Murgon Operations Progressive Rehabilitation and Closure Plan

Graymont

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Abbreviations

Abbreviation	Description
AEP	Annual Exceedance Probability
ALC	Agricultural Land Classification
BMRG	Burnett Mary Regional Group
BoM	Bureau of Meteorology
DAF	Department of Agriculture and Fisheries
DAWE	Department of Agriculture, Water and the Environment
DEEDI	Department of Employment, Economic Development and Innovation
DEM	Digital Elevation Model
DES	Department of Environment and Science
EA	Environmental Authority
EC	Electrical Conductivity
EP Act	Environmental Protection Act 1994
EPBC	Environment Protection and Biodiversity Conservation Act 1999
ERA	Environmental Relevant Activities
ERC	Estimated Rehabilitation Cost
EV	Environmental Value
FRP	Filterable Reactive Phosphorus
GDE	Groundwater Dependent Ecosystem
GLS	Ground Limestone
IAA	Important Agricultural Area
ITP	Inspection and Test Plan
MERFP Act	Mineral and Energy Resources (Financial Provisioning) Act 2018
LOD	Land Outcome Document
LOM	Life of Mine
ML	Mining Lease
NC Act	Nature Conservation Act 1992
NUMA	Non-use management area
PoO	Plan of Operations
PMLU	Post-Mine Land Use
PRCP	Progressive Rehabilitation and Closure Plan
PRCP Schedule	Progressive Rehabilitation and Closure Plan Schedule
QFAO	Queensland Floodplain Assessment Overlay
RA	Rehabilitation Area

Abbreviation	Description
RE	Regional Ecosystem
ROM	Run of Mine
RPI Act	Regional Planning Interests Act 2014
TN	Total Nitrogen
TPH	Total Petroleum Hydrocarbons
TSF	Tailings Storage Facility
TSS	Total Suspended Solids
WQO	Water Quality Objective
WQIP	Water Quality Improvement Plan

1. Introduction

The Graymont Murgon Limestone Quarry and Processing Plant (the site) is situated approximately 260 km north-west of Brisbane, 90 km south-west of Gympie and 160km south-west of Maryborough. The site is located on Haager Drive at the junction of Barambah and Barker Creeks, Murgon. The township of Murgon is located approximately 5 km to the north-west of the Murgon Limestone Mine mining lease (ML 50111) (Figure 1).

The site was acquired by Graymont in 2019 from Sibelco Lime Pty Ltd (Sibelco).

There are three limestone deposits on ML 50111 - the Northern, Central and Southern Deposits. Only the Northern Deposit, with an indicated resource of 1.03 million tonnes and minable reserve of 976,000 tonnes of limestone, is currently being worked to 2037.

This rehabilitation planning part of the Progressive Rehabilitation and Closure Plan (PRCP) has been prepared to meet the requirements of the *Environmental Protection Act* 1994 (EP Act).

1.1. Purpose and scope

The Murgon Operation PRCP Planning part provides guidance on the progressive rehabilitation of land affected by mining activities and the closure requirements of the mine once operations cease. The main purpose of a PRCP is to enable an EA holder to plan for how and where mining activities will be carried out on land in a way that maximises the progressive rehabilitation of the land to a stable condition; and provide details of the condition to which the EA holder must rehabilitate the land before the EA may be surrendered. This is a critical element of mine closure and ultimate relinquishment of the mining leases.

This PRCP has been prepared with reference to requirements for the preparation of a PRCP as set out in the Queensland Government Department of Environment and Science (DES), *Progressive Rehabilitation and Closure Plans (PRC Plans) Guideline (ESR/2019/4964)* (PCRP guideline) (DES 2021) effective from 17 March 2021.

The location and current disturbance associated with the site is outlined in Figure 1.

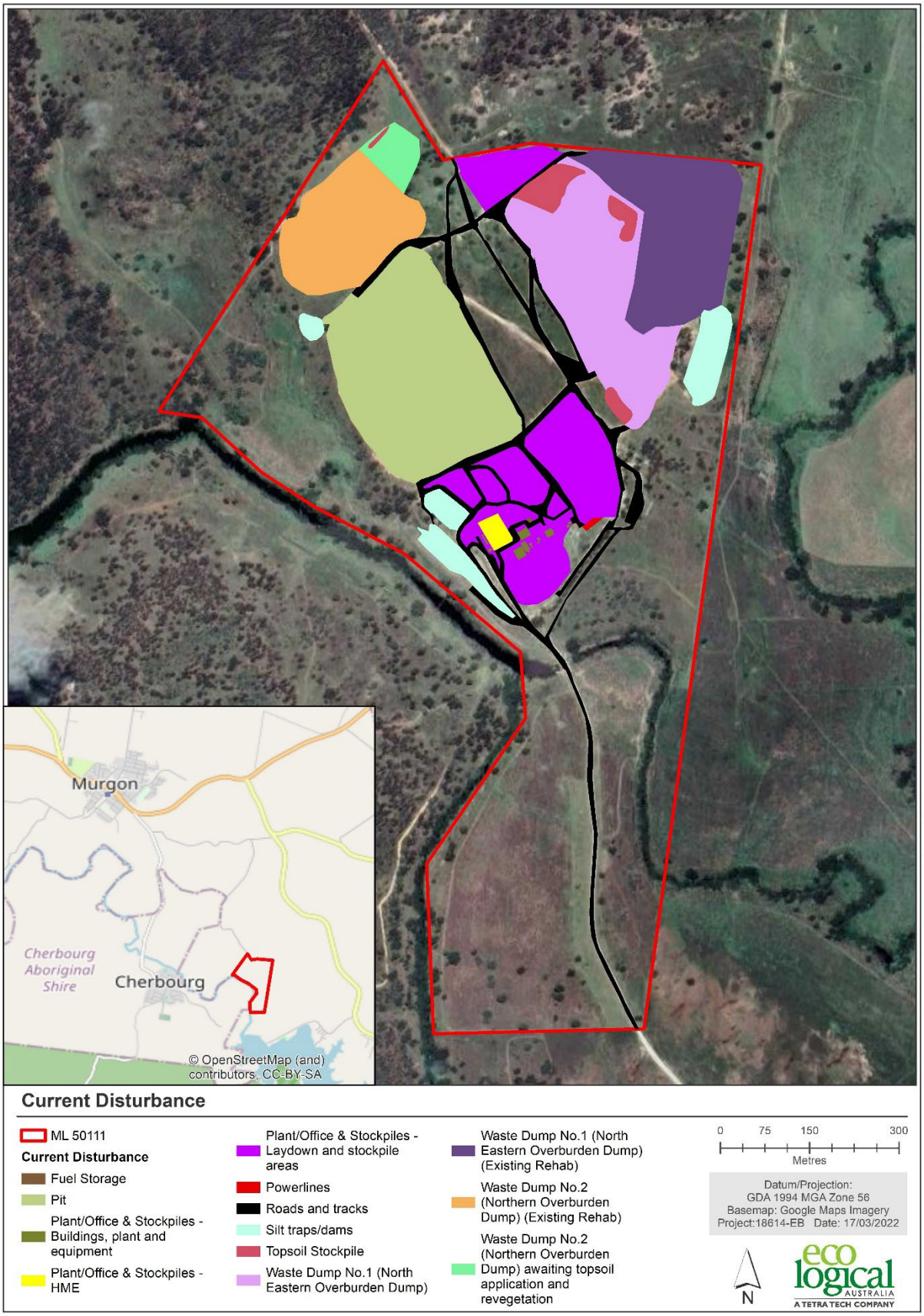

Figure 1 Locality, disturbance types and current areas of disturbance at Murgon Operations

2. Regulatory context

Rehabilitation at mining operations is regulated under the EP Act and its subordinate legislation including the *Environmental Protection Regulation 2019*. It is Queensland Government policy that land disturbed by mining activities will be rehabilitated progressively as it becomes available, to minimise the risk of environmental impacts and to reduce cumulative areas of disturbed land.

2.1. Queensland rehabilitation regulatory framework

Under amendments to the EP Act resulting from the passing of the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act), all new and existing EA holders for a mining activity relating to a mining lease approved through a site-specific application (DES 2021) are required to prepare a PCRP following receipt of a Notice from DES.

For existing operations, the transitional arrangements mean that existing "land outcomes" (Post Mine Land Uses (PMLU) and associated completion criteria) secured in a "land outcome document" (LOD) received by DES (and not rejected) before December 2018 can be carried forward (and do not need community consultation or stakeholder agreement). According to Section 750 of the EP Act a 'land outcome document' can be:

a) an EA

b) a document made under a condition of an EA that:

- *relates to the management or rehabilitation of land (e.g. rehabilitation and closure plan or residual void management plan); and*
- *was provided to the administering authority, and had not been superseded, before 30 November 2018; and*
- *before 15 January 2019, the administering authority had not notified the EA holder that the document was insufficient.*

c) a document made under a condition of an EA that:

- *i relates to the management or rehabilitation of land (e.g. rehabilitation and closure plan or residual void management plan); and*
- *ii was provided to the administering authority between 20 November 2019 and to 30 November 2021; and*
- *iii within 20 business days after receiving the document, the administering authority had not notified the EA holder that the document was insufficient.*

d) a report evaluating an EIS under section 34D of the State Development and Public Works Organisation Act 1971

e) an EIS assessment report

f) a written agreement between the EA holder and the State that is in force on 30 November 2018.'

The PCRP guideline (DES 2021) states that the land outcome document list is hierarchical and if there are inconsistencies between these documents on either the final outcomes or details of the outcome, then the document appearing first in the above list will prevail to the extent of the inconsistency.

For Murgon, the primary land outcome document is the EA EPML00352613 granted 27 April 2015.

The EA for Murgon Operations includes specific conditions relating to rehabilitation outcomes, including the PMLU. These specific conditions are provided in Table 1.

Table 1 EA conditions relevant to rehabilitation

Condition*	Land outcome document to be prepared
C1-2	Water management system
C6-1 & C6-2	A study to determine the recharge sources and connectivity in the open pit including a dewatering monitoring program (to monitor impacts on nearby water users and surface waters)
F2-1	Final Land Use and Rehabilitation Plan #
F3-2	Acceptance criteria to meet the outcomes specified in Condition F3-1 and Schedule F Table 1 (required prior to EA surrender)

* See Table 21 of the PRC Plan for PMLU requirements as provided in Condition F1-1.

This PRC Plan supersedes this document and provides all the information required in Condition F2-1.

3. Project Planning Section

3.1. Project Planning

This section includes background information, site location details, a description of the project and information on rehabilitation planning at Murgon.

The following descriptions satisfy the legislative requirements of the EP Act:

3.1.1. Site location, regional context and topography

The site is situated approximately 260 km north-west of Brisbane, 90 km south-west of Gympie and 160km south-west of Maryborough. The site is located on Haager Drive at the junction of Barambah and Barker Creeks, Murgon. The township of Murgon is located approximately 5 km to the north-west of the mining lease (Figure 1).

The mine is situated 1.5 km west of Barambah Road and approximately 3 km east of Cherbourg Road. The site is located in a sparsely populated location, with only two houses located within 1.5 km of the mine. Cherbourg Aboriginal Reserve is located approximately 2.2 km to the west of the mine and the small village of Moffatdale is located approximately 3.4 km to the east/south-east.

The site comprises a series of limestone lenses which occur over a north-south distance of 7 km along the valley of Barker Creek. The limestone block dips to the west at various angles and is steepest close to faults. The elevation of the mining lease varies from a low of 283 m AHD near Barambah Creek to a high of 334 m AHD in the north-eastern corner of the lease. The local relief comprises undulating hills, cleared for grazing and forms part of the catchment of Barambah Creek which flows from Bjelke-Peterson Dam/Lake Barambah, located approximately 1.4 km to the south (upstream) of the mining lease boundary. The dam is a popular tourism location in the region.

3.1.2. Climate

Climate data for the region has been captured by the Kingaroy Bureau of Meteorology (BoM) weather station (station no. 40112) approximately 30 km away from 1947 to present. Based on the climate data collected from this weather station, the region experiences an annual mean maximum temperature of 24.8°C, a mean minimum temperature of 11.3°C and a mean total annual rainfall of 774.4 mm. The long-term mean temperature is provided in Table 2 and the mean monthly rainfall presented in Figure 2.

A less complete set of climate data (rainfall only) for the location has been captured from 1909 to present at the Murgon Post Office BoM weather station (station no. 40152) 6 km north of the site. It recorded a slightly higher mean total annual rainfall of 790.5 mm (Figure 2).

The mean daily evaporation rate, averaged across the year, is 4.4mm/day.

Table 2 Long-term mean temperature since 1947 (BoM weather station 40112; Kingaroy Prince Street)

Temp (mean; °C)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Min	29.5	28.8	27.6	25.1	21.6	18.9	18.5	20.1	23.3	26.0	28.1	29.6	24.8
Max	17.4	17.5	15.8	12.1	8.6	5.4	4.0	4.8	7.9	11.7	14.4	16.5	11.3

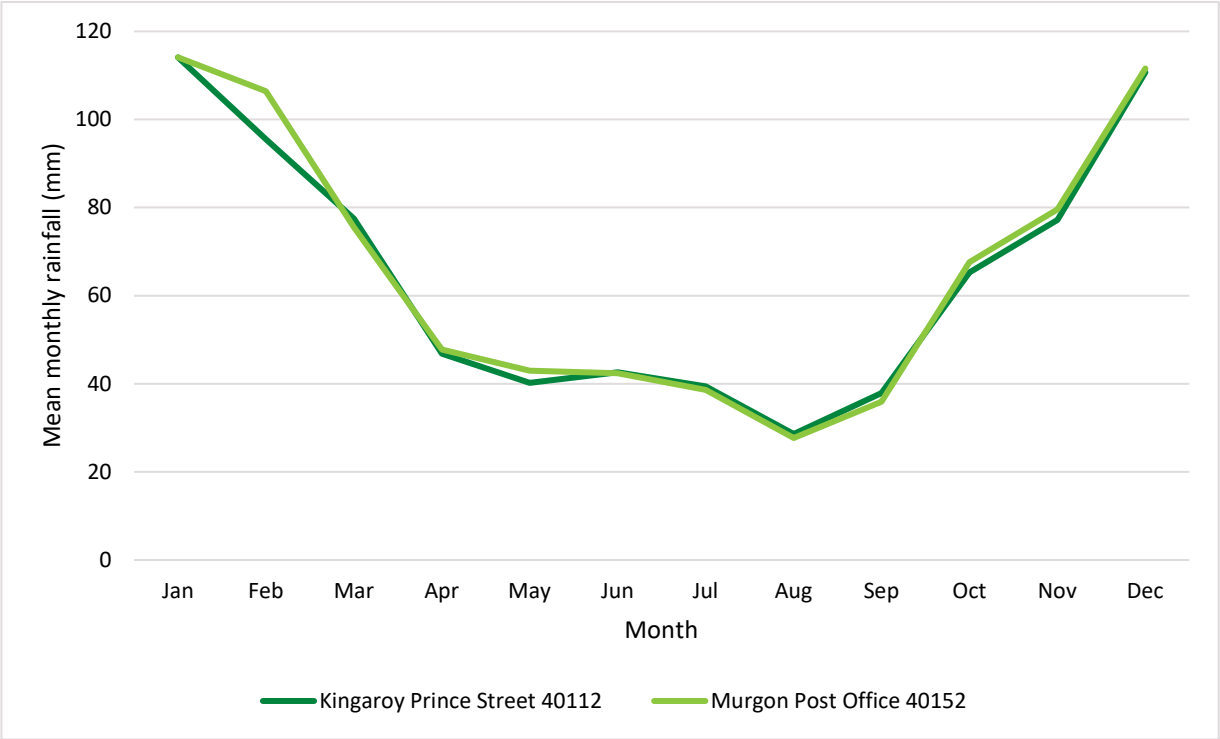

Figure 2 Mean monthly rainfall (BoM weather stations 40112; Kingaroy Prince Street and Murgon Post Office 40152)

3.1.3. Geological setting

The limestone orebody occurs within a sequence of limestones and mafic andesitic to basaltic volcanics; the latter rocks being referred to collectively as andesites. The rocks are overlain by a thin (5-10 m) deposit of recent alluvium and Tertiary sediments (Meyers 2015). The regional surface geology is shown in Figure 3 based on the Queensland Government's *Detailed surface geology – Queensland* data layer (Queensland Government 2020a).

The recent alluvial deposits comprise clayey-sands and sandy-clays. The tertiary sediments comprise interlayered clayey and gravelly sands, sandy clays and clays. The sediments also occur as fill within karst features in the top of the limestone.

The Barambah andesite and limestone form the Bjelke-Petersen beds. The beds were previously known as the Wondai Series of rocks. The rocks have been strongly deformed by widespread shearing. They have been faulted against sandstones and siltstones of the Triassic age Esk Formation.

The strikes of the footwall (east) and hanging wall (west) of the pit are defined by limestone/andesite contacts. The contacts are aligned with the structural trends in the Maronghi Creek Beds and the Esk Formation. These trends are predominantly north-northwest with dips of 60° to 75° to the west. The contact behind the west wall is well defined. The contact behind the east wall, particularly at the north end of the pit, is less well defined.

The north and south walls are defined by east-west striking faults. These faults have limited the extents of the limestone along strike and have significantly disturbed the rocks in the walls.

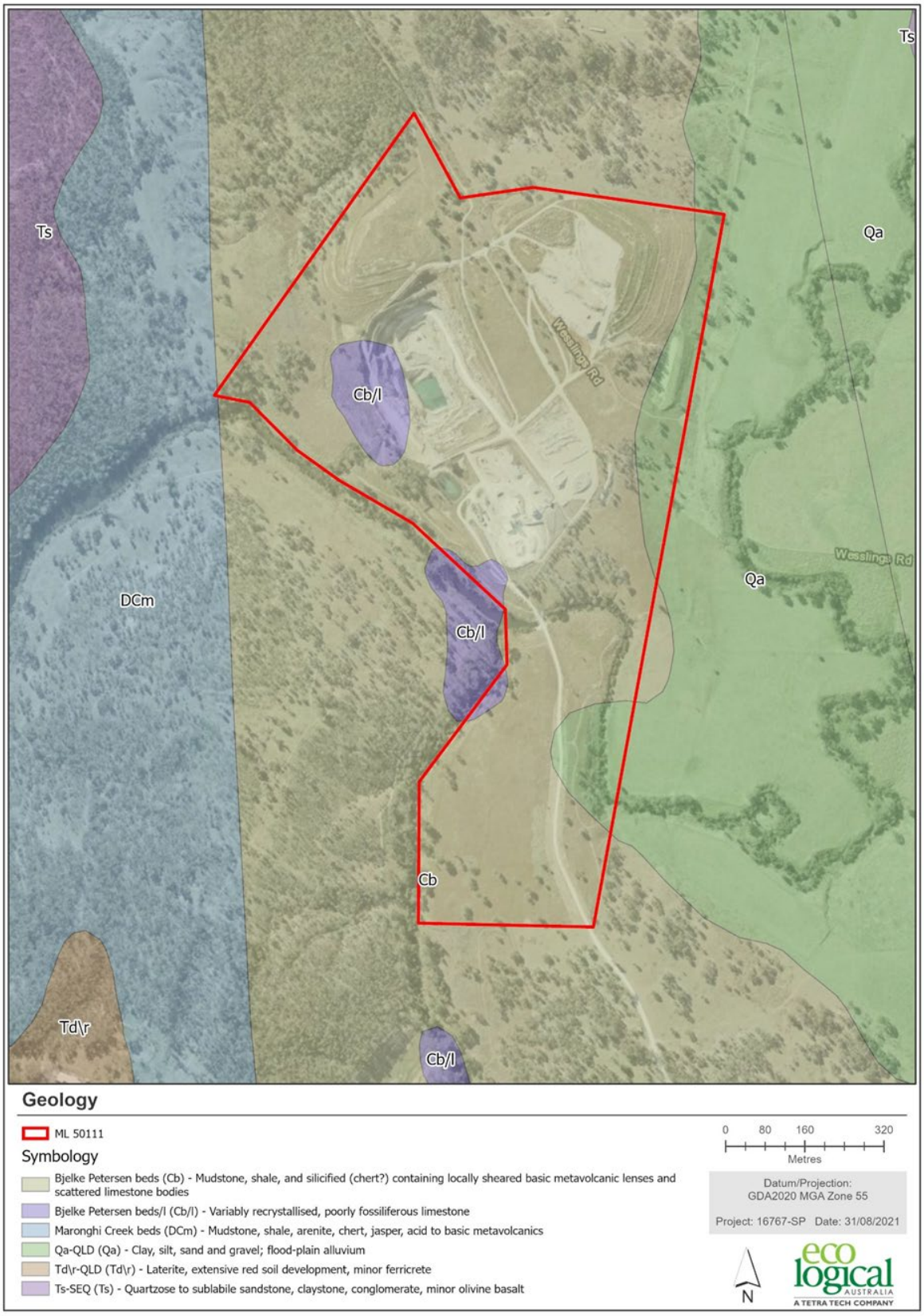

Figure 3 Regional surface geology (source: Queensland Government, 2020a)

3.1.4. Site hydrology and fluvial networks

The site is located within the Barker and Barambah Creeks drainage Sub-basin, in the freshwater catchment zone for the Burnett River. The site is situated downstream of the Bjelke-Petersen Dam and is outside of the declared catchment area of Lake Barambah formed by the dam.

Two minor watercourses Barker and Barambah Creeks flow adjacent to the lease areas drainage sub-basin occur around the site, namely. Barambah Creek flows around the southern border of ML 50111 with the junction to Barker Creek 120 m South (upstream) of the operation. Barker Creek terminates at the junction with Barambah Creek, while Barambah Creek flows north and drains into the Burnett River near Gayndah, approximately 90 km north of Murgon.

3.1.4.1. Environmental value and water quality objectives

There are currently no Environmental Values (EVs) or Water Quality Objectives (WQOs) scheduled under the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* for Barker and Barambah Creeks Sub-Basin. However, the catchment zone for the Burnett River is included within the *Water Quality Improvement Plan for the Burnett Mary Region* (WQIP) (BMRG NRM 2015) which contains draft WQOs and EVs for surface waters. The EVs for the 'Barambah Ck weir pools below Bjelke-Petersen Dam' area (i.e., those most relevant to the project area) are as follows:

- Aquatic ecosystems
- Irrigation
- Farm supply
- Stock water
- Aquaculture
- Human consumption of shellfish
- Primary recreation
- Secondary recreation
- Water recreation
- Cultural and spiritual values (Indigenous).

No draft High Ecological Value waters were recognised in the waters surrounding the Murgon Operation lease area and water would be considered Slightly to Moderately Disturbed with respect to WQOs for the protection of aquatic ecosystem EVs. The *Burnett Mary Region WQIP* (BMRG NRM 2015) provides draft WQOs for the project area (based on the default guidelines for central east coast upland (>150 m elevation) freshwaters from the Queensland water quality guidelines - EPA 2006) as follows:

- Turbidity: <25 NTU
- Suspended solids: <6 mg/L
- Chlorophyll a: <2 µg/L
- Total nitrogen (N): <250µg/L
- Oxidised N: <15 µg/L
- Ammonia N: <10 µg/L
- Organic N: <225 µg/L
- Total phosphorus: <30 µg/L
- Filterable reactive phosphorus (FRP): <15 µg/L
- Dissolved oxygen: 90 – 110% saturation

- pH 6.5 – 7.5.

However, the *Burnett Mary Region WQIP* (BMRG NRM 2015) acknowledged there was insufficient information available to establish WQOs for these upland waters, and local investigations would be required.

3.1.4.2. Local water quality and mine influence

Surface water quality data is available from July 2008. Water quality monitoring has included a range of variables specified in the EA. This includes pH, electrical conductivity (EC), total nitrogen (TN) and total suspended solids (TSS). The monitoring program includes a sampling location upstream (W1) of the site and a sampling location downstream of the site (W2) to determine potential impacts. Further details of the locations are provided below:

- W1 – Upstream at the confluence of Barambah and Barker Creeks
- W2 – Downstream at Barambah Creek, 100m downstream of Sediment Dam D.

The trends in water quality over time at the two sampling points are shown in Figure 4 to Figure 7 compared to either draft WQOs where applicable, or EA release limits where WQOs have not been nominated.

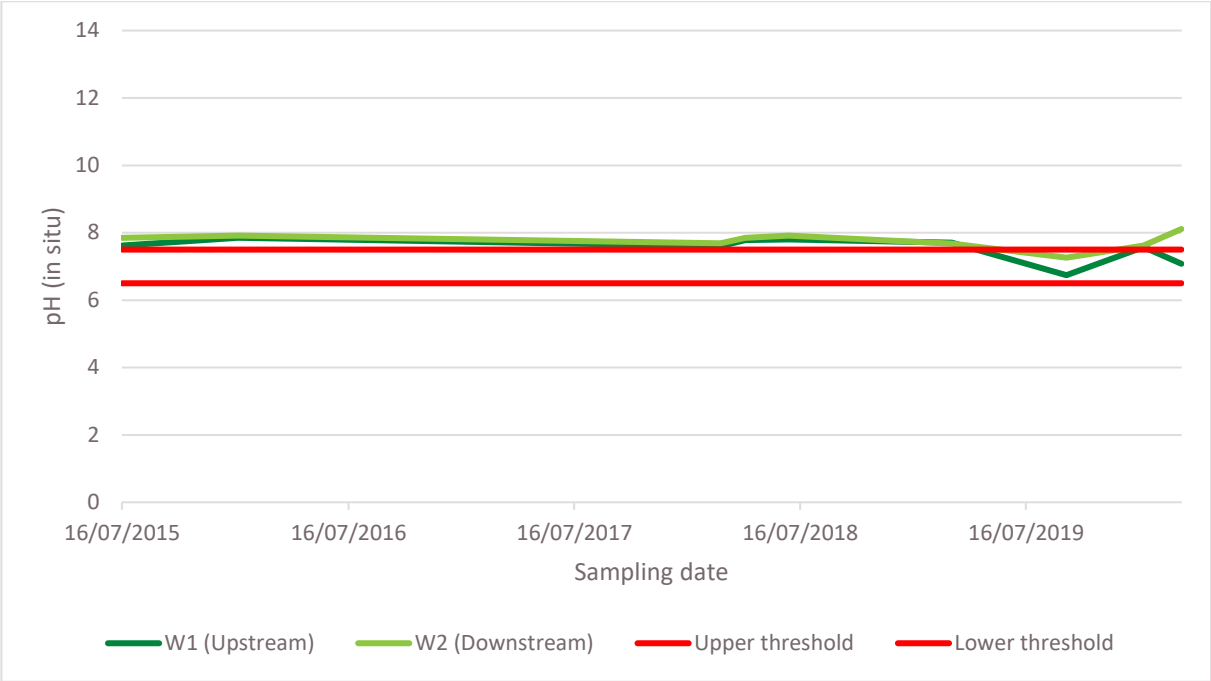

Figure 4 Surface water pH values at W1 (upstream background) and W2 (downstream impact) compared to the WQO (range between pH 6.5 and pH 7.5) (Note: Laboratory results were used in place of in situ results where outliers were detected)

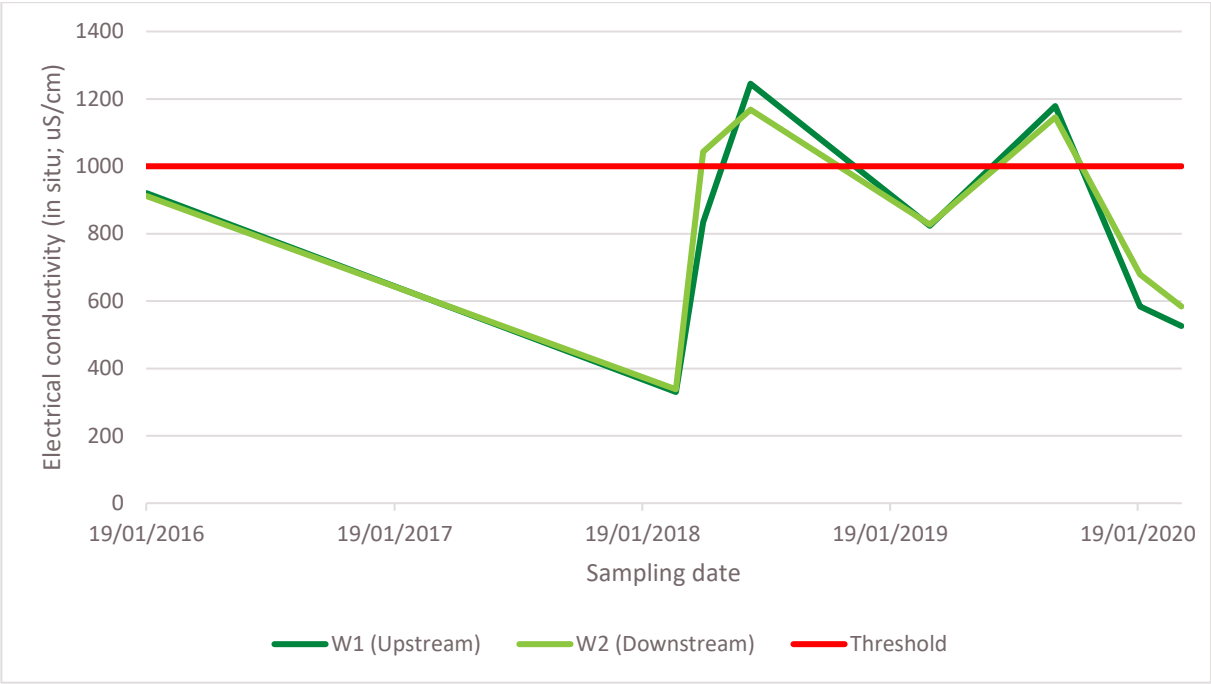

Figure 5 Surface water EC values at W1 (upstream background) and W2 (downstream impact) compared to the EA release limit (<1000 µS/cm)

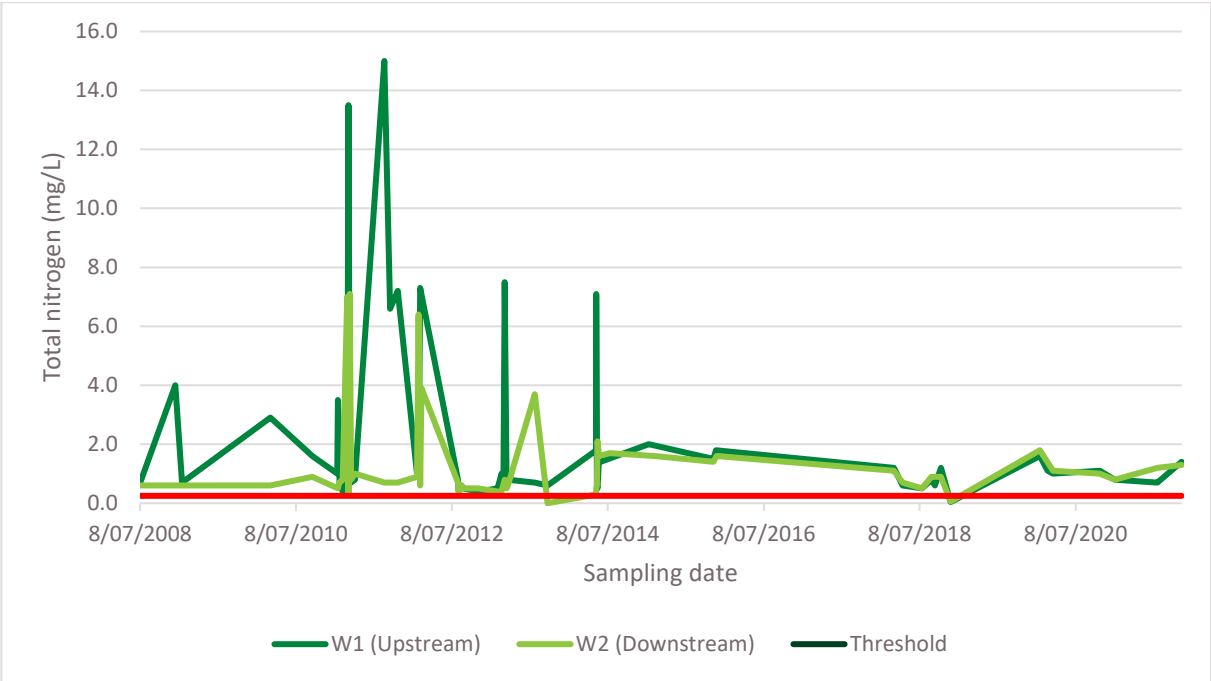

Figure 6 Surface water TN concentration at W1 (upstream background) and W2 (downstream impact) compared to the WQO (<0.25 mg/L)

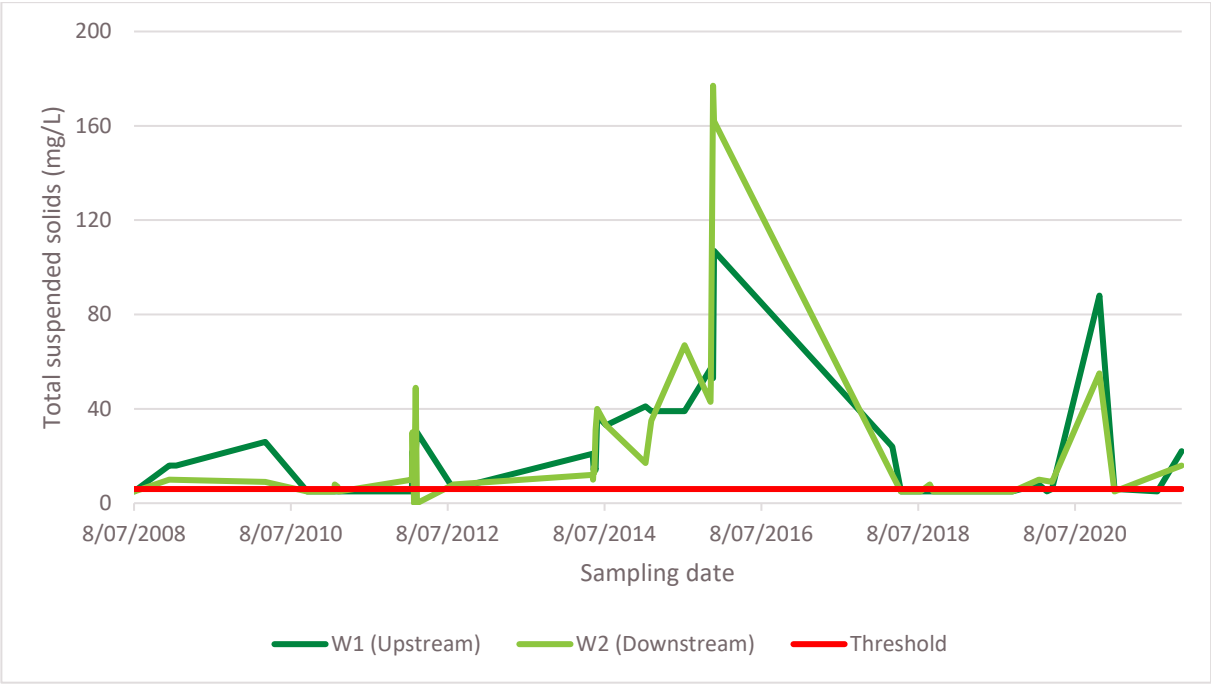

Figure 7 Surface water TSS concentration at W1 (upstream background) and W2 (downstream impact) compared to the WQO (<6 mg/L)

Since July 2015 pH levels have remained relatively consistent and the downstream pH has closely mirrored the upstream pH with no apparent material influence from the Murgon Operation. The pH upstream of the Murgon Operations is generally above the draft WQO range, but this appears the ambient pH in this part of the catchment.

EC measurements since 2016 have been compared against the EA threshold of <1000 µS/cm. EC has remained below the threshold limit for majority of the monitoring period with only two brief spikes above this threshold in June 2018 and September 2019. On each occasion the EC was lower at the downstream site W2 than upstream. At all other times, EC at the downstream site has closely mirrored the upstream EC with no apparent material influence from the Murgon Operation.

Analysis of total nitrogen (TN) since July 2008 shows that for the majority of the time period, the WQO threshold for TN (<0.25 mg/L) has been exceeded. This is due to upstream water quality and it likely influenced by agricultural activities and regulated flows in the catchment. On only one occasion in July 2013 was the TN markedly higher downstream than upstream. Since 2014, TN concentrations at the downstream site has closely mirrored those recorded upstream with no apparent material influence from the Murgon Operation.

TSS concentrations have fluctuated since July 2008 and may reflect the circumstances under which Murgon is required to undertake monitoring (high rainfall events that may result in discharge). Peak concentrations generally exceed the WQO threshold (<6 mg/L) which is to be expected in an agricultural and high regulated upstream catchment. Prior to 2016, downstream peak TSS concentrations exceeded those at the upstream site for three separate events. However, since 2016, TSS concentrations have been much lower and values recorded at the downstream site have closely mirrored those upstream TSS with no apparent material influence from the Murgon Operation.

After reviewing the water quality from W1 upstream background site against W2 downstream impact site, it has been concluded that there is no material impact due to on-going operations at Murgon and none would be expected following closure.

3.1.4.3. Flooding susceptibility

The site is located on the northern bank of Barambah Creek approximately 1.4 km downstream from the Bjelke-Peterson Dam. Major watercourses within the site and surrounding area include the Barambah Creek and Barker Creek (which is regulated by the Bjelke-Peterson Dam). Additionally, there are minor watercourses from the Burnett River basin which flow southerly towards site. Considering the proximity of waterways, a flood susceptibility model has been developed.

The model was developed by undertaking a review of publicly available flood assessments from The Queensland Globe, The Queensland Department of Resource Flood Check and The Australian Flood Risk Information Portal coupled with site specific catchment analysis. A digital elevation model (DEM) was generated to represent the topography of site and surrounding area compiled from a 1-section DEM from the Australia Government's spatial data hub. Sub-catchments were generated to determine the overland flow paths within the site and surrounding areas. It was determined there are three sub-catchments meeting at confluence of Barambah Creek and Barker Creek adjacent to the site which is considered to be a likely source of localised flooding. Further, the minor watercourse in the north-eastern section of the site diverges and eventually reach Barambah Creek. It is noted this watercourse can indirectly contribute to impacting the site when the creek is in flood. There is also an existing watercourse in the north-western section of the site which flow southerly adjacent the site before reaching Barambah Creek. This can carry water towards site, specifically in bigger events.

The Queensland Floodplain Assessment Overlay (QFAO) represents an estimate of areas potentially at threat of inundation by flooding (Queensland Reconstruction Authority 2013). A map showing this data layer over the project area is provided in Figure 8. This map shows that parts of the project area, including areas that will be rehabilitated, are potentially subject to flooding.

Through analysing the available flood information, it was concluded the site is expected to be partially flooded during a 1% Annual Exceedance Probability (AEP) flood event (Figure 9). This has the potential to affect the void, infrastructure and processing areas and a small section of the toe of the North-eastern Overburden Dump (but not the Northern Overburden Dump). Under a probable maximum flood (PMF), it is expected that site would be extensively flooded with large parts of the site impacted (Figure 10). Additionally, under a PMF scenario, the model was run with and without a scenario that included a failure of the Bjelke-Peterson Dam. There was no material difference to the flooding extent for site under the two scenarios.

Additional flood modelling has been undertaken (Pitt & Sherry, 2023, Appendix J) that validate the site is likely to be subject to periodic inundation events. This is further discussed in Section 3.5.2.

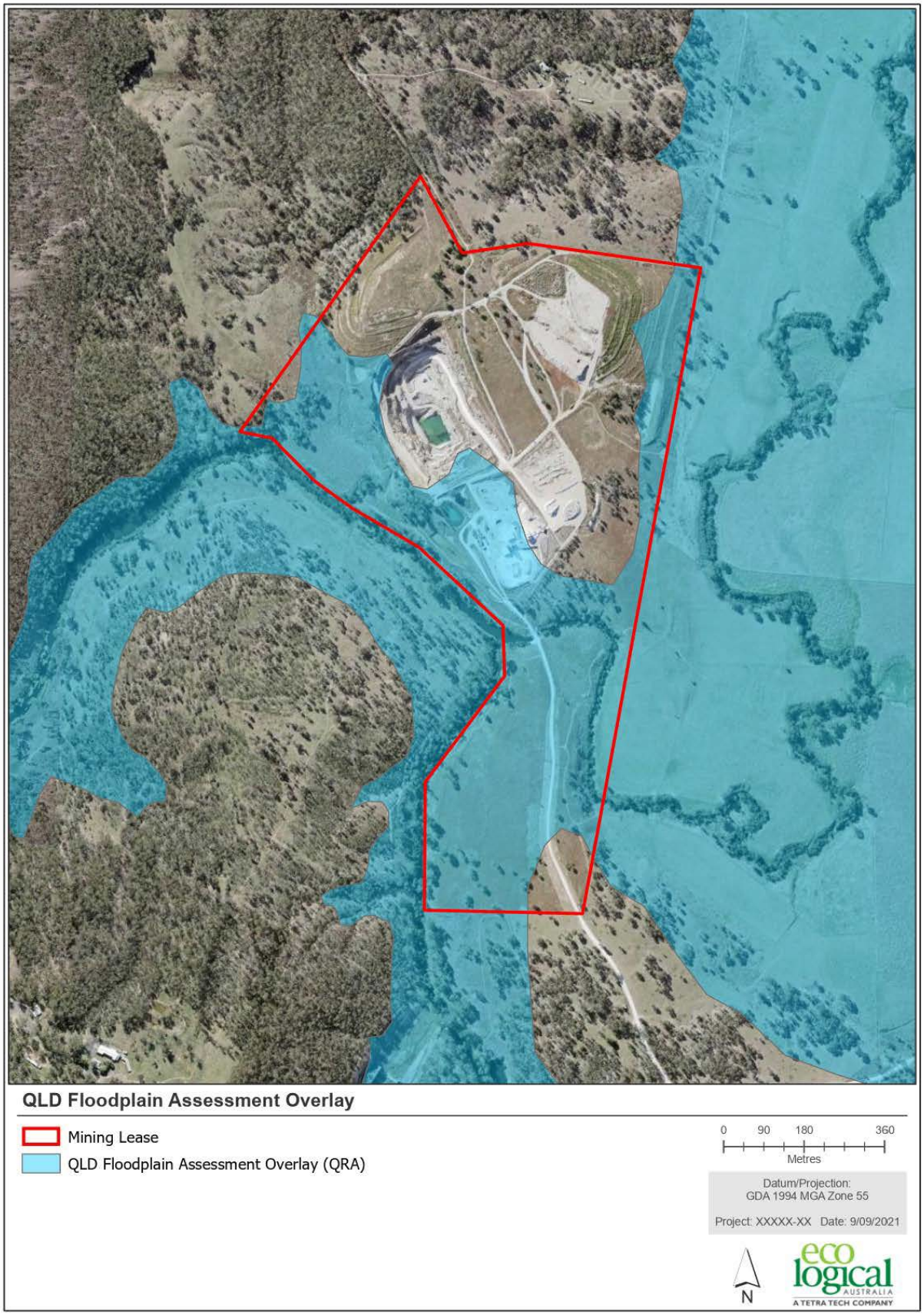

Figure 8 The extent of the Queensland floodplain assessment overlay in relation to the Murgon site

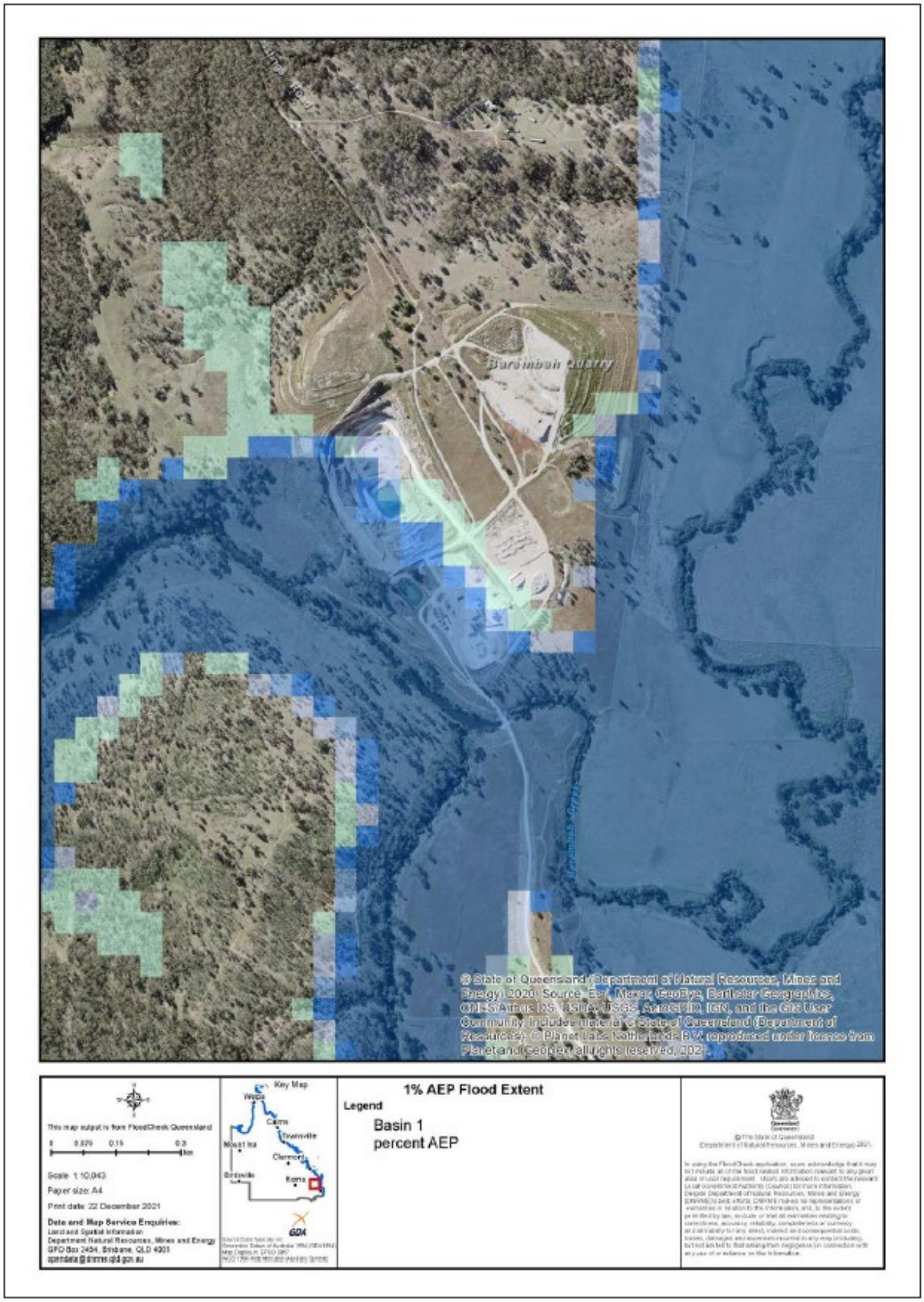

Figure 9 Predicted 1% AEP flood extent around the site where variants of blue blocks indicate depth of water

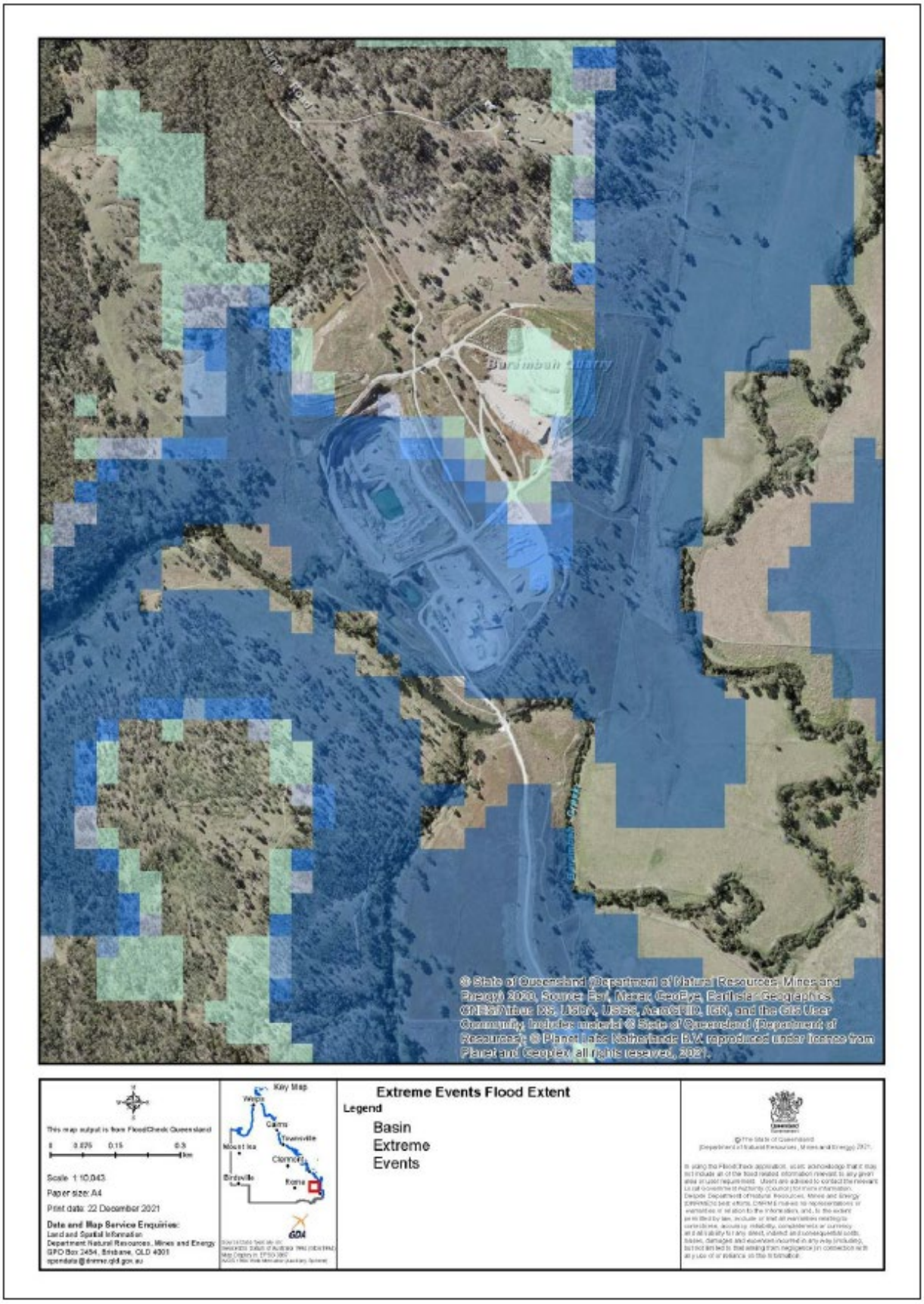

Figure 10 Predicted extreme events (approximation of PMF) flood extent where variants of blue blocks indicate depth of water

3.1.5. Groundwater

3.1.5.1. Hydrostratigraphy

Figure 11 shows the local geology around the Murgon project.

The limestone deposit is hosted by the Late Carboniferous Bjelke Petersen Beds which comprise mudstone, shale, and silicified (chert) containing locally sheared basic metavolcanic lenses and scattered limestone bodies. To the West of the Bjelke Petersen Beds are the Late Devonian to Early Carboniferous Maronghi Creek Beds, which comprise mudstone, shale, arenite, chert, jasper, acid to basic metavolcanics. To the East of the Bjelke Petersen Beds are the older Mid Triassic Esk Formation, consisting of polymictic pebble to boulder conglomerate, feldspathic sandstone, shale, minor acid tuff. To the East of the mining lease, the Esk Formation and sections of the Bjelke Petersen Beds are conformably overlain by Quaternary-age clay rich alluvium (Qa)) and clay-rich Tertiary-age sedimentary rocks (Ts). The Quaternary alluvium is also known as The Barambah Creek Alluvium in this area.

Unless substantially fractured, the rock formations (Esk, Maronghi and Bjelke Petersen) are unlikely to host significant volumes of groundwater or allow the transmission of significant groundwater flows. There are localised fractures (joints) exposed in the pit walls that allow small seepages as mentioned in section 3.1.5.2. Furthermore, "overall pit seepage is likely to be governed by flows from all the geological units surrounding the site" (ERM 2008).

ERM (2008) note that "Conservatively assuming that the limestone unit at the site is localised and approximates an area of 20 hectares and that recharge to groundwater ranges between 5 and 15% of average annual rainfall, it can be expected that rainfall recharge into the limestone aquifer system would approximate 20 to 60 m^3/day which suggests that pit seepage is likely to be primarily derived from rainfall recharge into the local limestone groundwater system. Due to the shape and dimensions of the limestone deposit being exploited it is likely that there are limited locations (likely to be to the south of the site) where the limestone unit sub-crops beneath the Barambah and Barker Creeks. These zones, while isolated are likely to represent the zones of greatest potential for a direct hydraulic connection between the creeks and groundwater within the limestone deposit".

3.1.5.2. Geological structures

The site is located within the Bjelke Petersen Beds (Figure 11). NW-NNW and NE-NNE Faults cross-cut site stratigraphy and are the primary mechanism for the plunge reversals evident in the quarry, Atkinson and further south. The fractured-rock groundwater system at Murgon (which causes minor pit seepage) is hosted by a fracture zone of limited extent and recharged by a localised fracture network.

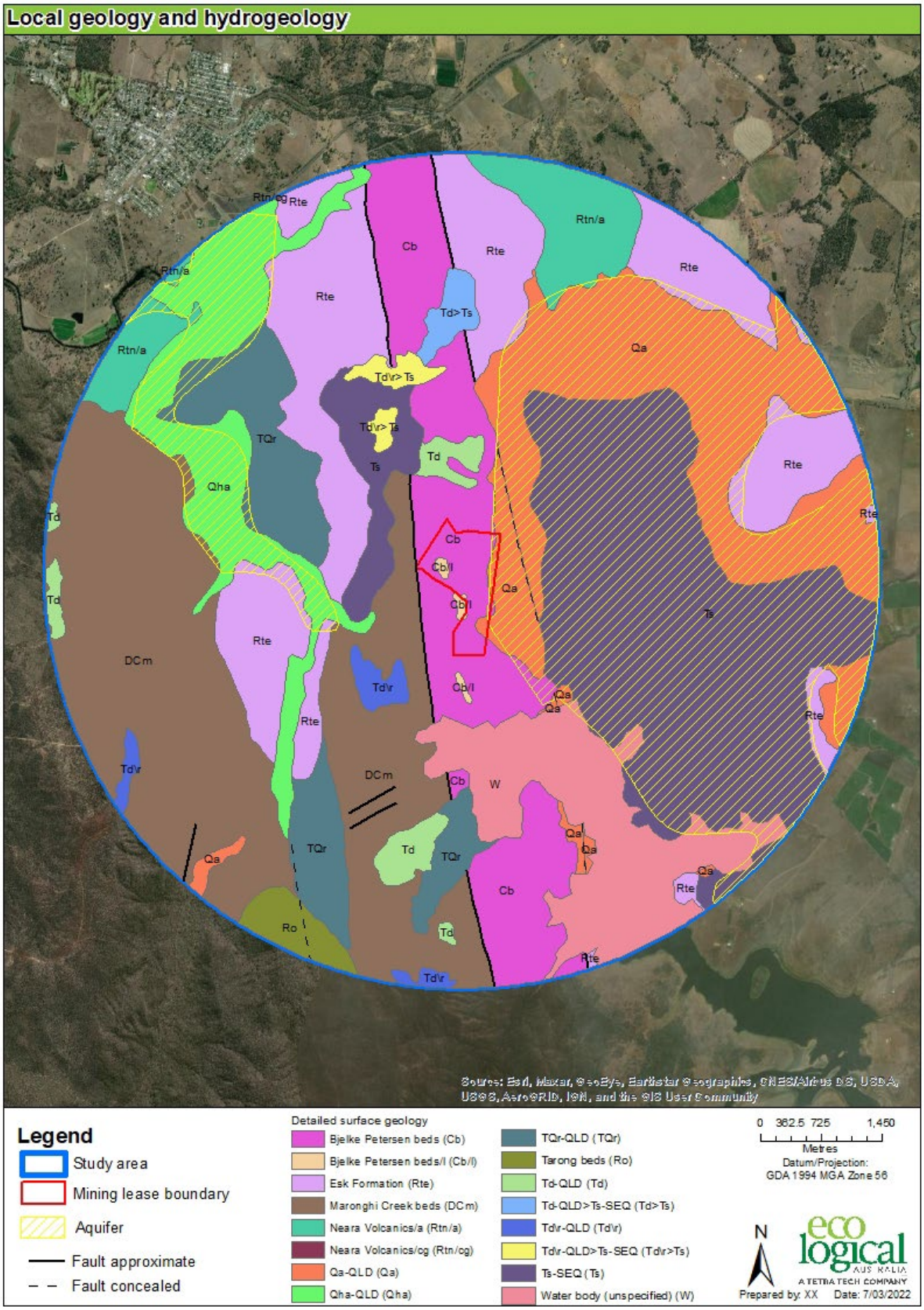

Figure 11 Regional geology and hydrogeology (see Table 3 for more details of the geology referenced in the legend)

Table 3 More information about detailed surface geology shown on Figure 11

Legend	Lithological Summary	Dominant Rock	Rock Type	Age
Ts-SEQ (Ts)	Quartzose to sublabile sandstone, claystone, conglomerate, minor olivine basalt	Sedimentary rock	Stratified unit (including volcanic and metamorphic)	Tertiary
Qa-QLD (Qa)	Clay, silt, sand and gravel; flood-plain alluvium	Alluvium	Stratified unit (including volcanic and metamorphic)	Quaternary
Bjelke Petersen beds (Cb)	Mudstone, shale, and silicified (chert?) containing locally sheared basic metavolcanic lenses and scattered limestone bodies	Mixed sedimentary rocks and mafites	Stratified unit (including volcanic and metamorphic)	Late carboniferous
Bjelke Petersen beds/l (Cb/l)	Variably recrystallised, poorly fossiliferous limestone	Carbonates (limestone or dolomite)	Stratified unit (including volcanic and metamorphic)	Late carboniferous
Qha-QLD (Qha)	Sand, gravel, silt and clay; active stream channels and low terraces	Alluvium	Stratified unit (including volcanic and metamorphic)	Holocene

3.1.5.3. Registered bores

Interrogation of the Bureau of Meteorology (BoM) Groundwater Explorer online database (BOM 2020) identified 59 bores that were within a 5 km radial extent of the Operation (Figure 13). Each of these bores had an assigned number and associated bore report (Business Queensland 2021). The following sections summarise the information contained in these bore reports.

Two site bores, MUR01 (South Bore) and MUR02 (North Bore) are not registered with the Department of Natural Resources and Mines (DNRM), and there is little data regarding their construction. These bores are used by site personnel to record local water levels and water chemistry.

3.1.5.4. Regional groundwater level

Water level data are available from the BoM Groundwater Explorer database for 7 of the 59 bores (Figure 13). Table 4 and Table 5 presents details of the seven bores including a summary of water levels. There is no applicable data from the BoM Groundwater Explorer database for the remaining 52 bores.

Table 4 Status and data availability of registered bores with water level within the study area

Bore ID	Bore purpose	Status	Start of record	End of record
13620103	Unknown	Decommissioned	1973	1993
13620104	Unknown	Decommissioned	1973	1992
13620300	Monitoring	Functional	1975	Ongoing
13620301	Unknown	Decommissioned	1975	2002
13620302	Unknown	Decommissioned	1975	2004
13620335	Monitoring	Functional	2006	Ongoing
13620336	Monitoring	Functional	2006	Ongoing

Table 5 Registered bores with water level data within the study area

Bore ID	SWL (mbgl)	Bore depth (m)	RSWL (m AHD)	Top aquifer (m AHD)	Measured date	Formation name	Aquifer lithology
13620103	14.22	12.9	Unknown	10.00	01/01/1993	Barambah Creek Alluvium	GRAV - Gravel
13620104	4.80	14.1	Unknown	10.00	12/05/1992	Barambah Creek Alluvium	GRAV - Gravel SAND - Sand
13620300	4.76	11.5	290.88	5.20	20/02/2020	Barambah Creek Alluvium	GRAV - Gravel
13620301	3.20	6.0	Unknown	Unknown	14/02/2002	Unknown	Unknown
13620302	3.76	12.2	Unknown	12.00	27/10/2004	Barambah Creek Alluvium	GRAV - Gravel
13620335	4.04	19.5	294.4	Unknown	07/09/2021	Unknown	Unknown
13620336	5.22	14.3	286.59	Unknown	07/09/2021	Unknown	Unknown

The depth of the bores with recent depth readings ranged from 4.04 to 5.22 (mbgl). All bores were screened with Barambah Creek Alluvium Formation aquifer. Groundwater level readings taken from the alluvial aquifer system show a range between 286.59 and 290.88 m AHD within the Barambah Creek Alluvium Formation. No flow data was available for these bores.

The existing bores that show water level data, are all screened within the Barambah Creek Alluvium, and are a significant distance (>2km) from the site. No water level data is recorded for bores screened in other rock types or aquifers. The water level data in Table 5 were collected at the time of drilling and are many years apart in most cases. Therefore, it is not possible to determine water level contours for the site, and for each aquifer type, or the region or derive groundwater flow directions.

In Figure 17, there are six bores located in a line on the Eastern side of the mining lease. These bores intersect clay-rich Barambah Creek Alluvium to depth of about 15 metres. Although alluvium is used as a water source some distance away, no groundwater was recorded during drilling of these six holes. Since the Barambah Creek Alluvium occurs along the Eastern side of the mining lease it is unlikely that the alluvium will contribute to pit inflows. Given the higher elevation of the Barambah Creek Alluvium, compared to historic seepages in the pit, it is certain that the final pit void will not discharge to the alluvium.

Water level readings within groundwater bores MUR 01 (South Bore) and MUR 02 (North Bore) (shown in Figure 13) have been recorded between 18/11/2016 and 17/10/2019.

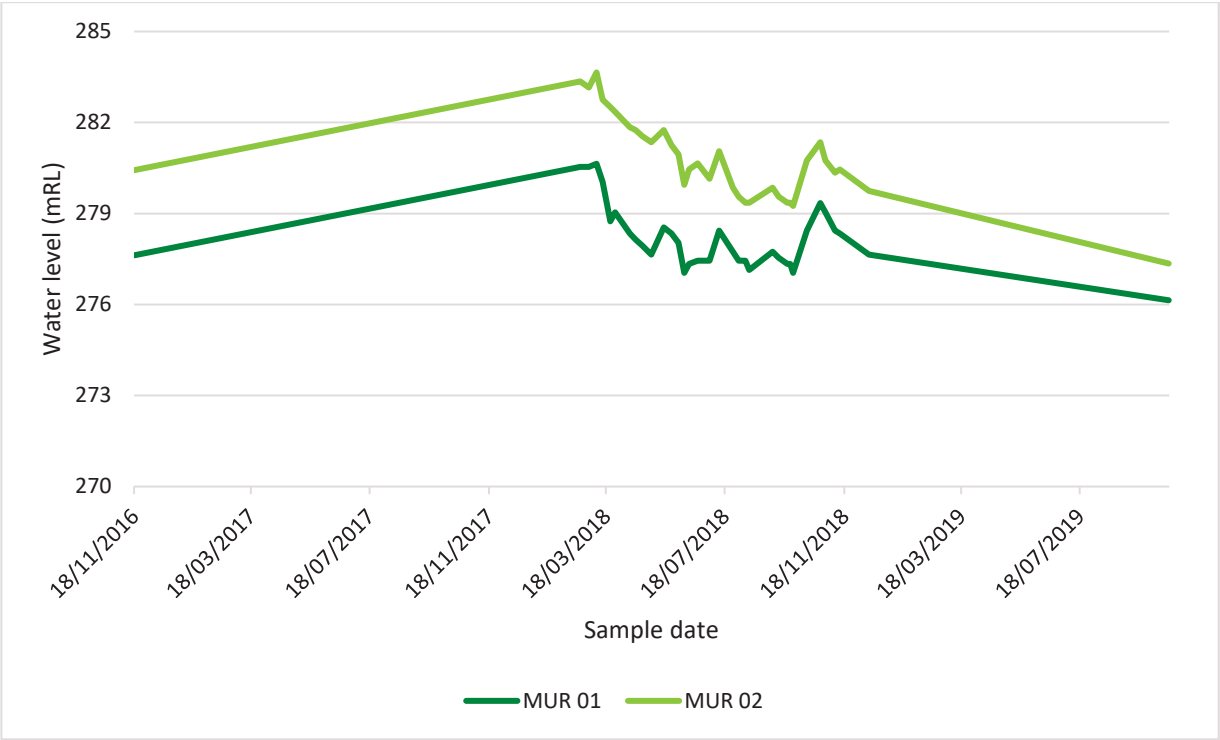

Figure 12 Changes in the groundwater levels within bores

There is no strong seasonal trend in the data and groundwater levels remained reasonably stable through the monitoring period, although there is a slight overall downward trend between 2016 and 2019. The water levels in these two bores are strongly influenced by pumping from the pit sump.

Bores MUR01 and MUR02 are collared on the Western side of the mine pit at similar elevations, although the water level data is different between them by an average of about 3 metres. This is likely to be a calculation error rather than reality given that the two bores are a similar depth and presumably screened in the same fractured-rock aquifer. Water levels would be expected to decline further only if the void is deepened and water continues to be pumped out to small-scale seepages and extracted into Dam C.

According to a report by Rocktest Consulting (2022; Appendix I) water constantly seeps from the 258-270mRL batter on the western wall. The pit is therefore a passive hydraulic sink. Also, at the EOML [end of mine life], inflows will no longer be pumped out of the pit. The level of water within the pit will subsequently increase progressively to form a pit lake. The upper surface of the lake will stabilise at an elevation where its open water surface area is large enough such that the evaporation losses from the surface and other outflows equal the combined inflows. This elevation will likely be below the pre-mining groundwater level. The surface of the [EOML] lake is expected to stabilise at ~275mRL.

The final pit void will likely remain a groundwater sink.

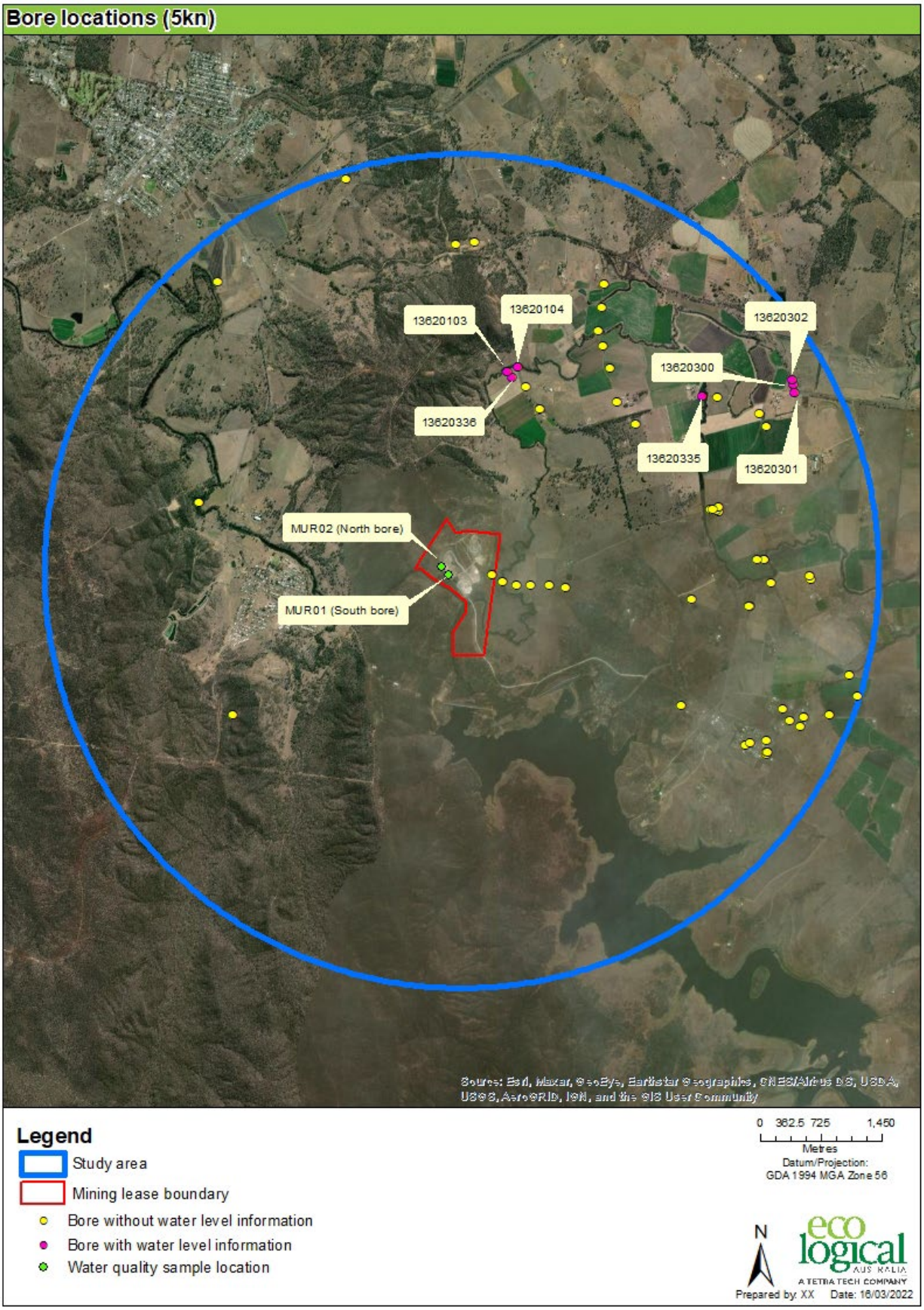

Figure 13 Registered bores within the study area and the groundwater level reading locations

3.1.5.5. Groundwater quality

The BoM groundwater explorer (BoM 2020) identified seven bores within the study area screened into the Barambah Creek Alluvium. Water quality data was available for three functional bores. Groundwater salinity (EC) for the three functional bores ranges from 813 to 4,780 µS/cm and pH ranges between 6.1 and 7.8.

Water quality data is available for the North bore (MUR02) and South bore (MUR01) as well as from the Pit (seepage derived) and Dam C (which received pumped pit seepage) shown on Figure 14. The results of the quality analysis for two sampling rounds of July 2021 and November 2021 are summarised in Table 6. The two bores, the Pit and Dam C are not located within a recognized the aquifer boundary (Figure 14).

The results of the quality analysis of a wider range of compounds undertaken in February and March 2022 are summarised in Table 7.

Groundwater salinity (EC) for the two bores, Pit and Dam C ranges between 270 and 1,030 (µS/cm) and pH ranges between 7.6 and 8.5.

ERM (2008) previously characterised the water from the mine sump (which is fed by groundwater seepage) as calcium-sodium-chloride-bicarbonate dominated (reflecting the surrounding geology) and the water in Barambah Creek as sodium-magnesium-chloride dominated. ERM (2008) concluded that groundwater seeping into the void is unlikely to be sourced directly from Barambah Creek, rather it reflects water derived from rainfall recharge into the local limestone groundwater system. The water quality results presented in Table 6 and Table 7) are in broad agreement with these findings.

None of the concentrations of groundwater quality indicators is of concern for the protection of groundwater EVs as presented in Section 3.1.5.7.

Table 6 Analytical results of the water quality measurement (July and November 2021)

Compound	Unit	Pit		Dam C		North bore		South bore	
		July 2021	Nov 2021	July 2021	Nov 2021	July 2021	Nov 2021	July 2021	Nov 2021
pH Value	Ph Unit	8.18	8.09	8.55	8.02	No data	6.19	No data	7.76
Electrical Conductivity	µS/cm	841	599	435	455	No data	390	No data	314
Oil and Grease	mg/L	<5	5	<5	<5	No data	<5	No data	<5
Total Suspended Solids	mg/L	<5	<5	11	12	No data	22	No data	16
Calcium	mg/L	84	60	24	34	No data	20	No data	20
Total Nitrogen as N	mg/L	3.7	7.4	0.7	3.4	No data	1.4	No data	1.3
Nitrite + Nitrate as N	mg/L	3.67	6.23	0.28	2.62	No data	0.19	No data	0.19
Total Kjeldahl Nitrogen as N	mg/L	<0.5	1.2	0.4	0.8	No data	1.2	No data	1.1

Table 7 Analytical results of the water quality measurement (February and March 2022)

Compound	Unit	Pit		Dam C		North bore		South bore	
		July 2021	Nov 2021	July 2021	Nov 2021	July 2021	Nov 2021	July 2021	Nov 2021
pH Value	pH Unit	8.22	7.98	8.49	7.54	8.10	8.18	7.64	8.17
Electrical Conductivity	µS/cm	551	560	270	247	323	372	1030	733
Suspended Solids	mg/L	10	9	25	10	<5	8	6	<5
Hydroxide Alkalinity as $CaCO_3$	mg/L	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as $CaCO_3$	mg/L	<1	<1	10	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as $CaCO_3$	mg/L	112	117	85	66	175	192	286	182
Total Alkalinity as $CaCO_3$	mg/L	112	117	96	66	175	192	286	182
Sulfate as SO_4	mg/L	29	27	4	6	1	1	34	23

Compound	Unit	Pit		Dam C		North bore		South bore	
Chloride	mg/L	94	84	33	15	5	8	168	122
Calcium	mg/L	45	53	24	25	26	32	48	40
Magnesium	mg/L	13	12	6	4	11	12	26	19
Sodium	mg/L	56	49	30	16	35	34	145	144
Potassium	mg/L	1	1	2	2	<1	<1	2	2
Arsenic	mg/L	<0.001	<0.001	0.001	0.001	<0.001	<0.001	0.002	0.002
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001
Copper	mg/L	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Nickel	mg/L	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005
Nitrite + Nitrate as N	mg/L	3.41	3.53	0.11	7.89	1.01	0.60	0.22	0.24
Total Kjeldahl Nitrogen as N	mg/L	0.6	0.7	0.6	1.0	<0.1	0.3	0.2	0.2
Total Nitrogen as N	mg/L	4.0	4.2	0.7	8.9	1.0	0.9	0.4	0.4
C6 - C9 Fraction	µg/L	<20	<20	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	<100	<100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	<50	<50	<50	<50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	<50	<50	<50	<50	<50	<50	<50	<50
Sum of BTEX	µg/L	<1	<1	<1	<1	<1	<1	<1	<1
Naphthalene	µg/L	<5	<5	<5	<5	<5	<5	<5	<5

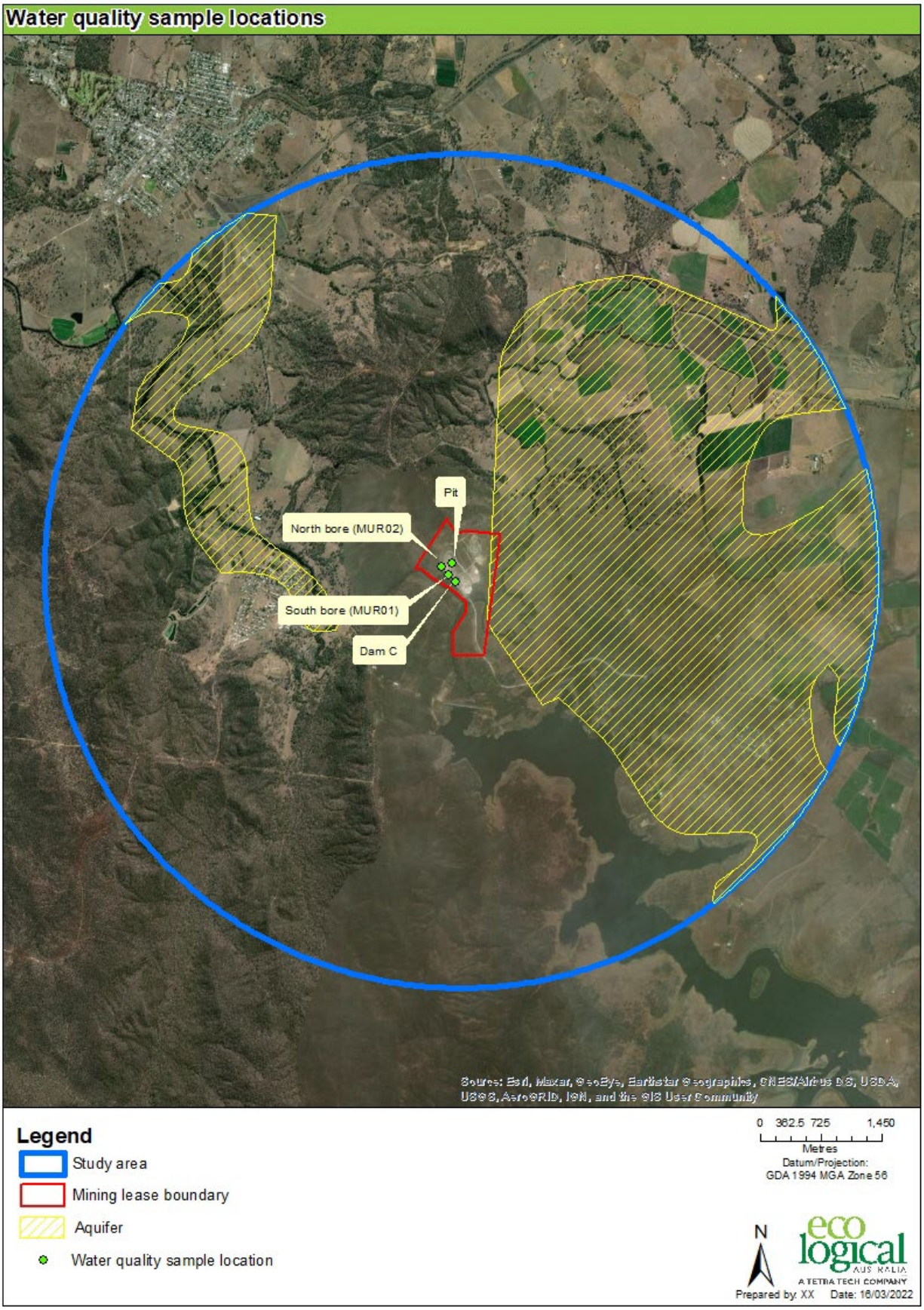

Figure 14 Changes in the groundwater levels within bores

3.1.5.6. Groundwater Use

ON-SITE

The site's water supply bore is screened within the Barambah Creek alluvium and as such its water elevations are more likely to be hydraulically controlled by flows within Barambah Creek.

Seepage of groundwater occurs on a consistent basis from the surrounding geology into the mine pit. The groundwater seepage into the mine pit void is subsequently pumped from the mine pit to Dam C.

As part of the groundwater hydrology assessment (ERM 2008), measurements were made to quantify the rate of seepage into the mine pit. Four flow tests were completed to obtain an estimate of the pumping rate from the pit, which gave an average and relatively consistent discharge rate of 14.4 L/s. The pump in the pit is generally turned on for two hours every two days. This results in an estimated rate of groundwater seepage into the pit and subsequent discharge to Dam C of 52 m^3/day (approximately 0.6 L/s continuously). Additional monitoring of the discharge rates from the mine over an extended period suggests this is a reasonable estimate of seepage rates.

OFF-SITE

There are 59 registered bores within 5 km of the site, of these bores only three of which are still in use. The remainder have been abandoned and/or destroyed. Of the four wells that are currently in use, all are in the vicinity of Barambah Creek and are screened within the Barambah Creek alluvium. The closest well which is still in use (well 191396) is approximately 1.8 km from the mine lease (ML).

Given that the distance to well 191396 from the site, that the well is screened within the Barambah Creek alluvium and that the limestone deposit present at the site is unlikely to extend to this well, it is considered unlikely that there is a hydraulic connection between the well and the mine void.

3.1.5.7. Environmental values and water quality objectives

ENVIRONMENTAL PROTECTION (WATER AND WETLAND BIODIVERSITY) POLICY 2019

The Environmental Protection Act 1994 and the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 — the EPP (Water and Wetland Biodiversity) — provide the framework for developing EVs, management goals and WQOs for Queensland waters. Schedule 1 of the EPP (Water and Wetland Biodiversity) lists the EVs and WQOs for Queensland waters. These are a part of the legislation and therefore considered by planners and managers when making decisions about waters and/or water quality.

WATER QUALITY IMPROVEMENT PLANS

Water quality improvement plans (WQIPs) for catchments draining to the Great Barrier Reef were initially prepared by Regional natural Resource Management (NRM) Bodies and Councils under the Australian Government's Coastal Catchments Initiative. As part of the development of the WQIPs, stakeholders ensured that the EVs and WQOs established were consistent with the (then) Environmental Protection (Water) Policy 2009 requirements.

Neither the *Water Quality Improvement Plan for the Burnett Mary Region* (WQIP) (BMRG NRM 2015) nor the EPP (Water and Wetland Biodiversity) 2019 contain groundwater-related EVs and WQOs over the site catchment area.

While the updated National Water Quality Guidelines (ANZG 2018) include default guideline values for physical and chemical stressors, local water quality information still applies as the first reference point. In Queensland. However, in the absence of EPP (Water and Wetland Biodiversity) scheduled values, guidance is taken from the Queensland Water Quality Guidelines (DEHP 2009). DEHP (2009) states that "These guidelines do not specifically address groundwater" and direct the reader to the previous version of the National Water Quality Guidelines (ANZECC & ARMCANZ 2000) for guidance of the application of EVs and WQOs to groundwater.,

As the groundwater affected by mining is not connected to surface waters around the operation, the most applicable EVs relate to the protection of raw water supply and primary industries use. The primary industries EV also aligns with the intended PMLU for the operation (water storage for stock water use). The guideline values and WQOs applied to the assessment of ground water quality relate to these EVs.

APPLICABLE 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.

Recent water quality data presented in (Table 7) indicates that physical and chemical characteristics in groundwater (including water in or pumped from the void) within the mining lease currently meets the drinking water and stock water quality guidelines (Table 8) and would be expected to meet the guidelines post-mining.

Table 8 The guideline values for physical and chemical characteristics applicable to groundwater at Murgon (NHMRC 2011 ANZECC & ARMCANZ 2000) compared to the maximum values recorded in analysis conducted in 2022

Water quality indicator	Unit	ADWG values		Stock water guidelines	Pit	Dam C	North bore	South bore
		Health	Aesthetic					
pH Value	pH Unit	NA	6.5 – 8.5	NA	8.22	8.49	8.18	8.17
Electrical conductivity	µS/cm	NA	938#	5,970	560	270	372	1,030
Chloride	mg/L	NA	250	NA	94	33	8	168
Sulfate (as SO_4)	mg/L	NA	250	1,000	29	4	1	34
Nitrate*	mg/L	50	NA	30	15	0.5	4.5	1.0
Arsenic	mg/L	0.01	NA	5	<0.001	0.001	<0.001	0.002
Cadmium	mg/L	0.002	NA	0.01	<0.0001	<0.0001	<0.0001	<0.0001
Copper	mg/L	2	1	1	0.001	<0.001	<0.001	0.001
Lead	mg/L	0.01	NA	0.1	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.02	NA	1	0.001	0.001	<0.001	<0.001
Sodium	mg/L	NA	180	NA	56	30	35	145
Zinc	mg/L	NA	3	20	<0.005	<0.005	<0.005	0.005

This is for good quality water and EC > 1,875 µS/cm is considered unacceptable.

* Water quality data related to nitrate plus nitrite N and has been converted.

3.1.5.8. Groundwater modelling works

There was insufficient data available to develop a groundwater model or to develop water level contour maps for the Murgon Operation. However, a numerical groundwater model capable of predicting contaminant migration would not necessarily be required at Murgon given the absence of groundwater contaminants in the pit waters and the lack of significant contaminant sources or geochemically reactive minerals in the void walls. Furthermore, the evidence supports relatively low groundwater flows and minimal flows into the mine void. The risk to groundwater quality posed by the presence of the void or a pit lake are negligible.

3.1.6. Pre-mining and current surrounding land use

Historic aerial images show that the site had been predominantly cleared of native vegetation and was being used for agriculture (grazing) as far back as 1951 (see Figure 15) and that mineral extraction at the site had started by 1993 (Figure 16).

A number of land-uses have been mapped within and surrounding the project area as shown in Figure 17. Apart from mining, the dominant land use in the surrounding areas is production (agricultural) from relatively natural environments (grazing on native pastures), and a small area of conservation land-uses (Queensland Government 2019).

Figure 15 An aerial photo of the project area from 1951 (source: https://qimagery.information.qld.gov.au)

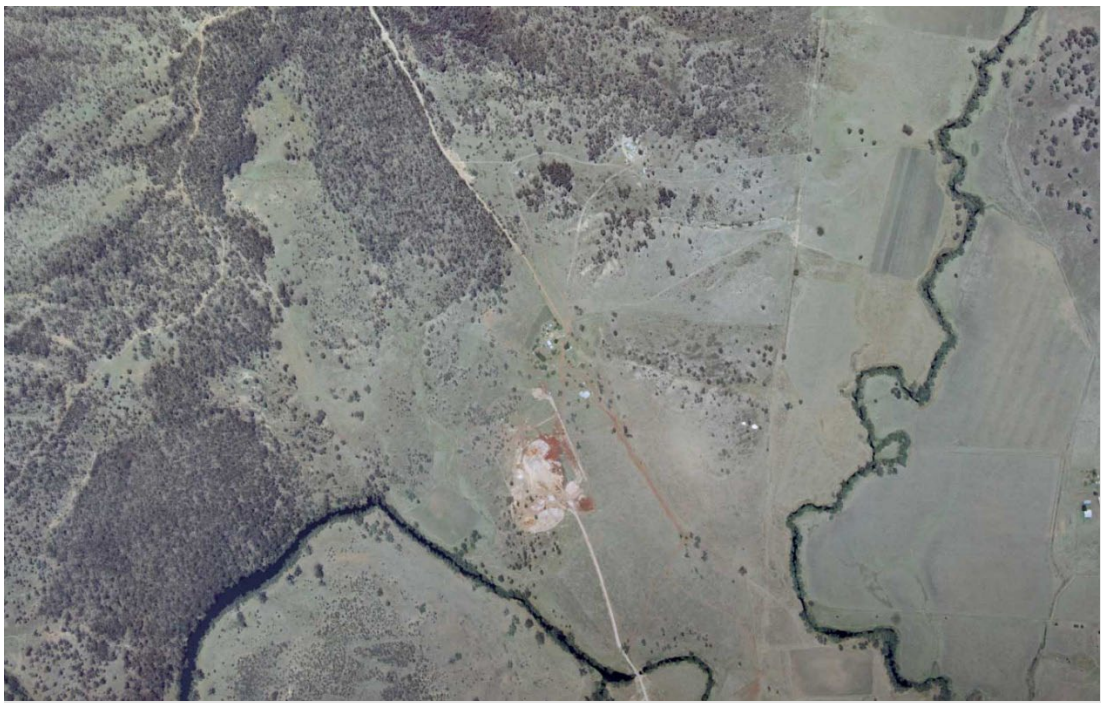

Figure 16 An aerial photo of the project area from 1993 (source: https://qimagery.information.qld.gov.au)

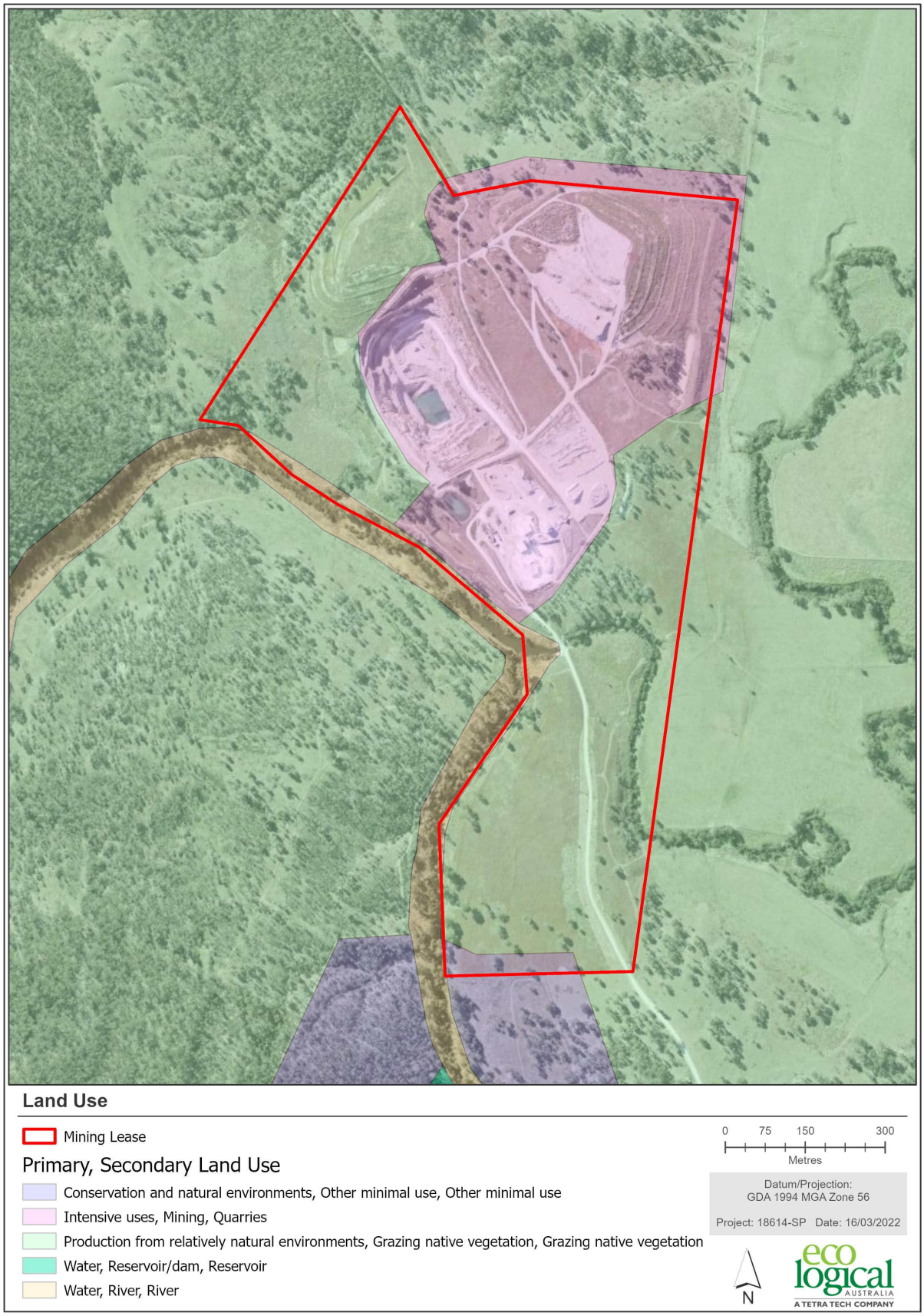

Figure 17 The land-uses surrounding the Murgon ML (Source: Queensland Government (2019))

3.1.7. Soil properties and productivity

Land system information is available for the project area (DNR 1998) (Figure 18). The majority of the ML area (and the main disturbance footprint) is located on mapping unit Re1 which occupies level to gently undulating terrain on the Esk formation. The major soils are described as shallow to moderately deep texture contrast soils with dark brown to yellowish brown clay subsoils (solodics and soloths, minor prairie soils) with dark cracking clays (black earths) on valley floors. Based on the underlying geology and the descriptions of topsoils used in rehabilitation, the main soils disturbed by mining activities are expected to be 'prairie soils' (Dermosols under the current Australian Soil Classification System).

A small section in the south-east of the ML, where the access road is located, in on unit Qa1 occurs on slightly undulating plains of recent alluvia with associated terraces and swales of rivers and creeks. The major soils are described as deep, dark cracking clays (black earths and alluvial soils) with minor areas of texture contrast soils with brown or yellowish-brown clay subsoils (solodic and solodized solonetz).

A small section of the north-west ML in on unit code Rn1 on gently undulating to low hilly terrain on Neara Volcanics. This has not been and is not expected to be disturbed by mining. The major soils are described as moderately deep to deep, dark and brown cracking clays (black earths and brown clays) with areas of gradational and texture contrast soils with brown clay subsoils (solodics and soloths).

The Land Capability mapping (DPI 1982) indicates that the different land systems mapping units have different qualities and suitability for agricultural use.

- Mapping Unit Re1 (where the majority of rehabilitation will occur) is given a suitability class 6 (equivalent to Land Capability Class V to VI). The main limitations are moderate depth, moisture availability and physical properties. The land is described as having a moderate to severe water erosion risk and minor rockiness and stoniness limitation. Limited areas are suitable for cropping, but the land is suitable for grazing on native and improved pastures (reflected in the existing land use in the area).
- Mapping Unit Rn1 is given a suitability class 2b (equivalent to Land Capability Class II-III). The land has slight to moderate erosion limitations as well as slight workability and microrelief limitations. The land is suitable for annual cropping (with appropriate soil conservation) and grazing on native and improved pastures.
- Mapping Unit Qa1 is given a suitability class 1 (equivalent to Land Capability Class II). The land has slight physical property as well as minor periodic flooding and water logging limitations. The land is suitable for annual cropping (including irrigated cropping) and grazing on native and improved pastures.

The equivalent Land Capability Classes are described below (DSITI & DNRM 2015):

- Class II - Land suitable for all agricultural uses but with slight restrictions to use for cultivation
- Class III - Land suitable for all agricultural uses but with moderate restrictions to use for cultivation
- Class V – Land that in all other characteristics would be arable but has limitations that make cultivation impractical and/or uneconomic
- Class VI – Land that is not suitable for cultivation but is well suited to pastoral use and on which pasture improvement involving the use of machinery is practicable.

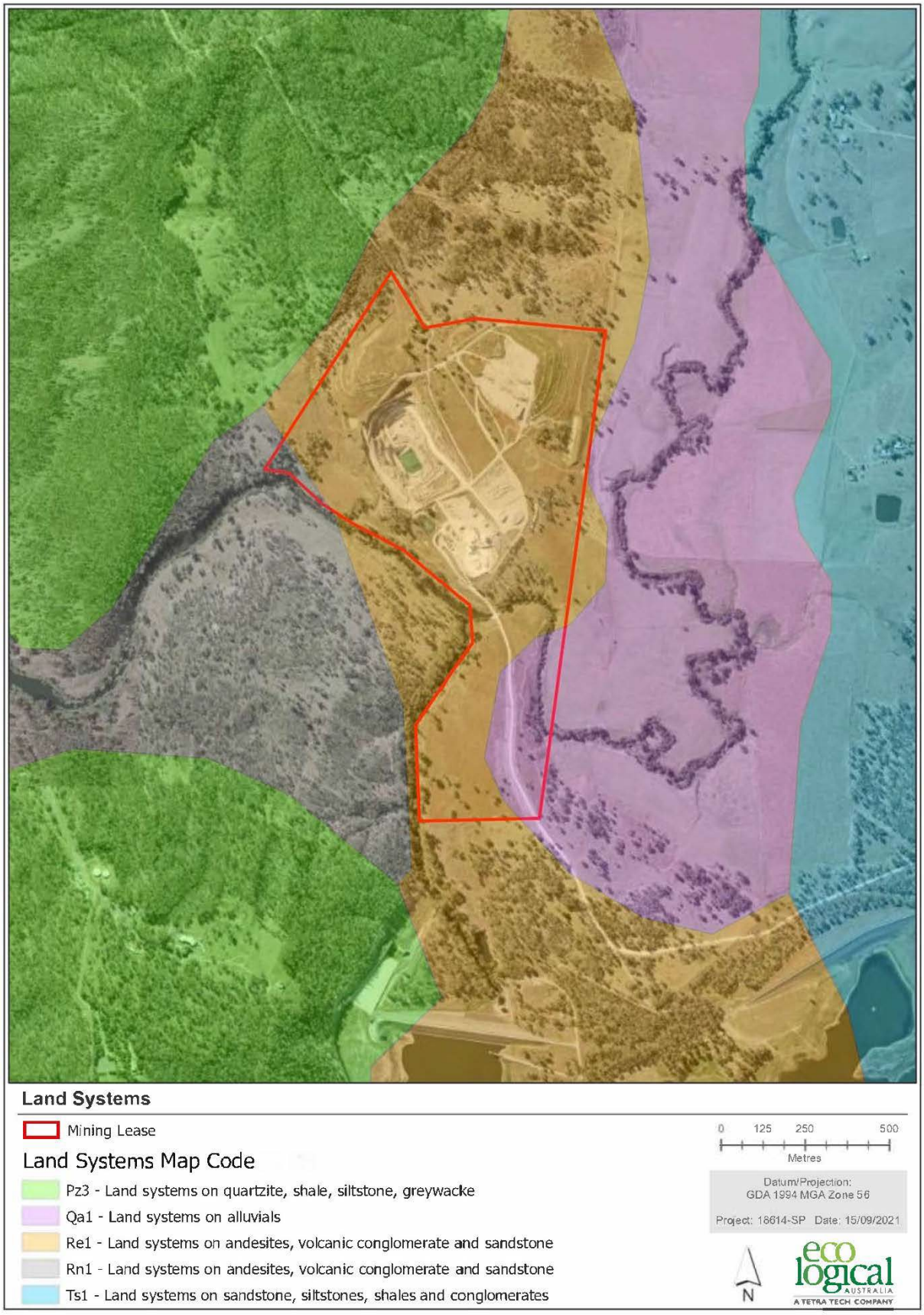

Figure 18 The land systems around the project area (source: Queensland Government 2020b)

3.1.7.1. Land stability

Although descriptions in the land evaluation mapping suggests that soil erosion may be an issue at the project site, aerial imagery (provided in Section 3.1.6) does not indicate widespread soil stability or erosion issues in areas under pasture. Soil analysis conducted for the stockpiled topsoil and used for the rehabilitation of the overburden dumps shows it to be non-sodic and with a low dispersion index (see Section 3.5.3.1). No significant soil stability issues are expected to limit rehabilitation efforts at Murgon.

3.1.8. Ecological values

The site is located in an area that has been extensively cleared for agricultural activities. The Mine Ecological Assessment (URS 2008) revealed a highly impacted environment with relatively low environmental integrity following the site's long-term use as grazing land. This had resulted in the land being cleared and non-native pastures established. However, a number of significant environmental values were identified in the riparian areas of Barambah and Baker Creeks. Two stands of non-riparian remnant eucalypt woodland were found to be scattered in the north and northwest of the site.

Searches by URS (2008) found records of 95 plant species associated with the three lots over which the mining lease extends. Of these, two were recorded as rare in Queensland at the time:

- *Indigofera baileyi* (Bailey's Indigo) - a perennial herb
- *Callitris baileyi* (Bailey's Cypress Pine) - A pine growing to 18 m in height, found on rocky, hilly or mountainous areas, usually near creeks, and on shallow and often clay soils.

A recent search of the Queensland herbarium has found amended status of *Indigofera baileyi* to "least concern" in reference to the *Nature Conservation Act 1992* and is no longer listed under conservation significance (Queensland Government 2022a). The status of *Callitris baileyi* is now listed as "near threatened" and remains listed under conservation significance (Queensland Government 2022b).

An updated review of conservation values was undertaken for the preparation of the PRCP. According to the Queensland Government Regional Ecosystem (RE) mapping (Queensland Herbarium 2019), there are no areas of mapped remnant vegetation on ML 50111. However, there are patches of Category B remnant vegetation and Category C High Value Regrowth in the surrounding landscape (Figure 19). Additionally, Category R regrowth watercourse vegetation is present along the creek banks and overland flow line adjacent to some existing disturbance areas.

A search of the Commonwealth Environmental Protection and Biodiversity Conservation (EPBC) Act Protected Matters Database (DAWE 2022) identified three threatened ecological communities within 2 km of the site, being:

- Poplar box grassy woodland on alluvial plains (endangered)
- Lowland rainforest on subtropical Australia (critically endangered)
- White box-yellow box-blakely's red gum grassy woodland and derived native grassland (critically endangered).

Additionally, potential habitat for 11 threatened flora species was also identified within 2 km of the site using the Protected Matters Database. One of these species, *Phebalium distans* (Mt Berryman phebalium), is listed as critically endangered under the EPBC Act and endangered under the NC Act. The

species *Cossinia australiana* is listed as endangered under both the EPBC Act and NC Act. The remaining species are listed as vulnerable under both the EPBC Act and NC Act (except *Dichanthium setosum* which is least concern under the NC Act). WildNet database searches were conducted to confirm the presence of these species within 2 km of the site. A likelihood of occurrence assessment was conducted and all of these species are unlikely to occur in or around the project area, as shown in Table 9.

Table 9 Threatened flora likelihood of occurrence assessment

Scientific name	Common Name	EPBC Act Status	NC Act Status	Habitat description	Likelihood	Justification
Anthraxon hispidus	Hairy-joint grass	V	V	In or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps, as well as woodland.	Unlikely	No WildNet records exist within a 2km radius of the project area.
Cadellia pentastylis	Ooline	V	V	Occurs in a range of vegetation types including semi-evergreen vine thicket, brigalow-belah, poplar box and bendee communities. Ooline often occurs on the edges of sandstone and basalt escarpments, 200 to 500 m above sea level.	Unlikely	No WildNet records exist within a 2km radius of the project area.
Cossinia australiana	Cossinia	E	E	Prefers ecotonal situations around dry rainforest edges, although it also occurs as scattered individual plants within closed forest communities. It grows in araucarian microphyll vine forest and relict semi-evergreen vine thicket on a variety of soils, including red volcanic soil and black loam.	Unlikely	No WildNet records exist within a 2km radius of the project area.
Denhamia parvifolia	Small-leaved Denhamia	V	V	Found in vineforests and semi-evergreen vine thickets (softwood and brigalow scrub), , commonly on basalt-derived, brown or red soils above 300 m altitude.	Unlikely	No WildNet records exist within a 2km radius of the project area.
Dichanthium setosum	Bluegrass	V	LC	Occurs in heavy soils (predominantly cracking clays or alluvium, often in gilgai) in woodland or open woodland usually dominated by Acacia (brigalow) and/or Eucalyptus species.	Unlikely	No WildNet records exist within a 2km radius of the project area.
Haloragis exalata subsp. Velutina	Tall velvet sea-berry	V	V	Recorded from eucalypt forests, from rainforest margins and grasslands from near sea-level to 1000 m altitude. The species has been recorded growing on brown heavy clay (Carnarvon National Park), shallow rock loam (Bunya Mountains National Park), and basaltic soils.	Unlikely	No WildNet records exist within a 2km radius of the project area.

Scientific name	Common Name	EPBC Act Status	NC Act Status	Habitat description	Likelihood	Justification
Macadamia integrifolia	Macadamia nut	V	V	The Macadamia Nut grows in remnant rainforest, preferring partially open areas such as rainforest edges.	Unlikely	No WildNet records exist within a 2km radius of the project area.
Paspalidium grandispiculatum	-	V	V	Has been recorded growing in tall woodland, sandy soil over sandstone, dry sclerophyll forest in rocky granite gorge on granite-derived sands, and upper slope below sandstone outcrop.	Unlikely	No WildNet records exist within a 2km radius of the project area.
Phebalium distans	Mt Berryman phebalium	CE	E	Found on red soils in vineforest, semi-evergreen vine thicket and open forest ecosystems and ecotones, generally above 200 m elevation.	Unlikely	No WildNet records exist within a 2km radius of the project area.
Samadera bidwillii	Quassia	V	V	Commonly occurs in lowland rainforest often with *Araucaria cunninghamii* or on rainforest margins, but it can also be found in other forest types, such as open forest and woodland, it is commonly found in areas adjacent to both temporary and permanent watercourses up to 510 m altitude.	Unlikely	No WildNet records exist within a 2km radius of the project area.
Thesium australe	Austral toadflax	V	V	Grows in grassland or woodland, often in damp sites.	Unlikely	No WildNet records exist within a 2km radius of the project area.

A desktop fauna search was conducted within 3 km of the project area using the WildNet database (Queensland Government 2021) (3.6.1). WildNet searches returned the potential presence of 129 birds, nine ray-finned fishes, six reptiles and four mammals. Of these species, only two were listed as threatened under State or Federal legislation, being the koala (*Phascolarctos cinereus*; QLD: Vulnerable; EPBC: Vulnerable) and southern snapping turtle (*Elseya albagula*; QLD: Critically Endangered; EPBC: Critically Endangered). Atlas of Living Australia searches (Atlas of Living Australia 2021) for threatened species were also conducted within the project area. A likelihood of occurrence assessment was conducted which determined only the Koala is likely to occur within the area (Table 10).

Table 10 Threatened fauna that are known to occur, or potentially occur, in or around the project area

Scientific name	Common Name	EPBC Act Status	NC Act Status	Habitat description	Likelihood	Justification
Phascolarctos cinereus	Koala	V	V	Occurs in a range of temperate, tropical and sub-tropical forests as well as woodland and semi-arid communities dominated by *Eucalyptus* species.	Likely	ALA species records occur within a 3 km radius of the project area.

Scientific name	Common Name	EPBC Act Status	NC Act Status	Habitat description	Likelihood	Justification
Elseya albagula	Southern snapping turtle	CE	CR	Occurs in riverine habitat throughout the Fitzroy, Mary, and Burnett catchments. Prefers clear, flowing, well-oxygenated waters. Also occurs in non-flowing waters but in greatly reduced numbers.	Unlikely	No ALA records within proximity of the project area. No suitable habitat occurs within the project area.

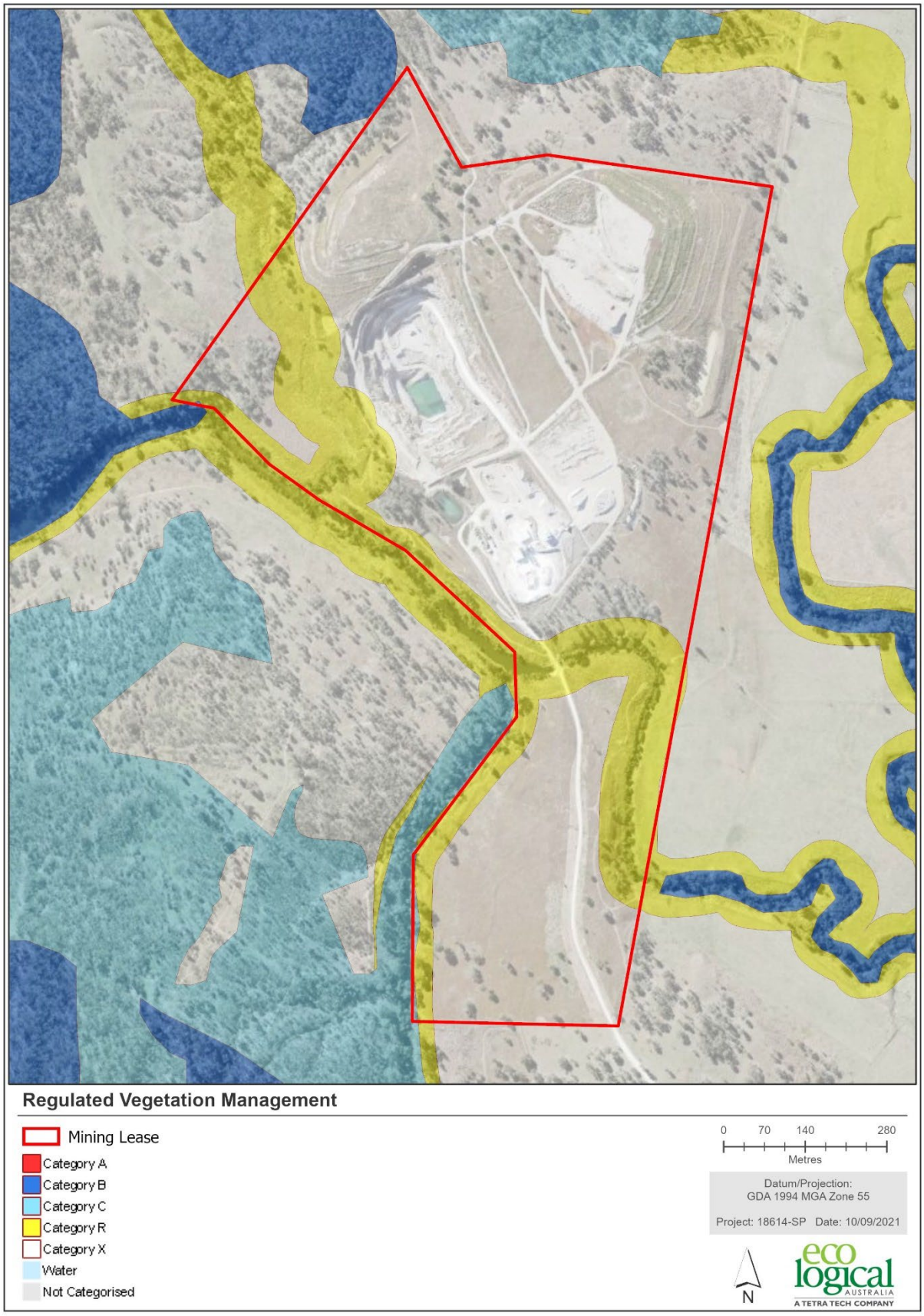

Figure 19 Regulated vegetation management categories for the Murgon Operation and surrounds

No significant disturbance is planned outside of that currently in place as part of the rehabilitation and closure activities described in the PRCP. Therefore, existing ecological values are not expected to be significantly impacted. Pre-clearance surveys will be undertaken prior to any disturbance in currently undisturbed areas (void cut back or new drains) to identify regulated vegetation and protected species or communities so that appropriate avoidance or mitigation measures can be employed.

3.1.9. Project description

3.1.9.1. Identification of underlying landholders

ML 50111 lies within the South Burnett Regional Council area. It is on Lot 6 Plan SP195988, Lot A Plan RP210698 and Lot A Plan AP221091 with Graymont (NSW) Pty Ltd listed as the registered owner. Graymont took ownership of the business on 1 August 2019. All three Lots extend over 83.8 ha of ML 50111 and the land is considered freehold.

3.1.9.2. Mining tenure

There are three limestone deposits on ML 50111; the Northern, Central and Southern Deposits. The current EA only authorises mining of the Northern Deposit (EA Condition A1-1). This has an indicated resource of 1.03 million tonnes and minable reserve of 976,000 tonnes of limestone. Details of the mining tenure are provided below in Table 11.

Table 11 Details of the mining tenure for Murgon

Mining Lease number	Lease holder	Date granted	Expiry date	Areas (ha)	Activity
ML 50111	Graymont (NSW) Pty Ltd	14/11/1996	30/11/2036	83.8	Mining limestone

3.1.9.3. Mining operation

Mining consists of conventional open cut benching methods currently being performed by Graymont and their respective contractors. Operations are conducted on a single shift basis, normally between the hours of 6.00am to 6.00pm Monday to Friday.

The mine and surrounds of the site are mostly devoid of tree cover due to historical land clearance and cattle grazing activities. Consequently, prior to drilling and blasting, little to no natural vegetation requires removal or grubbing out. Available topsoil is recovered prior to mining for future use in rehabilitation.

The shale overburden on the western side of the mine pit is free-dug by the excavator without blasting. The andesite overburden on the eastern side of the mine pit is drilled and blasted before removal. All overburden is taken to the overburden dumps.

Blast activities are generally performed with wet emulsion initiated with NONELs (non-electric). After blasting, limestone ore is loaded into articulated haul trucks by an excavator and/or a front wheel loader and transported to the plant for crushing, milling and screening.

The extraction rate is approximately 150,000 tonnes per annum. Quantities of desirable quality limestone product are estimated at around 90,000 tonnes per annum.

Once limestone is recovered from the pit it progresses through a scalping screen to the primary jaw crusher. The jaw crusher reduces the scalping oversize to a minus 75 mm size which is then stockpiled as ground limestone (GLS).

GLS is then fed into a Jacques A4 mill, where it is reduced to a minus 4 mm size. This product is then fed over a multi-deck Halls screen, with the following products being screened off:

- Oversize return to mill
- Kiln feed 4mm to 1mm
- Aglime <1mm
- Superfine Aglime <0.25 mm
- Neutra-Lime <2mm.

During the life of mine (LOM), the pit will be extended on the western boundary with cessation of active mining scheduled for 2037.

3.1.9.4. Mine features and disturbance types

The current disturbance and disturbance types are shown in Figure 1, with disturbance types listed in the EA (and associated activities and assets) described in Table 12.

To manage the rehabilitation of ground disturbance associated with mining activities, areas with similar rehabilitation requirements have been grouped together into Rehabilitation Areas (RA). These have been used to develop the PRCP Schedule.

The EA has agreed PMLUs for each disturbance type. For each type or RA, a rehabilitation strategy to achieve the nominated PMLU will be provided in Section 3.5.

There is no tailing storage facility (TSF) at Murgon.

Table 12 The Murgon disturbance types as provided in the EA

Disturbance type	Rehabilitation area	Details of disturbance types or assets within each type
Fuel storage and service area	RA9	Above ground tank HME parking area
Stockpiles	RA5	Limestone / product stockpiles
Plant/office	RA5	Sheds Silos/bins Plant Laydown area Miscellaneous scrap Small tanks
	RA10	Office (to be retained at end of mine life) Workshop (to be retained at end of mine life) Sheds (to be retained at end of mine life)
Waste Dump No. 2 North-West	RA1	Northern overburden dump – rehabilitation works completed

Disturbance type	Rehabilitation area	Details of disturbance types or assets within each type
	RA2	Northern overburden dump – under active rehabilitation
Waste Dump No. 1 North-West	RA1	North-eastern overburden dump – rehabilitation works completed
	RA3	North-eastern overburden dump – under construction
Topsoil stockpiles	RA2	Topsoil stockpiles located within the footprint of the Northern overburden dump – under active rehabilitation
	RA3	Topsoil stockpiles located within the footprint of the North-eastern overburden dump – under construction
Roads and tracks	RA7	Tracks (unsealed, gravel)
	RA10	Tracks (to be retained at end of mine life)
Silt traps/Dams	RA4	Sediment Dam C (will be decommissioned during mine life)
	RA8	Sediment Dam A (to be retained at end of mine life) Sediment Dam B (to be retained at end of mine life) Sediment Dam D (to be retained at end of mine life)
Open Pit (void)	RA6	Residual void

The extent of the RAs at Murgon are shown in Figure 21.

3.1.9.5. Notifiable activities

On ML 50111 there is a 20,000 L diesel above ground fuel tank which is used for operations. However, it does not trigger the volume threshold of a notifiable activity of 25,000L of petroleum products as specified in Schedule 3 (29)(b)(iii) of the EP Act 1994.

On ML 50111 there is a 20,000 L diesel above ground fuel tank which is used for operations; however, it does not trigger the notifiable threshold of 25,000L in association with the Schedule 3 (29)(b)(iii). Further, there are no kilns, explosive magazines, or sewage treatment plants on site.

ML 50111 is not listed on any Environmental Management Registers or Contaminated Land Registers.

3.1.9.6. Environmentally relevant activities

The Environmentally Relevant Activities (ERAs), as described in the *Environmental Protection Regulations 2019*, carried out at Murgon Operations are listed in Table 13. These are included in the EA.

Table 13 Murgon ERAs

Environmentally relevant activity/activities	Location
21: A mining activity that is an ineligible ERA, other than a mining activity mentioned in items 9 to 20	ML 50111

3.1.10. Design for closure (including consideration of voids in flood plains)

The location of the void was designed to maximise the extraction of the resource that has been approved. It has since been identified that the void is located within the potential flooding extent (refer to Section 3.1.4.3).

Following consultation with DES in February 2022, it was discussed that further modelling could be undertaken to fully understand the depth and velocity of flood events to help inform closure design for the site. This has now been completed and is discussed in Section 3.5.2. The model report has been appended to this PRCP (Appendix J).

Sensitive receptors have been identified in Figure 20 and are largely unaffected by disturbance. The existing site access track crosses a section of Category R regrowth watercourse vegetation and the void is adjacent to Category R regrowth watercourse vegetation.

There are no geochemically reactive or acid forming wastes, no tailings dams, no heap leach pads, or waste tyre stockpiles that would require selective location selection on the site to mitigate environmental risks.

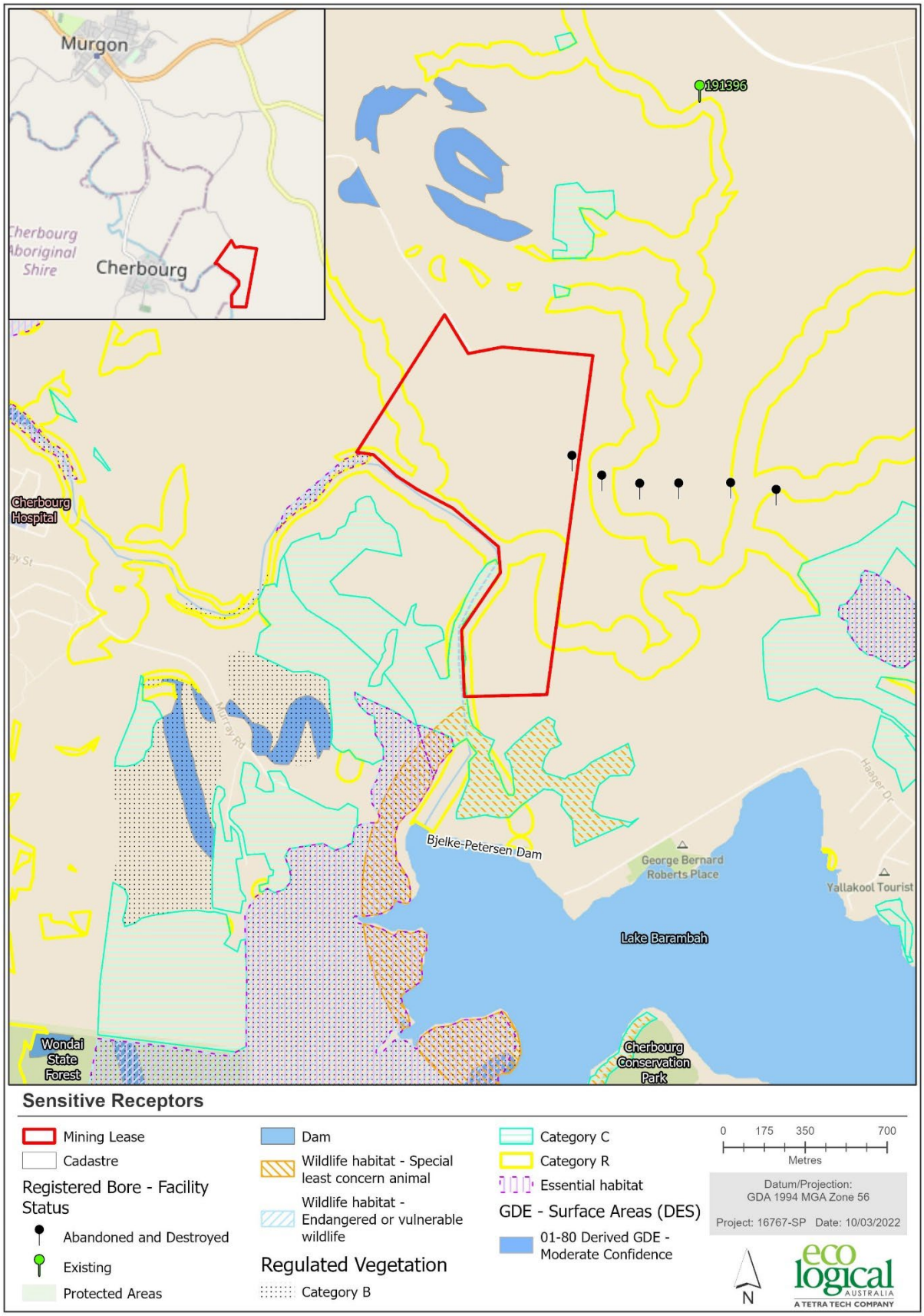

Figure 20 The sensitive receptors surrounding the Murgon ML

3.1.11. Rehabilitation planning and progressive rehabilitation

3.1.11.1. Progressive rehabilitation

Condition F1-2 of the EA states that, "*Progressive rehabilitation must commence when areas become available within the operational land*". Graymont recognises the importance of progressive rehabilitation in the overall production cycle as it allows for the disturbance area to be minimised as much as practicable.

To date, 8.66 ha of the Northern and North-eastern Overburden Dumps has been rehabilitated. The construction of the Northern Overburden Dump, including all landform development and major earthworks, has been completed and most of the dump has been topsoiled and revegetated. A small section (now nominated as RA2) is awaiting surface preparation, topsoil placement and revegetation (Figure 21). The remainder of the North-eastern Overburden Dump (now nominated as RA3), is still under construction and will continue to receive overburden until 2029 after which it will undergo landform reshaping and will be progressively topsoiled and revegetated until 2031 (refer to schedule in Appendix B).

Progressive rehabilitation of area associated with Plant/Office, Fuel Storage and Service Area and Product Stockpiles disturbance types will not be able to commence until operations have ceased in 2037. This is due to the infrastructure being retained for use in the active mining operation until such time that they are no longer required and can commence decommissioning and removal. Similarly, rehabilitation associated with Silt Trap/Sediment Dams, RA8, will not commence until 2040 as the they will be part of the site erosion and sediment control measures until closure.

Table 14 summarises the annual disturbance and rehabilitation activities for the period of the last Plan of Operations (2016).

Table 14 Summary of most recent annual disturbance and rehabilitation activities

Description	Annual disturbances and rehabilitation area (ha)						
	Prior to 2016	2016	2017	2018	2019	2020	2020 to 2037
Total lease area	83.80	83.80	83.80	83.80	83.80	83.80	83.80
Undisturbed area	62.99	61.71	61.39	61.92	61.64	58.85	47.48
New disturbance		2.86	0.32	0.00	0.81	2.79	11.37
Cumulative new disturbance		2.86	3.18	3.18	3.99	6.78	18.24
Established and active rehabilitation	5.85	1.58	0.00	0.53	0.00	0.00	8.65
Cumulative rehabilitation		7.43	7.43	7.96	7.96	7.96	16.61

Description	Annual disturbances and rehabilitation area (ha)						
	Prior to 2016	2016	2017	2018	2019	2020	2020 to 2037
Total area of remaining disturbance	20.81	22.09	22.41	21.88	22.16	24.95	19.71

A timeline showing important milestones is provided in Section 3.1.11.2 and the PRCP schedule is presented in Appendix B.

3.1.11.2. Rehabilitation milestones

The PCRP guideline requires the development of rehabilitation milestones and milestone criteria for all rehabilitation areas that have a PMLU (DES 2021). Milestones identify significant events or steps in the rehabilitation process and will be legally enforceable commitments once the PCRP Schedule is approved. In accordance with the PRCP Plan guideline, Graymont has developed milestones for Murgon, ensuring that the milestones are SMART:

- **S**pecific
- **M**easurable
- **A**chievable
- **R**elevant
- **T**ime bound.

For each milestone, milestone criteria have been developed to determine and demonstrate whether each milestone is achieved. The following rehabilitation site-specific milestones (guided by the examples in Appendix 3 of the PRCP guideline) will be applied to areas that have become available for rehabilitation:

- RM1 - Infrastructure decommissioning and removal
- RM2 - Contaminated land assessment and remediation
- RM3 - Landform development
- RM4 - Surface preparation
- RM5 - Revegetation
- RM6 - Achievement of surface requirements (grazing)
- RM7 - Achievement of post-mining land use to stable condition (grazing)
- RM8 - Achievement of post-mining land use to stable condition (water storage)
- RM9 – Retained infrastructure.

Table 15 to Table 19 outline the applicable RAs, the disturbance types that are covered by each RA and the rehabilitation milestones applicable to each.

Table 15 Rehabilitation milestones for RAs associated with Northern Overburden Dump (Waste Dump 2), North-eastern Overburden Dump (Waste Dump 1) and Topsoil Stockpiles Disturbance Types

RA #	Size of RA (ha)	Disturbance types or assets	Applicable milestones	Milestone description
RA1	8.66	Existing rehabilitation (on overburden dumps)	RM6 RM7	Rehabilitation monitoring and maintenance Sustainable achievement of PMLU
RA2	0.69	Northern overburden dump (Including part of the topsoil stockpiles located within the footprint of the dump)	RM4 RM5 RM6 RM7	Topsoiling and surface preparation Revegetation Rehabilitation monitoring and maintenance Sustainable achievement of PMLU
RA3	6.4	North-eastern overburden dump (includes part of the topsoil stockpiles located within the footprint of the dump)	RM3 RM4 RM5 RM6 RM7	Landform development and reshaping/reprofiling Topsoiling and surface preparation Revegetation Rehabilitation monitoring and maintenance Sustainable achievement of PMLU

Table 16 Rehabilitation milestones for RAs associated with the Silt Traps/Dams Disturbance Type

RA #	Size of RA (ha)	Disturbance types or assets	Applicable milestone	Milestone description
RA4	0.12	Silt Traps/Dams to be rehabilitated (Sediment Dam C only)	RM1 RM2 RM3 RM4 RM5 RM6 RM7	Infrastructure decommissioning and removal Remediation of contaminated land Landform development and reshaping/reprofiling Topsoiling and surface preparation Revegetation Rehabilitation monitoring and maintenance Sustainable achievement of PMLU
RA8	1.57	Silt Traps/Dams to be retained (Sediment Dam A, B and D)	RM1 RM2 RM7 RM8	Infrastructure decommissioning and removal Remediation of contaminated land Sustainable achievement of PMLU Sign-off for retained infrastructure

Table 17 Rehabilitation milestones for RAs associated with the Plant/Office, Fuel Storage and Service Area and Product Stockpiles Disturbance Types

RA #	Size of RA (ha)	Disturbance types or assets	Applicable milestone	Milestone description
RA5	5.85	Miscellaneous sheds Silos/bins Plant and equipment Laydown area Small tanks Product stockpiles	RM1 RM3 RM4 RM5 RM6 RM7	Infrastructure decommissioning and removal Landform development and reshaping/reprofiling Topsoiling and surface preparation Revegetation Rehabilitation monitoring and maintenance Sustainable achievement of PMLU
RA9	0.2	Above ground fuel tank HME parking area	RM1 RM2	Infrastructure decommissioning and removal Remediation of contaminated land

RA #	Size of RA (ha)	Disturbance types or assets	Applicable milestone	Milestone description
			RM3 RM4 RM5 RM6 RM7	Landform development and reshaping/reprofiling Topsoiling and surface preparation Revegetation Rehabilitation monitoring and maintenance Sustainable achievement of PMLU
RA10	0.81	Workshop Office Storage sheds Powerlines Bridge Laydown area aprons around retained buildings	RM1 RM2 RM8	Infrastructure decommissioning and removal Remediation of contaminated land Sign-off of retained infrastructure

Table 18 Rehabilitation milestones for RAs associated with the Open Pit (Residual Void) Disturbance Type

RA #	Size of RA (ha)	Disturbance types or assets	Applicable milestone	Milestone description
RA6	9.73	Residual void	RM1 RM3 RM6 RM7	Infrastructure decommissioning and removal Landform development and reshaping/reprofiling Rehabilitation monitoring and maintenance Sustainable achievement of PMLU

Table 19 Rehabilitation milestones for RAs associated with the Roads and Track Disturbance Type

RA #	Size of RA (ha)	Disturbance types or assets	Milestone #	Milestone description
RA7	2.35	Roads and Tracks	RM3 RM4 RM5 RM6 RM7	Landform development and reshaping/reprofiling Topsoiling and surface preparation Revegetation Rehabilitation monitoring and maintenance Sustainable achievement of PMLU
RA10	0.81	Roads and Tracks (retained)	RM8	Sign-off of retained infrastructure

The RAs are displayed in Figure 21 with a broad timeline of significant rehabilitation activities provided in Figure 22. This is reflected in the PRCP schedule presented in Appendix B which also specifies the nominated duration of each relevant rehabilitation milestone.

Rehabilitation objectives and milestone criteria are presented in Section 3.2.1. While Figure 24 provides an understanding of the final extent of disturbance at closure.

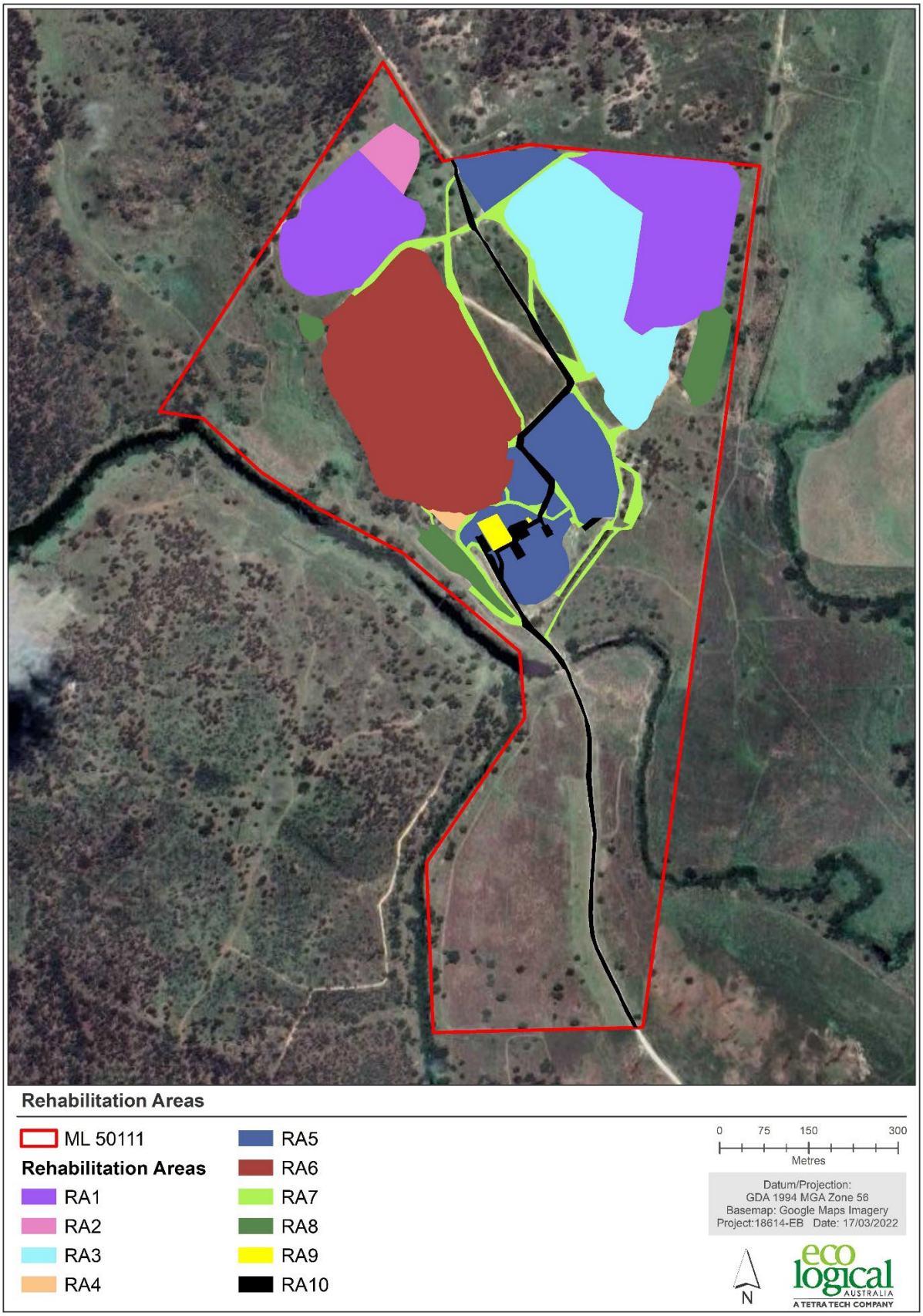

Figure 21: Rehabilitation areas at Murgon

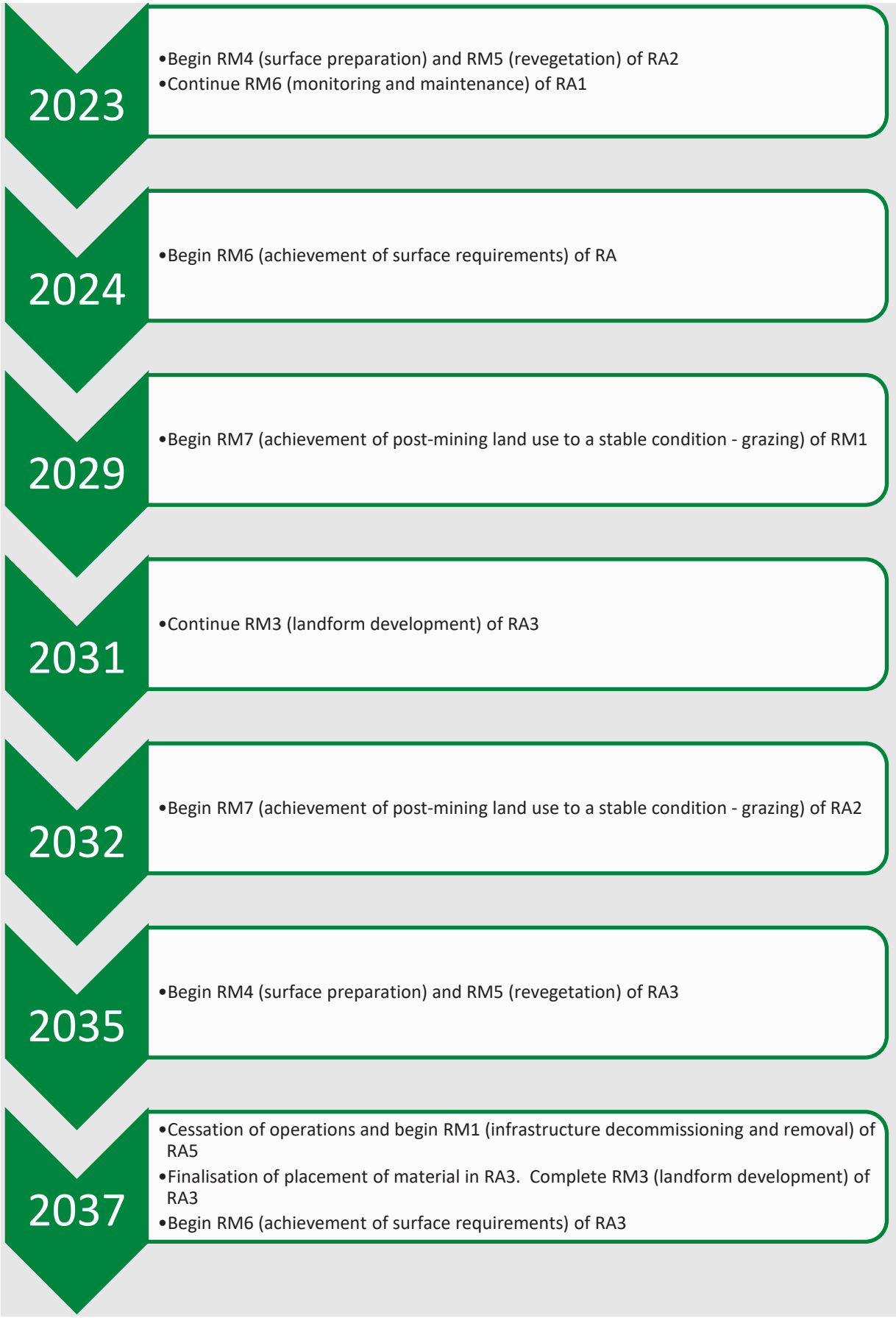

Figure 22 Timeline of significant rehabilitation works at Murgon (Part 1)

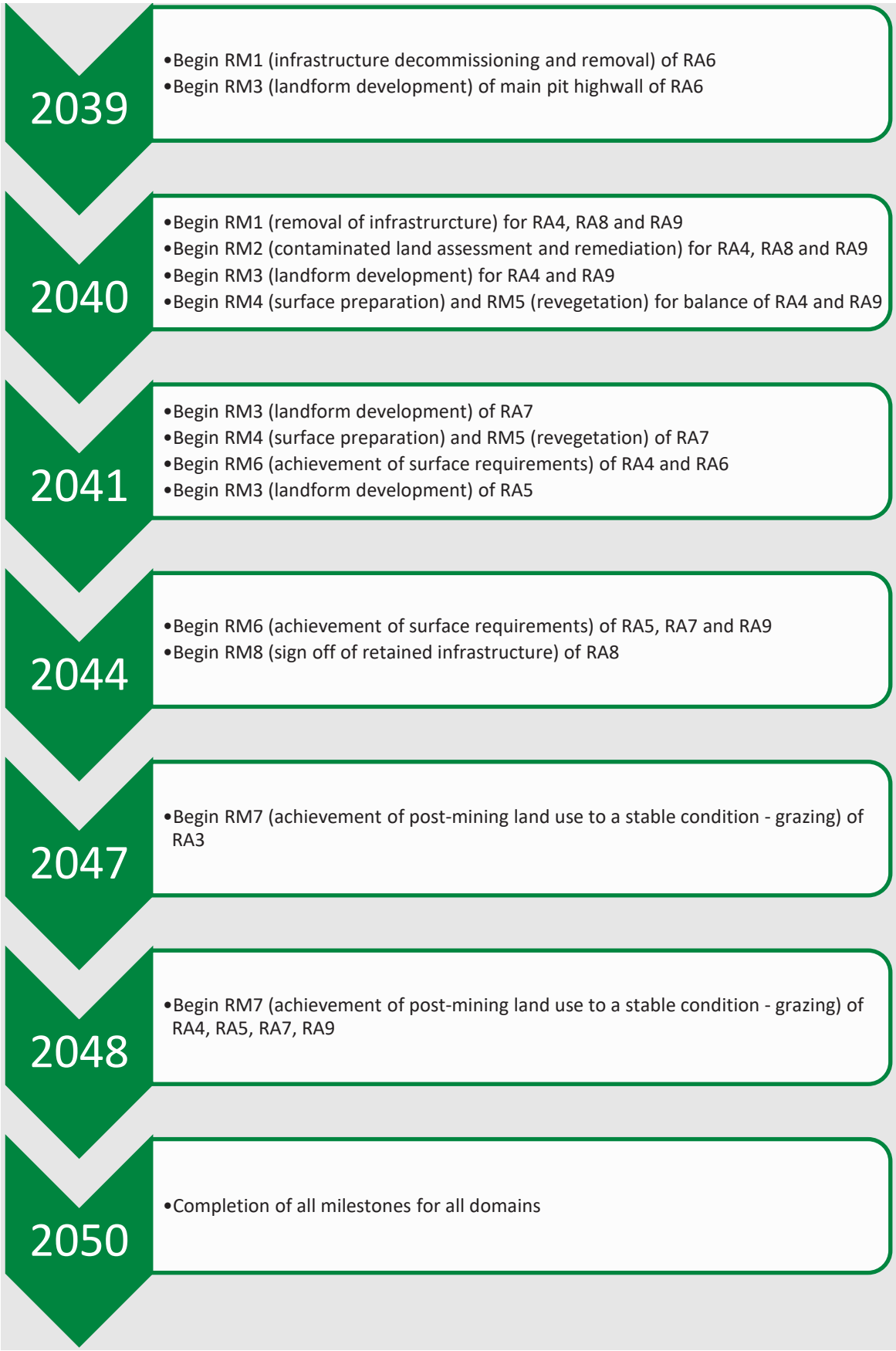

Figure 23 Timeline of significant rehabilitation works at Murgon (Part 2)

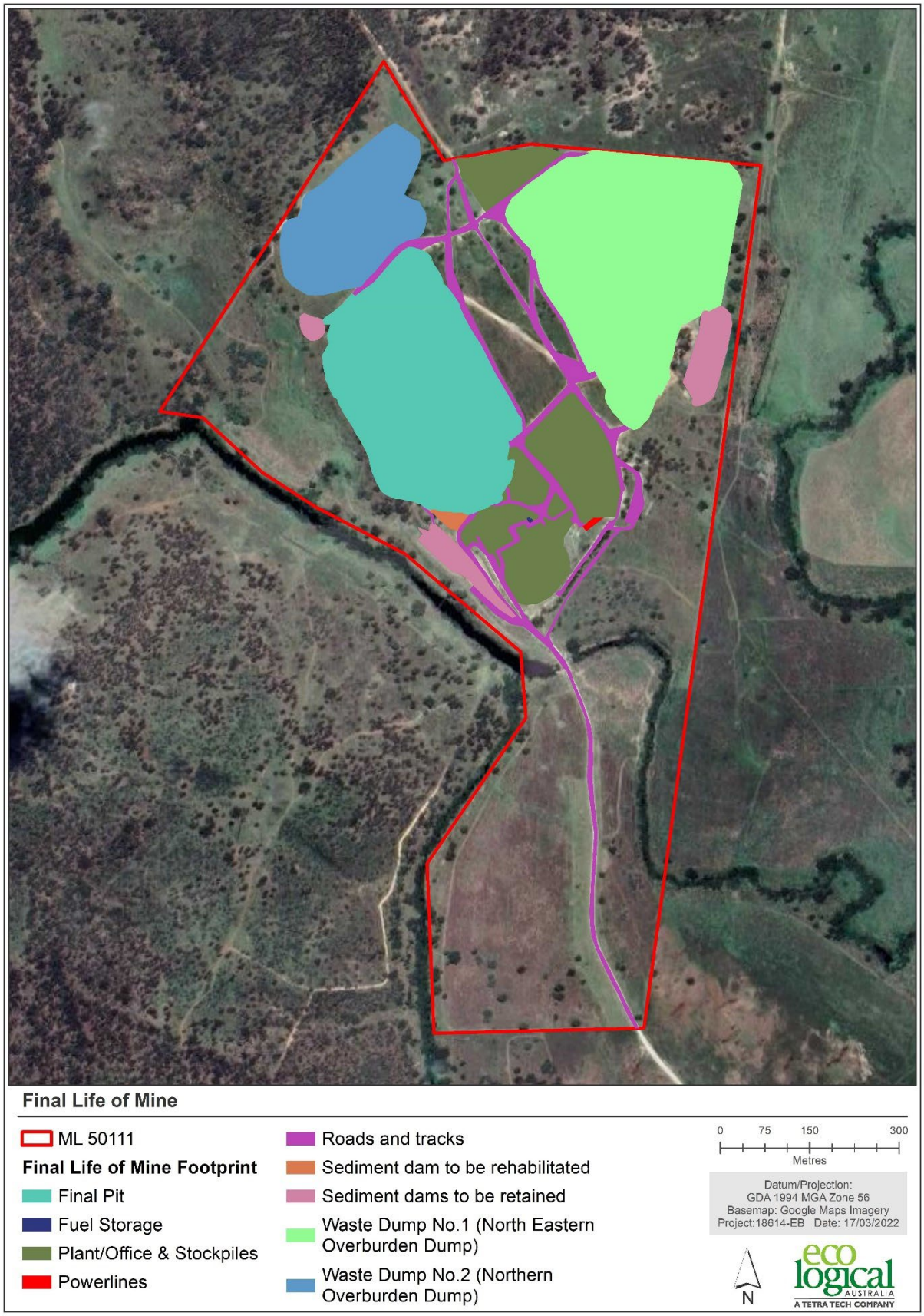

Figure 24 Final life of mine footprint

3.2. Community consultation

3.2.1. Murgon Community and Stakeholder Engagement Plan (CSEP)

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

- Stakeholders will be provided with timely and accurate information about Graymont's activities and plans for the future that may impact them.
- Stakeholders will be given ample opportunity to participate in a stakeholder-engagement process, express their views and voice any concerns they might have if and when issues arise.
- Graymont will strive to respect the culture and values of each stakeholder.

Graymont has maintained a Community and Stakeholder 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.

3.2.2. Relevant Stakeholders

For the purpose of this PRC Plan, the community area has been defined as the communities and surrounding areas of the towns of Cherbourg, Moffatdale and Murgon in the South Burnett Regional Council LGA. This 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. Table 20 provides a categorisation of the stakeholders as they relate to the identified stakeholder groups.

Table 20: Categorisation of relevant stakeholders

Category	Relevant stakeholder
Direct landholders	Landholders on 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 operations 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 regulation of the site. Police, emergency services, drug and alcohol services, housing Indigenous, employment and social services. Many of these services are provided by South Burnett Regional Council. All infrastructure and utility providers that the site could have an impact on during either operation or rehabilitation.
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 South Burnett region that may have an interest in the site.

3.2.3. Community Consultation Letter

In March 2023, 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, 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 Murgon's current and future planed operations.

The letter (Appendix H) was mailed to a total of 209 residences, with no responses received to date.

3.3. Post Mine Land Use

3.3.1. Selection of PMLUs

As described above, the PMLUs for Murgon have previously been approved through an existing LODs (the EA). Condition F1-1 of the EA require that, "*All areas disturbed as a result of mining activities must be rehabilitated to a stable landform with a self-sustaining vegetation cover in accordance with Schedule F – Table 1 and comply with the maximum distance between erosion control structures specified in Schedule F – Table 2*". The applicable LOD is presented in Appendix C and the PMLUs and criteria that are to be carried over from the EA for each disturbance type are provided in Table 21. With the exception of the mine void, remaining sediment dams and retained infrastructure, the PMLU for the entire site will be rehabilitated to Grazing Pasture. This is consistent with the pre-mining land use and the land capability for the areas affected by mining operations.

Existing Sediment Dam C will be decommissioned during operations as it will be partially removed during pit cut back and will no longer be in use at closure (i.e., will no longer be part of the sediment dam disturbance area at closure and will be absorbed into the infrastructure area). The remaining footprint of the former sediment dam will be rehabilitated to Grazing Pasture in line with adjacent plant and office areas.

The residual void and the remaining sediment dams have a PMLU of water storage.

There is an agreement in place with the landholder (Graymont) to retain the main access road, bridge, offices and some storage sheds at closure. These will be valuable assets for any post-mine agricultural enterprise. These retained assets are displayed in Figure 25 and accompanied by a Landholder Statement in Appendix G.

Table 21 Nominated PMLUs and slope criteria from the disturbance types nominated in the EA for Murgon

Disturbance Type	Estimated Area (ha)	Maximum Final Slope 1	Final (Post-Mine) land Use Description
Open pit (residual void)	3.22	Void wall – competent rock max slope = 70º Void wall – incompetent rock max slope = 38º	From the base of the pit to the height of the groundwater table: Water storage with water quality to be suitable for livestock use

	4.89	Void wall – competent rock max slope = 70º Void wall – incompetent rock max slope = 38º	Above the level of the natural groundwater table: Safe access is to be provided to the water for native animals and livestock
Waste Dump No.1 North West	11.41	15º (25%)	Grazing Pasture
Waste Dump No.2 North West	2.61	15º (25%)	Grazing Pasture
Fuel Storage and Service Area	0.13	10º (18%)	Grazing Pasture
Plant/Office	2.6	10º	Grazing Pasture[2]
Stockpiles	1.32	10º	Grazing Pasture
Silt Traps/Dams	0.47	N/A	Water Storage
Roads and Tracks	1.68	100	Grazing Pasture except where agreed with the landowner to be left as access tracks[3]
Topsoil Stockpiles	0.54	10º	Grazing Pasture

1. Slopes for the void defined in EA Schedule F Table 3
2. Agreement with the landholder is in place to retain some buildings and sheds in accordance with Condition F5-1 regarding retained infrastructure.
3. Agreement is currently in place to retain the main access and some internal tracks.

Figure 25 Retained buildings and infrastructure at end of mine life

3.3.1.1. Compatibility with regional, State and National planning

The site is located within the South Burnett Regional Council. Under the *South Burnett Planning Scheme*, the land is zoned as rural (South Burnett Regional Council 2017). Section 6.2.13 of the South Burnett Planning Scheme states the purpose of the rural zone code as follows:

- Provide for rural uses and activities;
- Provide for other uses and activities that are compatible with:
  - Existing and future rural uses and activities; and
  - The character and environmental features of the zone; and
  - Maintain the capacity of land for rural uses and activities by protecting and managing significant natural resources and processes.

The purpose of the zone will be achieved through development in the zone that accommodates predominantly rural uses. The return of mined land to grazing pasture (agricultural use) is therefore consistent with the current zoning.

The planning scheme also states that non-rural uses may be appropriate where they do not detract from its productivity and can demonstrate a direct relationship with the rural use in the immediate locality; or the potential to make a contribution to primary production or the diversification of rural industries. The retention of water storage (for primary industry use such as stock watering or irrigation) in the residual void and remaining dams, and the retention of access roads and storage sheds is also consistent with the planning scheme.

Regional interests (relating to agricultural land) are designated in the *Regional Planning Interests Act 2014* (RPI Act) and include Strategic Cropping Land. The project area is outside mapped areas of Strategic Cropping Land.

State interests, relating to land areas requiring protection for sustainable agriculture, are recognised by the *State Planning Policy – July 2017* (DILGP 2017). They include Important Agricultural Areas (IAAs) as identified by the Queensland Agricultural Land Audit (DAFF 2013). Designation of land as an IAA is based on Agricultural Land Classification (ALC) (DILGP 2017) with ALC Class A and ALC Class B land protected for sustainable agricultural use. The project area is outside mapped areas of AAs and areas recognised as ALC Class A and B.

The designation of a PMLU of grazing is therefore consistent with State and Regional Interests with respect to the protection of valuable productive agricultural land.

Plans for the rehabilitated areas are compatible with the surrounding land use and broader regional economic priorities. The importance of continued growth in agricultural production is recognised in the *Wide Bay Burnett Economic Development Strategy 2014-2019,* which encompasses the South Burnett region (WBBROC 2014). The Wide Bay Burnett area is recognised as a major 'food bowl' for Queensland, accounting for approximately 10% of Queensland's agricultural production (WBBROC 2014).

The designation of a PMLU of grazing is therefore consistent with Local Government Planning Scheme zoning, State Government State and Regional Planning Interests as well as Regional Economic and Development Strategies.

The final land use for all areas within the lease boundaries including un-mined areas is shown in Figure 26.

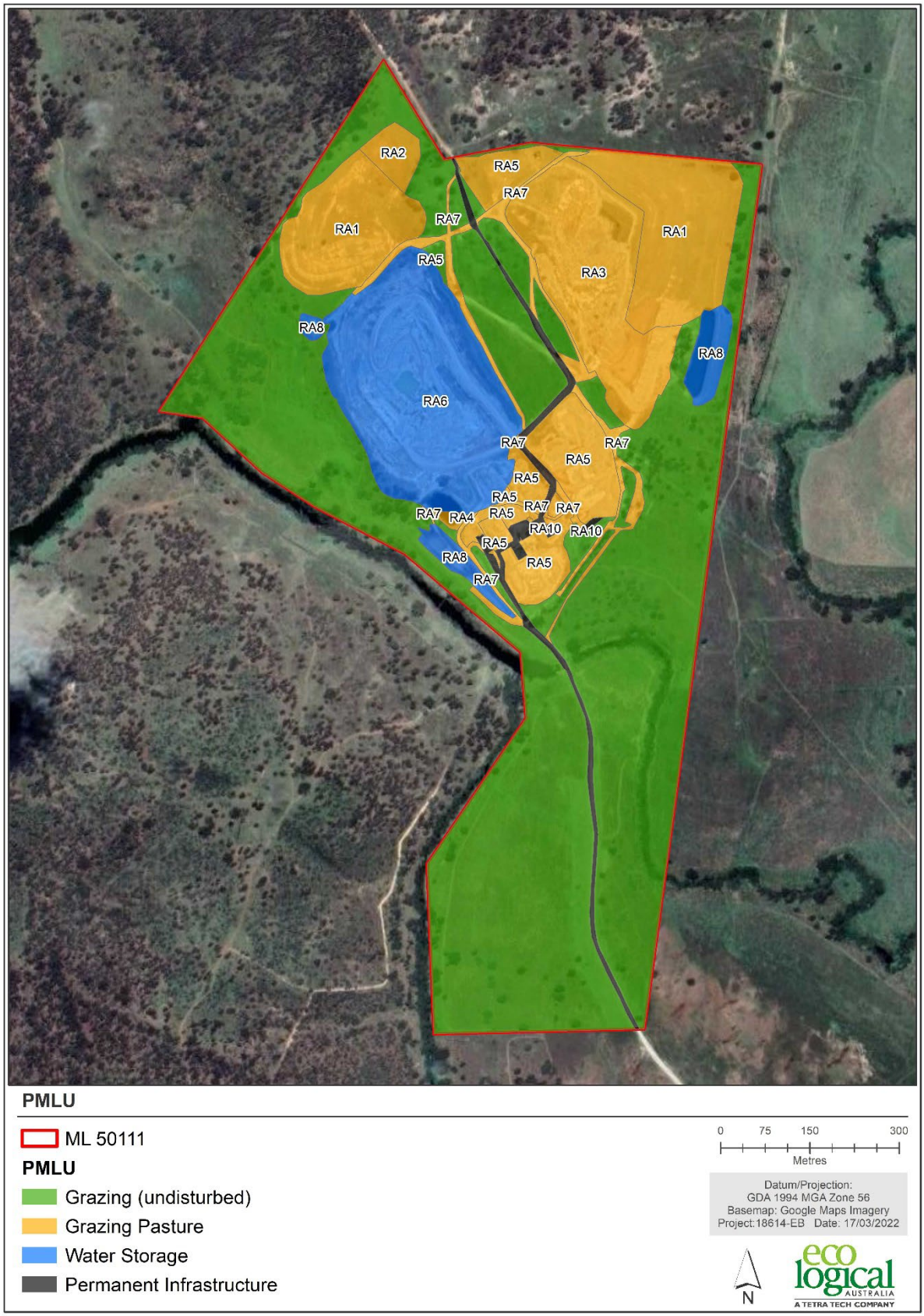

Figure 26 Final PMLU and Rehabilitation Areas

3.3.2. Rehabilitation objectives and completion criteria

Rehabilitation objectives for Murgon have been developed to ensure that the EA approval conditions for rehabilitation are met (see Table 1). They also address the overall rehabilitation aims as described in the PRCP Guidelines that rehabilitated land should be safe, stable, not cause harm to the environment and is able to sustain an agreed PMLU.

Specific rehabilitation objectives and milestone completion criteria have been developed for each RA and milestone described in Table 22 in Section 3.1.11.2 to reflect the activities undertaken within each disturbance type and RA. The following section provides the technical basis for the selection of a number of the critical milestone completion criteria, particularly those related to the creation of stable landforms and the sustainability of the PMLU.

3.3.2.1. Basis for selection of critical milestone completion criteria

MAXIMUM SLOPES FOR GRAZING PMLU

Maximum slopes for the areas with a PMLU of grazing pastures have been nominated in the EA as between 10° to 15° depending on the disturbance type. The suitability of these slopes was reviewed as part of the preparation of the PRCP.

The *Guidelines for agricultural land evaluation in Queensland* (DSITI & DNRM 2015) do not provide maximum slopes for the Land Capability Class VI originally approved in the EA and the Land Suitability Framework for the Inland Burnett area (DNRM & DSITI 2013), which includes Murgon, does not provide land quality requirements for native or improved pasture. Slopes up c. 15% are suitable for low intensity grazing on rainfed pastures with appropriate land management practices (DME 1995, DNRM & DSITI 2013). The land cleared for grazing surrounding the site is on topography similar to the proposed final landform. The maximum slopes nominated in the EA are therefore suitable for setting completion criteria for the nominated PMLU.

MAXIMUM SLOPES FOR WATER STORAGE PMLU IN THE VOID

The slopes for the residual void wall have been based on the geotechnical assessment and rehabilitation recommendations provided by Rocktest Consulting (2022) (Appendix I). The following batter slopes are required to provide acceptable slope stability:

- Maximum batter angles in unweathered rock 70°
- Maximum batter angles in weathered rock 38°
- Maximum height of benches 10 m
- Minimum widths of berms 8 m

The recommendations from Rocktest Consulting (2022) align with EA conditions for maximum slopes in the void.

FOLIAGE PROJECTIVE COVER FOR MINIMISING EROSION AND ENSURING LONG-TERM STABILITY FOR THE GRAZING PMLU

The EA does not nominate a minimum ground cover for rehabilitated land at Murgon.

According to The Queensland Government (2013), the critical level for cover in relation to pastures in tussock grasslands is approximately 40% cover and 1000 kg/ha of dry grass which ideally would be existent at the beginning of the summer storm season (prior to November annually). However, further research on post-mine landforms in central and southern Queensland specifies that groundcover of at least 50% would be required to significantly reduce the soil erosion rates (Loch 2000, NRA 2000, So et al. 2018). Further, reductions in erosion rates are seen as cover increases beyond this value. This has formed the basis for the minimum ground cover nominated in the milestone completion criteria.

TOPSOIL DEPTH FOR THE GRAZING PMLU

Topsoil between 150 mm and 300 mm is considered an acceptable (DME 1995) depth for establishment of vegetation, where shallower depths are still adequate with soils that have good water holding capacity and inherent fertility. The assessment of the topsoil stockpiles at site by SESL 2020 has confirmed the soil samples are non-sodic, with a low dispersion index and have moderate to high cation exchange capacity (nutrient retention capacity) (see Section 3.5.3.1).

The nominated topsoil depth of 150 mm is considered suitable for the establishment and maintenance of pasture at Murgon. Further, it is noted there is a surplus of scalps at site which could be used as part of the rehabilitation process as a subsoil material to improve overall growth medium depth and water-holding capacity (see Section 3.5.3.2).

Table 22 Murgon Operations rehabilitation objectives, milestones and milestone completion criteria for all RAs

Relevant objective	Milestone reference	Rehabilitation milestone	Milestone Completion Criteria	Validation
The rehabilitated site will not present an unacceptable hazard to persons, stock or native fauna.	RM1	Infrastructure decommissioning and removal	1. a) All services disconnected in coordination with service providers and all associated service infrastructure removed from site. 1. b) All hazardous building materials removed by appropriately licensed contractors. 1. c) All infrastructure (buildings, sheds, fixed assets) demolished, and demolition waste removed from site for recycling or disposal at an appropriately licensed facility, unless otherwise agreed for retention by all stakeholders (RM9). 1. d) All limestone feed stock not to be used for surface water management structures removed from stockpiles in RA1 and placed in the void. 1. f) All bitumen in RA8 removed and disposed of at an appropriately licensed facility. 1. g) Sediment dam (RA4) water quality is analysed for total metals/metalloids (As, Cd, Cr, Cu, Ni, Pb, Se, Zn) and hydrocarbons as per suite B (as documented in Section 3.7.2 of the Murgon Operations Progressive Rehabilitation and Closure Plan) prior to dewatering. Results will be compared to ARMCANZ & ANZECC (2000) guidelines for stock water (cattle). 1. h) Sediment dam (RA4) dewatered.	• Demolition and waste removal records • Inspection and Test Plans (ITPs) (demolition and equipment removal) • ITP hold point (product stockpile removal) • Photographic records • Water quality monitoring data

Relevant objective	Milestone reference	Rehabilitation milestone	Milestone Completion Criteria	Validation
Contamination associated with RA will not pose a risk to human or ecological receptors in terrestrial or aquatic environments assessed and remediation carried out or site management plan approved and implemented.	RM2	Contaminated land assessment and remediation	2. a) Contaminated land investigation for all areas that are identified as containing a source of contamination undertaken by an AQP1. 2. b) All contaminated material is to be removed from the site unless onsite remediation is being undertaken. 2. c) Contaminated material removed from site has been removed in accordance with relevant regulations. 2. d) A contaminated land investigation document has been prepared by an AQP, containing a site suitability statement confirming that land is not contaminated and is suitable for the proposed PMLU.	• Site Investigation Report • Records of validation sampling to confirm contaminant removal • ITPs (remediation of contaminated land) • Photographic records • Site Management Plan Document
The rehabilitation areas is reshaped to provide a stable landform. Maximum slopes are suitable for supporting the PMLU as approved by existing LOD. The rehabilitation area is reshaped to provide free drainage. Surface water is managed to maintain landform stability.	RM3	Landform development	3. a) An AQP1 has confirmed that geotechnical stability of the residual void walls (i.e., a factor of safety value of ≥1.3) has been achieved. 3. b) Surface aggregate from RA5 and RA7 removed to a depth of 300 mm and placed in the floor of the residual void. 3. c) All temporary and permanent Erosion and Sediment Control Structures have been designed and installed with reference to Best Practice Erosion & Sediment Control series (IECA 2008). 3. d) Average slope of areas to be revegetated does not exceed 15% (RA1 - RA5, RA7, RA9). 3. e) Unsealed tracks (RA7) graded to conform to the surrounding landform. 3. f) Sediment dam bund pushed onto dam and levelled (RA4) and the final (consolidated) landform surface will be water shedding. 3. g) All bores decommissioned in accordance with the Minimum Construction Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee 2020).	• Final survey data • ITPs (landform development) including surface water management sign off. • Geotechnical report and final landform design for overburden dumps and residual void

Relevant objective	Milestone reference	Rehabilitation milestone	Milestone Completion Criteria	Validation
Land quality and soil quality suitable for establishing vegetation required to sustain the rainfed grazing PMLU	RM4	Surface preparation	4. a) All areas to be revegetated ripped to a depth of 500 mm at 500-800 mm spacings (RA1 - RA5 , RA7, RA9). 4. b) Haul roads/access tracks within the residual void (RA6) ripped to a depth of 500 mm at 500-800 mm spacings. The exposed void floor (RA6) has been scarified. 4. c) Prior to application, stockpiled topsoil or imported topsoil has been assessed by an AQP1 to confirm it is suitable for target vegetation establishment. All sources and volumes of imported topsoil will be documented and locations where imported topsoil is used onsite recorded for reporting requirements. Source locations will exclude areas known to contain declared weeds (defined as a Category 2, 3, 4 or 5 restricted matter under the Biosecurity Act 2014). 4. d) Topsoil placed to an average depth of 150 mm (RA1 - RA5, RA7, RA9). 4. e) Onsite and imported topsoils quality will be assessed by an AQP1 and fertiliser / ameliorants applied at recommended rates prior to seeding for RA1 - RA5, RA7, RA9. 4. f) Active soil erosion and development of rills and gullies is repaired prior to seeding. •	• ITPs (topsoil and scalps) • Topsoil and subsoil quality assessment (this PRCP) • Rehabilitation records
Agreed PMLU is established and sustainably maintained	RM5	Revegetation	5. a) Seeding with Black Spear Grass (Heteropogon contortus) and Forest Bluegrass (Bothriochloa bladhii ssp. glabra) at a rate of 2 kg/ha each, and Lotonis (Lotononis bainsii) at 0.3 kg/ha, has been completed (RA1-RA5, RA7, RA9). 5. b) Pasture species germination and establishment have been assessed within 2 months of seeding. If any of the maintenance treatment triggers identified in Section 3.7.6 of the Murgon Operations Progressive Rehabilitation and Closure Plan have occurred, the maintenance treatments nominated in Section 3.7.6 of	• ITPs (revegetation) • Records of seed purchase • Rehabilitation records

Relevant objective	Milestone reference	Rehabilitation milestone	Milestone Completion Criteria	Validation
			the Murgon Operations Progressive Rehabilitation and Closure Plan have been applied as required.	
	RM6	Achievement of surface requirements	6. a) The rehabilitation monitoring program has been implemented. 6. b) Bare ground % is equivalent to at least a "fair" condition as defined by Future Beef (https://futurebeef.com.au/resources/land-condition/). 6. c) Native or introduced desirable palatable and productive species trending towards at least 50% of the vegetative ground cover. 6. d) Pasture standing biomass is >45% and trending towards 75% of average standing biomass of reference areas selected according to Section 3.7.1.5 of the Murgon Operations Progressive Rehabilitation and Closure Plan. 6. e) The cover of declared plant pest species will be no more than one rating2 greater than the average cover class recorded in reference areas selected according to Section 3.7.1.5 of the Murgon Operations Progressive Rehabilitation and Closure Plan. 6. f) No active3 gullies >1.0 m depth. 6. g) Any gullies <1.0 m >0.3m have shown progressive stabilisation (i.e., have become partly stabilised or stabilised)4 over successive annual monitoring events. 6. h) Temporary Erosion and Sediment Control Structures removed.	• Annual rehabilitation monitoring reports • Records of repair works
	RM7	Achievement of post-mining land use to stable condition (grazing)	7. a) An assessment of carrying capacity by an AQP1 demonstrates a sustainable grazing outcome has been achieved. 7. b) No active3 gullies >0.3 m depth. 7. c) Bare ground % is equivalent to at least a "fair" condition as defined by Future Beef (Land condition - https://futurebeef.com.au/resources/land-condition/).	• Annual rehabilitation monitoring reports • Records of repair works

Relevant objective	Milestone reference	Rehabilitation milestone	Milestone Completion Criteria	Validation
			7. d) Native or introduced desirable palatable and productive species trending towards at least 50% of the vegetative ground cover. 7. e) Pasture standing biomass is ≥ 75% of reference areas selected according to Section 3.7.1.5 of the Murgon Operations Progressive Rehabilitation and Closure Plan. 7. f) The cover of declared plant pest species will be no more than one rating greater than the average cover class recorded in reference areas selected according to Section 3.7.1.5 of the Murgon Operations Progressive Rehabilitation and Closure Plan.	
	RM8	Achievement of post-mining land use to stable condition (water storage)	8. a) An AQP1 has confirmed that geotechnical stability of the residual void walls (i.e., a factor of safety value of ≥1.3) has been achieved. 8. b) Access to the residual void is restricted by the installation of an appropriate abandonment barrier (bund and/or fence) located at least 10 m beyond the area potentially affected by void wall instability as specified Section 3.5.12.3. 8. c) Safety signage designed in accordance with relevant Australian Standards erected at a minimum of 100 m intervals. 8. d) An AQP1 confirms that the residual void walls drain internally to the residual void. 8. e) Pit Lake water quality physico chemical indicators do not exceed the trigger values for livestock (beef cattle) drinking water defined in Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 3 Primary Industries — Rationale and Background Information Sections 9.3.4 & 9.3.5 (ANZECC and ARMCANZ 2000) (RA6, RA8).	• Void wall inspection reports • Water quality monitoring reports
Retained permanent infrastructure is safe and fit for purpose	RM8	Retained infrastructure	9. a) Infrastructure to be retained has been signed off by an AQP1 as being in a suitable condition, with any residual hazards clearly documented. 9. b) A formal agreement is in place for transfer of liability associated with retained infrastructure.	• Records of hazard inspection report and sign-off by AQP • Evidence of formal agreement regarding transfer of liability

3.4. Non-Use Management Areas

No non-use management areas (NUMAs) will be present at Murgon at closure. They have not been considered during the preparation of this PRCP.

3.5. Rehabilitation Management Methodology

The following information contains information on issues that may affect the whole site (Section 3.5.1 to Section 3.5.14) and those relevant to specific areas or rehabilitation activities (remaining Sections).

3.5.1. Hydrogeological assessment

The groundwater setting and information of groundwater depth and characteristics is provided in Section 3.1.5. The following sections provide a hydrological assessment as it relates to the interaction of the void with groundwater resources and the potential for impact on groundwater quality and groundwater levels.

3.5.1.1. Regional groundwater flow

As a result of limited groundwater data within the region it is not possible to determine water level contours and derive groundwater flow directions (refer Section 3.1.5.1). However, considering the geology of the region, it is considered that the limestone deposit was made by North to South fracture zones transporting groundwater.

ERM (2008) specify the fractured rock groundwater system at Murgon is recharged by a localised fracture network that is replenished by annual rainfall. While there is a small amount of seepage seen in the pit, there are no groundwater springs or other potential discharge locations reported within the ML.

3.5.1.2. Mine void groundwater interaction and water quality

Groundwater seepage into the void has been observed to date (ERM 2008, Rocktest Consulting 2022). As specified in Section 3.1.5.1 there are localised fractures (joints) exposed in the pit walls that allow small seepages that ERM (2008) summarise as being derived from rainfall recharge into the local limestone. It is not believed that the void intersects the known aquifer in the area as shown in Figure 14 nor Barambah Creek (ERM 2008).

Water quality testing has been conducted for several water quality parameters listed in the ADWG (NHMRC 2011) and the ANZECC & ARMCANZ (2000) stock water guidelines as summarised in Section 3.1.5.7.

The results indicated that there have been no impacts to water quality to date that would affect the protection of relevant environmental values applicable to the site. Given existing water quality, the nature of the operation and the mineral resources being targeted, the risk of elevated contaminant concentrations being transported from the site via groundwater and impacting on downstream environmental values is negligible.

The water quality data to date indicates that the water quality in the final void at closure is expected to be suitable for use for stock (and safe for native fauna).

3.5.1.3. Groundwater dependent ecosystems (GDEs)

According to the Queensland Government Wetland Maps database (2022c), two moderately rated GDEs exist within a 2 km radius of site. When cross-referencing against the GDEs from BoM Atlas (2022), the same GDEs are referenced.

AQUATIC

The Wetland Maps have identified a surface expression GDE with the set name 'permeable geologies including deeply weathered basalt (red soils)' within proximity of the site. The class of GDE is 'surface ecosystem dependent on the surface expression of groundwater'. This classification of the GDE has confidence rating of moderate and is located not within the ML but approximately 380 m from site. Since the site/operation does not sit within the same formation, it may not have the potential to cause harm to this GDE.

TERRESTRIAL

There are no terrestrial GDEs within the ML, however the Wetland Map database has identified derived GDE with moderate confidence rating approximately 1.3 km from the ML. The permeable geologies including deeply weathered basalts (red soils) has been identified as a surface ecosystem dependent on the sub-surface presence of groundwater.

SUBTERRANEAN

No Subterranean GDEs have been identified in the ML or surrounding 2 km buffer distance.

3.5.1.4. Groundwater conceptualisation and hydrological summary

There is limited information on the Barambah Creek Alluvial Aquifer and fractured rock aquifers within the Bjelke Petersen Beds and other rock units such as the Esk Formation. Upon review of the regional bore information, the bores are screened within gravel and sand of the Barambah Creek Alluvial Aquifer, with depths ranging from 4.04 to 5.22 (mbgl). Groundwater level readings taken from the alluvial aquifer system show a range between 286.59 and 290.88 m AHD within the Barambah Creek Alluvium Formation.

Recharge of the system is likely to be predominately recharge through direct rainfall or surface water flows.

3.5.2. Flooding

A preliminary flood assessment was undertaken in 2022 to consider the risk that flood events may have on the final landform design. The assessment concluded that a 1% Annual Exceedence Probability (AEP) flood event could impact the void, infrastructure and processing areas, with extensive flooding during more extreme events.

Graymont commissioned Pitt & Sherry to undertake further modelling and assessment to:

- Validate the preliminary assessment predictions.
- Evaluate final landform stability in the predicted peak flood conditions.
- Evaluate the long-term integrity of the proposed abandonment bund.
- Evaluate the potential for contaminant release from the pit void during periods of flooding.

This report (Pitt & Sherry 2023) is included as Appendix J.

Modelling was undertaken using HEC-HMS 4.10 software and considered several scenarios:

- 1% AEP flood scenario.
- Probable Maximum Flood (PMF) flood scenario.
- Sunny day dam break failure of Joh Bjelke Peterson Dam with no flows in Barambah Creek.
- Dam break failure of the dam with concurrent flooding in Barambah Creek.

3.5.2.1. Impacts of flooding on landform integrity

The model predicts that natural flood waters will be largely confined to the areas adjacent to Barambah Creek, even during PMF conditions. However, the southwestern corner of the pit void is relatively close to the creek and is predicted to be subject to inundation, even during a 1% AEP event (Figure 27).

Whilst flood waters are predicted to extend into the site during periods of high rainfall, it is not predicted to result in significant scouring of constructed landforms. The risk of scouring is related to the velocity of catchment flows, and these are predicted to be modest in the location of site final landform features (Pitt & Sherry, 2023). Vegetated rehabilitation areas should have sufficient root matrix stabilisation to withstand these relatively mild erosive forces. Further, the proposed abandonment bund will be constructed with competent rock (>200mm particle size) that will provide adequate protection.

A dam break scenario of Joh Bjelke Peterson Dam (based on available information) is predicted to result in significant inundation of the site. Velocities have not been modelled due to uncertainties in model input data but may be sufficient to result in damage to the constructed landforms. However, this would be a highly unlikely event scenario, and the risk would be further mitigated by the elevated position of the site within the broader landscape, which will result in a natural velocity reduction.

3.5.2.2. Risk of contaminant release during periods of flooding

Geochemical enrichment of the Murgon pit lake is unlikely given the high volumes of neutralising geology with high bicarbonate alkalinity that will prevent acid formation and the subsequent mobililisation of metals from the pit walls.

However, in locations where evaporation exceeds rainfall, as is the case at Murgon, pit lake water quality can generally be expected to decrease over time due to the evapoconcentration (i.e. because the net

loss of water due to evaporation exceeds the water input from rainfall, salts will become progressively more concentrated).

In this situation, periodic flooding of the pit would offset the effects of evapoconcentration by diluting the impacted water with a pulse of fresh water, thereby limiting the build-up of salt concentrations, and maintaining good water quality. Furthermore, a portion of the salt load that develops within the pit lake will be flushed from the pit during a period of maximum dilution, when it would not be expected to result in any material impact to the surrounding environment. Periodic flushing during periods of flooding would therefore be a net positive outcome given that flood waters are not predicted to impact the physical integrity of the final landform.

The risk of impacts to the receiving environment are assessed to be very low because:

- The absence of acid forming geologies (e.g. reduced sulfides), along with significant quantities of neutralising geologies (dominated by bicarbonates) will prevent acid formation and the mobilisation of environmentally harmful metals from the pit walls.
- Episodic flushing of the pit lake with fresh water during flood events will prevent significant deterioration of water quality through evapoconcentration.
- In addition to a low contaminant loading during flood events, impacts would be further reduced by the significant dilution that occurs during these periods.

3.5.3. Soil and capping material assessment

3.5.3.1. Topsoil

The recovery of soils ahead of mining disturbance has been optimised for strategic use in rehabilitation. Topsoil will also be recovered from any additional areas that will be disturbed prior to closure (such as the pit extension). Topsoil management includes:

- Maintaining a topsoil resource inventory (mass balance) across the site to ensure topsoil resources are available for rehabilitation and closure.
- The following stripping and stockpiling techniques will be implemented to prevent excessive soil deterioration:
  - Topsoil material should be stripped when moist/friable condition. Material should not be stripped when it is either dry (dusty) or too wet.
  - Where possible stripped topsoil should be direct-placed onto reshaped limestone waste and spread immediately (if mining sequences, equipment scheduling and weather conditions permit).
  - As a general rule, stockpile will be no more than 3 m in height. Stockpiled greater than 3 m may occur for short periods and with appropriate amelioration during spreading and revegetation process.

- Prior to re-spreading stockpiled soil onto reshaped limestone waste, it will be inspected for weeds or undesirable pasture species. Serious infestations will be treated prior to respreading with appropriate herbicide application and/or “scalping” of surface material to remove the weeds and seed bank.

Graymont commissioned SESL to undertake soil analysis for soil samples taken from topsoil stockpiles (six samples) and from "scalps" (two samples) (SESL 2021). Scalps are a clayey material from the screen on the primary crusher and represent weathered soil forming material that if suitable could be used as part of the rehabilitation process either as a subsoil material or, in the event of a topsoil shortage, as a topsoil alternative subject to appropriate amelioration. The results from SESL have been further reviewed by ELA's Certified Professional Soil Scientist for this PRCP in line the rehabilitation and revegetation strategy.

The results of analysis of the stockpiled topsoil are presented in Table 23. The results indicate that the available soil resources:

- Are slightly acidic to slightly alkaline (based on pH in $CaCl_2$) and not limiting to the nominated PMLU
- Have low to slight salinity but very low soluble chloride content which is not limiting to the nominated PMLU
- Have moderate to high cation exchange capacity (nutrient retention capacity)
- Are non-sodic and not at risk of soil dispersion and tunnel erosion
- Generally have good quantities of readily available N
- Are generally low in available phosphorus, potassium and sulfur. Although the available phosphorus levels may be adequate for native species, for productive pasture establishment inclusive of legumes and additional phosphatic fertiliser application would be beneficial. All soils will require some amelioration as part of soil preparation works (Section 3.5.8).

Table 23: The results of analysis of the topsoil stored in stockpiles

Analyte	Units	Stockpile 1 sample 1	Stockpile 2 sample 1	Stockpile 2 sample 2	Stockpile 3 sample 1	Stockpile 3 sample 2	Stockpile 4 sample 1	Average
pH (in $CaCl_2$)	Units	6.69	7.05	6.8	7.57	7.68	6.29	7.01
Electrical Conductivity (EC 1:5 extract)	dS/m	0.12	0.24	0.21	0.18	0.15	0.14	0.17
Salinity rating	NA	Low	Slight	Slight	Low	Low	Low	-
Exchangeable calcium	cmol+/kg	14.07	19.21	15.92	25.52	27.78	6.43	18.16
Exchangeable magnesium	cmol+/kg	7.37	6.36	4.78	5.84	5.25	12.06	6.94
Exchangeable potassium	cmol+/kg	0.28	0.31	0.30	0.16	0.16	0.16	0.23
Exchangeable sodium	cmol+/kg	0.50	0.45	0.38	0.38	0.38	0.88	0.50
Effective Cation Exchange Capacity (ECEC)	cmol+/kg	22.22	26.33	21.38	31.9	33.57	19.53	25.82
Exchangeable sodium percentage (ESP)	%	2.3	1.7	1.8	1.2	1.1	4.5	2.1
Sodicity rating	NA	Non-sodic	Non-sodic	Non-sodic	Non-sodic	Non-sodic	Non-sodic	-
Chloride	mg/kg	67.1	34.7	43.7	26.5	34.3	43.9	41.7
Nitrate-N	mg N/kg	27	55	65	18	13	53	38.5
Available phosphorus (P)	mg P/kg	12.9	16.3	9.39	11.3	14.1	<5	11.50
Available iron (Fe)	mg/kg	99.6	118	80.8	77.5	60.7	76.8	85.57
Available manganese (Mn)	mg/kg	78	108	81	104	105	50	87.67
Available copper (Cu)	mg/kg	2.9	3.4	2.6	1.3	1.5	1.7	2.23
Available boron (B)	mg/kg	1	1	0.9	0.6	0.7	0.9	0.85
Available zinc (Zn)	mg/kg	<0.65	0.9	<0.65	<0.65	<0.65	<0.65	0.69

The results of analysis for the scalps is summarised in Table 24 The results of the analysis of "scalps".

Table 24 The results of the analysis of "scalps"

Analyte	Units	Sample 1	Sample 2	Average
pH (in $CaCl_2$)	Units	7.63	7.50	7.57
Electrical Conductivity (EC 1:5 extract)	dS/m	0.14	0.18	0.16
EC_{SE} (estimated saturate paste extract)	dS/m	1.30	1.50	1.40
Textural Class	NA	Sandy clay loam	Fine sandy clay loam	NA
Approximate clay content (low range)	%	20-30	30-35	c.30
Salinity rating	NA	Low	Low	Low
Exchangeable Calcium	cmol+/kg	190.77	96.96	143.87
Exchangeable Magnesium	cmol+/kg	2.70	3.98	3.34
Exchangeable Potassium	cmol+/kg	0.09	0.23	0.16
Exchangeable Sodium	cmol+/kg	0.13	0.13	0.13
Effective Cation Exchange Capacity (ECEC)	cmol+/kg	193.69	101.30	147.50
Exchangeable Sodium percentage (ESP)	%	0.07	0.13	0.10
Sodicity rating	NA	Non-sodic	Non-sodic	Non-sodic
Chloride	mg/kg	26.5	15.2	20.9
Nitrate-N	mg N/kg	7.5	14	10.8
Available phosphorus (P)	mg P/kg	<5	13.5	13.5
Available iron (Fe)	mg/kg	44.3	51	47.7
Available manganese (Mn)	mg/kg	47	51	49.0
Available copper (Cu)	mg/kg	3.8	3.2	3.5
Available boron (B)	mg/kg	0.1	0.4	0.3
Available zinc (Zn)	mg/kg	5.8	4.9	5.4

The scalps material is non-sodic and has a medium soil texture, slightly alkaline pH and low salinity. However, it is low in major nutrients. There is no physical or chemical limitation to this material being used as a subsoil or a soil forming material for manufacture of a topsoil substitute.

The scalps require no amelioration if they are used as a subsoil. If they are used as a topsoil substitute, they will require amelioration with 10% organic material (such as recycled organics) and an application of 200 kg/ha (20 g/m^2) of monoammonium phosphate (or equivalent) and 400 (40 g/m^2) of muriate of potash (potassium sulfate) to improve fertility.

3.5.3.2. Material Balance

There are four topsoil (Figure 1) stockpiles on site that have a combined volume of 9,345m^3. Additionally, there is approximately 25,000 m^3 of scalp product which can be used as a topsoil substitute. Based on the areas to be rehabilitated and the available topsoil resources, the nominal topsoil or topsoil substitute application depth will be 150 mm. Topsoil will be required for RA2 - RA5, RA7 and RA9. The

material balance for closure is provided in Table 25 below which shows a small surplus available for contingencies/repairs as required.

Table 25 Topsoil Material Balance

Location	Disturbed Area
RA2	6,900 m^2
RA3	64,400 m^2
RA4	1,200 m^2
RA5	50,400 m^2
RA7	23,500 m^2
RA9	2,000 m^2
Sub-total	**148,400 m^2**
Application depth	**0.15 m**
Total topsoil required for rehabilitation	**22,260 m^3**
Deficit of topsoil	**12,915m^3**
Available scalps as a topsoil replacement	**25,000 m^3**
Scalps to be used as subsoil on RA3	**9,660 m^3**
Surplus of scalps	**2,425 m^3**

There is sufficient scalps available to provide a subsoil layer to a depth of 150 mm on RA3.

Any surplus of scalps material at closure will be preferentially used in the rehabilitation of the remaining areas of RA3.

3.5.3.3. Capping requirements

No reactive wastes or geochemically unstable materials that require the placement of an engineered capping layer will remain on-site at Murgon at relinquishment. No engineered capping is required and therefore no capping material assessment is necessary.

3.5.4. Waste characterisation

Graymont commissioned SESL to characterise waste rock within the overburden dumps (SESL 2021). Samples were selected to be representative, accounting for areas with clear variability in material. Total element analysis was conducted using X-ray Fluorescence (XRF) methodology, and the presence of minerals was identified using X-Ray Diffraction (XRD). The dispersion percentage was also determined.

A summary of the XRD results has been provided in Table 26. None of the minerals identified are considered to pose a risk to environmental receptors as they are not acid-generating upon weathering.

Table 26. Summary of the XRD results from the waste rock dumps

Sample ID	Waste rock dump location	Minerals
SESL_N1	Northern	• Quartz, micaceous minerals at rarer alumino-silicates • Clay minerals including kaolinite or montmorillonite
SESL_N2	Northern	
SESL_N3	Northern	

Sample ID	Waste rock dump location	Minerals
SESL_N4	Northern	• Iron oxides
SESL_NE1	North-eastern	• Quartz, micaceous minerals at rarer alumino-silicates • Clay minerals including kaolinite or montmorillonite • Iron oxides • Calcite
SESL_NE2	North-eastern	
SESL_NE3	North-eastern	
SESL_NE4	North-eastern	
SESL_NE5	North-eastern	
SESL_NE6	North-eastern	
SESL_NE7	North-eastern	

XRF results indicate low concentrations of heavy metals, including those of primary concern. Concentrations of arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), nickel (Ni), and zinc (Zn) were negligible.

The dispersion % (proportion of clay that is goes into suspension on mechanical agitation) was classified as 'slight'. A summary of sample results can be seen in Table 27.

Table 27. Dispersibility results from waste rock dump sites

Sample ID	Clay dispersion (%)	Rating
Topsoil NE dump north dispersion	7.75	Slight
Topsoil north dump dispersion	13.2	Slight
Topsoil NE dump south dispersion	7.19	Slight
Topsoil NE dump south dispersion	8.06	Slight

SESL concluded that the XRD, XRF, and dispersibility results suggest that there is minimal environmental risk of acid mine drainage or dispersion presented by the mining overburden and that the material is fit for reuse in revegetation works onsite. The results align with water quality results from the void and sediment dam (Table 6 to Table 7) receiving mine affected drainage and there is no evidence of acid pH, elevate salt or elevated metals that would indicate the potential for acid, metalliferous or saline mine drainage.

3.5.5. Cover design

No reactive wastes or geochemically unstable materials that require the placement of an engineered capping layer will remain on-site at Murgon at relinquishment. No engineered capping or cover design is required.

3.5.6. Landform design

This section relates to the landform development of the areas outside the Open Pit (Residual Void). The landform development for the Residual Void is discussed separately in Section 3.5.12.

3.5.6.1. Existing landform

The existing landforms in the disturbance areas are broadly described below.

- The northern and eastern portion of the ML disturbance is predominantly occupied by the elevated North and North-eastern Overburden Dumps (RA1, RA2 and RA3), topsoil stockpiles (located on the overburden dumps part of the laydown area (RA5), part of the network of access tracks (RA7) and Sediment Dams A and B (RA8)
- The southern portion of the ML disturbance is level or gently included and consists of Sediment Dam D (RA8), Sediment Dam C (which will be decommissioned as the pit is developed to its full extent) (RA4), HME parking area and fuel tank (RA9), the balance of the network of access tracks (RA7) and laydown areas, stockpiles, offices/buildings and plant (RA5); some of which will be retained at closure (RA10).

3.5.6.2. Final landform design requirements

The most significant reconstructed landform remaining at Murgon will be the overburden dumps. The maximum height, area and shape of the overburden dumps have been designed with regard to the area of land available, and as far as practical, the geometry of the surrounding natural landforms. The overburden dumps abut the natural slopes and have final slopes in keeping with the surrounding landscape (Figure 27). Design has been informed by the Ground Control Management Plan - Murgon Limestone Mine (Sibelco 2016) developed by the previous operator with the input of the current external geotechnical engineering consultant Tony Meyers. To aid stability, during construction, no clays were placed in extensive layers near the base of the dump and only granular material was placed in these areas. Reject material from the processing plant (core, knibs) and clays are contained in cells within the dump rather than spread in thin layers.

Rocktest Consulting (2022) has confirmed that at the end of mine life, the overburden dumps will have met the design intent with the design parameters presented in Table 28.

Table 28 Specifications for the Northern and North-eastern Overburden Dump at end of mine life

Description	Specification	
	Northern Dump	**North-eastern Dump**
Trend for major axis	048°	350°
Length of major axis footing	290m	480m
Length of minor axis footing	235m	375m
Maximum height of dump	31m	40m
Bench heights	3.5 to 5m	5m
Maximum number of benches	5	8
Berm widths	7.5m	5.5m
Batter angles	12° to 18°	18°
Overall slope angles	15°	14°
Minimum concave grade on upper levels for drainage	2°	2°

For final closure, Rocktest Consulting (2022) have recommended the following measures be included to ensure the long-term geotechnical stability and minimise erosion and settlement. Rehabilitation of the north-eastern dump should include:

- Reducing slopes, ramps and haul roads to <14°

- Grading the upper surface to achieve an overall concave shape (to prevent water draining over the crest of the dump)
- Compact the slopes and surfaces to achieve as high a density of underlying material as practical
- Place a 1 m high edge bund of durable rock 1 m behind the crests of the upper surface to control flows of water and prevent access to the surface by vehicles.

The existing ground surface of the remaining rehabilitation areas dominated by RA5, RA7 and RA9 generally conforms to the pre-existing ground level and does not require specific landform design work. These areas naturally drain to Sediment Dam D and minor earthworks will be required to direct flows away from the void.

All RAs not associated with the residual void will have final slopes consistent with EA condition Schedule F – Table 1 to support achievement of the nominated grazing PMLU.

Permanent water management structures are dealt with in Section 3.5.7.2.

3.5.6.3. Final landform concept design

Figure 27 and Figure 28 display the concept final landform design and cross section across the site at completion of rehabilitation including a cross section through the most significant post mine landform features (residual void and the North-eastern overburden dump).

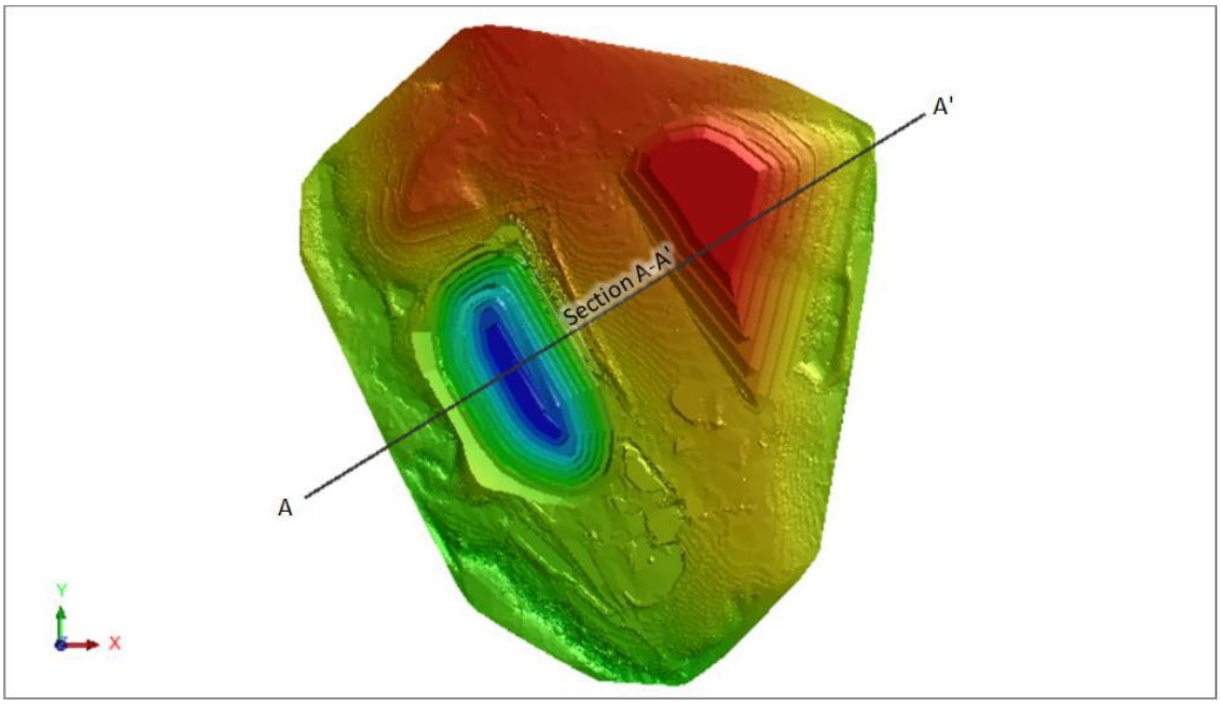

Figure 27 Final landform 3D elevation at completion of rehabilitation (Source: Graymont)

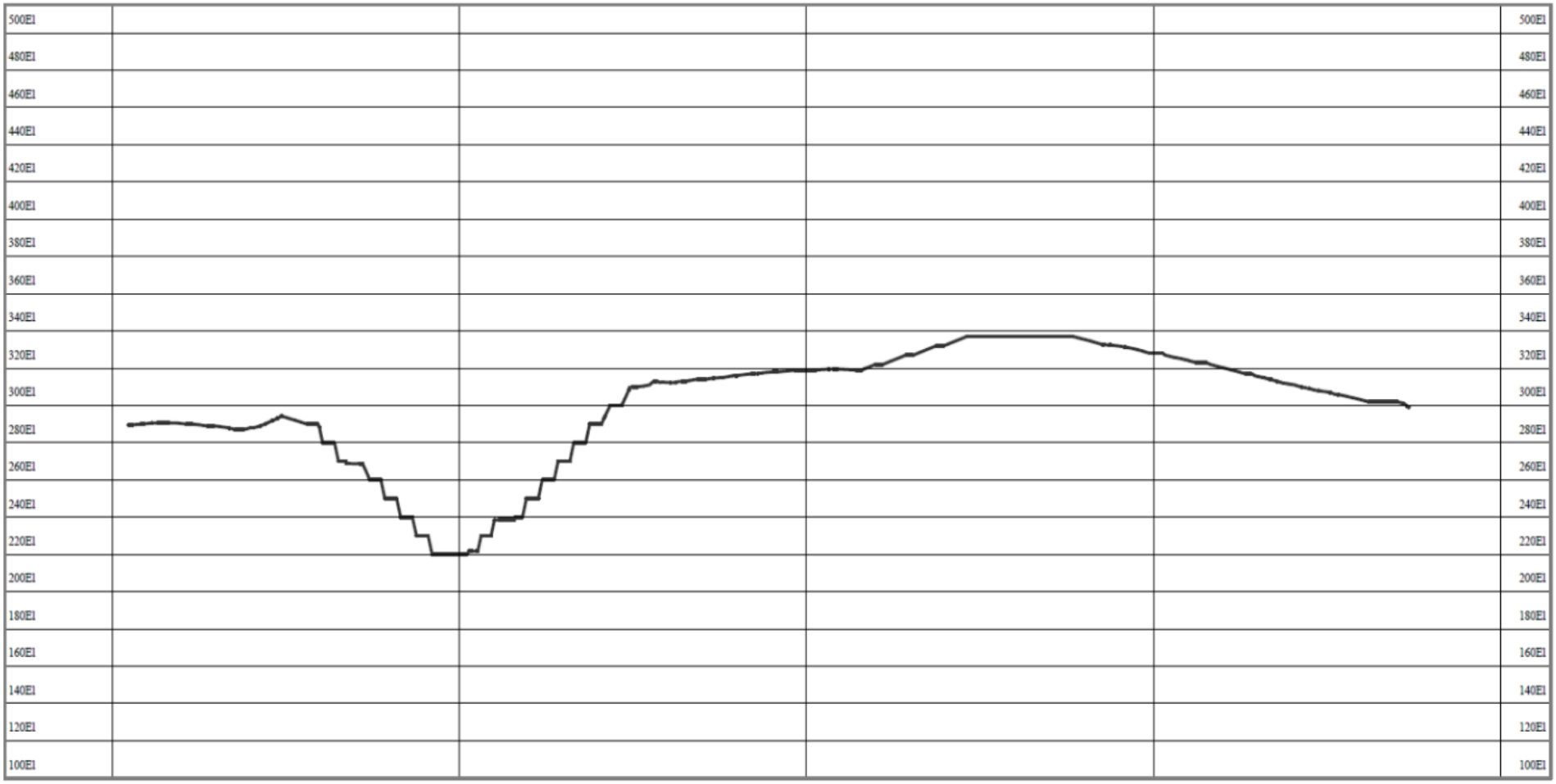

Figure 28 Final landform section view showing RL on the y axis (Source: Graymont)

3.5.7. Water management

The main potential source of contamination at Murgon is waste petroleum hydrocarbon (from fuel storage or workshop and minor spills). Materials characterisation and water quality monitoring to date has not revealed any significant contamination associated with ore, product or waste material at this site. Based on known and potential risks, a conceptual site model (CSM) has been developed for the site displaying the source, likely significant pathways and environmental and sensitive receptors.

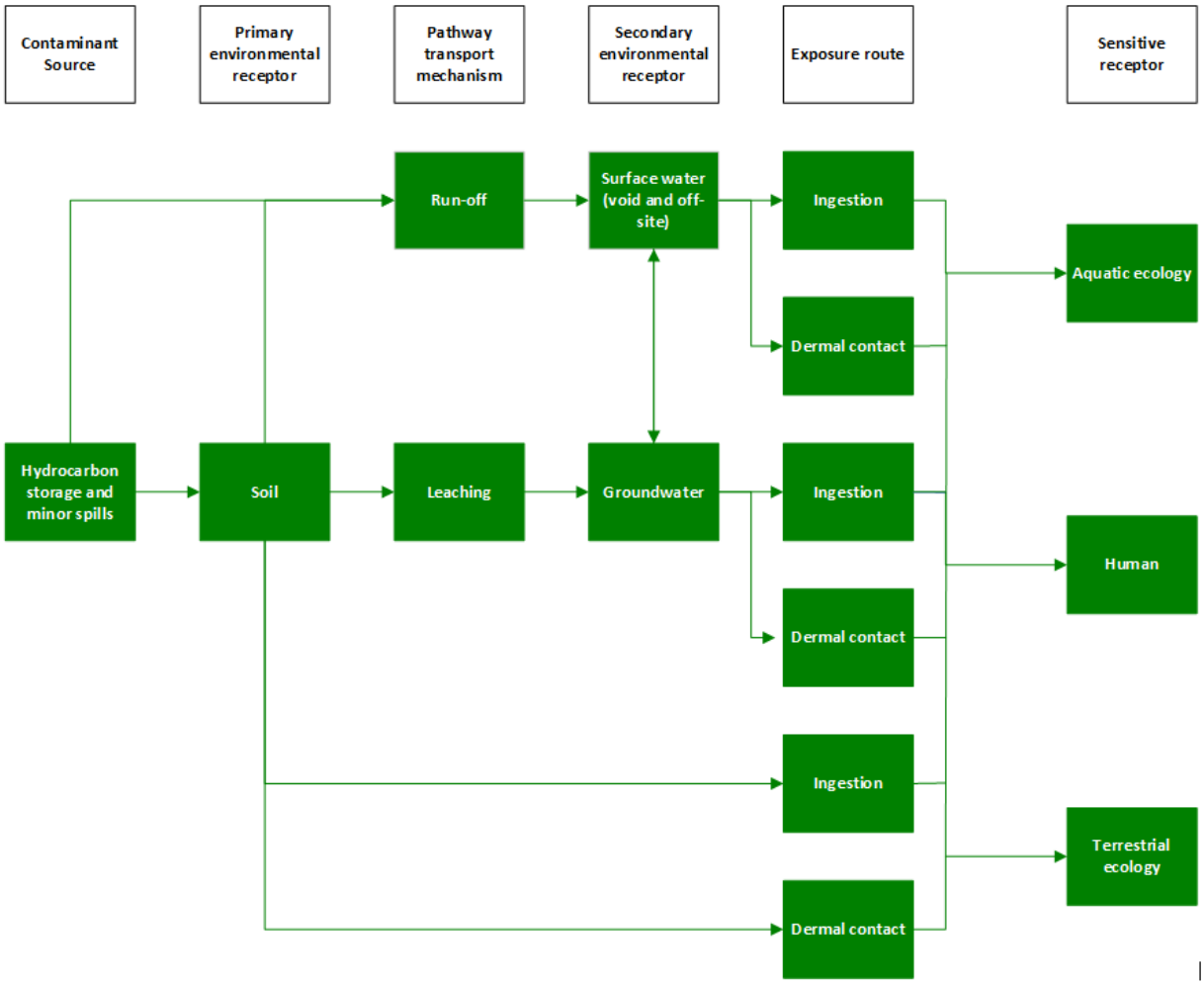

Figure 29 CMS for the Murgon Operation

3.5.7.1. Operational water management

Based on the topography of site, there are currently four catchments, being Catchment A, Catchment B, Catchment C and Catchment D. All four catchments have an associated sediment dam with the purpose to contain any drainage from operational areas associated with the catchment area. As per the EA, sediment dams A, B and D have been designed to hold a 1 in 10-year 24 hour storm ARI event. Sediment dam C does not receive direct run-off and does not need to be designed to a specific design event. It provides only temporary storage for water pumped from the void (used for process make up water etc).

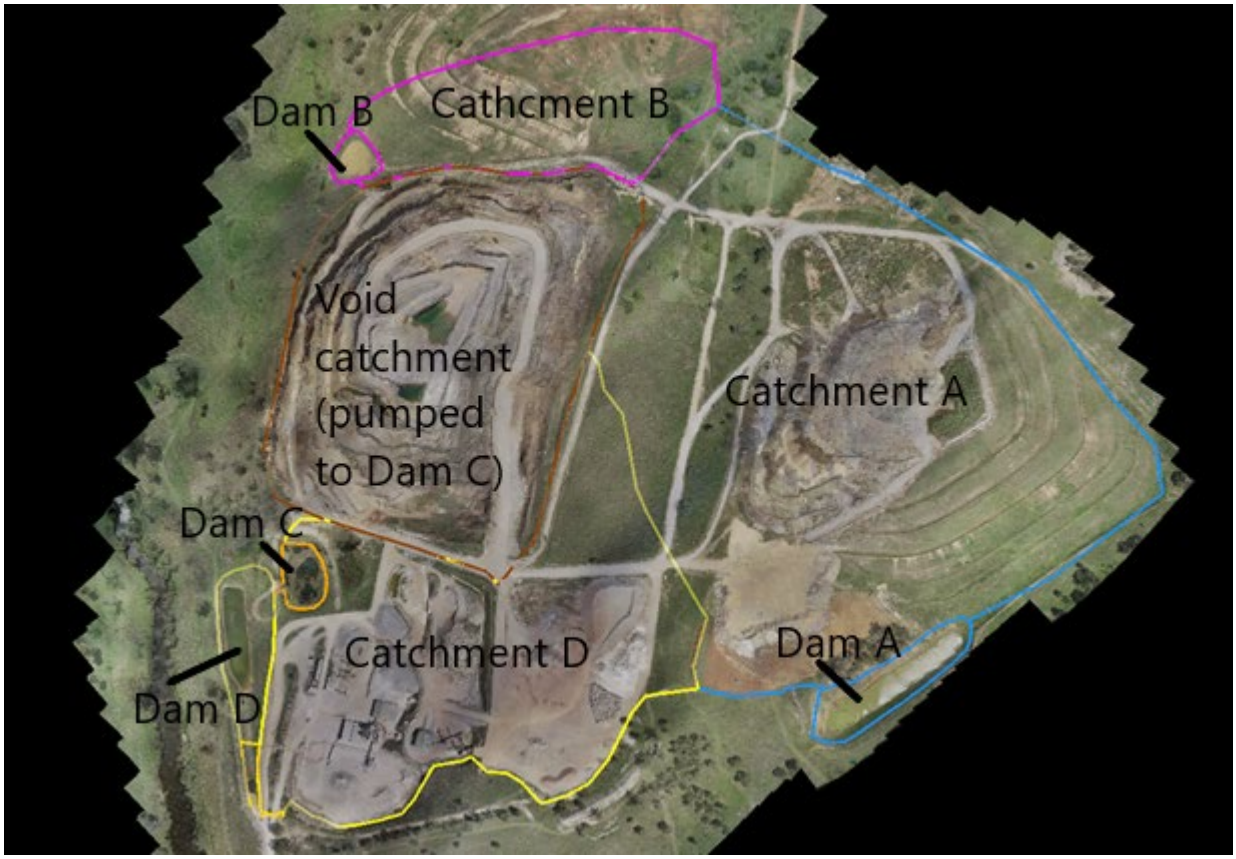

Figure 30 Operational sediment dams and catchments (Source: Graymont)

Table 29 Description of operational sediment dam catchments

Catchment/Sediment Dam	Description	Catchment area	Sediment Dam Capacity
Catchment A/Sediment Dam A	Drainage area for North eastern overburden dump	156,800 m²	10.1 ML
Catchment B/Sediment Dam B	Drainage area for the Northern overburden dump	30,500 m²	2.74 ML
Catchment C/Sediment Dam C	Void (pumped to sediment dam C)	81,700 m²	2 ML
Catchment D/Sediment Dam D	Drainage area for the Plant offices, laydown and stockpile areas	~35,000 m²	10.5 ML

The site water management plan was developed by ERM (2008) for the previous owners (Unimin Australia Limited, renamed Sibelco Australia) and has been adopted by Graymont. Operational water management is described in the following sections.

OBJECTIVES

The objectives of the water management plan are to meet the conditions listed under Schedule C1.1 to C1.5 of the EA.

TARGETS AND PERFORMANCE INDICATORS

The target is to comply with EA conditions Schedule C, specifically:

- C1-1: There must be no release of contaminants to waters except as authorised by Condition (C1-3)
- C1-3: Releases from the water management system to waters may only occur as a result of heavy or prolonged rainfall (equivalent to that expected from a 24-hour storm with an average recurrence interval of 1 in 10 years), and must comply with the limits prescribed in Schedule C Table 1
- C1-4: Releases from the water management system to waters must be monitored for the parameters and at the locations and frequencies defined in Schedule C Table 1
- C1-5: Notwithstanding the quality characteristic limits specified in Schedule C Table 1, the contaminants released must not have any properties nor contain any organisms or contaminants in concentrations that are capable of causing environmental harm.
- C2-1: All reasonable and practicable erosion protection measures and sediment control measures must be implemented and maintained to minimise erosion and the release of sediment.

The performance indicators are:

- No contaminants are released from site.
- Erosion and sediment controls are in place, maintained and monitored for effectiveness.

CONTROL MEASURES

Water management controls associated with the site are provided below:

- The extent of disturbed land is kept to a minimum area necessary for works.
- Overflow diversion bunds are installed around site to direct water to the applicable sediment dam.
- Sediment controls dams are regularly monitored and maintained as required.
- Pit water management is considered suitable with direct discharge to Sediment Dam C. Overflow water from the Northern Overburden Dump is directed to Sediment Dam B. Water from the North-eastern Overburden Dump is directed to Sediment Dam A. Water from the plant and stockpile area is directed to Sediment Dam D.
- The site drainage is designed so that clean water from undisturbed areas of the site is directed away from disturbed area catchments.
- Hydrocarbons are stored in self-bunded, above ground tanks, lubricants and waste oil are stored in a self-bunded dangerous goods storage shed. Bunding is compliant with Australian Standards (AS) 1940-2004 the storage and handling of flammable and combustible liquids.
- Spill control equipment is stocked at specific locations around the site for spill response.
- Vehicles are well maintained to avoid fuel or oil leakage.

In general, these controls have been successful in preventing contamination of site drainage and the maintenance of water quality in Barambah Creek (see Section 3.1.4.2).

MONITORING AND PERFORMANCE

- Event based monitoring of all on site dam water quality is undertaken to conform with EA criteria. This includes sampling for each release from the water management system and then weekly while flow continues.
- Monitoring points and requirements:
  - W1 - representative water samples must be collected within 20 m of the confluence of Barambah and Barkers Creeks, upstream of the point where runoff from areas of ML 50111 that are being used for mining activities potentially enter these watercourses.
  - W2 - representative water samples must be collected from Barambah Creek, downstream of, but within 100 m of the final discharge point for stormwater for the site to the creek.
  - WS3: (additional site not covered by the EA) main water sedimentation dam on site that captures run-off from the main area of operations (sediment dam D).
  - WS4: (additional site not covered by the EA) mine void sump (sediment dam C).

3.5.7.2. Rehabilitation and closure water management

The objective for rehabilitation and closure water management is to use Best Practice procedures to control the severity and extent of soil erosion and pollutant transport during the rehabilitation to provide long-term stability for closure.

CONTAMINANT MANAGEMENT

The rehabilitation strategy for site ensures that all known sources of potential contaminants that pose a risk to environmental values of the receiving environment will be removed. A contaminated land site investigation will be undertaken at closure and the site remediated to a safe condition. At closure, it is not expected that water stored in the void will require any additional treatment to reduce contaminants.

REHABILITATION CONSTRUCTION EROSION AND SEDIMENT CONTROL

Contractors engaged to undertake rehabilitation works will be required to provide a detailed Erosion and Sediment Control Plan to Graymont as part of contract deliverables. This document must be provided prior to ground disturbance and should include design specifications consistent with *best Practice Erosion and Sediment Control series* (IECA 2008).

Additionally, the following would be expected:

- Where possible, works will be scheduled to occur outside the main wet season.
- Work will be scheduled to minimise the extent of disturbed / exposed areas as much as possible.
- Disturbed land will be revegetated as soon as possible following earthworks.
- Temporary sediment controls to be implemented to minimise off site sediment transport including the use of sediment fencing (or equivalent) or temporary covers for any earthen material temporarily stockpiled onsite.
- Additional temporary sediment controls to be constructed where stormwater leaves the site. Based on the success of operational controls, rock filter dams would be appropriate.

The EA provides an appropriate target for suspended solids in discharges from site. The quality of water leaving the site will be no more than 10 mg/L above a background value (at W1) where the background

value is less than 100 mg/L or 10 percent greater than a background value where the background value is greater than 100 mg/L.

Any non-compliance with agreed performance criteria will be identified and corrective action undertaken as required. All temporary erosion and sediment control structures will be removed from site when vegetation is established, and the risk of erosion and sediment generation has been minimised.

PERMANENT FEATURES FOR CLOSURE

Some of the current diversion bunds used to control water flows across the site and direct water to sediment dams will be retained at closure. This is to:

- Minimise surface run-off to the void to minimise erosion and maintain void wall stability.
- Provide additional protection of downstream water quality by directing surface run off from rehabilitated areas to sediment dams.
- Maintain the water supply for the sediment dams (dams A, B and D) to be retained for PMLU of water storage (as covered under a Landholder Statement in Appendix G).

The diversions to be retained are shown in Figure 31.

The specifications and condition of the bunds to be retained will be assessed during rehabilitation implementation and repaired and upgraded as required in accordance with the *Best Practice Erosion and Sediment Control Series* (IECA 2008).

3.5.8. Site preparation and topsoiling

All compacted areas will be ripped to a depth of 500 mm at 500 – 800 mm spacings to relieve compaction. On overburden dump slopes, ripping will be undertaken on the contour following the spreading of scalps (subsoil) and topsoil to allow them to be keyed into the surface.

Scalps will be preferentially used to provide subsoil material for the rehabilitation of the remaining section of the North-eastern Overburden Dumps to increase the depth of the available growing medium. Based on a current material balance, there is sufficient material to allow a coverage of 150 mm. This will be placed after reshaping and prior to topsoil application. If scalps volume is higher than current at closure, this depth can be increased accordingly.

Based on the baseline soils information, topsoil for all future rehabilitated areas will be placed to a depth of 150 mm for all areas with a nominated PMLU of grazing (see further justification in Section 3.3.2.1).

No lime or gypsum is required as the soils are not acidic and are non-sodic.

The generic fertiliser rates provided by SESL were reviewed and amended to reflect a suitable initial establishment dressing for the pasture species specifically nominated in the PRCP Based on the soil test results, soil characteristics and crop requirements, an establishment dressing for areas using stockpiled topsoil of a compound fertiliser containing N, P (low), K and S (such as Crop King 88 or equivalent) will be applied at a rate of 300 kg/ha (30 g/m^2). For areas where scalps will be ameliorated to provide a topsoil substitute, they will require amelioration with 10% organic material (such as recycled organics) and an application of 200 kg/ha (20 g/m2) of monoammonium phosphate and 400 (40 g/m2) of muriate

of potash (potassium sulfate) to improve fertility. After incorporation of ameliorants, a seedbed will be prepared using harrows.

Fertiliser will only be applied to areas of existing revegetation (RA1) if vegetation appears to be deficient or ground cover is low.

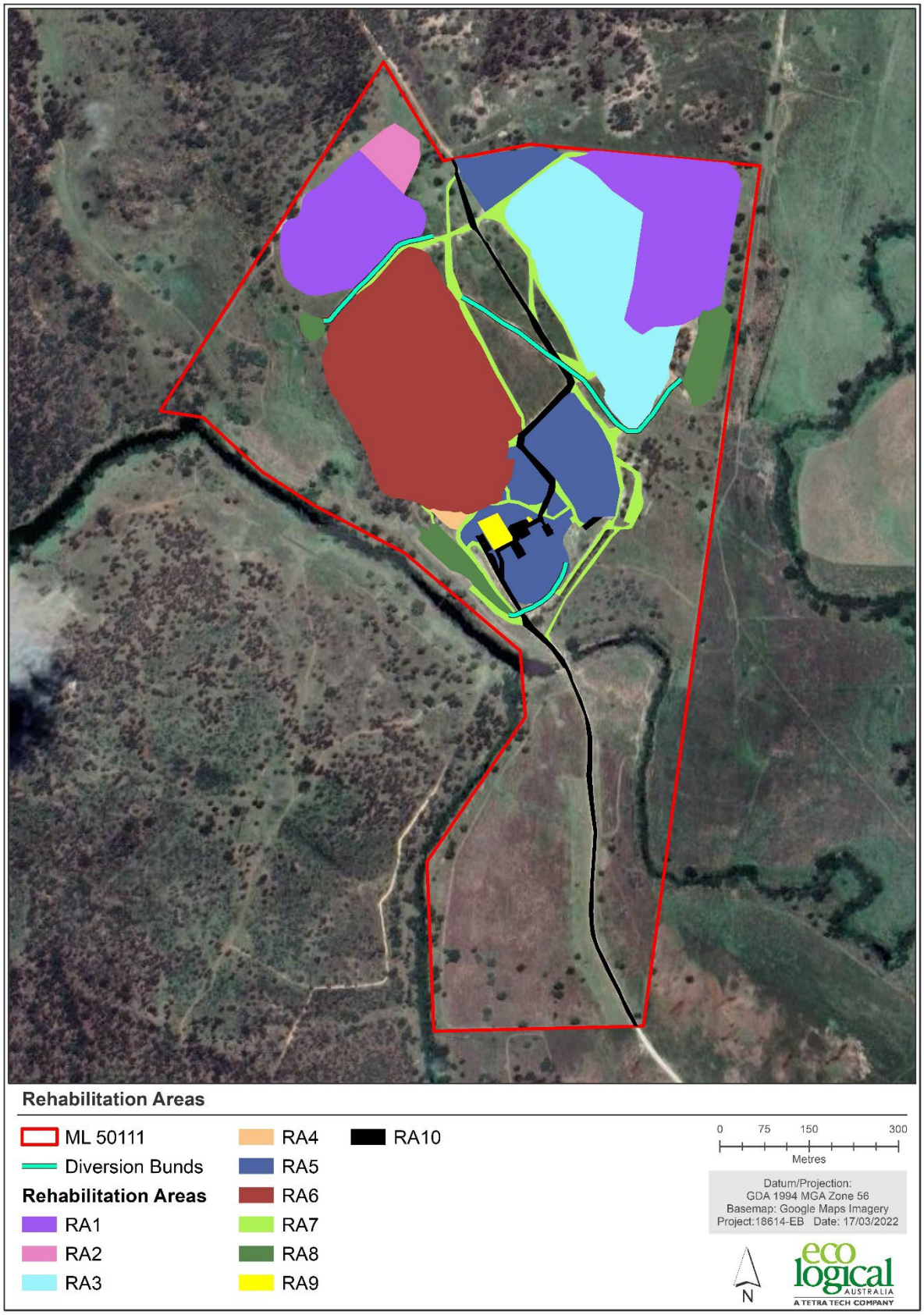

Figure 31 Location of diversions to be retained at closure

3.5.9. Revegetation

Revegetation activities on site are designed to result in the establishment of a grazing pasture consistent with the PMLU and the soil resources available for rehabilitation.

The PMLU is grazing pasture (i.e., for agricultural use). The species mix previously used on RA1 has been reviewed during the preparation of the PRCP. The results of monitoring of reference sites under existing pasture on the Murgon lease areas and existing rehabilitation areas have been considered to identify productive pasture species that are already thriving and known to tolerate site conditions. On advice of Damien O'Sullivan, an Extension Officer in Kingaroy with the Department of Agriculture and Fisheries (DAF), *Pasture Management for the Inland Burnett* (DEEDI 2009) was also referred to identify suitable pasture species for the Murgon region. Further, the species mix has been selected to remain consistent with the species list identified in the agronomist report (Grant Peterson 2020). The species mix that has been selected for pasture establishment for all areas being rehabilitation to a grazing pasture PMLU going forward:

- Black Speargrass (*Heteropogon contortus*). This native species is useful for providing erosion control for slopes up to 20°. It grows on a wide variety of well-drained soils, with surface textures ranging from loamy sand to clay loam, and uniform or texture contrast soils, as well as on very fertile clay loams. While well-adapted to low fertility, it is not tolerant of extremely low fertility, nor poor drainage or high levels of salinity. It is most abundant where the average annual rainfall is 600-1,000 mm, and where there are marked wet and dry seasons. It does tolerate short periods of inundation on otherwise well-drained soils but is not tolerant of prolonged flooding or waterlogging (Cook et al. 2020). This species is the dominant native pasture species in this landscape and present in the Murgon ML at reference sites and in the rehabilitated area (RA1).

- Forest Bluegrass (Swann Forest) (*Bothriochloa bladhii ssp. glabra*). Swann forest blue grass is a perennial tussock grass growing to 8- cm, generally with unbranched stems. The seed head is green to purplish that, along with the leaf, has a distinctive odour when crushed. It makes good hay if it is cut before flowering but loses quality after that point. The main flowering is last in the season. It grows well on both fertile and infertile soils but not on soils with high aluminium levels such as red acid soils. Maximum germination is reached 6 – 7 months after maturation. It is palatable, tolerates heavy grazing and survives seasonal frosting (DEEDI 2009).

- Lotononis (*Lotononis bainsii*). This perennial stoloniferous legume well established in the South Burnett (Vandersee and Kent 1983) and present within the Murgon ML. It used as for improving productivity in native pastures is a good companion legume for Black speargrass and Forest bluegrass (Cook et al. 2020). It is tolerant of heavy grazing and drought. It is suited to a wide range of soils except for heavy clays and tolerates poor fertility (Cook et al. 2020, DEEDI 2009). It is an extremely drought-hardy species, occurring in areas with rainfall as low as 350 mm/year although has mainly been used in areas with an annual rainfall of 600-900 mm (Cook et al. 2020).

Seeding rates will be 2 kg/ha for each grass species and 0.3 kg/ha for Lotononis. Lotononis seed will be pre-innoculated. Seeding will be conducted up to mid-November in time for the summer rains. Fertiliser and seeding rates will be adjusted based on monitoring of the performance of revegetation works.

Germination should be visible two to six weeks after seeding (or after the first wetting rains). If it is noted that germination has failed, re-seeding will be undertaken where there is probability of follow-up wet season rain. However, long-range weather forecast should be used to determine if there will be too much rainfall as waterlogged soils should be avoided.

Due to the general lack of feral animals no fencing and protection is considered required at this time. This will be re-evaluated annually.

3.5.10. Rehabilitation implementation quality control

ITPs that include specific witness or hold point have been developed for key rehabilitation milestones at Murgon. They will ensure that records are maintained for verification of completion of critical rehabilitation milestones in Section 3.3.2. These ITPs are provided in Appendix D and cross referenced in the PRPC schedule (Appendix B).

3.5.11. Tailings storage facilities

The site does not have a Tailings Storage Facility.

3.5.12. Void

The design considerations and rehabilitation strategy for the residual void are outlined below to ensure it if safe, stable, does not cause environmental harm and can sustain the agreed PMLU (water storage).

3.5.12.1. Potential for environmental harm

The residual void does not intersect local groundwater aquifers or Barambah Creek. The quality of the surface 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.

WATER BALANCE AND OVERTOPPING

Rocktest Consulting (2022) specify under typical rainfall conditions, inflow to the pit is predominately from pit wall runoff, groundwater inflow and incident precipitation due to rainfall. At the EOML, inflows will no longer be pumped out of the pit and resultantly the water level within the pit will progressively increase forming a pit lake. The upper surface of the lake will stabilise at an elevation where its open water surface area is large enough such that evaporative losses from the surface and other outflows equal the combined inflows. This elevation will likely be below pre-mining groundwater levels.

SEEPAGE AND INFILTRATION

Section 3.1.5 specifies there are localised fractures (joints) exposed in the pit walls that allow small seepages and overall pit seepage is likely to be governed by flows from all the geological units surrounding the site (ERM 2008). It is therefore reasonable to assume that the fractured-rock groundwater system at Murgon (which causes minor pit seepage) is hosted by a fracture zone of limited extent, and recharged by a localised fracture network.

As part of the groundwater hydrology assessment (ERM 2008), measurements were made to quantify the rate of seepage into the mine pit. Four flow tests were completed to obtain an estimate of the pumping rate from the pit, which gave an average and relatively consistent discharge rate of 14.4 L/s. The pump in the pit is generally turned on for two hours every two days. This results in an estimated rate of groundwater seepage into the pit and subsequent discharge to Dam C of 52 m^3/day

(approximately 0.6 L/s continuously). Additional monitoring of the discharge rates from the mine over an extended period suggests this is a reasonable estimate of seepage rates.

Given the relatively slow seepage into the void and lack of significant connectivity with Barambah Creek, ERM (2008) considered the potential impacts of mine pit dewatering practices were minor. As a result ERM (2008) did not recommend any water level monitoring as it was not considered necessary.

3.5.12.2. Void safety and stability

The design and construction of the void has been informed by the Ground Control Management Plan - Murgon Limestone Mine (Sibelco 2016) developed by the previous operator with the input of the current external geotechnical engineering consultant Tony Meyers (Rocktest Consulting).

A geotechnical assessment was undertaken by Rocktest Consulting (2022) for the current pit to consider safety measures, stability and rehabilitation recommendations for the design of the residual void at end of mine life (EOML). This conformed that existing design is suitable for closure with some additional battering back required for sections of the weathered or non-competent rock in the upper benches of the void (as per EA slope requirements). The geotechnical assessment including the stability analysis for the final design is provided in Appendix I.

The final engineering design specifications are provided in Table 30. The final design cross sections are in Figure 32 and a 3D concept if shown in Figure 27.

Table 30 Specifications of void at the end of mine life (Rocktest Consulting 2022)

Description	Specification
Trend of major axis	152°
Length of major axis at crest	400 m
Length of minor axis at crest	220 m
Maximum height of walls:	
North	85 m
South	71 m
East	90 m
West	74 m
Maximum height of benches	10 m
Maximum number of benches	10
Maximum width of berms	8 m
Maximum batter angles in unweathered rock	70°
Maximum batter angles in weathered rock	38°
Maximum interramp angles	41°
Maximum overall slope angles	38°
Ramp type/ minimum width	Spiral/ 10 m
Dip direction of walls	
North (South dip)	150°
South (North dip)	310°

Description	Specification
East (West dip)	240°
West (East dip)	060°

To achieve long-term geotechnical stability, the following has been recommended by Rocktest Consulting 2022:

- Reduce the batter angles of sections in the upper benches (above 290 mRL) to <14°. As they are in overburden and weathered rock, ripping the ground along contours, leaving it rough and cover with approximately 0.2m of rock and soil.
- Install abandonment bunds behind the full crest to restrict inadvertent access and divert water around the void. Maintain diversions up contour of the bund to control surface water run-on and erosion of the bund itself.
- Rip the initial 50 m of ramp to reduce accessibility into the void and place a 0.2 m thick cover of soil and rock on all haul roads and disturbed ground beyond the perimeter of the void.
- Install warning signs around the void informing of restricted access. Install approved fencing where required.

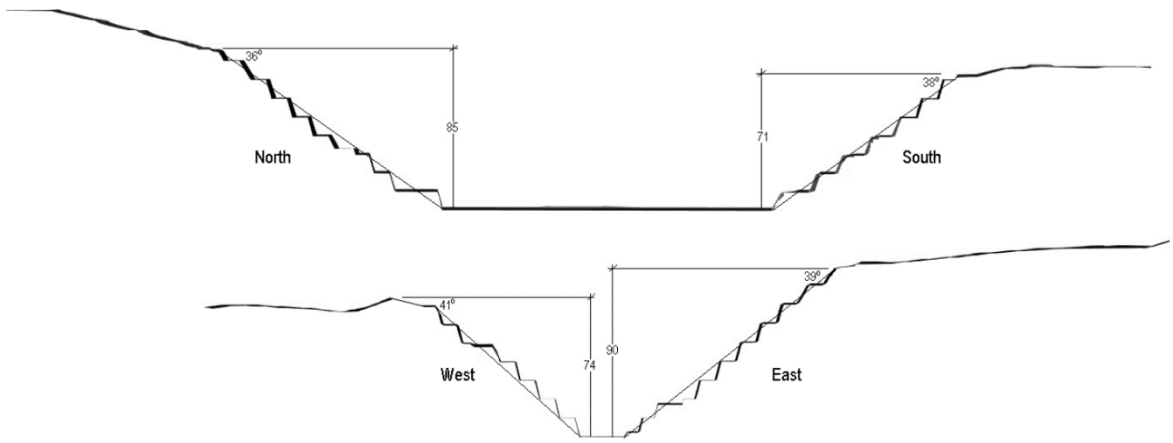

Figure 32 Cross section through void at EOML

3.5.12.3. Public safety risk mitigation

An abandonment bund will be constructed around the pit void to mitigate the public safety risk associated with inadvertent access. In the absence of specific Queensland standards, the bund will be constructed in accordance with the Western Australian *Safety Bund Walls Around Abandoned Open Pit Mines* (WA Department of Industry and Resources, 1997) which is generally adopted as the mining industry standard for such structures in Australia.

The guideline outlines both the principles behind siting of an abandonment bund, as well as design specifications, which are summarised as follows:

- Bund to be located at least 10m from the zone of geotechnical instability around the pit void, which can be estimated from pit geometry, or determined through site-specific geotechnical assessment.
- Constructed from unweathered competent rock to a height of at least 2m and a base width of at least 5m.

The specific location of the bund is presented in Figure 33. The bund will be fully outside the zone of geotechnical instability and will not interfere with normal riparian flows.

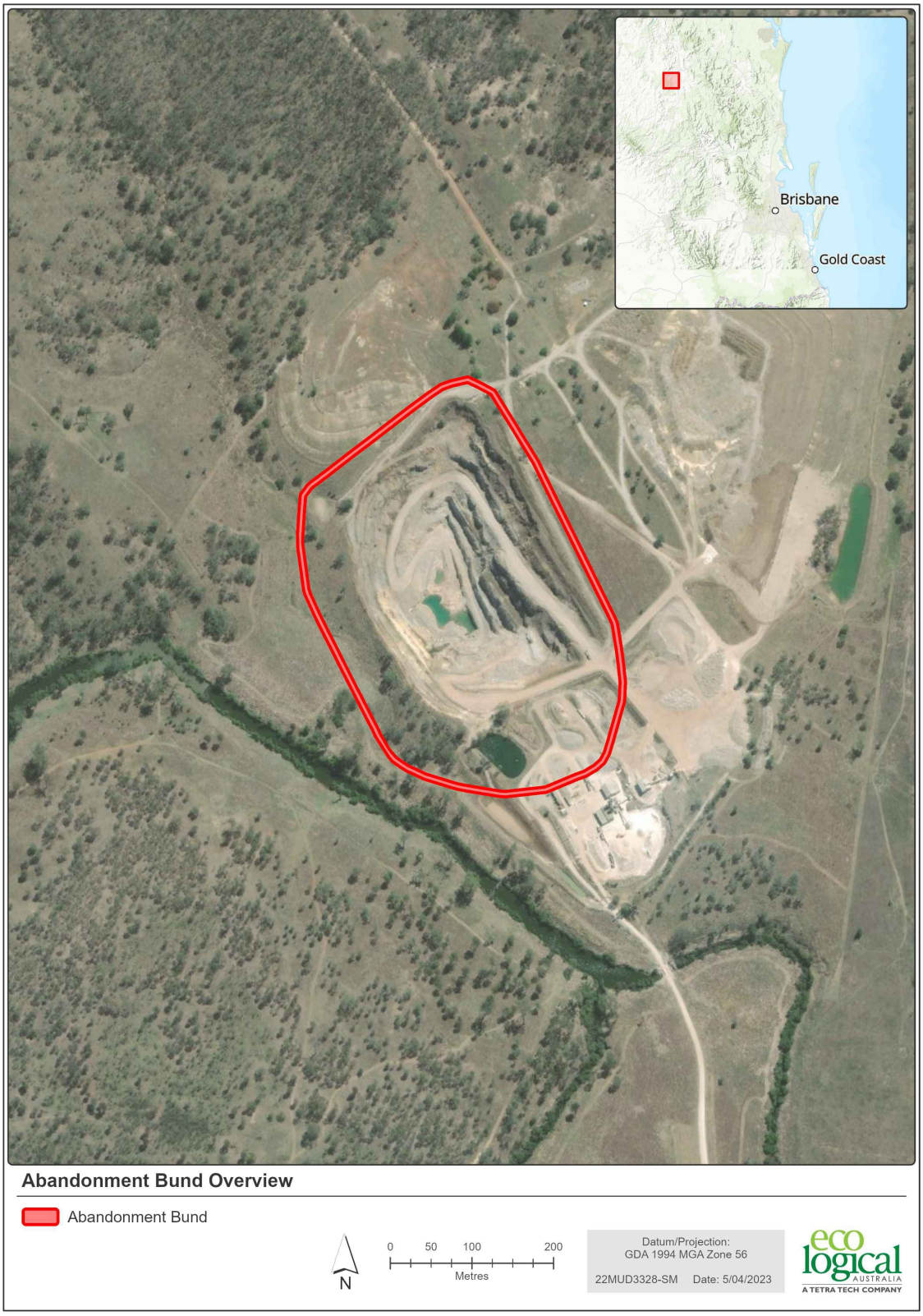

Figure 33: Abandonment bund location

The bund will not prevent flood waters from entering the void. This is because the natural landscape runs downhill from the southwestern portion of the pit crest to Barambah Creek, and the abandonment bund will therefore be at a lower elevation than either the pit crest or the predicted flood level.

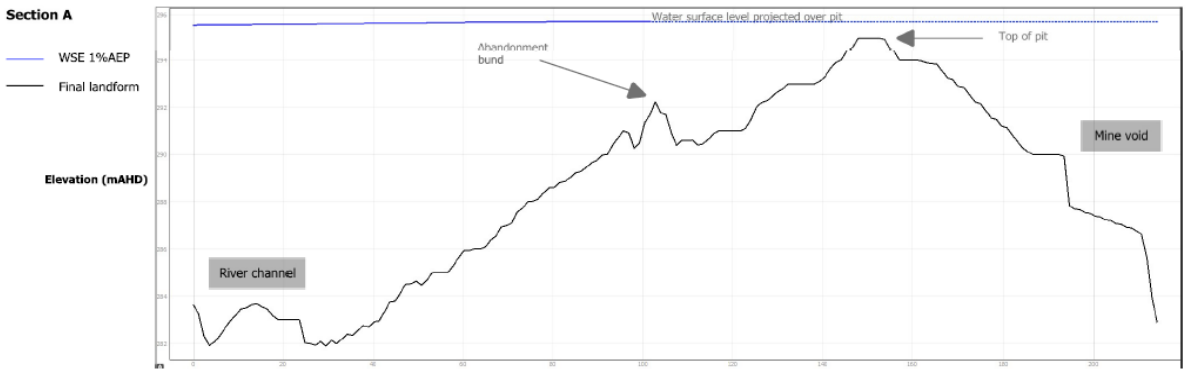

Figure 34: Landscape and flood elevations at southwestern corner of pit void (Pitt & Sherry 2023)

Modelling has been undertaken to evaluate the stability of the abandonment bund structure during flood events (see Section 3.5.2.1). The bund is not predicted to prevent ingress of water into the pit during peak floods, with water occasionally overtopping the bund by a considerable margin. However, flow velocities are predicted to be low, and the integrity of the bund is not anticipated to be at risk.

Whilst the bund will prevent inadvertent access, safety signage will also be erected at approximately 100m intervals (where topographically appropriate) to mitigate liability associated with deliberate access by a member of the public. This interval has been selected as a reasonable precaution, with signage likely to be visible when the void is approached from any direction.

3.5.13. Underground mining

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

3.5.14. Built infrastructure

All built infrastructure not covered under a Landholder Statement will be demolished and removed from site. The only built infrastructure which is covered under a Landholder Statement is the bridge and associated access road, a few storage sheds, workshop, associated power supply and the sediment dams.

3.5.14.1. Services

All service connections (aside from electricity) will be disconnected in coordination with service providers and all associated service infrastructure (such as pipework) will be removed from site. Electricity services and infrastructure will be made safe at end of mine life, but be retained under a Landholder Statement to provide power to the remaining storage sheds.

3.5.14.2. Bores

The water licence associated with the on-site bores North and South (MUR01 and MUR02) will be surrendered and the 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.

3.5.14.3. Buildings, plant, and equipment

Existing management plans and registers will be reviewed for the presence of hazardous substances on site (such as equipment containing PCB, lead paint or asbestos building materials). Where information is not available, additional surveys for hazardous materials will be undertaken at the end of mine life to identify any materials that require specialist contractors for removal and disposal. All other works will be undertaken once the site has been cleared of any hazardous materials.

Where possible, serviceable demountable buildings will be sold or provided for community use. Those that cannot be re-used along with all other general buildings, sheds and tanks used to store non-hazardous materials will be emptied, decommissioned, demolished and all waste materials removed from site. All concrete slabs and footings that are less than 0.5 m deep will be broken up and removed. Footings below 0.5 m will not interfere with rehabilitation operations or the nominated PMLU and will remain in situ.

All conveyors and gantries will be dismantled, and their associated waste removed from site.

Fuel storage tanks will be emptied and decommissioned with the remaining fuel removed by a licenced contractor. Plant and infrastructure not retained under a Landholder Statement will be decommissioned and demolished and all waste materials removed from site. All concrete slabs and footings that are less than 0.5 m deep will be broken up and removed.

Areas that may have been affected by notifiable activities (hydrocarbon storage), the workshop area or areas potentially contaminated through the operation of the plant and equipment will undergo a contaminated site investigation and a Site Investigation Report will be prepared by an appropriately qualified person. If the investigation demonstrates that on-site remediation or removal of contaminated material is required, these works will be undertaken, and validation sampling has been completed. Where the Site Investigation Report determines that contamination can safely remain in-situ (under appropriate management), a Site Management Plan will be prepared by an appropriately qualified person that will include a statement by the underlying landholder (Graymont (NSW) Pty Ltd) accepting responsibility to implement the Site Management Plan.

3.5.14.4. Roads, tracks, and hardstands

The aggregate used to create the trafficable surfaces around the administrations, plant and stockpile areas and on unsealed (gravel) roads will be removed to 300 mm and used to enhance the natural regeneration potential of areas within the void floor.

Following the removal of surface aggregate, these areas will be reshaped to create the final landforms and surface drainage pattern as described in Section 3.5.6, before site preparation, topsoiling (Section 3.5.8) and revegetation (Section 3.5.9).

Unsealed tracks that remain within the void domain will not be stripped of aggregate during rehabilitation, but they will be ripped in preparation for revegetation.

3.5.14.5. General

Vehicle hygiene controls will be implemented to minimise the risk of weeds being transported to the site.

3.6. Risk Assessment

Potential environmental risks of not achieving a stable condition have been assessed and current and additional risk control measures identified. The residual risk after controls has been assessed according to the criteria presented in Table 31 to Table 33.

The risk assessment outcomes are presented in Table 34.

All control measures identified have been incorporated into the rehabilitation and closure planning outlined in the PRCP.

Table 31 Likelihood measures

Level	Rating	Description	Frequency
5	Almost certain	The event is expected to occur in most circumstances	More than once a year
4	Likely	The event will probably occur in most circumstances	At least once per year
3	Possible	The event should occur at some time	At least once in 3 years
2	Unlikely	The event could occur at some time	At least once in 10 years
1	Rare	The event may only occur in exceptional circumstances	Less than once in 15 years

Table 32 Consequence measures

Rating (level)	Health	Financial Impact	Environment
Insignificant (1)	Minor injuries not requiring first aid or near miss. No psychological stress	Less than $10,000	Contained, reversible impact managed by on site response
Minor (2)	First Aid treatment and/or one off counselling	$10,000 to $100,000	Contained, reversible impact managed by internal response
Moderate (3)	Medical treatment required and/or psychological intervention/treatment required	$100,000 to $1,000,000	Contained, reversible impact managed by external agencies
Major (4)	Serious or extensive injuries and/or significant and long term psychological stress	$1,000,000 to $10,000,000	Uncontained, reversible impact managed by a coordinated response from external agencies
Catastrophic (5)	Death or severe permanent physical and/or psychological disablements	Greater than $10,000,000	Uncontained, irreversible impact

Table 33 Risk assessment matrix

Consequence Likelihood	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Almost certain (5)	Moderate (5)	High (10)	High (15)	Extreme (20)	Extreme (25)

Likely (4)	Low (4)	Moderate (8)	High (12)	High (16)	Extreme (20)
Possible (3)	Low (3)	Moderate (6)	Moderate (9)	High (12)	High (15)
Unlikely (2)	Low (2)	Low (4)	Moderate (6)	Moderate (8)	High (10)
Rare (1)	Low (1)	Low (2)	Low (3)	Low (4)	Moderate (5)

Table 34 Risk assessment outcomes

Closure domain	RA	Risk / Threat (Aspect)	Impact	Overview of current controls	Additional controls or actions required (and cross reference to rehabilitation milestones or location in PRCP)	Residual risk rating
Waste Dump 1 (North-eastern) and Waste Dump 2 (Northern)	RA1/RA2 – Northern dump RA1/RA3 – North-eastern dump Topsoil stockpiles on RA2 and RA3	Mine waste landforms provide an ongoing source of pollutants	Mine waste presents a risk to surface and groundwater resources	• Waste dumps geotechnical inspection and stability modelling undertaken by a suitably qualified expert. • Monitoring of groundwater is undertaken to confirm quality of water in respect to possible contamination. • 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. • Surface Water Monitoring Program has identified no impact from sediment transport off-site.	• The groundwater monitoring program will be restored, and action taken in the event of results indicating the potential for environmental harm. • Sediment Dam A and B to be tested for contaminants prior to final closure to determine management requirements (rehabilitation milestone RA8 RM2).	Rare, Minor, L2
		Waste landform stability	Mine waste landforms are not stable and will result in degradation and off-site impacts	• Waste dumps geotechnical inspection and stability modelling undertaken by a suitably qualified expert. • There is no tailings dam at site which would require a detailed landform design. • Topsoil in stockpiles to be used for rehabilitation has been assessed and results reviewed by a Certified Professional Soil Scientist for this PRCP. Topsoil will be sourced from the stockpiles on-site or manufactured from scalps material which	• Landform development and final landform slopes are consistent with the quality of the soils and the nominated PMLU. • Final maximum slope will be compliant with the EA. • Landform development criteria (including agreed slope outcomes in the EA) and water management measures provided in milestones.	Minor, Unlikely, L4

Closure domain	RA	Risk / Threat (Aspect)	Impact	Overview of current controls	Additional controls or actions required (and cross reference to rehabilitation milestones or location in PRCP)	Residual risk rating
				has been characterised as being a suitable soil forming material. There is no need to import topsoil for rehabilitation activities. • Flood risk and geotechnical assessments undertaken to look at susceptibility of flooding for the waste dumps. If required, slope toes should be protected from inflows associated with floods from Barambah Creek. • Periodic geotechnical assessments to review instability of overburden dumps.	• Minimum ground cover required specified that is known to minimise soil erosion (rehabilitation milestones RA1 RM6, RA2 RM6 and RA3 RM6). • Erosion monitoring requirements, criteria and erosion repair provided in (rehabilitation milestones RA1 RM6, RA2 RM6 and RA3 RM6). • All areas require certification from an appropriately qualified person that it has achieved stable condition (rehabilitation milestones RA1 RM7, RA2 RM7 and RA3 RM7).	
		Flooding threatens stability of landform	The site is in a floodplain and flooding assessment determined that landforms may be affected under extreme events (Section 3.5.2)	• Flood risk assessment has been undertaken to examine the susceptibility of the site to flooding and if this needs specific geotechnical considerations assessments with respect to the overburden dumps. • Modelling to understand the depth and velocity of PMF flooding events (including the potential failure of Bjelke-Peterson Dam). The aim of the modelling was to determine any additional measures required to provide landform design that will ensure stability in the long term.	• • Visual inspections after significant flooding events to validate predictions that the landforms are safe and stable under such conditions. • If landform integrity is found to be compromised during a flood event, repair works will be undertaken and the need to adopt additional controls will be evaluated.	Rare, Minor, L2

Closure domain	RA	Risk / Threat (Aspect)	Impact	Overview of current controls	Additional controls or actions required (and cross reference to rehabilitation milestones or location in PRCP)	Residual risk rating
Fuel storage, service area, plant and offices (including HME) and Stockpiles (product)	RA5	Site contamination and impact to surrounding sensitive receptors	Contamination present poses a threat to human, animal, or ecosystem safety	• Hydrocarbons are stored in self-bunded, above ground tanks with capacity of 20,000 litres. • Lubricants and waste oil are stored in a self-bunded dangerous goods storage shed. • Bunding is compliant with Australian Standards (AS) 1940-2004 the storage and handling of flammable and combustible liquids. • Site captures and manages run-off from disturbed areas within RA5, redirecting into the applicable Sediment Collection Dam. • Monitoring of groundwater is undertaken to confirm quality of water in respect to possible contamination. • Site has orientated stockpiles in direction that reduces exposed surfaces to prevailing winds where possible. • Watering of product stockpile is undertaken to minimise dust generation. • Water quality testing for oil and grease undertaken six monthly. • Water quality monitoring has not indicated contamination of surface or groundwaters related to site activities.	• Site Investigation Report to be prepared by an appropriated qualified person. Remediation and validation sampling undertaken and/ or a Site Management Plan prepared (rehabilitation milestone RA4 RM2, RA9 RM2 and RA10 RM2). • Monitoring and management of contaminated sites will continue in accordance with any Site Management Plan until an appropriately qualified person signs off that risks have been appropriately mitigated. • Any residual limestone stockpiles left at closure will be returned to the void (rehabilitation milestone RA5 RM2). • Sediment dam D tested for contaminants prior to closure to determine management requirements (rehabilitation milestone RA8 RM1).	Unlikely, Minor, L4

Closure domain	RA	Risk / Threat (Aspect)	Impact	Overview of current controls	Additional controls or actions required (and cross reference to rehabilitation milestones or location in PRCP)	Residual risk rating
		Mining infrastructure	Mining infrastructure poses a threat to human or animal safety	• The rehabilitation strategy is to remove all mine assets and infrastructure, unless otherwise agreed through a Landholder Statement. • Consultation with DES on 24 February 2022 confirmed process and approval from Minister for Mines will be sought upon ML relinquishment.	• Disconnect water and gas services (rehabilitation milestone RA5 RM1). • Electrical services remaining at site to be made safe. • Site bore decommissioned and rehabilitated (rehabilitation milestone RA5 RM1). • Hazardous building materials identified, managed and removed by appropriately licenced contractors (rehabilitation milestone RA5 RM1, RA10 RM1). • All infrastructure (aside from that which is covered under a Landholder Statement) to be removed from Rehabilitation Areas. • Tracks, the access bridge and retained buildings will be left in a condition that is fit for purpose and supported by a Structural Engineering Report prepared by an appropriately qualified person.	Rare, Minor, L2

Closure domain	RA	Risk / Threat (Aspect)	Impact	Overview of current controls	Additional controls or actions required (and cross reference to rehabilitation milestones or location in PRCP)	Residual risk rating
Residual void	RA6	Landform instability in residual void walls	Void landform is not stable and will result in degradation and off-site impacts	• Geotechnical assessments have been conducted to assess the current stability and to inform the rehabilitation strategy for the residual void. • Existing drainage controls around void minimise water flowing from north-east of site. These drainage controls will be retained at closure.	• Slopes requiring stabilisation works will be reshaped according to the agreed geotechnical design and comply with slope specified in the EA (RA6 RM3). • Run off from unmined areas will be directed away from the void crest where practical, and management measures will be informed by flood modelling outcomes (see Section 3.5.7). • Abandonment bund constructed will further minimise run-off to the void. Applicable safety signage will installed. • Annual visual monitoring of batters to demonstrate that they have remained stable (RA6 RM6).	Rare, Minor, L2
		Flooding threatens stability of landform	The site is in a floodplain and flooding assessment determined that landforms may be affected under extreme events (Section 3.5.2)	• Flood risk assessment has been undertaken to look at susceptibility of flooding in the residual void and inform geotechnical assessments. • Flow velocity is predicted to be relatively low during periods of natural flooding, and constructed landforms are predicted to be stable. • Abandonment bund to be constructed with hard rock (>200mm particle size).	• Visual inspections after significant flooding events to validate predictions that the landforms are safe and stable under such conditions.	Rare, Minor, L2

Closure domain	RA	Risk / Threat (Aspect)	Impact	Overview of current controls	Additional controls or actions required (and cross reference to rehabilitation milestones or location in PRCP)	Residual risk rating
				• Other constructed landforms to be vegetated, which will result in root matrix stabilisation.		
		Void presence, void geochemistry and void water quality	Void presents a risk to surface and groundwater resources	• Review of historical data and literature confirm there is no connection of the void intersecting known aquifer units within the area. • Hydrological assessment confirms negligible risk to regional groundwater resources or EVs. • Previous groundwater and void water quality samples have been taken which demonstrate results achieve the required standards to support the PMLU. • Additional monitoring of contaminant conducted for the preparation of the PRCP shows no elevated TPH, BTEX, metals/metalloids and no extremes of pH or EC.	• The void and groundwater and surface water monitoring program will be restored and monitoring data and data trends will be evaluated to identify current or potential future exceedences of the Australian Water Quality Guidelines for Primary Industries (RA6 RM6). • In the event that Guideline values are exceeded, or are trending towards exceedance, further evaluation will be undertaken to identify the cause(s) and determine an appropriate mitigation.	Unlikely, Minor, L4
		Void water quality unsuitable for stock watering	Inability to achieve and sustain nominated PMLU (water storage) to support grazing	• Previous groundwater and void water quality samples have been taken which demonstrate results achieve the required standards to support the PMLU.	• The void and groundwater monitoring program will be restored and action taken in the event of adverse results • Groundwater chemical analysis will comply with EA requirements for PMLU (water quality to be suitable for livestock use) (RA6 RM6).	Unlikely, Minor, L4

Closure domain	RA	Risk / Threat (Aspect)	Impact	Overview of current controls	Additional controls or actions required (and cross reference to rehabilitation milestones or location in PRCP)	Residual risk rating
Silt trap/dams (to be retained)	RA8 – Dam A, Dam B, Dam D	Site contamination	Contamination present poses a threat to human, animal, or ecosystem safety	Site captures and manages run-off from disturbed areas (including waste rock and stockpiles), redirecting into the applicable Sediment Collection Dams.	• Sediment dams to be retained will be inspected prior to closure and tested for contaminants. • Sediment dams will be desilted as required and sediment placed in the void or disposed of off-site at an appropriately licensed waste facility depending on the results of contaminant testing prior to rehabilitation to determine management requirements (rehabilitation milestone RA8 RM2). • Retained water management structures will be certified by an appropriately qualified person as confirming to design standards and specifications consistent with best practice.	Rare, Minor, L2
Silt trap/dams (to be rehabilitated)	RA4 – Dam C	Site contamination	Contamination present poses a threat to human, animal or ecosystem safety.	Site captures and manages run-off from disturbed areas (including waste rock and stockpiles), redirecting into the applicable Sediment Collection Dams.	• Sediment Dam C will decommissioned as part of the void expansion. • Sediment dam will be desilted, and sediment placed in the void or disposed of off-site at an appropriately licensed waste facility depending on the results of contaminant testing. This will inform rehabilitation management requirements	Rare, Minor, L2

Closure domain	RA	Risk / Threat (Aspect)	Impact	Overview of current controls	Additional controls or actions required (and cross reference to rehabilitation milestones or location in PRCP)	Residual risk rating
					(rehabilitation milestone RA4 RM2). • The former sediment dam will be rehabilitated to a stable condition (RA4 RM3-RM7).	
Roads and tracks	RA7	Mining infrastructure	Mining infrastructure poses a threat to human or animal safety	• The rehabilitation strategy is to remove all mine assets and infrastructure, unless otherwise agreed through a Landholder Statement. • Consultation with DES on 24 February 2022 confirmed process and approval from Minister for Mines will be sought upon ML relinquishment (Landholder agreement).	• Significant built infrastructure or infrastructure associated with site access will be left fit for purpose and supported by a Structural Engineering Report prepared and certified by an appropriately qualified person (rehabilitation milestone RA7 RM8).	Rare, Insignificant, L1
Areas with grazing PMLU	RA1-RA5 and RA7 and RA9	Insufficient topsoil quantity and quality Soil compaction prevent plant growth	Inability to achieve and sustain nominated PMLU (grazing)	• There is sufficient good quality topsoil or soil-forming material for rehabilitation purposes at site (Section 3.5.8) ○ Topsoil stockpiles are kept no more than 3m high to maintain physical and biological quality. ○ Topsoil in stockpiles to be used for rehabilitation has been assessed and results reviewed by a Certified Professional Soil Scientist for this PRCP (Section 3.5.3). ○ Characterisation has been undertaken of available soil forming materials to supplement topsoil resources as needed (Section 3.5.3).	• Prior to re-spreading stockpiled soil onto the reshaped waste dumps, an assessment of weed infestation on stockpiles will be undertaken to determine if individual stockpiles require herbicide application and/or scalping prior to topsoil spreading. • Applied topsoil or topsoil substitute will applied at the required depth and ameliorated as recommended in the PRCP (RM5). • Ripping will be undertaken to specifications. Criteria requiring	Rare, Insignificant, L1

Closure domain	RA	Risk / Threat (Aspect)	Impact	Overview of current controls	Additional controls or actions required (and cross reference to rehabilitation milestones or location in PRCP)	Residual risk rating
					adherence to the nominated species mix and seeding rate is specified in the Revegetation Section of the PRCP (RM5).	
	RA1-RA5 and RA7 and RA9	Vegetation selected is not suited to site conditions	Inability to achieve and sustain nominated PLMU (grazing)	• The seed mix chosen following ○ recommendations by Department of Agriculture and Fisheries (DAF) Extension Service (Section 3.5.9). ○ species in line with that of reference pastures in un-mined areas and provide erosion protection. ○ adaptive management following a review of the success of species used in existing rehabilitation areas and the species that are present in the un-mined reference areas. • The species mix is well suited to the available soil resources and site conditions (Section 3.5.9). • Rehabilitation monitoring annually to assess success and adaptive management requirements (Section 3.7).	• Monitoring of performance against agreed targets will be undertaken (RM6) • Rehabilitated areas will be visually assessed after the first year to identify any areas of low germination, and soil sampling undertaken to identify a likely cause. Ameliorative action will then be undertaken to improve the substrate if required and the area reseeded. • Trends in annual monitoring data will be assessed to identify whether interim and final targets are likely to be met, and contingency actions undertaken if required. • Maintenance and contingency planning provided in Section 3.7.5.	Rare, Minor, L2
		Inadequate water supply/ drought	Poor pasture establishment and inability to achieve and sustain	• The seed mix chosen was following recommendations by DAF Extension Service and species are tolerant of dry conditions (Section 3.5.9).	• No additional controls required.	Possible, Minor, M6

Closure domain	RA	Risk / Threat (Aspect)	Impact	Overview of current controls	Additional controls or actions required (and cross reference to rehabilitation milestones or location in PRCP)	Residual risk rating
			nominated PMLU (grazing)	• Site water storages can be used as a water source for irrigation during periods of drought. • Contingency measures included in rehabilitation monitoring and maintenance program (Section 3.7).		
		Rehabilitation vegetation not suitable for grazing use	Pasture quality not suitable to achieve and sustain nominated PMLU (grazing)	• The seed mix chosen was following recommended by DAF Extension Service and species selected are widely used in the region for productive pasture. Productivity potential has been improved by the selection of a conditions (Section 3.5.9). • Contingency measures included in rehabilitation monitoring and maintenance program (Section 3.7). • Refer to report specifying desirable species.	• Rehabilitation reference sites for grazing pasture PMLU established in unmined pastures areas within the lease. • Vegetation composition, weed presence and monitoring requirements and vegetation maintenance requirements provided (RA5).	Rare, Insignificant, L1
		Flooding threatens achievement of the grazing PMLU	The site is in a floodplain and flooding assessment determined that landforms may be affected even under extreme events (Section 3.5.2)	• Flood susceptibility model undertaken for site showing that during 1% AEP flood event, it could affect the void, plant/offices and lower slopes of the North-eastern waste dump. During a PMF event, Most areas could be affected. • The species selected are tolerant of periods of inundation and rare flooding events are unlikely to affect the long-term viability of the PMLU.	• Undertake a site inspection after a 1 in 10 year ARI 24 hour rainfall event.	Rare, Minor, L2
	RA4,RA5, RA7 and RA9	Landform instability in domains other	Final landforms outside the void are not stable and will	• The landform has not be significantly altered during operations and no specific landform design for closure is required.	• Landform development and final landform slopes are consistent with the quality of the soils and	Rare, Minor, L2

Closure domain	RA	Risk / Threat (Aspect)	Impact	Overview of current controls	Additional controls or actions required (and cross reference to rehabilitation milestones or location in PRCP)	Residual risk rating
		than the void and waste dumps	result in degradation and off-site impacts	• The final landform will conform to the existing slopes EA slope requirements. • There is no evidence of land on the lease areas being prone to instability and available topsoils have a low erosivity.	the nominated PMLU (Section 3.3.2). • Landform development criteria provided in milestones and water management measures specified. • Minimum ground cover required specified that are known to minimise soil erosion (RM6) • Erosion monitoring requirements, erosion criteria and requirements for erosion repair provided (RM6) • Adequate monitoring demonstrating no declared pest plants recorded within domain, established biomass and groundcover to meet milestone criteria within nominated timeframe (RM6). • All areas require certification from an appropriately qualified person that the area has achieved a stable condition (RM6)	

3.6.1. Rehabilitation trials

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

Lessons learned from rehabilitation monitoring outcomes to date have been incorporated into the rehabilitation strategy outlined in the PRCP.

3.7. Monitoring and Maintenance

Section 3.3.2 contains information on the objectives and completion criteria against which the success of the rehabilitation measures will assessed and the data required to validate completion of rehabilitation for each rehabilitation milestone nominated in Section 3.1.11.2.

The prescriptive criteria (requiring the completion of an action) will be captured in the QA/QC procedures outlined in the ITPs (Appendix D).

The following sections provide the routine monitoring requirements to determine rehabilitation progress against milestones for the achievement of agreed PMLUs to stable a condition. The data will be used to determine maintenance requirements.

All monitoring will be undertaken by appropriately qualified professionals.

3.7.1. Areas with a low intensity grazing PMLU

3.7.1.1. Vegetation monitoring

Vegetation monitoring will be undertaken by an appropriately qualified expert to gather data to support the milestone completion criteria. Monitoring will include, but may not be limited to, pasture establishment, ground cover, vegetation composition and biomass. Appropriate quality assurance checks on the data will be undertaken throughout the monitoring period.

Photographic records, taken at the same photographic point location, will be kept for each monitoring occasion as a permanent visual record of the development of rehabilitation.

Monitoring will be undertaken at multiple locations throughout the ML within the rehabilitated area in conjunction with reference locations in unmined areas.

3.7.1.2. Erosion, stability, and ponding

The site will be inspected for signs of active erosion and the development of rills and gullies. This can be conducted as a wandering transect with the observer meandering with full width of the rehabilitation area across the slope of RAs. The rehabilitation areas of particular interest for visual monitoring will be the overburden dumps and residual void to assess performance over the medium to long term. This will help ascertain whether the designs continue to perform to an acceptable measure (Rocktest Consulting 2022).

Active erosion will be noted as defined in the Australian Soil and Land Survey Field Handbook 3rd Edition (The National Committee on Soil and Terrain 2009). Areas of slumping or showing evidence of ponding (>10 m^2) will also be identified.

Active erosion features, slumping and ponded areas will be photographed and logged with a GPS for repairs as required.

3.7.1.3. Land management

The wandering transect used to examine erosion and stability could also be used to identify any areas of poor cover and significant declared weed infestations. These will be logged with a GPS and Graymont will follow up repairs as required.

3.7.1.4. Water management structures

Section 3.5.7 provides the recommended monitoring for water management structures.

3.7.1.5. Reference sites

Two reference sites have been established to assess rehabilitation performance against grazing analogues. As all rehabilitation areas at Murgon will be restored to achieve a grazing PMLU, this is considered sufficient to assess performance across the site.

Monitoring locations are shown in Figure 35.

Figure 35: Rehabilitation monitoring reference sites (source: *Murgon Quarry Rehabilitation Report February 2022*)

3.7.2. Water quality

Surface water quality sampling will be undertaken according to the methods presented in the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy* (DES 2018). Samples will be collected into appropriate containers supplied by the laboratory and chilled. Holding times specified in the manual (or as advised by the receiving laboratory) will be adhered to and samples will be analysed by a NATA accredited laboratory. Appropriate duplicates and sampling blanks should be taken for assessment of reproducibility and cross-contamination control. Samples will be collected from the nominated water storage areas RA6 (residual void) and RA8 (Sediment dams A, B and D), as well as from the current upstream and downstream creek monitoring locations W1 and W2.

The following analytical suites apply:

- Suite A: pH, EC, total suspended solids and major ions (Ca, Mg, K, Na, Cl, SO_4 and alkalinity)
- Suite B: Total metals (As, Cd, Cr, Cu, Ni, Pb, Zn), fluoride (F)and PAHs.

Results will be compared to ARMCANZ & ANZECC (2000) guidelines for stock water (cattle).

Groundwater sampling will be undertaken according to the same methods and for the same suite of as above with the addition of total petroleum hydrocarbons (TPH) and benxene, tolune, ethylbenzene and xylene (BTEX). The data will be used to inform the contaminated land investigation to be undertaken at closure.

Results will be compared the WQOs identified in Section 3.1.5.7.

3.7.3. Monitoring schedule and frequency

Table 35 provides the proposed monitoring schedule and frequency for Murgon.

Table 35: Monitoring schedule

Indicator	When monitoring should be initiated	Preferred time of year	Frequency and duration
Photographs (both PMLUs)	In the year after revegetation has been undertaken	Between February and May	Annually during RM6 and RM7
Pasture groundcover and standing biomass (%)	In the year after revegetation has been undertaken	In the dry season (between May and November)	Annually during RM6 and RM7
Pasture vegetation composition	In the year after revegetation has been undertaken	Between February and May to provide the best opportunities for grass identification	Annually during RM6 and RM7
Pasture dry season carrying capacity	Within at least 5 years after vegetation establishment	In the dry season (between May and November)	At least once prior to completion of RM7
Erosion, stability and ponding (pasture areas)	In the year after revegetation has been undertaken	Between February and May	Annually during RM6 and RM7
Land management	In the year after revegetation has been undertaken	Between February and May	Annually during RM6 and RM7

Void water quality	Within 6 months of the finalisation and approval of the PRCP	Wet season and dry season	Every 6 months for suite A Every 12 months for Suite B Until completion of RM8
Groundwater quality	Within 6 months of the finalisation and approval of the PRCP	Wet season and dry season	Every 6 months for suite A Every 12 months for Suite B, F and TPH Until completion of RM2 (contamination assessment) after which bores will be decommissioned.
Surface water quality (downstream creek)	Within 6 months of the finalisation and approval of the PRCP	Wet season and dry season	Every 6 months for suite A Every 12 months for Suite B Until completion of RM8

3.7.4. Reporting

Monitoring events will be recorded, including the results obtained and any immediate performance of land management issues identified will be documented after each event.

An annual report will be prepared after completion of each full round of annual sampling. This will contain details of the methods used, the data collected, quality assurance data. The data will be analysed against the milestone completion criteria and an assessment made of rehabilitation performance. It will also include an assessment of trends (both positive and negative). The report will provide recommendations for repairs or additional management action and any changes required to the monitoring methods or frequency. It will also include a statement regarding the achievement of each PMLU to a stable condition.

3.7.5. Maintenance and contingency measures

Monitoring may indicate that rehabilitation is not meeting the desired rehabilitation outcomes and management intervention may be required as identified in Table 36.

Table 36: Contingency measures

Issue	Maintenance treatment
Poor vegetation cover establishment	Adjust fertiliser / soil ameliorant inputs and reseed during appropriate seasonal conditions. Increase irrigation frequency if rainfall inadequate If issue persists conduct additional soil sampling and seek input from a suitably qualified professional.
Pasture species inconsistent with PMLU	Review rehabilitation strategy and planting lists. Review weed control measures or control frequency. Conduct reseed during appropriate seasonal conditions.
Erosion	Review water management controls and amend as required. Fill erosion features, provide soil surface protection and reseed during appropriate seasonal conditions.

Issue	Maintenance treatment
Water quality does not meet requirements for the PMLU	Investigate quality of drainage or seepage inputs. Consider remediation or treatment options. Consider alternative PMLU.

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Appendix A WildNet database output

Queensland Government

WildNet species list

Search Criteria: Species List for a Specified Point
Species: Animals
Type: Native
Queensland status: All
Records: All
Date: Since 1980
Latitude: -26.2910
Longitude: 151.9776
Distance: 3
Email: adam.garthwaite@ecoaus.com.au
Date submitted: Friday 10 Sep 2021 09:13:40
Date extracted: Friday 10 Sep 2021 09:20:01

The number of records retrieved = 164

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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	Acanthizidae	*Acanthiza nana*	yellow thornbill		C		1
animals	birds	Acanthizidae	*Gerygone mouki*	brown gerygone		C		2
animals	birds	Acanthizidae	*Gerygone olivacea*	white-throated gerygone		C		4
animals	birds	Acanthizidae	*Smicrornis brevirostris*	weebill		C		1
animals	birds	Accipitridae	*Aquila audax*	wedge-tailed eagle		C		3
animals	birds	Accipitridae	*Circus assimilis*	spotted harrier		C		1
animals	birds	Accipitridae	*Elanus axillaris*	black-shouldered kite		C		1
animals	birds	Accipitridae	*Haliaeetus leucogaster*	white-bellied sea-eagle		C		2
animals	birds	Accipitridae	*Haliastur sphenurus*	whistling kite		C		10
animals	birds	Accipitridae	*Hieraaetus morphnoides*	little eagle		C		1
animals	birds	Alcedinidae	*Ceyx azureus*	azure kingfisher		C		1
animals	birds	Anatidae	*Anas castanea*	chestnut teal		C		2
animals	birds	Anatidae	*Anas gracilis*	grey teal		C		11
animals	birds	Anatidae	*Anas superciliosa*	Pacific black duck		C		14
animals	birds	Anatidae	*Aythya australis*	hardhead		C		8
animals	birds	Anatidae	*Chenonetta jubata*	Australian wood duck		C		11
animals	birds	Anatidae	*Cygnus atratus*	black swan		C		7
animals	birds	Anatidae	*Dendrocygna arcuata*	wandering whistling-duck		C		1
animals	birds	Anatidae	*Malacorhynchus membranaceus*	pink-eared duck		C		2
animals	birds	Anatidae	*Nettapus coromandelianus*	cotton pygmy-goose		C		4
animals	birds	Anatidae	*Nettapus pulchellus*	green pygmy-goose		C		1
animals	birds	Anatidae	*Spatula rhynchotis*	Australasian shoveler		C		3
animals	birds	Anhingidae	*Anhinga novaehollandiae*	Australasian darter		C		14
animals	birds	Ardeidae	*Ardea alba modesta*	eastern great egret		C		8
animals	birds	Ardeidae	*Ardea intermedia*	intermediate egret		C		4
animals	birds	Ardeidae	*Ardea pacifica*	white-necked heron		C		1
animals	birds	Ardeidae	*Bubulcus ibis*	cattle egret		C		4
animals	birds	Ardeidae	*Egretta garzetta*	little egret		C		3
animals	birds	Ardeidae	*Egretta novaehollandiae*	white-faced heron		C		7
animals	birds	Artamidae	*Artamus leucorynchus*	white-breasted woodswallow		C		2
animals	birds	Artamidae	*Cracticus nigrogularis*	pied butcherbird		C		9
animals	birds	Artamidae	*Cracticus torquatus*	grey butcherbird		C		4
animals	birds	Artamidae	*Gymnorhina tibicen*	Australian magpie		C		13
animals	birds	Artamidae	*Strepera graculina*	pied currawong		C		3
animals	birds	Cacatuidae	*Cacatua galerita*	sulphur-crested cockatoo		C		1
animals	birds	Cacatuidae	*Calyptorhynchus funereus*	yellow-tailed black-cockatoo		C		1
animals	birds	Cacatuidae	*Eolophus roseicapilla*	galah		C		7
animals	birds	Cacatuidae	*Nymphicus hollandicus*	cockatiel		C		2
animals	birds	Campephagidae	*Coracina novaehollandiae*	black-faced cuckoo-shrike		C		8
animals	birds	Campephagidae	*Coracina papuensis*	white-bellied cuckoo-shrike		C		1
animals	birds	Charadriidae	*Elseyornis melanops*	black-fronted dotterel		C		2
animals	birds	Charadriidae	*Vanellus miles*	masked lapwing		C		8
animals	birds	Charadriidae	*Vanellus miles novaehollandiae*	masked lapwing (southern subspecies)		C		6
animals	birds	Cisticolidae	*Cisticola exilis*	golden-headed cisticola		C		8
animals	birds	Columbidae	*Geopelia humeralis*	bar-shouldered dove		C		2
animals	birds	Columbidae	*Geopelia striata*	peaceful dove		C		1

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Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Columbidae	*Ocyphaps lophotes*	crested pigeon		C		7
animals	birds	Columbidae	*Phaps chalcoptera*	common bronzewing		C		2
animals	birds	Coraciidae	*Eurystomus orientalis*	dollarbird		C		2
animals	birds	Corcoracidae	*Corcorax melanorhamphos*	white-winged chough		C		1
animals	birds	Corcoracidae	*Struthidea cinerea*	apostlebird		C		3
animals	birds	Corvidae	*Corvus orru*	Torresian crow		C		13
animals	birds	Cuculidae	*Cacomantis variolosus*	brush cuckoo		C		1
animals	birds	Cuculidae	*Centropus phasianinus*	pheasant coucal		C		4
animals	birds	Cuculidae	*Chalcites osculans*	black-eared cuckoo		C		1
animals	birds	Cuculidae	*Eudynamys orientalis*	eastern koel		C		4
animals	birds	Estrildidae	*Taeniopygia bichenovii*	double-barred finch		C		3
animals	birds	Falconidae	*Falco cenchroides*	nankeen kestrel		C		5
animals	birds	Falconidae	*Falco longipennis*	Australian hobby		C		1
animals	birds	Halcyonidae	*Dacelo leachii*	blue-winged kookaburra		C		1
animals	birds	Halcyonidae	*Dacelo novaeguineae*	laughing kookaburra		C		7
animals	birds	Halcyonidae	*Todiramphus macleayii*	forest kingfisher		C		1
animals	birds	Halcyonidae	*Todiramphus sanctus*	sacred kingfisher		C		5
animals	birds	Hirundinidae	*Hirundo neoxena*	welcome swallow		C		10
animals	birds	Hirundinidae	*Petrochelidon ariel*	fairy martin		C		5
animals	birds	Hirundinidae	*Petrochelidon nigricans*	tree martin		C		1
animals	birds	Laridae	*Chlidonias hybrida*	whiskered tern		C		1
animals	birds	Laridae	*Chroicocephalus novaehollandiae*	silver gull		C		6
animals	birds	Laridae	*Gelochelidon nilotica*	gull-billed tern		SL		2
animals	birds	Laridae	*Hydroprogne caspia*	Caspian tern		SL		7
animals	birds	Laridae	*Leucophaeus pipixcan*	Franklin's gull		C		1
animals	birds	Maluridae	*Malurus cyaneus*	superb fairy-wren		C		4
animals	birds	Maluridae	*Malurus lamberti*	variegated fairy-wren		C		3
animals	birds	Maluridae	*Malurus melanocephalus*	red-backed fairy-wren		C		5
animals	birds	Megaluridae	*Megalurus timoriensis*	tawny grassbird		C		2
animals	birds	Meliphagidae	*Entomyzon cyanotis*	blue-faced honeyeater		C		9
animals	birds	Meliphagidae	*Lichmera indistincta*	brown honeyeater		C		5
animals	birds	Meliphagidae	*Manorina melanocephala*	noisy miner		C		15
animals	birds	Meliphagidae	*Meliphaga lewinii*	Lewin's honeyeater		C		1
animals	birds	Meliphagidae	*Melithreptus albogularis*	white-throated honeyeater		C		4
animals	birds	Meliphagidae	*Melithreptus lunatus*	white-naped honeyeater		C		4
animals	birds	Meliphagidae	*Philemon citreogularis*	little friarbird		C		7
animals	birds	Meliphagidae	*Philemon corniculatus*	noisy friarbird		C		7
animals	birds	Meliphagidae	*Plectorhyncha lanceolata*	striped honeyeater		C		5
animals	birds	Meropidae	*Merops ornatus*	rainbow bee-eater		C		2
animals	birds	Monarchidae	*Grallina cyanoleuca*	magpie-lark		C		14
animals	birds	Monarchidae	*Myiagra inquieta*	restless flycatcher		C		5
animals	birds	Monarchidae	*Myiagra rubecula*	leaden flycatcher		C		1
animals	birds	Motacillidae	*Anthus novaeseelandiae*	Australasian pipit		C		1
animals	birds	Nectariniidae	*Dicaeum hirundinaceum*	mistletoebird		C		2
animals	birds	Oriolidae	*Oriolus sagittatus*	olive-backed oriole		C		4
animals	birds	Pachycephalidae	*Pachycephala pectoralis*	golden whistler		C		1

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Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Pachycephalidae	*Pachycephala rufiventris*	rufous whistler		C		4
animals	birds	Pardalotidae	*Pardalotus striatus*	striated pardalote		C		8
animals	birds	Pelecanidae	*Pelecanus conspicillatus*	Australian pelican		C		12
animals	birds	Phalacrocoracidae	*Microcarbo melanoleucos*	little pied cormorant		C		11
animals	birds	Phalacrocoracidae	*Phalacrocorax carbo*	great cormorant		C		11
animals	birds	Phalacrocoracidae	*Phalacrocorax sulcirostris*	little black cormorant		C		12
animals	birds	Phalacrocoracidae	*Phalacrocorax varius*	pied cormorant		C		7
animals	birds	Phasianidae	*Coturnix pectoralis*	stubble quail		C		2
animals	birds	Phasianidae	*Coturnix ypsilophora*	brown quail		C		2
animals	birds	Podargidae	*Podargus strigoides*	tawny frogmouth		C		1
animals	birds	Podicipedidae	*Podiceps cristatus*	great crested grebe		C		3
animals	birds	Podicipedidae	*Poliocephalus poliocephalus*	hoary-headed grebe		C		1
animals	birds	Podicipedidae	*Tachybaptus novaehollandiae*	Australasian grebe		C		11
animals	birds	Pomatostomidae	*Pomatostomus temporalis*	grey-crowned babbler		C		5
animals	birds	Psittacidae	*Alisterus scapularis*	Australian king-parrot		C		2
animals	birds	Psittacidae	*Aprosmictus erythropterus*	red-winged parrot		C		3
animals	birds	Psittacidae	*Parvipsitta pusilla*	little lorikeet		C		1
animals	birds	Psittacidae	*Platycercus adscitus*	pale-headed rosella		C		8
animals	birds	Psittacidae	*Psephotus haematonotus*	red-rumped parrot		C		2
animals	birds	Psittacidae	*Trichoglossus chlorolepidotus*	scaly-breasted lorikeet		C		6
animals	birds	Psittacidae	*Trichoglossus moluccanus*	rainbow lorikeet		C		8
animals	birds	Rallidae	*Amaurornis moluccana*	pale-vented bush-hen		C		1
animals	birds	Rallidae	*Fulica atra*	Eurasian coot		C		7
animals	birds	Rallidae	*Gallinula tenebrosa*	dusky moorhen		C		8
animals	birds	Rallidae	*Porphyrio melanotus*	purple swamphen		C		3
animals	birds	Rallidae	*Tribonyx ventralis*	black-tailed native-hen		C		1
animals	birds	Recurvirostridae	*Himantopus himantopus*	black-winged stilt		C		8
animals	birds	Rhipiduridae	*Rhipidura leucophrys*	willie wagtail		C		12
animals	birds	Scolopacidae	*Gallinago hardwickii*	Latham's snipe		SL		1
animals	birds	Strigidae	*Ninox boobook*	southern boobook		C		4
animals	birds	Threskiornithidae	*Platalea flavipes*	yellow-billed spoonbill		C		1
animals	birds	Threskiornithidae	*Platalea regia*	royal spoonbill		C		4
animals	birds	Threskiornithidae	*Plegadis falcinellus*	glossy ibis		SL		1
animals	birds	Threskiornithidae	*Threskiornis molucca*	Australian white ibis		C		5
animals	birds	Threskiornithidae	*Threskiornis spinicollis*	straw-necked ibis		C		3
animals	birds	Timaliidae	*Zosterops lateralis*	silvereye		C		3
animals	birds	Tytonidae	*Tyto delicatula*	eastern barn owl		C		1
animals	insects	Hesperiidae	*Ocybadistes walkeri*	green grass-dart				1
animals	insects	Lycaenidae	*Lampides boeticus*	long-tailed pea-blue				1
animals	insects	Lycaenidae	*Prosotas dubiosa dubiosa*	purple line-blue				1
animals	insects	Lycaenidae	*Psychonotis caelius taygetus*	small green-banded blue				1
animals	insects	Lycaenidae	*Zizina otis labradus*	common grass-blue (Australian subspecies)				1
animals	insects	Nymphalidae	*Acraea andromacha andromacha*	glasswing				1
animals	insects	Nymphalidae	*Danaus petilia*	lesser wanderer				1
animals	insects	Nymphalidae	*Junonia villida villida*	meadow argus				2

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Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	insects	Papilionidae	*Graphium eurypylus*	pale triangle				1
animals	insects	Papilionidae	*Papilio demoleus sthenelus*	chequered swallowtail				1
animals	insects	Pieridae	*Appias paulina ega*	yellow albatross				1
animals	insects	Pieridae	*Catopsilia pyranthe crokera*	white migrant				1
animals	insects	Pieridae	*Delias argenthona argenthona*	scarlet jezebel				1
animals	insects	Pieridae	*Eurema hecabe*	large grass-yellow				2
animals	insects	Pieridae	*Eurema smilax*	small grass-yellow				1
animals	mammals	Macropodidae	*Notamacropus rufogriseus*	red-necked wallaby		C		1
animals	mammals	Petauridae	*Petaurus notatus*	Krefft's glider		C		1
animals	mammals	Phalangeridae	*Trichosurus vulpecula*	common brushtail possum		C		1
animals	mammals	Phascolarctidae	*Phascolarctos cinereus*	koala		V	V	2
animals	mammals	Pteropodidae	*Pteropus sp.*			C		1
animals	ray-finned fishes	Anguillidae	*Anguilla reinhardtii*	longfin eel				1
animals	ray-finned fishes	Eleotridae	*Hypseleotris klunzingeri*	western carp gudgeon				1
animals	ray-finned fishes	Eleotridae	*Hypseleotris sp.*					1
animals	ray-finned fishes	Eleotridae	*Mogurnda adspersa*	southern purplespotted gudgeon				1
animals	ray-finned fishes	Eleotridae	*Philypnodon grandiceps*	flathead gudgeon				1
animals	ray-finned fishes	Melanotaeniidae	*Melanotaenia duboulayi*	crimsonspotted rainbowfish				1
animals	ray-finned fishes	Plotosidae	*Tandanus tandanus*	freshwater catfish				1
animals	ray-finned fishes	Terapontidae	*Amniataba percoides*	barred grunter				1
animals	ray-finned fishes	Terapontidae	*Leiopotherapon unicolor*	spangled perch				1
animals	reptiles	Agamidae	*Pogona barbata*	bearded dragon		C		1
animals	reptiles	Chelidae	*Elseya albagula*	southern snapping turtle		CR	CE	1
animals	reptiles	Chelidae	*Emydura macquarii krefftii*	Krefft's river turtle		C		1
animals	reptiles	Chelidae	*Emydura macquarii macquarii*	Murray turtle		C		1/1
animals	reptiles	Chelidae	*Wollumbinia latisternum*	saw-shelled turtle		C		1
animals	reptiles	Elapidae	*Demansia psammophis*	yellow-faced whipsnake		C		2

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.

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Queensland Government

WildNet species list

Search Criteria: Species List for a Specified Point
Species: Plants (including other non-animals such as fungi and protists)
Type: Native
Queensland status: Rare and threatened species
Records: All
Date: Since 1980
Latitude: -26.2910
Longitude: 151.9776
Distance: 2
Email: adam.garthwaite@ecoaus.com.au
Date submitted: Thursday 10 Mar 2022 11:00:34
Date extracted: Thursday 10 Mar 2022 11:10:02

There were no records retrieved for your selection

Disclaimer
Information presented on this product is distributed by the Queensland Government as an information source only. While every care is taken to ensure the accuracy of this data, the State of Queensland makes no statements, representations or warranties about the accuracy, reliability, completeness or suitability of any information contained in this product.
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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.

Appendix B PRCP Schedule

Provided separately as original Excel table.

Appendix C Supporting Land Outcome Documents (EA)

ecoaccess
environmental licences and permits

Notice of Decision – Amendment Application

This notice is issued by the Environmental Protection Agency to advise of a statutory decision made under section 257 of the Environmental Protection Act 1994.

Unimin Lime (NSW) Pty Ltd
PO Box 74
ROSEWATER EAST SA 5013

C/c The Mining Registrar
Department of Mines and Energy
PO Box 1475
COORPAROO QLD 4151

Our Reference: 188782

Attn: Mr Greg Watkins

Re: Amendment of environmental authority MIN100485506

The EPA has assessed the application received on 27-MAR-2008 to amend environmental authority MIN100485506 and wishes to advise you that the application has been granted.

A copy of the amended environmental authority is enclosed.

If you require more information please contact Louise Karle, the Project Manager, on (07) 4121 1935.

T. B

Tim Brain
Delegate
Environmental Protection Agency
24-APR-2008

Enquiries:
Environmental Services
Wide Bay /Burnett Region
Environmental Protection Agency
Ph. **(07) 4121 1800**
Fax. (07) 4121 1650

Environmental Protection Agency
www.epa.qld.gov.au ABN 87 221 158 786

Queensland Government
Environmental Protection Agency
Queensland Parks and Wildlife Service

ecoaccess
environmental licences & permits

Environmental Authority (Mining Activities) Non Code Compliant Level 1 Mining Project
Permit[1] Number: MIN100485506

Section 228 *Environmental Protection Act 1994*

Takes Effect From: ***28 April 2008***

Details

Permit Holder(s)	Name	Address
Principal Holder	Unimin Lime (NSW) Pty Ltd	Level 16, 111 Pacific Highway NORTH SYDNEY NSW 2060

Activity(s)	Location(s)
Mining Lease	ML50111

This amended environmental authority replaces the previous version of this document (Permit MIN100485506) dated 8 August 2007.

The anniversary date of the environmental authority is **8 August**.

The amended environmental authority is subject to the attached conditions of approval.

T. B

Tim Brain
Delegate
Environmental Protection Agency
24-APR-2008

[1] Permit includes licences, approvals, permits, authorisations, certificates, sanctions or equivalent/similar as required by legislation administered by the Environmental Protection Agency and the Queensland Parks and Wildlife Service

Environmental Protection Agency
www.epa.qld.gov.au ABN 87 221 158 786

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Environmental Protection Agency
Queensland Parks and Wildlife Service

This amended **Environmental Authority** incorporates the following schedules:

- Schedule A - General
- Schedule B - Air
- Schedule C - Water
- Schedule D - Noise and vibration
- Schedule E - Waste
- Schedule F - Land
- Schedule G - Community
- Schedule H - Definitions

Schedule A - General

Authorised Activities

(A1-1) This environmental authority permits mining activities at the Northern Limestone Deposit within ML50111, as identified on Figure 1, Attachment A.

Definitions

(A2-1) Words and phrases used throughout this environmental authority are defined in Schedule H – Definitions. Where a definition for a term used in this environmental authority is sought and the term in not defined within this environmental authority, the definitions in the *Environmental Protection Act 1994*, its Regulations and Environmental Protection Policies, must be used.

Financial assurance

(A3-1) Provide a financial assurance in the amount and form required by the administering authority prior to the commencement of activities proposed under this environmental authority.

(A3-2) The financial assurance is to remain in force until the administering authority is satisfied that no claim on the assurance is likely.

Maintenance of measures, plant and equipment

(A4-1) The holder must:

a) install all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority; and
b) maintain such measures, plant and equipment in a proper condition; and
c) operate such measures, plant and equipment in a proper manner.

Storage and handling of flammable, combustible and corrosive liquids

(A5-1) Spillage of all flammable and combustible liquids must be contained within an on-site containment system and controlled in a manner that prevents environmental harm (other than trivial harm) and maintained in accordance with AS 1940-2004 *: The Storage and Handling of Flammable and Combustible Liquids.*

Monitoring

(A6-1) Record, compile and keep for a minimum of five years all monitoring results required by this environmental authority and make available for inspection all or any of these records upon request by the administering authority. Monitoring results for rehabilitation will need to be kept until final surrender of this environmental authority is accepted.

(A6-2) Where monitoring is a requirement of this environmental authority, ensure that a competent person(s) conducts all monitoring.

Notification of Emergencies and Incidents

(A7-1) As soon as practicable after becoming aware of any emergency or incident which results in the release of contaminants not in accordance, or reasonably expected to be not in accordance with, the conditions of this environmental authority, the administering authority must be notified of the release by telephone or facsimile.

END OF CONDITIONS FOR SCHEDULE A

MB 24-4-08

Schedule B - Air

Dust nuisance

(B1-1) Subject to Condition (B1-5) the release of dust or particulate matter or both resulting from the mining activities must not cause an environmental nuisance at any sensitive place.

(B1-2) Within three months of the date of this authority, the holder of this authority must develop and implement a Dust Management Plan, which ensures that the mining activities are carried out by such reasonable and practicable means necessary to prevent the emission of dust that constitutes an environmental nuisance. This Plan may include, but not necessarily be limited to, strategies such as the following:

- orienting product stockpiles in a direction that reduces exposed surfaces to prevailing winds where possible;
- watering product stockpiles where possible;
- watering haul roads and other disturbed surfaces including around the plant and office buildings regularly;
- ensuring that trucks transporting fine materials are covered prior to leaving the site;
- assessing wind direction prior to undertaking work that is likely to generate large quantities of dust (eg. emptying silos, large earthworks), and postponing works if wind is blowing towards a nuisance sensitive place;
- establishing a cover crop on topsoil stockpiles and disturbed areas yet to be rehabilitated;
- enclosing crushing and Ground Limestone (GLS) plant where possible;
- using and maintaining effective dust suppression equipment on the processing plant, for example, installing a telescopic chute at the GLS plant;
- using particulate control devices (dust collectors) to treat air discharges from point sources where possible;
- establishing vegetated buffer zones upwind between the plant and sensitive receptors.

(B1-3) The holder of this authority must review the effectiveness of the Dust Management Plan required by Condition (B1-2) at least every six months after its implementation to ensure that it achieving its objective.

(B1-4) When requested by the Administering Authority, dust and particulate monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which, in the opinion of an authorised officer, is neither frivolous nor vexatious nor based on mistaken belief) of environmental nuisance at any sensitive place, and the results must be notified to the administering authority within 14 days following completion of monitoring.

(B1-5) If the environmental authority holder can provide evidence through monitoring that the following limits are not being exceeded then the holder is not in breach of (B1-1):

a) Dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with AS 3580.10.1 Methods for sampling and analysis of ambient air - Determination of particulates - Deposited matter - Gravimetric method of 1991; and if applicable

b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometre (µm) (PM10) suspended in the atmosphere of 150 micrograms per cubic metre over a 24 hour averaging time, at a sensitive or commercial place downwind of the operational land, when monitored in accordance with:

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- Particulate matter - Determination of suspended particulate PM10 high-volume sampler with size-selective inlet - Gravimetric method, when monitored in accordance with AS 3580.9.6 Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM (sub) 10 high volume sampler with size-selective inlet - Gravimetric method of 1990; or
- Any alternative method of sampling PM10, which may be permitted by the 'Air Quality Sampling Manual' as published from time to time by the administering authority.

(B1-6) If monitoring indicates that relevant limits specified in Condition (B1-5) are exceeded, then the environmental authority holder must immediately implement dust abatement measures so that emissions of dust from the activity do not result in further environmental nuisance.

END OF CONDITIONS FOR SCHEDULE B

Schedule C - Water

Release to waters

(C1-1) There must be no release of contaminants to waters except as authorised by Condition (C1-3).

(C1-2) The holder of this environmental authority must develop and implement a Water Management System within one month of the date of this authority to ensure that contaminants are not released to any waters or the bed and banks of any waters other than in accordance with Condition (C1-3).

The Water Management System must include, but may not be limited to, measures to:

a) prevent incident stormwater and stormwater run-off from contacting general waste and regulated wastes; and
b) divert upstream run-off away from disturbed areas, or areas containing wastes or contaminants; and
c) capture and manage run-off from disturbed areas (including waste rock and topsoil stockpiles); and
d) manage pit water (including that resulting from inflow of groundwater).

(C1-3) Releases from the water management system to waters may only occur as a result of heavy or prolonged rainfall (equivalent to that expected from a 24 hour storm with an average recurrence interval of 1 in 10 years), and must comply with the limits prescribed in Schedule C Table 1.

(C1-4) Releases from the water management system to waters must be monitored for the parameters and at the locations and frequencies defined in Schedule C - Table 1.

FB 24-4-08

Schedule C - Table 1 (Release Limits)

Parameter	Units	Minimum	Maximum	Monitoring Location	Monitoring Frequency
Total Suspended Solids**	mg/L	NS	10 mg/L above a background value^ where the background value is less than 100 mg/L or 10 percent greater than a background value where the background value is greater than 100 mg/L	Each final release point of the water management system (eg. the overflow point of sediment settling ponds).	Each time a release from the water management system occurs and weekly while the flow continues.
pH	units	6.5	9	"	"
Electrical Conductivity	µS/cm	NS	1000	"	"
Total Nitrogen	mg/L	NS	0.5	"	"
Oil and Grease	mg/L	NS	5	"	"

'NS' means not specified.

^ For the purposes of this condition, the background value is to be established using a sample collected during the run-off event, from a location immediately upstream of potential impacts from the mining activities and representative of waters that are not impacted by the mining lease activities.

**For the purposes of this condition, the environmental authority holder may nominate to measure the Turbidity (NTU) of water in addition to Total Suspended Solids (TSS) for a period of time. If a sufficient dataset is obtained to satisfy the administering authority that there is a direct correlation between Turbidity and TSS results, the environmental authority holder may conduct analysis of Turbidity in place of TSS.

(C1-5) Notwithstanding the quality characteristic limits specified in Schedule C Table 1, the contaminants released must not have any properties nor contain any organisms or contaminants in concentrations that are capable of causing environmental harm.

Sediment and erosion controls

(C2-1) All reasonable and practicable erosion protection measures and sediment control measures must be implemented and maintained to minimise erosion and the release of sediment.

Maintenance and cleaning of vehicles

(C3-1) The maintenance and cleaning of vehicles and any other equipment or plant must be carried out in areas that prevent the resultant contaminants being released into any waters

Water suitable for dust suppression

(C4-1) Water from the Water Management System may be used for dust suppression or other general purposes on the site provided that it does not have any properties nor contain any organisms or contaminants in concentrations that are capable of causing environmental harm.

Receiving Waters

(C5-1) Receiving waters affected by the release of storm water potentially contaminated by releases from areas disturbed by mining and associated activities must be monitored at the locations and frequencies defined in Schedule C – Table 2: Receiving water monitoring locations and frequency.

Monitoring Points:

W1 – Representative water samples must be collected within 20m of the confluence of Barambah and Barkers Creeks, upstream of the point where runoff from areas of ML50111 that are being used for mining activities enter these watercourses.

W2 – Representative water samples must be collected from Barambah Creek, downstream of, but within 100m of, the final discharge point for stormwater from the site to the Creek.

Schedule C - Table 2: Receiving water monitoring locations and frequency

Monitoring location	Quality characteristics (Water Samples)	Monitoring frequency
W1, W2	Electrical Conductivity (µS/cm)	Six-monthly during a rainfall event that results in run-off from the site*
W1, W2	pH	Six-monthly during a rainfall event that results in run-off from the site*
W1, W2	Total Suspended Solids	Six-monthly during a rainfall event that results in run-off from the site*
W1, W2	Calcium (mg/L)	Six-monthly during a rainfall event that results in run-off from the site*

*If, within one month after the prescribed sampling time there has not been any rainfall event that has resulted in run-off from the site, samples must still be collected from the specified monitoring points. In the event that there is no water at the sampling locations at this time, samples must be collected at the first opportunity thereafter.

(C5-2) The method of water sampling required by this environmental authority must comply with that set out in the latest edition of the Environmental Protection Agency's Water Quality Sampling Manual.

Groundwater

(C6-1) Within two months of the effective date of this environmental authority, the holder must have commissioned a study, to be undertaken by a suitably qualified and experienced person, to determine the recharge sources and connectivity with surface waters, of groundwater encountered in the open pit on the mining lease.

This study should include, but may not necessarily be limited to, the following:

- Standard chemical analyses (including sodium, calcium, magnesium, potassium, bicarbonate, carbonate, chloride, fluoride, nitrate and sulphate) of representative water samples collected from groundwater encountered in the active mine pit, water at a point within Barambah Creek closest to the mine pit, water in Barambah Creek during a release from Bjelke-Petersen Dam (if there is a release by Sunwater during the study period), and from the waterhole on Barambah Creek known locally as the 'Cherbourg Waterhole' downstream of the mining lease; and
- Records of the time required for water levels within the pit to recover to a specified level following pump-out (to determine accurate recharge rates), and associated information about water levels within, or releases from Bjelke-Petersen Dam to, Barambah Creek.

(C6-2) Within six months of the date of this authority, the holder must submit a report to the administering authority detailing the findings of the study required by (C6-1), including conclusions about the most likely recharge sources of groundwater, and the degree of connectivity with surface waters.

This report must also be accompanied by a proposed monitoring program which uses the information obtained by the study to identify the potential impacts of continually dewatering the pit on other users of the groundwater (particularly those with bores within 1km of the pit, but excluding those within alluvial /river flat areas) and on surface waters (considering other downstream users in addition to ecological impacts). The degree of monitoring required should reflect the risk of harm occurring, as determined by the study. For instance, if the study and report conclude that there is no connectivity between the groundwater encountered in the pit and surface waters, and that continual pumping will not adversely impact on other users of the groundwater resource, monitoring may be limited to recording levels of groundwater and pump-out rates within the pit.

The proposed monitoring program must be sufficient to quantify impacts of pit dewatering such that remedial action can be taken if it is identified that continual dewatering is likely to adversely impact on the ecological values of connected surface waters, or on other users of the water.

KB 24-4-08

(C6-3) Due regard must be given to comments made by the administering authority in finalising the monitoring program required by Condition (C6-2). This monitoring program must be implemented within 8 months of the effective date of this environmental authority.

(C6-4) Should monitoring undertaken in accordance with the program implemented under Condition (C6-3) identify adverse impacts, the environmental authority holder must immediately notify the administering authority.

(C6-5) Notwithstanding Conditions (C6-1) to (C6-4), the activities must not cause adverse impacts on the ecological values of connected surface waters, or on other users of the groundwater.

END OF CONDITIONS FOR SCHEDULE C

Schedule D - Noise and vibration

Noise nuisance

(D1-1) Noise from mining activities must not cause an environmental nuisance at any nuisance sensitive place.

(D1-2) When requested by the Administering Authority, noise monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which in the opinion of an authorised officer is neither frivolous nor vexatious nor based on mistaken belief) of environmental nuisance at any sensitive place, and the results must be notified within 14 days to the administering authority following completion of monitoring.

(D1-3) Noise Monitoring must include:

i) background noise level;
ii) $L_{Amax, adj, 15 mins}$ or where they can be justified as appropriate, $L_{A 10, adj, 15 mins}$ and $L_{A 1, adj, 15 mins}$;
iii) the level and frequency of occurrence of impulsive or tonal noise;
iv) atmospheric conditions including wind speed and direction;
v) effects due to extraneous factors such as traffic noise; and
vi) location, date and time of recording.

(D1-4) In the event of a complaint about noise environmental nuisance that the administering authority considers is not frivolous or vexatious, the environmental authority holder is to develop a noise management plan within two (2) weeks of being advised in writing of the complaint. The noise management plan must address at least, but not be limited to, the following matters:

i) identification of component noise sources and activities at the place(s) which impact on noise sensitive areas;
ii) the measured and/or predicted level of these noise sources and activities at noise sensitive places;
iii) the reasonable and practicable control or abatement measures that can be undertaken to reduce identified intrusive noise sources;
iv) the level of noise at noise sensitive places that would be achieved from implementing these measures.
v) the handling of future noise complaints;
vi) community liaison and consultation; and
vii) training of staff in noise management practices.

(D1-5) Upon the completion of the noise management plan it must be submitted to the administering authority within 14 days for its review and comment.

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(D1-6) After the Administering Authority has provided comment on the noise management plan, the holder of this authority must implement the plan as soon as practicable.

(D1-7) The method of measurement and reporting of noise levels must comply with the latest edition of the Environmental Protection Agency's Noise Measurement Manual.

(D1-8) The activities on ML50111 must be carried out by such reasonable and practicable means necessary to prevent the emission of noise that constitutes an environmental nuisance. The reasonable and practicable measures adopted may include but not necessarily be limited to the following noise abatement measures:

i) ensure that any equipment to be used for activities on ML50111 is assessed for potential noise nuisance impacts and appropriately attenuated;

ii) ensure that all plant and equipment is operated and maintained in a proper and efficient manner;

iii) ensure that engine cowlings and high efficiency silencers are fitted to all the engines of all plant and equipment identified as impacting on noise sensitive receivers;

iv) ensure that noise generating activities are not undertaken in close proximity to noise sensitive places or commercial places;

v) ensure that, where required, noise abatement barriers are sited such that they effectively intercept the sound transmission path between the sources of noise and receptor premises;

vi) locate any new haul and access routes within the premises as far away from sensitive places as is practical having regard to operational convenience; and

vii) where operation of reversing beepers is likely to cause environmental nuisance, taking measures to ensure mitigation of the nuisance, for example by de-tuning the reversing beepers, replacing the reversing beepers with other warning devices and/or replacing reversing beepers with alternative reversing beepers which adjust their noise level output in accordance with the prevailing background noise level.

Blasting

(D1-9) All blasting must be carried out in a proper manner by a competent person in accordance with best practice environmental management to minimise the likelihood of adverse effects being caused by the impact of airblast overpressure and ground-borne vibration in noise-sensitive places and people living in or using the surrounding area.

(D1-10) Blasting activities must be carried out in such a manner that if blasting noise should propagate to a noise-sensitive place, then

(a) the airblast overpressure must be not more than 115dB(linear) peak for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and
(b) the airblast overpressure must not exceed 120dB(linear) peak for any blast.

(D1-11) Blasting operations must be carried out in such a manner that if ground vibration should propagate to a noise-sensitive place:

(a) the ground-borne vibration must not exceed a peak particle velocity of 5mm per second for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and
(b) the ground-borne vibration must not exceed a peak particle velocity of 10mm per second for any blast.

(D1-12) Blasting is only permitted during the hours of 9am to 3pm, Monday to Friday, and from 9am to 1pm on Saturdays. Blasting must not take place on Sundays or public holidays.

END OF CONDITIONS FOR SCHEDULE D

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Schedule E - Waste

General

(E1-1) Waste must not be released to the environment, stored, transferred or disposed of contrary to any condition of this environmental authority.

(E1-2) Except as otherwise provided by the conditions of this authority, all disposal of waste generated in carrying out the activities on ML50111 must be to a proper and appropriate facility that is authorised to accept such waste.

Storage of tyres

(E2-1) Tyres stored awaiting disposal or transport for take-back and, recycling, or waste-to-energy options - should be stockpiled in volumes less than 3m in height and 200 sq.m in area and at least 10m from any other tyre storage area.

(E2-2) All reasonable and practicable fire prevention measures must be implemented, including removal of grass and other materials within a 10m radius of the scrap tyre storage area.

Waste Handling

(E3-1) All regulated waste must be removed from the site by a person who holds a current approval to transport such waste under the provisions of the *Environmental Protection Act 1994*.

END OF CONDITIONS FOR SCHEDULE E

Schedule F - Land

Rehabilitation Landform Criteria

(F1-1) All areas disturbed as a result of mining activities must be rehabilitated to a stable landform with a self-sustaining vegetation cover in accordance with Schedule F - Table 1, and comply with the maximum distance between erosion control structures specified in Schedule F - Table 2.

(F1-2) Progressive rehabilitation in accordance with the conditions of this schedule must commence as soon as areas become available within the operational land.

Final Land Use and Rehabilitation Plan

(F2-1) The holder of this environmental authority must develop and implement a Final Land Use and Rehabilitation Plan to ensure that all areas disturbed by mining activities will be suitably rehabilitated in accordance with Schedule F – Table 1 and the other conditions of this environmental authority. The Plan must include, but is not limited to the following:

i) disturbance type;
ii) disturbance area;
iii) pre and post mine land descriptions;
iv) pre mine and post mine land suitability;
v) reference site(s) identification;
vi) proposed vegetation species;
vii) a description of rehabilitation management techniques incorporating works and monitoring programs and timetables;
viii) indicators for success; and

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ix) keeping of appropriate records of rehabilitation measures implemented including taking of photographs demonstrative of rehabilitation achieved and the preparation of annual rehabilitation progress reports. A summary of the annual rehabilitation progress report must be submitted to the administering authority with each annual return.

NOTE: The Final Land Use and Rehabilitation Plan is to be managed through the Plan of Operations.

(F2-2) On or before 31 August 2007, the holder of this authority must submit a copy of the Final Land Use and Rehabilitation Plan, as required by condition (F2-1), to the administering authority, and in finalising the plan must have due regard to comments made by the administering authority.

Grazing Pasture Outcome

(F3-1) Areas which are to be rehabilitated to pasture must comply with the following outcomes:

i) generate vegetation with projective cover, species composition and species distribution similar to the reference site(s) to be selected; and

ii) landforms are stable and have been reshaped as close as practicable to the landform of the site prior to the commencement of mining activities; ;

iii) topsoil on rehabilitated areas is reinstated to a depth that is consistent with the depth of topsoil on the site prior to the commencement of mining activities; and

iv) measures of productivity (e.g. sustainable dry matter production of pasture species) are similar to the reference site(s) to be selected.

(F3-2) Prior to surrendering this authority, an investigation into rehabilitated areas must be conducted and a report submitted to the administering authority proposing acceptance criteria to meet the outcomes specified in condition (F3-1) and Schedule F Table 1.

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Schedule F - Table 1 (Landform Design and Suitability Criteria)

Disturbance		Pre-mine land capability class	Post-mine land capability class	Maximum Final Slope	Final Land Use Description
Type	Estimated Area (ha)				
Open Pit	3.22	vi	N/A	Refer Schedule F Table 3	From the base of the pit to the height of the groundwater table: Water storage with water quality to be suitable for livestock use.
	4.89	vi	viii	Refer Schedule F Table 3[1]	Above the level of the natural groundwater table: Safe access is to be provided to the water for native animals and livestock.[2]
Waste Dump No. 1 North-West	11.41	vi	vi	15° (25%)	Grazing Pasture
Waste Dump No. 2 North-West	2.61	vi	vi	15° (25%)	Grazing Pasture
Fuel Storage and Service Area	0.13	vi	vi	10° (18%)	Grazing Pasture
Plant /Office	2.6	vi	vi	10°	Grazing Pasture
Stockpiles	1.32	vi	vi	10°	Grazing Pasture
Silt Traps /Dams	0.47	vi	N/A	N/A	Water Storage
Roads and Tracks	1.68	vi	vi	10°	Grazing Pasture except where agreed with the landowner to be left as access tracks.
Topsoil Stockpiles	0.54	vi	vi	10°	Grazing Pasture

[1] Notwithstanding slopes specified in Schedule F Table 3 for the final void, access routes must have slopes suitable for the final land use, including animal access.

[2] also refer to condition (F4-1)

Schedule F – Table 2 Maximum distance between erosion control structures

Slope range (%)	Maximum distances between erosion control structures (m)
0 - 5	150
6 - 10	100
11 - 15	70
> 15	25

Residual void outcome

(F4-1) Residual voids must comply with the following outcomes;

- residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself, and subject to any other condition within this environmental authority;
- sufficient measures must be taken to ensure public safety and to direct livestock and fauna to safe access points; and
- residual voids comply with Schedule F - Table 3.

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Schedule F Table 3 (Residual Void Design)

Void Identification	Void Wall – Competent Rock Max Slope (degrees)	Void Wall – Incompetent Rock Max Slope (degrees)	Void Maximum Surface Area
Open Pit for Northern Limestone Deposit within ML50111	70°	38°	8.11ha

Infrastructure

(F5-1) All infrastructure, constructed by or for the environmental authority holder must be removed from the site prior to mining lease surrender, except where agreed in writing by the post mining land holder/owner, and for infrastructure other than water storages, with the approval of the Minister for Mines.

Contaminant Releases to Land

(F6-1) There must be no release of contaminants to land other than water from the Water Management System to be used for dust suppression (as authorised by condition (C4-1)) or for land rehabilitation purposes.

Protection of Rare Plant Species

(F7-1) The authority holder must take all reasonable and practicable measures to avoid disturbing any *Indigofera baileyi* (Bailey's Indigo) or *Callitris baileyi* (Bailey's Cypress Pine). If the authority holder is required to remove any of these plants from the mining area, the plants are to be translocated where practicable into an adjacent area of the same vegetation association, in accordance with the *Guidelines for The Translocation of Threatened plants in Australia,* Australian Network for Plant Conservation (2004), and monitored and maintained for a period of at least 12 months following translocation.

END OF CONDITIONS FOR SCHEDULE F

Schedule G - Community

Complaint response

(G1-1) All complaints received must be recorded, including details of complainant, reasons for the complaint investigations undertaken, conclusions formed and actions taken. This information must be made available for inspection by the administering authority on request.

END OF CONDITIONS FOR SCHEDULE G

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Schedule H - Definitions

Words and phrases used throughout this licence are defined below except where identified in the EP Act or subordinate legislation. Where a word or term is not defined, the ordinary English meaning applies, and regard should be given to the Macquarie Dictionary.

Word definitions

"acceptance criteria" means the measures by which actions implemented are deemed to be complete. The acceptance criteria indicate the success of the decommissioning and rehabilitation outcomes or remediation of areas which have been significantly disturbed by the mining activities. Acceptance criteria may include information regarding:

- stability of final land forms in terms of settlement, erosion, weathering, pondage and drainage;
- control of geochemical and contaminant transport processes;
- quality of runoff waters and potential impact on receiving environment;
- vegetation establishment, survival and succession;
- vegetation productivity, sustained growth and structure development;
- fauna colonisation and habitat development;
- ecosystem processes such as soil development and nutrient cycling, and the recolonisation of specific fauna groups such as collembola, mites and termites which are involved in these processes;
- microbiological studies including recolonisation by mycorrhizal fungi, microbial biomass and respiration;
- effects of various establishment treatments such as deep ripping, topsoil handling, seeding and fertiliser application on vegetation growth and development;
- resilience of vegetation to disease, insect attack, drought and fire;
- vegetation water use and effects on ground water levels and catchment yields.

"ambient (or total) noise" at a place, means the level of noise at the place from all sources (near and far), measured as the Leq for an appropriate time interval.

"appropriately qualified person" means any person who conforms to the EPA operational policy for an 'appropriately qualified person (analyst)' in accordance with Section 490(7) of the *Environmental Protection Act 1994*.

"authority" means environmental authority (mining activities) under the *Environmental Protection Act 1994*.

"commercial place" means a place used as an office or for business or commercial purposes, other than a place within the boundaries of the operational land.

"environmental authority holder" means the holder of this environmental authority.

"infrastructure" means water storage dams, roads and tracks, buildings and other structures built for the purpose of mining activities but does not include other facilities required for the long term management of mining impacts or the protection of potential resources. Such other facilities include dams containing hazardous waste, waste rock dumps, voids, or ore stockpiles and buildings as well as other structures whose ownership can be transferred and which have a residual beneficial use for the next owner of the operational land or the background land owner.

"$L_{A\ 10,\ adj,\ 10\ mins}$" means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 10% of any 10 minute measurement period, using Fast response.

"$L_{A\ 1,\ adj,\ 10\ mins}$" means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 1% of any 10 minute measurement period, using Fast response

"$L_{A,\ max\ adj,\ T}$" means the average maximum A-weighted sound pressure level, adjusted for noise character and measured over any 10 minute period, using Fast response.

"land" in the 'land schedule' of this document means land excluding waters and the atmosphere.

"land capability" as defined in the DME 1995 Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland.

"land suitability" as defined in the DME 1995 Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland.

"land use" term to describe the selected post mining use of the land, which is planned to occur after the cessation of mining operations.

"leachate" means a liquid that has passed through or emerged from, or is likely to have passed through or emerged from, a material stored, processed or disposed of at the operational land which contains soluble, suspended or miscible contaminants likely to have been derived from the said material.

"mineral processing areas" means those areas of the mining lease occupied by infrastructure and used for mineral processing activities e.g. loading areas, conveyor systems and sheds. Mineral processing areas do not include areas that are left undisturbed or are revegetated following initial disturbance and which do not form part of the processing activity e.g. open grassed areas, grassed banks.

"noxious" means harmful or injurious to health or physical well being, other than trivial harm.

"offensive" means causing reasonable offence or displeasure; is disagreeable to the sense; disgusting, nauseous or repulsive, other than trivial harm.

"peak particle velocity (ppv)" means a measure of ground vibration magnitude which is the maximum rate of change of ground displacement with time, usually measured in millimetres/second (mms)

"protected area" means
- a protected area under the Nature Conservation Act 1992; or
- a marine park under the Marine Parks Act 1992; or
- a World Heritage Area.

"progressive rehabilitation" means rehabilitation (defined below) undertaken progressively OR a staged approach to rehabilitation as mining activities are ongoing.

"reference site" means a site within the vicinity of the mining activities, that is not affected by mining activities and that is representative of the final land use description stated in Schedule F – Table 1.

"rehabilitation" the process of reshaping and revegetating land to restore it to a stable landform and in accordance with the acceptance criteria set out in this environmental authority and, where relevant, includes remediation of contaminated land.

"representative" means a sample set which covers the variance in monitoring or other data either due to natural changes or operational phases of the mining activities.

"self sustaining" means an area of land which has been rehabilitated and has maintained the required acceptance criteria without human intervention for a period nominated by the administering authority.

"sensitive place" means:

- a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises; or
- a motel, hotel or hostel; or
- an educational institution; or
- a medical centre or hospital; or
- a protected area under the Nature Conservation Act 1992, the Marine Parks Act 1992 or a World Heritage Area; or
- a public park or gardens; or
- a place used as a workplace, an office or for business or commercial purposes which is not part of the mining activities and does not include employees accommodation or public roads.

"stable" means geotechnical stability of the rehabilitated landform where instability related to the excessive settlement and subsidence caused by consolidation / settlement of the wastes deposited, and sliding / slumping instability has ceased.

"trivial harm" means environmental harm which is not material or serious environmental harm and will not cause actual or potential loss or damage to property of an amount of, or amounts totalling more than $5,000.

"waters" includes river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined water, natural or artificial watercourse, bed and bank of any waters, dams (with the exception of dams that form part of the on-site Water Management System), non-tidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and groundwater and any part-thereof.

END OF DEFINITIONS FOR SCHEDULE H

Attachment A – Figure 1

Figure indicating the location of the Northern Limestone Deposit for the purposes of Condition (A1-1)

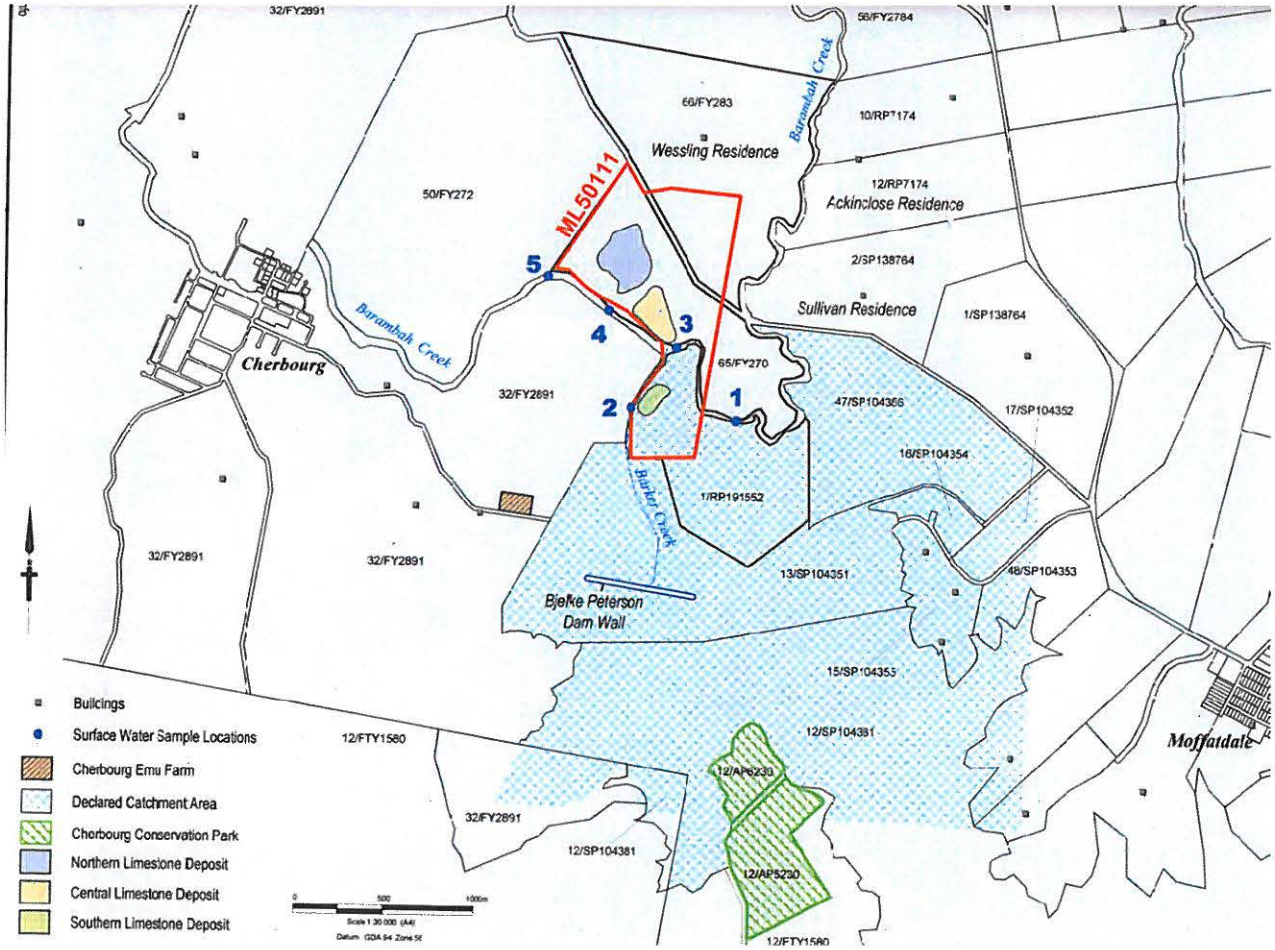

Figure 1 is taken from Figure 2 of the *Murgon Limestone Mine and Processing Plant Environmental Management Plan*, dated 23 November 2006, prepared by URS Australia Pty Ltd on behalf of Unimin Lime (NSW) Pty Ltd.

END OF ENVIRONMENTAL AUTHORITY

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Appendix D Inspection and Test Plans

Rehabilitation Inspection and Test Plan: Product Stockpile Removal

Site: Murgon Sheet number:

Applied to RA5

Milestone	Milestone Criteria or action required	Responsible party	Results, comment or record details	Hold or witness point	Date	Hold/Witness Point Signature
Infrastructure decommissioning and removal	All stockpiled unprocessed raw limestone or graded limestone products remaining at end of mine life have been returned to the base of the void			Hold		

Rehabilitation Inspection and Test Plan: Demolition and Equipment Removal

Site: Murgon Sheet number:

Applied to RA5-RA6 and RA8-RA10

Milestone	Milestone Criteria or action required	Responsible party	Results, comment or record details	Hold or witness point	Date	Hold/Witness Point Signature
Infrastructure decommissioning and removal	All services have been disconnected except where agreement has been reached with the landholder for these to remain			Hold		
	North Bore and South Bore decommissioned according to the preferred practices nominated in the Minimum Construction Requirements for Water Bores in Australia (Queensland Government)			Hold		
	Hazardous building materials have been identified, managed and removed by appropriately licenced contractors from buildings that will be either retained or removed as part of mine closure			Witness		
	Demolish and or remove all buildings, plant equipment, tanks from site that are not to be retained under an agreement with the landholder			Witness		
	All infrastructure assets to be removed (excludes those in RA10) have been demolished and demolition waste removed to an appropriately licenced waste facility			Witness		

Milestone	Milestone Criteria or action required	Responsible party	Results, comment or record details	Hold or witness point	Date	Hold/Witness Point Signature
	All concrete slabs and footings that are less than 0.5 m deep not associated with retained infrastructure have been broken up and removed to an appropriately licenced waste facility			Witness		

Rehabilitation Inspection and Test Plan: Remediation of contaminated land

Site: Murgon Sheet number:

Applied to RA4, RA9 and the workshop in RA10

Milestone	Milestone Criteria or action required	Responsible party	Results, comment or record details	Hold or witness point	Date	Hold/Witness Point Signature
Remediation of contaminated land	Site Investigation Report prepared by a certified/appropriately qualified person for RA4, RA9 and the workshop in RA10			Hold		
	If required, remediation is carried out and validated sampling has been complete			Hold		
	If residual contamination can safely remain insitu requiring the site to be placed on a Contaminated Land Register, a Site Management Plan: o Is prepared and certified by an appropriately qualified person o Includes a statement by the underlying landholder accepting responsibility to implement the Site Management Plan			Hold		

Rehabilitation Inspection and Test Plan: Landform development

Site: Murgon Sheet number:

Applied to RA1-RA7, RA9

Milestone	Milestone Criteria or action required	Responsible party	Results, comment or record details	Hold or witness point	Date	Hold/Witness Point Signature
Landform development and reshaping/re-profiling	Surface aggregate (limestone) from RA5 and RA7 (laydown areas and tracks) has been removed and placed in the void.			Hold		
	All major earthworks have been completed in accordance with the final engineering and design plans including: • Max. final slope for RA4, RA5, RA7 and RA9 do not exceed 10° • Max. final slope for RA1, RA2 and RA3 does not exceed 15° • Max. slope for RA6 (residual void) sections of non-competent (weathered) rock does not exceed 38° • Max. slope for RA6 (residual void) sections of competent rock does not exceed 70° • Perimeter abandonment bund and safety signage installed around RA6 (residual void)			Hold		

Milestone	Milestone Criteria or action required	Responsible party	Results, comment or record details	Hold or witness point	Date	Hold/Witness Point Signature
	Retained water management structures have been certified by an appropriately qualified person as confirming to the design standards and specifications consistent with those in the Best Practice Erosion and Sediment Control series (IECA 2008).			Hold		

Rehabilitation Inspection and Test Plan: Topsoil and scalps

Site: Murgon Sheet number:

Applied to RA2-RA5, RA7 and RA9

Milestone	Milestone Criteria or action required	Responsible party	Results, comment or record details	Hold or witness point	Date	Hold/Witness Point Signature
Topsoiling and surface preparation	Ripping completed to specifications (depth of 500 mm at 500 – 800 mm spacings).			Witness		
	An assessment of stockpiled soil quality and suitability for rehabilitation has been completed by an appropriately qualified person to confirm soil is suitable for target vegetation establishment			Hold		
	Scalps material applied to 150 mm on RA3 prior to application of topsoil			Witness		
	Topsoil or topsoil substitute placed to an average depth of 150 mm to RA2, RA3, RA4, RA5, RA7 and RA9			Witness		

Rehabilitation Inspection and Test Plan: Revegetation

Site: Murgon Sheet number:

Applied to RA2-RA5, RA7 and RA9

Milestone	Milestone Criteria or action required	Responsible party	Results, comment or record details	Hold or witness point	Date	Hold/Witness Point Signature
Revegetation	Applied topsoil will be ameliorated with an establishment dressing of a compound fertiliser containing N, P (low), K and S (such as Crop King 88 or equivalent) at a rate of 300 kg/ha (30 g/m2)			Witness		
	Applied topsoil substitute (scalps) amended with 10% organic material and an application of 200 kg/ha (20 g/m2) of monoammonium phosphate and 400 (40 g/m2) of muriate of potash (potassium sulfate)					
	After incorporation of fertiliser, the seedbed will be prepared will using harrows or equivalent			Witness		
	For RAs with a grazing pasture PMLU the following species and seeding rates have been applied: o Black Speargrass (*Heteropogon contortus*) at 2kg/ha o Forest Bluegrass (*Bothriochloa bladhii* ssp. Glabra)at 2kg/ha o Lotononis (*Lotononis bainsii*) at 0.3 kg/ha			Witness		

Rehabilitation Inspection and Test Plan: Retained infrastructure

Site: Murgon Sheet number:

Applied to RA10

Milestone	Milestone Criteria or action required	Responsible party	Results, comment or record details	Hold or witness point	Date	Hold/Witness Point Signature
Sign off of retained infrastructure	All retained permanent infrastructure in RA 10 has been inspected by a suitably qualified person no more than 6 months prior to rehabilitation certification and found to be structurally sound, safe and fit for its intended use.			Hold		

Appendix E PRCP spatial data (supplied separately)

SPATIAL DATA

A separate file is submitted with PRCP containing the required content of spatial information (shapefiles) for the submission of a PRC plan.

The following information is provided:

- Location and maximum extent of disturbance footprint for the mine life
- PMLU for the area within the resource tenure(s) (note there are no NUMAs)
- Rehabilitation areas within the resource tenure(s) (not there are no improvement areas)
- Floodplain
- MSES Wildlife Hab special least concern
- MSES Wildlife Hab endangered
- Regulated Veg category B
- Regulated Veg category C
- Regulated Veg category R
- GDE surface areas
- Protected areas
- 1 m buffer around bores.

File	Spatial information requirements	File name
1	PRC plan - polygon	EPML00352613_PRCP_PY_17032022.CPG
2	PRC plan - polygon	EPML00352613_PRCP_PY_17032022.dbf
3	PRC plan - polygon	EPML00352613_PRCP_PY_17032022.prj
4	PRC plan - polygon	EPML00352613_PRCP_PY_17032022.sbn
5	PRC plan - polygon	EPML00352613_PRCP_PY_17032022.sbx
6	PRC plan - polygon	EPML00352613_PRCP_PY_17032022.shp
7	PRC plan - polygon	EPML00352613_PRCP_PY_17032022.shp.xml
8	PRC plan - polygon	EPML00352613_PRCP_PY_17032022.shx

Appendix F Murgon Community Consultation Plan

GRAYMONT

MURGON COMMUNITY ENGAGEMENT PLAN

Consultation Objectives

Key objectives have been defined as follows:

› Ensure factual information about the project, including operational, rehabilitation and closure plans, is widely available to those stakeholders with an interest

› Provide stakeholders with an opportunity to ask questions

› Identify areas of concern with respect to the facility and respond to these within a timely manner

› Build relationships with stakeholder groups within the area

Targets and Key Performance Indicators

Target	Key Performance Indicator
Zero verified community complaints received regarding site operations	Number of community complaints received and the timeframes/response in resolving issues
Regular contact with closest neighbours. At a minimum when notifying of blasting activities	Record of meeting in diary If formal meeting, record meeting minutes

Consultation Approach

Designed to identify a consultation approach that aims to achieve the objectives.

It is also designed to identify a consultation approach somewhat determined by types of issues and level of perceived impacts on the community and stakeholders.

› It will include:

» Identifying stakeholders

» Developing factual information about the project and development

» Conducting awareness raising events to inform and engage stakeholders about the project, and seek their input

» Providing community updates as the site progresses

» Providing feedback mechanisms and how comments will be considered/actions taken

» Providing timely, and accurate responses

» Providing documented concerns, enquiries and feedback

» Providing ongoing and meaningful consultation

Key Stakeholders

All stakeholders to Graymont's operations have varying degrees of interest or concern with our operations and as a result varying needs for information and engagement. Stakeholders also change from time to time, depending on issue or circumstance. Therefore it is essential to identify not only the stakeholder but the key issues that group may have with our operations.

The following list details some key stakeholders identified by the Murgon site which are the focus of this community and stakeholder engagement plan for site operations.

› Department of Environment and Science

› Department of Resources
› South Burnett Regional Council
› Murgon Fire Brigade
› Murgon Police Department
› Sunwater (operator of Bjelke-Petersen Dam)
›The local community (Neighbours)

Stakeholders

› The stakeholder list is dynamic and people will move in and out of the consultation processes depending on their personal interest at any given time

› Consultation program is designed to facilitate this process

› The stakeholders and areas of interest help Graymont to recognise and adequately respond to the various key interests of the stakeholders

Stakeholder engagement processes

› Preferences for active/personal engagement processes include:

» Group meetings

» Information sessions

» Community forums

» Facility briefings

› Preferences for passive/support engagement include:

» Facility newsletter/community update

» Fact sheets

» Letters

» Complaints register

GRAYMONT

Community Engagement Methods

Proactive			
Engagement methods	**Rationale/Current Situation – Desired Outcome Target**	**Frequency**	**Responsibility**
Advise neighbours of blasting activities	• Allow neighbours to be aware of activities • Build rapport with neighbour – site aware of potential impact of activities on neighbours	In accordance with blast schedule	Site Manager
Regular contact with neighbours	• On an as required basis to discuss any potential or future issues	As required	Site Manager
Advise key stakeholders via letter or other means prior to major changes in operations	• Provide community awareness of potential increased levels of activity around the site	As required	Site Manager

Proactive			
Engagement methods	**Rationale/Current Situation – Desired Outcome Target**	**Frequency**	**Responsibility**
Consultation with relevant government agencies shall be conducted for all new developments proposed onsite. Consultation will be sought at the concept phase to determine approval processes and key stakeholder issues associated with the proposal.	• Prevent more stringent conditions on operations • Build community and stakeholder confidence in site operations by clearly communicating the environmental management and performance of site operations.	When required	QLD Environmental Advisor
Reactive			
Engagement methods	**Rationale/Current Situation – Desired Outcome Target**	**Frequency**	**Responsibility**
Complaints received shall be managed in accordance with the **EHS Incident Notification & Investigation Procedure**	• Ensure timely response to complaints	When received	Site Manager
Media enquiries received by the site shall be managed by the Corporate EHS Team.	• Ensure accurate and consistent information about site operations is delivered to media outlets	When received	Corporate EHS Team
Government agency enquiries shall be responded to by the Site Manager or Corporate EHS Team	• Ensure accurate and consistent information about site operations is delivered to government agencies.	When received	Site Manager/ Corporate EHS Team

Communication protocols

A number of communication protocols will be developed to enhance engagement processes overall. These include:

» Timing and distribution of communication material

» Traffic change notifications

» Enquiries and complaints management

» Progressive rehabilitation status

» Unresolved complaints/disputes

» Media protocols.

Monitoring and reporting

This has been included to facilitate the monitoring, checking and reporting on potential issues and measuring the effectiveness of the stakeholder engagement program. Reporting will include:

› Quarterly sustainability reporting to the Graymont Board that incorporates

» Stakeholder engagement – including economic and social benefits reporting

» Environmental reporting

» Rehabilitation progress

› Complaints, breaches and incidents.

Monitoring and Reporting Schedule

Description of monitoring	Timing/ Frequency	Report to:	Follow up action:
Record of all meeting minutes at all stakeholder related meetings and forums	When required	Forward meeting minutes to key stakeholders	Plant Manager/HSE Specialist

Record and file all correspondence with key stakeholders	Ongoing	Maintain site diary entry.	QSE Coordinator
All complaints to be tracked, investigated and signed off	When required	Report in JD Edwards Incident recording and tracking system (JDE) and review annually with Corporate EHS team	QSE Coordinator
Track all commitments and agreements made with key stakeholders and the progress of these commitments and agreements	Ongoing	Corporate EHS team annually	Community Engagement Plan and Community Advisory Group Meetings (held quarterly)

Complaints

In the event of an environmental complaint, the receiver of the complaint shall document details from the complainant. As a minimum, the following information will be collected:

» the date and time of the complaint;
» the method by which the complaint was made;
» any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect; and
» the nature of the complaint.

Site personnel will conduct an initial investigation to verify the complaint. If the investigation has determined that the source of the complaint is from site activities, corrective actions will be developed and assigned to specified site personnel to rectify the cause of complaint or minimise any future events from occurring. Site personnel will respond to the complaint (if contact details are available) with the outcome of its investigation and advise of any actions that have or will be taken to prevent or minimise future impacts. The outcomes of the investigation and the close out of any corrective actions will be documented in JDE.

Any environmental complaint will prompt a review of the sites legal compliance and environmental risk registers.

Management Review

Management review is to ensure that rigour is retained and systems and processes are continuously evaluated. The facility manager will chair a review of community engagement processes and performance every 12 months.

MURGON COMMUNITY ENGAGEMENT REGISTER

Type of Engagement	Consultation Date	People Involved	Issue raised/information provided	Outcomes of engagement and/or actions taken	Responsibility
Regulatory	15 February 2022	G. Bezzina	Flood assessment and interaction with final landform design	Agreed to attend meeting to determine requirements for a 2D Flood Model	Site Manager
Regulator	24 February 2022	G. Bezzina M. Ramsay A. O'Brien C. Wake D. Cheong P. Shine A. Herron	Discussed requirements of a Flood Model (showing depth and velocity) to support the PRCP.	Consider further flood modelling to support the PRCP. Proposed infrastructure to remain at site at closure to be covered by a Landholder Agreement.	Environment Manager
Sunwater	24 February 2022	Caitlyn at customersupport@sunwater.com.au	Historical flood modelling for the Bjelke-Petersen Dam. Request historical flooding information used by Sunwater and to set up a meeting.	Request still with Sunwater	Environment Manager

GRAYMONT

Landholder Statement – Retained infrastructure

Murgon EPML00352613 Progressive Rehabilitation and Closure Plan

Graymont (NSW) Pty Ltd as the landowner (Landowner) of Lot 6 SP195988, Lot A RP210698 and Lot A AP221091 (Land) confirms and agrees that at the end of life of mine period for mining operations being conducted on ML50111, that infrastructure identified in the 2022 Progressive Rehabilitation and Closure Plan submission to the Department of Environment & Science, will be retained after rehabilitation and relinquishment of mining leases, and that the Landowner will be responsible for these items. The infrastructure consists of four structures (offices, workshop, kiln-feed shed and ground limestone shed), three sediment dams, overhead power lines and associated access roads and bridge.

Signed by Graymont (NSW) Pty Ltd

John McBride	John McBride	17 March 2022
Name of Authorised person	**Signature of Authorised person**	**Date**

By signing this Agreement, the signatory warrants that they are duly authorised to execute this statement on behalf of Graymont (NSW) Pty Ltd.

Appendix G Murgon Landholder Statements

Graymont Murgon
Wesslings Road
Murgon QLD 4605

27 March 2023

Dear Landholder

SUBJECT: GRAYMONT MURGON PRC PLAN

1 WHAT DO YOU NEED TO KNOW?

We have prepared this letter to inform you of future rehabilitation planning occurring at the Murgon Limestone Quarry.

It is a statutory requirement under the *Environmental Protection Act 1994* that community notification and consultation is undertaken to communicate the development of a **Progressive Rehabilitation and Closure Plan** for end of mine life.

We want to provide you an opportunity, if you wish, to ask questions and comment on the proposed rehabilitation plans for end of mine life of the Murgon Limestone Quarry. We have compiled a list of questions to provide you with further information about the Quarry and what changes will occur as a part of this future work.

2 WHO IS GRAYMONT?

Graymont acquired lime and limestone assets in Australia in August 2019, including the Murgon Limestone Quarry. Graymont is a family owned company that has been in operation for over 70 years. Headquartered in Canada, Graymont employs over 1600 people globally.

Lime and limestone are essential in addressing today's most pressing environmental issues, while supporting vital industrial processes and agricultural needs. Uses for our 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.

For further information, refer to our website, here: https://www.graymont.com/en

3 ABOUT THE SITE

Limestone mining has been ongoing at Murgon for around 40 years, with Graymont managing operations since 2019. The site is located on Haager Drive at the junction of Barambah and Barker Creeks, Murgon. The quarry produces approximately 100,000 tonnes of limestone products per annum.

Mining consists of conventional open cut benching methods and begins with topsoil stripping and removal of clay rich overburden and waste rock. Limestone ore is then extracted by drilling and blasting, then crushed and screened onsite before being transported to our Tamaree Lime Operation for further processing into Quicklime and Hydrated Lime products.

Limestone, overburden and waste rock of different grades and suitable physical properties are also sold as Aglime, Neutralime and Superfine Aglime with remaining materials stockpiled onsite.

4 WHAT IS A PROGRESSIVE REHABILITATION AND CLOSURE PLAN?

A Progressive Rehabilitation and Closure Plan is a report required under Section 126 of the *Environmental Protection Act 1994* and the *Mineral and Energy Resources (Financial Provisioning) Act 2018.* All areas that are disturbed within a Mining Lease must be rehabilitated to a post mine land use.

For our Murgon Limestone Quarry, the proposed post mining land use will be predominantly grazing for livestock, consistent with surrounding land uses. The quarry pit will have a post mining land use of water storage and will be grassed above the water level for stability. Roads will be maintained for land management and access.

Some infrastructure including buildings and roads will be retained with agreement of stakeholders, but otherwise will be demolished and the land rehabilitated.

The pit void will not be rehabilitated and will form a pit lake that meets stock drinking water quality criteria. An abandonment bund will be constructed around the pit lake as a public safety measure to prevent inadvertent access.

All remaining land will be rehabilitated to achieve a grazing post-mining land use.

The proposed schedule for achieving rehabilitation outcomes is shown in **Figure 1** are as follows:

1. Previously rehabilitated portions of the northern and north-eastern overburden dump will be rehabilitated by 2029.
2. In 2032, the remainder of northern overburden dump will be rehabilitated by means of topsoil placing and grassing.
3. Rehabilitation of infrastructure areas will be completed by 2046.
4. In 2047, the remainder of north-eastern overburden dump will be rehabilitated by means of topsoil placement and grassing.
5. By the end of 2050, all other areas on site will have been rehabilitated in line with the post mine land use of grazing and water storage.

Graymont Murgon
Wesslings Road
Murgon QLD 4605

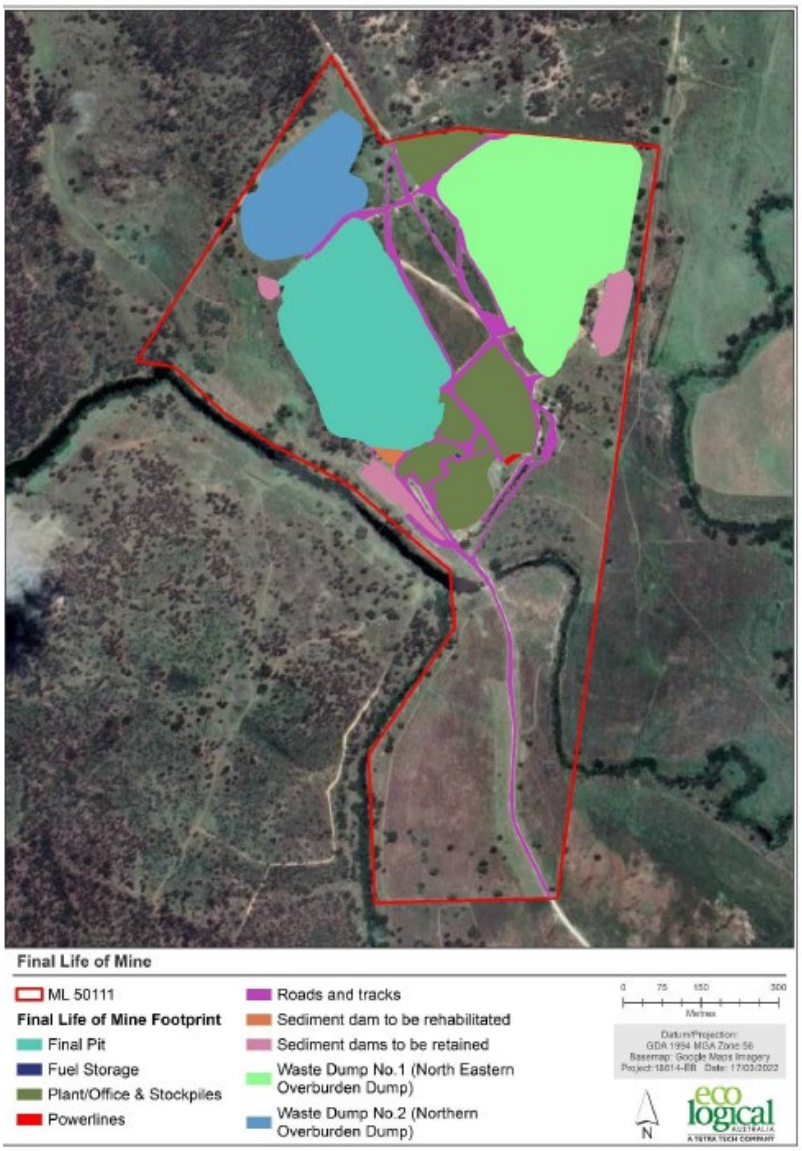

Figure 1. Post mining land uses at Murgon

5 CLOSURE

If you have any questions or would like to provide comment on the proposed rehabilitation plans outlined above for the Murgon Limestone Quarry, please do not hesitate to contact me via phone or the email provided below. I look forward to our ongoing engagement.

Kind regards

Michelle Muir
HSE Specialist Northern
+61 429 985 534
michelle.muir@graymont.com

Appendix H March 2022 Community Consultation Letter

MURGON MINE PRCP
PIT AND WRDS:
GEOTECHNICAL

for

GRAYMONT

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7 March 2022

Global Mine Engineering Lead
Graymont Australia Pty Ltd
9 Carlton Street
Port Adelaide SA 5015
emmanuel.ashong@graymont.com

ATTENTION: EMMANUEL ASHONG

Dear Sir

Murgon Progressive Rehabilitation and Closure Plan (PRCP) - Pit and WRDs: Geotechnical

This report addresses geotechnical issues relevant to the PRCP. 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 (Civil), NER APEC Engineer IntPE(Aus) RPEQ (Mining, Civil)
Principal Rock Mechanics Engineer

DOCUMENT CONTROL

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2	07/03/2022	Final	E. Ashong of Graymont	Edited after comments from P. Shine, A. Butler and

DOCUMENT APPROVAL

Signature	
Approval	Tony Meyers
Position	Principal Rock Mechanics Engineer
Date	28 February 2022

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ACRONYMS

AEP	Annual Exceedance Probability flood event
BGL	Below Ground Level
ELA	Eco Logical Australia
FoS	Factor of Safety
EOML	End of Mine Life
FPC	Foliage Projective Cover
GCMP	Ground Control Management Plan
GLE	General Limit Equilibrium method of slope stability analysis
IECA	International Erosion Control Association
PGA	Peak Ground Acceleration
PMF	Probable Maximum Flood
PoF	Probability of Failure
PRCP	Progressive Rehabilitation and Closure Plan
RL	Relative Level
SESL	SESL Australia Pty Ltd Environment & Soil Science Consultants
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 Murgon Mine. The landforms considered are the open-cut pit and the northern and eastern waste rock dumps (WRDs). The requirements of the PRCP, as outlined by the Guideline prepared by the QLD Dept of Environment and Science[2], are that it should provide details of how the landforms will achieve post-closure stabilities.

The project was undertaken by Rocktest at the request[3] of Graymont Australia Pty Ltd (Graymont).

1.2 Requirements in the PRCP

In regard to geotechnical issues associated with the pit, the PRCP requires discussion of the:

- location and specifications i.e., depth, length, width, overall slope angle, bench specifications
- method of construction with 3D design plan
- soil/rock characteristics
- geotechnical conditions (i.e., soil/rock characteristics)
- pit wall geotechnical stabilities, considering the effects of long-term erosion and weathering and the effects of significant hydrological events
- rehabilitation strategies.

In regard to geotechnical issues associated with the WRDs, the PRCP requires discussion of the:

- locations and specifications i.e., heights, lengths, widths, 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 strategies.

1.3 Terminology

Time periods referred to in this report are:

- Short-term < 5 years
- Medium-term 5 – EOML
- Long-term > 100 years

[1] This report considers geotechnical issues only. Surface and subsurface hydrology issues are not considered.

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

[3] Email to T. Meyers of Rocktest from E. Ashong of Graymont, 31 January 31, 2022.

2 LANDFORM CHARACTERITICS

2.1 Locations and Flood Characteristics

Figure 1 shows the locations of the proposed final footprints of the pit and the northern and eastern WRDs.

The figure shows Barambah Creek, which meanders south and east of the site. The creek is ephemeral. Under typical flow conditions, its water is 130m from the west crest of the pit, 275m from the southeast toe of the northern WRD and 185m from the south toe of the eastern WRD.

ELA (2022)[4] noted that under a PMF event, "all parts of the site, and in particular significant post-mining structures such as the void, [eastern] overburden dump and the Northern overburden dump [western slope], could be impacted". An abandonment bund will encircle the pit (Section 2.3) thereby providing some protection for the pit from the floods. Whether additional protection is required requires the results from additional flood modelling prior to the EOML.

2.2 Pit

2.2.1 Pit at the EOML

The pit is excavated using standard drill/blast/dig/scale method. Clean, ore-grade, limestone is hauled to the ROM pad. Low-grade limestone, clay contaminated limestone and volcanics (i.e., andesite and basalt) are hauled to the eastern WRD. Topsoil is stockpiled.

Figure 2 shows the elevations of the final pit at the EOML. It will have an oval circumference with a major axis trending northwest. All walls will have approximately similar cross-sections (Figure 3) having the specifications listed in Tables 2.1 and 2.2.

Water constantly seeps from the 258-270mRL batter on the western wall. Its source is likely the Bjelke-Peterson (BP) reservoir. The floor of the reservoir is as 276mRL . The maximum depth of water in the reservoir is at ≈307mRL . The shallowest contour lows between the dam wall and the pit are at ≈270mRL , which is above the level of seepage. The pit is therefore a passive hydraulic sink.

The intact mudstone and shale of the Maronghi Creek beds[5] west of the pit and the volcanics and limestone of the Bjelke Petersen beds[6] between the south wall of the pit and the wall of the BP reservoir are likely to be relatively impervious. Flows likely occur within sandier sediments in the beds, within shallow to moderate dipping joints and within sand filled karst within the limestone.

---

[4] Memo from A. Pouya of ELA to D. Cheong of Graymont dated 21 January 2022 titled *Flood susceptibility assessment for Project 18614*.

[5] The Maronghi Creek beds consist of mudstone, shale, arenite, chert, jasper, acid to basic metavolcanics. Highly structurally deformed metasediments. They shed a chert-rich scree blanket over sections of the Bjelke Petersen beds.

[6] The beds are named after the Bjelke Petersen dam. They comprise mainly interbedded andesitic to basaltic lava, limestone, mudstone, chert, and phyllite

Table 2.1. Specifications of the pit at EOML.

Trend of major axis	152°
Length of major axis at crest	400m
Length of minor axis at crest	220m
Maximum height of walls: north/south/east/west	85/71/90/74m
Maximum heights of benches	10m
Maximum number of benches	10
Minimum widths of berms	8m
Maximum batter angles in unweathered rocks	70°
Maximum batter angles in unweathered rocks	38°
Maximum interramp angles	41°
Maximum overall slope angles	38°
Ramp type / Minimum width	spiral / 10m

Table 2.2 Dip directions of the walls at EOML.

North (South dip)	*South (North dip)*	*East (West dip)*	*West (East dip)*
150°	310°	240°	060°

2.2.2 Final Landform for the Pit

Over the long-term, the key geotechnical related considerations will be:

- pit wall stability – failure of multiple benches or an overall slope, potentially resulting in loss of material at a crest or undermining of the toe of the south slope of the northern WRD
- erosion of a crest, due possibly to ineffective management of surface flows.

These events will be visually monitored and assessed until the EOML and subsequently as required against the indicators and completion criteria outlined in Section 7 to demonstrate the success of the plan. Achieving the desired outcomes will require:

- reducing to <14° the batter angles of sections of the upper benches above 290mRL that are in soil and extremely weathered rocks, ripping the ground along contour, leaving the ground rough, then covering it with the soil and rocks excavated from the benches
- installing an abandonment bund behind the full crest to restrict inadvertent vehicular access to a crest and to divert water from up contour around the pit (refer Section 2.3)
- ripping the initial ≈50m of the ramp to reduce accessibility into the pit
- where necessary, placing a ≈0.15m thick cover of soil and rocks on all haul roads and disturbed ground beyond the perimeter of the pit
- installing warning signs around the pit
- restricting public access to the site.

Pit Water Management: Typical Rainfall Conditions

Under typical rainfall conditions, inflows to the pit comprise predominantly pit wall runoff, groundwater inflow, and incident precipitation due to rainfall. Water in other storages (e.g., sediment dams down-contour of the WRDs) is occasionally transferred to the pit.

At the EOML, inflows will no longer be pumped out of the pit. The level of water within the pit will subsequently increase progressively to form a pit lake. The upper surface of the lake will stabilise at an elevation where its open water surface area is large enough such that the evaporative losses from the surface and other outflows equal the combined inflows. This elevation will likely be below the pre-mining groundwater level. The surface of the lake is expected to stabilise at ≈275mRL.

The water in the pit will contribute to the stability of the west wall by negating any deleterious effect of excess hydrostatic pressures in the wall resulting from flows into the pit. The exception could be if the level of the water is reduced (i.e., drawn down) rapidly. The resulting pressure differential either side of the rocks exposed in the surfaces of the walls could result in failures being triggered anywhere below the original level of the water. However, this action is unlikely to occur as there is no conceivable method by which a rapid draw-down will occur.

The lake will be within durable unweathered limestone rather than less durable andesite. The water is unlikely to significantly reduce the strength of the saturated limestone hence progressive loss of the support the limestone provides the walls is unlikely.

The ultimate level of the water in the pit is expected to be significantly below the lowest level on the crests of the walls (i.e., 290-RL) hence water is unlikely to discharge from the lake as overland flows.

Pit Water Management: Extreme Flood Events

Inflows to the pit are expected to include floodwater under a 0.1% AEP, 1% AEP and extreme flood events. If not controlled, these events could rapidly increase the level of water in the pit. The level of water is likely to stabilise below ≈290mRL. The consequences of the increased level could be:

- Sediments exposed in the upper benches experiencing flows are likely to scour.
- Some sections of benches experiencing flows could slump.
- Flow paths beyond the pit crests could experience scouring and gully erosion.

As the flood water subsides, the water level in the pit will reduce as water either evaporates or dissipates into the walls and down contour through the adjacent strata. The level will eventually stabilise at the pre-flood level.

One of two strategies will likely be adopted in relation to these events. Which strategy is adopted will be decided before the EOML:

Strategy 1. Manage the consequences of the flood event after the event. Doing so will involve reinstating damaged batters and benches and repairing scouring and gullying.

Strategy 2. Place flood control bunds beyond the crests of the west, south and east walls. If this strategy is adopted, the characteristics and specifications of the bunds will be considered before the EOML.

2.3 Abandonment Barrier

2.3.1 General Requirements

The final landform will include an abandonment barrier behind the crest of each pit wall to:

- prevent inadvertent access to the crest of a wall by a vehicle and restrict access by motorbikes and persons on foot
- ensure overland flows of water from up contour do not progressively erode a crest
- provide an area between the crest and the barrier sufficiently flat to enable the area to be safely accessed for inspections and for cracks to be observed.

In lieu of Queensland specific guidelines on abandonment barriers, the recommendations in the Western Australian Guideline (1997)[7] will be applied. The requirements are:

- A physical barrier to be installed behind the crest of each wall beyond potential failure zones.
- The barrier is to encircle the pit. There should be no gaps or access anywhere between a barrier and the crest. Locked gates can be incorporated into a barrier if access is required.
- The barrier should be obvious and have sufficient height to restrict access.
- The barrier should have sufficient longevity to remain functional for the long-term.
- The barriers should preferably comprise a bund rather than a fence[8].

The approximate specifications of the abandonment bunds will be:

- Total height 2m
- Footing width 6m
- Slopes angles 35°
- Material Well-graded coarse strong durable rock of +25mm

2.3.2 Offsets from the Crests

The Guideline recommend abandonment bund be offset a minimum of 10m 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° in unweathered rocks and 25° in weathered rocks. On this basis, the minimum offsets are as listed in Table 2.3. The offsets significantly exceed the maximum break-back distances that have occurred to date and those likely to occur (refer Section 5.2). They are therefore likely to be sufficient to ensure sections of the bund are not undermined if a wall scale instability occurs.

---

[7] 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.

[8] 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.

Table 2.3. Parameters influencing the offset of the abandonment bund from the crests of the walls.

Wall	*Effective Height of Wall (m)*	*Overall Slope Angle of Wall*	*Depth of weathering (m)*	*Minimum Barrier Offset Required (m)*
North	102	30°	60	10
South	73	37°	30	21
East	95	37°	40	25
West	75	36°	50	39

2.4 Northern and Eastern WRDs

2.4.1 WRDs at EOML

The northern and eastern WRDs are the sidehill type.

The dumps are founded on gently sloping natural surfaces from which topsoil was stripped prior to placing the first lift. Their toes are therefore founded on flat terrain with sufficient shear strengths to contribute to the stability of the dumps. No major drainage paths were blocked.

The dumps are constructed using a top down method. Material is end dumped near crests from trucks. A dozer then spreads, pushes over crests, shapes, and compacts the materials. The front slopes are advanced in the same direction as the topography.

The northern dump was completed prior to 2002. Since then, all material has been hauled to the eastern WRD.

Figure 2 shows the proposed final elevations of the northern and eastern dumps respectively at the EOML. Their circumferences are teardrop shaped. Their major axes trend northeast and north respectively. All slopes have approximately similar cross sections (Figure 4). Their specifications are listed in Table 2.4.

The toes of the slopes of both dumps are generally located an adequate distance (>20m) from the pit to avoid potential interactions. However, a 110m long section of the south slope of the northern dump was placed within 20-m of the crest of the north wall of the pit. The results of stability analyses (Section 6.2.2) indicate that the slope has acceptable stability and the loading applied by it to the ground behind the crest of the wall does not significantly reduce the capacity of the wall.

2.4.2 Final Landform for WRDs

Over the long-term, the key geotechnical related considerations for the WRDs are likely to be:

- geotechnical stability – slumping or mass failure of a bench or overall slope potentially resulting in loss of material to the surrounding area
- erosion, due possibly to failure of vegetation to establish and/or ineffective management of surface flows
- settlement.

Achieving the desired outcomes for the slopes of the eastern dump include reshaping the upper surface of the dump and progressively reducing its slopes, ramps, and haul roads to <14°. Successful rehabilitation of the

northern dump prior to 2002 and the eastern slopes of the eastern dump prior to 2005 (Figure 5) demonstrate that these procedures have been appropriate.

The performances of the dumps will be visually monitored and assessed against the indicators and completion criteria outlined in Section 6 to demonstrate the success of the plan.

Table 2.4. Specifications of the WRDs at EOML.

	Northern WRD	*Easter WRD*
Trend of major axis	048°	350°
Length of major axis footing	290m	480m
Length of minor axis footing	235m	375m
Maximum height of dump	31m	40m
Bench heights	3.5 to 5m	5m
Maximum number of benches	5	8
Berm widths	7.5m	5.5m
Batter angles	12° to 18°	18°
Overall slope angles	15°	14°
Minimum concave grade on upper levels for drainage	2°	2°

2.4.3 Rehabilitation of Surfaces

At the EOML, the surface of the eastern dump will be rehabilitated:

1. Using a dozer, beginning from the upper level, push down the slopes to <14°. Doing so will remove all or some of the underlying berms.
2. Grade the upper surface to achieve an overall concave shape. Achieve this shape by grading a slight gradient from the crests to the middle of the surface. The shape will contribute to the collection and retention of rainwater that falls on the surface thereby reducing the likelihood of overland runoff from the surface eroding the slopes.
3. Moisture condition the slopes and surfaces to achieve a moisture content as close to optimum (refer table 3.1.1) as practical.
4. Compact the slopes and surfaces to achieve as high a density of the underlying material as practical. Do so by successively tracking across the slopes and surfaces with preferably a roller or, if not available, a dozer or loaded trucks. Compaction reduces transmissivity of water through the body of the dump. It also reduces consolidation of the material and hence surface subsidence over time.
5. Place a 1m high edge bund of durable rocks 1m behind the crest of the upper surface to control flows of water and to prevent access to the surface by vehicles.

2.4.4 Settlement of the WRDs

Settlement of the WRDs will occur over the long-term as materials within the dumps spatially rearrange to minimise the inter-granular void spaces.

These actions will occur as water infiltrating through the bodies of the dumps causes rocks to degrade and as the self-weight of the overlying rocks cause consolidation. Crushing of grains is unlikely to occur at the low vertical pressures that will apply within these relatively low (<40m) dumps.

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)[9], the amount of settlement will likely be small (i.e., ≈0.3m) [10] over the long-term. As the land on and around the dumps will be used for grazing, and no infrastructure will be constructed on the dumps, this amount is insignificant.

The associated increases in the bulk densities of the materials within the dumps will reduce the permeabilities of the dumps and enhance their stabilities. Both actions will reduce the rates of subsequent settlement.

3 GEOLOGY

The limestone orebody is overlain by a thin (<2.5m) cover of soil.

The orebody occurs within a sequence of limestones[11] and extrusive mafic volcanics referred to as the Bjelke Petersen beds. Within the pit, the beds dip steep to very steep (i.e., >75°), generally to the west, and strike north and south. The east foot-wall and west hanging-wall are defined by limestone/volcanic contacts.

West of the pit, displacements along a north-trending fault have caused the beds to be truncated by the Maronghi Creek beds. The contact is well defined. East of the pit, the beds have been faulted against sandstones and siltstones of the Esk Formation (Fm.)[12]. This contact is less well defined. The north wall is defined by an assumed east-west striking fault. The fault has limited the extent of the limestone along strike to the north and has significantly disturbed the rocks in the north wall.

3.1 Soil

3.1.1 Characteristics

The soil exposed in the upper bench of all walls comprises predominantly the four types listed in Table 3.1. They are generally derived from weathering of the rocks:

- Dark red-brown to yellowish brown gravelly silty clay, stiff, fissured, nondispersive. Likely derived from weathering of the volcanics.

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[9] 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.

[10] Assumes the dumps are a maximum of 40-m high, the rockfill has a density of 1.9-t/m^3. and some compaction occurred during placement. The average vertical stress at the centre of the dumps is 0.37-MPa. This equates to a maximum strain of 0.75% which equates to an overall settlement of 0.3-m.

[11] The unit is also referred to as the Barambah limestones. It was previously referred to as the Wondai Metamorphics.

[12] The Esk Formation comprises polymictic pebble to boulder conglomerate, feldspathic sandstone, shale, minor acid tuff.

- Dark-brown silty gravel with trace clay. Non-dispersive. Likely derived from weathering of the volcanics.
- Cream to grey gravels, sands with some clay. Calcareous. Non-dispersive. Derived from weathering of the limestone.
- Orange yellow gravelly clay/clayey gravel weakly cemented. Source unknown.

The distribution of each type of soil is highly variable. All types are mixed spatially with other types so there are no areas where any type is dominant. The depths of soil and the thickness of each type are also highly variable over the site. They tend to be shallow (i.e., <0.5m) around contour highs, overland flows having removed soil to valleys and contour lows to the south and west of the site where depths tend to be greater (i.e., >1m). The depths are also controlled by the profiles of the surfaces of the underlying weathered rocks. These profiles are highly irregular, particularly on the limestone, hence so too are the depths of the overlying soil. The depths tend to be shallowest in areas where rocks are more durable and/or stronger and/or less calcareous. The depths are greatest above:

- shallow channels eroded into the surfaces of the underlying rocks by overland flows
- ,and as infill within karst in the limestone.

3.1.2 Soil Management

All soil types are, or can be made, suitable for supporting vegetation.

As the depths of soil is generally shallow, soil stripping and handling requires:

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

The stability of the soil stockpiles and the integrity of nutrients within the soil within them are maintained by:

- maximising height to below 3m
- placing slopes at less than 3H:1V
- vegetating slopes
- installing sediment fences and/or up contour diversions
- re-using soil as soon as practical.

A depth of ≈0.15m of soil mixed with strong durable rocks will be placed on stripped areas. In flatter areas where the landform may support grazing, additional depths may be applied to improve the final land use outcomes.

3.2 Volcanic Rocks

3.2.1 Intact Rocks

The volcanic rocks are exposed in the upper two to three benches of the north, east and west walls. They range in composition from basalt to andesite; collectively referred to as "andesite".

The andesite is highly altered, fine grained, has a matte texture and is dark grey-green to purple-brown. The rocks exposed in the pit are generally more weathered than are the limestones. In the upper benches and adjacent to faults, the andesite is moderately-weathered[13] to highly-weathered[14]. With weathering their strength reduces from high (i.e., <53MPa ave. 34MPa) to low (i.e., 14MPa). As weathering increases, the rocks become extremely[15]-weathered then gravels and residual silts and clays. At greater depths, the rocks are generally slightly-weathered [16] to moderately-weathered. They have high to very high strengths (i.e., <170MPa ave. 91MPa) [17].

Where unweathered[18], the andesite is durable[19] and, as its average strength is very high, it is suitable for use as erosion control on bunds. Where weathered[20], it is less durable although its average strength remains high. It may not be suitable for use as erosion control on bunds.

3.2.2 Discontinuities

The andesite is strongly sheared and has well-defined foliation. Data from discontinuity mapping (Figure 6a) indicates that most discontinuities can be assigned to one of 5 sets[21]. Set 1 contains foliation, the dominant fabric. Sets 2 to 5 contain joints.

The characteristics of the orientation values within each set can be described by a Fisher distribution. This distribution is defined in terms of two parameters: the mean orientation and Fisher's constant[22], the latter quantifying the spread of the data around the mean. The values of these parameters are listed in Table 3.1. Based on the mean orientations of each set:

- Set 1 dips steep[23] towards the southwest consistent with the regional trend.
- Set 2 dips very steep towards the south.
- Set 3 dips shallow towards the southeast.

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[13] "Moderate" defines a weathering degree where the strength of the rock has not decreased but the whole of the rock substance is discoloured to the extent that the original colour is not recognizable.

[14] "Highly" defines a rock that has a strength reduced by weathering. The whole of the rock substance is discoloured such that the colour of the original rock is not recognizable. .

[15] "Extremely" defines a rock that has weathered to such an extent that it has soil like characteristics. The fabric of the original rock is not recognizable.

[16] "Slightly" defines a weathering degree where the strength of the rock has not decreased but the rock substance is slightly discoloured.

[17] Strength is defined by the point load strength index I_{s50}. A "high strength" rock is defined as having an I_{s50} value ≥1-MPa and a compressive strength of ≈20 to 60-MPa.

[18] In this report, the term "unweathered" describes a rock that has not had a strength loss due to weathering. It includes rocks that are classified as being fresh, slightly weathered or moderately weathered.

[19] Durability is defined by the 2nd stage slake durability index I_{d2}. The index quantifies the mass retention after two cycles of wedding, abrasion and drying. A "durable" rock is defined as having an I_{d2} ≥95%.

[20] In this report, the term "weathered" describes a rock that has had a strength loss due to weathering. It includes rocks that are classified as being highly weathered or extremely weathered.

[21] Orientation characteristics based on mapping of 378 discontinuities in andesite.

[22] Fisher's constant quantifies the maximum deviation of the orientations within a set from the mean orientation of the set.

[23] Dip terms: Very shallow 0-20°; Shallow 20-40°; Moderate 40-60°; Steep 60-75°; Very steep 75-90°.

- Set 4 dips very steep towards the southeast.
- Set 5 dips moderate towards the northeast.
- Set 0 contains random discontinuities having no preferential orientation.

Deformation of the rockmass influences the degree to which discontinuities within each set deviate from the mean orientation of the set, defined in terms of Fisher's constant (F), and the proportion (P_r) of random discontinuities. Lower values of F and greater values of P_r can be indicative of greater deformation. Assessment of the data indicates:

- the average F value is 18, which is moderate[24]
- the proportion (P_r) of random discontinuities (P_r = 14%) is low[25].

These values and the number of sets[26] are indicative of the rockmass having been moderately deformed, which is consistent with its tectonic history.

The foliation (Set 1) can have very high persistences[27] (i.e., >20m); sufficient to underlie multi-bench scale masses of rocks. The joints (Sets 2 to 5) generally have low to medium-persistence (i.e., <10m), sufficient to underlie masses of rocks of bench or lesser scales.

The shear strength characteristics of discontinuities are described in terms of non-linear relationships defined in terms of estimated peak friction angles (refer Appendix 1.4). The average angles in unweathered and weathered andesite are ≈36° and 43° respectively although the angles can be as low as ≈23°.

Table 3.1. Mean orientations of sets of discontinuities in andesite.

Set	*Dip*	*Dip Direction*	*Fisher's constant*[28]	*Number logged (% of total)*
1 (foliation)	68	260	10	151 (40)
2	86	191	15	72 (19)
3	37	140	22	34 (9)
4	79	151	30	32 (8)
5	42	047	15	34 (9)
0	n/a		0	55 (15)
			Total	378 (100)

[24] Values of Fisher's constants greater than fifty are rare as they imply the discontinuities within sets are more parallel than typically occurs. values of approximately 25 to 35 are typical for rock masses that have not been highly deformed. Values of approximately 15 to 25 typically apply when moderate deformation has occurred. Values less than 15 can be indicative of a highly deformed rockmass.

[25] A proportion of random discontinuities less than 5% is rare. Values of between 10% and 20% are typical for rock masses that have not been deformed significantly. Value exceeding 40% are high, often indicative of significant deformation.

[26] Three sets are typical where negligible deformation has occurred. The number increases as the degree to which a rockmass has been deformed increases.

[27] Persistence it the area of a discontinuity. Its units are m^2.

[28] Fisher's constant is a measure of the deviation of the orientation values in a set about the mean orientation.

3.3 Limestone

3.3.1 Intact Rock Characteristics

The limestone is of late Carboniferous age (311-314Ma). It is fine grained, moderately to strongly recrystallised and light to dark-grey to pale-pink. It is generally contaminated by andesite near the contacts.

The rocks exposed in the upper benches are generally less weathered than are the andesites indicating the limestone is the more durable of the two units. At shallow depths and adjacent to faults and karst, the surfaces of individual rocks tend to be highly-weathered. However, the cores of these rocks may be only slightly-weathered hence the strengths of the weathered rocks can be similar to those of the unweathered[29] rocks. As the depths of weathering increase, the strengths progressively decrease (i.e., <44MPa ave. 33MPa). The rocks eventually become extremely-weathered gravels (<14MPa) then residual silts and sands. At greater depths, the rocks are generally fresh to moderately-weathered with high to very high strengths (i.e., <138MPa ave. 90MPa).

Where unweathered, the limestone is durable and, as its average strength is very high, it is suitable for erosion control on bunds. Where weathered, it is less durable although its average strength generally remains high. Only the most weathered rocks are not suitable for erosion control and these rocks are non-typical.

3.3.2 Discontinuities

The limestone is extensively fractured. Data from mapping (Figure 6b) indicates that most discontinuities can be assigned to one of 5 sets[30] (Table 3.2). Set 1 contains bedding-parallel slatey cleavage; the dominant fabric. Sets 2 to 5 contain joints. The pit is aligned along the strike of Set 1. Based on the mean orientations of each set:

- Set 1 dips very steep towards the southwest.
- Set 2 very steep towards the north.
- Set 3 dips moderate towards the east.
- Set 4 dips very steep towards the southeast.
- Set 5 dips shallow towards the north.
- Set 0 contains random discontinuities having no preferential orientation.

The average value of Fisher's constant (i.e., F=15) is low to moderate and the proportion of random discontinuities (8%) is low. These values are indicative of the rockmass having been moderately deformed.

The cleavage (Set 1) can have very high persistence[31] (i.e., >20m); sufficiently to underlie multi-bench scale masses of rocks. The joints (Sets 2 to 5) generally have low to medium-persistence (i.e., <10m), sufficient to underlying masses of rocks of bench or lesser scales.

The shear strength characteristics of the discontinuities can be described in terms of a non-linear relationship defined in terms of peak friction angles (refer Appendix 1.4). The average angles in weathered and unweathered limestone are $\approx 36^{o}$ although the angles can be as low as $\approx 18^{o}$.

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[29] "Fresh" rocks show no evidence of decomposition or discoloration.

[30] Orientation characteristics based on mapping of 885 discontinuities in limestone.

[31] Persistence it the area of a discontinuity. Its units are m^2.

3.3.3 Karst

The geologically most recent beds of limestone are exposed at ≈275mRL in the western wall. Their upper surface is irregular; dissolution of the carbonates by water has resulted in karstification. The most prevalent karst features are caverns, which can be up to 20m wide and at least 50m below surface (Figure 7). The caverns are filled predominantly with residual soil derived from weathering of the limestone and andesite and sands and clays derived from the overlying soils. The features also contain a chaotic assemblage of boulders that detached from the walls and roofs.

Table 3.2. Mean orientations of sets of discontinuities in limestone.

Set	*Dip*	*Dip Direction*	*Fisher's constant*	*Number logged (% of total)*
1 (cleavage)	86	256	10	233 (26)
2	88	005	18	192 (22)
3	46	079	13	149 (17)
4	81	145	17	108 (12)
5	38	351	15	131 (15)
0	n/a		0	72 (8)
			Total	885 (100)

3.4 Earthquakes

Geoscience Australia (2013)[32] places Murgon in a zone of Low earthquake hazard. A peak ground acceleration (PGA) of ≈0.06g (0.6m/s^2) has a 10% probability of being exceeded in a 250-year period. This relationship corresponds to a 2500-year average recurrence interval for this low intensity of movement. There is a 10% probability that an acceleration (A_e) of 0.024g (100/250^{ths} of 0.07g) will be exceeded during the 100-year period considered in this study.

Several studies have reported on PGA values of 0.2g generating falls of individual rocks from pit walls[33] in low stress conditions. PGA values of 0.024g are unlikely to generate many rockfalls. On this basis, a 100-year event is unlikely to significantly increase the risk to persons within the pit perimeter when an earthquake of this intensity occurs prior to the EOML.

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 is considered in the stability analyses.

[32] Geoscience Australia (2013) Atlas of Seismic Hazard Maps Australia. (Edt. Leonard M. et.al.) GeoCat 77399.

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

4 GEOTECHNICAL MONITORING

The Ground Control Management Plan (GCMP) requires the following geotechnical monitoring and management strategies be implemented until the EOML:

- Every 2 months, profiles of the pit wall and the WRD slopes will be collected 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 ensure the risk to persons and the operation remain acceptable
- Data quantifying the orientations of the discontinuities most recently exposed in the pit will be collected annually using discontinuity mapping techniques. The data will be compared to date collected elsewhere to highlight whether the characteristics of the discontinuities are consistent with those recorded elsewhere in the pit. If different, the data will be used as input to kinematic analyses to ascertain whether the wall specifications are still appropriate or require modification.
- Visual inspections of the pit walls and the WRD slopes 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 18months.

A programme for visually monitoring and auditing the walls, slopes, and the landform after the EOML will be established prior to then.

5 STABILITIES OF THE PIT WALLS

Multi-bench scale instabilities[34] are significant hazards for persons within the perimeter of the pit prior to the EOML. These instabilities can occur relatively rapidly.

Wall scale (i.e., crest to toe) instabilities are relevant to persons after the EOML when a pit lake has formed as they influence the stabilities and locations of the crests. These instabilities can develop over months to years.

5.1 Multi-Bench Scale Stability

Instabilities at multi-bench scale have historically involved masses of rocks sliding along underlying discontinuities that dip out of a wall (Figure 8). A series of analyses summarised in Appendix 2 quantifies the likelihood for these modes to occur over the long-term as the rocks weather. Toppling is not considered as this mode has not been relevant since the pit was developed.

The results of the analyses are quantified in terms of likelihood for sliding (Pf) values[35]. These values are listed in Tables A2.1 and A2.2 in Appendix 2. They indicate that the most likely modes of instabilities involve masses of weathered rocks sliding along underlying pairs of intersecting discontinuities (i.e., wedge failure). Sliding occurs in the directions of the trends of the lines formed by the intersecting surfaces. The

[34] Instabilities of bench and lesser scales are generally controlled by the berms.

[35] The likelihood of sliding quantifies the probability that a particular location on a wall will experience a sliding type instability.

locations on the walls where this mode is most likely to occur over the long-term is consistent with where it has occurred previously:

- In andesite, the most likely locations are the upper benches of all walls and less so on the south wall. At the EOML, the batter angles of some sections of these bench will be reduced thereby significantly reducing the likelihood for these events to occur.
- In limestone, the most likely locations are the lower benches on the west wall. They may occur on the other walls but to a significantly lesser degree.

In Section 5.3, the acceptabilities of the likelihood values are considered by comparing them to values typically considered acceptable in the civil and mining industries.

5.2 Wall Scale Stabilities

No instability at wall scale has occurred in the pit to date. A series of analyses were undertaken to ascertain whether they may occur over the long-term as the rocks weather. The analyses were also required to estimate the locations behind the crests of the walls where the surfaces having the lowest capacities daylight. These distances inform decisions on the offset distances for the abandonment bunds and the widths of the areas within which evidence of large scale instabilities are most likely to be observed.

The analyses for the east and west walls are discussed in Appendix 3 and for the north wall in Appendix 4. The analyses for the north wall are applicable to the south wall as their geologies and wall specifications are similar. However, the results for the north wall represent a worst case scenario for both walls due to static loads being applied behind the crest of the wall by the northern WRD.

The analyses assume:

- lower bound strengths for the weathered and unweathered andesite and limestone
- cleavage in the unweathered limestone may contribute to anisotropic behaviour[36]
- characteristics for the Esk Fm. rocks to the east and the Maronghi Creek beds to the west of the pit
- earthquakes can be represented as a pseudo-static horizontal force directed out of the walls (refer Section 3.4).

Two scenarios are considered for the west wall; with and without the clay filled karst (Figure 7).

The results of the analyses are quantified in terms of Factor of Safety (FoS)[37] values for each of the hundreds of surfaces assessed[38] within each model. Figures A3.2 to A3.4 in Appendix 3 and Figure A4.3 in Appendix 4 highlight surfaces having FoS values less than 1.5. These surfaces are generally non-circular.

[36] Some steep dipping sections of surfaces along which displacements could occur may develop preferentially along cleavage rather than through the rockmass.

[37] 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 (1.00) indicates a 50% or greater likelihood for an unstable scenario.

[38] A cuckoo search algorithm was used to find the surfaces with the lowest capacities.

The results indicate:

- No wall scale surface has a FoS value of 1.5 or less. This result is consistent with the performances of the walls to date.
- The most likely scale of instability on all walls is at multi-bench scale. This scale was considered in Section 5.1.
  - On the west wall it is likely to occur in the benches between 240 and 290mRL where karst is present. It is likely to occur between 250 and 260mRL where karst is not present.
  - On the east wall and the north wall, it is likely to occur between 260 and 290mRL.

  These results are consistent with performances to date (Figures 7 to 9).
- On the west wall, all wall scale surfaces that daylight behind the crest have FoS values exceeding 1.3. The presence of karst does not significantly influence the shape or location of the surfaces. The surface with the lowest capacity (i.e., FoS = 1.46) daylights 25m behind the crest.
- On the east wall, no surface having an FoS value less than 1.5 daylights behind a crest. The surface with the lowest capacity that does so, has a FoS value of 1.7 and daylights 13m behind the crest.
- On the north wall, the lowest capacity surface, with a FoS value of 1.4, daylights 9.8m behind the crest and under the toe of the WRD.

The acceptabilities of the FoS values are considered in Section 5.3.

5.3 Acceptability of Stabilities

The acceptabilities of the PoF and FoS values applicable to multi-bench and wall scale instabilities respectively are considered by comparing them to values typically considered acceptable in the civil and mining industries[39].

Impact by falling rocks or subsummation within collapsing rocks at a crest are considered to be high consequence events. However, these events are very unlikely to occur due to the implementation of the strategies listed in Section 2.2.2 and Sections 4, 7 and 8. They are therefore medium risk events[40].

5.3.1 Multi-bench Scale Instabilities

Read and Stacey (2009) recommends maximum PoF values of 10% to 20% as a general guide for multi-bench scale instabilities where the consequence of instability can be medium to high. A comparison of the results from the analyses (Tables A2.1 and A2.2) with the criteria indicates all but one PoF value is less than 10% and all are less than 20% hence are considered to be within the general range of acceptability.

[39] Acceptance criteria are listed in Read, J. and Stacey, P. (2009) Chapter 9: Acceptance Criteria. *Guidelines for Open Pit Slope Design*. CSIRO Publications.

[40] Risk classification terms are consistent with AS/NZS ISO 31000-2009 Risk management— Principles and guidelines. Standards Australia

5.3.2 Wall Scale Instabilities.

Read and Stacey (2009) recommend a minimum FoS of 1.5 under static loading and 1.1 under dynamic (earthquake) loading conditions for wall scale instabilities. A comparison of the results (Figures A3.2 to A3.4 and Figure A4.2) with the criterion indicates all values exceed 1.5 hence are within the range of acceptability.

5.4 Risk Management Strategies for the Pit

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

- restricting public access to the site
- ripping the upper section of the ramp and access roads to the pit
- removing and/or ripping the lower section of the ramp and access to berms
- installing the abandonment bund
- ensuring the offsets of the abandonment bunds are as specified (Section 2.3.2)
- visually monitoring and auding the performances of the walls (Section 4).
- routinely inspecting the areas behind the crests of the walls for evidence (e.g., cracking, subsidence etc.) that may be indicative of a large scale instability developing
- adherence to the requirements of the completion criteria (Section 7).

5.5 Limitations in the Stability Analyses

- The stability analyses for the pit walls (and for the WRD slopes in Section 6) 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 the walls and how these structures may influence the performances of the walls during the long-term. Some significant instabilities could occur that have not been reflected in the analyses. The implication will have been an underestimation of the likelihoods for instabilities.
- Limitations in the risk assessment process, implicit in any geotechnical study, should be considered when deciding to accept or otherwise the results and recommendations:
  - The judgement content of the inputs has resulted in considerable uncertainties in the values of the estimated likelihoods for instabilities. The results of the assessment are therefore unlikely to be verifiable. Other assessors, even if using the same method, could obtain different values.
  - Only relatively simplistic analysis methods have been used to estimate the likelihoods. Other methods may result in differences, possibly significant, in the calculated values.
  - Limitation in the availability of data has reduced the reliability of the likelihood estimates. Revisiting the analyses if additional data becomes available, a different method is applied or the circumstances change could lead to significant changes in the values.
- Due to these limitations, adherence to the recommended strategies will be necessary to ensure the risks to persons and the post-closure landform remain acceptable.

6 STABILITIES OF THE WRD SLOPES

The stabilities of the slopes of the northern and eastern WRDs are relevant to persons upon or behind a slope or near the toe of a slope. Instabilities can influence the locations of the toes of the slopes, which can affect water flows in contour lows adjacent the dumps. The stabilities can also influence the rehabilitation efforts. The stability of the north wall of the pit affects whether retreat of its crest could undermine the toe of the south slope of the northern dump thereby enabling rocks to flow over the wall.

6.1 Modelling

The stabilities of the slopes of both WRDs are quantified in Appendix 4. The analyses for the northern dump include the north pit wall. They assume:

- clayey sand has been stripped from the footings of the dumps to a solid strong base comprising gravelly sand
- water that infiltrates the surfaces of the dumps, which does not subsequently evaporate, seeps freely from the down contour toes therefore excess hydrostatic pressures do not develop within the rockfill
- earthquake loading applies a horizontal acceleration of 0.024g to the slopes as discussed in Section 3.4.
- a linear groundwater level is applied within the pit as discussed in Section 2.2.2.

The results of the analyses are quantified in terms of a Factor of Safety (FoS) value for each of hundreds of surfaces assessed within each model.

Figures A4.3 and A4.4 in Appendix 4 highlight surfaces having FoS values less than 1.5. The results indicate that no slope scale surface through either dump has a FoS value of 1.5 or less. The acceptabilities of these values are considered in Section 6.2.

The most likely instabilities occur at bench scale. These results are consistent with the performances of the slopes to date. Over the long-term, the angles of the benches may progressively reduce as:

- weathering of the materials will create additional fines which may result in an increase in the densities of the materials
- high moisture infiltration rates and reductions in the permeabilities of the materials could enable pore water pressures to develop
- infiltration of water softens the andesite resulting in a decrease in its shear strength

These actions may result in the overall angles of the slopes reducing progressively. As they do, the slopes will progressively become more stable.

6.2 Acceptability and Risk Management Strategies

The acceptabilities of the FoS values for the WRDs are considered by comparing them to values typically considered acceptable in the civil and mining industries[41].

Subsummation within flowing rocks at the toe of a slope of a dump or within a collapsing crest are considered to be high consequence events. However, these events will be unlikely due to the implementation of the strategies listed in Section 2.3.2 and Sections 4, 7 and 8. They are therefore medium risk events[42].

6.2.1 Multi-bench Scale Instabilities

Hawley and Cunning (2017) recommend a minimum FoS of 1.2 under static loading and 1.1 under dynamic loading as general guides for multi-bench scale instabilities where the consequence of instability is medium to high. A comparison of the results from the analyses (Figures A4.3 and A4.4) with the criteria indicates all FoS values exceed 1.2 and are therefore within the range of acceptability.

6.2.2 Wall Scale Instabilities.

Hawley and Cunning (2017) recommend a minimum FoS of 1.5 under static loading and 1.15 under dynamic loading as a general guide for slope scale instabilities. A comparison of the results from the analyses (Figures A4.3 and A4.4) with the criteria indicates all FoS values exceed 1.5 and are therefore within the range of acceptability.

6.3 Risk Management Strategies for the WRDs

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

- restricting public access to the site
- ripping the ramps and access roads to the dumps
- visually monitoring the performances of the dumps over the medium to long-term (Sections 4, 7 and 8) to ascertain whether the designs continue to perform acceptably
- preparedness to modify plans, designs and/or site works if the dumps or their environs deviate from the design and/or their performances do not comply with the criteria.

[41] 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.

[42] Risk classification terms are consistent with AS/NZS ISO 31000-2009 Risk management— Principles and guidelines. Standards Australia

7 COMPLETION CRITERIA

Table 7.1 lists the general objectives relevant to geotechnical aspects of the pit and the WRDs during the short- to long-terms. Completion criteria relevant to these aspects are listed in Table 7.2. The respective landforms will be considered suitable for relinquishment when these objectives and non-geotechnical related criteria have been met.

Table 7.1. 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 required for the operation and by progressively rehabilitating areas. • 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. • Stabilise areas between the west and south walls of the pit and Barambah Creek where, and as soon as, practical to do so. • Reshape sections of the batters of the upper benches to their final landform so they can be progressively rehabilitated. • Stabilise haulroads, batters of the upper benches of the pit and slopes of the WRDs as soon as practical. • Visually monitor the performances of the pit walls, WRD slopes and the surrounding landforms.	• Provide self-maintaining, geotechnically stable and safe landforms that compliment with the surrounding landforms in terms of slope, geomorphological characteristics, and postmining land use. • Remediate hazards associated with the pit and the WRDs that may increase the risks applicable to persons and/or animals. • Construct the upper surfaces of the WRDs to ensure rainfall runoff drains away from the crests of the slopes. • Minimise the catchment area applicable to the pit with an up contour abandonment bund.

Table 7.2. Completion Criteria Relevant to Geotechnical Aspects of the Final Landform.

Domain	*Long-term Goal*	*Objective*	*Performance Indicators*	*Completion criteria*
Pit	Stability	• Slopes and surfaces are geotechnically stable. • Landforms having very low probabilities of slope instability with high safety and environmental consequence. • Void volume and surface area is minimised. • Pit hydrology is understood. • Interconnectivity between pit and groundwater is understood. • Pit acts as groundwater sink into perpetuity.	• Engineering design • Records of slope instability • Floodwater isolated from the pit. • Surface water and groundwater parameters. • Groundwater monitoring and modelling.	• Walls profiled for long-term stabilities as evidenced by surveys of walls. • Visual evidence that the stabilities of the walls have remained constant or increased as rehabilitation is established. • Evidence that the pit water is contained with no overflows as predicted by modelling. • If required, pit walls are protected from possible inflows associated with floods.
	Safety	• Structurally sound. • Pit safe for persons and fauna. • Crest locations are clearly defined.	• Fall from height hazards • Impact hazards • Drowning hazards	• Perimeter abandonment bund in the correct location and structurally sound. • Signs installed. • Site access restricted.

Table 7.2 (continued). Preliminary Completion Criteria Relevant to Geotechnical Aspects of the Final Landform.

Domain	*Long-term Goal*	*Objective*	*Performance Indicators*	*Completion criteria*
WRDs	Stability	• Slopes and surfaces of WRDs are geotechnically stable. • Landforms having very low probabilities of slope instability with high safety and environmental consequence. • WRDs are adequately managed to ensure surface runoff and water seepage are not detrimental to the environment.	• Engineering design • Records of WRD slope instability	• Slopes profiled for long-term stabilities as evidenced by surveys of the WRDs. • Visual evidence that the stabilities of the slopes have remained constant or increased as rehabilitation is established. • No ponding occurring on a WRD. • If required, slope toes are protected from inflows associated with floods from Barambah Creek.
	Safety	• Structurally sound.	• Engineering design.	• Site access restricted to the general public.

8 SUMMARY

- The proposed landform designs satisfy the geotechnical related requirements of the PRCP Guideline
- The stabilities of the pit walls and the slopes of the WRDs are within the ranges typically considered acceptable in the civil and mining industries.
- After the EOML, the water level in the pit will increase. A pit lake will form with a final level at approximately 275mRL , which is likely to be below the pre-mining groundwater level. The water will not significantly reduce the performance of the pit walls unless rapid drawdown occurs.
- After the EOML, the principal strategies to reduce the risks applicable to the pit walls and the slopes of the WRDs will be:
  - restricting public access to the site
  - ripping the upper section of the ramp and access roads to the pit and the dumps
  - removing and/or ripping the lower section of the ramp and access to berms
  - installing the abandonment bund
  - ensuring the offsets of the abandonment bunds are as specified (Section 2.5.2)
  - visually monitoring and auding the performances of the pit walls (Section 4).
  - routinely inspecting the areas behind the crests of the pit walls and the WRD slopes for evidence (e.g., cracking, subsidence etc.) that may be indicative of large scale instabilities developing
  - adherence to the requirements of the completion criteria (Section 7)
  - prior to EOML, preparedness to modify plans and/or designs and/or site works if any landform deviates from the design and/or its performance does not comply with the criteria.

9 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. Footprints of final landforms.

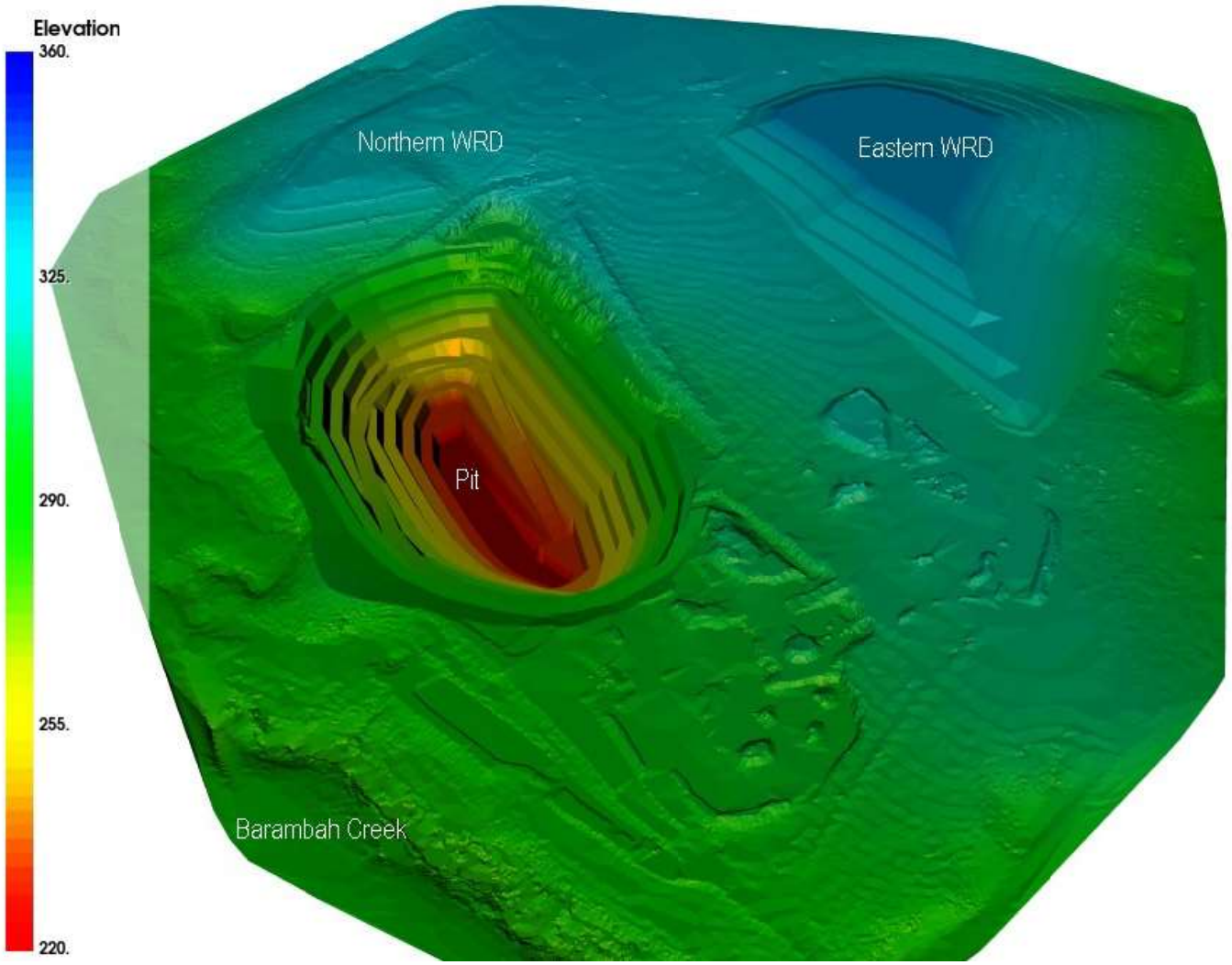


Figure 2. Landforms highlighting elevations.

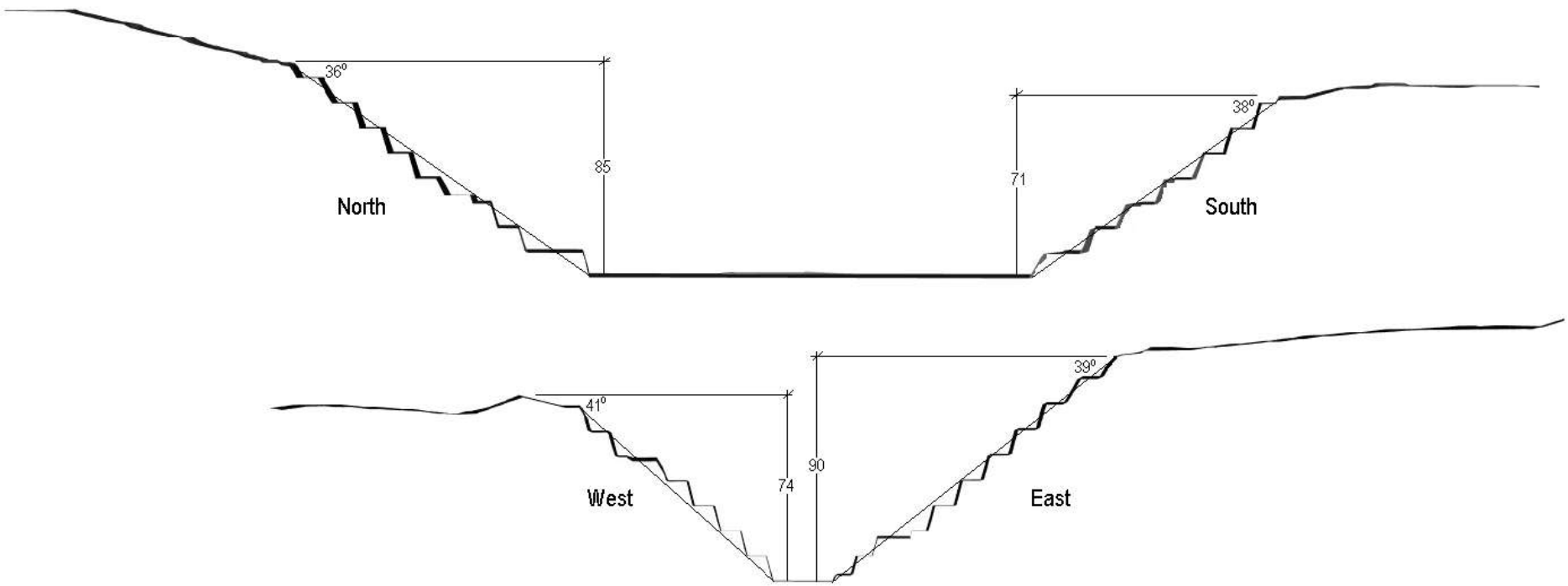
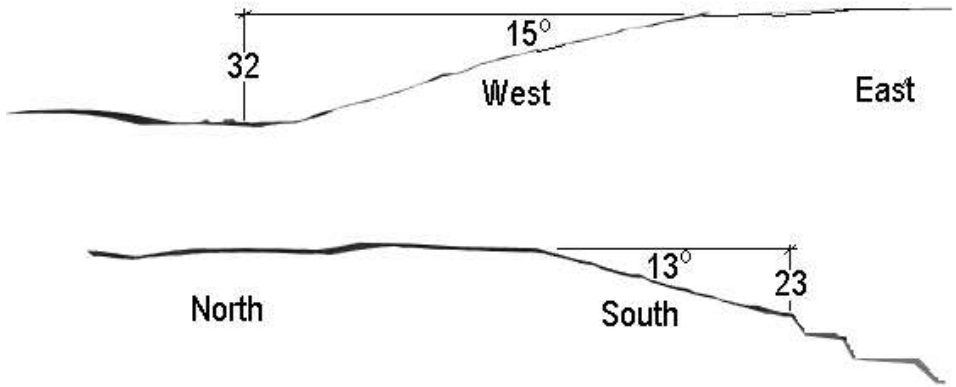
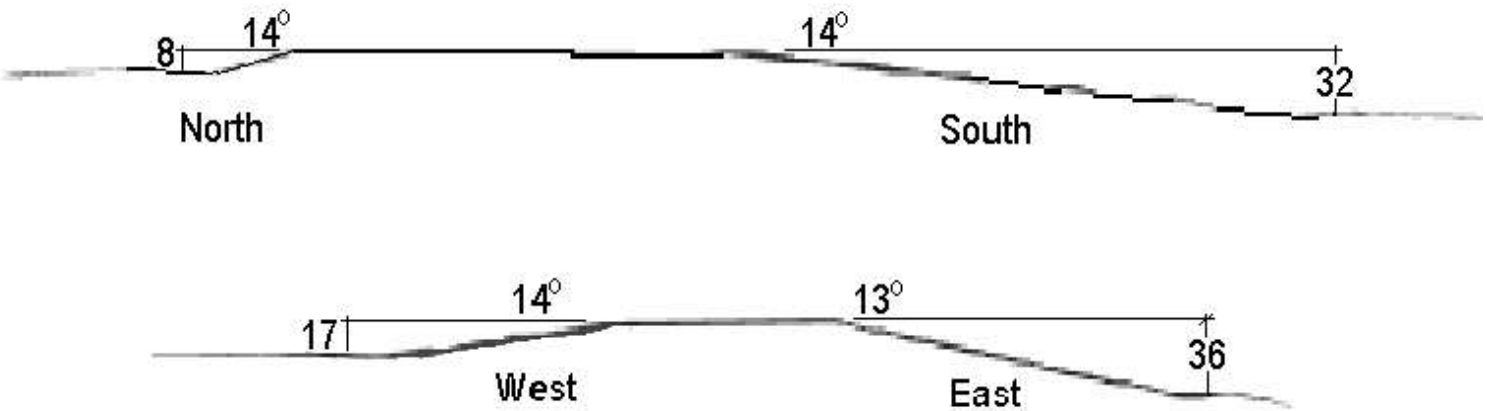


Figure 3. Cross sections through the pit walls at EOML.



(a). Northern WRD.



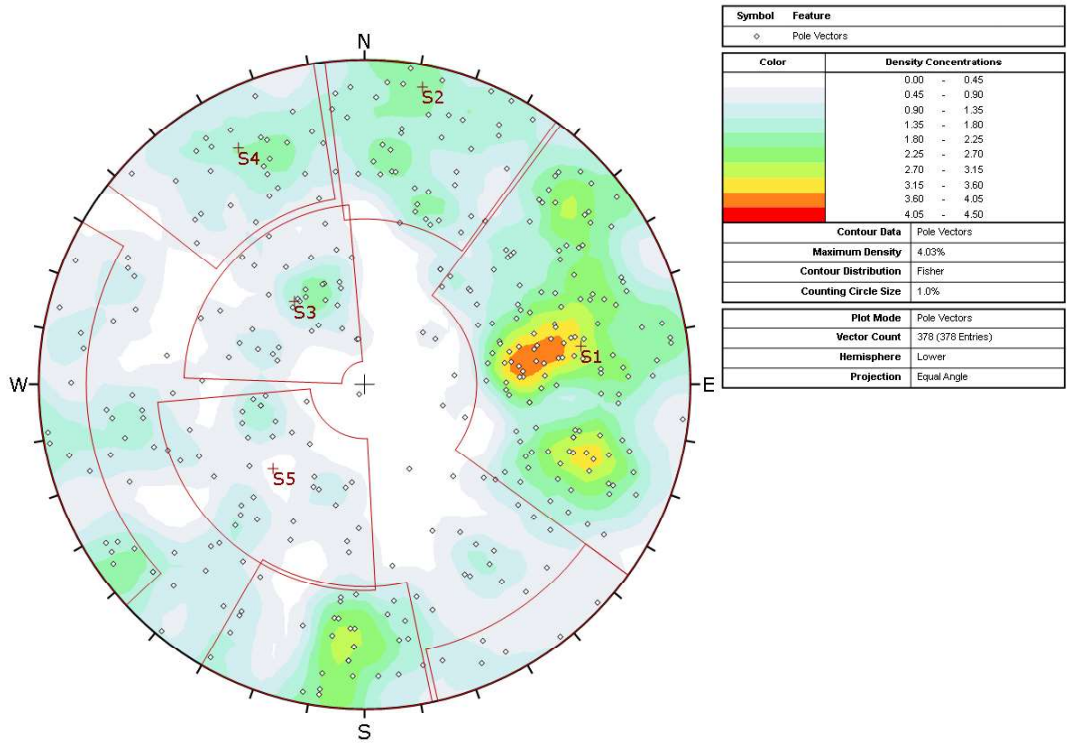
(b) Eastern WRD

Figure 4. Cross sections through the **(a)** northern and **(b)** eastern WRDs at EOML (not to scale).

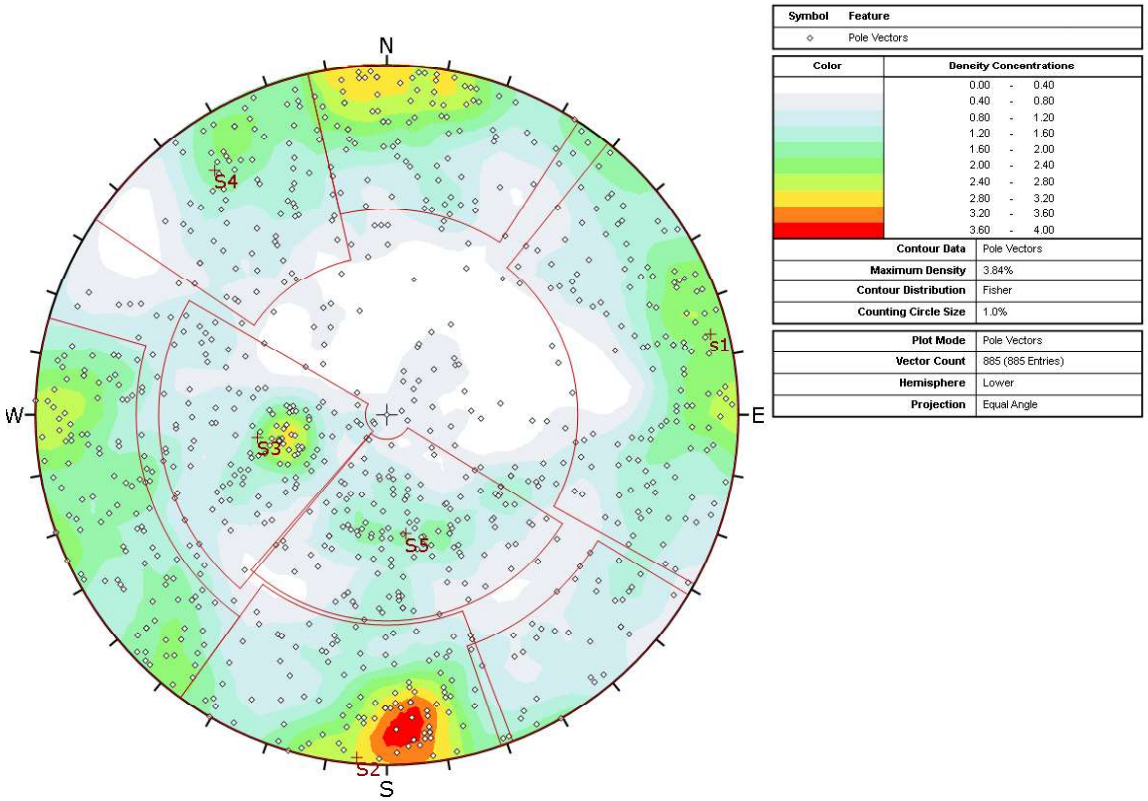
(a) Northern WRD

(b) East slope of the eastern WRD

Figure 5. Rehabilitation strategy proposed for the final landform has been demonstrated to be effective on the **(a)** northern WRD and on the **(b)** east slope of the eastern WRD.



(a) Andesite

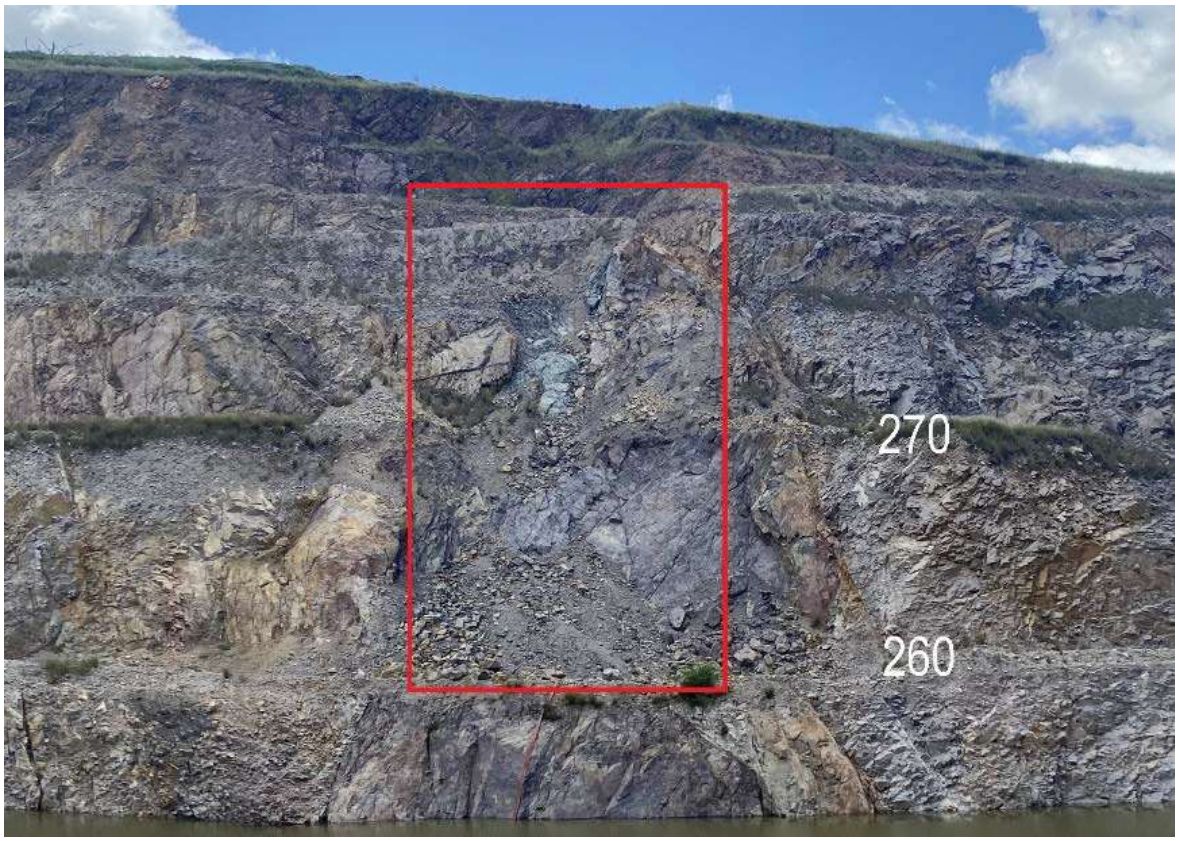


(b) Limestone

Figure 6. Stereonets highlighting the orientations of poles to (a) 378 and (b) 885 discontinuities within the andesite and limestone respectively, the boundaries of the 5 sets into which the discontinuities have been assigned and the mean orientations of the sets.

Figure 7. Highlighted are the sides of a large clay filled karst exposed on the west wall.

(a) Planar sliding of unweathered andesite along single discontinuities dipping out from the north wall.



(b) Wedge sliding of unweathered limestone along two discontinuities dipping out of the east wall.

Figure 8. Typical bench scale failure mechanisms.

Figure 9. Typical bench scale rotational sliding failure through weathered andesite on the north wall.

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 long-term geotechnical related risks applicable to the landforms at the Murgon mine, 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 affects 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 I Rocktest Consulting Report 2022

APPENDIX 1
ROCKMASS CHARACTERISTICS

A1.1 Compressive Strengths

The strengths of weathered and unweathered limestone and andesite were defined in terms of Point-Load Strength Indices, $I_{s(50)}$.

Samples of limestone and andesite 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[43]) and AS 4133.4.1 9 (1993[44]).

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[45] if opposite sides of the failure plane were not parallel.

The results are summarised in Table A1.1.1.

Table A1.1.1. Summary of point load strength indices.

		Number of tests	*Minimum (MPa)*	*Mean (MPa)*	*Maximum (MPa)*	*Stnd Dev (MPa)*
Limestone	unweathered	30	2.7	4.6	7.9	1.6
	weathered	11	0.8	1.9	2.4	0.5
Andesite	unweathered	14	3.0	5.1	9.5	2.1
	weathered	10	0.8	1.9	2.9	0.8

A1.2 Specific Gravities

The densities of samples of weathered and unweathered limestone and andesite 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 A1.2.2.

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[43] 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

[44] 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.

[45] 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.

$$\text{Density} = \frac{1000\ M_d}{M_w - M_s}$$

Table A1.2.2. Summary of density values.

		Number of tests	*Minimum (kg/m³)*	*Mean (kg/m³)*	*Maximum (kg/m³)*	*StndDev (kg/m³)*
Limestone	unweathered	18	2576	2663	2756	52
	weathered	22	2381	2564	2703	77
Andesite	unweathered	12	2593	2695	2800	72
	weathered	12	2444	2509	2588	48

A1.3 Basic Friction Angles

The basic friction angle[46] (ϕ_b) of a discontinuity within weathered and unweathered limestone and andesite 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 A1.3.1 summarises the results from the tests:

Table A1.3.1. Summary of basic friction angles test data.

		Minimum	*Mean*	*Maximum*	*StndDev (kg/m³)*
Limestone	unweathered	15°	22°	26°	3°
	weathered	15°	19°	23°	2°
Andesite	unweathered	20°	22°	29°	3°
	weathered	24°	26°	28°	1°

[46] The basic friction angle quantifies the inter-granular friction after all roughness asperities have been abraded from opposing surfaces of a discontinuity.

A1.4 Discontinuity Shear Strengths

Bench scale instabilities within the pit are dominated by gravity driven sliding of rocks. Sliding occurs when the driving forces applied to individual rocks and masses of rocks exceed the shear strengths of the underlying discontinuities[47]. In this study, these strengths are quantified in terms of a peak friction angle[48]. The discontinuities are assumed to have negligible cohesive strengths as:

- the rocks within the benches having been vibrated during blasting
- most discontinuities having undergone some shear displacements during tectonic deformations and creep which destroyed cementation
- relatively low stresses are applied to the discontinuities within the benches.

The "shape" of the shear strength/normal stress curve is described by the non-linear Barton-Bandis (BB) shear strength criterion[49]. The criterion is defined in terms of the following parameters. Their assumed values are listed in Table A1.4.1:

- 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 A1.1.1. 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 A1.2.1.
- 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 A1.3.1.
- Joint Roughness Coefficients[50] (JRC) was quantified by comparing the surfaces of the in-situ discontinuities to standard roughness profiles. The corresponding JRC values are listed in Table A1.4.1.

The estimated peak friction angles are listed in Table A1.4.2. The ranges of values are typical for limestone and volcanics.

Table A1.4.1. Description of surfaces of discontinuities and corresponding JRC values for 30-cm rocks.

	Surface weathering	
Surface Description	*Unweathered*	*Weathered*
Average surface	smooth, planar to undulating	slightly rough, planar to undulating
JRC	1 to 10 (ave. 5)	3 to 12 (ave. = 7)
Occasional surface	slightly rough, stepped	moderately rough, stepped
JRC	15	17

[47] Assuming rocks are free to move out from a bench.

[48] Any movement along a discontinuity destroys any cohesive bonds leaving a surface that is purely frictional.

[49] 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. (B-B model)

[50] 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.

Table A1.4.2. Summary of peak friction angles based on B-B model.

		Minimum	*Mean*	*Maximum*	*Stnd.Dev.*
Limestone	unweathered	18°	36°	64°	15°
	weathered	21°	36°	61°	12°
Andesite	unweathered	23°	36°	52°	15°
	weathered	30°	43°	50°	12°

A1.5 Rock Mass Strengths

The shear strengths of the limestone and andesite rockmasses were estimated using the Generalised Hoek-Brown Rock Mass Strength criterion[51]. The criterion is defined in terms of the parameters listed in tables A1.5.1 and A1.5.2:

- The Hoek-Brown intact rock constant (m_i) for each rock type.
- The disturbance factor (D) 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[52]. A value of 0.5 is applied as controlled blasting has not been used and hence benches have undergone some disturbance.
- The Geological Strength Index (GSI)[53] is a quantitative value that defines the quality of the rockmass in terms of the parameters[54]:
  - Rock volume – the edge length ranges from 10 to 60-cm for both rock types where unweathered and 2 to 30-cm where weathered.
  - Joint Condition Factor (J_c) is the ratio of the following two qualitative parameters from the Q[55] rock mass classification system:
    - Joint Roughness number (J_r) ranges from 1 to 3 for both weathering grades
    - Joint Alteration number (J_a) ranges from:
      - 2 to 3 for weathered limestone and 0.75 to 1.0 for unweathered limestone
      - 3 to 4 for weathered andesite and 1 to 2 for unweathered andesite

Figure A1.5.1 shows the likely ranges in the GSI values based on the data described above. The average values decrease from 53 to 32 as the limestone weathers and from 48 to 36 for the andesite. Although these values are not definitive, they still provide an indication of the decrease in the quality of the limestone and andesite as the degree of weathering increases during the long-term.

Parameters estimated for the rockmasses of the Esk Fm. and Maronghi Creek beds to the east and west of the pit are listed in Table A1.5.3.

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[51] Hoek, E. Carranza-Torres, C. & Corkum, B. (2002) Hoek-Brown failure criterion, 2002 edn. In *Mining and Tunnelling Innovation and Opportunity*. *Proc. 5th North Americal Rock Mech. Symp*. Toronto, vol. 1 pp.267-273 Uni. Toronto Press, Toronto.

[52] D varies from 0 for undisturbed rockmasses to 1 for very disturbed rockmasses.

[53] The geological strength index (GSI) produces quantitative values used to calculate the strength properties of a rockmass.

[54] 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

[55] Barton and Choubey (1977) The shear strength of rock joints in theory and practice. *Rock Mechanics* **6** 183-236.

Table A1.5.1. Rock mass shear strength parameters for limestone.

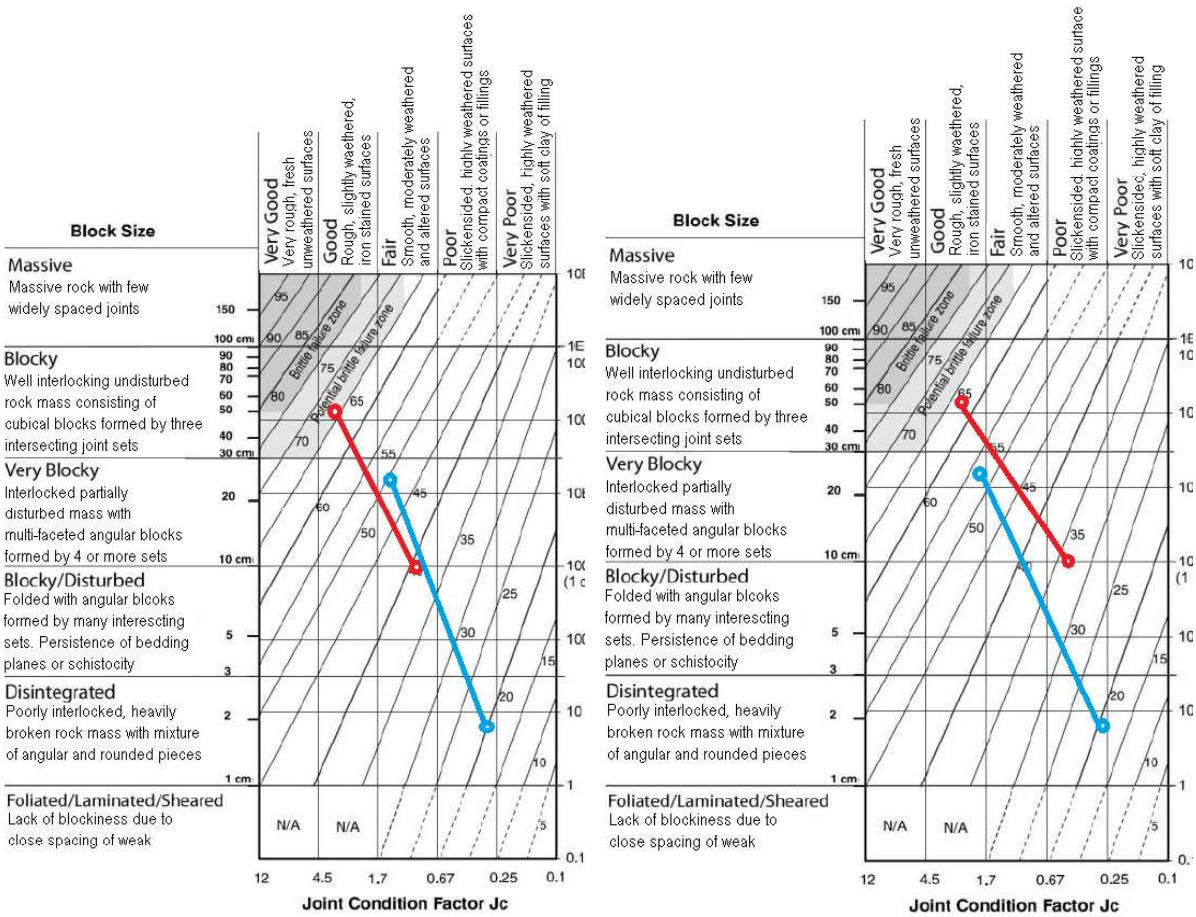
Characteristic	*Grade*	*Min*	*Mean*	*Max*
Intact rock constant, m_i.	all	9	12	15
Unit weight, (kN/m^3)	unweathered	24.9	25.9	27.0
	weathered	23.4	24.4	24.7
Disturbance factor, D.	all		0.5	
Uniaxial compressive strength, UCS (MPa)	unweathered	54.5	89.7	137.8
	weathered	14.4	33.5	43.6
Rock volume (cm^3)	unweathered	1,000	27,000	216,000
	weathered	8	8,000	27,000
Joint condition factor, $J_c = J_r/J_a$	unweathered	1	2.5	4
	weathered	0.3	0.9	1.5
Geological Strength Index, GSI.	unweathered	39	53	67
	weathered	20	32	48
Rock mass shear strength friction angle	unweathered	34°	40°	45°
cohesion (MPa)		1.0	2.3	5.6
friction angle	weathered	27°	34°	41°
cohesion (MPa)		0.1	0.6	1.0

Table A1.5.2. Rock mass shear strength parameters for andesite.

Characteristic	*Grade*	*Min*	*Mean*	*Max*
Intact rock constant, m_i.	all	20	25	30
Unit weight, (kN/m^3)	unweathered	24.7	26.1	27.5
	weathered	24.0	24.3	24.6
Disturbance factor, D.	all		0.5	
Uniaxial compressive strength, UCS (MPa)	unweathered	54.0	91.4	170.5
	weathered	14.1	33.9	52.9
Rock volume (cm^3)	unweathered	1000	27000	216000
	weathered	8	8000	27000
Joint condition factor, $J_c = J_r/J_a$ (Table 4).	unweathered	0.5	1.8	3.0
	weathered	0.3	1.1	2.0
Geological Strength Index, GSI.	unweathered	33	48	63
	weathered	19	36	53
Rock mass shear strength friction angle	unweathered	39°	45°	5°
cohesion (MPa)		1.0	2.3	6.1
friction angle	weathered	34°	42°	48°
cohesion (MPa)		0.2	0.7	1.5

Table A1.5.3 Estimated parameters for the rockmasses east and west of the pit.

Formation	*Location*	*Material*	γ_i *(kN/m³)*	*UCS (MPa)*	*GSI*	*H-B prmtr, m_i*	*D*
Esk Fm.	East of the pit	Polymictic pebble to boulder conglomerate, feldspathic sandstone, shale, minor acid tuff.	24	40	34	21	0
Maronghi Creek beds	West of the pit	Mudstone, shale, arenite, chert, jasper, metavolcanics. Highly structurally deformed metasediments.	24	30	20	6	0



(a) Limestone **(b)** Andesite

Figure A1.5.1. Ranges of GSI values for (red) unweathered and (blue) weathered (a) limestone and (b) andesite.

A1.6 Rockfill Shear Strength

On dumping, coarse rocks ravels downslope at the angle of repose of the loose rocks. In addition to other factors, the angle:

- increases with the mean particle size (i.e., D_{50})[56]
- increases with angularity and roughness
- increases with specific gravity
- decreases with increases in the height of the fall
- increases when a little water is present but decreases with further saturation.

The angle of repose is affected by the weathering of the rocks over time.

Table A4.1 list the angle of repose of dry weathered limestone and andesite exposed in the northern and western slopes of the eastern WRD. These slopes have not been rehabilitated. The rocks exposed within them are in various degrees of decomposition.

Table A6.1. Observed angle of repose and estimated friction angles of weathered rocks in the WRD.

	minimum	*average*	*maximum*	*stnd dev.*
Angle of repose	22°	30°	40°	5°
Estimated friction angle	24°	32°	42°	

The strength of the rocks at a location within a WRDs can be described by a friction angle. This angle is typically a few degrees higher than the angle of repose. Based on the average values in Table A6.1, the friction angles range from 24° to 42°. As the rocks in the WRDs are essentially free-draining, their values when saturated will differ little from the values when dry.

The friction angle can be estimated in terms of the parameters that influence the angle of repose using the method of Barton (2008)[57]. The function is defined in terms of the parameters listed in Table A1.6.2. The table lists the values applicable to the weathered andesite and limestone. The values listed are the mean values minus one standard deviation.

The values in Table A1.6.2 estimated using the function are similar to the observed values listed in Table A1.6.1. Based on these data, a conservative lower bound value of 25° is assumed for the long-term friction angle of the rockfill.

Table A1.6.2. Estimated parameters for the weathered waste rock.

Parameter	*Source*	*Limestone*	*Andesite*
Basic friction angle, ϕ_b	A1.2	17°	25°
Compressive strength of intact rock, UCS (MPa)	A1.1	25	19
Mean size of rocks, D_{50} (mm)			
Compacted porosity, n (%)	typical	29	26
Density of rocks in WRD, d (t/m^2)	estimated	1.9	1.8
Size dependent equivalent strength, S = *f*[UCS, D50] (MPa)	chart	6.3	4.7
Equivalent roughness, R = *f*[n]	chart	7.3	7.3
Friction angle = *f*[S, R, ϕ_b]	calculated	25° to 32°	32° to 40°

[56] D50 is the diameter below which are 50% of the rock sizes

[57] Shear Strength of Rockfill, Interfaces and Rock Joints, and their Points of Contact in Rock Dump Design. N.R. Barton. Rock Dumps 2008, Perth, Australia 15 pages

APPENDIX 2 PIT MULTI-BENCH SCALE STABILITY

A series of stability analyses were undertaken to quantify the likelihoods[58] for discontinuity controlled sliding modes of instabilities at multi-bench (inter-ramp) scales to occur.

The analyses used the stereographic method, implemented in the software Dips[59], to assess whether the kinematics[60] 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 along single (planar) or multiple (wedge) 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 assume the following:

- The five sets of discontinuities have the orientation characteristics listed in Tables 3.1 and 3.2.
- Inter-ramp angles of 43° as listed in Table 2.1. Loss of sections of benches at steeper (i.e., batter) angles are not significant hazards after the EOML.
- The slopes dip towards the directions listed in Table 2.2.
- Discontinuities in limestone and andesite have long-term lower bound shear strengths of 18° and 21° respectively as listed in Table A1.5.1.

The percentage of discontinuities having orientations conducive to sliding is defined as,

- for planar sliding, the percentage (P_{fp}) of the total number of poles[61] to the logged discontinuities that are within "critical zones[62]".
- for wedge sliding, 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 (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 a multi-bench scale instability.

Cleavage in the limestone and foliation in the andesite (Set 1) can have very high persistence. Their orientations significantly influence the performances of the west or the east walls and less so the north and south walls. The east and west walls are therefore assigned conservative P_l values of 1.0 i.e., 100% of discontinuities dipping out of the east and west walls have sufficient persistences to underlie multi-bench scale instabilities. The north and south walls are assigned conservative P_l values of 0.7 i.e., 70% of discontinuities have sufficient persistences to underlie multi-bench scale instability. These values are

---

[58] 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.

[59] The kinematic analysis software, Dips, is produced by Rocscience Inc, Toronto.

[60] 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.

[61] 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.

[62] "Critical zones" are areas on a stereonet within which a pole is deemed to have the orientation characteristics conducive to sliding.

consistent with evidence that multi-bench, structurally controlled, instabilities have been more prevalent on the east and west walls than on the north and south walls (e.g., Figure 8).

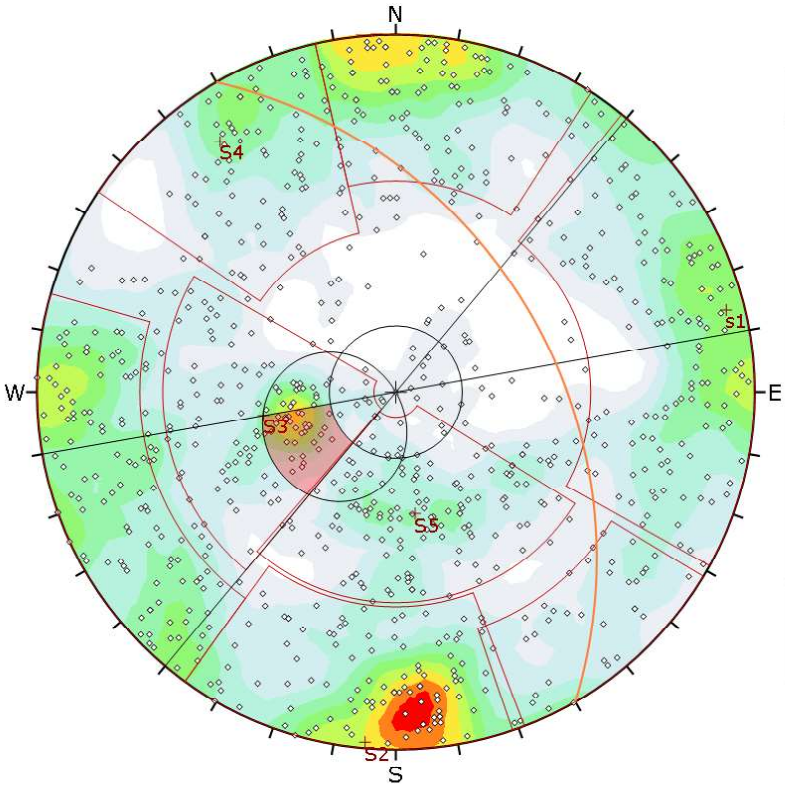
Figures A2.1 and A2.2 shows example of the stereonets applicable to planar and wedge sliding. The results of the analyses are listed in Tables A2.1 and A2.2 and discussed in Section 5.1.

Table A2.1. Results of stereonet analyses for multi-bench scale instabilities in weathered limestone.

	Wall (dip direction)			
	North (150°)	*South (310°)*	*East (240°)*	*West (060°)*
Sliding Mode	*Percentage of poles in critical area/s (%)*			
Planar, P_{fp}	0.7	1.8	0.6	3.8
Wedge, P_{fw}	6.6	10.3	5.7	14.9
Total, $P_u = f(P_{fp}, P_{fw})$	7.3	11.9	6.3	18.1
Likelihood for sliding, $P_f = P_u \times P_i$	5.1	8.3	6.3	18.1

Table A2.2. Results of stereonet analyses for multi-bench scale instabilities in weathered andesite.

	Wall (dip direction)			
	North (150°)	*South (310°)*	*East (240°)*	*West (060°)*
Sliding Mode	*Percentage of poles in critical area/s (%)*			
Planar, P_{fp}	3.7	0	0.5	1.8
Wedge, P_{fw}	10.8	7.5	7.3	6.8
Total, $P_u = f(P_{fp}, P_{fw})$	14.1	7.5	7.8	8.5
Likelihood for sliding, $P_f = P_u \times P_i$	9.9	5.3	7.8	8.5



Symbol	Feature
◇	Pole Vectors

Color	Density Concentrations
	0.00 - 0.40
	0.40 - 0.80
	0.80 - 1.20
	1.20 - 1.60
	1.60 - 2.00
	2.00 - 2.40
	2.40 - 2.80
	2.80 - 3.20
	3.20 - 3.60
	3.60 - 4.00

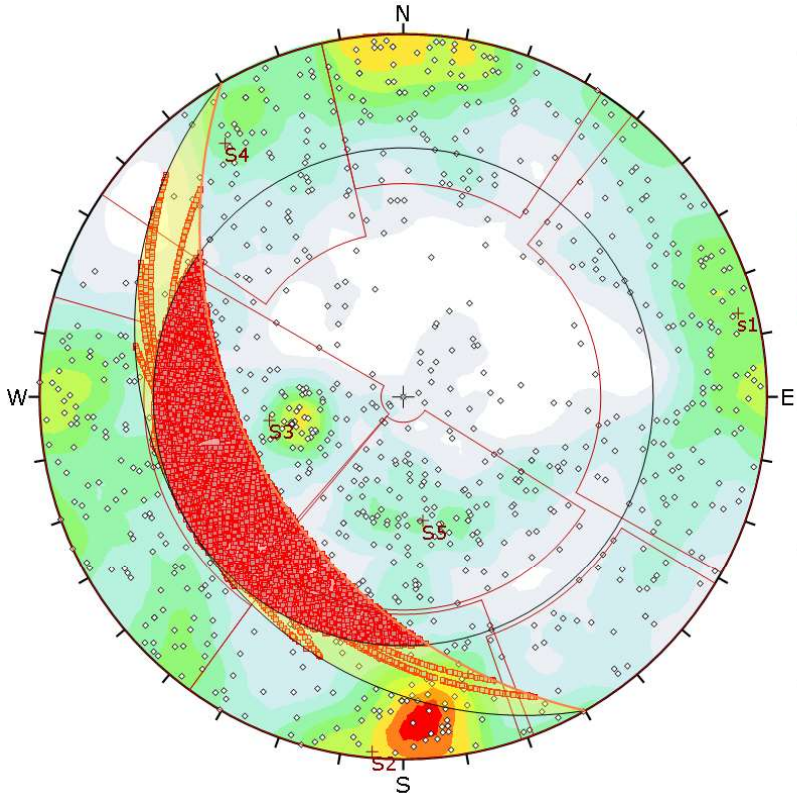
Contour Data	Pole Vectors
Maximum Density	3.84%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	43
Slope Dip Direction	60
Friction Angle	21°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	33	885	3.73%
Planar Sliding (Set 7: S3)	33	121	27.27%

Plot Mode	Pole Vectors
Vector Count	885 (885 Entries)
Hemisphere	Lower
Projection	Equal Angle

Figure A2.1. Stereonet applicable to planar sliding within limestone on the west wall.



Symbol	Feature
◇	Pole Vectors
▫	Critical Intersection

Color	Density Concentrations
	0.00 - 0.40
	0.40 - 0.80
	0.80 - 1.20
	1.20 - 1.60
	1.60 - 2.00
	2.00 - 2.40
	2.40 - 2.80
	2.80 3.20
	3.20 - 3.60
	3.60 - 4.00

Contour Data	Pole Vectors
Maximum Density	3.84%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	43
Slope Dip Direction	240
Friction Angle	21°

	Critical	Total	%
Wedge Sliding	18303	391137	4.68%

Plot Mode	Pole Vectors
Vector Count	885 (885 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	391137
Hemisphere	Lower
Projection	Equal Angle

Figure A2.2. Stereonet applicable to wedge sliding within limestone on the east wall.

APPENDIX 3 PIT WALL SCALE STABILITY

The stabilities of large surfaces through the east, west and north pit walls[63] were assessed using a limit-state equilibrium method implemented in the software *Slide2*[64]. The two-dimensional analysis code is applicable as the walls are wide relative to their heights and they are relatively straight.

The following characteristics are assumed:

- The east and west walls in Figure A3.1 and the north wall in Figure A4.1 in Appendix 4 have the specifications listed in Table 2.1. The figures show the assumed geologies.
- Weathered and unweathered andesite overlies the limestone and is within the upper benches. The lower benches comprise weathered limestone overlying unweather limestone. Esk Fm. rocks occur to the east. and rocks of the Maronghi Creek beds occur to the west.
- The shear strength characteristics of the limestone and andesite rockmasses are estimated using a Generalised Hoek-Brown (GHB) shear strength model discussed in Section A1.5 and listed in Tables A1.5.1 and A1.5.2. Each rockmass type is defined in terms of the:
  - unit weight (γ_i) and compressive strength (UCS) of the intact rock
  - Geological Strength Index (GSI) for the rockmass
  - Hoek-Brown parameter (m_i) for the rock type
  - disturbance factor (D).

  Lower bound values are assumed as they become progressively more applicable over the long-term.
- An anisotropic model is applied to allow for cleavage in the unweathered limestone. The shear strength characteristics of the cleavage are applied to sections of potential sliding surfaces that dip towards the west at $75^o \pm 10^o$. 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. The values applicable to weathered limestone are assumed.
- The shear strength characteristics of the Esk Fm. and Maronghi Creek beds are estimated using a GHB model in terms of the parameters listed in Tables A1.5.3.
- The analyses consider non-circular surfaces to allow changes in the geology and cleavage to influence the shapes.
- Earthquake loading applies an acceleration of 0.024g as discussed in Section 3.4.
- A linear groundwater level is applied as discussed in Section 2.2.2.

Two scenarios were considered for the west wall; surfaces passing through karst (Figure A3.2) and through weathered limestone (Figure A3.3).

Figures A3.2 to 4.4 and Figure A4.2 shows the critical surfaces applicable to each model. The surfaces highlighted are the largest which daylight behind the crests. The results of the analyses are discussed in Section 5.2.

[63] The stability of the north pit wall is considered in Appendix 4.

[64] *Slide2 Ver 9.02* is developed by RocScience Inc. Toronto, Ontario.

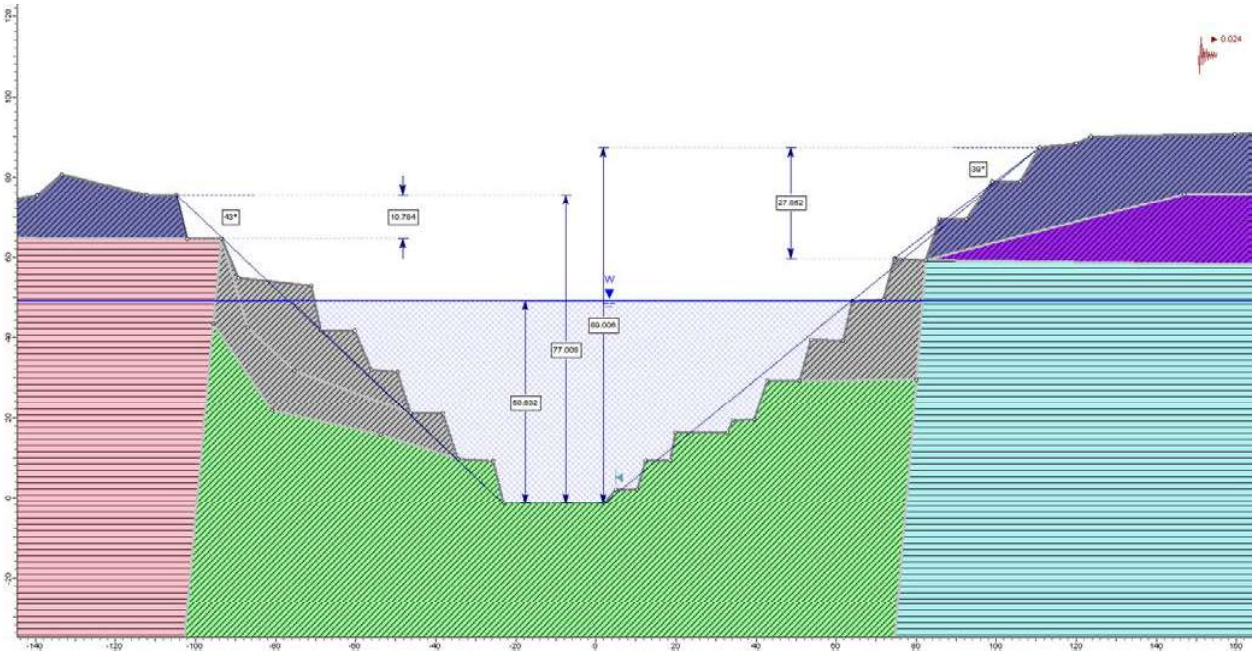


Figure A3.1. Cross-section through the west (left) and east walls.

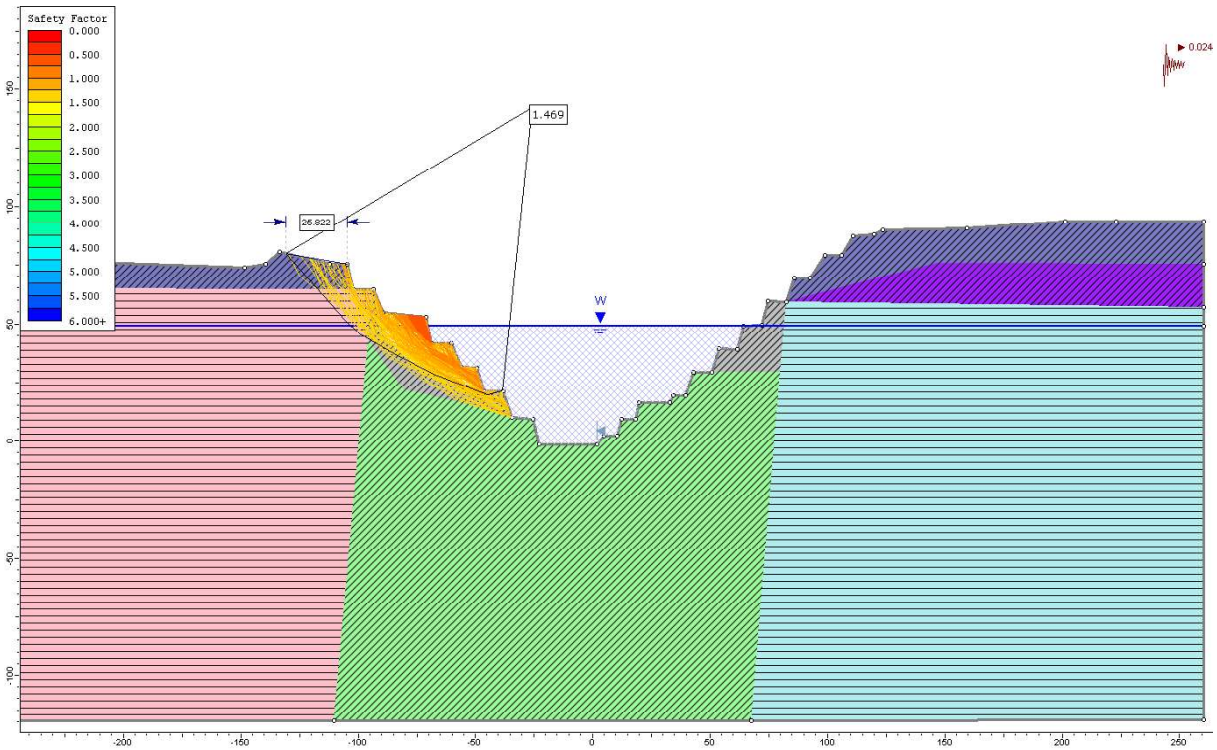


Figure A3.2. Highlighted are surfaces within the west wall (with karst) having FoS values less than 1.5. Also highlighted is the surface with the lowest stability that daylights within the upper surface behind the crest. The presence of the karst has negligible influence on the characteristics of the surfaces.

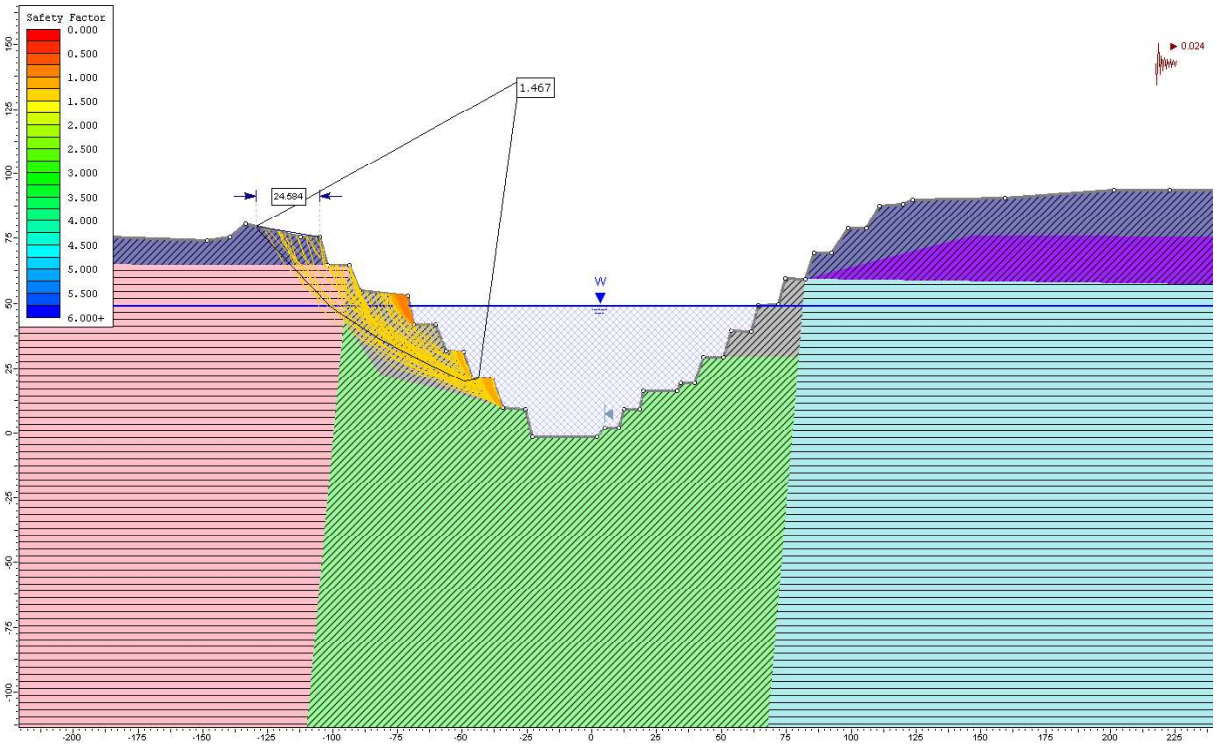


Figure A3.3. Highlighted are surfaces within the west wall having FoS values less than 1.5. Also highlighted is the largest surface that daylights within the upper surface behind the crest.

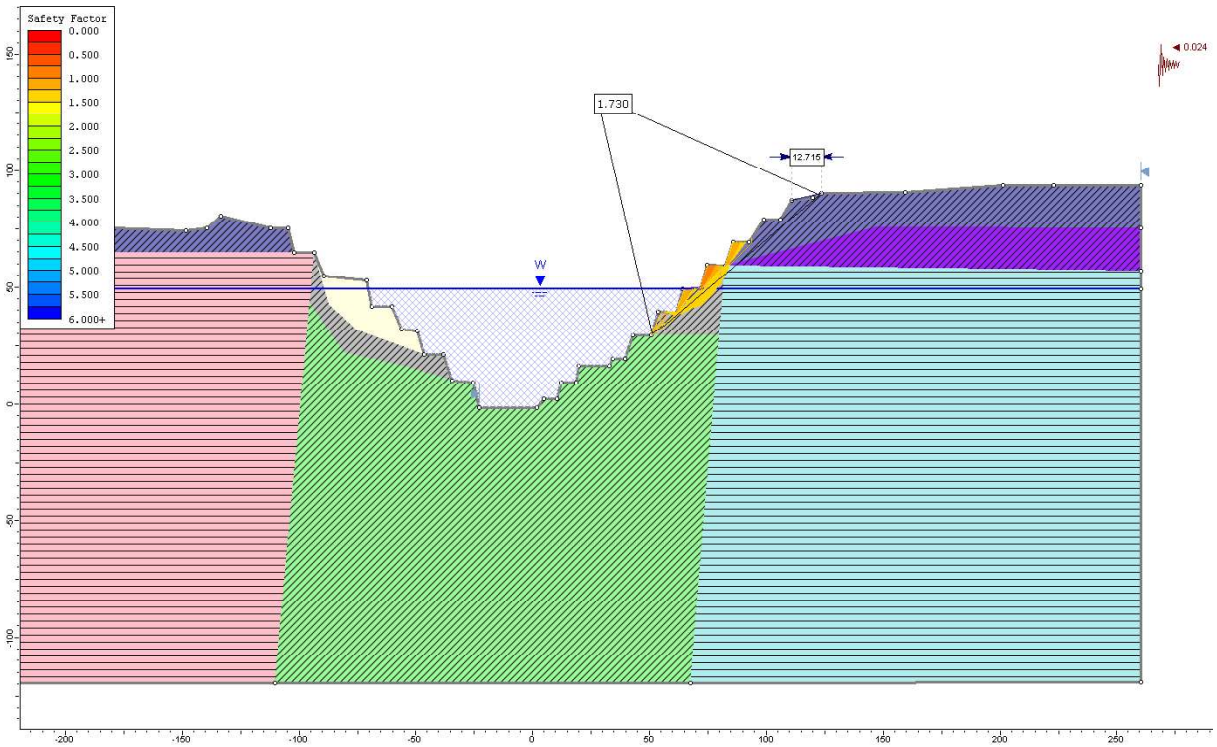


Figure A3.4. Highlighted are surfaces within the east wall having FoS values less than 1.5. Also highlighted is the surface with the lowest stability that daylights within the upper surface behind the crest.

APPENDIX 4 WRD SLOPE STABILITY

The stabilities of large surfaces through the steepest and highest slopes of the northern and eastern WRDs and the north wall of the pit were assessed using the limit-state equilibrium method implemented in *Slide2.*

The following characteristics are assumed:

- The slopes and north pit walls highlighted in Figures A4.1 and A4.2 have the dimensions listed in Tables 2.1 and 2.3. The figures show the assumed geologies.
- The shear strength characteristics of the limestone and andesite rockmasses are described using a Generalised Hoek-Brown (GHB) shear strength model discussed in Section A1.5 and listed in Tables A1.5.1 and A1.5.2.
- Clayey sand has been stripped from the footing to a base of gravelly sand. The shear strength characteristic of the base is described using a linear Mohr-Coulomb model as discussed in Section 3.1.1.
- The shear strength characteristics of the weathered rockfill over the long-term are described by a linear Mohr-Coulomb model defined in terms of a 25° friction angle as discussed in Section A1.6 in Appendix 1.
- As evidenced by observation, the rockfill is assumed to be permeable. Water that infiltrates its surface, and does not subsequently evaporate, seeps from the down contour south toe. Excess hydrostatic pressures do not develop within the rockfill.
- The analyses consider non-circular surfaces to allow changes in the geologies to influence the shapes.
- Earthquake loading applies an acceleration of 0.024g as discussed in Section 3.4.
- A linear groundwater level is applied within the pit as discussed in Section 2.2.2.

Figures A4.3 and A4.4 shows the critical surfaces applicable to each model. The surfaces highlighted are the largest which daylight behind the crests. The results of the analyses are discussed in Section 6.

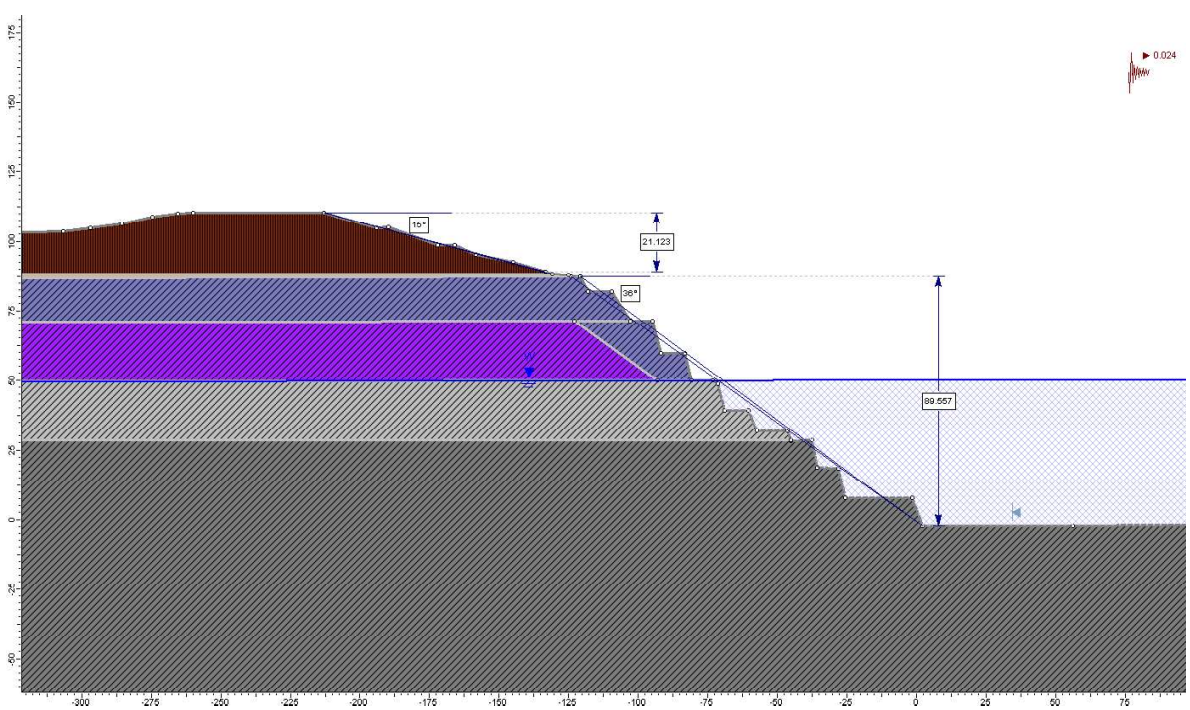


Figure A4.1. Cross-section through the south slope of the northern WRD and the north pit wall.

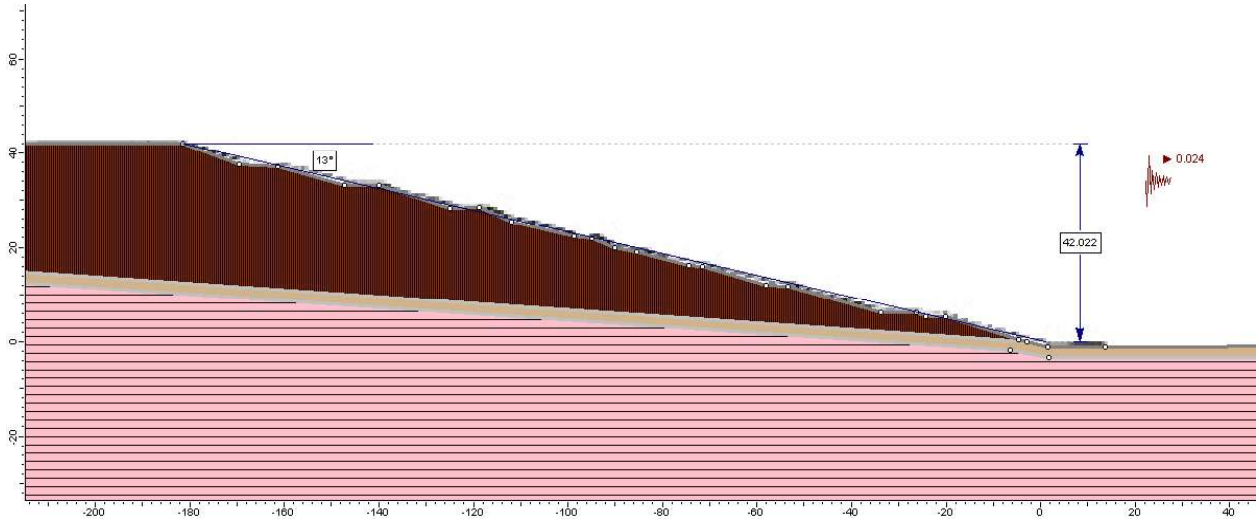


Figure A4.2. Cross-section through the south slope of the eastern WRD at EOML.

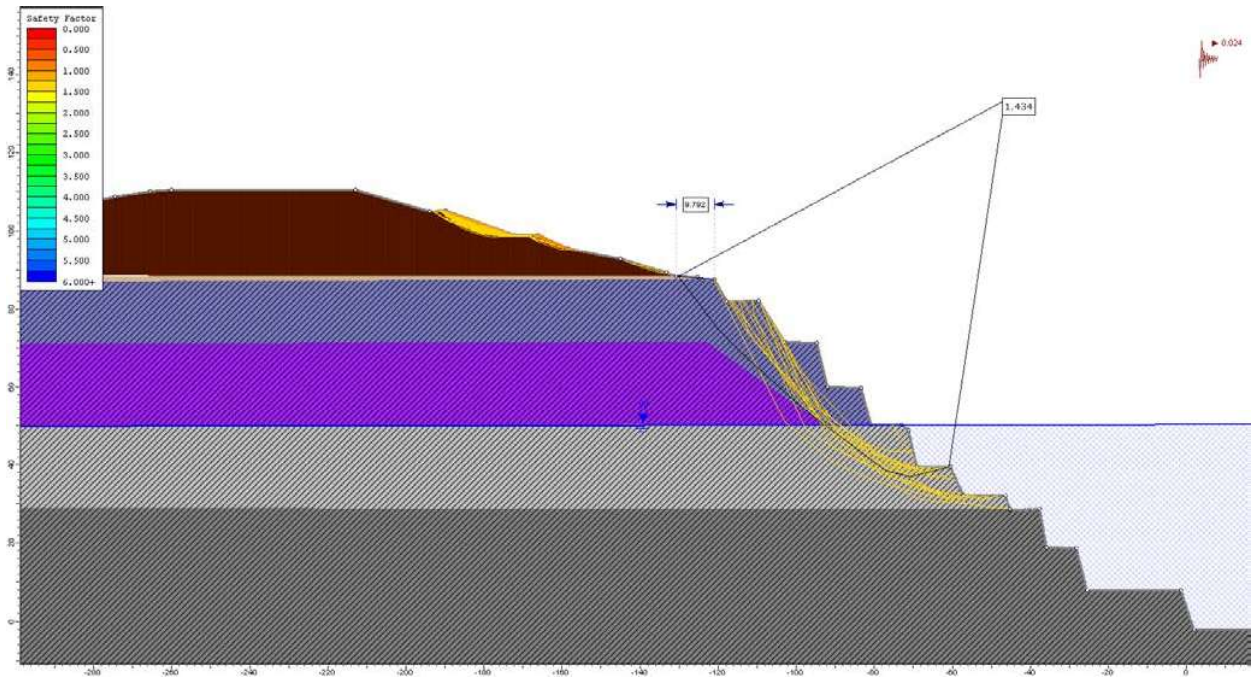


Figure A4.3. Highlighted are surfaces within the south slope of the northern WRD and the north wall of the pit having FoS values less than 1.5. Also highlighted is the surface with the lowest stability that daylights within the upper surface behind the crest of the wall.

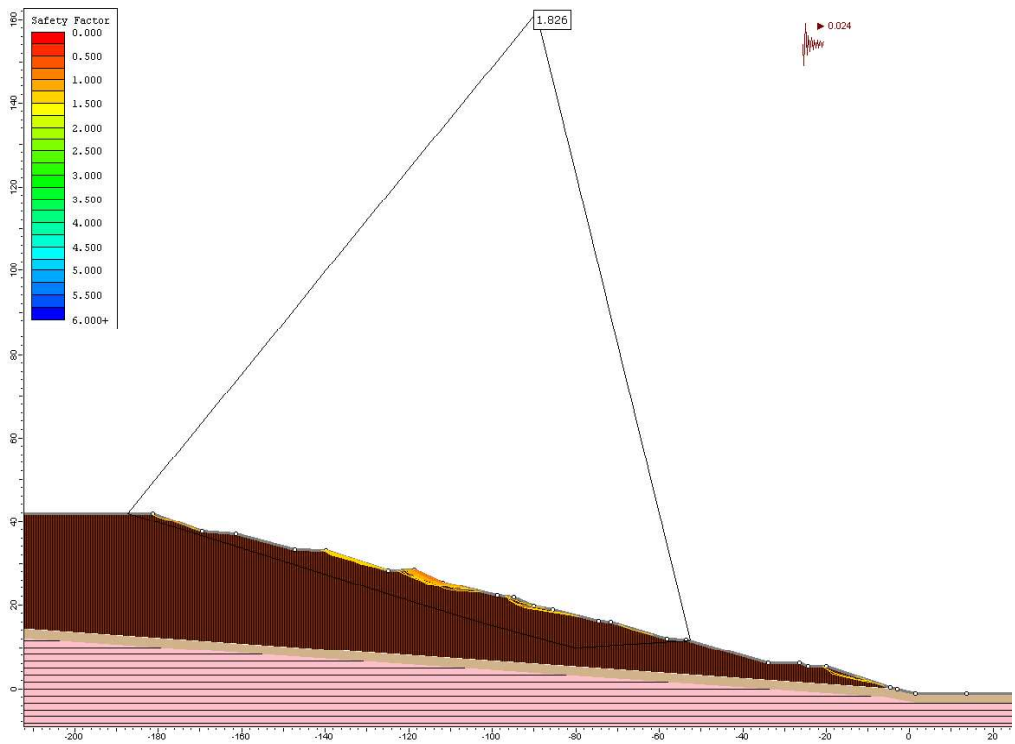


Figure A4.4. Highlighted are surfaces within the northern WRD and the north wall of the pit having FoS values less than 1.5. Also highlighted is the surface with the lowest stability that daylights within the upper surface behind the crest.

Appendix J Pitt and Sherry Flood Modelling Report 2023

pitt&sherry

Murgon Limestone Mine PRCP

Flood modelling

Prepared for

Graymont

Client representative

Michelle Muir

Date

1 March 2023

Rev00

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Appendix D — Maps

Prepared by — Martin Jacobs		**Date — 1 March 2023**
Reviewed by — Bryan Hernandez		**Date — 1 March 2023**
Authorised by — Martin Jacobs		**Date — 1 March 2023**

Revision History

Rev No.	Description	Prepared by	Reviewed by	Authorised by	Date
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Executive Summary

A flood assessment was carried on Graymont's Limestone Mine at Murgon in Queensland in support of a Progressive Rehabilitation and Closure Plan (PRCP). The purpose of the assessment is to provide additional information detailing how flood flows may interact with the final landform, which includes a proposed abandonment bund.

Flood flows were estimated by hydrological modelling that included the effects of joint probability floods from the Bjelke-Petersen Dam and Barambah Creek upstream of the mine site. Flood depths and velocities were estimated by hydraulic modelling, which included the conceptual design of the abandonment bund.

The flood assessment found that:

- the abandonment bund would be affected by flood flows, but the velocities at the bund do not require additional rock scour protection
- the abandonment bund and edge of void will be overtopped by 1%AEP flood flows, which presents an opportunity for any contaminants that may be present in the pit void to be released into Barambah Creek; and
- the abandonment bund will increase 1%AEP flood levels by up to about 0.05m upstream of the site.

1. Context

This report has been developed on behalf of Graymont to support a Progressive Rehabilitation and Closure Plan (PRCP) for the Murgon Limestone Mine, which is in the South Burnett Region of Queensland.

Eco Logical Australia (ELA) previously conducted a preliminary flood hazard assessment, based on resources available in the public domain. The flood hazard assessment showed that the final void of the Murgon Limestone Mine is within the expected extent of inundation during a Probable Maximum Flood (PMF) event with or without an upstream failure of the Bjelke-Petersen Dam. Past flood events have inundated the pit void.

As part of a request for further information, the Department of Environment and Science (DES) requested that Graymont conducts or commissions additional hydrological modelling to provide additional information detailing how flood flows may interact with the final landform (void and mine-waste landforms). This assessment describes the modelling to allow completion of the Murgon PRCP.

DES requested the following information:

- *Please demonstrate how the final landform will achieve and maintain a stable condition under 1%AEP, PMF and dam failure flooding events. This includes (but may not be limited to) further flood modelling to investigate the effect that flood depth and velocity may have on the final landform.*
- *Please provide information to demonstrate that the Abandonment Bund will achieve a safe and stable condition. For example, engineering design by an appropriately qualified person, consideration of risks and associated risk mitigation, monitoring, and maintenance strategies. Furthermore, consider the limitations imposed by the mining lease boundary and include mining lease boundaries in landform design cross sections; and*
- *Please provide further analytical results to demonstrate the potential for contaminant release to the environment in the event of void inundation due to flooding and demonstrate the suitability of water in the void for stock use (the intended PMLU).*

The scope of this report is to address DES's queries except for the suitability of water in the void for stock use, which is a water quality issue that requires further consideration of the quantity and quality of potential contaminants that could be present in the water collected in the void. This assessment does not address water quality.

2. Site

2.1 Location

The site is located near Murgon, Queensland at the coordinates shown in Table 1 and as shown in Map 1. The site is located just downstream of the confluence of Barambah Creek and the outlet spillway of the Bjelke-Petersen Dam (BP Dam), on Barker Creek. Hydrologically, the estimation of flows at the site is complex as it requires consideration of the joint probability of flood flows from Barambah Creek and releases from the BP Dam.

Table 1: Site coordinates

Grid	Coordinates
MGA	Zone 56 Easting 397768.309 Northing 7092016.720[1]
Geographic	Lat -26.288° Long 151.976°

2.2 Site description

The site comprises the Murgon limestone mine that is owned and operated by Graymont (Australia) Pty Ltd. The mine landform includes the open cut pit void, northern and eastern waste rock dumps (WRDs), ROM pad, stockpiles, processing, administration, and water management infrastructure.

At end of mine life the mine will be rehabilitated to enable productive uses including agriculture. This will include reshaping and revegetation of the waste rock dumps and other exposed parts of the site. The open void will be retained. It has been identified that the void could be inundated by flood events.

2.3 Abandonment Bund

The final landform will include an abandonment barrier (bund) behind the crest of each pit wall. The principal purpose of the Abandonment Bund is to act as a security barrier to prevent unauthorized persons from entering the abandoned mine and as a visual screen for the site. The bund provides an area between the crest and the barrier sufficiently flat to enable the area to be safely accessed for inspections and for cracks to be observed. The bund also diverts runoff from slopes above the mine void so that they do not enter the mine and erode the crest.

The alignment of the Abandonment Bund has been determined by Graymont. The form of the Abandonment Bund is expected to follow the Western Australian guidelines, as follows:

- Construction – rock
- Height – 1.5m; and
- Width – 3.0m.

For this assessment, the Abandonment Bund has been modelled as a solid structure that extends above flood level along its entire alignment. It therefore excludes all floodwaters from the mine site, which might not be the case in the final landform. This conservative approach ensures that the modelling estimates the maximum flood depths, velocities and impacts that are expected from the construction of the Abandonment Bund, whilst allowing flexibility in determining the final form of the height and slopes of the bund.

[1] Calculated from geographic coordinates by Redfearn's formula at http://www.ga.gov.au/geodesy/datums/redfearn_geo_to_grid.jsp

3. Hydrology

3.1 Rainfall IFD

Rainfall intensity-duration-frequency (IFD) data were acquired from the Bureau of Meteorology website[2] for 2016 data at the coordinates shown in Table 1. The resulting IFD table is shown in Appendix B.

3.2 Rainfall and Stream Gauge Records

Rainfall and stream gauge records were downloaded from the Bureau of Meteorology's website Water Data Online[3] for nearby gauges. The catchments, gauges and location of the site are shown in Map 2.

3.3 Generation of synthetic long term rainfall series

Interpolated daily series (to 09:00 am) for rainfall and evaporation were downloaded from the LongPaddock SILO website[4]. These series provided continuous series from 1889 to the present day.

The Australian Rainfall and Runoff temporal patterns were downloaded from the AR&R DataHub[5] for several points around the catchments shown in Map 2.

The daily series were disaggregated into hourly series using a software program developed in-house by pitt&sherry. This program performs the following operations:

- Normalize SILO daily data to BoM IFD for the whole of the SILO record at 1-day increments
- Disaggregate SILO daily data to 1-hour increments, using a selection from the ARR2016 temporal patterns for storms of 24 hours duration for the site location; and
- Normalize resulting 1-hour time series to BoM IFD for the whole of the SILO record at 1-hour increments.

Normalization is a process that adjusts rainfall totals to align with the BoM IFD for the site, whilst maintaining the total accumulated depth over the period of the time series. This is an iterative process that attempts to maintain the integrity of the source data, whilst finding a best-fit approximation.

The result is a synthetic time series that:

- Has daily rainfalls adjusted to the BoM IFD for 24-hour durations
- Has hourly rainfalls adjusted to the BoM IFD to 60-minute durations
- Incorporates the suite of ARR temporal patterns; and
- Covers the period from 01 Jan 1889 to the present, which is about 133 years.

[2] http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016
[3] Water Data Online: Water Information: Bureau of Meteorology (bom.gov.au)
[4] SILO | LongPaddock | Queensland Government
[5] Home | ARR Data Hub (arr-software.org)

3.4 Catchments

Terrain data were downloaded from the ELVIS elevation portal[6]. The most detailed data that were available for the whole catchment were the SRTM-H data, which have a grid size of 1 second (about 30m at the site location). These data were derived by using hydrological enforcement on the SRTM data, which is a process that aims to fill sinks such that creeks and rivers are not constrained by artificial dams created by the gridding of the landform. The accuracy of the data is addressed in the user's guide as follows:

> *The elevation error for DEM-H is difficult to characterize. In general, it will be similar to the raw SRTM 1 second data, with 90% of tested heights within 9.8m for Australia, but significant changes to the elevation have occurred due to the smoothing and drainage enforcement process.*

Catchments and reaches were delineated by using the tools within HEC-HMS. Break points and boundaries were introduced at points of interest, such as the locations of gauges on the creeks, the BP Dam, and the site. The resulting hydrological model is shown in Map 2. The catchment characteristics are summarized in Table 2.

Table 2: Summary of catchment characteristics

Catchment label	Feature	Area (km²)
C01	Reports to BP Dam	1682.2
C02	Model sub-catchment downstream of confluence and adjacent to site	68.9
C03	Model catchment downstream of BP dam	0.9
C04	Model sub-catchment downstream of Gauge 136202D	0.4
136202D	Combines with 136213A and reports to Gauge 136202D	16.1
136213A	Reports to Gauge 136213A	633.4

3.5 Bjelke-Petersen Dam

3.5.1 Disclaimer

The following discussion is not intended to be a formal review or critique of the Emergency Action Plan (EAP) for the Bjelke-Petersen dam. The discussion describes how the information in the EAP has been interpreted to provide inputs to the hydrological modelling for this assessment. The outcomes of the hydrological modelling for this assessment might differ from the outcomes of the hydrological modelling for the EAP. Readers should not apply the outcomes of this assessment to matters related to the design, or to safety assessments of the Bjelke-Petersen dam. Where there was a need to interpret the EAP, the inputs selected for this assessment were those that were expected to provide the greatest flows at the Murgon Limestone Mine site.

[6] Elvis (fsdf.org.au)

3.5.2 Major dimensions

The major hydrological dimensions of the Bjelke-Petersen dam were acquired from the Emergency Action Plan (EAP) – Bjelke- Petersen Dam (ID 219), Issue 7.3, September 2021. These dimensions are summarized in Table 3.

The EAP includes a stage-storage or stage-elevation curve as shown in Figure 1 which was used in the HEC-HMS model.

The EAP includes a discharge curve for the dam spillway, which is shown in Figure 2. There is a difference between the curve in Figure 2 and the spillway capacity at DCL in Table 3. The curve in Figure 2 indicates that the spillway capacity is about 3,800m³/s at DCL (315.60mAHD), but Table 3 indicates it is 4,920m³/s at DCL. We have not attempted to reconcile this difference but have adjusted the discharge curve by applying a multiplier factor to yield a discharge of 4,920m³/s at DCL, as shown in Figure 3.

Table 3: Major hydrological dimensions of Bjelke-Petersen Dam

Description	Specification
Main dam type	Central core earth and rock-fill
Full supply level (FSL)	307.30 mAHD
Historical recorded max storage – Jan 2011	311.819 m AHD
Storage capacity at FSL	137,900ML
Storage area at FSL	2,250ha
Dam crest level (DCL)	315.60 mAHD
Dam length	550m Original 620 Stage 1
Top of crest wall	Dam crest level (DCL) 317.45 mAHD
Spillway type	Un-gated concrete ogee crest spillway chute and dissipator
Spillway crest level	307.30 m AHD
Spillway capacity at DCL	4,920 m³/s (425,088 ML/d)
Spillway crest length	80m
Outlet description	Irrigation and river outlets – 2400mm concrete-lined mild steel pipe with a 900mm offtake to Joe Sippel Weir and 2 x 2100mm offtakes to Barker Creek
Outlet control	Each offtake controlled by fixed cone dispersion valves and isolated by butterfly valves

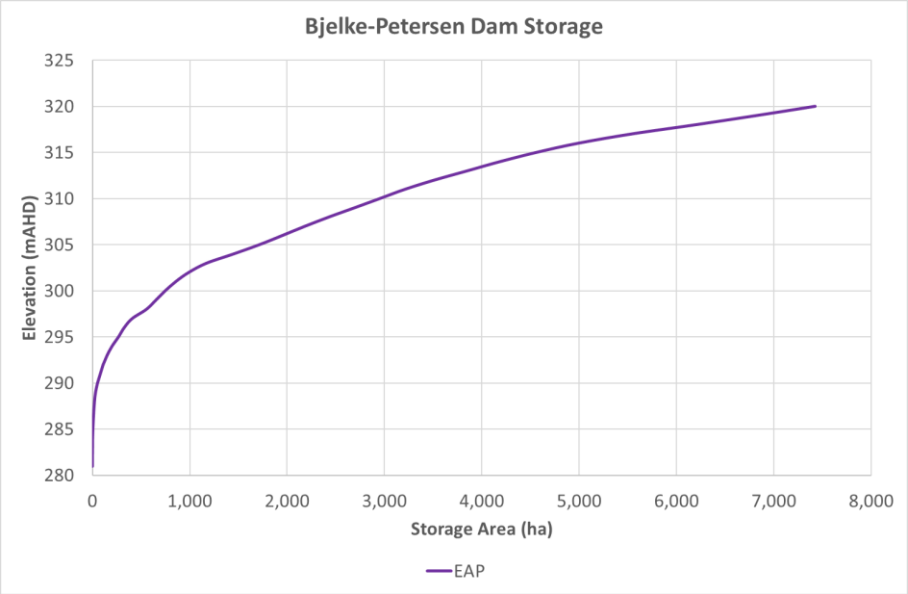

Figure 1: Elevation-Area curve for Bjelke-Petersen Dam, from EAP

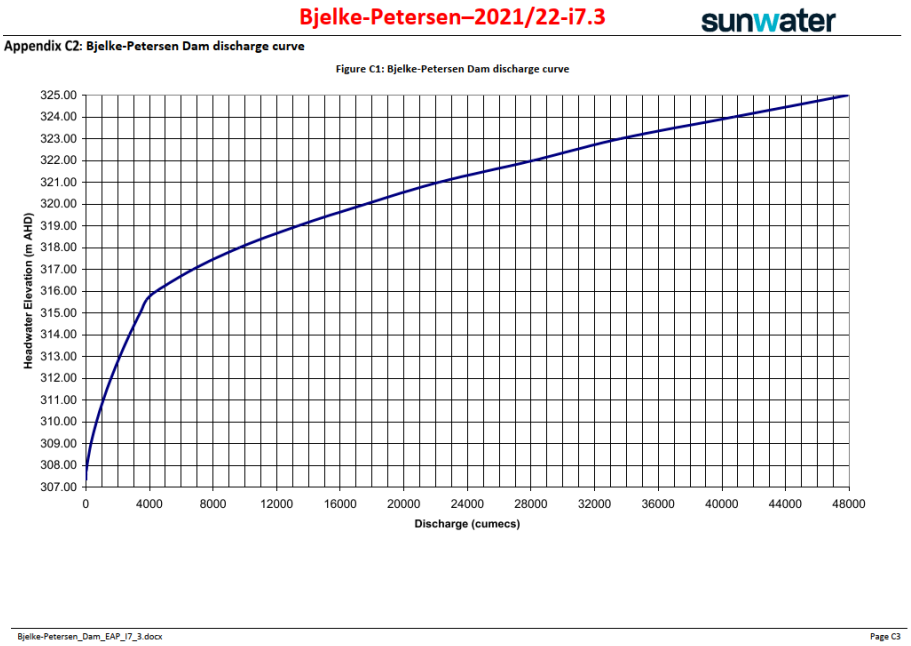

Figure 2: Bjelke-Petersen Dam discharge curve from the EAP

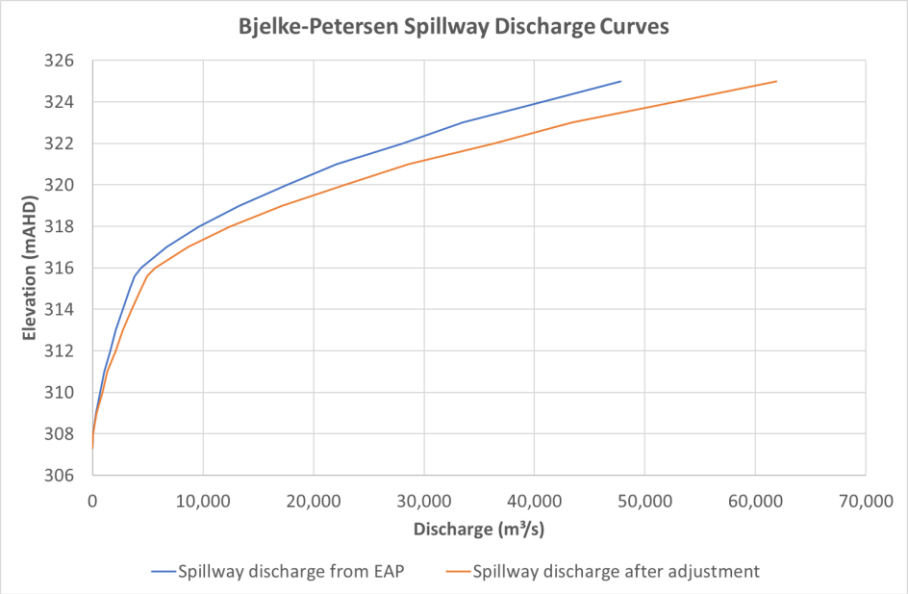

Figure 3: Bjelke-Petersen Discharge Curves used in the hydrological modelling

3.5.3 Design capacity of the spillway

Section 3.1 of the EAP describes the development of the design capacity of the spillway, as follows:

> *The Bjelke-Petersen Dam was originally constructed in 1988. Additional works (Stage 1 Upgrade) involving the construction of a crest parapet wall, were carried out in 2007 as part of the spillway upgrade program to improve the discharge capacity of the dam to safely pass the 50% Probable Maximum Precipitation Design Flood (PMPDF) – flood event. This has subsequently been reassessed and the dam satisfies 100% Acceptable Flood Capacity (AFC) under a risk-based approach.*

Section 3.3 of the EAP provides further commentary on spillway capacity as follows:

> *A Comprehensive Risk Assessment (CRA) of the Dam was completed in June 2006, updated in October 2010 and after this a summary revision was completed in July 2012. That CRA concluded that the dam is capable of safely passing 50% of the acceptable flood capacity (standard-based assessment). A 50%AFC represents a 1:93,000 AEP flood (DCF) and is equivalent to the minimum standard Sunwater has set for all its major dams. The CRA further concluded that the current Stage 1 arrangement satisfies 100%AFC as determined by the Risk Assessment approach.*

The current assessment includes an estimate of the Probable Maximum Flood (PMF). The outcomes of the hydrological modelling indicate that the spillway headwater during PMF conditions will exceed the DCL. It must be noted that Sunwater's risk assessment uses a different design flood (50%AFC) than the PMF that is used in this assessment. As the PMF is greater than the 50%ACF used by Sunwater, the spillway headwater level exceeds the DCL. This does not necessarily indicate a fault in Sunwater's risk assessment because this assessment and Sunwater's assessment use different conditions. Further, this assessment and Sunwater's risk assessment address different concerns and use different criteria in estimating flows.

3.6 Hydrological modelling

3.6.1 Modelling strategy

Hydrological modelling has been undertaken using the hydrologic and hydraulic modelling software, HEC-HMS 4.10[7].

The model was calibrated and verified by comparing observed flow records at the gauges with computed flows at the gauge locations.

Catchment losses were represented by the Deficit and Constant loss model with a simple canopy. The addition of the canopy allows for the recovery of losses between rainfall by evaporation. The evaporation rates were calculated from the Longpaddock SILO daily series. All catchments were assigned a fraction impervious of zero.

Catchment response times were represented by the Variable Clark Unit Hydrograph transform functions. These functions vary catchment response times at each timestep in the simulation according to rainfall intensity using Tc and R curves that are derived from rain-on-grid modelling[8].

Links were represented as lag-links, which translate hydrographs without attenuation. Lag times were estimated by dividing the length of the link by an assumed velocity of 3m/s.

The BP Dam was represented as a reservoir with the major dimensions and elevation-area curve described in Section 0. Two losses were applied to the BP dam as follows:

- Evaporation losses, which were input as monthly averages from the Longpaddock SILO data; and
- Extraction losses to represent extractions for irrigation, which were input as a constant extraction rate.

Rainfall was applied to the catchments as follows:

- For calibration events, rainfall was calculated at the centroid of each catchment by applying a distance-weighting to all the rainfall gauges in the vicinity; and
- For long-term continuous simulation, rainfall was calculated at the centroid of each catchment by applying a distance-weighting to all the Longpaddock SILO data points in the vicinity.

3.7 Long-term continuous simulations

Two kinds of long-term simulations were used:

- 1995-2022 which uses rainfall data from the gauges and is based on the overlapping period of the rainfall and stream gauge records. This simulation provides a better representation of real, historic storms as it includes rainfall at hourly intervals; and
- 1889-2022 which uses the synthetic series generated from the Longpaddock SILO data points. This simulation is longer, but coarsely approximates historic storms because of the adjustments made to the rainfall at a daily, and sub-daily level. The longer period provides an improved estimate of 1%AEP flows and describes more events in which the flows are combined from the BP Dam spillway flows and Barambah Creek flows.

[7] HEC-HMS (army.mil)
[8] Creating Variable Clark Transform Method Parameters using the 2D Diffusion Wave Transform Method (army.mil)

3.8 Calibration of hydrological model

3.8.1 Calibration of catchment losses and transforms

Calibration was an iterative process that was developed as follows:

- Develop Tc and R curves from initial TUFLOW modelling
- Select major events and optimise parameters separately for each event (Optimisation used the tools in HEC-HMS to adjust all the relevant parameters simultaneously for each event to produce a best-fit between the observed and computed hydrographs). Examples of optimised events are shown in the graphics in Appendix C
- Process the results from the major events to calculate average values for losses and transforms
- Input average values into the hydrological model and run long term continuous simulations (LTCS); and
- Validate the results of long-term continuous simulation (LTCS) as described in Section 3.9 and adjust loss or transform parameters accordingly.

A snapshot of the calibrated model output is shown in Figure *4*, which shows a comparison between the observed and calculated flows at Gauge 136213A.

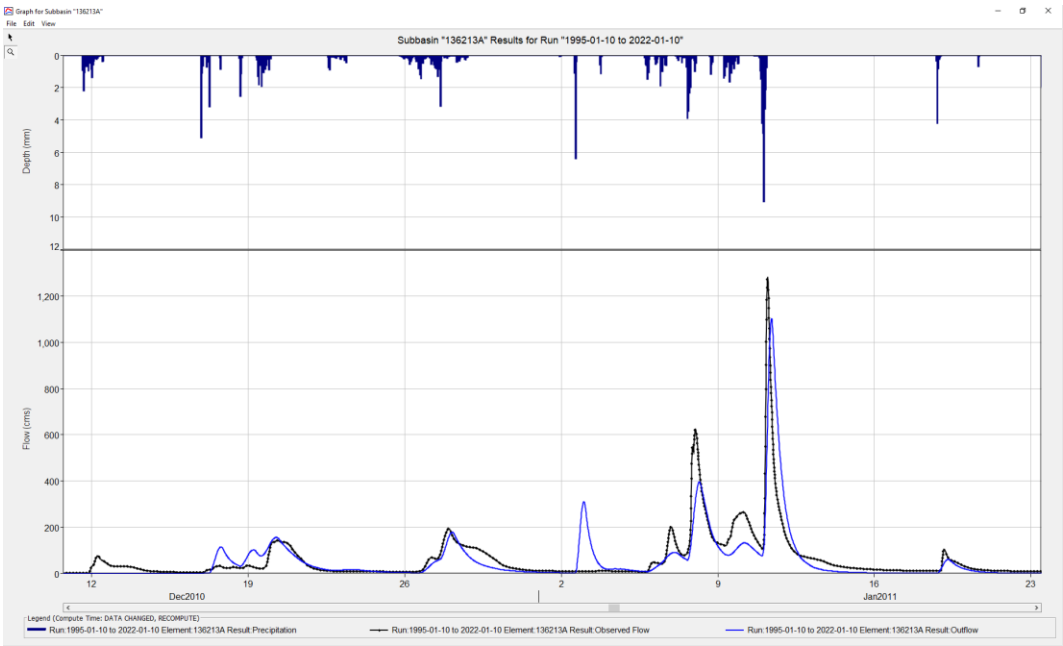

Figure 4: Extract from long-term continuous simulation at Gauge 136213A, comparing computed (blue) and observed (dotted black) flows

3.8.2 Calibration of dam extraction

The extraction rate was adjusted to yield a fair fit between the calculated and observed levels in the dam for the 1995-2022 simulation, as illustrated in Figure 5.

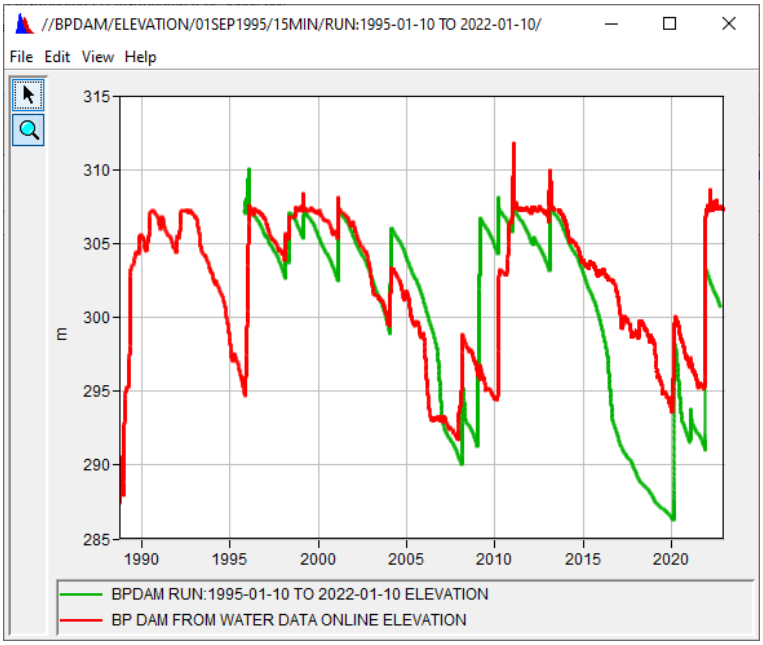

Figure 5: Results of long-term continuous simulation showing a comparison between observed and computed BP Dam levels

3.9 Validation of hydrological model

3.9.1 Validation at Gauge 136213A

A comparison of the total volumes of the 1995-2022 computed and observed simulations is shown in Table 4. This shows good agreement for the total volume of runoff at this gauge.

Table 4: Comparison of Computed and Observed flows at Gauge 136213A for the period 1995-2022

Type	Total volume (mm)	Total volume (1000m³)
Observed	1668	1,056,434
Computed	1684	1,066,774

The results of the 1995-2022 and 1889-2022 simulations for long-term continuous modelling were subject to a flood frequency analysis (FFA) which was compared to the FFA of the gauge record as shown in Figure 6. This plot is based on a Weibull statistical model, which provides the best fit to the Observed gauge data (the best fit is indicated by the lowest RMSE).

The results in Figure 6 show that the curvature of the 1995-2022 FFA compares fairly with the Observed FFA, although it tends to overestimate peak flows by about 40% to 50%. The 1889-2022 FFA has a similar curvature up to about 1.00E-02 (1%AEP) and it overestimates peak flows by up to about 120% at the frequent end of the spectrum (e.g., 1.00E-01, or 10%AEP).

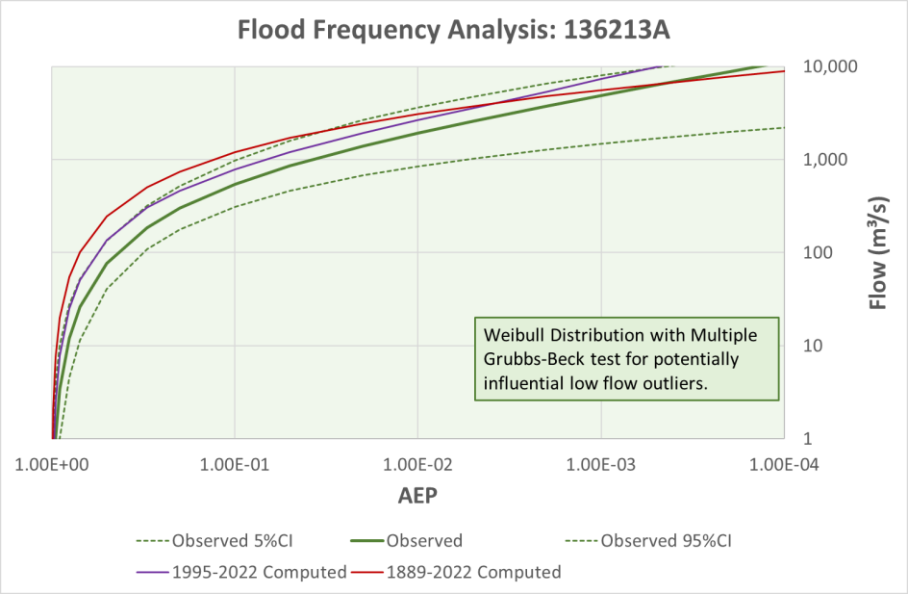

Figure 6: Comparison of flood frequency analyses for observed and computed at gauge 136213A

3.9.2 Validation at Gauge 136202d

A comparison of the total volumes of the 1995-2022 computed and observed simulations is shown in Table 5. This shows that the model under-estimates the total volume at this gauge by about 20%.

Table 5: Comparison of Computed and Observed flows at Gauge 136202A for the period 1995-2022

Type	Total volume (mm)	Total volume (1000m³)
Observed	2099	1,363,205
Computed	1688	1,096,309

The results of the 1995-2022 and 1889-2022 simulations for long-term continuous modelling were subject to a flood frequency analysis (FFA) which was compared to the FFA of the gauge record as shown in Figure 7. This plot is based on a LPIII statistical model, which provides the best fit to the Observed gauge data.

The results in Figure 7 show that the curvature of the 1995-2022 FFA varies from the Observed FFA. The 1995-2022 and 1889-2022 Computed peak flows agree closely with the Observed peak flow at 1.00E-02 (1%AEP) but overestimate the more frequent flows and under-estimate the more extreme flows.

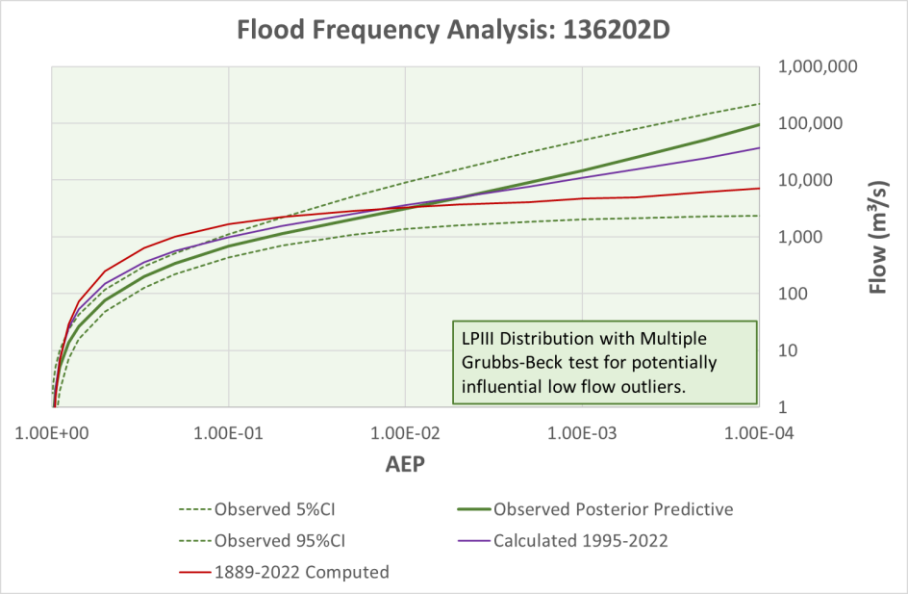

Figure 7: Comparison of flood frequency analyses for observed and computed at gauge 136202A

3.9.3 Bjelke-Petersen Dam

The dam's Emergency Access Plan notes that the historic high in the dam occurred in January 2011 at a level of 311.819mAHD. The hydrological model shows a high in Jan 2011 of about 311.65mAHD. This indicates that the model is approximating dam overflows, which then combine with the flows from Barambah Creek to form the design flows at the site.

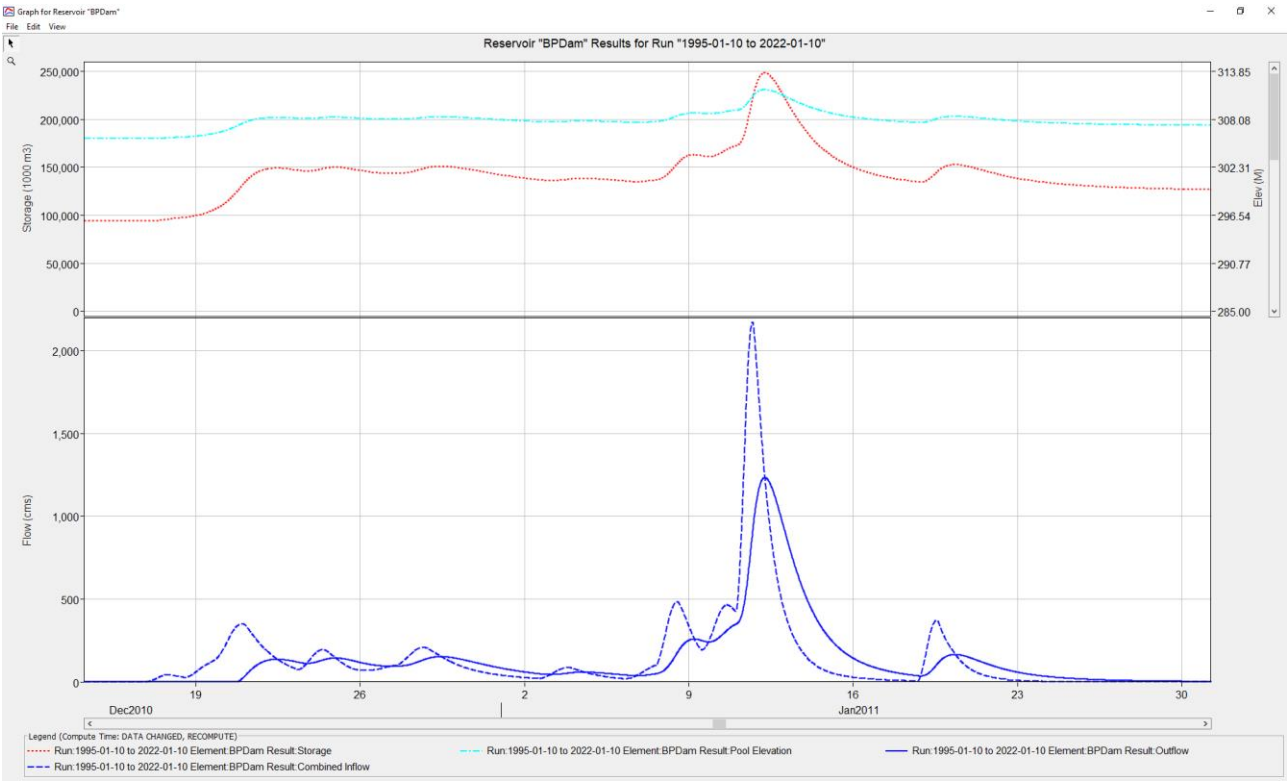

Figure 8: Computed storage, stage and flow at BP Dam in January 2011

3.9.4 ARR Temporal Patterns

A suite of 10 temporal patterns were downloaded from the ARR Data Hub website through the software program Storm Injector. The program then applies burst losses according to the ARR guideline for each catchment element in HEC-HMS.

Storm Injector was used to set up model runs in HEC-HMS to determine the critical 1%AEP flows for catchment 136213A. The resulting flows shown in Figure 9 indicate that the critical flow is equivalent to 1,278m³/s for a 24-hour storm duration.

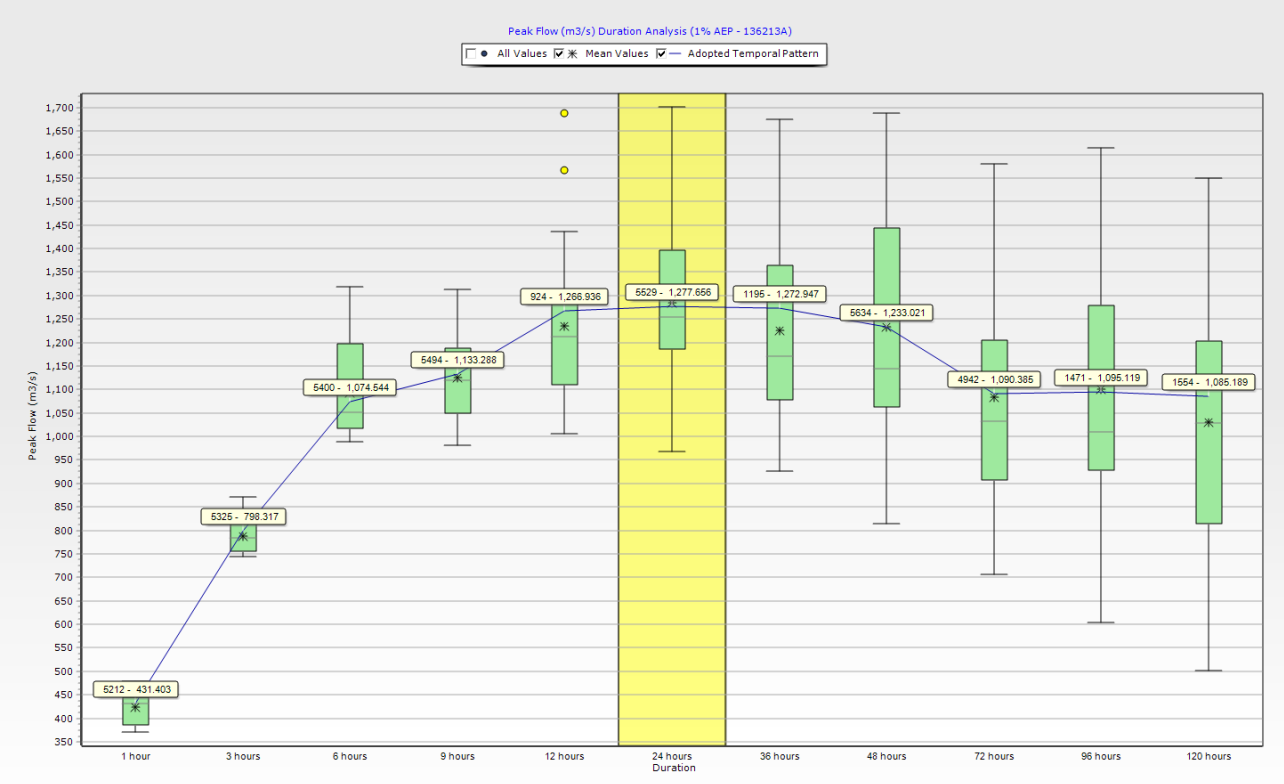

Figure 9: 1%AEP flows at Gauge 136213A

The resulting critical flow using the ARR temporal patterns was then compared to the FFA discussed in Section 3.9.1, and indicates this flow is lower than the estimated 1%AEP flow from the long-term continuous simulation. The result from the long-term continuous simulation is then used as this is expected to provide greatest flow at the mine site.

3.10 Estimation of dam break flows

This assessment used piping as a mode of failure because it is the failure mode described in the EAP. A sunny-day piping failure was estimated by assuming that the water elevation is at full supply level at the time of breach. Dam break parameters were estimated using the Froehlich 2016 equations and are summarised in Table 6.

Table 6: Dam break parameters

Breach width	**118m**
Breach time	113.75mins
Peak flow rate	11,690m³/s

The resulting hydrograph was used as input to the hydraulic model further discussed in Section 0 and is shown in Figure 10.

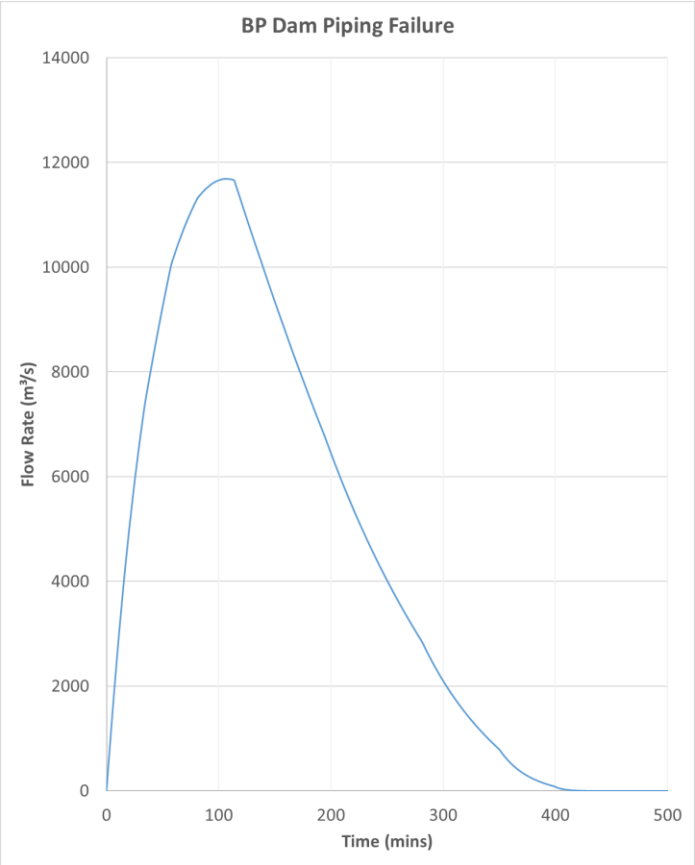

Figure 10: Dam break hydrograph

4. Hydraulic Modelling

4.1 Analysis

Hydraulic modelling used HEC-RAS[9] software. The hydraulic model is a two-dimensional model with model extents shown in Map 3 and the following parameters and features:

- The terrain model was based on the 1-metre digital elevation model (DEM) downloaded from the ELVIS elevation data portal. Tiles used were *KingaroytoMurgon_2011_Rgn_SW_399000_7092000_1K_DEM_1m* etc.
    - The terrain for the existing case used the unaltered ELVIS terrain
    - The terrain for the developed case altered the ELVIS terrain by raising ground levels around the perimeter of the Abandonment Bund. This is a conservative approach that prevents all floodwaters from crossing the bund, which might not be the case, and so represents the greatest likely impacts of the Abandonment Bund on flooding
- The extent of the 2D domain is shown in Map 3. The typical cell size was 20x20m. Break lines were used to align cell edges to major features, such as bund walls and road embankments
- The inflow hydrographs were applied as boundary condition inflows at the following locations:
    - Barambah Creek
    - Barker Creek downstream of Bjelke-Petersen Dam spillway
- The downstream boundary condition was represented by a normal depth calculation with a slope of 0.018 (1.8%). The slope was calculated from the results of preliminary hydraulic runs
- The Manning's n value was 0.06
- Bridges and other hydraulic structures were not modelled in detail
- A variable computational interval was used, based on maintaining Courant numbers within the range of 0.4 to 0.9
- Computational periods differed according to each event and were selected to extend to the falling limb of the hydrographs at the site; and
- The abandonment bund was represented in the model by a vertical wall placed on the alignment of the bund. This is a conservative approach that does not allow the abandonment bund to be overtopped. Overtopping would allow the mine void to be filled, which could lower flood levels outside the mine and reduce changes to flood levels. The model therefore represents a conservative approach that provides an upper bound estimate of flood levels and changes to flood levels. It also allows for further modifications to the height of the abandonment bund, should they be required at later stages of the PRCP.

[9] https://www.hec.usace.army.mil/software/hec-ras/

4.2 Flood scenarios

The flood scenarios included in the hydraulic modelling are summarised in Table 7.

Table 7: Hydraulic flood scenarios

Scenario	Existing	Developed	Notes
1%AEP	1%AEP with existing terrain	1%AEP after abandonment bund	Outputs include • Depths • Velocities • Change in depths • Rock protection
Probable maximum flood	PMF with existing terrain	PMF after abandonment bund	Critical duration PMF with BP Dam remaining intact
Sunny day failure	SDF with existing terrain	SDF after abandonment bund	Sunny Day Failure (SDF) dam break with no flows in Barambah Creek
Concurrent flood failure	CF with existing terrain	CF after abandonment bund	Dam break with concurrent flooding in Barambah Creek

4.3 Results

4.3.1 Mapping of model results

Appendix D includes the following maps:

Map 1: Site location

Map 2: Catchments and gauges

Map 3: Extent of hydraulic model

Map 4: 1%AEP with existing terrain flood depth

Map 5: 1%AEP after abandonment bund flood depth

Map 6: 1%AEP with existing terrain flood velocity

Map 7: 1%AEP after abandonment bund flood velocity

Map 8: 1%AEP changes to flood depths due to abandonment bund

Map 9: 1%AEP rock scour protection required at abandonment bund

Map 10: PMF with existing terrain flood depth

Map 11: PMF after abandonment bund flood depth

Map 12: SDF with existing terrain flood depth

Map 13: SDF after abandonment bund flood depth

Map 14: CF with existing terrain flood depth

Map 15: CF after abandonment bund flood depth; and

Map 16: Section view 1%AEP after abandonment bund.

4.3.2 Bjelke-Petersen Dam and Flood behaviour

Bjelke-Petersen Dam lies on Barker Creek to the south of the Site. There is a short remnant section of Barker Creek between the dam and the site. Barambah Creek lies to the east of the site in a broad valley and flows past the site in a westerly direction, towards Cherbourg, before entering a reach in which the valley narrows downstream of the site.

The dam burst scenarios show that water exits the Bjelke-Petersen dam, approaches the Site, and then splits. Some water flows westwards in the downstream direction of Barambah Creek towards Cherbourg and some flows eastwards in an upstream direction into the Barambah Creek valley towards Redgate. The extent of upstream travel and storage is indicated in the EAP for the Bjelke-Petersen Dam. The model used in this assessment does not include all the storage in the Barambah Creek valley as flows are not permitted to exit the northern boundary of the model, as shown in Map 3. This means that the storage in the model is less than the storage in the Barambah Creek valley, so the water levels in the model are expected to be higher than real levels. The model therefore represents a worst-case scenario that provides an upper bound estimate of levels and changes to flood levels.

4.3.3 Impacts of Abandonment Bund on flood levels

The modelling indicates that the Abandonment Bund encroaches into the 1%AEP flooded area of Barambah Creek. It therefore creates a further minor constriction on the northern bank of the creek in an area where the flood plain is already constricted, causing floodwaters to pond upstream in the Barambah Creek valley towards Redgate. The Abandonment Bund increases 1%AEP flood levels upstream by up to about 0.05m, and the increase extends up Barambah Creek to the limits of the model as shown in Map 8. As discussed previously, the model does not include all the storage available in the Barambah Creek valley upstream, so the estimated increase of 0.05m in flood levels is conservatively high and real increases may be less.

4.3.4 Impacts of flooding on abandonment bund

A map of the theoretical required size of rock protection was calculated from 1%AEP velocities as shown in Map 9. The mapping shows theoretical scour protection in the creek beds; however, it is not proposed to line creek beds with rock scour protection. The theoretical scour protection in the creek beds has been retained in the mapping for completeness and for comparison.

The distribution of theoretical rock scour protection in Map 9 shows that the abandonment bund does not require additional rock scour protection because velocities are too low. The material forming the bund, which comprises rock, is expected to provide more than sufficient scour protection to the bund.

5. DES Queries

5.1 How the final landform will maintain a stable condition under flooding

Modelling of the 1%AEP, PMF and dam failure flooding events provides quantitative information relating to flood levels and velocities around the final landform of the abandonment bund. The results of the modelling indicate that additional rock protection is not required for the abandonment bund and that material forming the bund, which comprises rock, is expected to provide more than sufficient scour protection to the bund.

5.2 Condition of abandonment bund

The dimensions of the abandonment bund have been determined by others, accounting for the properties of the material used in forming the bund. The height of the bund is limited by the lease boundary. Flood modelling indicates that the bund will not scour.

5.3 Potential for contaminant release to the environment in the event of mine void inundation

The modelling indicates that 1%AEP flood levels adjacent to the abandonment bund will vary from about 295.4mAHD to 295.8mAHD. A cross-section showing how these flood levels relate to the final landform is shown in Map 16.

The lowest section of the Abandonment Bund is within a remnant gully on the western face of the void, which has a crest elevation of about 287.0mAHD. Sections adjacent to the gully have a crest level of about 291.0mAHD. Comparing these levels with the 1%AEP flood levels shows that the abandonment bund will be overtopped.

The edge of the mine void is higher than the Abandonment Bund. The lowest crest levels on the edge are about 293.5mAHD. Comparing these levels with the 1%AEP flood levels shows that the pit edge will be overtopped, and 1%AEP floodwaters will enter the pit.

Overtopping of floodwater during 1%AEP events presents an opportunity for any contaminants that may be present within the pit void to be released into Barambah Creek. The scope of this hydraulic assessment does not extend to describing the nature or quantity of these potential contaminants or the likelihood for them to cause environmental harm.

5.4 Suitability of water in the void for stock use

The scope of this hydraulic assessment does not extend to describing the quality of water in the mine void or its suitability for stock use.

6. Conclusions and recommendations

The primary purpose of the modelling is to provide further information describing how flood flows may interact with the final landform, including the proposed abandonment bund. The impacts on flood flows around the mine site is a secondary issue. The alignment and dimensions of the abandonment bund have been determined by others, taking the constraints of the mine lease boundary into account.

The modelling uses conservative approaches to the estimation of flood flows, the height of the bund and the volume of flood storage in Barambah Creek to the effect that the estimated flood levels and velocities are at the upper limits of real flood levels and velocities. The modelling therefore represents a worst-case scenario for flood conditions around the abandonment bund and it allows for further adjustment of the alignment and dimensions of the abandonment bund in later stages of detailed design and construction. Such changes might include enlarging the bund, or moving it upslope and closer to the pit crest. The outcomes of current modelling with respect to the impacts of the bund, would still be conservative.

The Abandonment Bund will be affected by 1%AEP floodwaters, but velocities at the bund are low and do not require additional rock scour protection. The material forming the bund is expected to comprise waste rock, which will be more than sufficient to resist scour forces.

The Abandonment Bund and edge of pit void will be overtopped by 1%AEP floodwaters, as indicated in Map 16, which presents an opportunity for any contaminants that may be present within the pit void to be released into Barambah Creek. The nature or quantity of these potential contaminants, or the likelihood for them to cause environmental harm, is not addressed in this report.

The Abandonment Bund will affect 1%AEP flood levels around the mine site, although the approach to modelling presented here over-emphasises these impacts. . According to the worst-case scenario represented in the model, the 1%AEP flood levels could be increased by up to about 0.05m upstream. The actual increase in flood levels is likely to be lower because the mitigating effects of bund overtopping, and further storage upstream have not been represented fully in the model. Because of the flooding properties of Barambah Creek, the increase in flood depth is uniformly distributed along Barambah Creek upstream of the site.

Glossary

Appendix A

pitt&sherry

CHAPTER 14

Terminology

In a nutshell

The acronyms and glossary of relevant terms is provided below. If using this handbook within their jurisdiction, States and Territories may wish to provide a list of jurisdictional terms where they differ from this handbook.

14.1 Acronyms

AAD	average annual damage
AEP	annual exceedance probability
AHD	Australian height datum
ARI	average recurrence interval
DFE	defined flood event
FME	floodplain management entity
FPL	flood planning level
KPI	key performance indicator
PMF	probable maximum flood
PMP	Probable maximum precipitation

14.2 Glossary

Annual exceedance probability (AEP)

The likelihood of the occurrence of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood flow of 500 m3/s has an AEP of 5%, it means that there is a 5% chance (that is, a one-in-20 chance) of a flow of 500 m^3/s or larger occurring in any one year (see also *average recurrence interval, flood risk, likelihood of occurrence, probability*).

Astronomical tide

The variation in sea level caused by the gravitational effects of (principally) the moon and sun. It includes highest and lowest astronomical tides (HAT and LAT) occur when relative alignment and distance of the sun and moon from the earth are 'optimal'. Water levels approach to within 20 cm of HAT and LAT twice per year around mid-summer and mid-winter 'king tides'.

Australian height datum (AHD)

A common national survey height datum as a reference level for defining reduced levels; 0.0 m AHD corresponds approximately to sea level.

Average annual damage (AAD)

Depending on its size (or severity), each flood will cause a different amount of flood damage to a flood-prone area. AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time. If the damage associated with various annual events is plotted against their probability of occurrence, the AAD is equal to the area under the consequence–probability curve. AAD provides a basis for comparing the economic effectiveness of different management measures (i.e. their ability to reduce the AAD).

Average recurrence interval (ARI)

A statistical estimate of the average number of years between the occurrence of a flood of a given size or larger than the selected event. For example, floods with a flow as great as or greater than the 20-year ARI (5% AEP) flood event will occur, on average, once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event (see also *annual exceedance probability*).

Catchment

The area of land draining to a particular site. It is related to a specific location, and includes the catchment of the main waterway as well as any tributary streams.

Catchment flooding

Flooding due to prolonged or intense rainfall (e.g. severe thunderstorms, monsoonal rains in the tropics, tropical cyclones). Types of catchment flooding include riverine, local overland and groundwater flooding.

Chance

The likelihood of something happening that will have beneficial consequences (e.g. the chance of a win in a lottery). Chance is often thought of as the 'upside of a gamble' (Rowe 1990) (see also *risk*).

Coastal flooding

Flooding due to tidal or storm-driven coastal events, including storm surges in lower coastal waterways. This can be exacerbated by wind-wave generation from storm events.

Consent authority

The authority or agency with the legislative power to determine the outcome of development and building applications.

Consequence

The outcome of an event or situation affecting objectives, expressed qualitatively or quantitatively. Consequences can be adverse (e.g. death or injury to people, damage to property and disruption of the community) or beneficial.

Defined flood event (DFE)

The flood event selected for the management of flood hazard to new development. This is generally determined in floodplain management studies and incorporated in floodplain management plans. Selection of DFEs should be based on an understanding of flood behaviour, and the associated likelihood and consequences of flooding. It should also take into account the social, economic, environmental and cultural consequences associated with floods of different severities. Different DFEs may be chosen for the basis for reducing flood risk to different types of development. DFEs do not define the extent of the floodplain, which is defined by the PMF (see also *design flood, floodplain* and *probable maximum flood*).

Design flood

The flood event selected for the treatment of existing risk through the implementation of structural mitigation works such as levees. It is the flood event for which the impacts on the community are designed to be limited by the mitigation work. For example, a levee may be designed to exclude a 2% AEP flood, which means that floods rarer than this may breech the structure and impact upon the protected area. In this case, the 2% AEP flood would not equate to the crest level of the levee, because this generally has a freeboard allowance, but it may be the level of the spillway to allow for controlled levee overtopping (see also *annual exceedance probability, defined flood event, floodplain, freeboard* and *probable maximum flood*).

Development

Development may be defined in jurisdictional legislation or regulation. This may include erecting a building or carrying out of work, including the placement of fill; the use of land, or a building or work; or the subdivision of land.

Infill development refers to the development of vacant blocks of land within an existing subdivision that are generally surrounded by developed properties and is permissible under the current zoning of the land. Conditions such as minimum floor levels may be imposed on infill development.

New development is intensification of use with development of a completely different nature to that associated with the former land use or zoning (e.g. the urban subdivision of an area previously used for rural purposes). New developments generally involve rezoning, and associated consents and approvals. It may require major extensions of existing urban services, such as roads, water supply, sewerage and electric power.

Redevelopment refers to rebuilding in an existing developed area. For example, as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either rezoning or major extensions to urban services.

Ecologically sustainable development

Using, conserving and improving natural resources so that ecological processes on which life depends are maintained, and the total quality of life – now and in the future – can be maintained or increased.

Effective warning time

The effective warning time available to a flood-prone community is equal to the time between the delivery of an official warning to prepare for imminent flooding and the loss of evacuation routes due to flooding. The effective warning time is typically used for people to self-evacuate, to move farm equipment, move stock, raise furniture, and transport their possessions.

Existing flood risk

The risk a community is exposed to as a result of its location on the floodplain.

Flash flood

Flood that is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. It is generally not possible to issue detailed flood warnings for flash flooding. However, generalised warnings may be possible. It is often defined as flooding that peaks within six hours of the causative rain.

Flood

Flooding is a natural phenomenon that occurs when water covers land that is normally dry. It may result from coastal or catchment flooding, or a combination of both (see also *catchment flooding* and *coastal flooding*).

Flood awareness

An appreciation of the likely effects of flooding, and a knowledge of the relevant flood warning, response and evacuation procedures. In communities with a high degree of flood awareness, the response to flood warnings is prompt and effective. In communities with a low degree of flood awareness, flood warnings are liable to be ignored or misunderstood, and residents are often confused about what they should do, when to evacuate, what to take with them and where it should be taken.

Flood damage

The tangible (direct and indirect) and intangible costs (financial, opportunity costs, clean-up) of flooding. Tangible costs are quantified in monetary terms (e.g. damage to goods and possessions, loss of income or services in the flood aftermath). Intangible damages are difficult to quantify in monetary terms and include the increased levels of physical, emotional and psychological health problems suffered by flood-affected people that are attributed to a flooding episode.

Flood education

Education that raises awareness of the flood problem, to help individuals understand how to manage themselves and their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.

Flood emergency management plan

A step-by-step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of connected emergency operations. The objective is to ensure a coordinated response by all agencies having responsibilities and functions in emergencies.

Flood emergency management

Emergency management is a range of measures to manage risks to communities and the environment. In the flood context, it may include measures to prevent, prepare for, respond to and recover from flooding.

Flood fringe areas

The part of the floodplain where development could be permitted, provided the development is compatible with flood hazard and appropriate building measures to provide an adequate level of flood protection to the development. This is the remaining area affected by flooding after flow conveyance paths and flood storage areas have been defined for a particular event (see also *flow conveyance areas* and *flood storage areas*).

Flood hazard

Potential loss of life, injury and economic loss caused by future flood events. The degree of hazard varies with the severity of flooding and is affected by flood behaviour (extent, depth, velocity, isolation, rate of rise of floodwaters, duration), topography and emergency management.

Floodplain

An area of land that is subject to inundation by floods up to and including the probable maximum flood event – that is, flood-prone land.

Floodplain management entity (FME)

The authority or agency with the primary responsibility for directly managing flood risk at a local level.

Floodplain management plan

A management plan developed in accordance with the principles and guidelines in this handbook, usually includes both written and diagrammatic information describing how particular areas of flood-prone land are to be used and managed to achieve defined objectives. It outlines the recommended ways to manage the flood risk associated with the use of the floodplain for various purposes. It represents the considered opinion of the local community and the floodplain management entity on how best to manage the floodplain, including consideration of flood risk in strategic land-use planning to facilitate development of the community.

It fosters flood warning, response, evacuation, clean-up and recovery in the onset and aftermath of a flood, and suggests an organisational structure for the integrated management for existing, future and residual flood risks. Plans need to be reviewed regularly to assess progress and to consider the consequences of any changed circumstances that have arisen since the last review.

Flood planning area

The area of land below the flood planning level, and is thus subject to flood-related development controls.

Flood planning level (FPL)

The FPL is a combination of the defined flood levels (derived from significant historical flood events or floods of specific annual exceedance probabilities) and freeboards selected for floodplain management purposes, as determined in management studies and incorporated in management plans.

Flood-prone land

Land susceptible to flooding by the probably maximum flood event. Flood-prone land is synonymous with the floodplain. Floodplain management plans should encompass all flood-prone land rather than being restricted to areas affected by defined flood events.

Flood proofing of buildings

A combination of measures incorporated in the design, construction and alteration of individual buildings or structures that are subject to flooding, to reduce structural damage and potentially, in some cases, reduce contents damage.

Flood readiness

An ability to react within the effective warning time (see also *flood awareness* and *flood education*).

Flood risk

The potential risk of flooding to people, their social setting, and their built and natural environment. The degree of risk varies with circumstances across the full range of floods. Flood risk is divided into three types – existing, future and residual.

Flood severity

A qualitative indication of the 'size' of a flood and its hazard potential. Severity varies inversely with likelihood of occurrence (i.e. the greater the likelihood of occurrence, the more frequently an event will occur, but the less severe it will be). Reference is often made to major, moderate and minor flooding (see also *minor, moderate and major flooding*).

Flood storage areas

The parts of the floodplain that are important for temporary storage of floodwaters during a flood passage. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas (see also *flow conveyance areas* and *flood fringe areas*).

Flood study

A comprehensive technical investigation of flood behaviour. It defines the nature of flood hazard across the floodplain by providing information on the extent, level and velocity of floodwaters, and on the distribution of flood flows. The flood study forms the basis for subsequent management studies and needs to take into account a full range of flood events up to and including the probable maximum flood.

Flow

The rate of flow of water measured in volume per unit time – for example, cubic metres per second (m^3/s). Flow is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).

Flow conveyance areas

Those areas of the floodplain where a significant flow of water occurs during floods. They are often aligned with naturally defined channels. Flow conveyance paths are areas that, even if only partially blocked, would cause a significant redistribution of flood flow or a significant increase in flood levels. They are often, but not necessarily, areas of deeper flow or areas where higher velocities occur, and can also include areas where significant storage of floodwater occurs.

Each flood has a flow conveyance area, and the extent and flood behaviour within flow conveyance areas may change with flood severity. This is because areas that are benign for small floods may experience much greater and more hazardous flows during larger floods (see also *flood fringe areas* and *flood storage areas*).

Freeboard

The height above the DFE or design flood used, in consideration of local and design factors, to provide reasonable certainty that the risk exposure selected in deciding on a particular DFE or design flood is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels and so on. Freeboard compensates for a range of factors, including wave action, localised hydraulic behaviour and levee settlement, all of which increase water levels or reduce the level of protection provided by levees. Freeboard should not be relied upon to provide protection for flood events larger than the relevant defined flood event of a design flood.

Freeboard is included in the flood planning level and therefore used in the derivation of the flood planning area (see also *defined flood event, design flood, flood planning area* and *flood planning level*).

Frequency

The measure of likelihood expressed as the number of occurrences of a specified event in a given time. For example, the frequency of occurrence of a 20% annual exceedance probability or five-year average recurrence interval flood event is once every five years on average (see also *annual exceedance probability, annual recurrence interval, likelihood* and *probability*).

Future flood risk

The risk that new development within a community is exposed to as a result of developing on the floodplain.

Gauge height

The height of a flood level at a particular gauge site related to a specified datum. The datum may or may not be the AHD (see also *Australian height datum*).

Habitable room

In a residential situation, a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom. In an industrial or commercial situation, it refers to an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.

Hazard

A source of potential harm or a situation with a potential to cause loss. In relation to this handbook, the hazard is flooding, which has the potential to cause damage to the community.

Hydraulics

The study of water flow in waterways; in particular, the evaluation of flow parameters such as water level, extent and velocity.

Hydrograph

A graph that shows how the flow or stage (flood level) at any particular location varies with time during a flood.

Hydrologic analysis

The study of the rainfall and runoff process, including the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.

Intolerable risk

A risk that, following understanding of the likelihood and consequences of flooding, is so high that it requires consideration of implementation of treatments or actions to improve understanding, avoid, transfer or reduce the risk.

Life-cycle costing

All of the costs associated with the project from the cradle to the grave. This usually includes investigation, design, construction, monitoring, maintenance, asset and performance management and, in some cases, decommissioning of a management measure.

Likelihood

A qualitative description of probability and frequency (see also *frequency* and *probability*).

Likelihood of occurrence

The likelihood that a specified event will occur. (With respect to flooding, see also *annual exceedance probability* and *average recurrence interval*).

Local overland flooding

Inundation by local runoff on its way to a waterway, rather than overbank flow from a stream, river, estuary, lake or dam. Can be considered synonymous with stormwater flooding.

Loss

Any negative consequence or adverse effect, financial or otherwise.

Mathematical and computer models

The mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.

Merit approach

The merit approach weighs social, economic, ecological and cultural impacts of land-use options for different flood-prone areas, together with flood damage, hazard and behaviour implications, and environmental protection and wellbeing of rivers and floodplains. This approach operates at two levels. At the strategic level, it allows for the consideration of flood hazard and associated social, economic, ecological and cultural issues in formulating statutory planning instruments, and development control plans and policies. At a site-specific level, it involves consideration of the best way of developing land in consideration of the zonings in a statutory planning instruments, and development control plans and policies.

Minor, moderate and major flooding

These terms are often used in flood warnings to give a general indication of the types of problems expected with a flood:

Probability

A statistical measure of the expected chance of flooding. It is the likelihood of a specific outcome, as measured by the ratio of specific outcomes to the total number of possible outcomes.

Probability is expressed as a number between zero and unity, zero indicating an impossible outcome and unity indicating an outcome that is certain. Probabilities are commonly expressed in terms of percentage. For example, the probability of 'throwing a six' on a single roll of a die is one in six, or 0.167 or 16.7% (see also *annual exceedance probability*).

Probable maximum flood (PMF)

The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from PMP and, where applicable, snow melt, coupled with the worst flood-producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood-prone land – that is, the floodplain. The extent, nature and potential consequences of flooding associated with a range of events rarer than the flood used for designing mitigation works and controlling development, up to and including the PMF event, should be addressed in a floodplain risk management study.

Probable maximum precipitation (PMP)

The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given-size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (WMO 1986). It is the primary input to probable maximum flood estimation.

Rainfall intensity

The rate at which rain falls, typically measured in millimetres per hour (mm/h). Rainfall intensity varies throughout a storm in accordance with the temporal pattern of the storm (see also *temporal pattern*).

Residual flood risk

The risk a community is exposed to that is not being remedied through established risk treatment processes. In simple terms, for a community, it is the total risk to that community, less any measure in place to reduce that risk.

The risk a community is exposed to after treatment measures have been implemented. For a town protected by a levee, the residual flood risk is the consequences of the levee being overtopped by floods larger than the design flood. For an area where flood risk is managed by land-use planning controls, the residual flood risk is the risk associated with the consequences of floods larger than the DFE on the community.

Risk

'The effect of uncertainty on objectives' (ISO31000:2009). NOTE 4 of the definition in ISO31000:2009 also states that 'risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence'. Risk is based upon the consideration of the consequences of the full range of flood behaviour on communities and their social settings, and the natural and built environment (see also *likelihood* and *consequence*).

Risk analysis

The systematic use of available information to determine how often specified (flood) events occur and the magnitude of their likely consequences. Flood risk analysis is normally undertaken as part of a floodplain management study, and involves an assessment of flood levels and hazard associated with a range of flood events (see also *flood study*).

Risk management

The systematic application of management policies, procedures and practices to the tasks of identifying, analysing, assessing, treating and monitoring flood risk. Flood risk management is undertaken as part of a floodplain management plan. The floodplain management plan reflects the adopted means of managing flood risk (see also *floodplain management plan*).

Riverine flooding

Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam. Riverine flooding generally excludes watercourses constructed with pipes or artificial channels considered as stormwater channels.

Runoff

The amount of rainfall that drains into the surface drainage network to become stream flow; also known as rainfall excess.

Stage

Equivalent to water level. Both stage and water level are measured with reference to a specified datum (e.g. the Australian height datum).

Storm surge

The increases in coastal water levels above predicted astronomical tide level (i.e. tidal anomaly) resulting from a range of location dependent factors including the inverted barometer effect, wind and wave set-up and astronomical tidal waves, together with any other factors that increase tidal water level (see also *astronomical tide, wind set-up* and *wave set-up*).

Stormwater flooding

Is inundation by local runoff caused by heavier than usual rainfall. It can be caused by local runoff exceeding the capacity of an urban stormwater drainage systems, flow overland on the way to waterways or by the backwater effects of mainstream flooding causing urban stormwater drainage systems to overflow (see also *local overland flooding*).

Temporal pattern

The variation of rainfall intensity with time during a rainfall event.

Tidal anomaly

The difference between recorded storm surge levels and predicted astronomical tide level.

Treatment options

The measures that might be feasible for the treatment of existing, future and residual flood risk at particular locations within the floodplain. Preparation of a treatment plan requires a detailed evaluation of floodplain management options (see also *floodplain management plan*).

Velocity of floodwater

The speed of floodwaters, measured in metres per second (m/s).

Vulnerability

The degree of susceptibility and resilience of a community, its social setting, and the natural and built environments to flood hazards. Vulnerability is assessed in terms of ability of the community and environment to anticipate, cope and recover from flood events. Flood awareness is an important indicator of vulnerability (see also *flood awareness*).

Wave set-up

The increase in water levels in coastal waters (within the breaker zone) caused by waves transporting water shorewards. The zone of wave set-up against the shore is balanced by a zone of wave 'set-down' (i.e. reduced water levels) seawards of the breaker zone. Wave set-ups of 2–4 m could occur during tropical cyclones.

Wind set-up

The increase in water levels in coastal waters caused by the wind driving the water shorewards and 'piling it up' against the shore. Wind set-up can be as high as 10 m in an extreme case, and often exceeds 2–3 m in typical tropical cyclones.

IFD

Appendix B

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IFD Design Rainfall Intensity (mm/h)

Issued: 24/11/2022

Location Label:

Requested coordinate: Latitude -26.36636 Longitude 152.20926

Nearest grid cell: Latitude 26.36636 (S) Longitude 152.20926 (E)

Annual Exceedance Probability (AEP)

Duration	Duration in min	63.20%	50%	20%	10%	5%	2%	1%
1 min	1	135	153	208	243	277	321	353
2 min	2	112	127	171	200	227	259	281
3 min	3	105	119	161	188	214	244	266
4 min	4	101	114	154	180	205	235	257
5 min	5	96.6	109	148	173	197	227	249
10 min	10	79.6	90.4	123	144	164	190	210
15 min	15	67.6	76.7	105	123	140	162	179
20 min	20	58.8	66.7	90.9	107	122	141	156
25 min	25	52.1	59.1	80.5	94.5	108	125	138
30 min	30	46.9	53.2	72.3	84.9	96.9	112	124
45 min	45	36.3	41.1	55.8	65.5	74.6	86.3	95
1 hour	60	29.9	33.8	45.7	53.6	61.1	70.7	77.7
1.5 hour	90	22.4	25.3	34.1	39.9	45.5	52.6	57.9
2 hour	120	18.1	20.4	27.5	32.2	36.7	42.5	46.9
3 hour	180	13.4	15.1	20.3	23.7	27.1	31.5	34.8
4.5 hour	270	9.97	11.2	15	17.6	20.1	23.5	26.1
6 hour	360	8.09	9.07	12.2	14.3	16.4	19.3	21.5
9 hour	540	6.06	6.79	9.15	10.8	12.5	14.7	16.5
12 hour	720	4.95	5.56	7.52	8.91	10.3	12.3	13.8
18 hour	1080	3.74	4.21	5.75	6.86	8	9.59	10.8
24 hour	1440	3.07	3.47	4.77	5.72	6.71	8.07	9.16
30 hour	1800	2.64	2.98	4.13	4.98	5.85	7.06	8.02
36 hour	2160	2.32	2.63	3.67	4.43	5.23	6.32	7.19
48 hour	2880	1.9	2.16	3.03	3.68	4.36	5.28	6
72 hour	4320	1.42	1.61	2.28	2.79	3.31	4	4.55
96 hour	5760	1.14	1.3	1.84	2.24	2.66	3.21	3.65
120 hour	7200	0.955	1.09	1.54	1.86	2.21	2.66	3.02
144 hour	8640	0.824	0.938	1.31	1.58	1.87	2.25	2.55
168 hour	10080	0.725	0.823	1.14	1.37	1.6	1.93	2.19

Hydrological Calibration

Appendix C

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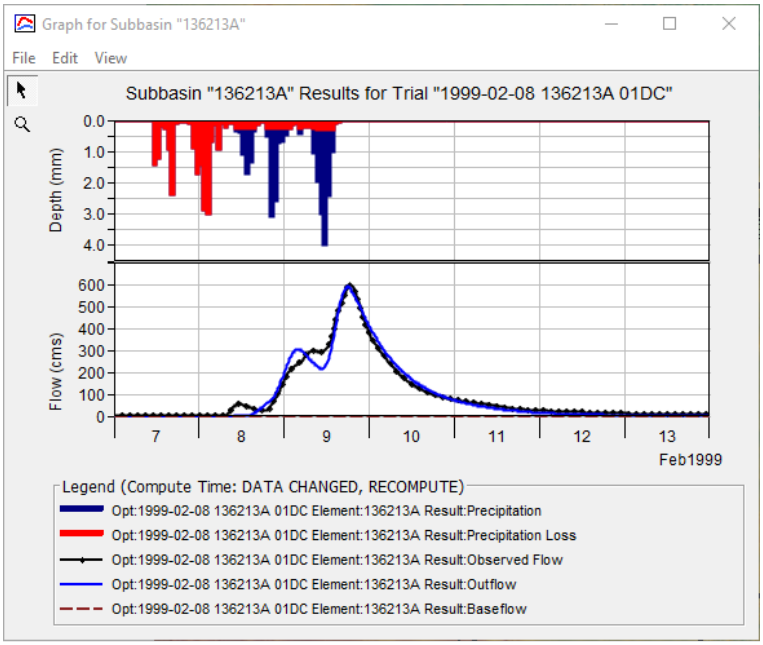

Figure 11: Example of optimization of event; 1999-02-08

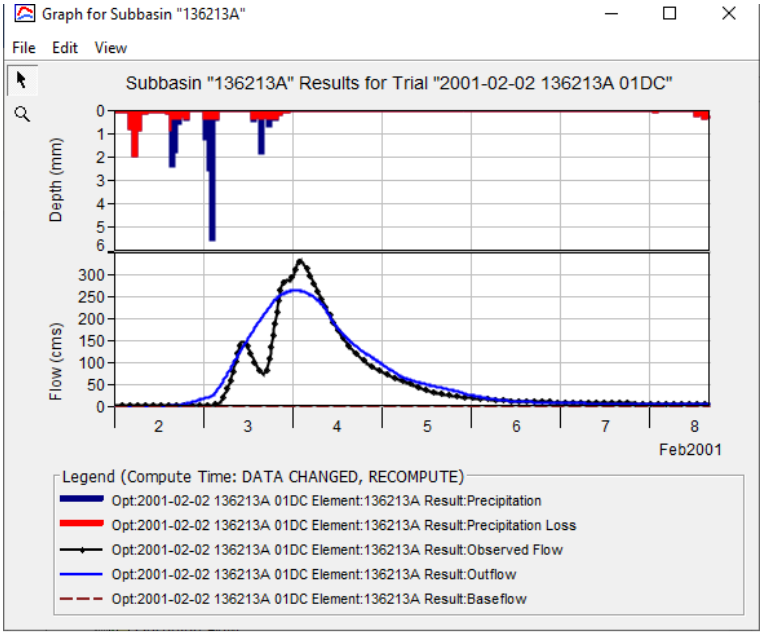

Figure 12: Example of optimization of event; 2001-02-02

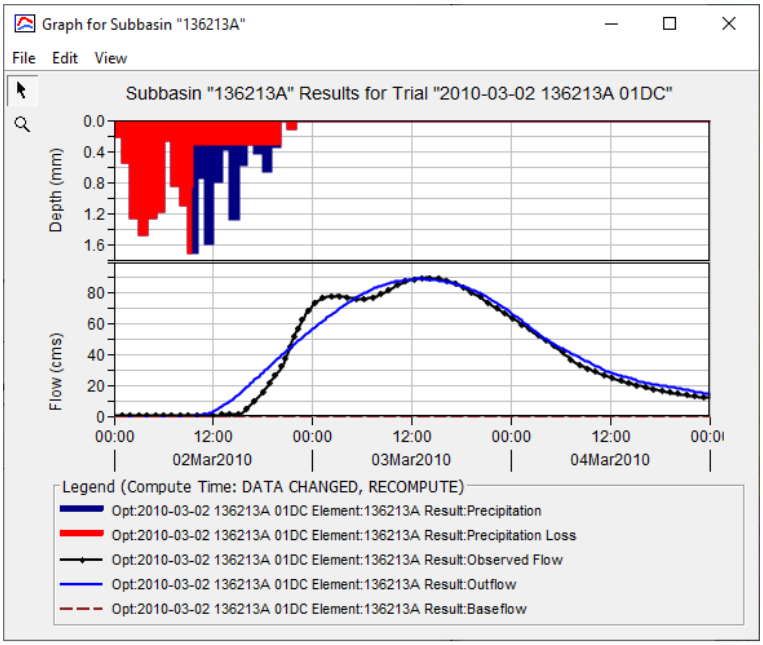

Figure 13: Example of optimization of event; 2010-03-02

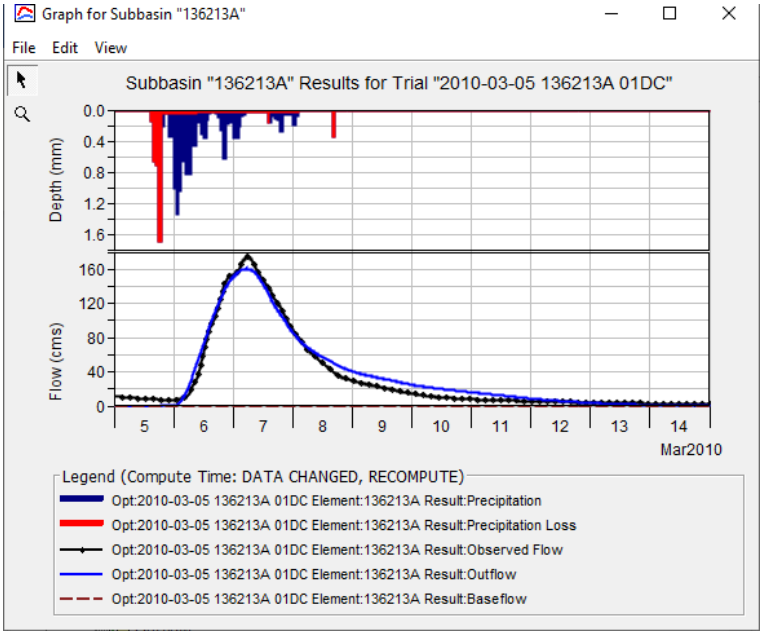

Figure 14: Example of optimization of event; 2010-03-05

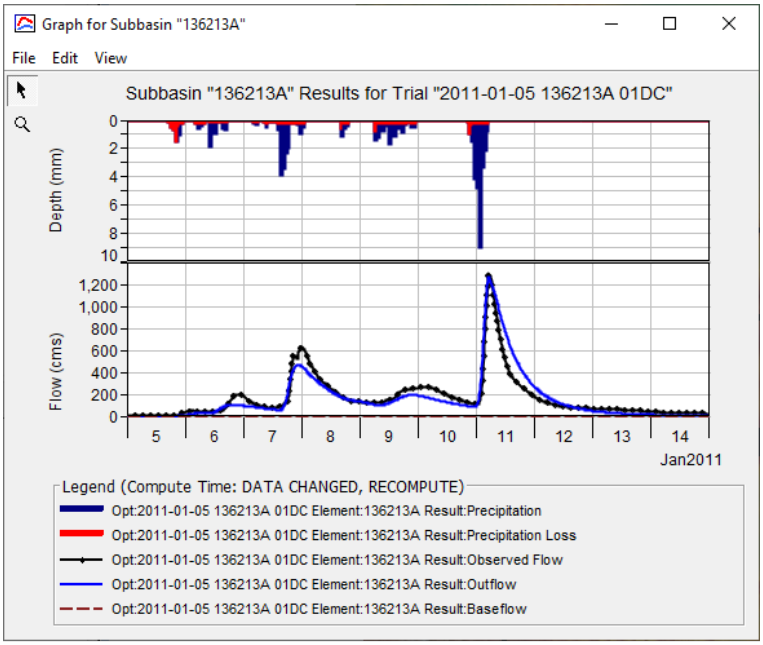

Figure 15: Example of optimization of event: 2011-01-05

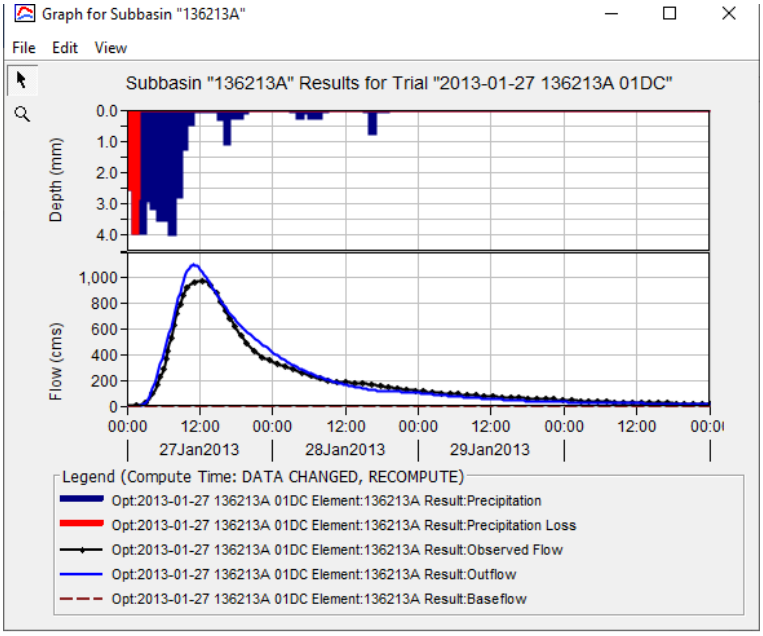

Figure 16: Example of optimization of event: 2013-01-27

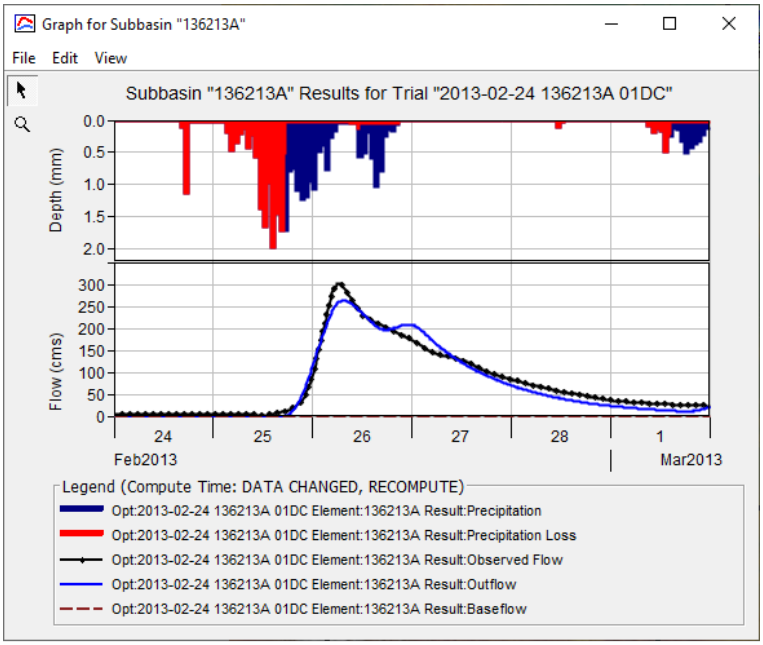

Figure 17: Example of optimization of event: 2013-02-24

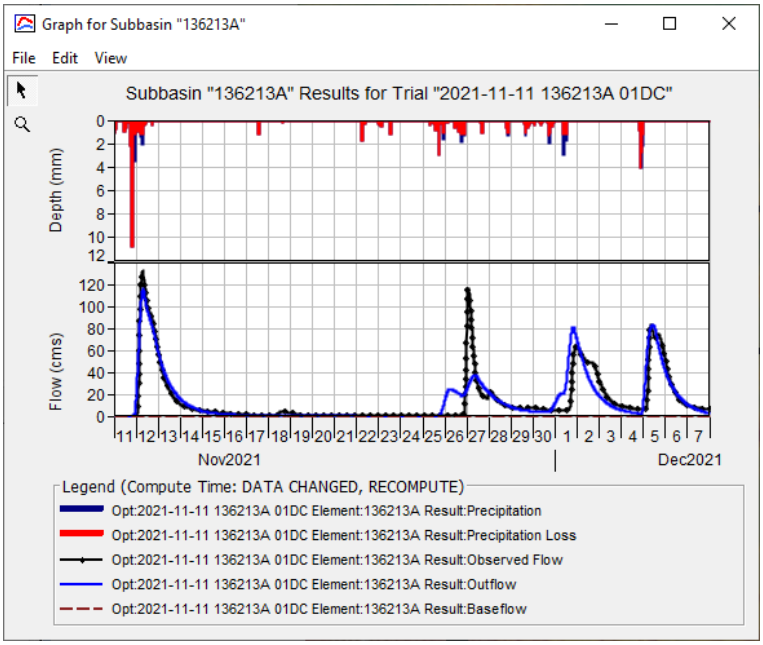

Figure 18: Example of optimization of event: 2021-11-11

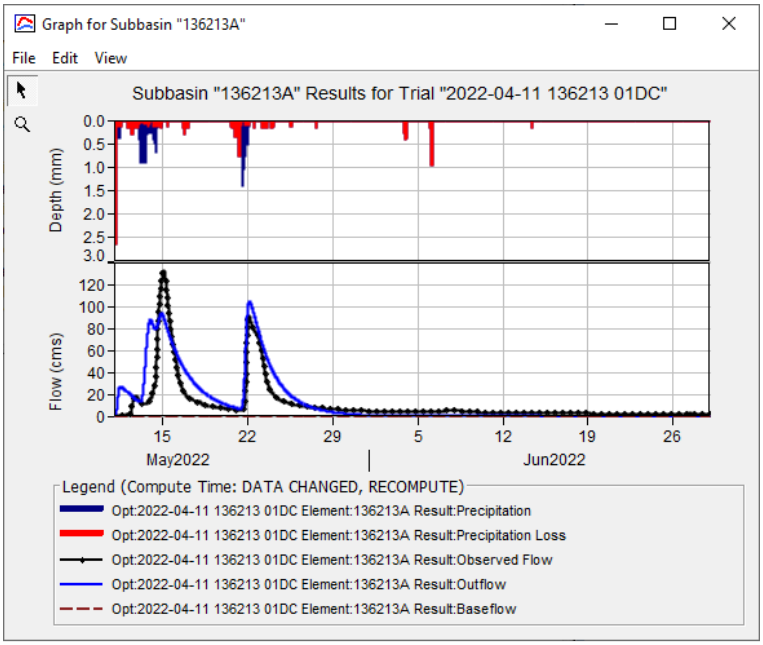

Figure 19: Example of optimization of event: 2022-04-11

Maps

Appendix D

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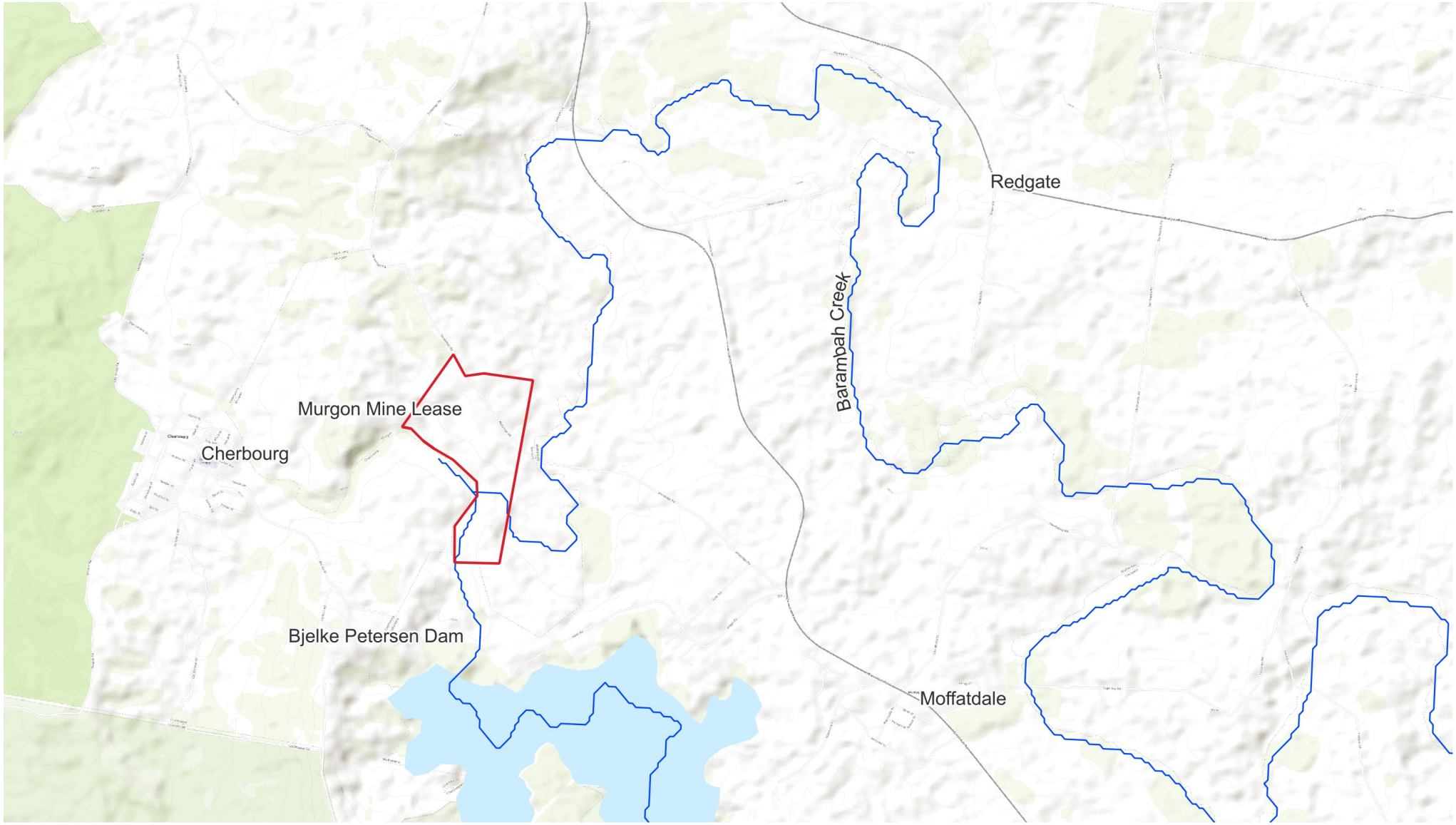

Map 01: Site Location

LEGEND — Mine lease boundary

Graymont (Australia)
Graymont Murgon Flood Modelling

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MAP REF:	P.22.1743.qgz
AUTHOR:	mjacobs
REVISION:	A
DATE:	01/03/2023

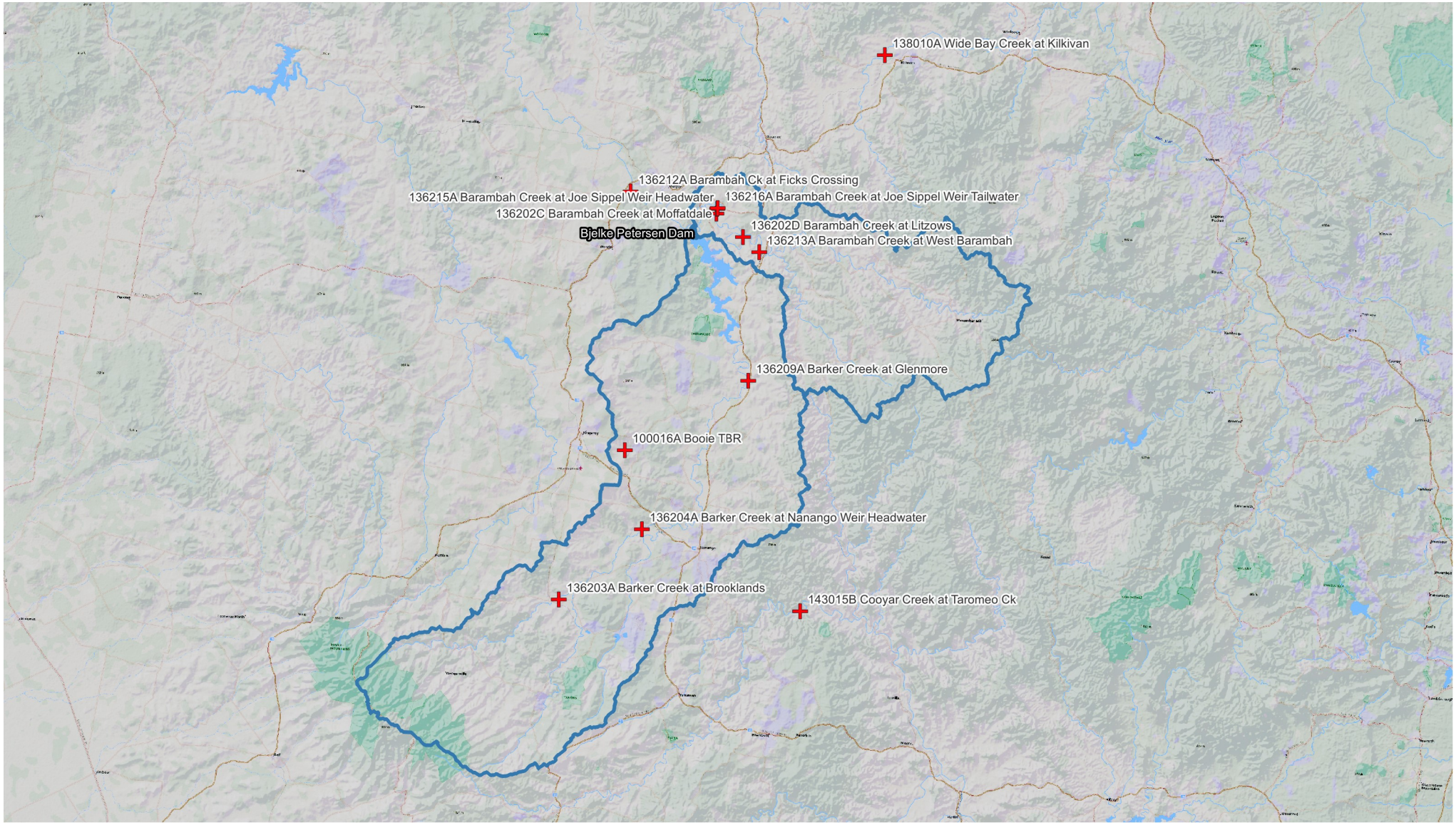
DATA SOURCES: Base map - Google Roads, Google Maps, ESRI World Topo

N

0 1 1 2 2 km

COORDINATE SYSTEM: GDA94 / MGA zone 56

SCALE @ A3: 1:30000



Map 02: Catchments and gauges

LEGEND Gauge locations Catchments

Graymont (Australia)
Graymont Murgon Flood Modelling

pitt&sherry

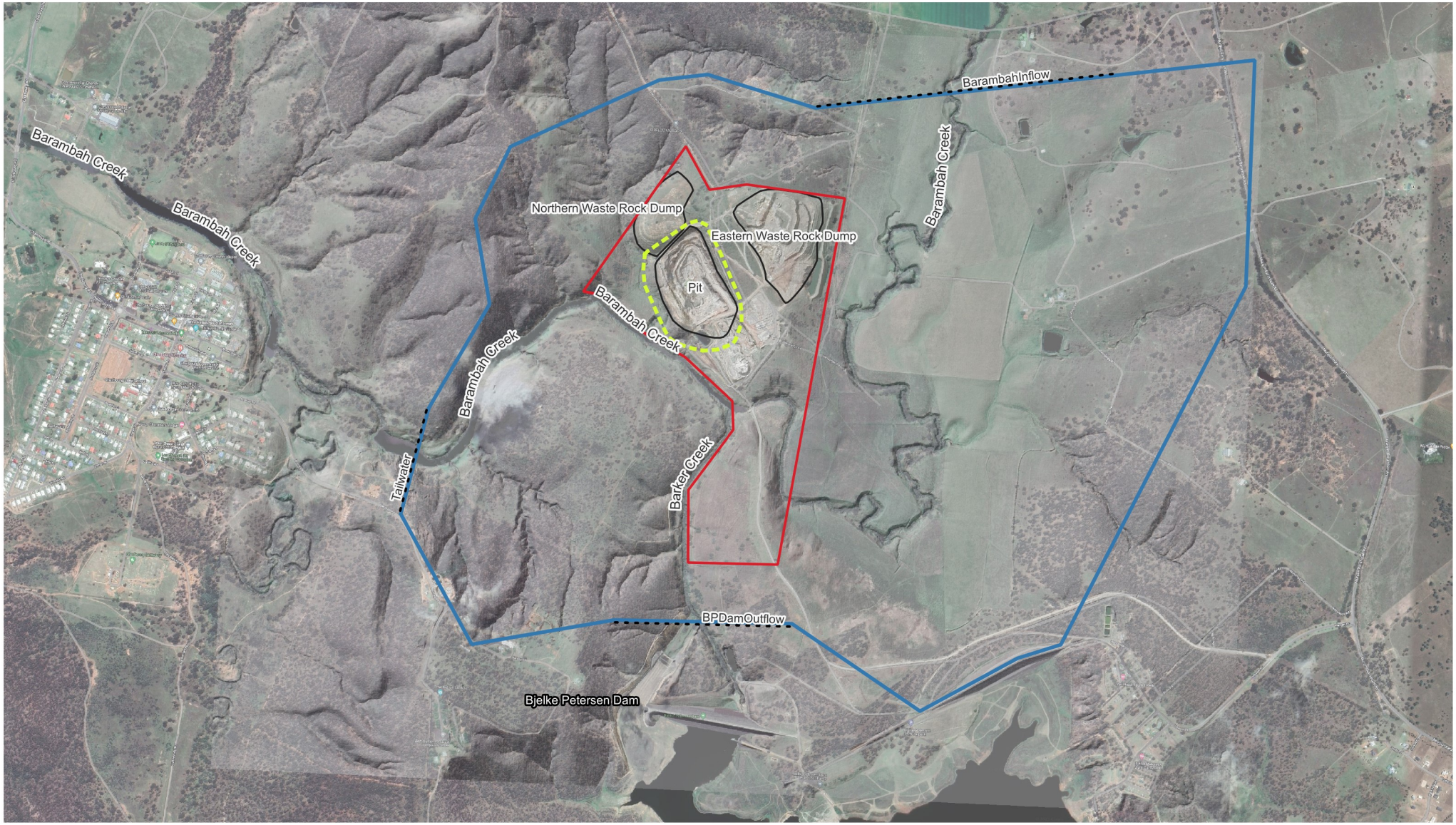
MAP REF:	P.22.1743.qgz
AUTHOR:	BHernandez
REVISION:	A
DATE:	28/02/2023

DATA SOURCES: Base map - ESRI National Geographic

N

0 10 20 30 40 km

COORDINATE SYSTEM: GDA94 / MGA zone 56
SCALE @ A3: 1:500000



Map 03: Extent of hydraulic model

LEGEND
- Footprints of final landforms
- Mine lease boundary
- Model extent
- Boundary conditions
- Abandonment Bund

Graymont (Australia)
Graymont Murgon Flood Modelling

pitt&sherry

MAP REF:	P.22.1743.qgz
AUTHOR:	mjacobs
REVISION:	A
DATE:	21/02/2023

DATA SOURCES: Base map - Google Satellite

N

0 300 600 900 1,200 m

COORDINATE SYSTEM: GDA94 / MGA zone 56

SCALE @ A3: 1:15000

Map 04: 1%AEP with existing terrain flood depth

Graymont (Australia)
Graymont Murgon Flood Modelling

pitt&sherry

LEGEND
- Bjelke Petersen Dam
- Footprints of final landforms
- Mine lease boundary

MAP REF: P.22.1743.qgz
AUTHOR: mjacobs
REVISION: A
DATE: 21/02/2023

DATA SOURCES: Base map - Google Satellite, QLD Cadastre Weekly

N

0 100 200 300 400 m

COORDINATE SYSTEM: GDA94 / MGA zone 56
SCALE @ A3: 1:5000

Map 05: 1%AEP after abandonment bund flood depth

Graymont (Australia)
Graymont Murgon Flood Modelling

pitt&sherry

LEGEND
- Bjelke Petersen Dam
- Footprints of final landforms
- Mine lease boundary
- Abandonment Bund

MAP REF: P.22.1743.qgz
AUTHOR: mjacobs
REVISION: A
DATE: 21/02/2023

DATA SOURCES: Base map - Google Satellite, QLD Cadastre Weekly

N

0 100 200 300 400 m

COORDINATE SYSTEM: GDA94 / MGA zone 56
SCALE @ A3: 1:5000

Map 06: 1%AEP with existing terrain flood velocity

Graymont (Australia)
Graymont Murgon Flood Modelling

pitt&sherry

LEGEND
- Bjelke Petersen Dam
- Footprints of final landforms
- Mine lease boundary

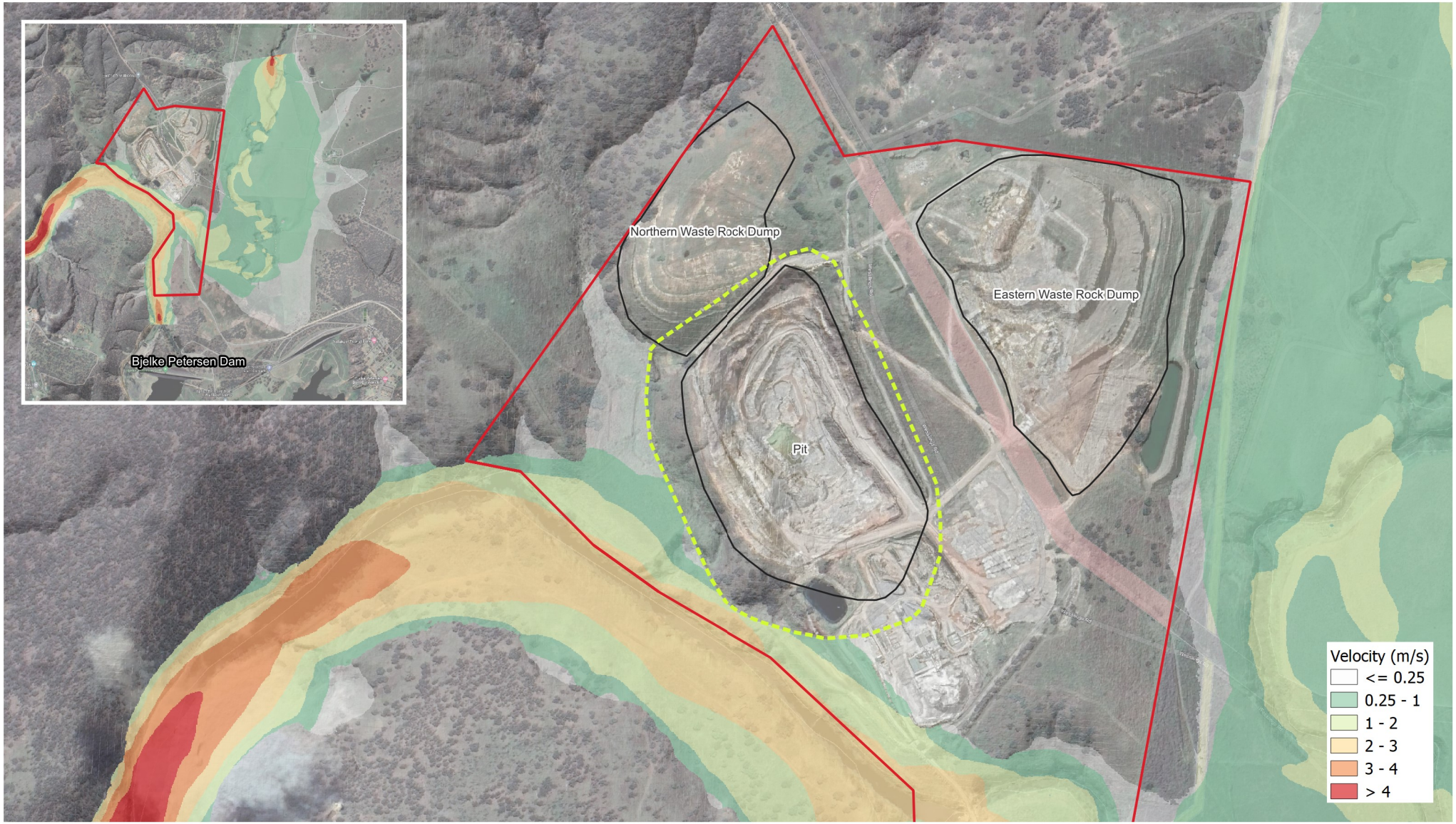
MAP REF: P.22.1743.qgz
AUTHOR: mjacobs
REVISION: A
DATE: 21/02/2023

DATA SOURCES: Base map - Google Satellite, QLD Cadastre Weekly

N

0 100 200 300 400 m

COORDINATE SYSTEM: GDA94 / MGA zone 56
SCALE @ A3: 1:5000



Map 07: 1%AEP after abandonment bund flood velocity

Graymont (Australia)
Graymont Murgon Flood Modelling

pitt&sherry

LEGEND
- Bjelke Petersen Dam
- Footprints of final landforms
- Mine lease boundary
- Abandonment Bund

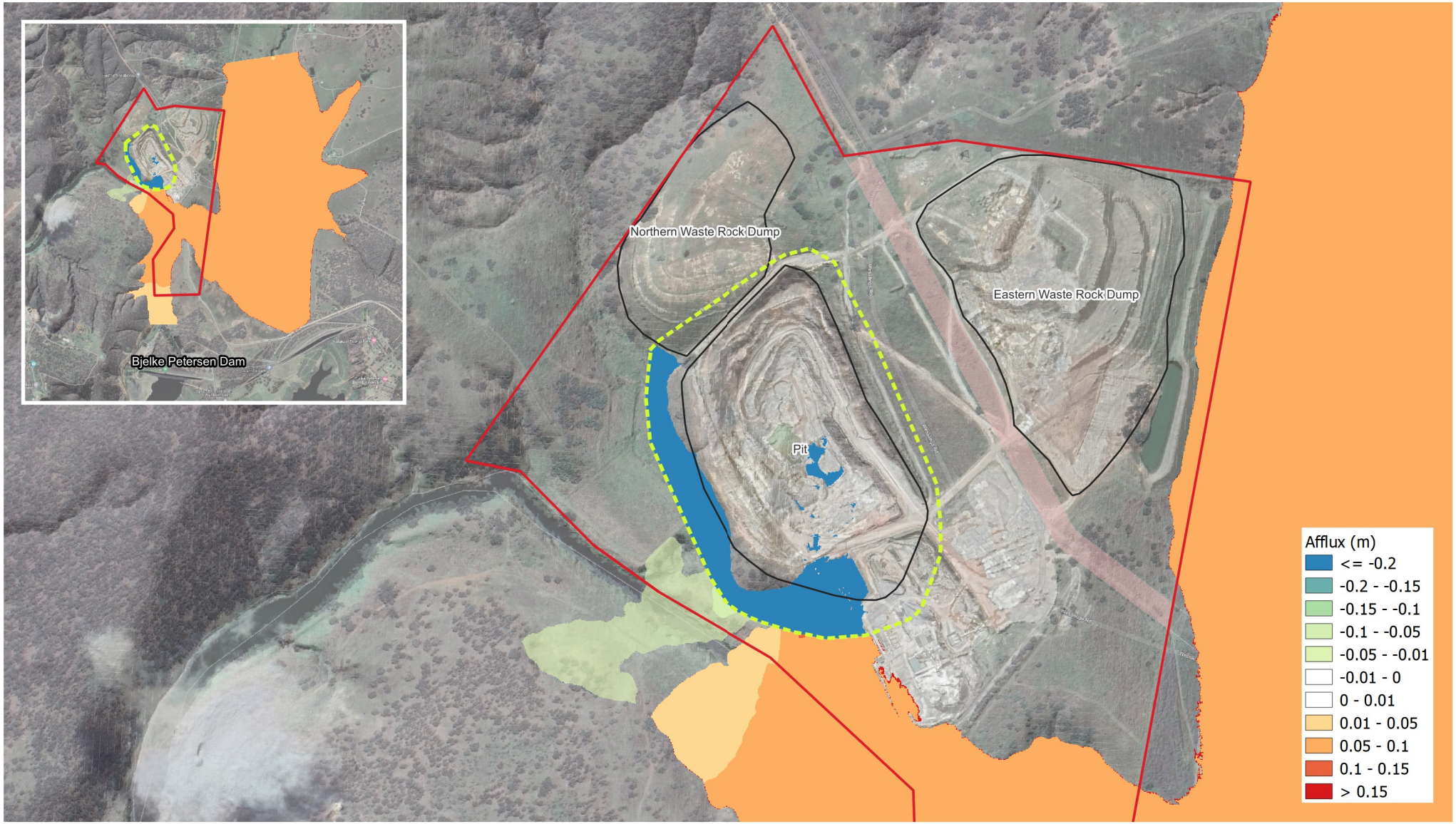
MAP REF: P.22.1743.qgz
AUTHOR: mjacobs
REVISION: A
DATE: 21/02/2023

DATA SOURCES: Base map - Google Satellite, QLD Cadastre Weekly

N

0 100 200 300 400 m

COORDINATE SYSTEM: GDA94 / MGA zone 56
SCALE @ A3: 1:5000



Map 8: 1%AEP Changes to flood depths due to abandonment bund

Graymont (Australia)
Graymont Murgon Flood Modelling

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LEGEND
- Bjelke Petersen Dam
- Footprints of final landforms
- Mine lease boundary
- Abandonment bund

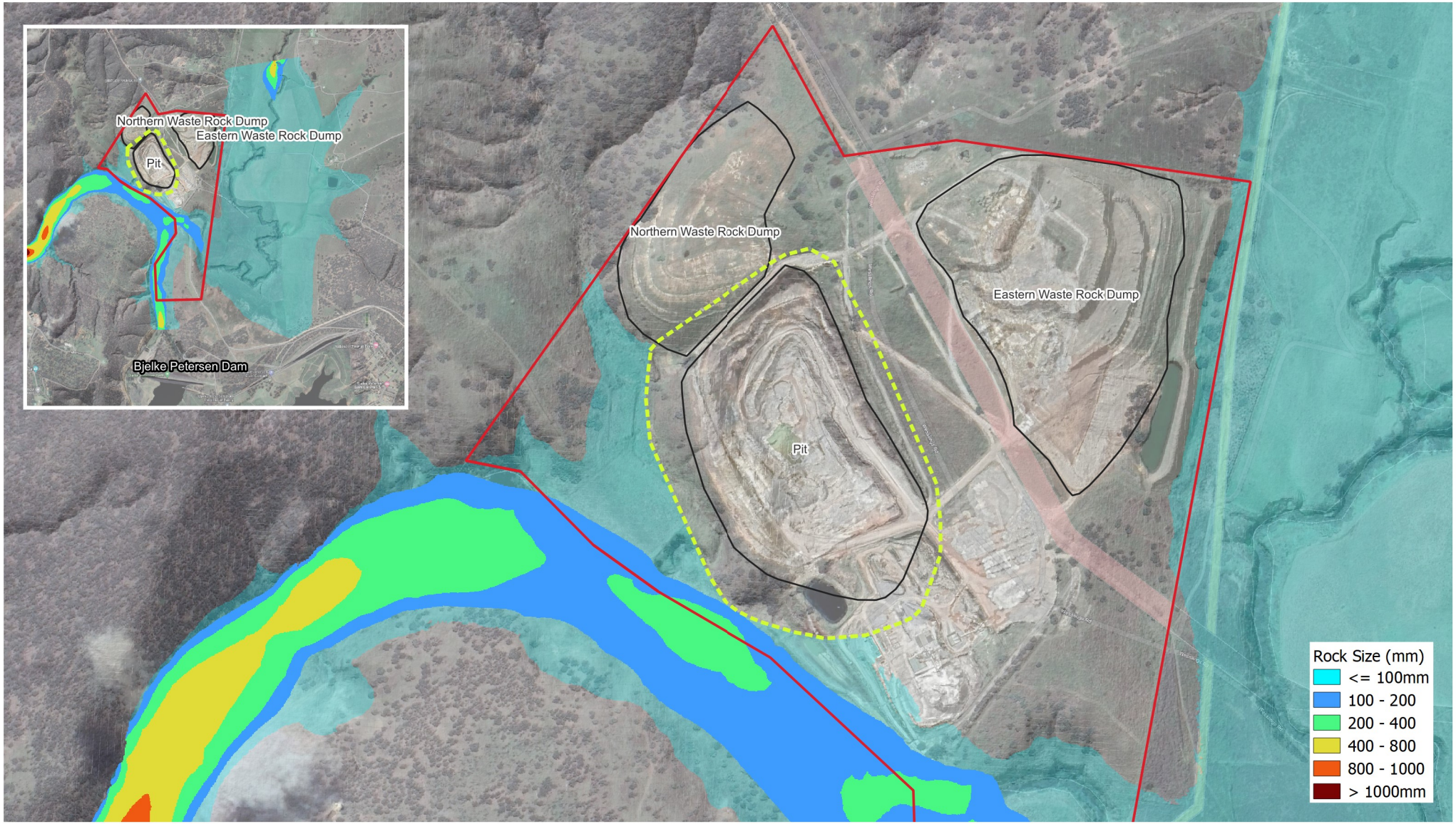
MAP REF: P.22.1743.qgz
AUTHOR: mjacobs
REVISION: A
DATE: 21/02/2023

DATA SOURCES: Base map - Google Satellite, QLD Cadastre Weekly

N

0 100 200 300 400 m

COORDINATE SYSTEM: GDA94 / MGA zone 56
SCALE @ A3: 1:5000



Map 09: Rock scour protection required at abandonment bund

Graymont (Australia)
Graymont Murgon Flood Modelling

pitt&sherry

LEGEND
Bjelke Petersen Dam
Footprints of final landforms
Mine lease boundary
Abandonment bund

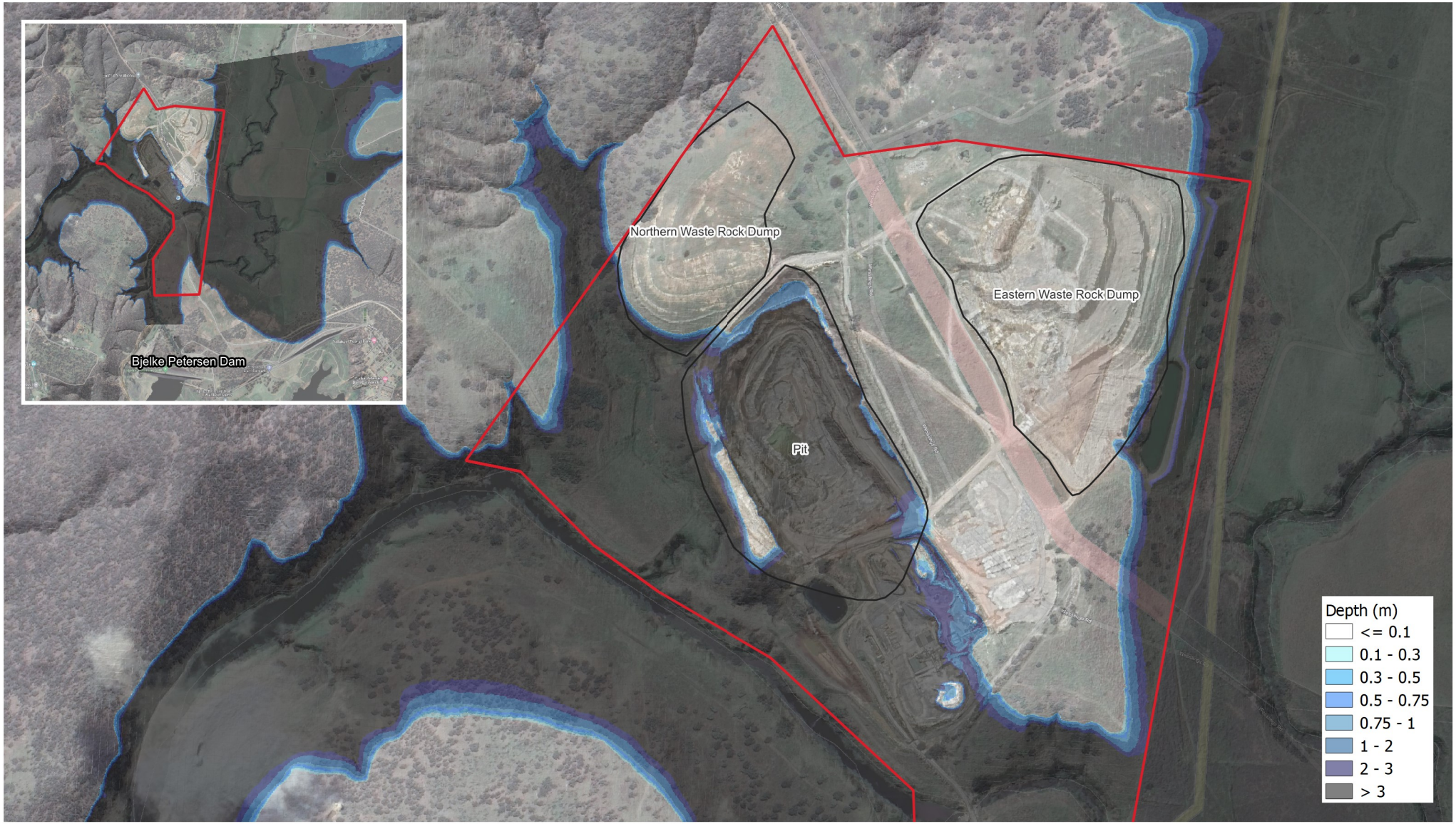
MAP REF:	P.22.1743.qgz
AUTHOR:	mjacobs
REVISION:	A
DATE:	22/02/2023

DATA SOURCES: Base map - Google Satellite, QLD Cadastre Weekly

N

0 100 200 300 400 m

COORDINATE SYSTEM: GDA94 / MGA zone 56
SCALE @ A3: 1:5000



Map 10: PMF with existing terrain flood depth

Graymont (Australia)
Graymont Murgon Flood Modelling

pitt&sherry

LEGEND
- Bjelke Petersen Dam
- Footprints of final landforms
- Mine lease boundary

MAP REF: P.22.1743.qgz
AUTHOR: mjacobs
REVISION: A
DATE: 21/02/2023

DATA SOURCES: Base map - Google Satellite, QLD Cadastre Weekly

N

0 100 200 300 400 m

COORDINATE SYSTEM: GDA94 / MGA zone 56
SCALE @ A3: 1:5000

Map 11: PMF after abandonment bund flood depth

Graymont (Australia)
Graymont Murgon Flood Modelling

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LEGEND
- Bjelke Petersen Dam
- Footprints of final landforms
- Mine lease boundary
- Abandonment Bund

MAP REF: P.22.1743.qgz
AUTHOR: mjacobs
REVISION: A
DATE: 21/02/2023

DATA SOURCES: Base map - Google Satellite, QLD Cadastre Weekly

N

0 100 200 300 400 m

COORDINATE SYSTEM: GDA94 / MGA zone 56
SCALE @ A3: 1:5000

Map 12: SDF with existing terrain flood depth

Graymont (Australia)
Graymont Murgon Flood Modelling

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LEGEND
- Bjelke Petersen Dam
- Footprints of final landforms
- Mine lease boundary

MAP REF: P.22.1743.qgz
AUTHOR: mjacobs
REVISION: A
DATE: 21/02/2023

DATA SOURCES: Base map - Google Satellite, QLD Cadastre Weekly

N

0 100 200 300 400 m

COORDINATE SYSTEM: GDA94 / MGA zone 56
SCALE @ A3: 1:5000

Map 13: SDF after abandonment bund flood depth

Graymont (Australia)
Graymont Murgon Flood Modelling

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LEGEND

- Bjelke Petersen Dam
- Footprints of final landforms
- Mine lease boundary
- Abandonment Bund

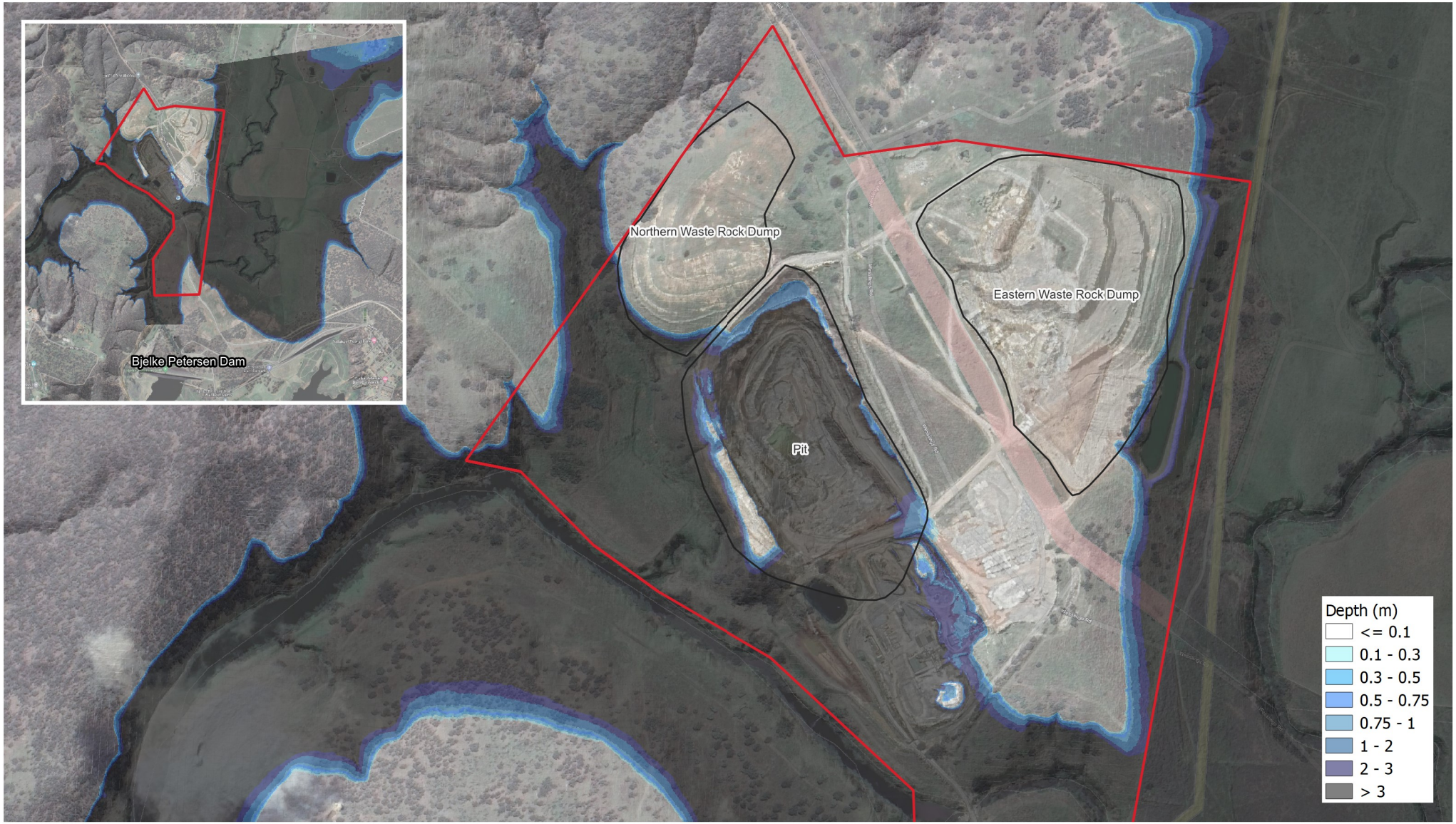
MAP REF: P.22.1743.qgz
AUTHOR: mjacobs
REVISION: A
DATE: 21/02/2023

DATA SOURCES: Base map - Google Satellite, QLD Cadastre Weekly

N

0 100 200 300 400 m

COORDINATE SYSTEM: GDA94 / MGA zone 56
SCALE @ A3: 1:5000



Map 14: CF with existing terrain flood depth

Graymont (Australia)
Graymont Murgon Flood Modelling

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LEGEND
- Bjelke Petersen Dam
- Footprints of final landforms
- Mine lease boundary

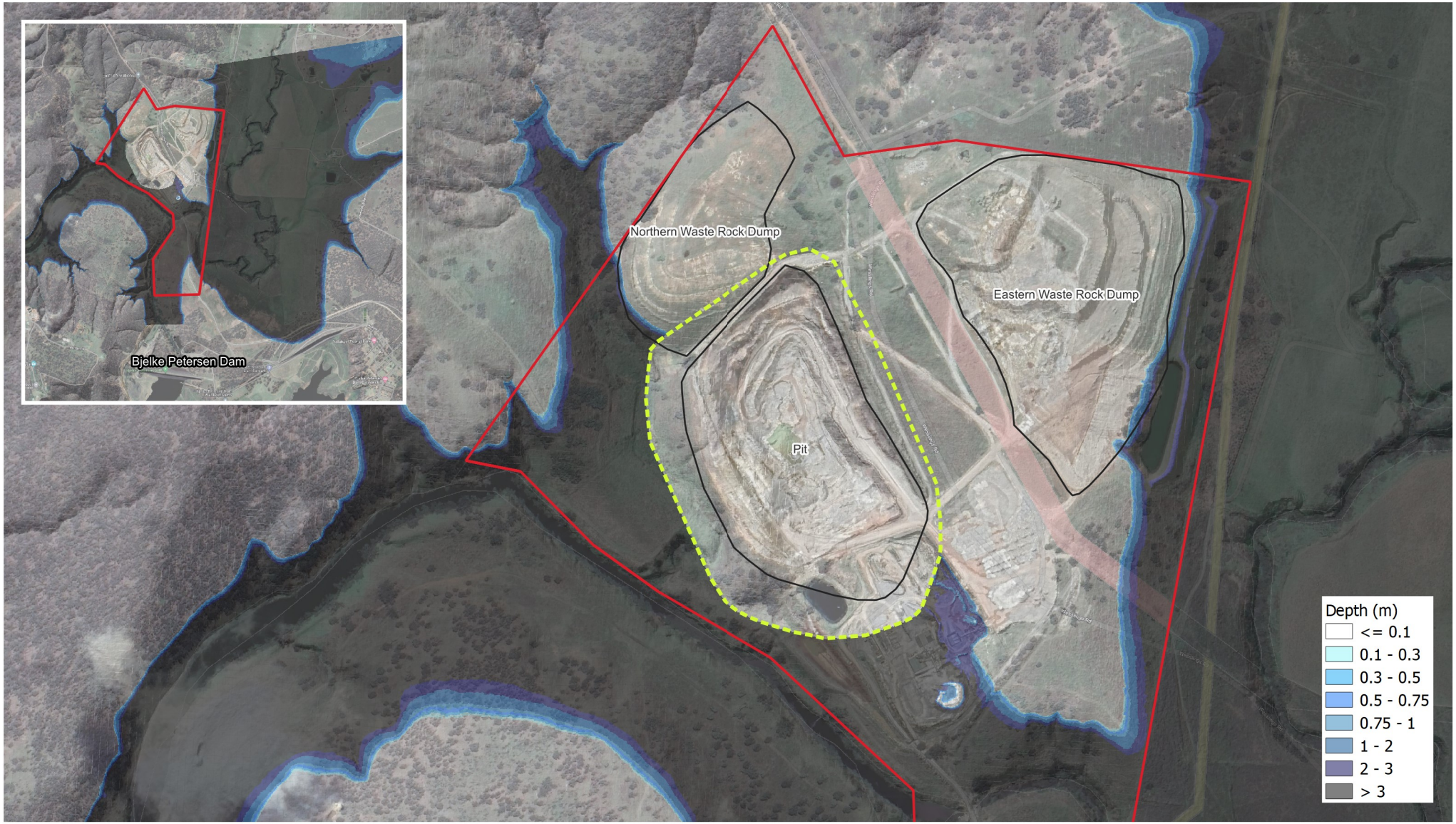
MAP REF: P.22.1743.qgz
AUTHOR: mjacobs
REVISION: A
DATE: 21/02/2023

DATA SOURCES: Base map - Google Satellite, QLD Cadastre Weekly

N

0 100 200 300 400 m

COORDINATE SYSTEM: GDA94 / MGA zone 56
SCALE @ A3: 1:5000



Map 15: CF after abandonment bund flood depth

Graymont (Australia)
Graymont Murgon Flood Modelling

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LEGEND
- Bjelke Petersen Dam
- Footprints of final landforms
- Mine lease boundary
- Abandonment Bund

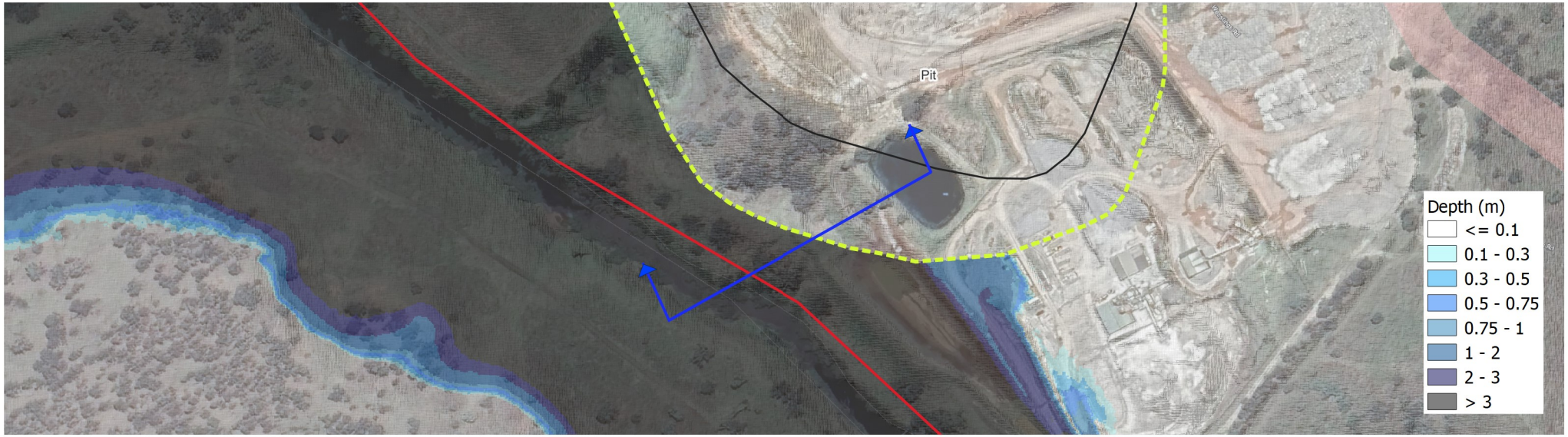
MAP REF: P.22.1743.qgz
AUTHOR: mjacobs
REVISION: A
DATE: 21/02/2023

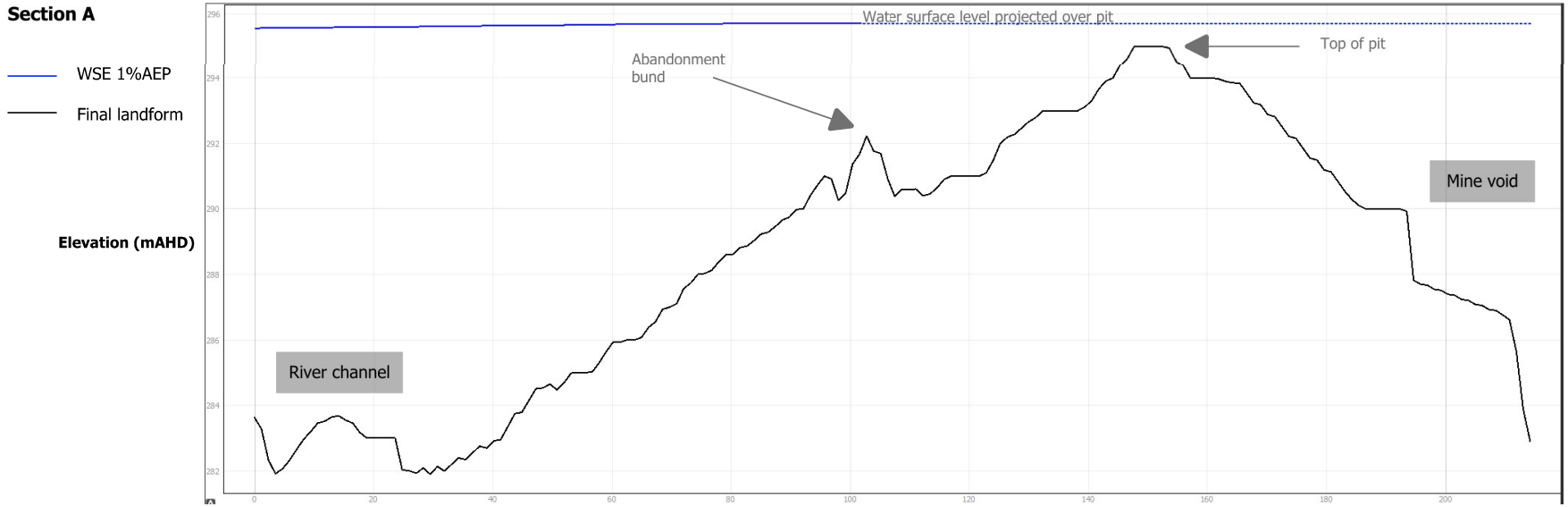
DATA SOURCES: Base map - Google Satellite, QLD Cadastre Weekly

N

0 100 200 300 400 m

COORDINATE SYSTEM: GDA94 / MGA zone 56
SCALE @ A3: 1:5000





Map 16: Section A - 1%AEP
after abandonment bund flood depth

Graymont (Australia)
Graymont Murgon Flood Modelling

pitt&sherry

LEGEND
Footprints of final landforms
Mine lease boundary
Abandonment Bund
Section A

MAP REF: P.22.1743.qgz
AUTHOR: BHernandez
REVISION: A
DATE: 28/02/2023

DATA SOURCES: Base map - Google Satellite, QLD Cadastre Weekly

N

0 50 100 150 200 m

COORDINATE SYSTEM: GDA94 / MGA zone 56
SCALE @ A3: 1:2500

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Murgon Limestone Mine PRCP

Flood modelling

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mjacobs@pittsh.com.au

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Melbourne
Sydney
Brisbane
Hobart
Launceston
Newcastle
Devonport

ref: P.22.1743-HYD-REP-Murgon Limestone Mine-001-Rev00/MJ/ab

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