's aerial photography, Landsat TM imagery, geology, soils, land systems data, field survey and historical records.

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Map 6 - Wetlands and waterways



Wetlands and Waterways

- Towns
- Roads
- Springs
- Rivers/Creeks
- Directory of Important Wetlands
- Ramsar Sites - QLD

Wetland Type

Hydrologically natural Wetlands
- Lacustrine Wetlands (hydrologically natural)
- Palustrine Wetlands (hydrologically natural)
- Riverine Wetlands (hydrologically natural)
- Intertidal Wetlands (hydrologically natural)
- Subtidal Wetlands (hydrologically natural)
- Intertidal/Subtidal Wetlands (hydrologically natural)

Hydrologically Modified and Artificial Wetlands
- Lacustrine Wetlands (hydrologically modified or artificial)
- Palustrine Wetlands (hydrologically modified or artificial)
- Riverine Wetlands (hydrologically modified or artificial)
- Intertidal Wetlands (hydrologically modified or artificial)
- Subtidal Wetlands (hydrologically modified or artificial)
- Intertidal/Subtidal Wetlands (hydrologically modified or artificial)

Subdominant Wetlands
- Subdominant Wetlands (51 - 80%)

Contains Wetlands
- Contains Wetlands (1 - 50%)
- Queensland
- 2 kilometre buffer

LOCALITY DIAGRAM



N

0 250 500 750 1000 1250 m

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Links and Other Information Sources

The Department of the Environment, Tourism, Science and Innovation's Website - http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/ provides further information on the regional ecosystem framework, including access to links to the Regional Ecosystem Database, Broad Vegetation Group Definitions, Regional Ecosystem and Land zone descriptions.

Descriptions of the broad vegetation groups of Queensland can be downloaded from: https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/broad-vegetation

The methodology for mapping regional ecosystems can be downloaded from: https://www.qld.gov.au/__data/assets/pdf_file/0033/459186/methodology-mapping-surveying-v7.pdf

Technical descriptions for regional ecosystems can be obtained from: http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

Benchmarks can be obtained from: http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

For further information associated with the remnant regional ecosystem dataset used by this report, refer to the metadata associated with the Biodiversity status of pre-clearing and Remnant Regional Ecosystems of Queensland dataset (version listed in **Appendix 1**) which is available through the Queensland Spatial Catalogue, Queensland Spatial Catalogue : Queensland Government (information.qld.gov.au)

The Queensland Globe is a mapping and data application. As an interactive online tool, Queensland Globe allows you to view and explore Queensland maps, imagery (including up-to-date satellite images) and other spatial data, including regional ecosystem mapping. To further view and explore regional ecosystems over an area of interest, access the Biota Globe (a component of the Queensland Globe). The Queensland Globe can be accessed via the following link: https://qldglobe.information.qld.gov.au/

References

Neldner, V.J., Niehus, R.E., Wilson, B.A., McDonald, W.J.F., Ford, A.J. and Accad, A. (2023). The Vegetation of Queensland. Descriptions of Broad Vegetation Groups. Version 6.0. Queensland Herbarium, Department of Environment and Science. (https://publications.qld.gov.au/dataset/redd/resource/78209e74-c7f2-4589-90c1-c33188359086)

Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S., Butler, D.W., McDonald, W.J.F, Richter,D., Addicott, E.P. and Appelman, C.N. (2023) Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland. Version 7.0. Updated December 2023. Queensland Herbarium, Queensland Department of Environment, Science and Innovation, Brisbane. (https://www.qld.gov.au/__data/assets/pdf_file/0033/459186/methodology-mapping-surveying-v7.pdf).

Sattler, P.S. and Williams, R.D. (eds) (1999). *The Conservation Status of Queensland's Bioregional Ecosystems.* Environmental Protection Agency, Brisbane.

Appendices

Appendix 1 - Source Data

The dataset listed below is available for download from:
http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/download/

- Regional Ecosystem Description Database

The datasets listed below are available for download from:
Queensland Spatial Catalogue : Queensland Government (information.qld.gov.au)

- Biodiversity status of pre-clearing and 2021 remnant regional ecosystems of Queensland
- Pre-clearing Vegetation Communities and Regional Ecosystems of Queensland
- Queensland Wetland Data Version - Wetland lines
- Queensland Wetland Data Version - Wetland points
- Queensland Wetland Data Version - Wetland areas
- Pre-clearing broad vegetation groups of Queensland
- Remnant 2021 broad vegetation groups of Queensland

Appendix 2 - Acronyms and Abbreviations

AOI - Area of Interest
GIS - Geographic Information System
RE - Regional Ecosystem
REDD - Regional Ecosystem Description Database
VMA - *Vegetation Management Act 1999*

Queensland Government

WildNet species list

Search Criteria: Species List for a Specified Point
Species: All
Type: All
Queensland status: Rare and threatened species
Records: All
Date: All
Latitude: -24.1043
Longitude: 151.2392
Distance: 25
Email: dcox@epicenvironmental.com.au
Date submitted: Friday 11 Apr 2025 14:22:06
Date extracted: Friday 11 Apr 2025 14:30:04

The number of records retrieved = 45

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Information about your Species lists request is logged for quality assurance, user support and product enhancement purposes only.
The information provided should be appropriately acknowledged as being derived from WildNet database when it is used. As the WildNet Program is still in a process of collating and vetting data, it is possible the information given is not complete. Go to the WildNet database webpage (https://www.qld.gov.au/environment/plants-animals/species-information/wildnet) to find out more about WildNet and where to access other WildNet information products approved for publication. Feedback about WildNet species lists should be emailed to wildlife.online@des.qld.gov.au.

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Accipitridae	*Erythrotriorchis radiatus*	red goshawk		E	E	1
animals	birds	Apodidae	*Hirundapus caudacutus*	white-throated needletail		V	V	10
animals	birds	Burhinidae	*Esacus magnirostris*	beach stone-curlew		V		19
animals	birds	Cacatuidae	*Calyptorhynchus lathami*	glossy black-cockatoo		V		1
animals	birds	Cacatuidae	*Calyptorhynchus lathami erebus*	glossy black-cockatoo (northern)		V		3
animals	birds	Charadriidae	*Charadrius leschenaultii*	greater sand plover		V	V	2
animals	birds	Charadriidae	*Charadrius mongolus*	lesser sand plover		E	E	23
animals	birds	Charadriidae	*Pluvialis squatarola*	grey plover		V	V	1
animals	birds	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)		V	V	35
animals	birds	Scolopacidae	*Arenaria interpres*	ruddy turnstone		V	V	5
animals	birds	Scolopacidae	*Calidris acuminata*	sharp-tailed sandpiper		V	V	11
animals	birds	Scolopacidae	*Calidris ferruginea*	curlew sandpiper		CR	CE	5
animals	birds	Scolopacidae	*Calidris tenuirostris*	great knot		V	V	1
animals	birds	Scolopacidae	*Gallinago hardwickii*	Latham's snipe		V	V	1
animals	birds	Scolopacidae	*Limosa lapponica baueri*	Western Alaskan bar-tailed godwit		E	E	36
animals	birds	Scolopacidae	*Numenius madagascariensis*	eastern curlew		CR	CE	110
animals	birds	Scolopacidae	*Tringa nebularia*	common greenshank		E	E	9
animals	birds	Scolopacidae	*Xenus cinereus*	terek sandpiper		V	V	13
animals	birds	Strigidae	*Ninox strenua*	powerful owl		V		10
animals	birds	Turnicidae	*Turnix melanogaster*	black-breasted button-quail		V	V	15
animals	insects	Lycaenidae	*Jalmenus eubulus*	pale imperial hairstreak		V		1
animals	mammals	Delphinidae	*Sousa sahulensis*	Australian humpback dolphin		V	V	2
animals	mammals	Petauridae	*Petaurus australis australis*	yellow-bellied glider (southern subspecies)		V	V	5
animals	mammals	Phascolarctidae	*Phascolarctos cinereus*	koala		E	E	16
animals	mammals	Pseudocheiridae	*Petauroides volans volans*	southern greater glider		E	E	6
animals	reptiles	Chelidae	*Elseya albagula*	white-throated snapping turtle		CR	CE	1
animals	reptiles	Cheloniidae	*Natator depressus*	flatback turtle		V	V	1
plants	land plants	Acanthaceae	*Graptophyllum excelsum*			NT		3/1
plants	land plants	Apocynaceae	*Parsonsia kroombitensis*			V		1/1
plants	land plants	Asteraceae	*Cassinia collina*			V		2/2
plants	land plants	Celastraceae	*Apatophyllum olsenii*			E	V	4/4
plants	land plants	Combretaceae	*Dansiea elliptica*			NT		6/4
plants	land plants	Combretaceae	*Macropteranthes leiocaulis*			NT		3/3
plants	land plants	Cycadaceae	*Cycas megacarpa*			E	E	4/3
plants	land plants	Hernandiaceae	*Hernandia bivalvis*	cudgerie		NT		2/1
plants	land plants	Leguminosae	*Acacia eremophiloides*			V	V	1
plants	land plants	Leguminosae	*Acacia sp. (Castletower N.Gibson TOI345)*			V		1/1
plants	land plants	Myrtaceae	*Eucalyptus decolor*			NT		6/5
plants	land plants	Myrtaceae	*Rhodamnia angustifolia*	narrow-leaved malletwood		CR	CE	16/16
plants	land plants	Myrtaceae	*Rhodamnia dumicola*	rib-fruited malletwood		E		2
plants	land plants	Myrtaceae	*Rhodamnia glabrescens*			CR		5/4
plants	land plants	Myrtaceae	*Rhodamnia spongiosa*			CR		2/1
plants	land plants	Myrtaceae	*Xanthostemon oppositifolius*	southern penda		V	V	1/1
plants	land plants	Proteaceae	*Grevillea venusta*	grevillea		V		7/2
plants	land plants	Rubiaceae	*Scleromitrion gibsonii*			CR		11/11

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.*
The codes are Extinct (EX), Extinct in the Wild (PE), Critically Endangered (CR), Endangered (E), Vulnerable (V), Near Threatened (NT), Special Least Concern (SL) and Least Concern (C).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.*
The values of EPBC are Extinct (EX), Extinct in the Wild (XW), Critically Endangered (CE), Endangered (E), Vulnerable (V) and Conservation Dependent (CD).

Records - The first number indicates the total number of records of the taxon (wildlife records and species listings for selected areas).
This number is output as 99999 if it equals or exceeds this value. A second number located after a / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

APPENDIX B SURVEY DATA

Flora Species List

Common name	Species name	Non-native	Biosecurity	WoNS
Green Wattle	*Acacia deanei*			
Pretty Wattle	*Acacia decora*			
Catkin Wattle	*Acacia julifera*			
Chaff Flower	*Achyranthes aspera*			
Blue Billygoat Weed	*Ageratum houstonianum*	*		
Chain Fruit	*Alyxia ruscifolia*			
Dark Wiregrass	*Aristida calycina*			
White Speargrass	*Aristida leptopoda*			
Queensland Wiregrass	*Aristida queenslandica*			
Reedgrass	*Arundinella nepalensis*			
Slender Bamboo Grass	*Austrostipa verticillata*			
Cobbler's Pegs	*Bidens pilosa*	*		
Forest Bluegrass	*Bothriochloa bladhii*			
Pitted Bluegrass	*Bothriochloa decipiens*			
Desert Bluegrass	*Bothriochloa ewartiana*			
Coffee Bush	*Breynia oblongata*			
Wild Orange	*Capparis canescens*			
Currant Bush	*Carrisa ovata*			
Canadian Fleabane	*Conyza bonariensis*	*		
Red Bloodwood	*Corymbia erythrophloia*			
Moreton Bay Ash	*Corymbia tessellaris*			
Woolly Rattlepod	*Crotalaria incana*	*		
Rubber vine	*Cryptostegia grandiflora*	*	3	*
Tuckeroo	*Cupaniopsis anacardioides*			
Tiger Orchid	*Cymbidium canaliculatum*			
Barbed-wire Grass	*Cymbopogon refractus*			
Slender Sedge	*Cyperus gracilis*			
Queensland Bluegrass	*Dichanthium sericeum*			
Cotton Panic	*Digitaria brownii*			
Nine-awn Grass	*Enneapogon lindleyanus*			
Brown's Lovegrass	*Eragrostis brownii*			
African Lovegrass	*Eragrostis curvula*	*		
Mountain Wanderrie Grass	*Eriachne mucronata*			
Narrow-leaved Ironbark	*Eucalyptus crebra*			
Gum-topped Box	*Eucalyptus moluccana*			
Queensland Bluegum	*Eucalyptus tereticornis*			
Dwarf Poinsettia	*Euphorbia cyathophora*	*		
Asthma Plant	*Euphorbia hirta*			
Creek Sandpaper Fig	*Ficus coronata*			
Moreton Bay Fig	*Ficus macrophylla*			
Maynes pest	*Glandularia aristigera*	*		
Glycine Pea	*Glycine tabacina*			
Woolly Glycine	*Glycine tomentella*			
Balloon Cottonbush	*Gomphocarpus physocarpus*	*		
Dogs Balls	*Grewia retusifolia*			
Dysentery Plant	*Grewia latifolia*			
Black Speargrass	*Heteropogon contortus*			
Australian Indigo	*Indigofera australis*			
Native Indigo	*Indigofera linifolia*			
Common Rush	*Juncus usitatus*			
Lantana	*Lantana camara*	*	3	*
Creeping Lantana	*Lantana montevidensis*	*	3	
Argentine Peppercress	*Lepidium bonariense*	*		
Siratro	*Macroptilium atropurpureum*	*		
White Cedar	*Melia azedarach*			
Red Natal Grass	*Melinis repens*	*		
Common name	**Species name**	**Non-native**	**Biosecurity**	**WoNS**

Murdannia	*Murdannia graminea*			
Prickly Pear	*Opuntia stricta*	*	3	*
Native Millet	*Panicum decompositum*			
Hairy Panic	*Panicum effusum*			
Paspalidium	*Paspalidium sp*			
Water Couch	*Paspalum distichum*			
Corky Passion Flower	*Passiflora suberosa*	*		
Fuzzweed	*Peripleura hispidula*			
Princes Feathers	*Persicaria orientalis*			
Lippia	*Phyla canescens*	*		
Spurge	*Phyllanthus maderaspatensis*			
Cockatoo Apple	*Planchonia careya*			
Applebush	*Pterocaulon sphacelatum*			
Rhynchosia	*Rhynchosia minima*			
Castor Oil Bush	*Ricinus communis*	*		
Senna	*Senna sophora*			
Flannel Weed	*Sida cordifolia*	*		
Spiked Sida	*Sida subspicata*			
High Sida	*Sida trichopoda*			
Fairy Grass	*Sporobolus caroli*			
American Ratstail Grass	*Sporobolus jacquemontii*	*	3	*
Snake Weed	*Stachytarpheta cayennensis*	*		
Shrubby Stylo	*Stylosanthes scabra*	*		
Kangaroo Grass	*Themeda triandra*			
Small Burr Grass	*Tragus australianus*			
Urena Weed	*Urena lobata*	*		
Mimosa Bush	*Vachellia farnesiana*	*	3	
Verbena	*Verbena littoralis*	*		
Noogoora Burr	*Xanthium occidentale*	*		

Tertiary RE Assessments

siteID	RE7	RE8
RE	11.11.15 Cat R	11.11.15
GTRE	11.11.15	11.11.15
Geology	Dark brown reddish clay loam sediment	Grey-brown clay loam
Landform	Gully	Undulating hills
Status	B	B
TEC	No	No
EDL	T1	T1
EDL height range	11-15.5	16.5-17.5
EDL_med_height m	14	17
EDL_cover %	32	20
struc_clas	Open-forest	Woodland
T1_hei	14	17
T1_cover	32	20
T1_sp	*Eucalyptus crebra, Corymbia tessellaris, Corymbia erythrophloia,*	*Eucalyptus crebra, Corymbia tessellaris,*
T2_hei	7.5	8
T2_cover	3	5
T2_sp	*Corymbia erythrophloia, Eucalyptus crebra*	*Eucalyptus crebra*
S1_hei	1.1	1.8
S1_cover	10	20
S1_sp	*Crotalaria incana, Sida subspicata, Grewia latifolia,*	*Sida subspicata, Capparis canescens, Eucalyptus tereticornis, Glycine tabacina, Acacia deanei,*
S2_hei		0.3
S2_cover		2
S2_sp		Glycine tomentella, Grewia latifolia,
G_hei	1.5	1.5
G_cover	80	80
G_sp1	*Austrostipa verticillata, Peripleura hispidula, Glycine tomentella, Heteropogon contortus,*	*Peripleura hispidula, Sida trichopoda, Panicum effusum, Heteropogon contortus, Themeda triandra, Panicum decompositum, Glycine tomentella, Eriachne mucronata*
G_sp2	*Indigofera linifolia, Bothriochloa decipiens, Phyllanthus maderaspatensis, Sida trichopoda , Aristida calycina,*	*Euphorbia hirta*
W_cover	29	45
W_sp	*Euphorbia cyathophora, Passiflora suberosa, Cryptostegia grandiflorum, Macroptilium atropurpureum, Lantana camara, Ageratum houstonianum, Conyza bonariensis, Stylosanthes scabra, Bidens pilosa,*	*Sida cordifolia, Stylosanthes scabra, Sporobolus jacquemontii, Lantana montevidensis,*
Disturbanc		Adjacent road
x	151.2418585	151.2345759
y	-24.10077866	-24.12159939

siteID	RE10	RE3
RE	X	11.11.15
GTRE	11.11.15	11.11.15
Geology	Light brown gravelly clay loam	Ligh brown sediment
Landform	Hillside	Undulating hills
Status	B	C
TEC	No	No
EDL	T1	T1
EDL height range	15-18	Dec-19
EDL_med_height m	16	17
EDL_cover %	24	11
struc_clas	Woodland	Woodland
T1_hei	16	17
T1_cover	24	11
T1_sp	*Eucalyptus crebra, Corymbia tessellaris, Eucalyptus tereticornis*	*Eucalyptus crebra, Eucalyptus tereticornis*
T2_hei	7.5	7
T2_cover	5	5
T2_sp	*Eucalyptus crebra, Eucalyptus tereticornis, Corymbia tessellaris*	*Eucalyptus crebra, Corymbia erythrophloia*
S1_hei		1.2
S1_cover		2
S1_sp		*Acacia julifera, Sida subspicata*
S2_hei		
S2_cover		
S2_sp		
G_hei	0.2	1.1
G_cover	80	95
G_sp1	*Bothriochloa decipiens, Indigofera linnaei, Heteropogon contortus, Sida trichopoda, Euphoria hirta, Glycine tomentella, Peripleura hispidula,*	*Heteropogon contortus, Peripleura hispidula, Austrostipa verticillata, Glycine tomentella, Themeda triandra, Eragrostis sp., Rhynchosia minima*
G_sp2	*Phyllanthus maderaspatensis,*	*Heteropogon contortus, Bothriochloa decipiens, Panicum effusum, Cymbopogon refractus, Aristida queenslandica*
W_cover	30	5
W_sp	*Lantana montevidensis, Stachytarpheta cayennensis*	*Stylosanthes scabra, Conyza bonariensis, Bidens pilosa, Sida cordifolia*
Disturbanc	Regularly slashed	Historical land clearing
x	151.2399746	151.2389132
y	-24.09409076	-24.11959077

siteID	RE5	RE2
RE	11.11.15	11.11.15
GTRE	11.11.15	11.3.25
Geology	Ligh brown sediment	Ligh brown sediment
Landform	Undulating hills	Drainage line
Status	C	B
TEC	No	No
EDL	T1	T1
EDL height range	13.5-18	18-23
EDL_med_height m	17.5	21
EDL_cover %	12	24
struc_clas	Woodland	Woodland
T1_hei	17.5	21
T1_cover	12	24
T1_sp	*Eucalyptus crebra, Eucalyptus tereticornis, Corymbia tessellaris*	*Eucalyptus tereticornis*
T2_hei	6	5
T2_cover	4	1
T2_sp	*Eucalyptus crebra, Eucalyptus tereticornis*	*Eucalyptus tereticornis*
S1_hei	2.4	1.8
S1_cover	20	1
S1_sp	*Sida subspicata,*	*Cupaniopsis anacardioides , Carrisa ovata,*
S2_hei		0.5
S2_cover		1
S2_sp		Breynia oblongata , Crotalaria incana
G_hei	0.7	1.5
G_cover	90	80
G_sp1	*Heteropogon contortus, Peripleura hispidula, Austrostipa verticillata, Glycine tomentella, Themeda triandra, Eragrostis sp., Rhynchosia minima*	*Austrostipa verticillata, Peripleura hispidula, Bothriochloa decipiens, Sida trichopoda*
G_sp2	*Austrostipa verticillata, Crotalaria incana*	*Juncus usitatus, Eragrostis sp, Heteropogon contortus, Sida subspicata, Crotalaria incana*
W_cover	5	10
W_sp	*Gomphocarpus physocarpus, Stylosanthes scabra*	*Stylosanthes scabra, Lantana camara, Conyza bonariensis, Passiflora suberosa, Macroptilium atropurpureum, Bidens pilosa, Stachytarpheta cayennensis,*
Disturbanc	Historical land clearing	Pigs
x	151.2397935	151.238321
y	-24.11675423	-24.12170596

siteID	RE9	RE6
RE	11.11.15 Cat R	11.11.15 Cat R
GTRE	11.3.25	X
Geology	Light brown clay loam	Modified
Landform	Drainage line	Hill crest
Status	B	X
TEC	Yes	No
EDL	T1	G
EDL height range	18-28	0-0.5
EDL_med_height m	20	0.3
EDL_cover %	40	20
struc_clas	Open-forest	Grassland
T1_hei	20	
T1_cover	40	
T1_sp	*Eucalyptus tereticornis, Corymbia tessellaris, Eucalyptus crebra*	
T2_hei	9	
T2_cover	10	
T2_sp	*Eucalyptus tereticornis, Corymbia tessellaris*	
S1_hei	1.2	0.6
S1_cover	1	2
S1_sp	*Breynia oblongata*	*Indigofera australis*
S2_hei		
S2_cover		
S2_sp		
G_hei	0.5	0.3
G_cover	60	20
G_sp1	*Peripleura hispidula, Sida trichopoda, Heteropogon contortus, Verbena littoralis, Bothriochloa decipiens, Arundinella nepalensis, Paspalidium sp.,*	*Bothriochloa decipiens, Heteropogon contortus, Indigofera linifolia, Aristida calycina,*
G_sp2	*Cyperus gracilis*	*Panicum effusum*
W_cover	10	25
W_sp	*Stachytarpheta cayennensis, Macroptilium atropurpureum, Xanthium occidentale, Ricinus communis, Lepidium bonariense*	*Stachytarpheta cayennensis, Stylosanthes scabra , Ageratum houstonianum,*
Disturbanc	Washout	Handstand, modified landform
x	151.2426603	151.2367055
y	-24.10716855	-24.0916857

Quaternary RE Assessments

siteID	Q1	Q2	Q3	Q4	Q5	Q6
RE	12.11.15	X	X	X	X	X
condition	Remnant	non-remnant	non-remnant	non-remnant	non-remnant	non-remnant
EDL	T1	G	S1	G	G	G
EDL_cover	25	100	20	1	1	85
EDL_med_he	17	0.4	2	0.2	0.1	1.5
struc_clas	Woodland	Grassland	Low shrubland	Grassland		Grassland
Landform	Undulating hills	Undulating hills	Waste rock dump	Stockpile	Road	Hill slope
TEC	No	No	No	No	No	No
T1	*Eucalyptus crebra*					
S1			*Melia azedarach*	*Melia azedarach*		
G3		*Austrostipa verticillata*		*Paspalum distichum*	*Paspalum distichum*	*Heteropogon contortus , Austrostipa verticillata*
Weed			*Cryptostegia grandiflora*			
x	151.2391222	151.2391116	151.2359585	151.2324764	151.2324122	151.2349816
y	-24.1196263	-24.1162737	-24.0961502	-24.0972694	-24.0983061	-24.1206321

BioCondition Data

Site	Open woodland	Grassland
# Eucs > 30cm	13	-
Large tree benchmark	34	N/A
# large trees	10	-
Large Euc diameter	39, 38, 37, 31, 31, 45, 30, 36, 39, 41, 35, 41, 36	
Canopy species	Eucalyptus crebra, Corymbia erythrophloia	-
Tree sp rich #	2	N/A
Canopy height range (m)	14-15.5	-
Canopy height (m)	14.5	-
Recruitment%	100	-
Canopy cover%	31	-
Sub-canopy height (m)	7	-
Sub-canopy cover (%)	5	-
Shrub cover%	7.3	-
Shrub species	*Acacia decora, Acacia excelsa, Grewia latifolia, Acacia disparrima, Capparis canescens, Planchonia careya, Alyxia ruscifolia, Melia azedarach*	-
Shrub sp rich	8	-
Grass species	*Aristida queensladicum, Bothriochloa decipiens, Heteropogon contortus, Aristida calycina, Panicum decompositum, Themeda triandra, Eragrostis brownii, Enneapogon mucronata*	*Austrostipa verticillata, Heteropogon contortus, Bothriochloa decipiens, Aristida calycina, Panicum effusum*
Grass speceies rich	8	5
Forbs_other	*Sida subspicata, Cyperus gracilis, Rhynchosia minima, Cyanthillium cinereum, Glycine tomentella, Phyllanthus virgatus, Indigofera pratensis, Euphorbia drummondii, Alternanthera nana*	*Indigofera australis, Indigofera linifolia*
Forbs_other species rich	9	2
Total species rich	27	7
CWD	50	N/A
Weed cover %	5	1

Weeds	*Melinis repens, Opuntia stricta, Ageratum houstonianum, Stachytarpheta cayennensis, Lantana montevidensis, Lantana camara*	
Q1 perrenial grass %	2	
Q1 litter %	20	
Q2 perrenial grass %	75	
Q2 litter %	20	
Q3 perrenial grass %	20	
Q3 litter %	40	
Q4 perrenial grass %	15	
Q4 litter %	5	
Q5 perrenial grass %	90	
Q5 litter %	10	
Mean perrenial grass %	40.4	75
Mean litter %	19	10

Fauna Habitat Assessments

SiteID	Hab01	Hab02	Hab03	Hab04	Hab05	Hab06	Hab07
ng_cover	Dense >40%	Dense >40%	Dense >40%	Sparse <10%	Sparse <10%	Dense >40%	Dense >40%
tree_cover	Moderate	Riparian	Moderate	Not	Not	Moderate	Riparian
hollow_pre	Sparse	Common	Sparse				
hollow_not		Small <200mm	None				
woody_debr	Common	Sparse	Common	Not	Not	Sparse	Common
Mis_presen	yes	no	no	no	no	yes	yes
Mis_cover	Sparse and immature					Abundant	Sparse and immature
rocky_hab	no	no	no	no	yes	no	no
rocky_pres							
rocky_note					Waste rock dump		
water_pres	no	yes	yes	yes	no	yes	yes
water_note		Waterhole	Waterhole	Farm dam with dense aquatic vegetation		Waterhole	Waterhole
fire_evide	no		no		no	no	no
cattle_dis			None		None	None	None
site_note	Macropod	Pigs, macropods	Grey kangaroos		High density agile wallaby		
x	151.2390169	151.2383154	151.2394408	151.2393969	151.2366682	151.2343961	151.2426392
y	-24.1212533	-24.1217193	-24.1198191	-24.1186276	-24.0917038	-24.1215204	-24.1071716

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Appendix O Surface Water Impact Assessment

A Montrose Environmental Company

Surface Water Impact Assessment

Graymont
Calliope Limestone Quarry Approvals
Calliope
BAA250025.01
19 June 2026

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EXECUTIVE SUMMARY

Epic Environmental Pty Ltd (Epic) has been engaged by Graymont (NSW) Pty Ltd (Graymont) to provide ongoing environmental approvals support for the Calliope Limestone Quarry (the Project). This assessment has been prepared to satisfy an information request from the QLD Department of Environment, Tourism, Science and Innovation (DETSI), to assess potential surface water impacts associated with proposed landform changes over the life of mine.

Potential impacts associated with progressive disturbance throughout the life of mine and final landform have been assessed through a catchment and stormwater flow analysis. The existing sediment basin was also reviewed to confirm its capacity to capture sediment-laden runoff under both current and maximum disturbance scenarios.

The surface water impact assessment concludes that the potential risk of downstream surface water and receiving environment impacts associated with the proposed maximum disturbance landform is low, based on the following key findings:

- The site operates effectively as a closed surface water system, with all disturbed areas draining internally to site water storages
- Catchment changes in the maximum disturbance scenario are minimal, with the most notable change being the amalgamation of the Pit 3, Pit 4, and Farm Dam catchments
- The stormwater flow assessment undertaken indicates that the predicted changes in peak discharge between current and maximum disturbance scenarios are minimal
- Water balance modelling undertaken by Graymont (2025) suggests overtopping from site water storages is unlikely, even during extreme rainfall events
- An assessment of the sediment basin confirms that the current basin is adequately sized to capture runoff during both current and maximum disturbance, minimising the potential risk for uncontrolled releases to the receiving environment

The existing mitigation and management measures detailed in the site's Sediment and Erosion Management Plan are considered appropriate to manage the risks to the receiving surface water environment throughout the life of mine.

1 INTRODUCTION

Epic Environmental Pty Ltd (Epic) has been engaged by Graymont (NSW) Pty Ltd (Graymont) to provide ongoing environmental approvals support for the Calliope Limestone Quarry (the Project). This assessment has been prepared to support the preparation of a Progressive Closure and Rehabilitation Plan (PRCP) for the Project.

1.1 Project Location

The Project is located in Taragoola, approximately 11 kilometres (km) south of the township of Calliope and 30 km south of Gladstone in Central Queensland within the Gladstone Local Government Area (LGA) (see **Figure 1**). For the purpose of this report the Project refers to the Mining Leases (MLs) approved under the existing EA which comprise: ML3594, ML3595, ML3596, ML3597, ML3598, ML3599, ML3600, ML3602, ML3603, ML3604, ML3605, ML3606, ML3608, ML3609, ML80036, ML80189, ML80190, ML80191, and ML80192 (the MLs). The Project area comprises the current and proposed maximum disturbance areas within the MLs, as displayed in **Figure 2** and **Figure 3**.

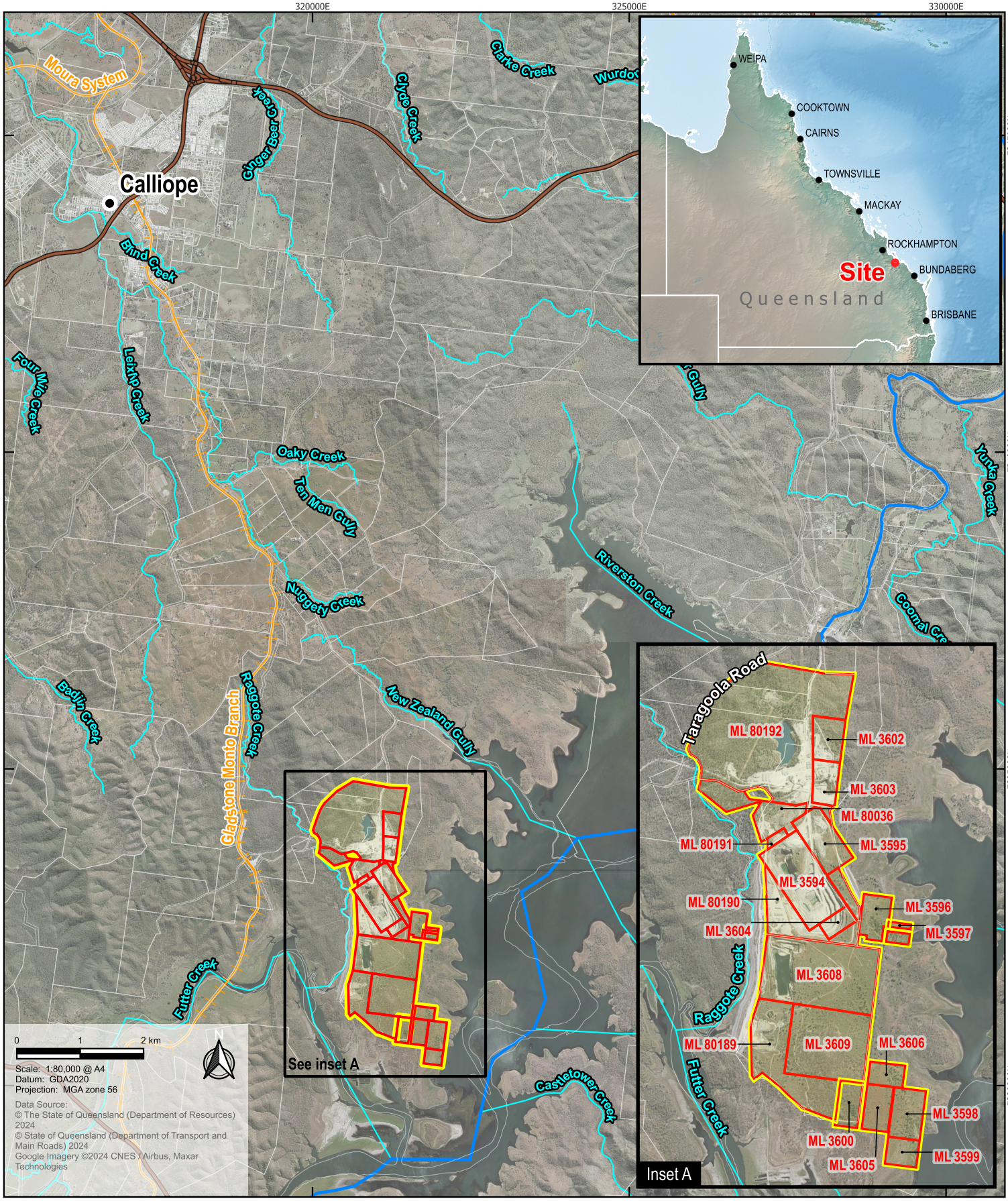
1.2 Objectives

The objective of this report is to assess potential impacts on surface water due to the proposed changes in land disturbance over the life of mine.

1.3 Scope of Works

The stated objectives have been achieved through the following scope of works undertaken by Epic:

- Desktop assessment including a summary of the following:
  - Regional and local geographic and climatic setting
  - Local hydrological conditions, including a description of:
    - Catchments and watercourses within the project area
    - Available existing water quality data
    - Flow conditions for watercourses
    - Relevant Environmental Values
- Hydrological assessment to determine the expected changes to the hydrological regime due to the proposed changes in landform, including:
  - Stormwater quantity assessment to predict the change in peak discharge of stormwater runoff, using the empirical rational method
  - Assessment of predicted changes to flow paths
  - Assessment of potential impacts to the Great Barrier Reef
  - Assessment of changes to sediment basin catchment and its capacity to limit sediment releases



Filepath: -BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 Surface Water Impact Assessment\1. Surface Water Impact Assessment\Rev 0\Figure 1 Regional location.qgz

Legend

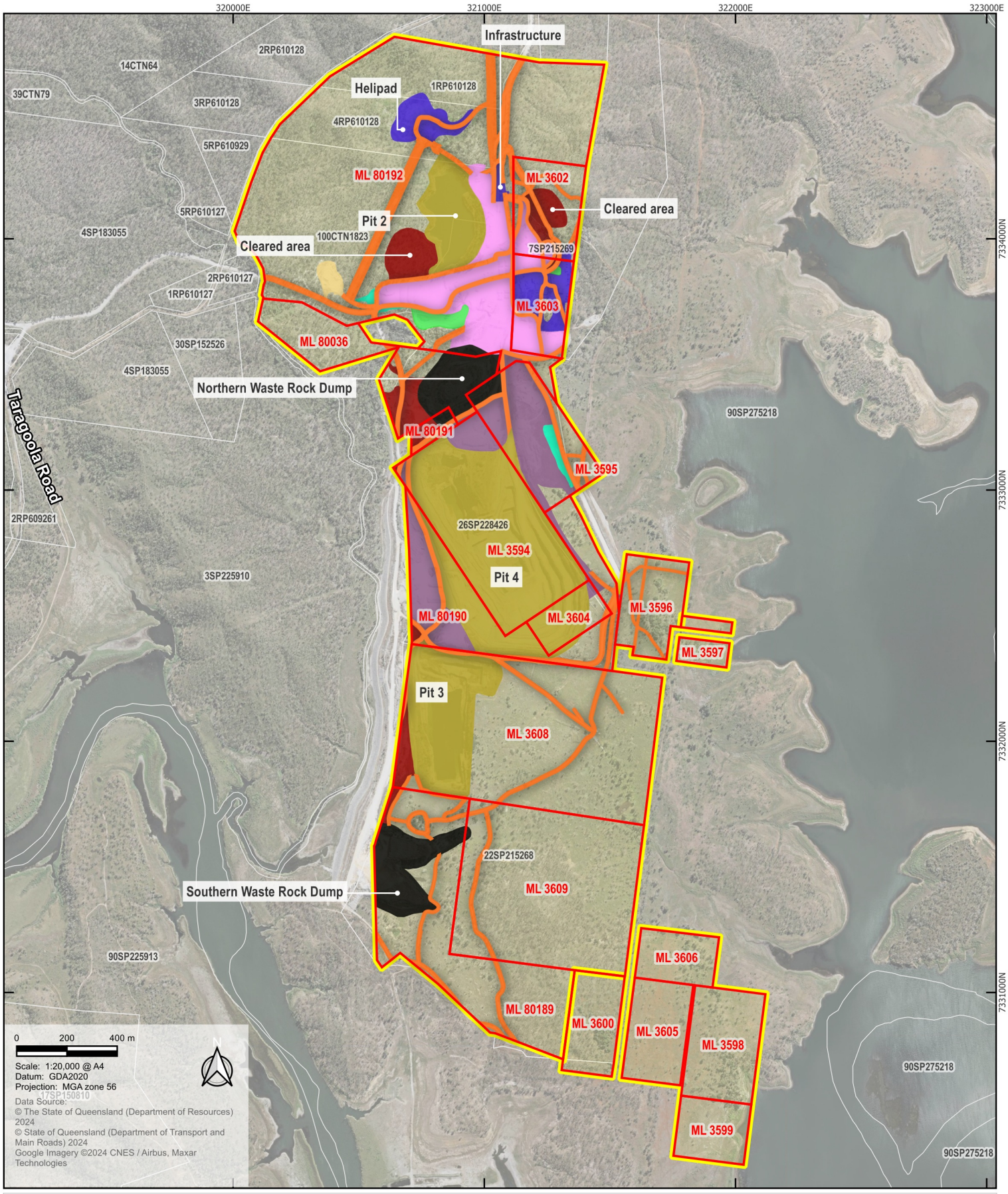
- Site boundary
- Mining leases
- Cadastre (DCDB)
- State controlled roads
- Railways

Watercourses

- Major
- Minor

Graymont
Calliope Limestone Quarry
Surface Water Impact Assessment

Figure 1
Regional location



Legend

- Site boundary
- Mining Leases
- Cadastre (DCDB)

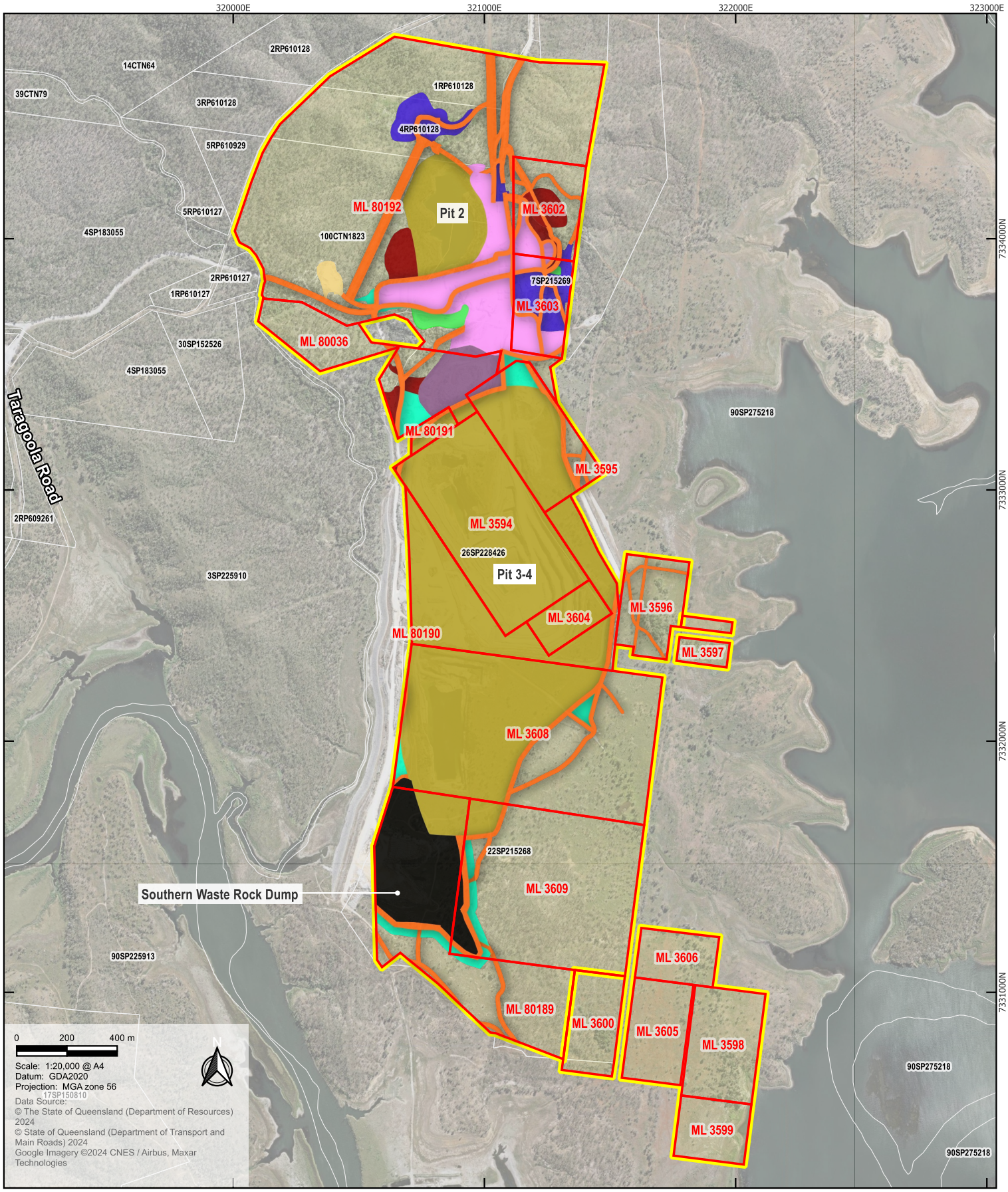
Current disturbance

- Access tracks
- Cleared areas and laydowns
- Infrastructure and plant
- Sediment pond
- Pit
- ROM processing area
- Silt dump
- Temporary spoil storage area
- Topsoil stockpile
- Waste rock dump

Graymont
Calliope Limestone Quarry
Surface Water Impact Assessment

Figure 2
Current disturbance area

Filepath: ~G:\S\Projects\2022\BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 Surface Water Impact Assessment\1. Surface Water Impact Assessment\Rev 0\Figure 2 Current disturbance area.qgz



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 Surface Water Impact Assessment\1. Surface Water Impact Assessment\Rev 0\Figure 3 Maximum disturbance extent.qgz

Legend

- Site boundary
- Cadastre (DCDB)
- Mining Leases

Maximum disturbance

- Access tracks
- Cleared areas and laydowns
- Infrastructure and plant
- Sediment pond
- Pit
- ROM processing area
- Silt dump
- Temporary spoil storage area
- Topsoil stockpile
- Waste rock dump

Graymont
Calliope Limestone Quarry
Surface Water Impact Assessment

Figure 3
Maximum disturbance extent

2 PROJECT DESCRIPTION AND BACKGROUND

Graymont holds a site-specific Environmental Authority (EA) (reference: EPML00969013), enabling limestone mining activities to be undertaken at the Project. Limestone mining has been ongoing at Calliope since 1967, with Graymont managing operations since 2019. The Project produces approximately 0.8 million tonnes per annum of limestone products.

The Project area covers 429.6 hectares (ha) and includes four open cut pits. The Project area includes 162.64 ha of existing disturbance (i.e. operational areas, pits etc) and 68.91 ha of proposed disturbance areas. Two non-operational pits (Pit 1 and Pit 2) are located in the northern end of the mine site. Pit 1 was backfilled and Pit 2 is utilised for on-site water storage. Water from Pit 2 is primarily utilised at the wash plant. Pit 3 and Pit 4 are located to the southern extent of the mine MLs. The Project adjoins land owned and operated by the Gladstone Area Water Board (GAWB), with some access tracks in the area used by both Graymont and the GAWB.

Other infrastructure located on site includes the main office, weighbridge, run of mine (ROM) stockpile, access roads, crushing and screening plant, wash plant, main stockpile area of final product, silt ponds and spoil areas located in the northern portion of the Project.

Mining operations have remained consistent throughout the life of mine (LOM) and consists of conventional open cut benching methods which begins with topsoil stripping and removal of clay rich overburden and waste rock. Limestone ore is extracted by drilling and blasting, then crushed, screened and washed onsite before being loaded by a 120 tonne (t) excavator serviced by two 100 t and one 85 t off road dump trucks. There is a second 75 t excavator on site which is utilised as a backup for the open cut operations. Material is hauled either to:

- The ROM pad for crushing
- Stockpile for screening or placement in the designated spoil dumps

Extractive activities are also conducted following a similar process where limestone of different grades and suitable physical properties are mined for the production of road base and aggregates. Extractive activities are authorised and conducted under EA EPPR00881913.

The current Project schedule includes limestone ore to be mined exclusively from the existing open cut mining pit (Pit 4), which is located centrally within the Project area. Lateral and vertical expansion of Pit 4 is projected to occur over the next 70 years, with amalgamation of Pit 3 expected to occur during southern expansion. All future disturbance until end of mine life (EOML) will be authorised by, and undertaken in accordance with, an amended EA (to be amended in the future). Limestone ore will continue to be processed onsite utilising pre-existing purpose-built infrastructure in the crushing and screening plant and wash plant, with a rate of production of 10-20,000 t a week. Mine closure is scheduled for about 2100.

3 ASSESSMENT METHODOLOGY

3.1 Project Area

For the purposed of this assessment, the Project area is defined as the current and maximum disturbance areas within the MLs, as shown in **Figure 2** and **Figure 3**, respectively. The Project area includes both existing disturbances (i.e. operational areas, pits) and proposed disturbance areas. Some existing disturbance areas, including cleared areas, access tracks, waste rock dump, and spoil pile areas, will be overlapped by the proposed Pit 3-4 footprint, resulting in changes to the classification of disturbance by activity type.

The proposed new disturbance areas will be confined within the existing MLs for the Project (specifically ML80192, ML3594, ML3595, ML80190, ML3604, ML3608, ML80189, and ML3609), and will primarily occur within the land parcel described as Lot 22 on SP15268. Some minor additional disturbance will occur on land parcels described as Lot 4 on RP610128, Lot 100 on CTM1823, Lot 7 on SP215269, and Lot 26 on SP228426.

Existing disturbed areas will be preferentially used for alternative activities as the pit expands into adjacent areas. This approach will minimise additional environmental harm from new disturbance; however it will thereby require disturbed land to be used for operations until EOML.

3.2 Methodology

The methodology for this surface water impact assessment includes:

- Description of the existing environment relevant to the study area, through a desktop review of publicly available and client provided data and information
- Assessment of potential impacts on surface water associated with the proposed changes in Project disturbance

3.3 Relevant Legislation and Guidelines

This report has been prepared with reference to the applicable legislation and policies as below:

3.3.1 Environmental Protection Act 1994

The objective of the *Environmental Protection Act 1994* (EP Act) is to protect Queensland's environment and to promote ecologically sustainable development. The EP Act defines a General Environmental Duty under which all persons in Queensland have a responsibility not to carry out an activity that causes or is likely to cause environmental harm, and to take all reasonable and practicable measures to prevent or minimise the harm.

The EP Act provides the key legislative framework for environmental management and protection in Queensland. The objective of the EP Act is to: “Protect Queensland’s environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains ecological processes on which life depends” (Section 3 of the EP Act).

Under the EP Act, Graymont must comply with the general environmental duty not to undertake an: “Activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm are taken” (Section 319 of the EP Act).

The Project requires an Environmental Authority and Progressive Rehabilitation and Closure (PRC) Plan to be approved under the EP Act.

3.3.2 Best Practice Erosion and Sediment Control (IECA, 2008)

The Best Practice Erosion and Sediment Control (IECA, 2008) guidelines contain the necessary strategies and techniques to assist erosion and sediment control practitioners to reduce the degradation of land and water from uncontrolled erosion and sedimentation. Erosion and Sediment Control is a primary pathway for contamination from the site and therefore this guideline is relevant to the Project.

3.3.3 Reef Discharge Standards for Industrial Activities (DESI, 2024)

This guideline outlines information an applicant should include in an environmental authority application to address section 41AA of the *Environmental Protection Regulation 2019*, where the proposed activity involves the discharge of fine sediment or dissolved inorganic nitrogen to the Great Barrier Reef (GBR) catchment waters. The Project is within the Boyne River Basin, which is located in the GBR catchment and therefore these standards are relevant to the Project.

3.3.4 Environmental Protection (Water and Wetland Biodiversity) Policy 2019

The purpose of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP (Water)) is to determine the environmental values (EVs) and associated water quality objectives (WQOs) for Queensland waters. Under the EPP (Water and Wetland Biodiversity), the Project is located within the Curtis Island, Calliope River and Boyne River Basins.

3.3.4.1 Environmental Values

Identification of environmental values (EVs) has been undertaken in accordance with the *Application requirements for activities with impacts to water guideline* (DESI 2024c). The EVs for the Project's receiving surface water environment has been defined as WQ13131— Boyne River in Schedule 1 of the *Environmental Protection Policy (Water and Wetland Biodiversity) 2019* (EPP (Water and Wetland Biodiversity). The specific EVs applicable to the Project are detailed in the supporting EPP (Water and Wetland Biodiversity) document, *Curtis Island, Calliope River and Boyne River Basins Environmental Values and Water Quality Objectives* (EPP 2014) and have been summarised in **Table 1**.

Table 1. EVs of Project receiving surface waters

Value	Icon	Discussion	Pathway/ Receptor Linkage
Aquatic Ecosystems		The Project is adjacent to Lake Awoonga, a tributary to Boyne River. Areas downstream may support aquatic ecosystems.	Possible
Irrigation		The Project is in proximity to a few groundwater bores that may be used for irrigation, however, the Project is not expected to impact irrigation use of Lake Awoonga.	Low
Farm Supply Use		The Project has a farm dam which does not support farming activities, and is therefore not expected to impact on water used for farming.	Low
Stock Water		The Project is not expected to impact on the water used for livestock on Lake Awoonga or Boyne River.	Low
Aquaculture		The Project is not located in proximity to any aquaculture facilities.	Unlikely
Human Consumer		Areas downstream from the Project may be utilised for the consumption of aquatic foods, including fish.	Possible
Primary Recreation		Recreational activities, including swimming and diving, occur in areas adjacent to the Project. Discharges from the Project are only expected to pose a potential contamination risk to Lake Awoonga during flood events associated with elevated dam levels.	Unlikely
Secondary Recreation		Lake Awoonga supports recreational fishing and boating activities.	Unlikely

Value	Icon	Discussion	Pathway/ Receptor Linkage
Visual Recreation		The Project is located approximately 7km south west of the Lake Awoonga lookout, boat ramp, and camping area, and is not clearly visible from this location. Potential contamination at the Project is unlikely to be contributing to deterioration of the aesthetics of Lake Awoonga.	Low
Drinking Water		Lake Awoonga supplies raw water that is processed at water treatment plants for potable use.	Low
Cultural and Spiritual Values		The Project is not considered to impact on the cultural and spiritual values of Lake Awoonga.	Low
Groundwaters (aquatic ecosystems, irrigation, farm supply/use, stock water, drinking water)		Mining activities occur above the groundwater table so any discharges to groundwater are unlikely.	Unlikely

3.3.4.2 Water Quality Objectives

Water Quality Objectives (WQOs) for the Boyne River Basin have been defined within the *Curtis Island, Calliope River and Boyne River Basins Environmental Values and Water Quality Objectives* (EPP (Water) 2014). The WQOs for the water areas relevant to the Project have been summarised in **Table 2** below. Lowland fresh waters considered relevant are Raggotte Creek and Futter Creek, which are tributaries of Lake Awoonga, and which have elevations less than 150 m.

Table 2. Boyne River Basin WQOs relevant to the Project (EPP (Water) 2014)

Water area/ type	Management Intent / level of protection	Amm (N) (µg/L)	Oxid N (µg/L)	Total N (µg/L)	FRP (µg/L)	Total P (µg/L)	Chl-a (µg/L)	DO (% sat)	Turb (NTU)	SS (mg/L)	pH
Lake Awoonga	Moderately Disturbed (MD)	-	-	<700	-	<40	-	85-105	<4.7	-	7.75-8.4
Lowland fresh <150m (other waters)	MD	<20	<60	<500	<20	<50	<5	85-110	<50	<10	6.5-8.0

The site is within the Boyne River Basin which is within the GBR catchment for which the GBR Water Quality Protection Plan (the Reef Plan) applies. The Reef Plan sets targets for improved water quality in terms of load reduction and land management practices which are implemented through each water quality improvement plan (WQIP).

3.3.5 Environmental Authority

The Project operates under Environmental Authority EPML00969013. The EA lists authorised surface water release points from the Project, as detailed in **Table 3**. The defined contaminant release limits for the release points are detailed in

Table 3. Contaminant release points, sources and receiving waters (EPM00969013, Table 2)

Release Point (RP)	Easting (GDA94)	Northing (GDA94)	Contaminant Source and Location	Monitoring Point	Receiving waters
F1	321 432	733 2026	Pit 3 and Pit 4	End of pipe F1 (Discharge Monitoring Point)	Lake Awoonga Dam
F2	320 399	733 1469	Undisturbed natural flow and/or Pit 3	Raggote Ck at F2 (Downstream Monitoring Point)	Farmers Dam
C1	320 757	733 3601	Pit 1, Pit 2 and Pit 4	C1 dam spillway (Discharge Monitoring Point)	Pit 2 and/or Recycled Water Storage Dam
C2	320 102	733 3854	Undisturbed natural stormwater flow	C2 creek adjacent to rail siding road (Upstream Monitoring Point)	Raggote Creek

Table 4. Contaminant release limits (EPM00969013, Table 3)

Quality Characteristic	Release Limits	Monitoring Frequency
Electrical conductivity (µS/cm)	900	Weekly during discharge
pH (pH Unit)	6.5 (minimum) 8.5 (maximum)	Weekly during discharge
Total Suspended Solids (mg/L)	100 (maximum) Or when measured at C1, F2 or F1 not more than 110% of value at monitoring point C2	Weekly during discharge

3.4 Data Sources

The following data sources have been used in preparation of this technical report:

- Climate data: SILO (Scientific Information for Land Owners)
- Topographic data (provided by Graymont)
- Water quality data (provided by Graymont)
- Sediment and Erosion Control Plan (prepared by Graymont)
- Water Management Plan (prepared by Graymont)
- Calliope Hydrogeology Report (prepared by Graymont)

4 EXISTING ENVIRONMENT

4.1 Topography

The topography surrounding the Project area is hilly, with elevations ranging from 40 to 100 mAHD. The land surface generally slopes to the east, south, and west towards Lake Awoonga. The land surrounding the Project is classified as low intensity cattle grazing. The topography of the Project is shown in **Figure 4**.

Two earthen bunds (Eastern and Western) have been constructed at the Project. A 1,900 m long earth and rock wall is located adjacent to Raggote Creek on the western side of the Project, and a smaller wall exists along the eastern perimeter of the Project area. Both bunds also function as access tracks with a crest elevation of approximately 52 mAHD.

4.2 Climate

The Project is located within Queensland's sub-tropical climatic zone which is characterised by high summer temperatures, warm dry winters, and distinct wet and dry seasons. It lies within the southeast trade wind belt but is too far south to experience monsoonal influence from the northwest and too far north to benefit from higher altitude cold fronts (Bureau of Meteorology (BoM) 2025a).

Median monthly rainfall and evaporation data are summarised in **Table 5**, based on data from SILO database (SILO, 2025), using data from the BOM station at Gladstone Radar (no. 39123). Median annual evaporation (1,855.5 mm) exceeds median annual rainfall (808.3 mm) by approximately 130% and evaporation is greater than rainfall on average in all months.

Table 5. Summary of climate data, 1957 – 2025 (SILO data set from BOM station 39123)

Month	Median Monthly Rainfall (mm)	Median Monthly Evaporation (mm)
January	106.5	207.8
February	85.6	170.2
March	61.2	172
April	32.7	136.1
May	29.7	108.2
June	18.4	89.5
July	21.9	97.1
August	20.8	119.2
September	13.1	150.7
October	54.8	188.6
November	65.8	199.5
December	86.5	213.4
Annual Total	**808.3**	**1855.5**

4.3 Hydrology

4.3.1 Catchment Overview

The Project is located within the Fitzroy catchment within the Boyne River Basin, which covers an area of approximately 2,590 km^2. The area is bound by Many Peaks Range to the east, Dawes Range to the south, Calliope Range to the south-west and Boyne Range to the west. The terrain of the bounding ranges is relatively steep with heights ranging from 600 to 850 m above sea level. Several towns are also located within the catchment including Nagoorin, Ubobo, and Builyan. The Boyne River Basin Plan area comprises a single catchment with one major river system (the Boyne River) and a number of tributaries (including Ridler, Degalgil, Marble and Diglum Creeks) that drain to Gladstone Harbour and the Great Barrier Reef (GBR).

4.3.2 Watercourses

The Project is located adjacent to Lake Awoonga which bounds the site in the east, south, and southwest. Raggote Creek, located to the west of the site, is a tributary of Lake Awoonga. The hydrology of the site is shown in **Figure 4**.

4.3.3 Wetlands

Lake Awoonga is mapped as a lacustrine wetland (QGlobe, 2025), as shown in **Figure 5.** The existing farm dam adjacent to the Southern WRD is mapped as a hydrologically modified or artificial lacustrine wetland. There are no internationally important wetlands within the vicinity of the Project area; the closest internationally Important Wetland is located greater than 1,000 km away. There are no MSES - High ecological significance wetlands mapped within the Project area. The closest of which is approximately 15 km northwest of the Project area.

4.4 Lake Awoonga Water Quality

Water quality data from Lake Awoonga is collected by Gladstone Regional Council as part of their annual Drinking Water Service Report (Gladstone Regional Council, 2024). The latest report presents data from 2023 – 2024, as summarised in **Table 6** and shows that there were no exceedances of the drinking water guideline values.

Table 6. Lake Awoonga Water Quality

Parameter	Unit	Australian Drinking Water Guideline Value	Min	Average	Max
Aluminium - Total	mg/L		0.02	0.06	0.08
Antimony - Total	mg/L	0.003	<	<	<
Arsenic - Total	mg/L	0.01	<	<	<
Barium - Total	mg/L	2	0.012	0.01	0.017
Boron - Total	mg/L	4	<	<	<
Bromate	mg/L	0.02	<	<	<
Bromide	mg/L		<	0.02	0.064
Bromodichloromethane	µg/L	250	<	25	41
Bromoform	µg/L	250	<	<	14
Cadmium - Total	mg/L	0.002	<	<	<
Chlorate	mg/L	0.8^	0.022	0.14	0.41
Chloride	mg/L		27	40	52
Chlorine (free)	mg/L	5	<	<	2.5
Chloroform	µg/L	250	6	30	60
Chromium - Total	mg/L	0.05	<	<	0.003
Copper - Total	mg/L	2	<	0.003	0.019
Dibromochloromethane	µg/L	250	8	18	28
E. coli (Colilert)	MPN/100mL	0	<	<	<
Electrical Conductivity	µS/cm		306	363	468
Fluoride	mg/L	1.5	<	<	0.1
HPC (22°C)	CFU/mL		<	15	>300
Iron - Total	mg/L		<	<	0.22
Lead - Total	mg/L	0.01	<	<	<
Manganese - Dissolved	mg/L	0.5	<	<	0.007
Manganese - Total	mg/L	0.5	<	<	0.008
Mercury - Total	mg/L	0.001	<	<	<
Molybdenum - Total	mg/L	0.05	<	<	<
Nickel - Total	mg/L	0.02	<	<	<
Nitrate as NO_3^-	mg/L	50	0.03	0.09	0.16
Nitrite NO_2	mg/L	3	<	0.006	0.07
pH	pH units		6.8	7.4	8.6
Phosphate PO_4	mg/L		<	0.007	0.08

Parameter	Unit	Australian Drinking Water Guideline Value	Min	Average	Max
Selenium - Total	mg/L	0.01	<	<	<
Sulfate as SO_4	mg/L		23	28	37
Temperature	°C		17.7	25.6	35.5
Total Alkalinity (as CaCO3)	mg/L		70	82	107
Total Coliforms (Colilert)	MPN/100mL		<	<	<
Total Hardness (as CaCO3)	mg/L		82	95	112
Trihalomethanes Total	µg/L	250	25	73	125
True Colour	HU		<	<	3
Turbidity (NTU)	NTU		<	0.15	1.2
Zinc - Total	mg/L		<	<	0.009

4.5 Existing Water Quality

There is limited available water quality data for the Project. Water quality samples are collected from the monitoring points defined in the EA during releases from the Project area. Monitoring point C1 is the discharge point for releases from the sediment basin. Available data from discharge point C1 during 2025 is summarised in **Table 7**, along with the site targets and EA limits. This shows that there have been no exceedances of the EA limits in 2025.

Monitoring point F1 is the discharge point for controlled releases from Pit 4. There is only one water quality sample available in 2025 for F1, as shown in **Table 8**. Water quality during this release was below the EA limits.

Table 7. C1 discharge water quality data – 2025

Parameter	Site Target	EA Limit	Minimum Recorded Value	Maximum Recorded Value
pH	6.5 – 8.5	6.5 – 8.5	7.64	7.84
EC	450	900	157	488
TSS	50	100	<5	10

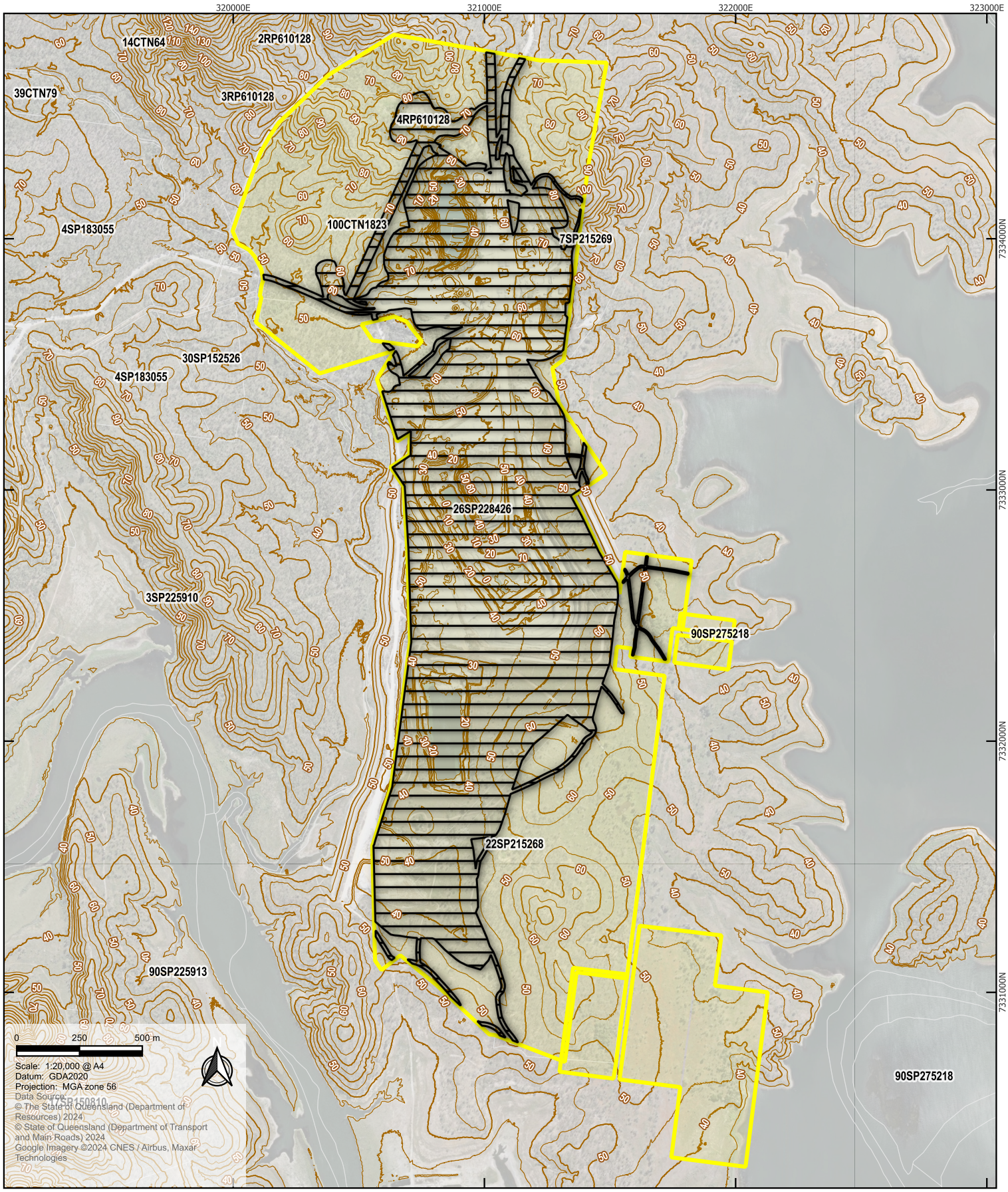
Table 8. F1 discharge water quality data - 2025

Parameter	Site Target	EA Limit	Recorded Value (13/03/25)
pH	6.5 – 8.5	6.5 – 8.5	7.85
EC	450	900	721
TSS	50	100	6

Water quality data from samples collected in March 2025 from Pit 3 and Pit 4 have been summarised in **Table 9,** along with the relevant water quality guidelines. This data shows that recorded water quality does not exceed guideline values.

Table 9. Pit water quality (collected 19/03/25)

Parameter	Units	Australian drinking water guideline	ANZECC stock watering guideline	Pit 3 Seepage	Pit 3	Pit 4
pH	pH units	6.5 - 8.5	6 - 8.5	8.1	8.1	8.2
Electrical Conductivity	µS/cm	-	5970	1144	733	472
Dissolved Oxygen	mg/l	-	-	6.5	5.7	3.9
Turbidity	NTU	-	-	24.1	9.59	5.7
Suspended Solids	mg/L	-	-	<5	<5	<5
Total Alkalinity as CaCO3	mg/L	-	-	242	89	116
Sulfate as SO4 - Turbidimetric	mg/L	-	-	55	37	47
Chloride	mg/L	-	-	143	142	18
Calcium - Dissolved	mg/L	-	-	126	60	50
Magnesium - Dissolved	mg/L	-	-	7	7	7
Sodium - Dissolved	mg/L	-	-	87	59	24
Potassium - Dissolved	mg/L	-	-	<1	<1	<1
Calcium - Total	mg/L	-	-	137	63	58
Magnesium - Total	mg/L	-	-	8	8	8
Sodium - Total	mg/L	-	-	94	64	26
Potassium - Total	mg/L	-	-	<1	<1	<1
Aluminium - Dissolved	mg/L	-	-	<0.01	<0.01	<0.01
Arsenic - Dissolved	mg/L	-	-	<0.001	<0.001	<0.001
Cadmium - Dissolved	mg/L	-	-	<0.0001	<0.0001	<0.0001
Chromium - Dissolved	mg/L	-	-	<0.001	<0.001	<0.001
Copper - Dissolved	mg/L	-	-	<0.001	0.001	<0.001
Nickel - Dissolved	mg/L	-	-	<0.001	<0.001	<0.001
Lead - Dissolved	mg/L	-	-	<0.001	<0.001	<0.001
Zinc - Dissolved	mg/L	-	-	0.007	0.01	<0.005
Iron - Dissolved	mg/L	-	-	<0.05	<0.05	<0.05
Aluminium - Total	mg/L	0.1	5	0.03	0.04	0.06
Arsenic - Total	mg/L	0.01	0.5	<0.001	<0.001	<0.001
Cadmium - Total	mg/L	0.002	0.01	<0.0001	<0.0001	<0.0001
Chromium - Total	mg/L	0.05	1	<0.001	<0.001	<0.001
Copper - Total	mg/L	2	1	<0.001	<0.001	<0.001
Nickel - Total	mg/L	0.02	1	<0.001	<0.001	<0.001
Lead - Total	mg/L	0.01	0.1	<0.001	<0.001	<0.001
Zinc - Total	mg/L	3	20	<0.005	<0.005	<0.005
Iron - Total	mg/L	-	-	<0.05	<0.05	0.06
Mercury - Dissolved	mg/L	-	-	<0.0001	<0.0001	<0.0001
Mercury - Total	mg/L	-	-	<0.0001	<0.0001	<0.0001



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 Surface Water Impact Assessment\1 Surface Water Impact Assessment\Rev 0\Figure 4 Topography.qgz

Legend

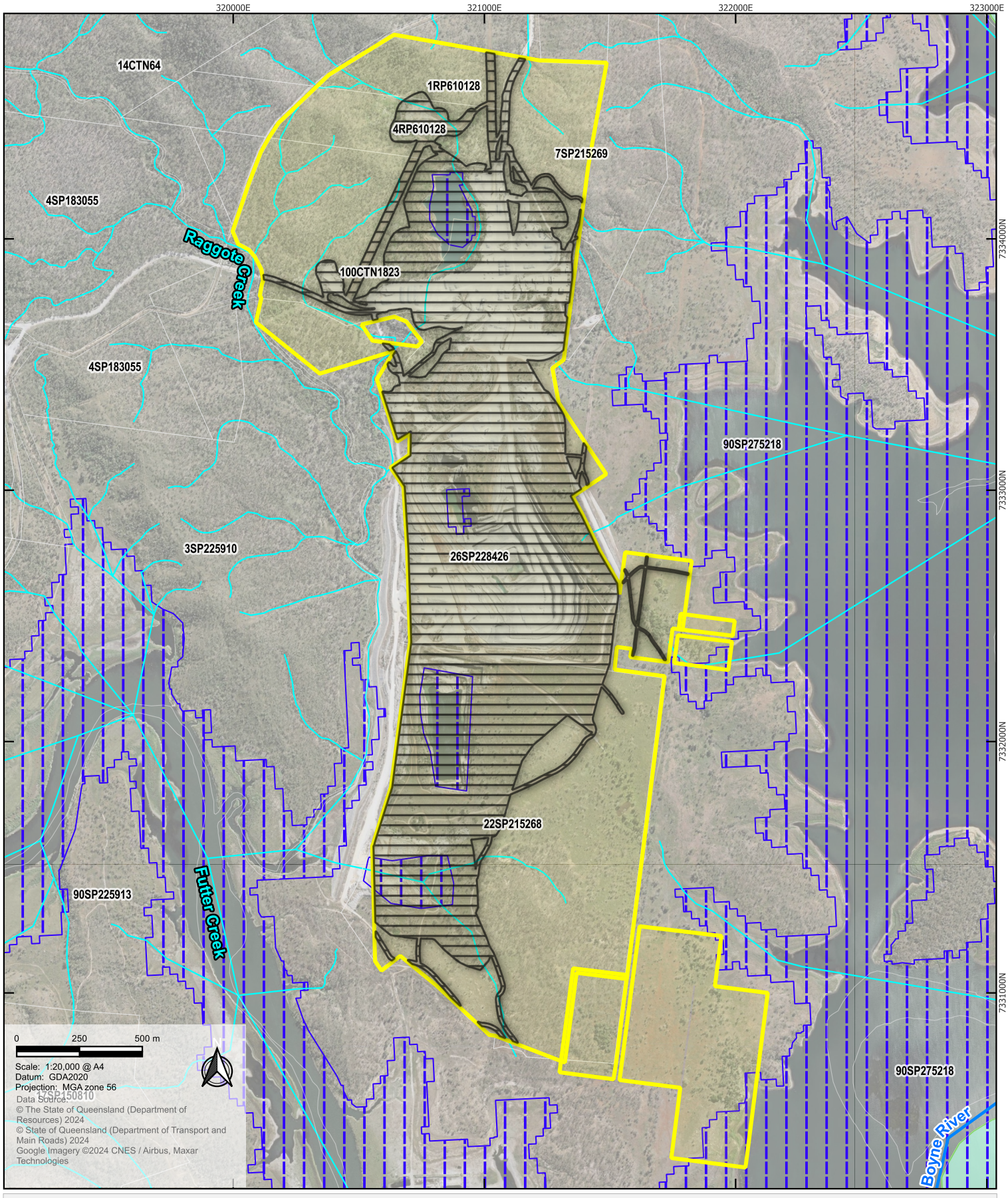
- Site boundary
- Maximum disturbance extent

Elevation contours

- 5m intervals
- 10m intervals

Graymont
Calliope Limestone Quarry
Surface Water Impact Assessment

Figure 4
Topography



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 Surface Water Impact Assessment\1. Surface Water Impact Assessment\Rev 0\Figure 5 Hydrology.qgz

Legend

- Site boundary
- Cadastre (DCDB)
- Maximum disturbance extent
- MSES - Regulated vegetation (100m from wetland)

Wetland areas (Qld Wetland Mapping v5.0)

- Lacustrine

Watercourses

- Major
- Minor

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Calliope Limestone Quarry
Surface Water Impact Assessment

Figure 5
Hydrology

5 IMPACT ASSESSMENT

5.1 Catchment Analysis

Catchment analysis has been undertaken using available topographic data to assess changes between the existing and final (maximum disturbance) landform. The following sections detail the current and final catchments, as well as the changes in catchment area and water flow paths.

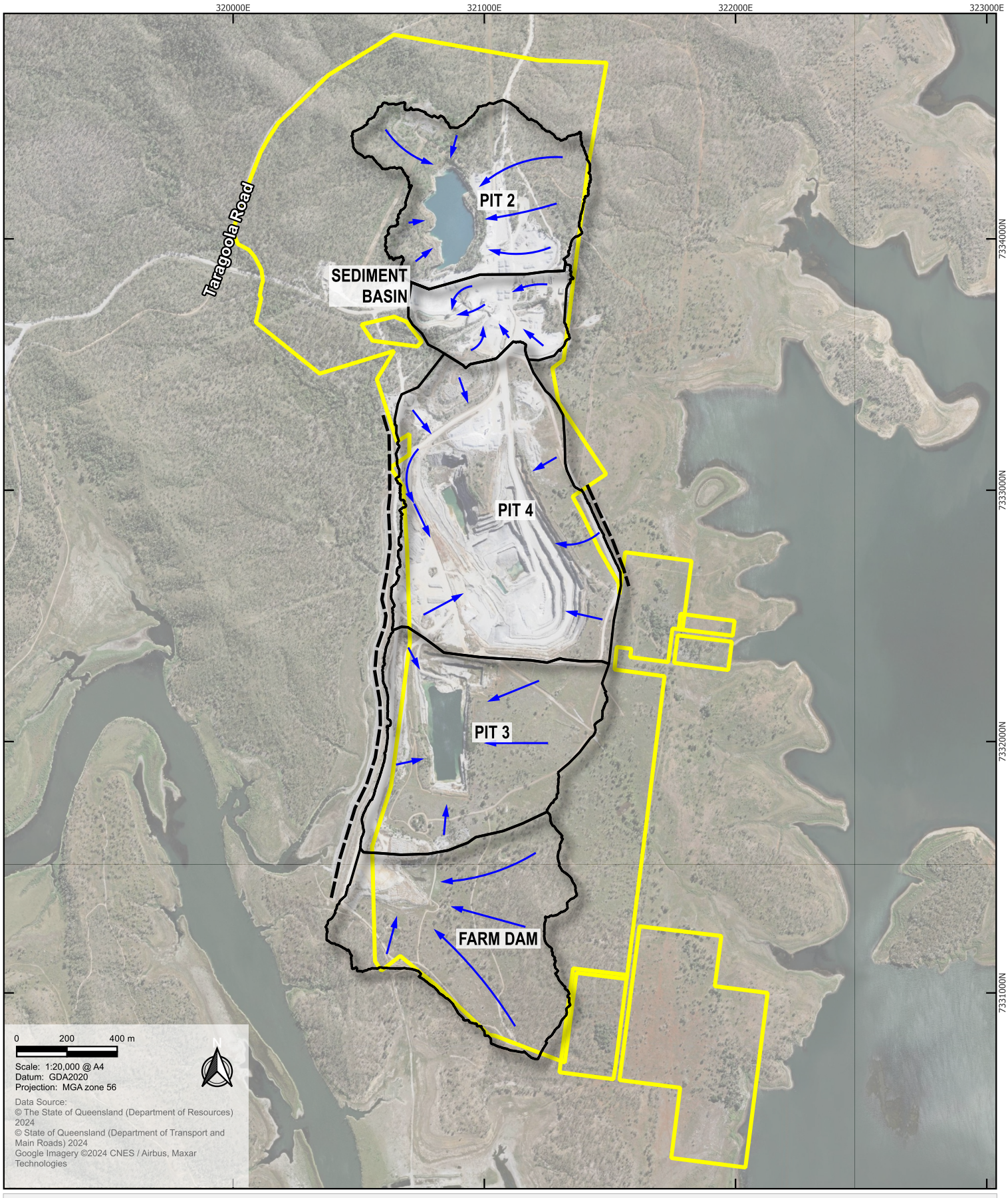
5.1.1 Current Disturbance

The surface water catchments within the current Project disturbance are detailed in **Table 10** and shown in **Figure 6**. These catchments have been derived using topographic survey data (2024 & 2025) provided to Epic by Graymont. Former Pit 1 has recently been backfilled, and surface runoff from this area now reports to the sediment basin catchment.

The current Project catchment has a naturally occurring north-south surface water divide located to the east of the Project, which prevents runoff discharging from that direction. The construction of a bund wall to the west of the Project has created another north-south surface water divide, similarity preventing runoff from leaving the Project to the west. Together, these surface water features form a closed surface water system within the Project with surface water runoff retained within the Project area and reporting to onsite water storages.

Table 10. Current Disturbance Catchments

Catchment	Description	Area (ha)
Pit 2	Includes: • Main site entrance • Contractor truck waiting area • Main office • Plant stockpile storage areas • Helipad	49.2
Sediment basin	Includes: • ROM processing area • Wash-plant and screening area • Backfilled Pit 1	18.1
Pit 3	Includes: • Northern portion of southern waste rock dump • Cleared areas and laydowns • Undisturbed area to the east of Pit 3	59.7
Pit 4	Includes: • Northern waste rock dump • Topsoil stockpile • Temporary spoil storage area	86.7
Farm Dam	Includes: • Southern waste rock dump • Undisturbed area previously draining into Raggotte Creek	56.8
	Total	270.5



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA250025.01 Surface Water Impact Assessment\1. Surface Water Impact Assessment\Rev 0\Figure 6 Current disturbance catchment areas.qgz

Legend

- Site boundary
- Current disturbance catchment areas
- Bund wall
- Flow path

Graymont
Calliope Limestone Quarry
Surface Water Impact Assessment

Figure 6
Current disturbance catchment areas

5.1.2 Maximum Disturbance

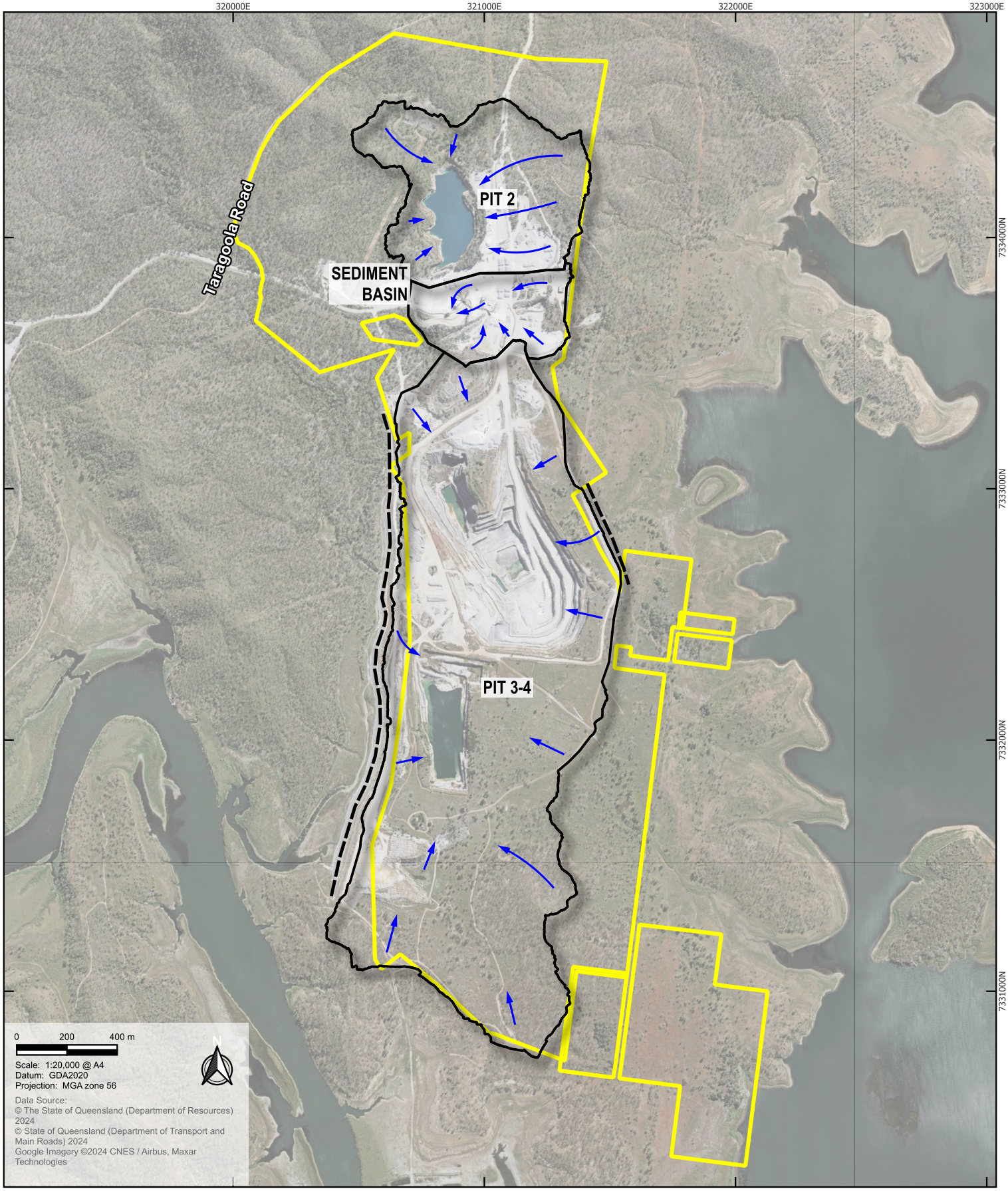
The surface water catchments associated with the maximum Project disturbance extent are detailed in **Table 11** and shown in **Figure 7**. These catchments have been derived from the maximum disturbance surface data, provided to Epic by Graymont.

The expanded disturbance area associated with the final development of Pit 3-4 will result in the removal of the existing Farm Dam. Under the maximum disturbance scenario, the existing farm dam catchment will flow into Pit 3-4. As a result the catchment area for Pit 3-4 in the maximum disturbance will encompass the current catchments for Pit 3, Pit 4, and the Farm Dam.

No changes are anticipated to the catchment areas for Pit 2 and the Sediment Basin in the maximum disturbance landform. Additionally, the existing natural and constructed surface water divides to the east and the west of the Project remain unchanged, maintaining a closed surface water system in which all runoff is contained within the Project area.

Table 11. Maximum Disturbance Catchments

Catchment	Description	Area (ha)
Pit 2	Includes: • Main site entrance • Contractor truck waiting area • Main office • Plant stockpile storage areas • Helipad	49.2
Sediment basin	Includes: • ROM processing area • Wash-plant and screening area • Backfilled former Pit 1	18.1
Pit 3 - 4	Includes: • Previous Pit 3 catchment • Previous Pit 4 catchment • Previous Farm Dam catchment, including southern waste rock dump and undisturbed area previously draining into Raggotte Creek	203.2
	Total	270.5



Legend

- Site boundary
- Maximum disturbance catchment areas
- Bund wall
- Flow path

Graymont
Calliope Limestone Quarry
Surface Water Impact Assessment

Figure 7
Maximum disturbance catchment areas

5.2 Stormwater Flow Assessment

A stormwater flow assessment has been completed to quantify potential changes in peak stormwater discharge from the site under the maximum disturbance scenario across a range of design rainfall events.

The Rational Method was used to estimate peak discharge rates for each catchment under both current and maximum disturbance conditions. This approach was selected in accordance with the Queensland Urban Drainage Manual (QUDM, 2016). Input parameters used in the calculations are summarised in **Table 12**, **Table 13**, and **Table 14**. The relative areas of land use within each catchment have been calculated based on topographic survey data provided by Graymont.

Table 12. Rational Method input parameters

Parameter	Value	Source
Site catchment area – Ha	See **Table 10** and **Table 11**	Calculated from topographic data (provided by Graymont)
Fraction impervious - unitless	Natural/Undisturbed = 0 Disturbed = 0.9 Pit/Pond = 1 Infrastructure/Buildings = 1	QUDM (dependent on land use)
Composite Runoff Coefficient (C) – unitless	See **Table 13** and **Table 14**	Calculated
Frequency factors (Fy)	QUDM table 4.5.2	QUDM
Time of concentration (t_c) – minutes	5	QUDM
Rainfall intensity - 1 hour, 10% AEP ($^1I_{10}$) – mm/hr	61.5	BOM IFD design rainfall (BOM, 2024)

Table 13. Current disturbance catchment areas and runoff coefficients

Catchment	Site catchment area per land use (ha)				Composite Runoff Coefficient (C) – unitless
	Natural/Undisturbed	Disturbed	Pit/Pond	Infrastructure/Buildings	
Pit 2	19.60	20.27	8.51	0.82	0.81
Sediment basin	0.67	12.25	1.91	3.27	0.87
Pit 3	36.15	7.82	15.74	0.00	0.77
Pit 4	11.93	32.61	42.15	0.00	0.86
Farm Dam	50.44	6.37	0.00	0.00	0.72

Table 14. Maximum disturbance catchment areas and runoff coefficients

Catchment	Site catchment area per land use (ha)				Composite Runoff Coefficient (C) – unitless
	Natural/Undisturbed	Disturbed	Pit/Pond	Infrastructure/Buildings	
Pit 2	17.91	19.00	11.47	0.82	0.82
Sediment basin	0.42	12.26	1.42	4.00	0.88
Pit 3-4	39.4	54.11	109.69	0.00	0.85

Table 15, **Table 16**, and **Table 17** show the estimated peak discharge for a range of design rainfall events under both current and maximum disturbance scenarios. As the total catchment areas remain largely unchanged, with the exception of Pit 3-4, the primary influence on peak discharge is the change in land use within the catchments. These modelling results show that the predicted changes in peak discharge are minimal, with a <1% change expected within the sediment basin catchment.

Table 15. Peak discharge – Sediment basin

AEP %	ARI (1 in x years)	Peak Discharge (m^3/s)		Change in peak discharge (m^3/s)	% change
		Current Disturbance	Maximum Disturbance		
39%	1 in 2 years	0.38	0.39	0.00	0%
18%	1 in 5 years	0.57	0.57	0.00	0%
10%	1 in 10 years	0.70	0.70	0.00	0%
5%	1 in 20 years	0.83	0.84	0.00	0%
2%	1 in 50 years	1.05	1.06	0.00	0%
1%	1 in 100 years	1.21	1.21	0.00	0%

Table 16. Peak discharge – Pit 2

AEP %	ARI (1 in x years)	Peak Discharge (m^3/s)		Change in peak discharge (m^3/s)	% change
		Current Disturbance	Maximum Disturbance		
39%	1 in 2 years	0.97	0.98	0.01	+1%
18%	1 in 5 years	1.44	1.45	0.01	+1%
10%	1 in 10 years	1.76	1.77	0.02	+1%
5%	1 in 20 years	2.10	2.12	0.02	+1%
2%	1 in 50 years	2.65	2.68	0.03	+1%
1%	1 in 100 years	3.05	3.08	0.03	+1%

Table 17. Peak discharge – Pit 3 and Pit 4

AEP %	ARI (1 in x years)	Current Disturbance Peak Discharge (m^3/s)				Maximum Disturbance Peak Discharge (m^3/s)	Change in peak discharge (m^3/s)	% change
		Farm Dam	Pit 3	Pit 4	Total	Pit 3-4		
39%	1 in 2 years	0.99	1.82	1.13	3.93	4.22	0.28	+7%
18%	1 in 5 years	1.48	2.70	1.67	5.85	6.27	0.42	+7%
10%	1 in 10 years	1.80	3.30	2.04	7.14	7.66	0.51	+7%
5%	1 in 20 years	2.16	3.94	2.44	8.54	9.15	0.61	+7%
2%	1 in 50 years	2.73	4.98	3.09	10.80	11.58	0.77	+7%
1%	1 in 100 years	3.13	5.72	3.55	12.40	13.29	0.89	+7%

5.3 Sediment Basin Capacity Assessment

An assessment of the existing sediment basin was undertaken to determine whether it provides sufficient capacity to prevent sediment-laden runoff from discharging to the receiving environment under the maximum disturbance scenario.

The sediment basin dimensions were estimated using topographic survey data collected in March 2025 (provided by Graymont). Based on this data, the existing sediment basin is estimated to have a surface area of approximately 4,950 m^2, and an available volume of approximately 5,330 m^3.

The sediment basin sizing calculations presented in the existing Sediment and Erosion Management Plan (Graymont, 2023) are based on a catchment size of 7.2 ha. However, catchment analysis undertaken as part of this assessment has redefined the sediment basin catchment area to be 18.1 ha for both the current and maximum disturbance scenarios.

The minimum required sediment basin sizing for this updated catchment area has been calculated using the methodology for a C-type basin as outlined in 'Best Practice Erosion and Sediment Control' (IECA, 2018).

The following assumptions were adopted in the absence of site-specific data to support the sediment basin sizing calculations:

- Runoff for the Q-3 month (0.5 x 1 year ARI) was applied
- Approximately 90% of the sediment is larger than 0.05 mm diameter
- Bulk density of limestone used was 28 kN/m^3
- Clean out frequency of basin is once per year

The minimum required dimensions for the sediment basin are as follows:

- Surface area = 532.2 m^2
- Volume = 470.9 m^3
- Width = 13.2 m, Length = 39.6 m

The existing sediment basin size (Surface ware of approximately 4,950 m^2, and volume of approximately 5,330 m^3) is significantly larger than the calculated minimum requirements and is therefore considered adequate to manage runoff and sediment loads under both the current and maximum disturbance scenarios.

5.4 Impacts to Great Barrier Reef

The catchment analysis completed as part of this assessment confirms that the surface water catchments within the Project area effectively act as a closed system under both the current and maximum disturbance conditions. A natural surface water divide is present to the east of the Project area, while a man-made bund aligned approximately north-south is located to the west of the Project area. These surface water divides prevent runoff from exiting the site, with surface water flows reporting internally to site water storages.

The site water balance included in the Hydrogeological report (Graymont, 2025) indicates that the storage capacities of Pit 2 and Pit 3-4 are sufficient under the maximum disturbance scenario. No uncontrolled releases are predicted to occur, even under extreme rainfall events.

The discharge of sediment laden water from mining operations is expected to have a negligible impact on the receiving environment, including the EVs of Raggote Creek and Lake Awoonga (as a lacustrine wetland). Waste characterisation studies undertaken by RGS (2023) and Epic (2024) confirm the absence of acid and metalliferous drainage (AMD) materials in waste rock. Therefore in the unlikely event of uncontrolled releases, potential impacts to water quality are expected to be limited to localised increases of turbidity, suspended solids and nutrients.

The potential residual impact of suspended solids and nutrients to the downstream Great Barrier Reef is also considered to be low. This assessment has confirmed that the sediment basin is adequately sized to capture sediment laden runoff from the processing areas, with no increase in catchment area expected under the maximum disturbance scenario. Water quality data from releases at discharge point C1 from the sediment basin during 2025 show that discharge water was within the release limits specified in the EA, and within the recorded historic range of water quality for Lake Awoonga in 2023-24. Therefore, it is expected that any releases into the receiving environment are unlikely to negatively impact the water quality of the receiving watercourses.

The Sediment and Erosion Management Plan outlines mitigation measures that are to be undertaken at the site, including regular visual inspections of the sediment basin, and cleaning as required. Monitoring of any water discharged from the site will continue to undertaken to ensure compliance with EA conditions. These measures will be continued to be implemented throughout the life of mine.

6 CONCLUSIONS

This surface water impact assessment concludes that the potential impact to downstream surface water and the receiving environment under the maximum disturbance landform is considered low based on the following factors:

- The site functions as a closed surface water system, with all disturbed areas draining internally into site water storages
- Changes to the current catchments are minimal in the maximum disturbance, with the primary change being the amalgamation of the Pit 3, Pit 4, and Farm Dam catchments
- The stormwater flow assessment undertaken demonstrates that the predicted changes in peak discharge between current and maximum disturbance scenarios are minor
- Water balance (Graymont,2025) indicates that overtopping of site water storages is unlikely, even during extreme rainfall events
- An assessment of the sediment basin indicates that the existing dam has sufficient capacity to manage runoff under both current and maximum disturbance conditions, thereby minimising the potential for uncontrolled releases into the receiving environment

In addition, existing mitigation and management measures, as outlined in the Sediment and Erosion Management Plan, are considered appropriate and will continue to minimise the risks to the receiving surface water environment throughout the life of mine.

7 REFERENCES

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