APPENDIX R ESE - GROUNDWATER TECHNICAL REPORT

Escarpment Extended Sub-Area

Groundwater Technical Report

21 July 2026

J-NZ0433-002-R-FINAL

MINE WASTE MANAGEMENT
GREENROAD GROUP

BATHURST RESOURCES LIMITED

Escarpment Extended Sub-Area

Groundwater Technical Report

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EXECUTIVE SUMMARY

Bathurst Resources Limited (BRL) is seeking to obtain authorisation through the Fast-track Approvals Act (FTAA) to progress development and mining of the coal resources across the wider Buller Plateaux. This project is referred to as the Buller Plateaux Continuation Project (BPCP or Project). Mine Waste Management Limited (MWM) has developed this report for BRL to support the permitting of the Escarpment Extended sub-area (ESE), of the BPCP.

This report was prepared to assess potential environmental effects related to groundwater for ESE. Potential effects to groundwater quantity and quality were identified, including changes to:

- Groundwater levels, mainly from pit excavation.
- Groundwater flow, mainly from pit excavation and sealing of underground workings.
- Groundwater quality, from seepage from ex-pit and in-pit engineered landforms (ELFs) and sealing of underground workings.

Potential effects were assessed conceptually, with supporting calculations where appropriate. Findings from the assessment are summarised below:

Groundwater Quantity:

- Groundwater levels:
  - Pit excavation and dewatering will intercept the water table, forming a groundwater sink during operations. During operations and post-closure, the passive drainage of backfilled pit voids will mean this condition likely remains.
  - The degree of change in groundwater level will vary by location across the ESE sub-area. Near existing underground workings that have already lowered groundwater levels on the eastern side of the ESE sub-area (~40% of the pit area), pit excavation and dewatering are estimated to reduce groundwater levels in the region of 5 m in the long term. Given the interpreted low permeability nature of the hydrogeological units, the cone of depression is estimated to remain close to the pit footprint, with limited drawdown away from the pit walls
  - On the western side of the ESE sub-area where groundwater levels are interpreted to be shallower with an absence of existing underground workings, groundwater levels may be lowered in the range of 50 to 70 m in places close to the pit in the long term.
  - Given the distance between the ESE pit and groundwater users (>4 km), effects are interpreted to be less than minor.
- Groundwater flows:
  - In the Whareatea River catchment, discharge of groundwater to streams and rivers will be reduced as the contributing catchment is mined out and the pit void acts as a groundwater sink. However, the more permeable nature of ELFs compared to the undisturbed in situ Brunner Coal Measures (BCM) means treated ELF seepage will offset any changes in groundwater discharge to the Whareatea River. Overall, changes in groundwater flow to

streams and rivers is interpreted to be negligible relative to treated water discharges. Changes in low flow conditions are assessed further in the ESE Water and Load Balance Model (WLBM) provided by Mine Waste Management (MWM, 2026b).

- Mining out and sealing off the existing underground workings as required within the pit footprint will reduce the amount of underground mine discharge to the Cascade Creek catchment by approximately 40%. Changes in low flow conditions are assessed further in the ESE WLBM.

Known groundwater users are over 4 km away, located on the coastal flats and unlikely to be impacted by the ESE. Any potential effect would be negligible.

Groundwater Quality:

- ELF Seepage
  - In most cases, ex-pit and in-pit ELF seepage will be collected for treatment. Areas where ELF seepage could pool and develop a driving head towards surface water receptors were identified. Calculated flow rates were orders of magnitude lower than anticipated low flow conditions, suggesting dilution factors of 10^3 or more. In stream water quality is assessed further in the ESE WLBM.
- Cascade Creek AMD Load
  - Mining out and sealing off the existing underground workings is estimated to reduce the AMD load by similar amounts as to reductions in flow (i.e., ~40%) with discharge water quality remaining similar.

Recommendations for forward works to support final design and confirm assumptions made in this assessment are as described below.

Forward Works:

This assessment has been completed based on estimates of hydraulic properties (e.g., hydraulic conductivity, K) of the BCM and Basement units documented in other areas of the Buller Plateaux. Available data is considered sufficiently representative to be applied to the ESE sub-area for this assessment. Prior to operations commencing in the ESE sub-area it is recommended that a hydrogeological characterisation programme is completed to confirm this assumption remains appropriate. The following programme partitioning is proposed:

- Prior to operations commencing, complete a hydrogeological characterisation programme focused on the eastern portion of the ESE-sub area (Stage 1 through 4). Performance monitoring wells will be established in Area B.
- During operations, complete a hydrogeological characterisation programme focused on the western portion of the ESE-sub area (Stage 5 onwards). Performance monitoring wells will be established in Area A. MWM recommend this second programme occur no less than one year before Stage 5 occurs to advance understanding of pre-mining groundwater condition in the western portion of the ESE sub-area.

Both programmes will focus on confirming hydraulic properties, groundwater levels and background groundwater quality

Performance Monitoring:

Based on interpretation of currently available data, the pit is anticipated to act as a groundwater sink long term (except for the identified zone of sub-ELF pooling). A reasonable amount of groundwater level data to the eastern side of the pit is available to support this interpretation. However, performance monitoring is required to confirm this condition is maintained. It is recommended further hydrogeological characterisation works be completed during the construction phase to (i) confirm groundwater levels on the western side of the pit area remote from underground workings, and (ii) allow for groundwater monitoring (water levels and quality) between the in-pit ELFs and surface water receptors to confirm the pit does act as a groundwater sink, thereby limiting potential pathways to receptors (i.e., performance monitoring). Further details of groundwater monitoring recommendations are contained within the main body of this report.

Efficient collection of in-pit ELF seepage is predicated on maintaining a lower phreatic surface within the backfilled material than that external to the pit (i.e., pit acts as a hydraulic sink to maintain hydraulic containment of seepage). Although the higher K backfill material (compared to in-situ rock) and use of underdrains will act to lower the phreatic surface within the in-pit ELFs, high rainfall conditions could theoretically counteract this leading to higher in-pit phreatic surface than anticipated (and the pit no longer being a hydraulic sink everywhere). Therefore, to complement groundwater monitoring external to the pit, the phreatic surface within the ELF should be monitored to confirm the basal drainage network is performing adequately and the pit remains a hydraulic sink, thereby minimising the potential for ELF seepage to reach surface water receptors. This can be achieved by installing nested vibrating wire piezometers following rehabilitation. In addition, periodic seepage surveys should be completed following rehabilitation to identify any unexpected seepage emerging through the rehabilitation surface. Collection of this data will support management processes.

Changes to underground workings flows and AMD loads reporting to Cascade Creek should be confirmed by monitoring creek flow and water quality in this catchment. This monitoring programme needs to be developed to confirm betterment opportunities.

TABLE OF CONTENTS

1 Introduction 1
1.1 Background 1
1.2 Scope and Objectives 1
1.3 Project Description 1
1.3.1 Water Management Overview 4
2 Hydrogeological Conceptual Model 6
2.1 Overview 6
2.2 Topography 6
2.3 Previous Mining 6
2.4 Climate and Hydrology 7
2.4.1 Climatic Records 7
2.4.2 Rainfall 7
2.4.3 Air Temperature and Evaporation 8
2.4.4 Hydrology 9
2.5 Geological Setting 12
2.5.1 Regional Geology 12
2.5.2 Site Geology 13
2.5.3 Structural Geology 13
2.6 Hydrostratigraphy 17
2.7 Groundwater Flow Regime 17
2.7.1 Groundwater Levels 17
2.7.2 Groundwater Recharge 22
2.7.3 Groundwater Flow 22
2.7.4 Underground Workings Discharge 23
2.7.5 Groundwater – Surface Water Interactions 23
2.8 Groundwater Users 24
2.9 Hydrogeological Conceptual Model Summary 25
3 Groundwater Effects Assessment 30
3.1 Groundwater Quantity 30
3.1.1 Groundwater Levels 30
3.1.2 Groundwater Flows 34
3.1.2.1 Whareatea River Catchment 34
3.1.2.2 Cascade Creek Catchment 34
3.2 Groundwater Quality 35
3.2.1 ELF Seepage 35
3.2.1.1 Ex-Pit Seal 37
3.2.1.2 WWH Sump 38
3.2.1.3 Sub-ELF Pooling Zone 38
3.2.2 Cascade Creek AMD Load 39

4 Conclusions 40
4.1 Groundwater Quantity 40
4.1.1 Groundwater Levels 40
4.1.2 Groundwater Flows 40
4.2 Groundwater Quality 40
4.2.1 ELF Seepage 40
4.2.2 Cascade Creek AMD Load 40
5 Recommendations 42
5.1 Forward Works 42
5.2 Performance Monitoring 42
6 References 44
7 Limitations 46
Appendix A Proposed Groundwater Monitoring 47
Appendix B Limitations 49

LIST OF TABLES

Table 1: Groundwater levels in relation to the coal floor.....22
Table 2: Whareatea River catchment simulated low flow changes. 34
Table 3: Adopted parameters for calculation of seepage from Ex-Pit Seal. 38
Table 4: Adopted parameters for calculation of seepage from the sub-ELF pooling zone.....38

LIST OF FIGURES

Figure 1: ESE site overview. 3
Figure 2: ESE sub-area disturbance schedule. 4
Figure 3: Historic underground mining. 7
Figure 4: Average annual rainfall. 8
Figure 5: Seasonal average rainfall. 8
Figure 6: Average daily air temperature. 9
Figure 7: Estimated monthly potential evaporation 9
Figure 8: Flow recorder sites. 10
Figure 9: WM2 flow record. 11
Figure 10: V40 Stream flow record. 12
Figure 11: ESE Stratigraphy. 14
Figure 12: Geology map and major geological structures. 15
Figure 13: Coal floor contours. 16
Figure 14: Depth to groundwater level. 19
Figure 15: Groundwater flow regime. 20
Figure 16: Groundwater levels in monitoring wells. 21
Figure 17: Nearby groundwater bores and permitted takes. 25
Figure 18: Baseline conceptual model - Section A-A'. 27
Figure 19: Baseline conceptual model - Section B-B'. 28
Figure 20: Cross section locations. 29
Figure 21: Operations and Post-closure conceptual model - Section A-A'. 32
Figure 22: Operations and Post-closure conceptual model - Section B-B'. 33
Figure 23: Post-closure Sub-ELF seepage flow paths. 36
Figure 24: Ex-Pit Seal location. 37
Figure 25: Potential untreated groundwater discharge zone from groundwater pooling. 39
Figure 26: Proposed groundwater monitoring areas. 43

1 INTRODUCTION

Bathurst Resources Limited (BRL) is seeking to obtain authorisation through the Fast-track Approvals Act 2024 (FTAA) to progress development and mining of the coal resources across the wider Buller Plateaux. This project is referred to as the Buller Plateaux Continuation Project (BPCP or Project).

1.1 Background

The purpose of the BPCP is to secure the existing infrastructure and mining operations associated with the Stockton Mine and provide access to additional mining areas as the coal resources in the current operations are depleted. The Project proposes to mine 20 million tonnes of coking coal utilising existing infrastructure facilities over a 25-year timeframe to support and extend the mine life of the current Stockton Mine operations.

There are four key Project areas (also referred to as sub-areas) that make up the BPCP:

- Stockton.
- Mount Frederick South.
- Escarpment Extended (ESE).
- Upper Waimangaroa Haul Road (UWHR).

This report relates to ESE only.

1.2 Scope and Objectives

This report documents the assessment of potential environmental effects related to groundwater for the ESE sub-area of the Project.

This report was prepared to achieve the following objectives:

- Develop a Hydrogeological Conceptual Model for the ESE sub-area to develop an understanding of the system in regard to groundwater and interaction with other environmental receptors.
- Assess potential effects of the ESE sub-area on the environment via groundwater pathways during operations and post-closure.

1.3 Project Description

This assessment was based on the Project Description set out in the BPCP FTAA Application Assessment of Environmental Effects.

BRL wish to consent the Project, which incorporates the existing approved Escarpment Mine, a proposed extension into the adjacent mining areas covered by Mining Permits MP51279 and MP60138, and the Sullivan Coal Mining Licence (CML 37161) - together the ESE sub-area. Access to this area is currently provided via the existing public road network on the Denniston Road, but as part of the BPCP it will be connected to the Stockton sub-area by the proposed UWHR.

Coal mined at ESE will be transported to the Stockton sub-area via the UWHR for washing, processing and blending as required at the Coal Handling and Processing Plant, before being transported via the aerial ropeway to the Ngakawau Rail Loadout. The ESE Borrow Pit will also be established in the ESE sub-area, to provide aggregate for the construction and establishment of ESE, the construction of the UWHR, and for any ongoing aggregate requirements. ESE will also have four primary infrastructure areas to support the mining operations.

A site overview is presented in Figure 1, indicating the Life of Mine (LOM) site area, pit extent, planned landforms as well as sumps and pit voids.

The ESE sub-area involves the following major activities:

- Open-cast mining of the Escarpment Extended Pit.
- Construction of Engineered Landforms (ELFs) for waste rock storage. The majority of the ELFs will be placed within the mined-out pit shell, with a component constructed externally to the pit on the eastern side. An ex-pit ELF on the northern side of the Whareatea River, known as the Sullivan NAF ELF, will be constructed, with a portion of the ELF repurposed prior to closure for use in the cover system for the primary ELF. All ELFs will be rehabilitated with cover systems as part of the mine closure activities.
- Excavation of a pit east of the mine to access and seal the historical underground workings with a low permeability barrier. This is henceforth referred to as the Ex-Pit Seal and will act as a surge pond for the planned Water Treatment Plant (WTP) to be constructed at the ESE sub-area.
- Construction of an active WTP to treat mine affected waters on site during operation and into the closure phase.
- Construction of five Mussel Shell Reactors (MSRs) post mine closure, to passively treat ELF seepage water prior to discharge to surface water receptors.
- A borrow operation located across the Whareatea River to the north-east of the main mining area (ESE Borrow Pit).

The scheduled disturbance of the ESE sub-area is shown in Figure 2, where disturbance starts in the east of the sub-area, and generally progresses west-ward.

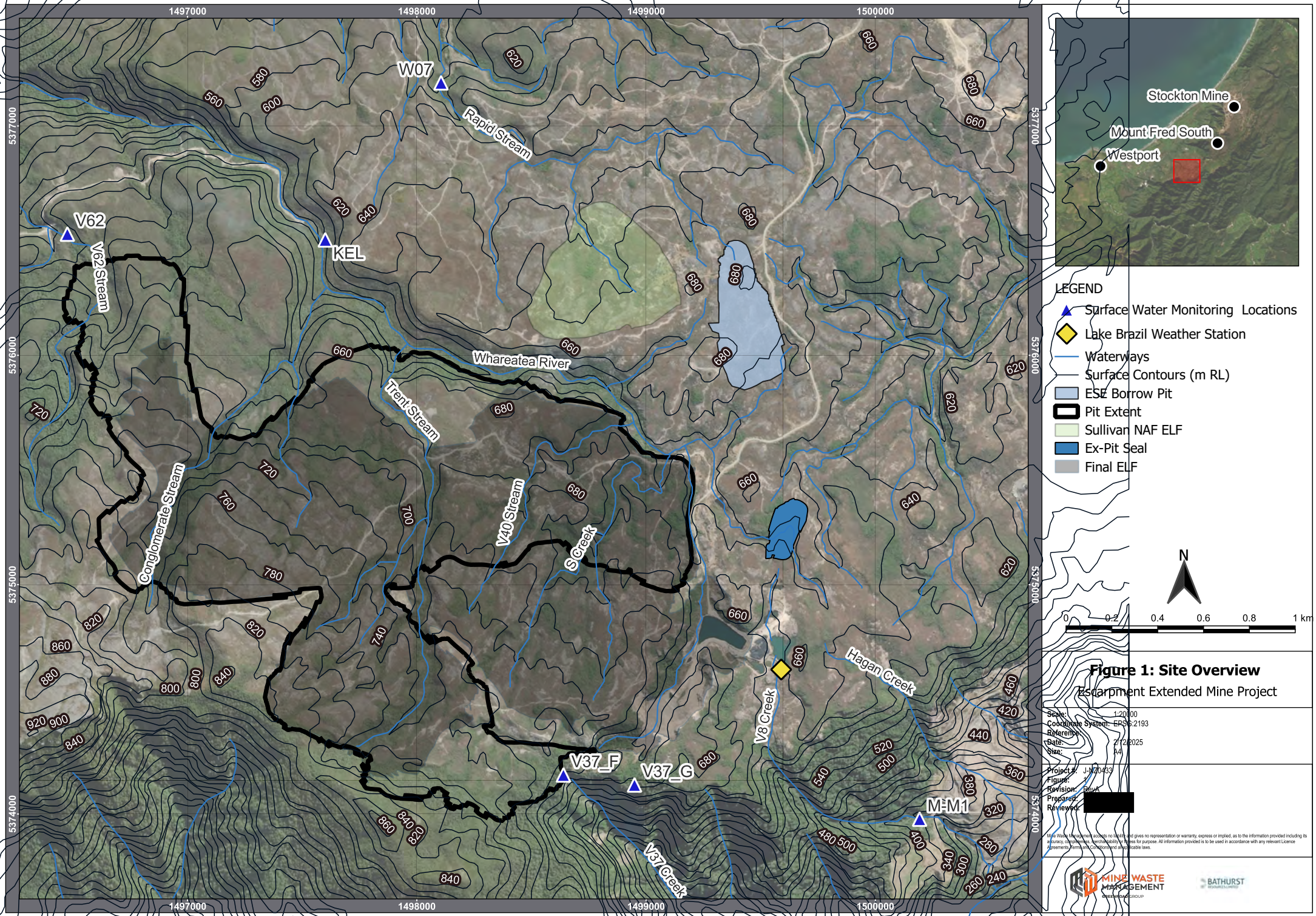

Figure 1: Site Overview

Escarpment Extended Mine Project

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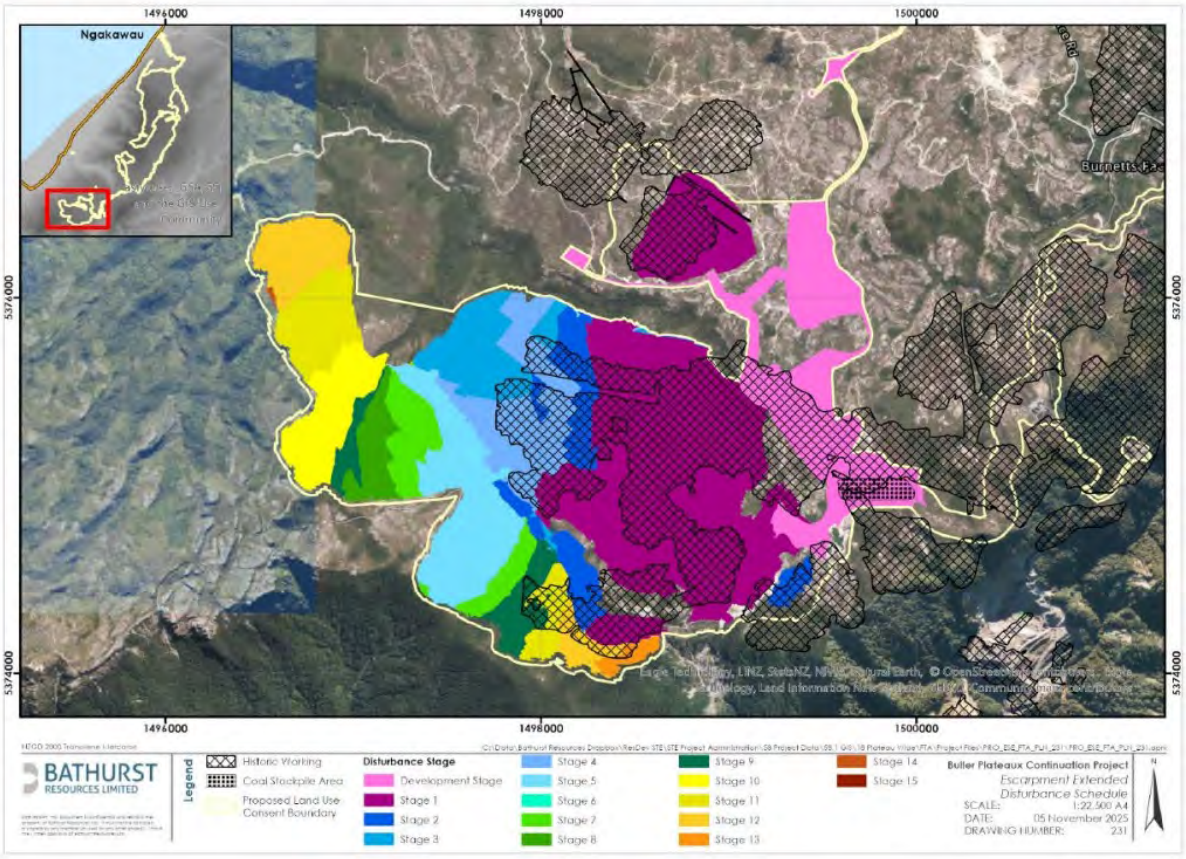

Figure 2: ESE sub-area disturbance schedule.

Source: BPCP FTAA Application Assessment of Environmental Effects.

1.3.1 Water Management Overview

Planned water management approaches have been summarised for the operational and post-closure phases of the ESE sub-area within this section.

Operational phase water management will comprise:

- In-pit dewatering, involving collection of in-pit water within sumps and pumping to the Ex-Pit Seal prior to treatment at the WTP (active treatment). Runoff and seepage from ex-pit ELFs will be collected in sumps and conveyed to the WTP. Treated water will be discharged to the Whareatea River and Cascade Creek.
- Construction of bypass mechanisms to divert high flows (e.g., >95th percentile event flows) around sumps to the receiving environment.
- Construction of sub-ELF basal and perimeter drains to direct ELF seepage to passive water treatment systems, each comprising a MSR and a polishing pond. Current water management plans include four MSRs associated with the ELF, and an additional MSR for the Sullivan NAF ELF.
- Construction of clean water diversion drains to direct clean water away from the pit.
- Dewatering of the Escarpment Borrow Pit, with water pumped to the Ex-Pit Seal.

Post-closure water management will comprise:

- Continuation of active treatment and associated operational water management infrastructure until discharge water quality meets compliance criteria or passive treatment can be utilised.
- Ongoing passive water treatment for ELF seepage and associated water management infrastructure to separate ELF runoff and ELF seepage (for treatment).
- Cessation of dewatering associated with active treatment, and subsequent filling with water of in-pit sumps, Ex-Pit Seal, and ESE Borrow Pit.

2 HYDROGEOLOGICAL CONCEPTUAL MODEL

2.1 Overview

A Hydrogeological Conceptual Model (HCM) can be described as a descriptive representation of a groundwater system that incorporates an interpretation of the geological and hydrological conditions. It consolidates the understanding of the key processes of the groundwater system, including the influence of stresses, and assists in the understanding of possible future changes (Barnett et al., 2012). The HCM is presented within this section based on available data from the site and studies from the Denniston Plateau. A summary of the HCM is presented in Section 2.9.

2.2 Topography

The ESE sub-area is located on the Denniston Plateau, on the west coast of the South Island. The Denniston Plateau is typically elevated at 600 – 1,100 m above sea level and hosts several current and former coal mining operations. The ESE sub-area includes a proposed pit encompassing a 300 ha area at surface elevations ranging from 565 – 820 m RL and is located within moderately sloping, hilly terrain with deeply incised drainage channels. The total ESE disturbance area is 584Ha (source: BRL). Topography of the wider site setting is shown in Figure 1. The site has an overall slope to the northwest and has several watercourses draining the site either to the north/northwest, or southeast via a steep topographical drop into the Cascade Creek catchment. Cascade Creek ultimately drains into the Buller River.

The main drainage feature within the vicinity of ESE is Whareatea River, of which the source is within the ESE sub-area. The Whareatea River becomes deeply incised approximately 1 km north of the site and receives flows from numerous tributaries on the Denniston Plateau. Ultimately, the river drains in a north-westerly direction towards the coast and discharges into the Tasman Sea.

2.3 Previous Mining

The ESE sub-area is host to a network of historical underground mine workings (Figure 2), which were mined between the 1890's and 1990's. These workings cover approximately 40% of the proposed ESE pit footprint. Collapse of these underground mine workings has altered the surface topography in some locations via subsidence (Buller Coal Limited, 2014), thereby creating preferential pathways for surface water to enter historical workings in addition to groundwater flow sources. While some surface water losses to underground workings have been identified (e.g., Trent Stream), there are possibly others that are not yet identified. Adits associated with these underground mines beneath ESE still discharge mine impacted water to receiving surface water environments. The majority of these flows are directed to the Cascade Creek catchment via gravity drainage pathways underground, whilst the historical Sullivan mine adit discharges to Rapid Stream in the Whareatea catchment.

Recent mining was undertaken at the existing Escarpment Mine, from which BRL (through subsidiary Buller Coal Limited), possess resource consent to extract coal. A small portion in the northeastern corner of the existing Escarpment Mine was mined from 2014; however, the mine was placed into care and maintenance in 2016. Current landscape features relating to previous mining activities at the existing Escarpment Mine include the Barren Valley ELF and Pit 3 Lake.

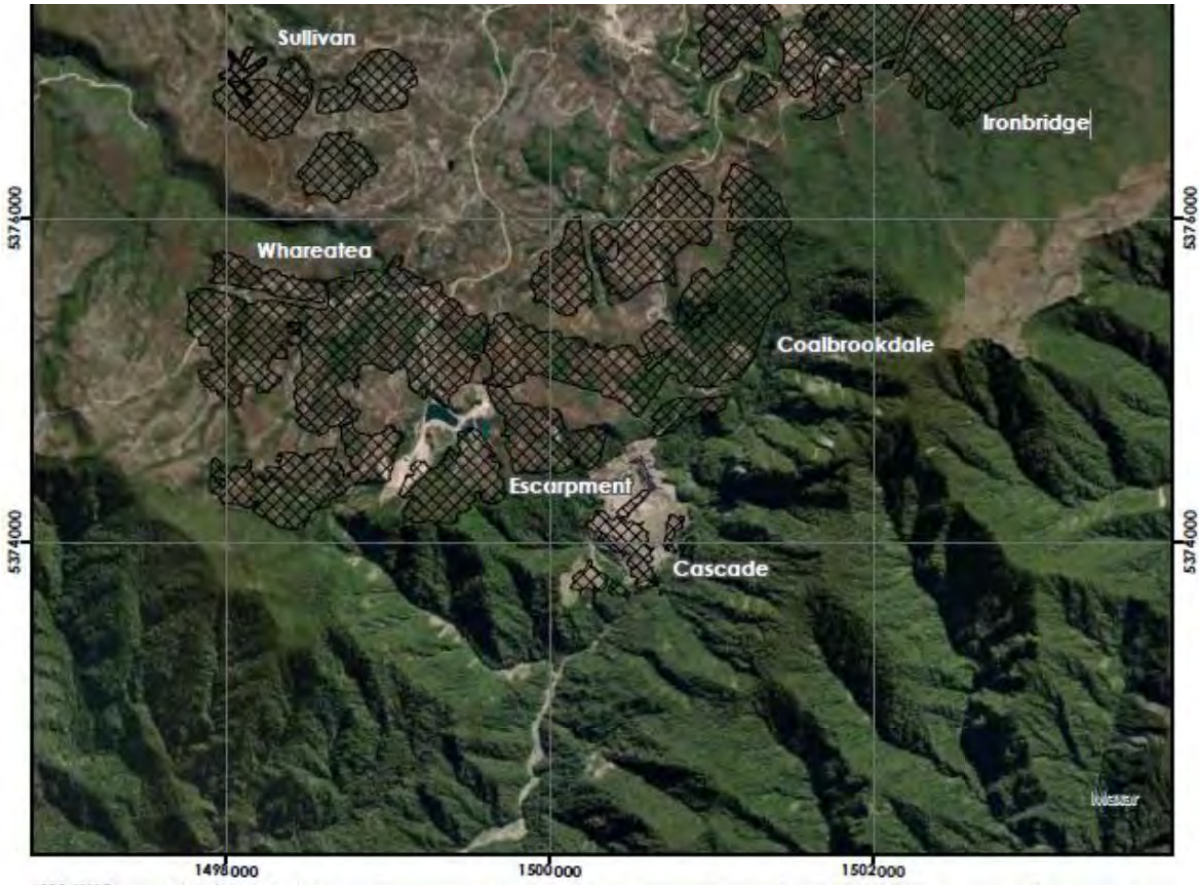

Figure 3: Historic underground mining.

Source: BRL

2.4 Climate and Hydrology

2.4.1 Climatic Records

Climatic conditions within the ESE sub-area have been summarised within this section utilising the data collected from Lake Brazil weather station (Figure 1), located on-site at an elevation of 640 m. The weather record contains data from 2010 – 2023. The data records lack continuity and contain numerous data gaps. In such cases, data has been estimated using climatic data from the Stockton Office Met station which is located at the Stockon mine at a similar elevation (Chater, 2024). The patched dataset is henceforth referred to as the ESE sub-area climate dataset.

2.4.2 Rainfall

The West Coast of the South Island is characterised by high rainfall and is the wettest region in New Zealand. High rainfall is attributed to the region's exposure to moisture laden air masses passing over the Tasman Sea, with typical annual rainfall in coastal areas of 2,000 – 3,000 mm/year (Macara, 2016). However, rainfall is significantly higher in elevated areas such as on the Denniston Plateau.

Figure 4 presents the rainfall records between 2011 to 2023 from the ESE sub-area climate dataset. Figure 5 presents the average seasonal rainfall. The following is noted regarding these figures:

- Mean rainfall is approximately 5,500 mm.
- Annual rainfall varied between 4,345 mm (2018) to 6,619 mm (2021).

- Rainfall is comparable between summer, autumn, and winter, with an average of approximately 1,300 mm for each season.
- Spring is the wettest season with an average of 1,544 mm.

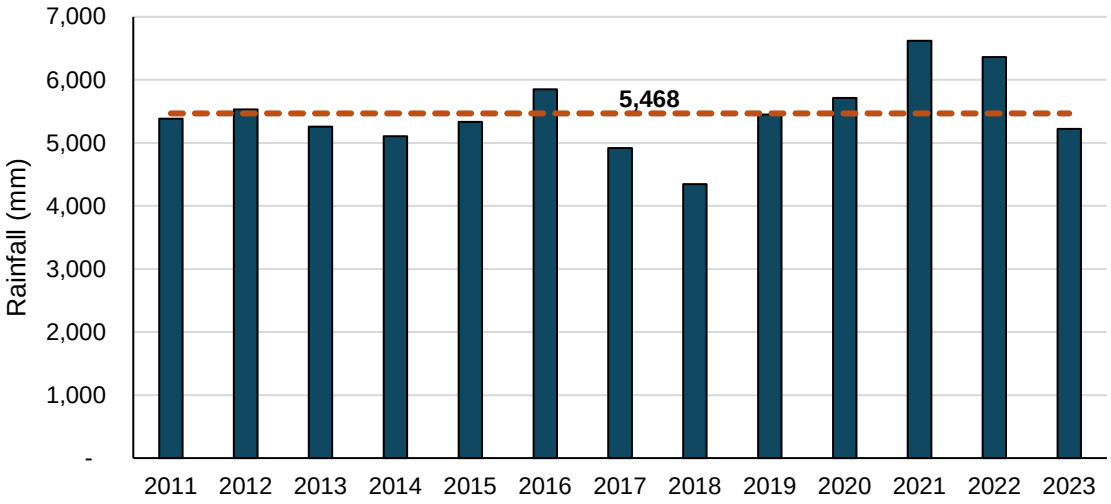

Figure 4: Average annual rainfall.

Notes: Mean rainfall indicated as dashed line.

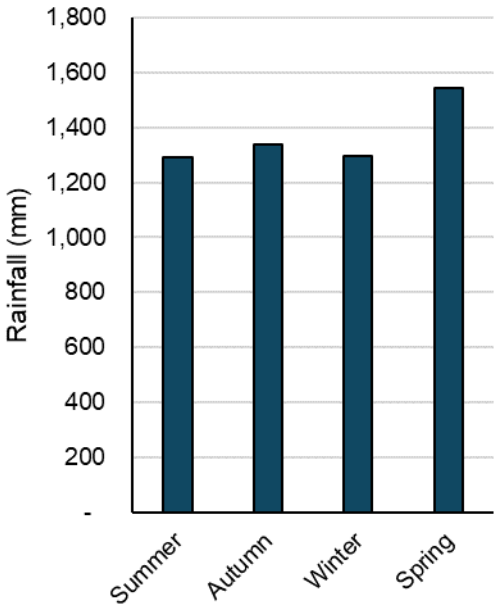

Figure 5: Seasonal average rainfall.

2.4.3 Air Temperature and Evaporation

Air temperature records from the ESE sub-area climate dataset are presented in Figure 6. Temperatures at the site are considered mild, with peak temperatures occurring in February (~14 °C) and minimum temperatures occurring in July (~5 °C).

Potential evaporation (PE) has also been estimated utilising the ESE sub-area climate dataset record (Mine Waste Management, 2026a). Monthly estimates of PE are illustrated in Figure 7. As indicated, PE is anticipated to be highest in December, and lowest in June. An energy deficit (i.e., Rainfall > PE)

is apparent throughout all months. Mean annual PE was estimated to be 840 mm, which is approximately 15% of mean annual rainfall.

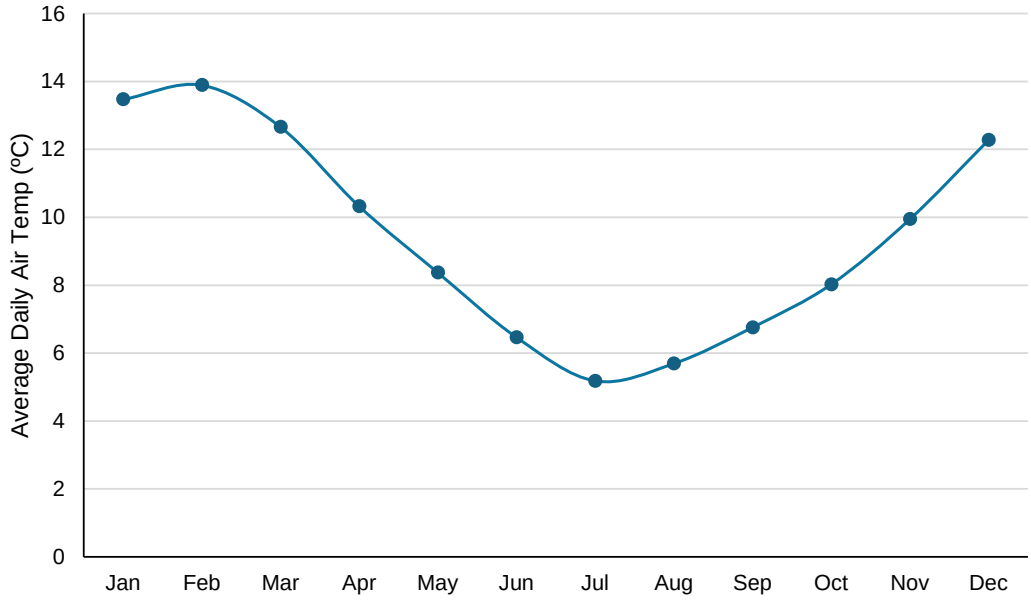

Figure 6: Average daily air temperature.

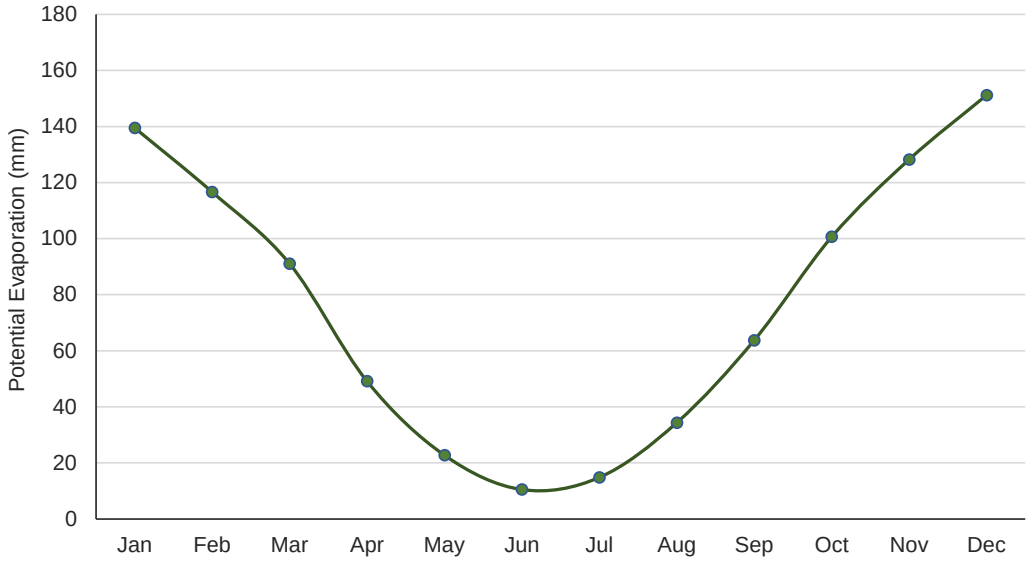

Figure 7: Estimated monthly potential evaporation

2.4.4 Hydrology

At ESE sub-area watercourses generally drain either to the north and in to Whareatea River, or south toward Cascade Creek (Figure 8). In addition, Rapid Stream, which joins the Whareatea River near the coast, also receives discharges from historic underground workings. Since the Denniston Plateau is characterised by high rainfall, elevated topography and either exposed bedrock or thin soils with limited soil moisture holding capacity, a large proportion of rainfall is expected to reach streams and rivers via surface run-off rather than via groundwater flow paths Golder (2012a).

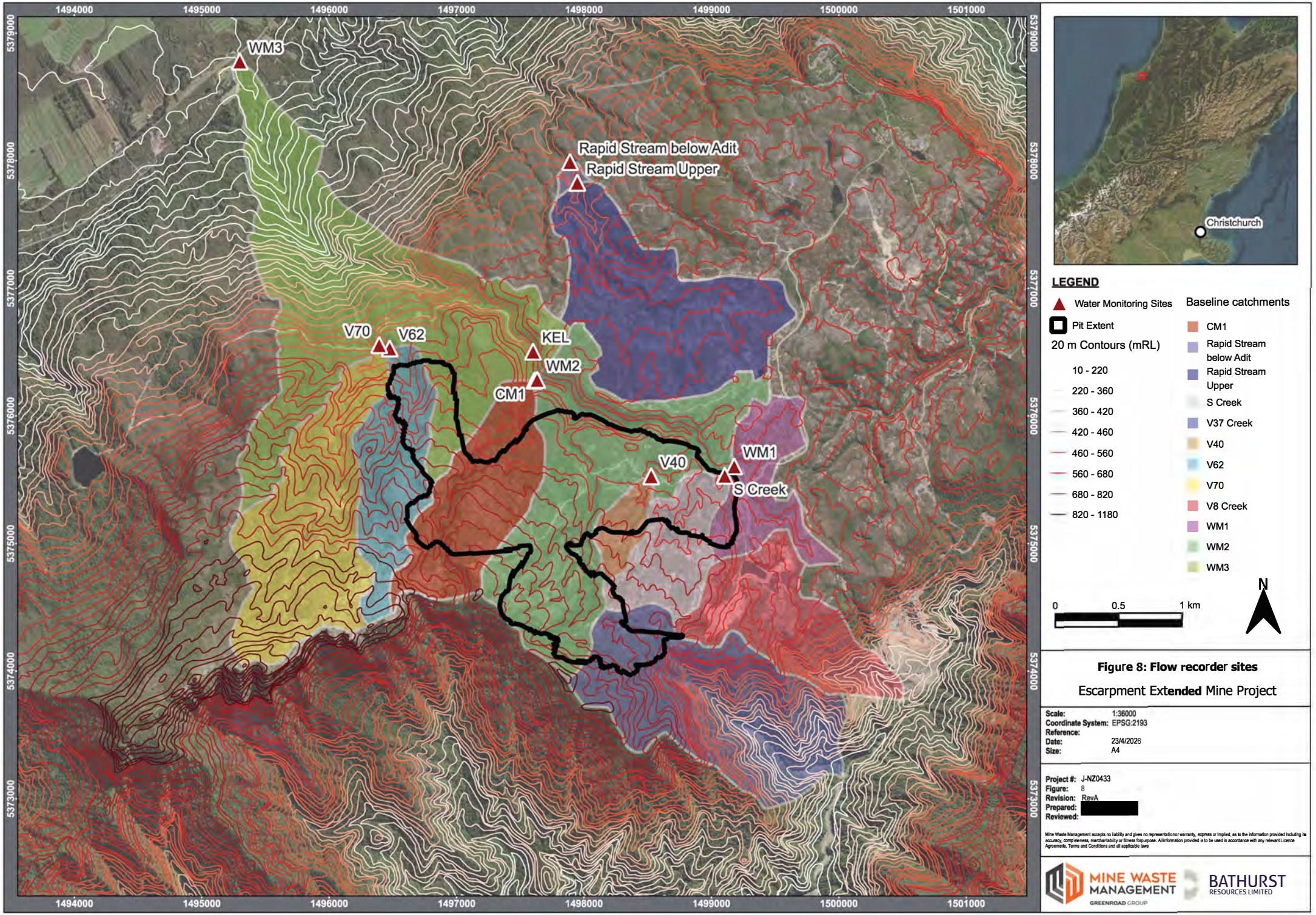

Figure 8: Flow recorder sites

Escarpment Extended Mine Project

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Figure 9 presents a hydrograph of the WM2 flow record, which measures flow from the Whareatea downstream from the ESE sub-area. The WM2 flow record site captures flow from the following feeder catchments:

- WM1 (flow site WM1).
- South Creek catchment (flow site S Creek).
- V40 Stream catchment (flow site V40).
- Trent Stream catchment (no flow site).

Notably, the hydrograph illustrates that baseflow is maintained following periods of minimal rainfall. This indicates the potential for groundwater to be interacting with the Whareatea River at some location within the WM2 catchment. The minimum recorded flow rate over the recording period was approximately 3 L/s.

Field mapping of Whareatea River tributaries completed by NIWA (2024) identified 'intermittent' streams across the ESE sub-area. NIWA follow the definition of an intermittent stream as a waterway that flows continuously only at certain times of the year when the water table intercepts the surface along the channel course. They noted observing springs or seeps of water flowing into the channel/stream at various locations, indicating a groundwater connection for at least part of the year. This is evident in the flow record for V40 Stream, which drains the ESE sub-area, and is presented in Figure 10.The recorded stream flow is highly variable and rises and falls rapidly in response to rainfall events. During periods of limited rainfall, stream flow reduces to nearly no flow, representing minimal to no input from groundwater.

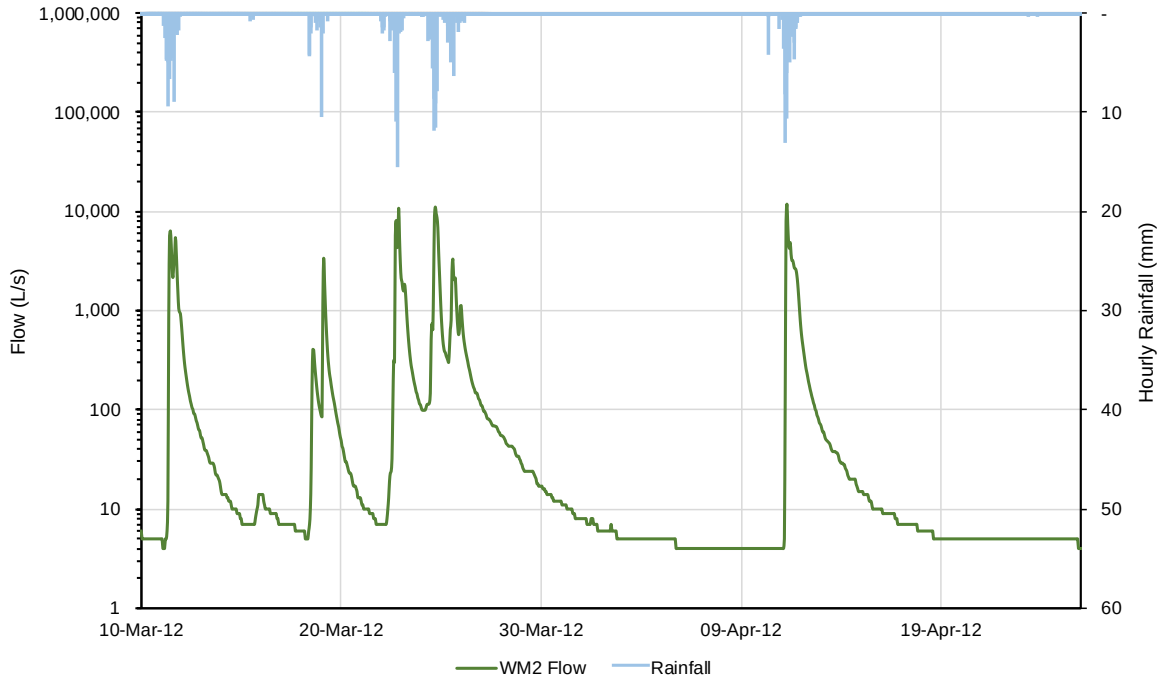

Figure 9: WM2 flow record.

Source: Flow data provided by BRL.

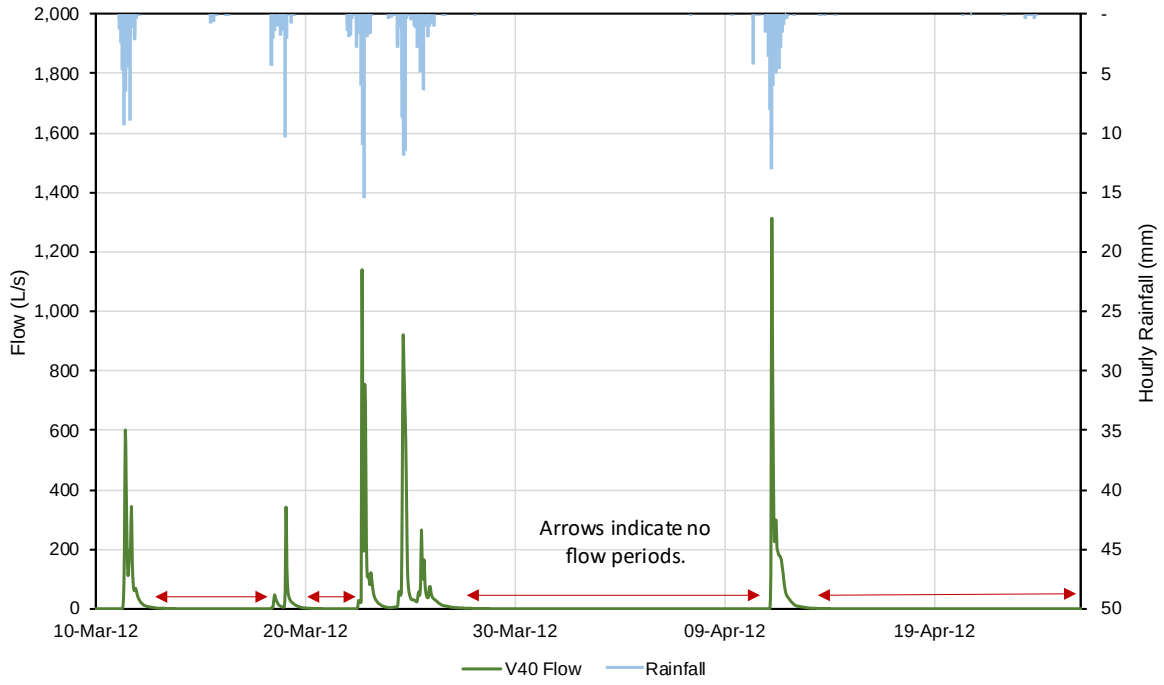

Figure 10: V40 Stream flow record.

Flow data provided by BRL.

2.5 Geological Setting

2.5.1 Regional Geology

The following description of regional geology has been summarised from the work of Flores & Sykes (1996).

The Buller Coalfield in the West Coast Basin-and-Range Province has undergone subsidence and extension since the Late Cretaceous. The Brunner Coal Measures (BCM), deposited from the middle Eocene to Oligocene, form the foundational layer of a transgressive sequence, which are a succession of estuarine high sulfur sedimentary rocks consisting of clastic rocks and coal seams. The BCM unconformably overlie the basement rocks comprising Greenland Group turbidite sequences, intruded by granites and porphyries. The BCM are dominated by sandstones inter-layered with siltstones, mudstones, carbonaceous mudstones, and coal seams. The sequence is 70 – 130 m thick and was deposited in a fluvioparalic environment consisting of braided and meandering streams within a deltaic, barrier, tidal environment. The BCM are conformably overlain by, and laterally interfingered with, the Eocene marine Kaiata mudstone formation, which has increasing carbonate content upwards away from the BCM contact.

The BCM unconformably overlie Greenland Group, Karamea Batholith, Berlins Porphyry, and Hawks Crag Breccia (Golder, 2012a). Weathering below the unconformity is highly variable but has been observed to extend to approximately 15 m depth.

2.5.2 Site Geology

The soil thicknesses within the ESE sub-area are typically thin (<300 mm) to absent, with tussock root mass comprising a significant portion of the surface soil (Golder, 2012a).

Underlying the soil and exposed across much of the ESE sub-area, is typically indurated coarse sandstone of the BCM. The general stratigraphic sequence is illustrated by the stratigraphic column below (Figure 11). The main coal seam, and additionally the target coal seam for mining, is the Mangatini Seam. The Mangatini Seam is typically located near the base of the BCM (Buller Coal Limited, 2014) and contains several daughter splits which are observed beneath ESE. The coal seam is typically overlain and underlain by siltstone and mudstone sequences, which are founded on basal sandstones and conglomerates. The ESE sub-area is bound by the Berlins Porphyry and Greenland Group Basement rock to the south. The geology of the site is presented in Figure 12 based on Nathan et al. (2003).

Coal extraction is proposed to occur wholly within the BCM sequence, which extends over the majority of the Denniston Plateau. However, the south boundary of the ESE pit is planned to cut into Berlins Quartz Porphyry basement in order to access target coal seams and locally cut into basement at in-pit sumps.

Coal floor surface contours are shown in Figure 13, showing decreasing elevation to the northwest and northeast-east directions.

2.5.3 Structural Geology

Known major and minor faults identified across the ESE sub-area are shown in Figure 12 based on BRL (2025). They are described as follows:

- The most regionally extensive major fault is the Mt William Fault, approximately 1 km, and forms the eastern limit to the Denniston Plateau. It has been mapped for approximately 24 km trending southwest-northeast along the Mt William Range.
- Less extensive but partially intercepting the ESE pit is the normal motion Escarpment Fault, trending in a north-northwest/south-southeast direction. It forms a contact between the BCM and Greenland Group basement formation, with displacement of ~100 m.
- Minor, unnamed faults, typically trend sub-parallel to either the Mt William Fault or Escarpment Fault. One of these crosses near the middle of the ESE pit, with a similar trend to the Escarpment Fault and mapped for approximately 3 km. These faults typically have offsets of several metres.

Structural jointing is variable across the site. Golder (2012a) describes subvertical joints orthogonal to bedding being common in BCM sandstones and mudstones, with generally wide to very wide joint spacing within the main rock mass. Sometimes these joints were observed to be infilled with silicate or soil materials. Gaps of up to 1 m were measured closer to steep slopes where movement of large blocks resulting in opening of joints.

According to BRL (2025), bedding within the coal measures sequence the ESE sub-area is shallow dipping (5°-12°) to the northeast but is folded by a series of northeast plunging anticlines and synclines.

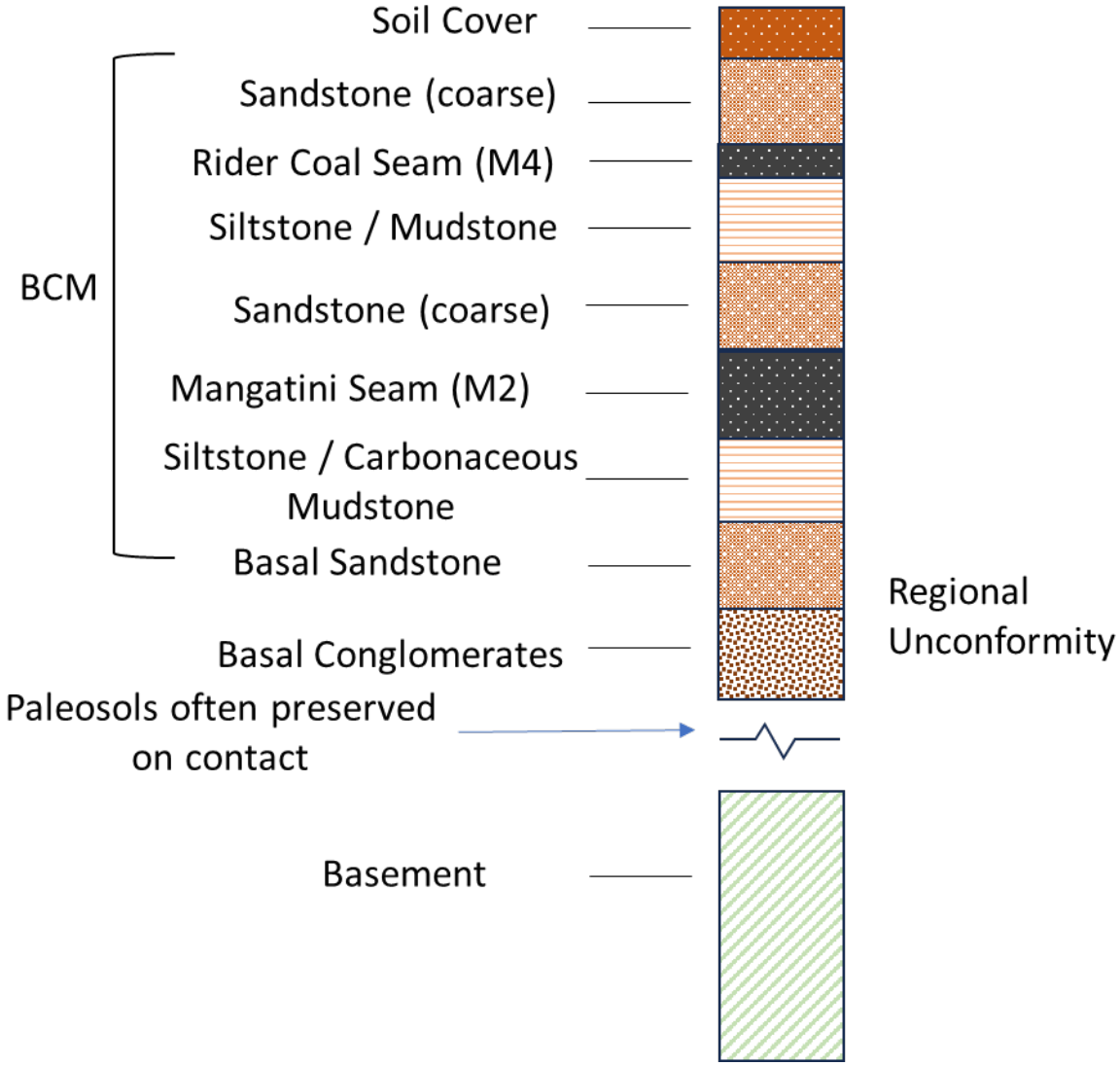

Figure 11: ESE Stratigraphy.

Note: Stratigraphic column is indicative only and spatial variability is likely across the ESE sub-area.

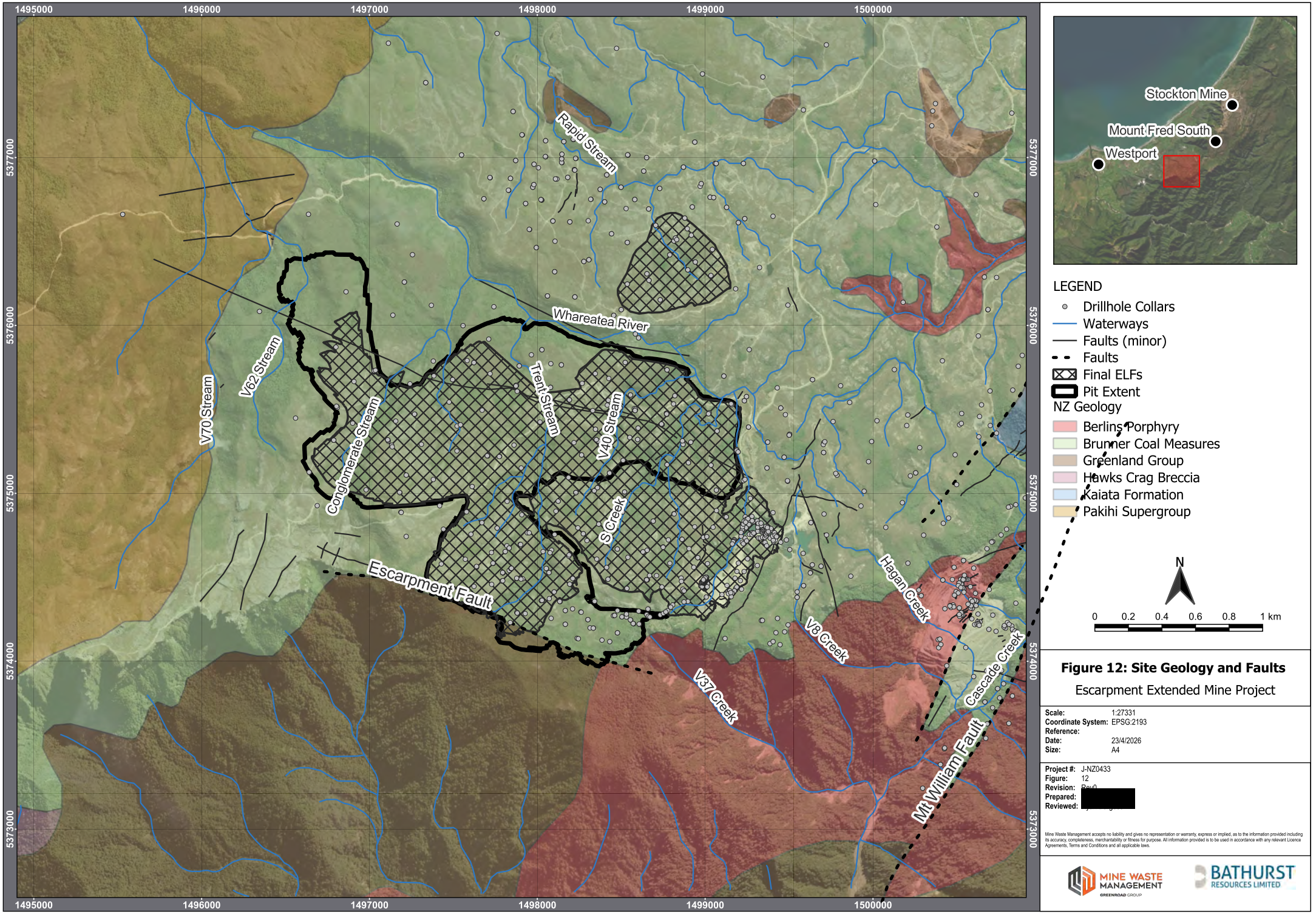

Figure 12: Site Geology and Faults

Escarpment Extended Mine Project

Scale:	1:27331
Coordinate System:	EPSG:2193
Reference:	
Date:	23/4/2026
Size:	A4

Project #:	J-NZ0433
Figure:	12
Revision:	Rev0
Prepared:	[redacted]
Reviewed:	

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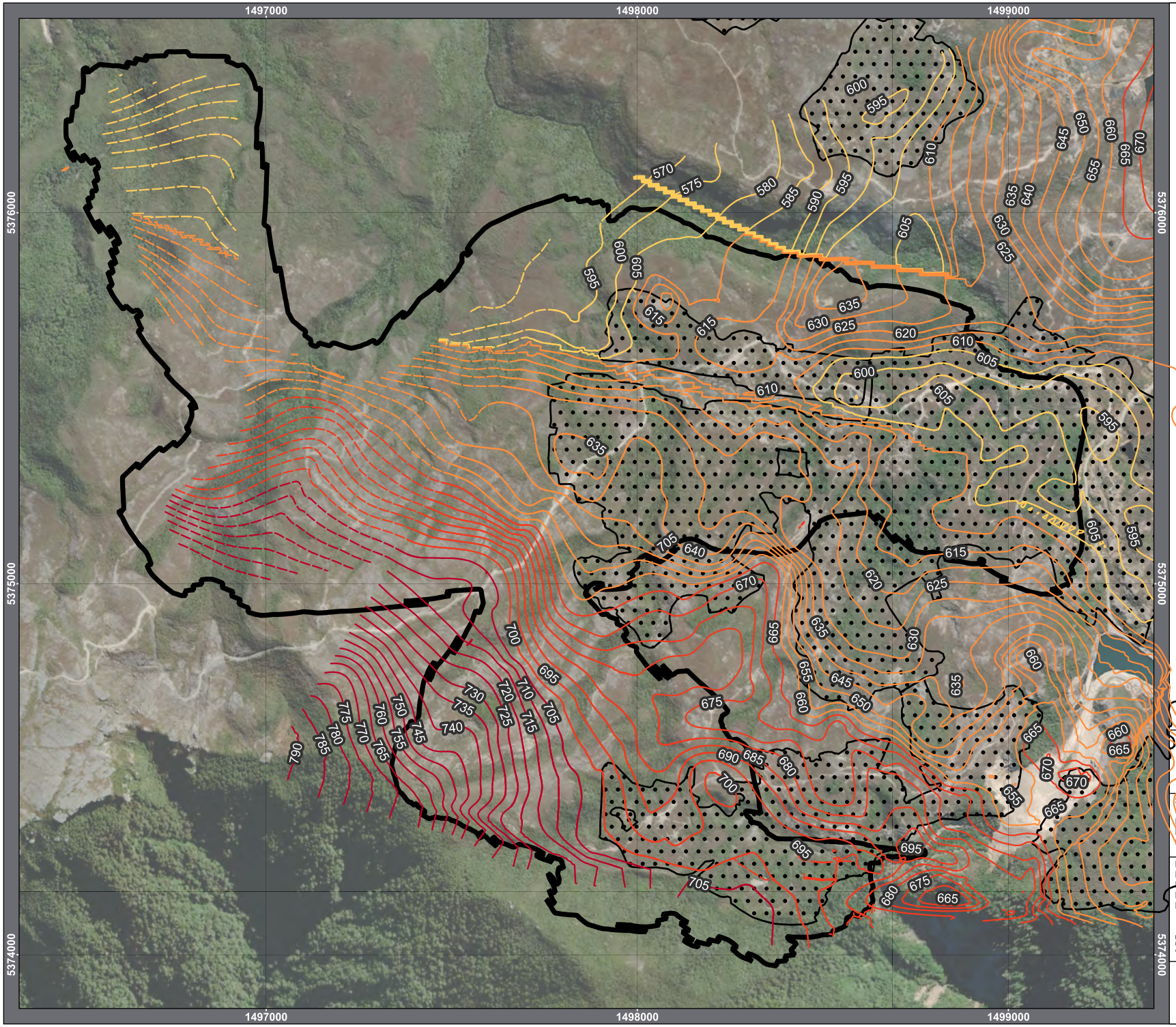

LEGEND

Coal Floor (mRL)

- 533 - 608 mRL
- 608 - 664 mRL
- 664 - 700 mRL
- 700 - 792 mRL

LOM features

- Pit Extent
- Historic Underground Workings

N

0 0.2 0.4 0.6 km

Figure 13: Coal Floor Contours

Escarpment Extended Mine Project

Scale:	1:42898
Coordinate System:	EPSG:2193
Reference:	
Date:	28/4/2026
Size:	A4
Project #:	J-NZ0433
Figure:	13
Revision:	Rev0
Prepared:	[redacted]
Reviewed:	

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2.6 Hydrostratigraphy

The main geological units encountered on-site are reported in Section 2.5**.** These units are regionally extensive and have been identified at several mine sites in the region (e.g., Stockton Mine). The key hydrostratigraphic units (HSU) at ESE are BCM and Basement Rock.

Although BCM comprise various lithologies including sandstone, siltstone, conglomerate, and coal seam units of varying hydraulic properties, they are interpreted to form one HSU at the scale of the ESE sub-area. The primary porosity of BCM and Basement rock is anticipated to be low, such that secondary porosity associated with fracturing is the dominant mechanism for groundwater flow (Golder, 2012a). Where present, underground workings also provide a significant control on groundwater flow.

No hydraulic testing has been completed at ESE; however, hydraulic conductivity (K) estimates from hydraulic testing are available for the same HSUs at nearby sites from across the Buller Plateaux (e.g., Fergusson, 1995; Kingett Mitchell, 1999; MWH; 2003, Kingett Mitchell, 2005; URS, 2010; Stockton Alliance, 2014; Golder, 2012b; MWM, 2025) and it is reasonable to apply those to the ESE sub-area. K estimates vary by approximately three orders of magnitude from these sources, but can be summarised as follows:

- BCM ranging between $2x10^{-8}$ m/s to $1x10^{-5}$ m/s, with a geometric average of $5x10^{-7}$ m/s.
- Basement ranging between $9x10^{-10}$ m/s to $4x10^{-6}$ m/s, with a geometric average of $4x10^{-7}$ m/s.

Calibration of numerical groundwater flow models has generally led to lower estimates of K for Basement (<$1x10^{-7}$ m/s) and higher K for BCM (>=$1x10^{-6}$ m/s) for the Cypress Mine (e.g., Golder, 2010; GHD, 2021). This would suggest the BCM has a higher degree of lateral connectivity between fracture zones, potentially related to continuous bedding contacts, compared to Basement where these continuous structures are less prevalent. However, fractured damaged zones associated with the Mt William Fault at the Cypress Mine could also explain the higher K inferred by modelling. Golder (2012a) suggest lower levels of fracture intensity and facture infilling at ESE than other sub-areas of the Buller Plateaux, implying lower K.

Mine roof subsidence over historic underground workings has been noted at ESE, causing localised increase in rock mass K (Golder, 2012a), likely by an order of magnitude or more.

2.7 Groundwater Flow Regime

2.7.1 Groundwater Levels

A number of boreholes have been installed across the ESE sub-area, with monitoring wells installed in some and the remainder left as open holes (Figure 14). Within the vicinity of the planned ESE pit, there are eight monitoring wells and 14 open holes with groundwater level data. Whilst the locations of these monitoring wells are known, well construction details are not available, limiting the understanding of where they are screened in the sub-surface.

Groundwater level data collected from open holes can provide an approximate indication of average groundwater levels. However, they may not always be representative. For example, DEN115 and DEN165 show a 40 m head difference despite being very close together (see Figure 14). Furthermore, open hole groundwater levels have not been regularly monitored, typically with one groundwater level measurement taken at the end of drilling. Groundwater level data from monitoring wells at ESE sub-area have often displayed a 5 to 30 m decrease from initial measurements to those taken three months

later after which levels stabilised. As such, majority of groundwater level data interpretation has mainly relied upon measurements made from monitoring wells where conditions are judged to have stabilised.

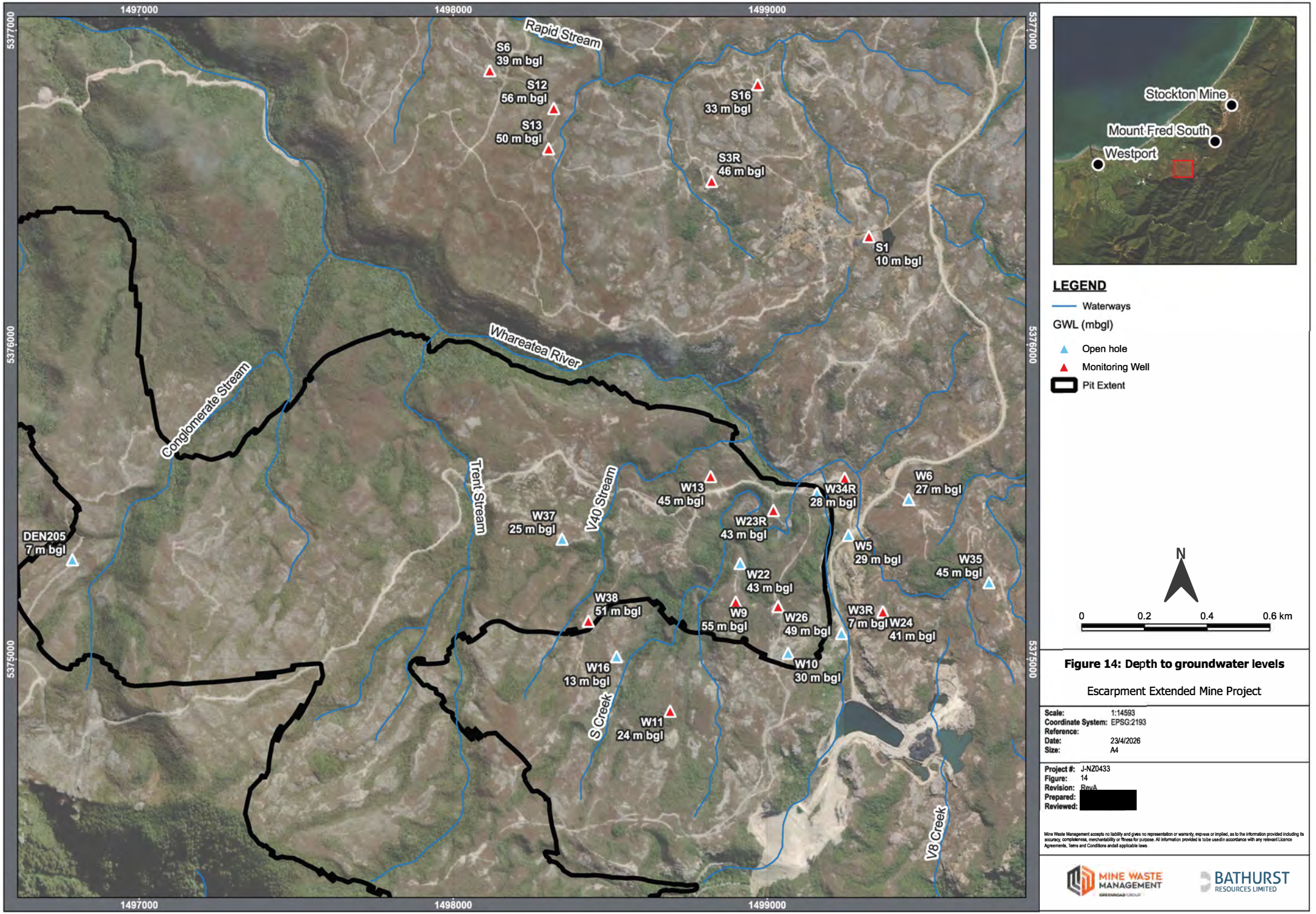

Figure 14: Depth to groundwater levels

Escarpment Extended Mine Project

Scale:	1:14593
Coordinate System:	EPSG:2193
Reference:	
Date:	23/4/2026
Size:	A4

Project #:	J-NZ0433
Figure:	14
Revision:	RevA
Prepared:	[redacted]
Reviewed:	

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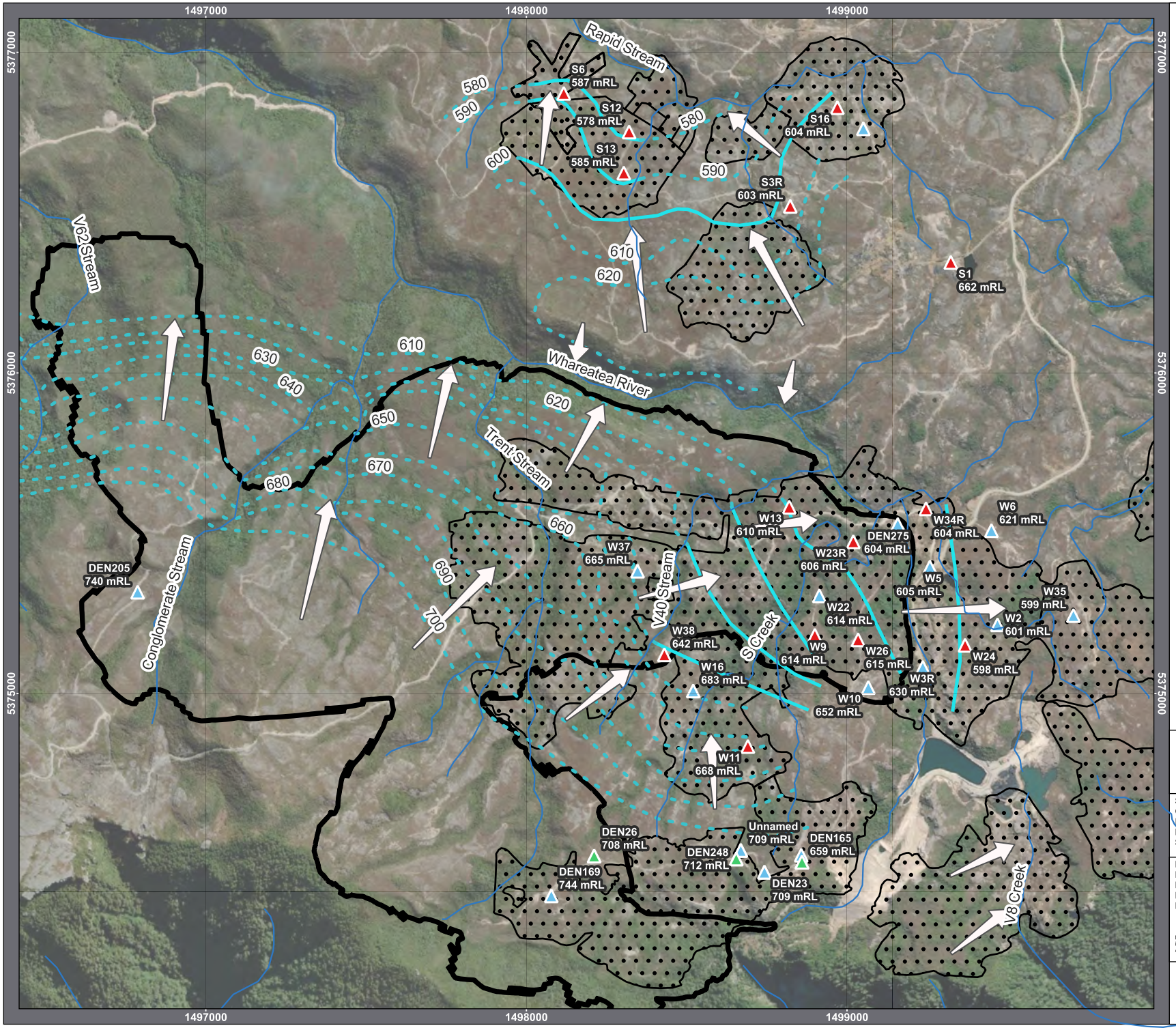

LEGEND

Waterways

Groundwater Flow Regime

Inferred GW Flow Direction

Groundwater Level Contours (Inferred

Groundwater Level Contours

Groundwater Levels

Open hole

Monitoring Well

Pit Extent

Historic Underground Workings

N

0 0.2 0.4 0.6 km

Figure 15: Groundwater Flow Regime

Escarpment Extended Mine Project

Scale:	1:16089
Coordinate System:	EPSG:2193
Reference:	
Date:	28/4/2026
Size:	A4
Project #:	J-NZ0433
Figure:	15
Revision:	Rev0
Prepared:	[redacted]
Reviewed:	

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Available groundwater level measurements over time are presented in Figure 16. Repeat groundwater measurements are consistent through time with the exception of two outliers: W9 and W26 measurement were taken on 1 June 2024, with increases of 27.5 m and 37.5 m respectively compared to the previous measurements taken on 25 January 2021. The outliers are likely spurious; however, it is unclear what has caused the significantly elevated measurements.

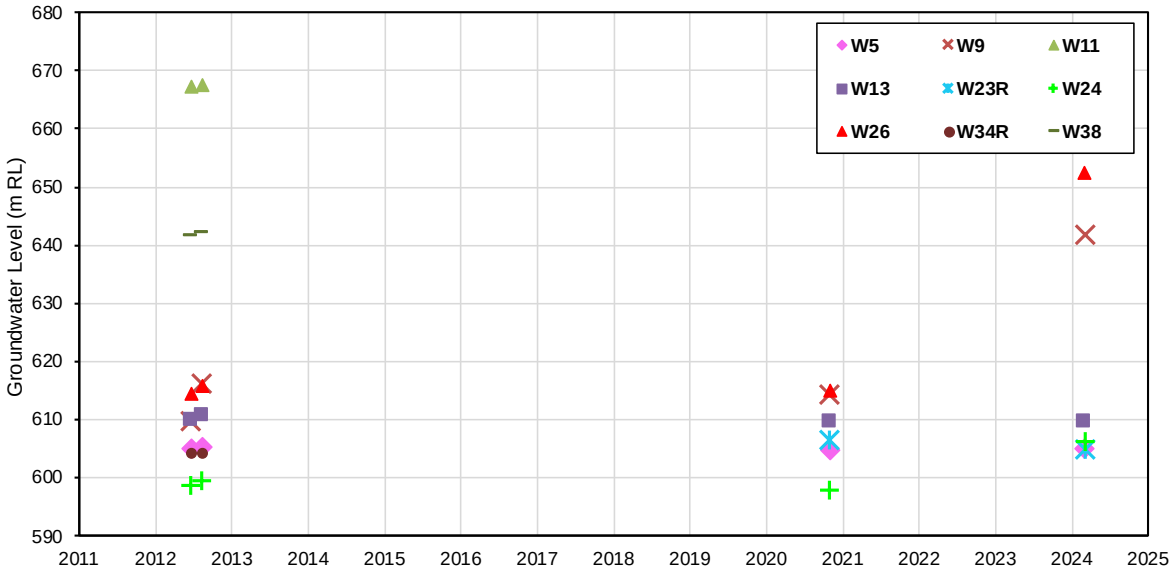

Figure 16: Groundwater levels in monitoring wells.

As shown in Figure 14, available groundwater level data is clustered in the eastern portion of the ESE sub-area, consisting of both monitoring wells and open drillholes (which may be less reliable). This area has an extensive network of underground mine workings. The monitoring well groundwater level data has been tabulated in Table 1, with comparisons to the elevation of the coal floor directly beneath the respective monitoring well location. This allows for comparison of groundwater levels in relation to the coal floor, which is conceptually understood to be the base of the underground workings, where present. The following is noted relating to groundwater levels:

- Groundwater levels are between 1.4 m and 14.3 m above the coal floor with the exception of one outlier (W11). This indicates the phreatic surface is generally in proximity to the elevation of the Mangatini Seam, which aligns with the likely location of the historical underground workings. This is consistent with interpretations made by Golder (2012a). Groundwater levels are typically 50 m below ground level (bgl) in this area.
- The groundwater level within monitoring well W11 is significantly higher than the Mangatini Seam, with an elevation above the coal floor of ~40 m. The cause of this difference is unclear since this well falls within the underground workings but could be due to localised collapses or flooding of the workings near this well due to local synform structures.
- Open drillholes suggest groundwater levels in the south region of the ESE sub-area (e.g., DEN23) are closer to ground surface, in the region of 10 m bgl. Underground workings in this region are known to be first worked only (i.e., not pillared) and potentially flooded in places (Lincoln Agritech Ltd, 2015); either would cause less depression of the water table.

- One open drillhole (i.e., DEN205) on the western side of the ESE sub-area, where underground workings are absent, indicates a shallower depth to water than most eastern wells near underground workings, in the region of 10 m bgl.

Table 1: Groundwater levels in relation to the coal floor.

MONITORING WELL	COLLAR ELEVATION (m RL)[1]	GWL (m RL)[1]	COAL FLOOR (m RL)[1, 2]	GWL ABOVE COAL FLOOR (m)	GWL (m btoc)
W13	654.5	609.6	601	8.6	44.9
W23R	649.0	606.5	601	5.5	42.5
W34R	632.0	604.4*	603	1.4	27.6
W24	638.5	598.0	593	5.0	40.5
W26	664.0	615.2	611	4.2	48.9
W9	668.9	614.4	607	7.4	54.5
W11	691.1	667.5*	628	39.5	23.6
W38	693.1	642.3*	628	14.3	50.8

Notes: *[1]Elevations presented in New Zealand Vertical Datum (NZVD) 2016.*

[2]Coal floor data provided by BRL as elevation contours.

**Measurement taken on 29/10/2012.*

All other measurements taken on 25/01/2021.

Measurements from 2024 were omitted due to the two outliers identified from W9 and W26.

GWL – Groundwater level

m RL – metres above reference level.

m btoc – metres below top of casing.

2.7.2 Groundwater Recharge

Groundwater recharge via land surface infiltration is generally interpreted to be low due to the low K of the BCM and thin overlying soils (where present). The majority of precipitation is interpreted to runoff into the streams and drain from the area. However, elevated infiltration rates are anticipated in areas where land subsidence associated with collapsed underground workings has occurred.

Steady state aquifer recharge estimates for the Cypress Mine and surrounding area, forming part of the nearby Stockton Mine, are between 5-7% of mean annual rainfall (GHD, 2021). While the Cypress Mine has a different hydrogeological setting near its pit, the surrounding area to the west of the pit which is part of the model domain included in GHD (2021) has a similar geological setting with BCM at the surface overlying Basement rock.

Groundwater levels on the eastern side of the ESE sub-area are interpreted to be lower than the Whareatea River (see Section 2.7.5 for further discussion). There is likely some leakage from the river (to groundwater) in this location given the inferred hydraulic gradient, but low K rock would act to limit any leakage.

2.7.3 Groundwater Flow

Piezometric contours have been inferred from the available groundwater level records and are included in Figure 15.

To provide a broader conceptual understanding, groundwater contours have been extrapolated westward over the ESE sub-area. However, these extrapolated contours are not based on direct groundwater level measurements. Instead, they have been estimated using the elevation of surface

water features (e.g., Conglomerate Stream), assuming that groundwater discharge occurs into these waterways. The following observations are made:

- Groundwater flow is interpreted to flow in the inferred dip direction of the underground workings, indicating these provide a strong control on flow direction. The exact flow path past W2 and W35 is uncertain, but ultimately, the majority of the underground workings on the southern half of the Denniston Plateau discharge to the Cascade Creek catchment (Buller Coal Limited, 2014).
- Groundwater on the northern side of the Whareatea River flow northwards, likely following known underground workings in this region that discharge to Rapid Stream.

Minimal groundwater level data from monitoring wells are available to derive groundwater levels or flow directions in the western portion of the site. However, the following can be inferred:

- The absence of mapped underground workings in the western half of the ESE sub-area may indicate higher groundwater levels in relation to the coal seam floor, given that the workings are not acting to drain the groundwater system.
- The groundwater flow direction likely follows the topographical gradient, flowing in a general north to north-easterly direction and discharging to the Whareatea River.

2.7.4 Underground Workings Discharge

The historical underground workings beneath the ESE footprint drain groundwater and are known to discharge to the Cascade Creek catchment via a number of underground mine discharges, including from the Cascade, historical Escarpment, and Coalbrookdale mines. The underground workings are mapped in Figure 15.

Measured flow rates from the study by Jewiss (2018) were highest from the Cascade Mine adits with a combined average flow rate of 214 L/s, compared to 7.8 L/s (Coalbrookdale), 45 L/s (Sullivan), and 17 L/s (historical Escarpment). It is noted that the majority of the underground workings beneath the planned ESE footprint ultimately discharge to the Cascade Creek catchment via the Cascade Mine adits, while the Sullivan Adit discharges to Rapid Stream (Whareatea catchment).

Existing Acid and Metalliferous Drainage (AMD) loads into the Cascade Creek catchment from underground workings have been calculated using measured flow rates and water chemistry data from discharge locations (Jewiss, 2018). Jewiss estimated an average acid load rate of approximately 650,000 kg ($CaCO_3$)/yr, comprising contributions from the Cascade, Coalbrookdale, and historical Escarpment Mines.

2.7.5 Groundwater – Surface Water Interactions

Interpretation of groundwater-surface water interactions based on Figure 14 and Figure 15 indicate the following:

- In the eastern portion of the ESE sub-area, groundwater levels within the monitoring wells are approximately 40-50 m below the stage of the waterways immediately adjacent to the monitoring wells, confirming that the waterways do not receive localised groundwater discharge assuming perched aquifers are absent. Rapid underground flow responses to rainfall at Cascade adits (e.g., Jewiss, 2018) support the interpretation of a strong connection between

land surface recharge and underground workings and absence of perched aquifers within the BCM, at least where underground workings are present. Whilst groundwater levels are confirmed to be lower than the Whareatea River in the upper reaches of the river, it is unclear whether this is the case further downstream where it becomes deeply incised, due to the absence of monitoring wells in that area.

- Elsewhere in the ESE sub-area, groundwater level data taken from open holes suggest shallower groundwater levels, potentially providing localised discharge to the waterways. For example, DEN205, located within 100 m of Conglomerate Stream at the western extent of the site, has a measured groundwater elevation of 740 m RL (7 m bgl). The Conglomerate Stream level is approximately 5 m lower in the vicinity of DEN205, indicating potential discharge of the groundwater table to the stream.
- Surface water may provide recharge to the groundwater system via leakage of stream beds. However, recharge through this process is generally considered to be minimal due to the limited hydraulic conductivity of the underlying rock. There is an exception where collapsed workings have increased rock mass permeability. For example, this was observed at Trent Stream where it intercepts a collapsed portion of the historic Whareatea Mine, which is inferred to drain the stream (Lincoln Agritech Ltd, 2015). Adit flows from the Escarpment and Cascade area are noted to be sensitive to rainfall events, suggesting preferential pathways from land surface to underground workings where they are present.

2.8 Groundwater Users

Review of publicly available West Coast Regional Council data[1] shows all known non-BRL groundwater bores and permitted groundwater takes are located on the coastal flats, over 4 km from the Project (Figure 17). Two permitted groundwater takes associated with the permit number AUTH-RC02239-7 are owned by Buller Coal Limited (a subsidiary of BRL).

[1] *Data source (accessed 15 July 2025):*
https://gis.westcoast.govt.nz/WestMapsViewer/?map=f00edc0d875f4508b76c89e321c64f1a

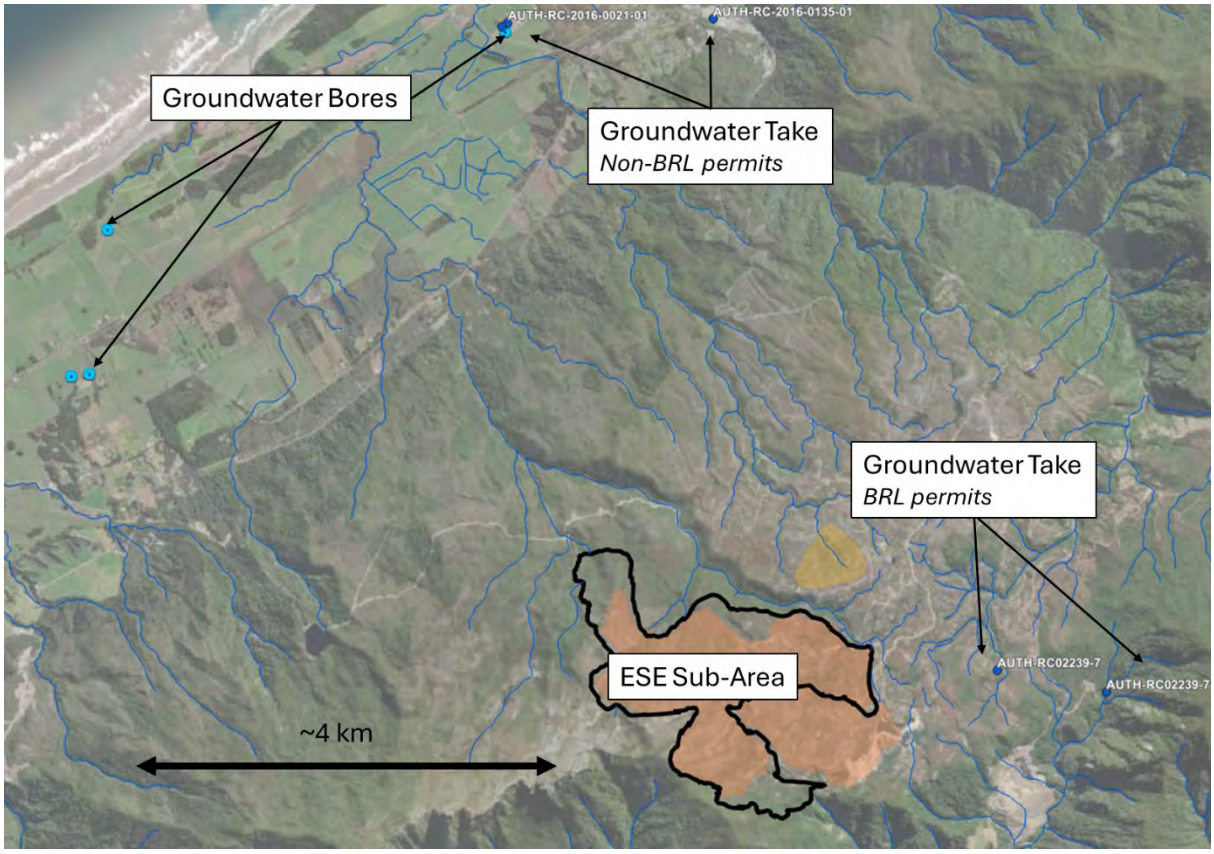

Figure 17: Nearby groundwater bores and permitted takes.

Source: West Coast Regional Council[1].

2.9 Hydrogeological Conceptual Model Summary

This section synthesises the data and information presented in Section 2 into a HCM representing baseline conditions at the ESE sub-area. The HCM is presented visually in Figure 18 and Figure 19as a cross-section, with the section line shown in Figure 20.

The ESE sub-area is characterised by moderately sloping terrain towards the northwest and provides the headwaters of a number of drainage channels. The Whareatea River drains from the ESE sub-area and becomes deeply incised towards the north as it receives inflows from a number of tributaries. The southeastern portion of the ESE drains into the steep topography of the Cascade Creek catchment.

Generally, surface runoff into waterways is high due to the limited soil cover and low to moderate hydraulic conductivity of the rock. However, in areas of subsidence and elevated rock hydraulic conductivity, seepage rates into the groundwater system may be elevated due to the increased fracture intensity.

The two main geological formations on-site (BCM and Basement rock) are considered to form two main HSUs. The HSUs are regionally extensive and groundwater flow at the site is dominated by fracture flow, with hydraulic conductivity anticipated to vary with fracture intensity. Land subsidence resulting from collapse of workings has occurred on-site, and therefore hydraulic conductivity is anticipated to be elevated in these areas. Flashy hydrographs and low baseflow components are consistent with hydraulic conductivity towards the lower end of previous K estimates. However, drainage by underground workings could also explain hydrograph pattern. Higher BCM K estimates from previous groundwater modelling for the Cypress Mine may suggest the BCM fractures are more laterally

connected than Basement, but this has not been demonstrated by field testing. Alternatively, high BCM K could be related to the specific structural setting at the Cypress Mine making it a poor analogue. Overall, the lack of site-specific K data at ESE sub-area makes it difficult to be conclusive about which regional data is most representative. As such, representative bulk K for each HSU could range between:

- BCM 10^{-7} m/s to 10^{-6} m/s. Where mine roof collapse has occurred, K could be even higher.
- Basement 10^{-8} m/s to 10^{-7} m/s.

The phreatic surface is maintained within the BCM within or above the level of the Mangatini Seam in the eastern portion of the ESE sub-area (50 m bgl in places). Outside the footprint of the underground workings, the limited data available suggests the phreatic surface is closer to ground surface (~10 m bgl). Localised perched aquifers may exist between lower K siltstones, but the current monitoring network is not sufficient to identify any of these.

In the east of the ESE sub-area where groundwater levels have been measured near underground workings, it is relatively deep and does not locally discharge to the waterways. However, it is unclear whether groundwater intercepts the Whareatea River further downstream where it becomes increasingly incised. Historical underground workings beneath the eastern part of the site appear to have locally depressurised the groundwater system, and as such are likely to act as a low point for groundwater. These workings are not mapped to extend to the western side of the ESE sub-area; therefore, groundwater conditions may be shallower, and potentially locally discharge to the waterways on this side.

Groundwater is interpreted to flow in a northeasterly direction in the eastern portion of the ESE sub-area, before flowing to the east in alignment with the dip direction of the historical underground workings. The historical underground mine adits discharge into the Cascade Creek catchment and provide a significant AMD load due to the acid generating potential of the disturbed rock. Elsewhere in the ESE sub-area, groundwater is likely to flow in the direction of the topographical gradient downwards to the north or northeast.

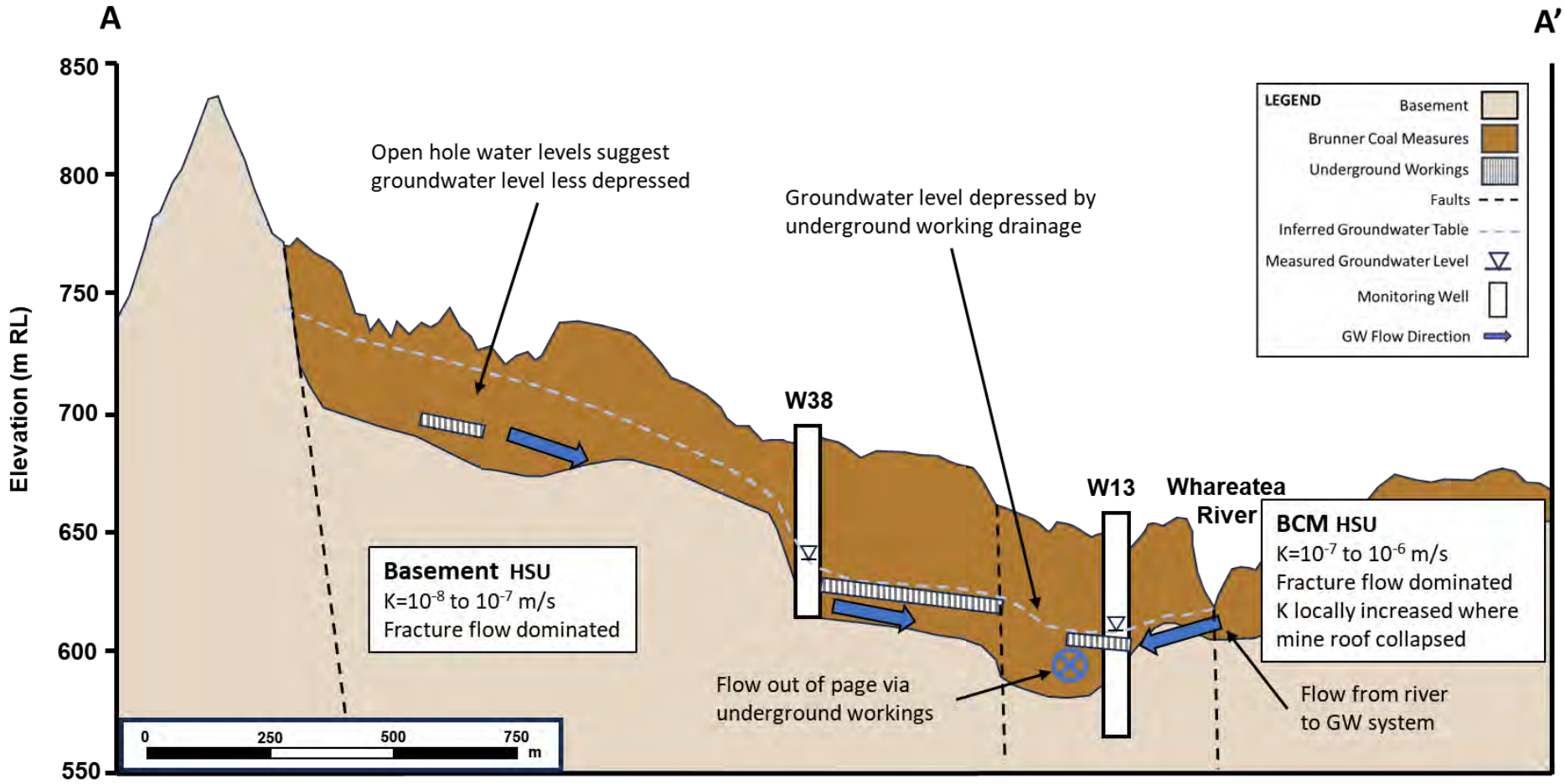

Figure 18: Baseline conceptual model - Section A-A'.

Note: 5x vertical exaggeration applied.

Monitoring wells do not directly intersect cross section, however, are approximately 50 m away.

Underground workings locations are approximate and are based on BRL provided coal floor contours.

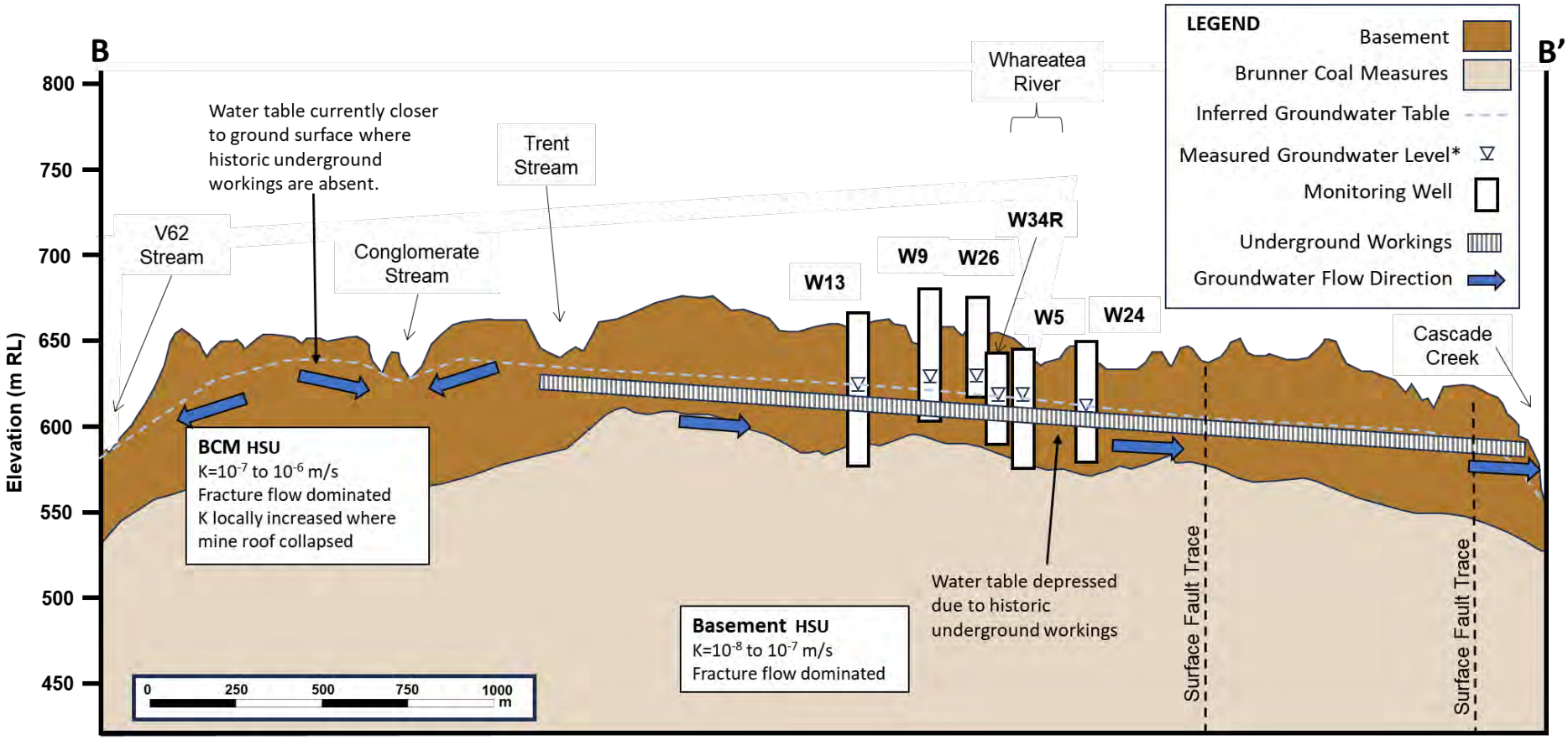

Figure 19: Baseline conceptual model - Section B-B'.

Note: *5x vertical exaggeration applied.*

Monitoring wells do not directly intersect cross section, however, are up to 100 m away.

Underground workings locations are approximate and are based on BRL provided coal floor contours.

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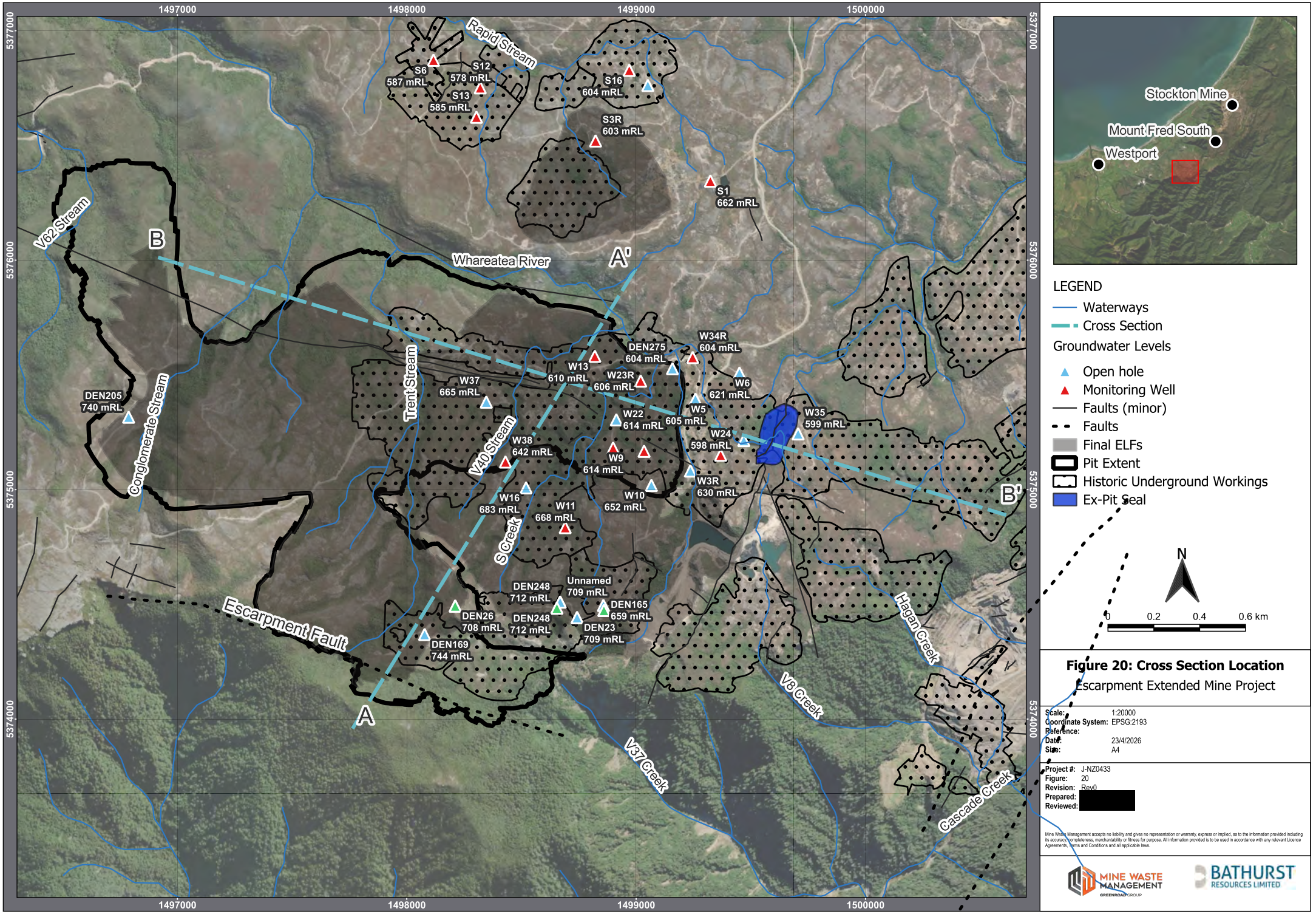

Figure 20: Cross Section Location

Escarpment Extended Mine Project

Scale:	1:20000
Coordinate System:	EPSG:2193
Reference:	
Date:	23/4/2026
Size:	A4
Project #:	J-NZ0433
Figure:	20
Revision:	Rev0
Prepared:	[redacted]
Reviewed:	

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3 GROUNDWATER EFFECTS ASSESSMENT

The effects assessment presented in this section focusses on potential groundwater-related effects that could occur during the operational and post-closure phases of the ESE sub-area. These potential effects are presented in terms of groundwater quantity and groundwater quality.

A HCM for post-closure conditions is shown in Figure 21 and Figure 22 (Figure 20 shows the section locations). Note that the ESE sub-area will involve backfilling of pit voids as the pit expands laterally along with progressive rehabilitation. As such, hydrogeological potential effects will be transient, but are expected to be similar for operations and closure/post-closure conditions.

ESE has the potential to interact with groundwater in the following ways:

- Groundwater Quantity: open pit mining below the water table may alter the groundwater flow regime.
- Groundwater Quality: development of ELFs and associated AMD seepage may alter groundwater quality.

In addition, removal and sealing of the existing underground workings will reduce the associated AMD load (and flow) to Cascade Creek.

Known groundwater users are over 4 km way, located on the coastal flats (see Section 2.8) and are unlikely to be impacted by the ESE sub-area. Any potential effect would be negligible. As such, they are not considered further in this assessment.

Potential effects are described further below based on the HCM and supporting calculations.

3.1 Groundwater Quantity

During operations, passive dewatering (i.e., with in-pit sumps) will be required within the ESE pit given the low bulk K of the rock mass. This practice is consistent with experience at the Stockton Mine where the high rainfall environment means pit dewatering is dominated by rainfall/runoff inflow rather than groundwater inflows.

3.1.1 Groundwater Levels

ESE pit voids will intercept the water table and, along with passive dewatering, will alter the groundwater flow regime by lowering the phreatic surface as the pit void acts as a groundwater sink. The degree of change will vary across the site:

- In the western area of the ESE sub-area that is not influenced by historic underground workings, open pit mining and dewatering will lower the water table in the order 50 to 70 m. For example, the groundwater level at DEN205 is ~740 m RL and the pit floor in the vicinity will be approximately 670 m RL.
- In contrast, where underground workings exist to the east of the ESE sub-area, the pit void depth will be similar to the level of the underground workings, so changes to the water table position will be less. For example, the groundwater level at W23R is ~606 m RL while the pit floor in this vicinity will be approximately 600 m RL.

- In the Sullivan section of the ESE sub-area, groundwater level conditions are unlikely to be altered with the establishment of the Sullivan NAF ELF.

Given the low bulk K of the rock mass, the cone of depression is unlikely to typically extend far from the pit walls.

Review of ELF mine rock properties by Mine Waste Management (2026a), found K to range between 10^{-6} and 10^{-5} m/s, implying the ELFs are likely to be free draining for the most part, enhanced by underdrainage systems. As a result, development of in-pit ELFs is not interpreted to substantially change the groundwater levels near an open pit void once it is backfilled (i.e., they will remain depressed).

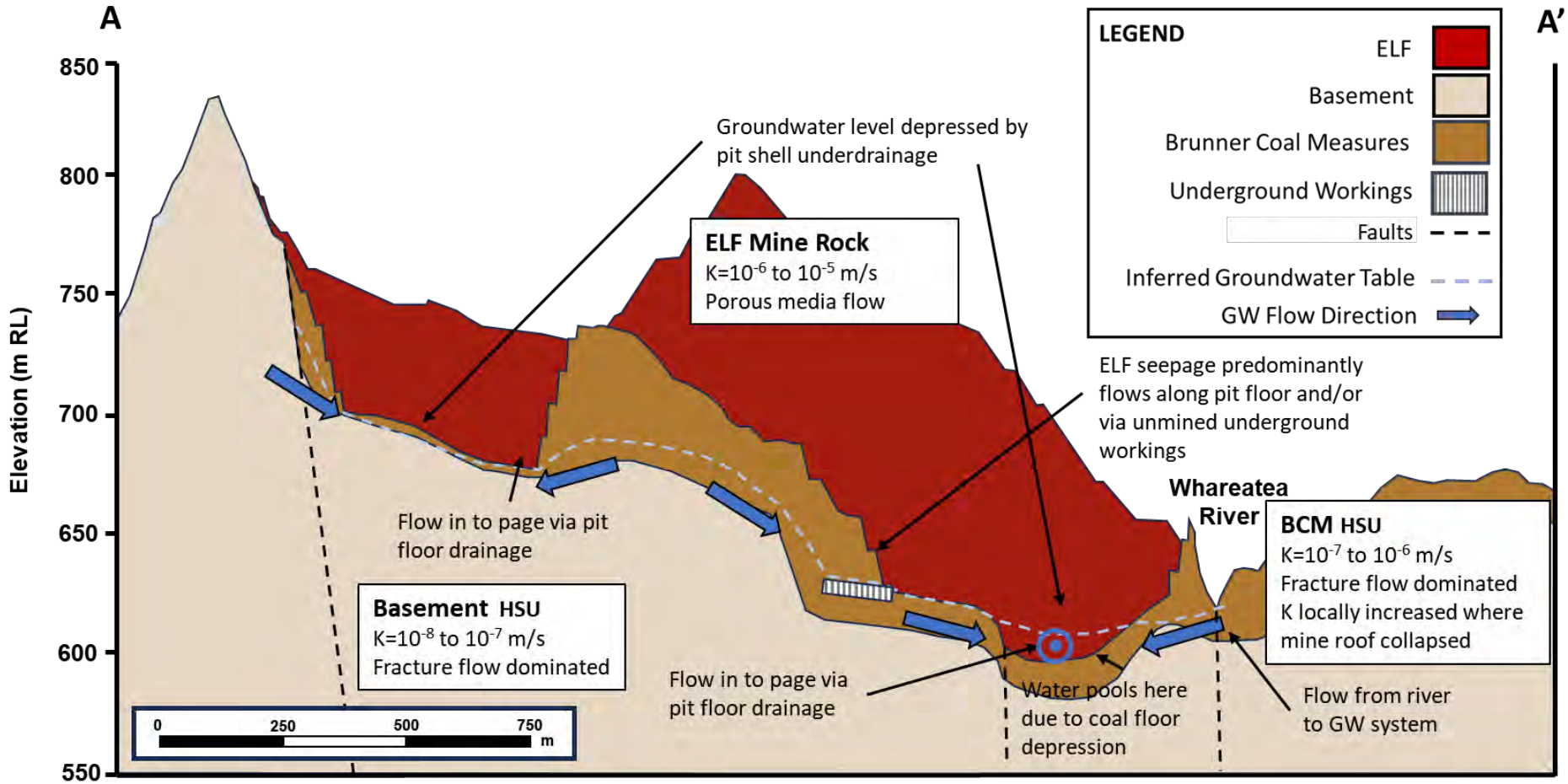

Figure 21: Operations and Post-closure conceptual model - Section A-A'.

Notes: 5x vertical exaggeration applied.

Groundwater table inferred, assuming pit floors drains ELF seepage, except where pooling may occur in natural depressions (as illustrated).

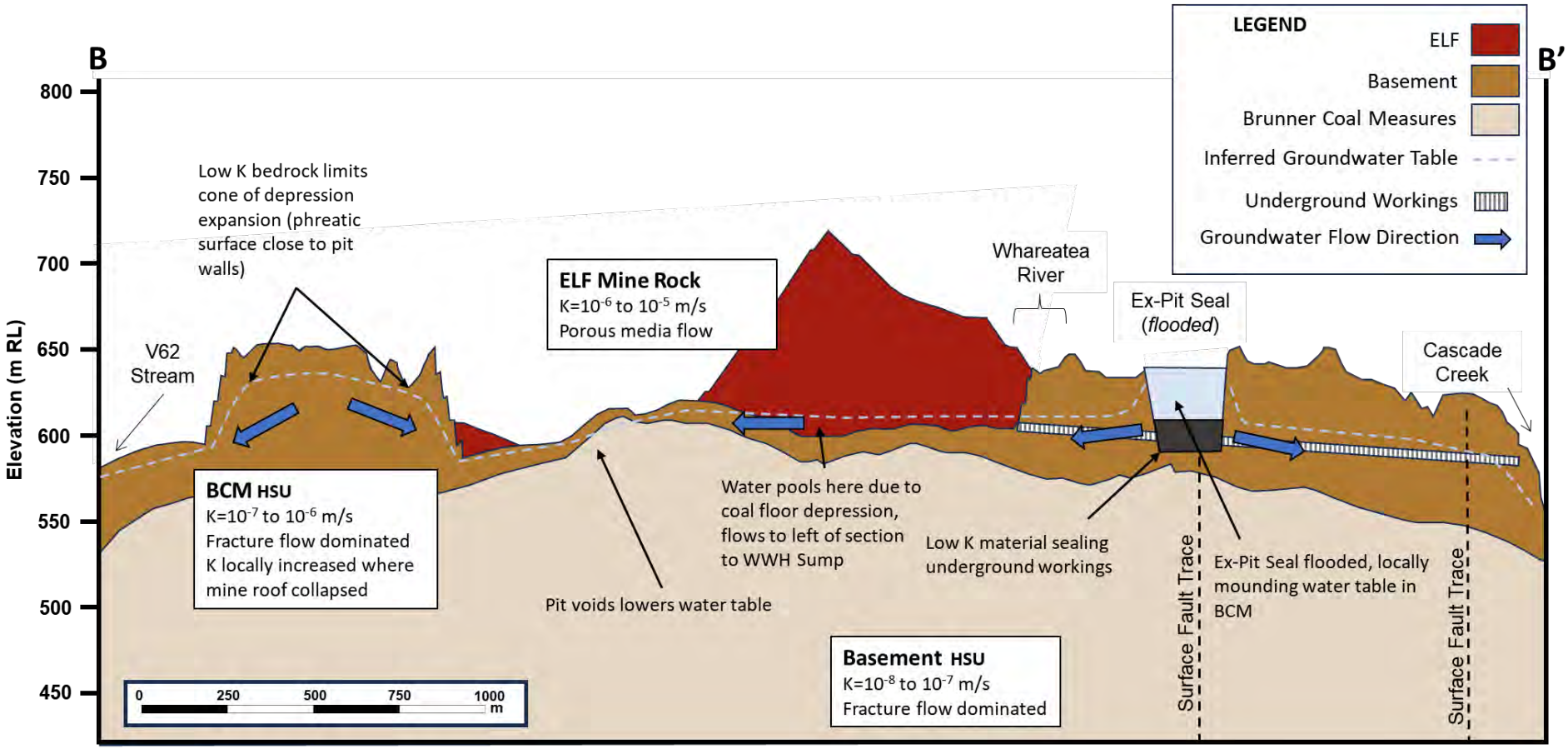

Figure 22: Operations and Post-closure conceptual model - Section B-B'.

Notes: 5x vertical exaggeration applied.

Groundwater table inferred, assuming pit floors drains ELF seepage, except where pooling may occur in natural depressions (as illustrated).

Ex-Spit Seal shown conceptually.

3.1.2 Groundwater Flows

Open pit mining and dewatering activities will likely result in capture of groundwater that would otherwise report to the Whareatea River Catchment and Cascade Creek Catchment. Each is described further below.

3.1.2.1 Whareatea River Catchment

Given the interpreted groundwater levels and groundwater-surface water interactions, this potential effect will be mainly localised to the western portion of the ESE sub-area where a groundwater discharge setting is conceptualised. The ESE WLBM (Mine Waste Management, 2026b) approximates changes in groundwater discharge to the Whareatea River by reducing the baseflow component from undisturbed areas on an aerial basis (i.e., portion of undisturbed area in a given catchment is mined out). The WLBM also incorporates changes in water management, such as in-pit pumping and water treatment discharges. Simulated changes in low flow conditions are tabulated in Table 2. Compared to the simulated baseline conditions, model results suggest low flows, when groundwater is typically the greatest proportion of river/creek flow, will increase substantially in the long term. The increase in low flow is attributed to the steady discharge of treated water. Overall, changes in groundwater flow to streams and rivers is interpreted to be negligible relative to treated water discharges.

Table 2: Whareatea River catchment simulated low flow changes.

PHASE	KEL	V62
Simulated Baseline Conditions	2.4 L/s	0.4 L/s
Operations and Active Closure (2028-2057)	151 L/s [+6,230%]	1.0 L/s [+136%]
Post-closure (2058-2143)	124 L/s [+5,090%]	72 L/s [+17,400%]

Note: simulated 7 day mean annual low flows are presented.

Source: Mine Waste Management, 2026b.

3.1.2.2 Cascade Creek Catchment

Removal of a portion of the historic underground workings that are interpreted to currently discharge to Cascade Creek, along with implementation of the Ex-Pit Seal, will act to lower these flows discharging to Cascade Creek. The underground workings located upgradient of the seal (west) account for an estimated approximately 40% of the total underground workings area discharging into the Cascade Creek catchment. Using the available estimates of Escarpment Adit and Cascade Adit flows (230 L/s, see Section 2.7.4), a reduction of ~90 L/s is calculated assuming a spatially uniform flow generation rate. Although this assumption is a simplification where streams directly discharge to underground workings. Performance monitoring is proposed to confirm the change in flow.

3.2 Groundwater Quality

3.2.1 ELF Seepage

Seepage flow paths from ELFs are shown in Figure 23, and are interpreted as follows:

- At the base of in-pit ELFs, the lower K in situ rock mass will likely promote seepage to preferentially follow the coal floor/pit floor surface. In addition, sub-ELF underdrains and perimeter drains will be cut into bedrock to control seepage flow paths.
- Ex-pit ELFs seepage flow paths will either follow pre-mining topography and/or be transported via underground workings. In both cases, ex-pit ELF seepage will be predominantly directed either back into the backfilled pit void, or to collection and treatment locations.
- In the case of the Sullivan NAF ELF, any ELF seepage reporting to the Sullivan underground workings would discharge to Rapid Stream, where it would mix with higher alkalinity water discharged from the planned MSR in this catchment.

The only areas where AMD seepage would not preferentially flow towards collection locations is where water pools in a sump or within the pit void where a local coal floor depression exists. Three such areas are identified at ESE:

- Ex-Pit Seal, which will collect AMD impacted water.
- WWH Sump, which will collect AMD impacted water.
- Coal floor depression on eastern side of pit void.

Each of these locations is assessed in the following sub-sections.

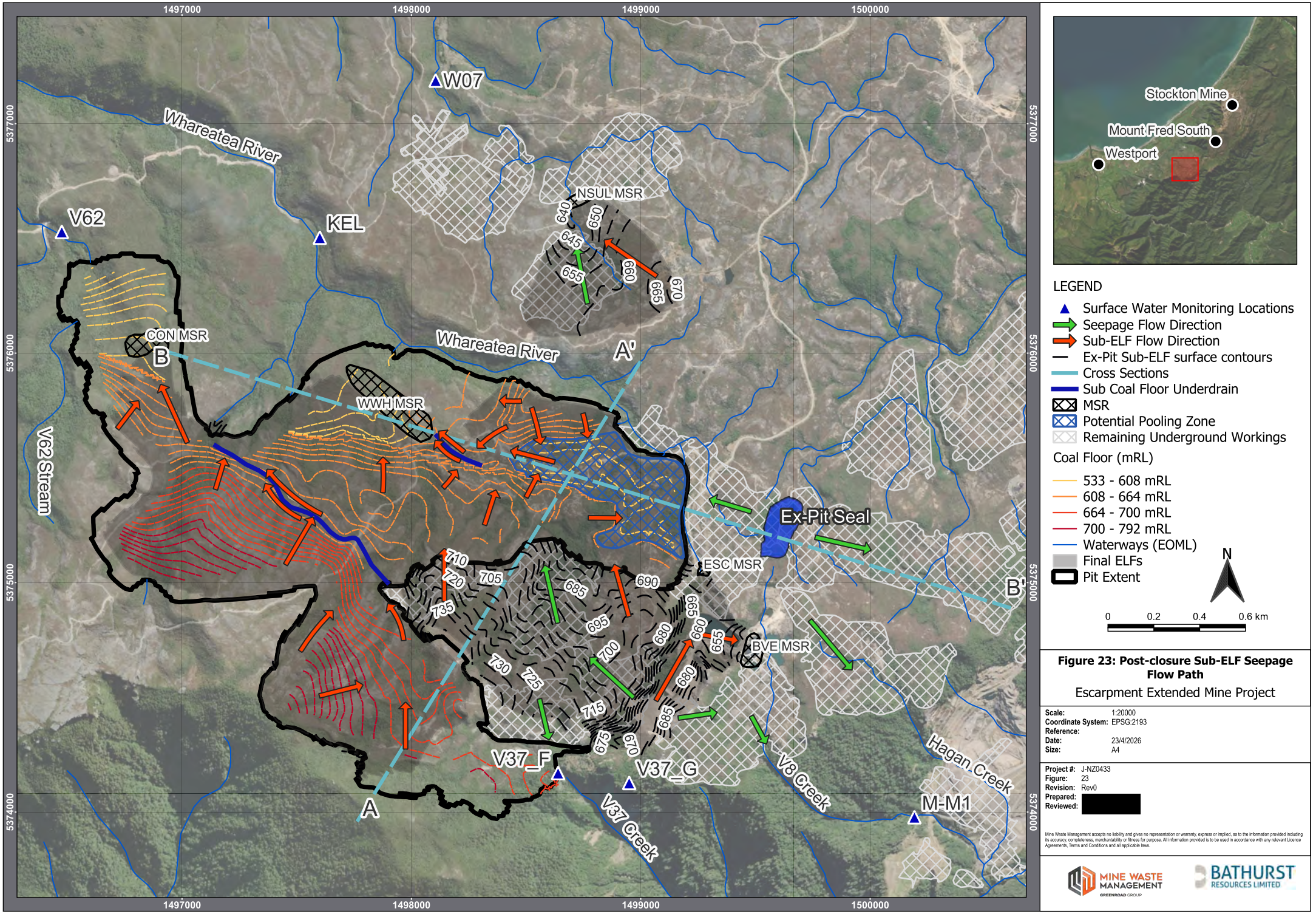

Figure 23: Post-closure Sub-ELF Seepage Flow Path

Escarpment Extended Mine Project

Scale:	1:20000
Coordinate System:	EPSG:2193
Reference:	
Date:	23/4/2026
Size:	A4

Project #:	J-NZ0433
Figure:	23
Revision:	Rev0
Prepared:	[redacted]
Reviewed:	

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3.2.1.1 Ex-Pit Seal

The primary purpose of the Ex-Pit Seal, and associated drillhole plug (Figure 24), is to seal off the historic underground workings to prevent ELF seepage from the ESE sub-area reporting to Cascade Creek (BPCP FTAA Application AEE). In addition, the void will be used as a surge sump for the active WTP. The base of the void will be filled with compacted low permeability material to an appropriate height to seal off connection between the eastern side of the workings to the ESE sub-area. Above this material a void will remain that will function as a surge sump, receiving AMD impacted water during active water treatment. During excavation of the void, any facture networks exposed along the void walls will either be sealed with the basal seal material or sealed with a grout-based injection. Design criteria for the seals, including material to be used and target permeability will be established at the detailed design stage.

Post-closure, once active water treatment is no longer needed, the sump will not receive AMD affected water. Underground workings west of the Ex-Pit Seal would be flooded to a certain extent, and flow towards the ESE pit void.

Any leakage from the Ex-Pit Seal would report either west, to the ESE pit (and be managed with in-pit ELF seepage), or east to Cascade Creek (via the underground workings). Leakage out of the Ex-Pit Seal void will predominantly be through the intact rock mass rather than the low permeability seal (assuming the seal is 10^{-8} m/s or lower). A leakage rate of ~0.5 L/s from each side was estimated based on Darcy's Law (Darcy, 1856) and the adopted parameters in Table 3. This is orders of magnitude lower than anticipated underground working discharge to Cascade Creek of ~140 L/s (see Section 3.1.2.2).

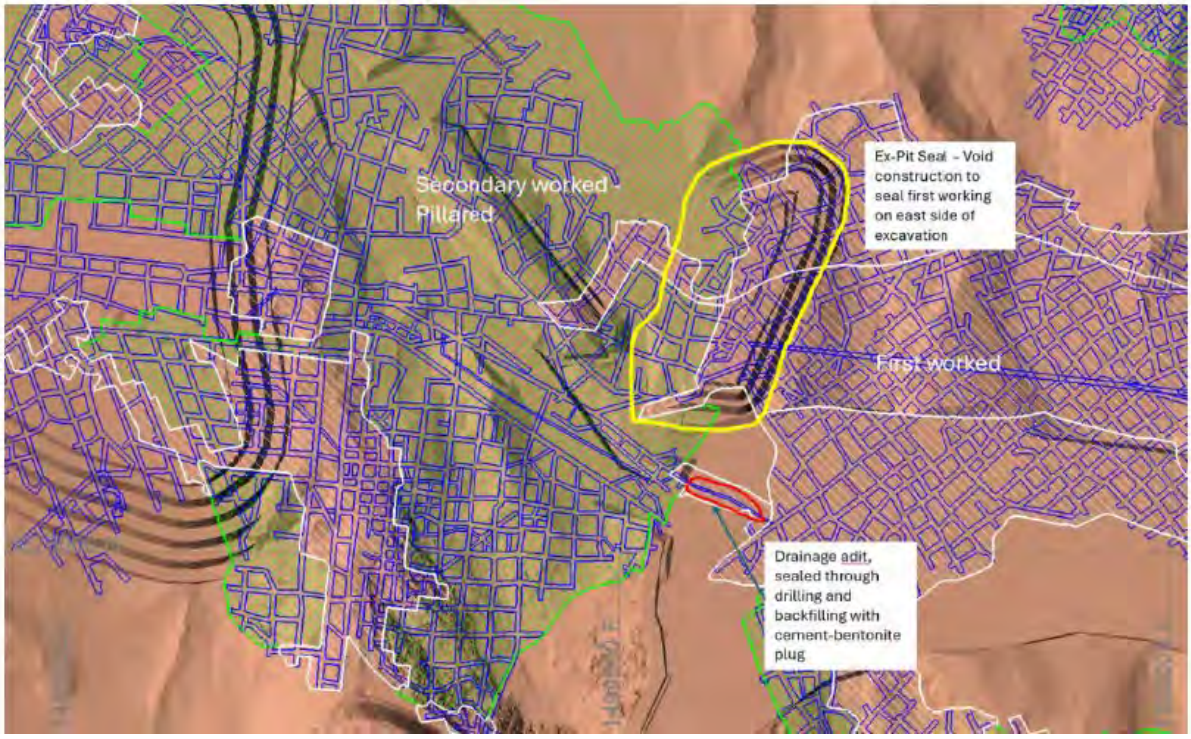

Figure 24: Ex-Pit Seal location.

Source: BRL.

Table 3: Adopted parameters for calculation of seepage from Ex-Pit Seal.

PARAMETER	VALUE	UNIT	JUSTIFICATION
Hydraulic Conductivity	$5x10^{-7}$	m/s	Midpoint of estimated BCM rock hydraulic conductivity range.
Hydraulic Gradient	0.3	-	Based on sump level of 630 m RL, underground workings water level of 600 m RL, and distance from sump to river of 100 m.
Sump width	200	m	Width of sump.
Depth	20	m	Water column depth assuming water level of 630 m RL and top of Ex-Pit Seal at 610 m RL.

Any remaining underground workings (i.e., not mined out) west of the Ex-Pit Seal will still produce a certain amount of AMD load. This load is accounted for in the ESE WLBM.

3.2.1.2 WWH Sump

The WWH Sump will collect both mine affected surface water and AMD impacted water while active treatment occurs (BPCP FTAA Application AEE). The water level in the sump will likely be maintained at a low level for the majority of the time, only increasing for short durations following significant rainfall events. The operational sump level (590 m RL or lower) is anticipated to be below the adjacent Whareatea River level (~600 m RL), such that leak via groundwater to the river would be very limited.

Once treatment in this area switches from active to passive, the sump will fill with water and receive treated water outflows from the MSR, and spill to the Whareatea River. Ultimately, these outflows will improve water quality and other groundwater discharges would be small relative to surface spilling flow.

3.2.1.3 Sub-ELF Pooling Zone

The coal floor depression shown in Figure 23 and Figure 25 may pool with AMD affected water up to a level of ~610 m RL. Above this elevation seepage would report to the WWH Sump location via ELF underdrains. During the active treatment phase, the operational level of the WWH Sump (590 m RL or lower) will be the hydraulic low point for any seepage from the pooled water. When the sump is full and spilling once treatment in this area switches from active to passive (~600 m RL), there may be a small portion of seepage from the pool that could report directly to the Whareatea River. Applying Darcy's Law (Darcy, 1856) with the adopted parameters in Table 4 suggests any seepage from this pooled water would be in the order of 0.025 L/s, which is orders of magnitude lower than simulated 7 day mean annual low flows in the Whareatea River of 100 L/s (Mine Waste Management, 2026b) if it is conservatively assumed all this seepage bypasses the sump and reports directly to the river. This suggests dilution factors of ~4,000:1.

Table 4: Adopted parameters for calculation of seepage from the sub-ELF pooling zone.

PARAMETER	VALUE	UNIT	JUSTIFICATION
Hydraulic Conductivity	$5x10^{-7}$	m/s	Midpoint of estimated BCM rock hydraulic conductivity range.
Hydraulic Gradient	0.0125	-	Based on pooling area water level of 610 m RL, river elevation of 605 m RL, and distance from sump to river of 400 m.
Width	400	m	Width pooling area towards river.
Depth	10	m	Water column depth assuming water level of 610 m RL and the base of the pit at 600 m RL.

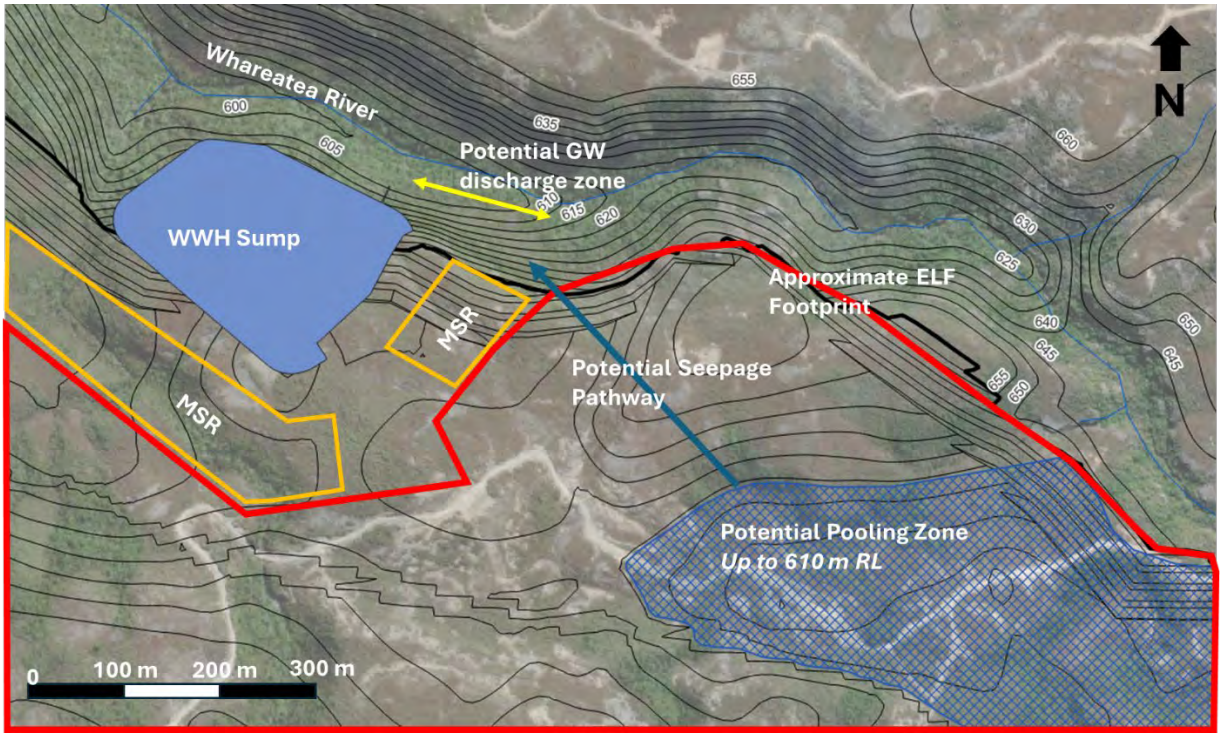

Figure 25: Potential untreated groundwater discharge zone from groundwater pooling.

Notes: Contours (black) indicate mined out surface (m RL).
Thick black line shows ESE pit extent.
Orange line shows indicative mussel shell reactor (MSR) footprint.
Red line shows approximate engineered landform (ELF) footprint.
m RL = meters above reference level.
Reference level is New Zealand Vertical Datum.

3.2.2 Cascade Creek AMD Load

Previous estimates of existing AMD load from underground workings reporting to Cascade Creek were in the order of 650,000 kg ($CaCO_3$)/yr (Jewiss, 2018). The development of the Ex-Pit Seal and mining out of underground workings by the ESE pit is anticipated to reduce this load. Assuming the AMD load from the underground workings is approximately uniform, and assuming the underground discharge is reduced by 40% (commensurate with the removal of the existing underground workings, see Section 2.7.4), the emplacement of the seal is estimated to reduce acidity loads by the same proportion or a reduction of 260,000 kg ($CaCO_3$)/yr. Reduction in acidity load would theoretically improve water quality in Cascade Creek.

4 CONCLUSIONS

Findings from the assessment are summarised below:

4.1 Groundwater Quantity

4.1.1 Groundwater Levels

- Pit excavation and dewatering will intercept the water table, forming a groundwater sink during operations. During operations and post-closure, the passive drainage of backfilled pit voids will mean this condition likely remains.
- The degree of change in groundwater level will vary by location across the ESE sub-area. Near existing underground workings that have already lowered groundwater levels on the eastern side of the ESE sub-area, pit excavation and dewatering are estimated to reduce groundwater levels in the region of 5 m.
- On the western side of the ESE sub-area where groundwater levels are interpreted to be shallower with an absence of existing underground workings, groundwater levels may be lowered in the range of 50 to 70 m in places.

4.1.2 Groundwater Flows

- In the Whareatea River catchment, discharge of groundwater to streams and rivers will be reduced as contributing catchment is mined out and the pit void acts as a groundwater sink. However, the more permeable nature of ELFs compared to the undisturbed in situ BCM means treated ELF seepage will offset any changes in groundwater discharge to Whareatea River. Overall, changes in groundwater flow to streams and rivers are interpreted to be negligible relative to treated water discharges. Changes in low flow conditions are assessed further in the ESE WLBM (Mine Waster Management, 2026b).
- In the Cascade Creek catchment, mining out and sealing off of existing underground workings is estimated to reduce the amount of underground mine discharge to this catchment by approximately 40%.

4.2 Groundwater Quality

4.2.1 ELF Seepage

In most cases, ex-pit and in-pit ELF seepage will be collected for treatment. Areas where ELF seepage could pool and develop a driving head towards surface water receptors were identified. Calculated flow rates were orders of magnitude lower than anticipated low flow conditions, suggesting dilution factors of 10^3 or more. In stream water quality is assessed further in the ESE WLBM.

4.2.2 Cascade Creek AMD Load

Assuming loading from the underground workings discharging to Cascade Creek is spatially uniform, mining out and sealing off of existing underground workings is estimated to reduce the AMD load by similar amount as the flow (i.e., ~40%).

Known groundwater users are over 4 km way, located on the coastal flats and unlikely to be impacted by the Project.

5 RECOMMENDATIONS

Recommendations for forward works to support final design and confirm assumptions made in this assessment are as described below.

5.1 Forward Works

This assessment has been completed based on estimates of hydraulic properties (e.g., hydraulic conductivity, K) of the BCM and Basement units documented in other areas of the Buller Plateaux. Available data is considered sufficiently representative to be applied to the ESE sub-area for this assessment. Prior to operations commencing in the ESE sub-area it is recommended that a hydrogeological characterisation programme is completed to confirm this assumption remains appropriate. The following programme partitioning is proposed:

- Prior to operations commencing, complete a hydrogeological characterisation programme focused on the eastern portion of the ESE sub-area (Stage 1 through 4). Performance monitoring wells will be established in Area B (see Figure 26).
- During operations, complete a hydrogeological characterisation programme focused on the western portion of the ESE-sub area (Stage 5 onwards). Performance monitoring wells will be established in Area A (see Figure 26). MWM recommend this second programme occur no less than one year before Stage 5 occurs to advance understanding of pre-mining groundwater condition in the western portion of the ESE sub-area.

Both programmes will focus on confirming hydraulic properties, groundwater levels, and background groundwater quality.

5.2 Performance Monitoring

Based on interpretation of currently available data, the pit is anticipated to act as a groundwater sink long term (except for the identified zone of sub-ELF pooling). A reasonable amount of groundwater level data to the eastern side of the pit is available to support this interpretation. However, performance monitoring is required to confirm this condition is maintained. It is recommended further hydrogeological characterisation works be completed during the construction phase to (i) confirm groundwater levels on the western side of the pit area remote from underground workings, and (ii) allow for groundwater monitoring (water levels and quality) between the in-pit ELFs and surface water receptors to confirm the pit does act as a groundwater sink, thereby limiting potential pathways to receptors (i.e., performance monitoring). Areas for long term monitoring to target are shown in Figure 26. Further details on the planned groundwater monitoring are provided in Appendix A, to be refined as mine design studies advance. Collected monitoring data will support adaptive management and development of trigger action response plans.

It is recommended that groundwater level monitoring is undertaken using a combination of automatic pressure transducers with data loggers, and manual measurements. The groundwater level monitoring network should be maintained for the duration of the Project to monitor long term groundwater levels.

Efficient collection of in-pit ELF seepage is predicated on maintaining a lower phreatic surface within the backfilled material than that external to the pit. Although the higher K backfill material (compared to in-situ rock) and use of underdrains will act to lower the phreatic surface within the in-pit ELFs, high rainfall conditions could theoretically counteract this leading to higher in-pit phreatic surface than

anticipated. Therefore, to compliment groundwater monitoring external to the pit, the phreatic surface within the ELF should be monitored to confirm the basal drainage network is performing adequately and the pit remains a hydraulic sink, thereby minimising the potential for ELF seepage to reach surface water receptors. This can be achieved by installing nested vibrating wire piezometers (VWPs) following rehabilitation. Approximately five sets of nested VWPs should be installed, primarily along the northern face of the ELF. In addition, periodic seepage surveys should be completed following rehabilitation to identify any unexpected seepage emerging through the rehabilitation surface. Collection of this data will support management processes.

Changes to underground workings flows and AMD loads reporting to Cascade Creek should be confirmed by monitoring creek flow and water quality in this catchment. This monitoring program needs to be developed to confirm betterment opportunities.

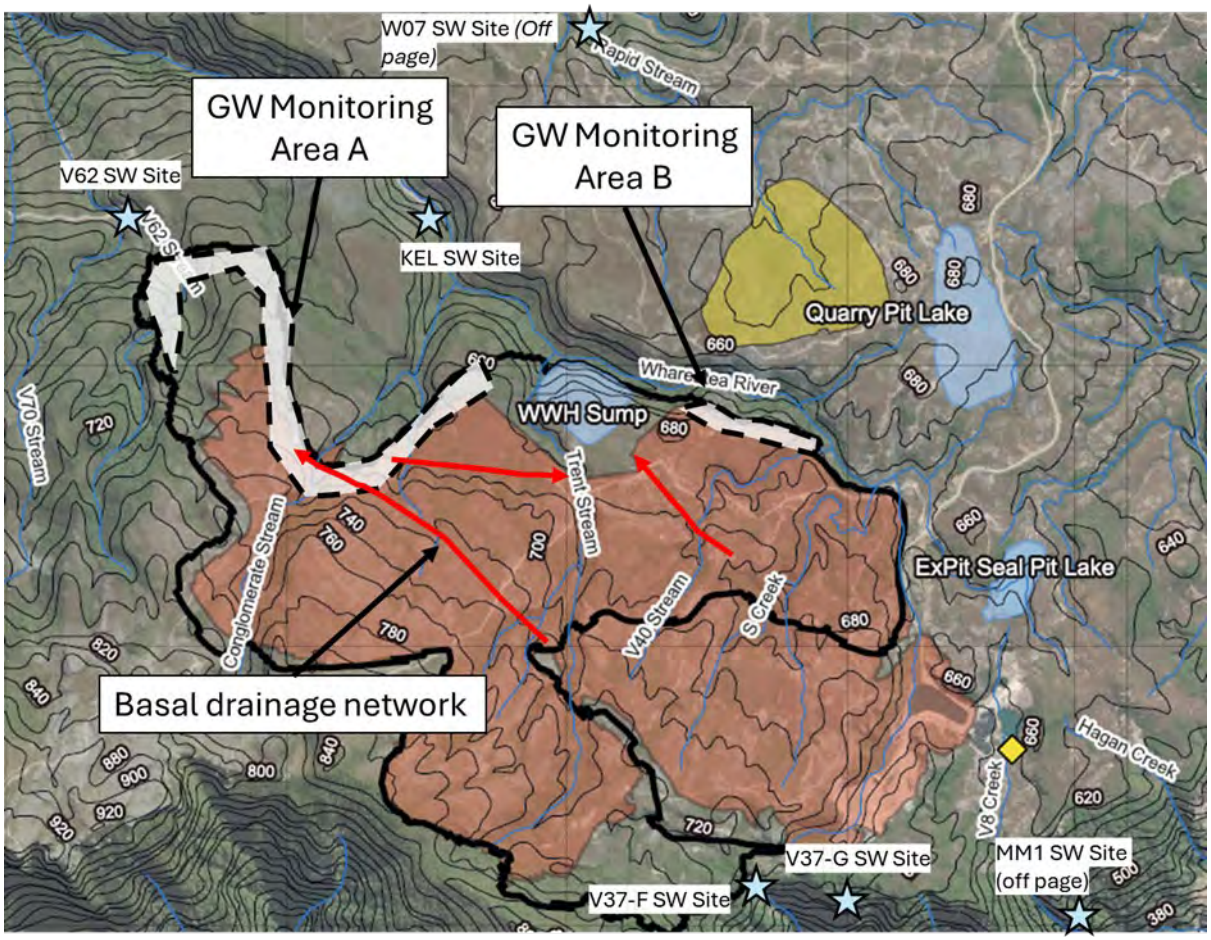

Figure 26: Proposed groundwater monitoring areas.

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7 LIMITATIONS

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

APPENDIX A PROPOSED GROUNDWATER MONITORING

Table A.1: Proposed groundwater monitoring details.

DETAILS	DESCRIPTION
Monitoring purpose	The purpose of the groundwater monitoring activities will be to: • Monitor for potential seepage migration along groundwater flow pathways.
Number of monitoring wells	The proposed number of monitoring wells proposed for each area (see Figure 25 for location), are provided below: • Area A: 4 • Area B: 1 Location and number of wells will be refined as mining studies advance.
Screen targets	Screens will target intercepted structures (e.g., fracture zones) and/or bedding contacts (e.g., BCM and Basement contact).
Sampling frequency	Sampling frequency will be quarterly.
Sampling methodology	• Manual and automated (with pressure transducers) groundwater level measurement. • Low flow sampling methodology is the preferred method to obtain a representative sample where possible.
Sampling parameters	Field: • Groundwater level (manual and from pressure transducers). • pH, temperature, electrical conductivity, oxidation reduction potential, dissolved oxygen. Laboratory: • pH • Electrical Conductivity • Alkalinity • Acidity (to pH 8.3) • Sulfate • Dissolved Aluminium • Dissolved Zinc • Dissolved Iron • Dissolved Nickel • Dissolved Copper • Dissolved Cadmium • Dissolved Manganese • Dissolved Calcium • Dissolved Magnesium • Dissolved Organic Carbon • Total Suspended Solids • Turbidity
Quality Control sampling	• One trip blank per sampling event. • One duplicate sample per every 10-20 primary samples. • One field blank per sampling event
Reporting requirements	Groundwater monitoring data collected will be reported in an annual water report alongside surface water monitoring.

APPENDIX B LIMITATIONS

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APPENDIX S ELF WATER QUALITY AND MSR DESIGN SUMMARY

ELF Water Quality and MSR Design Summary

Buller Plateaux Continuation Project

21 July 2026

J-NZ0453-006-R-FINAL

MINE WASTE MANAGEMENT
GREENROAD GROUP

BATHURST
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ELF Water Quality and MSR Design Summary

Buller Plateaux Continuation Project

Document Number: J-NZ0453-006-R-FINAL

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TABLE OF CONTENTS

1 Introduction 1
1.1 Background 1
1.2 Report Objectives 1
2 Project Background and Design Principles 3
2.1 BPCP Timeline 3
2.2 Treatment Options 4
2.3 Purpose 5
2.4 ESE Engineered Landforms 5
2.5 Mt Fred South Engineered Landforms 8
2.6 Upper Waimangaroa Haul Road 11
2.7 Background – Barren Valley ELF Water Quality Model 11
2.8 Estimating ELF Water Quality and Flow Rates 13
2.8.1 ELF Basal Sub-catchment Modelling 13
2.9 Long Term Acidity Load 14
2.10 MSR Treatment Efficiencies 15
2.11 Passive Treatment Capacity 16
2.12 Model Clarifications 17
2.13 Uncertainty 18
2.14 Model Integration 19
2.15 Sensitivity Modelling 19
3 BVE ELF Basal Sub-Catchment 20
3.1 BVE ELF Model Inputs 20
3.2 BVE ELF Water Quality 20
3.3 BVE ELF Water Quality Model 21
3.4 BVE ELF Mussel Shell Reactor Conceptual Design 22
4 CON ELF Basal Sub-Catchment 23
4.1 CON ELF Model Inputs 23
4.2 CON ELF Water Quality 23
4.3 CON ELF Water Quality Model 24
4.4 CON ELF Mussel Shell Reactor Conceptual Design 25
5 NSUL ELF Basal Sub-Catchment 26
5.1 NSUL ELF Model Inputs 26
5.2 NSUL ELF Water Quality 26
5.3 NSUL ELF Long-term PCOC Decay 27
5.4 NSUL ELF Mussel Shell Reactor Conceptual Design 28
6 PPG ELF Basal Sub-Catchment 29
6.1 PPG ELF Model Inputs 29
6.2 PPG ELF Water Quality 29
6.3 PPG ELF Long-term PCOC Decay 30

6.4 PPG ELF Mussel Shell Reactor Conceptual Design 31
7 ESC ELF Basal Sub-Catchment 32
7.1 ESC ELF Model Inputs 32
7.2 ESC ELF Water Quality 32
7.3 ESC ELF Water Quality Model 33
7.4 ESC ELF Mussel Shell Reactor Conceptual Design 34
8 WWH ELF Basal Sub-Catchment 35
8.1 WWH ELF Model Inputs 35
8.2 WWH ELF Water Quality 35
8.3 WWH ELF Water Quality Model 36
8.4 WWH ELF Mussel Shell Reactor Conceptual Design 37
9 MSR1 ELF Basal Sub-Catchment 38
9.1 MSR1 ELF Model Inputs 38
9.2 MSR1 ELF Water Quality 38
9.3 MSR1 ELF Water Quality Model 39
9.4 MSR1 ELF Mussel Shell Reactor Conceptual Design 40
10 MSR2 ELF Basal Sub-Catchment 41
10.1 MSR2 ELF Model Inputs 41
10.2 MSR2 ELF Water Quality 41
10.3 MSR2 ELF Water Quality Model 42
10.4 MSR2 ELF Mussel Shell Reactor Conceptual Design 43
11 MSR3 ELF Basal Sub-Catchment 44
11.1 MSR3 ELF Model Inputs 44
11.2 MSR3 ELF Water Quality 44
11.3 MSR3 ELF Water Quality Model 45
11.4 MSR3 ELF Mussel Shell Reactor Conceptual Design 46
12 MSR4 ELF Basal Sub-Catchment 47
12.1 MSR4 ELF Model Inputs 47
12.2 MSR4 ELF Water Quality 47
12.3 MSR4 ELF Water Quality Model 48
12.4 MSR4 ELF Mussel Shell Reactor Conceptual Design 49
13 MSR5 ELF Basal Sub-Catchment 50
13.1 MSR5 ELF Model Inputs 50
13.2 MSR5 ELF Water Quality 50
13.3 MSR5 ELF Water Quality Model 51
13.4 MSR5 ELF Mussel Shell Reactor Conceptual Design 52
14 MSR6 ELF Basal Sub-Catchment 53
14.1 MSR6 ELF Model Inputs 53
14.2 MSR6 ELF Water Quality 53
14.3 MSR6 Water Quality Model 54
14.4 MSR6 ELF Mussel Shell Reactor Conceptual Design 55

15 MSR7 ELF Basal Sub-Catchment 56
15.1 MSR7 ELF Model Inputs 56
15.2 MSR7 ELF Water Quality 56
15.3 MSR7 ELF Water Quality Model 57
15.4 MSR7 ELF Mussel Shell Reactor Conceptual Design 58
16 MDC1 ELF Basal Sub-Catchment 59
16.1 MDC1 ELF Model Inputs 59
16.2 MDC1 ELF Water Quality 59
16.3 MDC1 ELF Long-term PCOC Decay 60
16.4 MDC1 ELF Mussel Shell Reactor Conceptual Design 61
17 MDC2 ELF Basal Sub-Catchment 62
17.1 MDC2 ELF Model Inputs 62
17.2 MDC2 ELF Water Quality 62
17.3 MDC2 ELF Long-term PCOC Decay 63
17.4 MDC2 ELF Mussel Shell Reactor Conceptual Design 64
18 MSR8 ELF Basal Sub-Catchment 65
18.1 MSR8 ELF Model Inputs 65
18.2 MSR8 ELF Water Quality 65
18.3 MSR8 ELF Water Quality Model 66
18.4 MSR8 ELF Mussel Shell Reactor Conceptual Design 67
19 MSR9 ELF Basal Sub-Catchment 68
19.1 MSR9 ELF Model Inputs 68
19.2 MSR9 ELF Water Quality 68
19.3 MSR9 ELF Water Quality Model 69
19.4 MSR9 ELF Mussel Shell Reactor Conceptual Design 70
20 MSR10 ELF Basal Sub-Catchment 71
20.1 MSR10 ELF Model Inputs 71
20.2 MSR10 ELF Water Quality 71
20.3 MSR10 ELF Water Quality Model 72
20.4 MSR10 ELF Mussel Shell Reactor Conceptual Design 73
21 MSR11 ELF Basal Sub-Catchment 74
21.1 MSR11 ELF Model Inputs 74
21.2 MSR11 ELF Water Quality 74
21.3 MSR11 ELF Water Quality Model 75
21.4 MSR11 ELF Mussel Shell Reactor Conceptual Design 76
22 MSR12 ELF Basal Sub-Catchment 77
22.1 MSR12 ELF Model Inputs 77
22.2 MSR12 ELF Water Quality 77
22.3 MSR12 ELF Water Quality Model 78
22.4 MSR12 ELF Mussel Shell Reactor Conceptual Design 79
23 Summary 80

23.1 Summary – Acidity Loads 80
23.2 Summary – Passive Treatment 81
23.3 Overview 83
24 References 85
25 Limitations 87
Appendix A Limitations 88

LIST OF TABLES

Table 1: Proposed Escarpment Extended Project ELF sub-catchment descriptions. 7
Table 2: Proposed Mt Fred South ELF sub-catchment descriptions. 10
Table 3: MSR treatment efficiencies. 16
Table 4: General guidelines for selection - active versus passive treatment 17
Table 5: BVE ELF basal sub-catchment water quality model criteria. 20
Table 6: BVE ELF model source terms and respective loads for FY2036 (Post Stabilisation Phase). 20
Table 7: BVE ELF MSR sizing. 22
Table 8: CON ELF basal sub-catchment water quality model criteria. 23
Table 9: CON ELF model source terms and respective loads for FY2047 (Post Stabilisation Phase). 23
Table 10: CON ELF MSR sizing. 25
Table 11: NSUL ELF basal sub-catchment water quality model criteria. 26
Table 12: NSUL ELF model source terms and respective loads for FY2036 (Post Stabilisation Phase) 26
Table 13: NSUL ELF MSR sizing. 28
Table 14: PPG ELF basal sub-catchment water quality model criteria. 29
Table 15: PPG ELF model source terms and respective loads for FY2033 (Post Stabilisation Phase). 29
Table 16: PPG ELF MSR sizing. 31
Table 17: ESC ELF basal sub-catchment water quality model criteria. 32
Table 18: ESC ELF model source terms and respective loads for FY2031 (Post Stabilisation Phase). 32
Table 19: ESC ELF MSR sizing. 34
Table 20: WWH ELF basal sub-catchment water quality model criteria. 35
Table 21: WWH ELF model source terms and respective loads for FY2050 (Post Stabilisation Phase). 35
Table 22: WWH ELF MSR sizing. 37
Table 23: MSR1 ELF basal sub-catchment water quality model criteria. 38
Table 24: MSR1 ELF model source terms and respective loads for FY2031 (Post Stabilisation Phase). 38
Table 25: MSR1 ELF MSR sizing. 40
Table 26: MSR2 ELF basal sub-catchment water quality model criteria. 41

Table 27: MSR2 ELF model source terms and respective loads for FY2030 (Post Stabilisation Phase). 41
Table 28: MSR2 ELF MSR sizing. 43
Table 29: MSR3 ELF basal sub-catchment water quality model criteria. 44
Table 30: MSR3 ELF model source terms and respective loads for FY2031 (Post Stabilisation Phase). 44
Table 31: MSR3 ELF MSR sizing. 46
Table 32: MSR4 ELF basal sub-catchment water quality model criteria. 47
Table 33: MSR4 ELF model source terms and respective loads for FY2039 (Post Stabilisation Phase). 47
Table 34: MSR4 ELF MSR sizing. 49
Table 35: MSR5 ELF basal sub-catchment water quality model criteria. 50
Table 36: MSR5 ELF model source terms and respective loads for FY2040 (Post Stabilisation Phase). 50
Table 37: MSR5 ELF MSR sizing. 52
Table 38: MSR6 ELF basal sub-catchment water quality model criteria. 53
Table 39: MSR6 ELF model source terms and respective loads for FY2039 (Post Stabilisation Phase). 53
Table 40: MSR6 ELF MSR sizing. 55
Table 41: MSR7 ELF basal sub-catchment water quality model criteria. 56
Table 42: MSR7 ELF model source terms and respective loads for FY2039 (Post Stabilisation Phase). 56
Table 43: MSR7 ELF MSR sizing. 58
Table 44: MDC1 ELF basal sub-catchment water quality model criteria. 59
Table 45: MDC1 ELF model source terms and respective loads FY2030 (Post Stabilisation Phase). 59
Table 46: MDC1 ELF MSR sizing. 61
Table 47: MDC2 ELF basal sub-catchment water quality model criteria. 62
Table 48: MDC2 ELF model source terms and respective loads for FY2038 (Post Stabilisation Phase). 62
Table 49: MDC2 ELF MSR sizing. 64
Table 50: MSR8 ELF basal sub-catchment water quality model criteria. 65
Table 51: MSR8 ELF model source terms and respective loads for FY2046 (Post Stabilisation Phase). 65
Table 52: MSR8 ELF MSR sizing. 67
Table 53: MSR9 ELF basal sub-catchment water quality model criteria. 68
Table 54: MSR9 ELF model source terms and respective loads for FY2042 (Post Stabilisation Phase). 68
Table 55: MSR9 ELF MSR sizing. 70
Table 56: MSR10 ELF basal sub-catchment water quality model criteria. 71
Table 57: MSR10 ELF model source terms and respective loads for FY2041 (Post Stabilisation Phase). 71
Table 58: MSR10 ELF MSR sizing. 73
Table 59: MSR11 ELF basal sub-catchment water quality model criteria. 74

Table 60: MSR11 ELF model source terms and respective loads for FY2030 (Post Stabilisation Phase). 74
Table 61: MSR11 ELF MSR sizing. 76
Table 62: MSR11 ELF basal sub-catchment water quality model criteria. 77
Table 63: MSR12 ELF model source terms and respective loads for FY2030 (Post Stabilisation Phase). 77
Table 64: MSR12 ELF MSR sizing. 79
Table 65: ELF acidity load summary - ELF Construction Phase. 80
Table 66: MSR treatment capacity summary. 82

LIST OF FIGURES

Figure 1: BPCP timelines (by stage and by indicative year) 4
Figure 2: Escarpment Extended Project ELF basal sub-catchments and MSR locations. 6
Figure 3: Mt Fred South Project ELF basal sub-catchments and MSR locations (yellow boxes) 9
Figure 4: BV-ELF acidity concentration data. 11
Figure 5: BVE ELF acidity decay. 22
Figure 6: CON ELF acidity decay. 25
Figure 7: NSUL ELF closure Zn decay. 28
Figure 8: PPG ELF Zn decay. 31
Figure 9: ESC ELF acidity decay. 34
Figure 10: WWH ELF acidity decay. 37
Figure 11: MSR1 ELF acidity decay. 40
Figure 12: MSR2 ELF acidity decay. 43
Figure 13: MSR3 ELF acidity decay. 45
Figure 14: MSR4 ELF acidity decay. 48
Figure 15: MSR5 ELF acidity decay. 51
Figure 16: MSR6 ELF acidity decay. 54
Figure 17: MSR7 ELF acidity decay. 57
Figure 18: MDC1 ELF Zn decay. 61
Figure 19: MDC2 ELF Zn decay. 64
Figure 20: MSR8 ELF acidity decay. 66
Figure 21: MSR9 ELF acidity decay. 69
Figure 22: MSR10 ELF acidity decay. 72
Figure 23: MSR11 ELF acidity decay. 75
Figure 24: MSR12 ELF key parameter contaminant decay. 78
Figure 25: ESE peak ELF acidity loads 81
Figure 26: MFS Peak ELF acidity loads 81

1 INTRODUCTION

1.1 Background

Bathurst Resources Limited (BRL) is seeking to obtain authorisation through the Fast-track Approvals Act (FTAA) to progress development and mining of the coal resources across the wider Buller Plateaux. This project is referred to as the Buller Plateaux Continuation Project (BPCP or Project).

The purpose of the BPCP is to reconsent the existing infrastructure and mining operations associated with the existing Stockton Mine and provide access to additional coal mining areas across the Buller Plateaux, as the coal resource in the current Stockton Mine is close to depletion, and further coal resources for blending are required. There are five key Project sub-areas:

- Stockton mining area (Stockton)
- Mount Frederick South (MFS)
- Escarpment Extended (ESE)
- Upper Waimangaroa Haul Road (UWHR)
- Cypress mining area (Cypress)

Mine Waste Management Limited (MWM) has been engaged to develop the water quality source terms for toe seepage from the various engineered landforms (ELFs) associated with the BPCP at MFS and ESE, including where multiple seepage paths exist from any individual ELFs. This work builds on from previous studies that developed tools to forecast acid and metalliferous drainage (AMD) seepage water quality from ELFs (e.g., MWM, 2026a).

1.2 Report Objectives

The purpose of this report is to address the following:

- Provide water quality (source terms) for the ELF basal sub-catchment flows that may require management/treatment. Source terms are derived for:
    - Concentrations / loads at the end of the stabilisation period.
    - Decay curves for concentration and load associated with potential constituents of concern (PCOC), which are extrapolated forward in time from the end of the stabilisation phase.
    - Long term concentrations / loads due to oxygen flux through the cover system (with and without the benefits of acidity neutralisation by limestone).
- Provide a summary of the key design criteria for each mussel shell bioreactor (MSR) based on the preliminary ELF seepage source terms and forecast load / flow rates for each ELF where flow rate drives the basis of these designs.
- Identify when the transition from active treatment to passive treatment of AMD is considered feasible.

The report does not integrate the data into any water and load balance model (WLBM). This work is completed in other documents (e.g., MWM, 2026b,c,d).

2 PROJECT BACKGROUND AND DESIGN PRINCIPLES

The overburden removed as part of the BPCP will be placed in ELFs. Seepage from these ELFs will be affected by AMD and are expected to be of poor water quality that will persist after mine closure. An understanding of the expected water quality for each ELF and any treatment requirements is required to ensure the risks associated with AMD are managed such that operational and closure objectives are achieved (e.g., water quality).

2.1 BPCP Timeline

Indicative BPCP timelines are reflected in Figure 1. There are four distinct Project phases that are defined by the way mine-impacted waters (MIW) elevated in Total Suspended Solids (TSS) and AMD are managed:

- Construction Phase: defined by the commencement of earthworks on site up until the active permanent water treatment plants (WTPs) and associated WTP ponds are commissioned. This will require routing of water and minor water management / treatment using a small portable water treatment plant(s) to neutralise acidity using either $Ca(OH)_2$ (hydrated lime/calcium hydroxide[1]) or NaOH (caustic); and the addition of flocculants as required to treat TSS. AMD sludge management is also required.
- Operational Phase: Water Management and active water treatment using CaO, flocculants, and metal-chelating agents with AMD sludge being separated from treated discharge water by lamella clarifiers and mechanical sludge dewatering using pressure filtration (plate and frame filters (Process Flow, 2025a)) with AMD sludge disposal to ELFs. Some passive treatment commences for ELFs that are completed.
- Active Closure Phase: Active water treatment continues with a gradual transition to passive treatment of ELF basal seepage. AMD sludge disposal will either be onsite at an appropriate location, disposal at Stockton, or by other approved methods that may be developed over the Operational Phase of the BPCP.
- Post Closure Phase: defined by the decommissioning of the WTPs with water treatment being completed by gravity fed passive treatment systems. The proposed current technology being a MSR. AMD sludge disposal will either be onsite at an appropriate location, disposal at Stockton, or by other approved methods that may be developed over the Operational Phase of the BPCP. Back-up options include disposal to approved offsite landfills.

The transition from active treatment to passive treatment is expected to occur over a period of ~20 years, following closure and final rehabilitation of ELFs.

NOTE: the BPCP Construction Phase is explained above and is different to the ELF Construction Phase that relates to the time to build each ELF associated with the relevant basal sub-catchment.

[1] *Noting: MgO may also be used as a neutralising agent.*

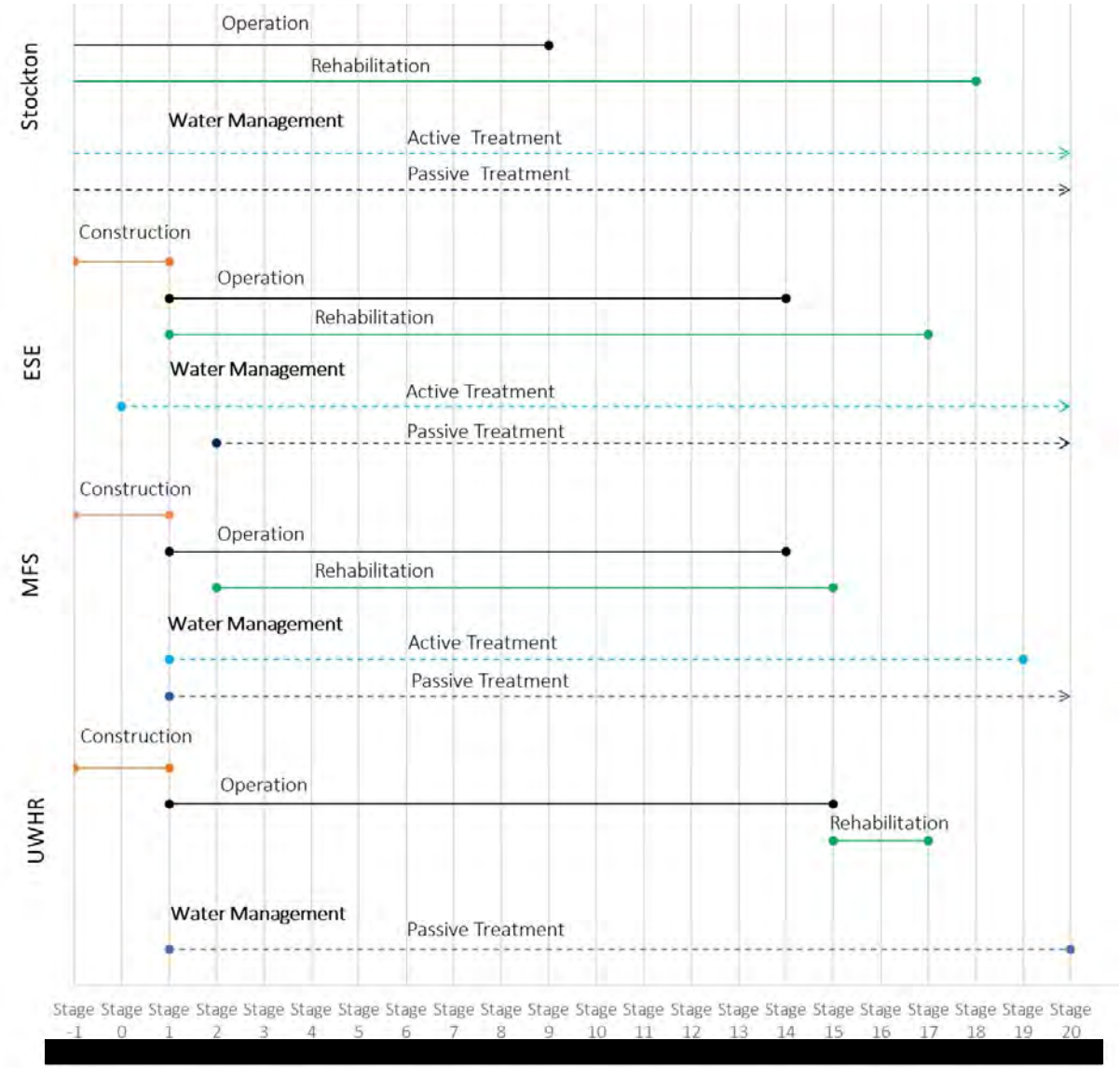

Figure 1: BPCP timelines (by stage and by indicative year)

2.2 Treatment Options

Studies have been undertaken to assess AMD treatment options:

Active treatment using lime-based products has been selected for the Construction and Operational phases as explained by Process Flow (2026), which will continue into the Closure Phase until passive treatment technologies can be utilised.

- Passive treatment using MSRs is proposed following a multi-component analysis (MCA) that identified this as the preferred technology (MWM, 2026e). Passive treatment using MSR will utilise two treatment stages:
    - Stage 1: MSR treatment to remove PCOC within the MSR substrate.
    - Stage 2: MSR Polishing Pond treatment to remove trace metals such as Ni, Zn through adsorption to Fe-hydroxides and treatment of secondary contaminants (e.g., ammoniacal nitrogen, hydrogen sulfide, etc).

Further details of this two-stage system are described in the MSR Design Toolkit (MWM, 2026e).

2.3 Purpose

This report provides an overall summary of the expected ELF water quality and the key MSR design principles including:

- The proposed ELF basal sub-catchments.
- Estimation of water quality, flow rate, and loads for each ELF basal sub-catchment based on key ELF design parameters (e.g., sulfur content, height, and area).
- The estimated treatment removal efficiencies associated with each MSR: Stage 1 and Stage 2.

Background on how ELF water quality was determined through numerical modelling is provided in MWM (2026a). Background on the MSR treatment efficiencies and design are provided in MWM (2026e).

2.4 ESE Engineered Landforms

Each ELF in the ESE sub-area was assessed to identify ELF toe seepage locations based on the topography of the ELF basal sub-catchments (i.e., the coal floor and/or deeper excavations when required). These locations were determined by BRL. Figure 2 shows the ELF basal sub-catchments for the ESE sub-area. Key design data for each ELF basal sub-catchment are provided in Table 1. The data indicates that:

- Total volume of loose cubic metres (LCM) of material to be disturbed as part of the BPCP at ESE is 153,580,780 m^3 (318,154,097 tonnes).
- Sulfur (S) content ranges from 0.09 – 0.43 wt%.
- Water quality models are based on the assumption that low S materials are placed in ELF 10 m shells[2].
- Section 3 to Section 8 of this report provides average wt% S for the 10 m shell of each ELF where sulfur content for the non-acid forming (NAF) NSUL ELF was applied (i.e., 0.13 wt% S; see Table 1). This varies from current mine scheduling information provided by BRL[3] for the ELF.
- Two ELFs (NSUL and PPG) within the ESE sub-area will be constructed entirely using NAF material. As a result, they are not expected to generate acidic drainage but could generate neutral metalliferous drainage (NMD) elevated in some trace metals. Hence passive treatment is proposed for NAF ELFs. Four ELFs (CON, WWH, BVE and ESC) within the ESE sub-area will be constructed using a mix of potentially acid forming (PAF) and NAF materials.

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[2]Note: variation of wt % S does not affect long term acidity loads (after passive treatment commences) as loads are based on oxygen flux through the cover system. Any difference in sulfur content (i.e., a higher sulfurcontent) would mean a slightly longer active treatment phase prior to transitioning to passive treatment technologies.

[3] Current mine scheduling outputs did not prioritise low S material placement within the 10 m shell.

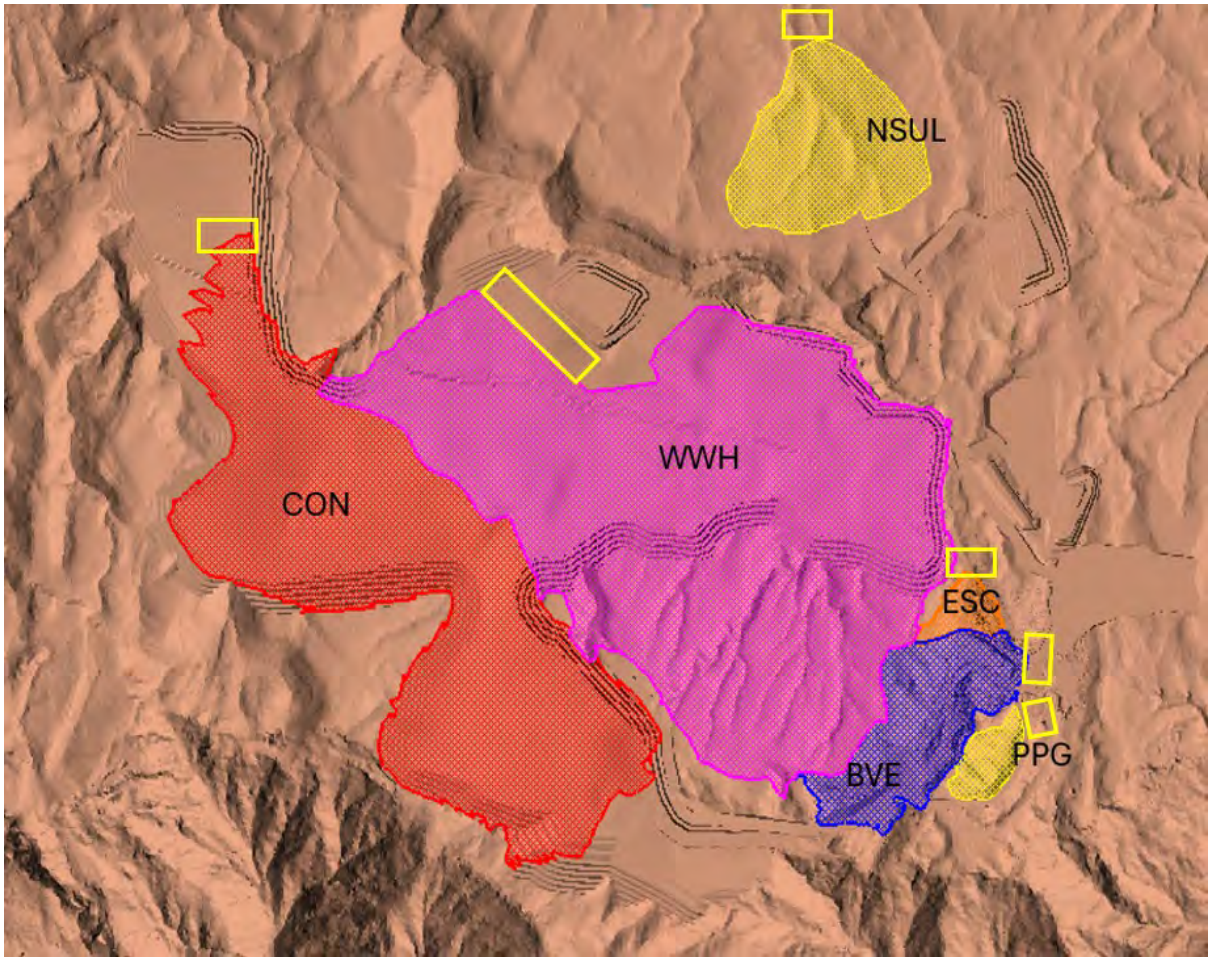

Figure 2: Escarpment Extended Project ELF basal sub-catchments and MSR locations.

MSR Locations shown by yellow boxes

Source: pers. comm. Huw Parker (BRL), email dated, 20 December 2024; Jon Gane (email dated 27 February 2025).

Table 1: Proposed Escarpment Extended Project ELF sub-catchment descriptions.

BASAL ELF SUB-CATCHMENT MSR	LCM (m^3)	TONNES	PLAN AREA (m^2)	AVERAGE HEIGHT (m)	AVERAGE S (wt%)
BVE	7,017,463	14,537,200	200,171	35.1	0.43
CON	38,784,258	80,344,498	1,086,249	35.7	0.28
NSUL	4,022,469 [2]	8,332,846 [2]	259,753	21.07 – Operational 15.49 - Closure	0.13
PPG	698,196	1,446,366	39,774	17.6	0.09
WWH	100,987,674	209,203,536	1,692,122	59.7	0.38
ESC	621,386	1,287,248	31,849	19.5	0.34
Total	**153,580,780**	**318,154,097**	**3,309,917**	**-**	**-**

Source: pers. comm. Huw Parker (BRL), email dated, 20 December 2024; Jon Gane (email dated 27 February 2025).

Yellow cells indicate NAF ELFs.

1. *where the maximum height during operations is 21.07m before NAF is removed for PAF ELF capping in 2044.*
2. *Closure quantities*

2.5 Mt Fred South Engineered Landforms

Each ELF at the MFS sub-area was assessed to identify ELF toe seepage locations based on the topography of the ELF basal sub-catchments (i.e., the coal floor and/or deeper excavations when required). These locations were determined by BRL. Figure 3 shows the ELF basal sub-catchments. Key design data are provided in Table 2. Results indicate that:

- Total volume of LCM material to be disturbed is 18,415,167m^3; the total quantity of overburden that will be disturbed is 36,945,599 tonnes.
- Sulfur content ranges from 0.12 to 0.28 wt%. Section 9 to Section 22 of this report provides average wt% S for the 10 m shell of each ELF. Data was applied as provided by BRL from mine scheduling data. The value is generally lower than average ELF core wt % S[4].
- Two ELFs (MDC1 and MDC2) within the MFS project area will be constructed entirely using NAF material. As a result, they are not expected to generate acidic drainage but could generate NMD elevated in some trace metals. All other ELFs within the MFS sub-area will be constructed using a mix of PAF and NAF materials.
- Although MFS ELFs have similar S wt % to the NSUL NAF ELF, low S wt % does not necessarily equate to NAF material. Process flow classification for the ESE (Olds, et al., 2015) indicates material between 0.015 and 0.2 wt % S with a NAG pH ≤ 4.5 and a net acid producing potential (NAPP)[5] between >0 and 5 kg $CaCO_3$ eq./t is classified as Low Risk or PAF. Behaviour of Low Risk and PAF material will vary from NAF material with the same S wt% due to the inherent acid neutralisation capacity (ANC) of NAF material.

[4] MSR1 and MSR2 ELF basal sub-catchments have a 10 m shell of 0.16 S wt% and core of 0.12 S wt%. Due to the low variation these values as provided from BRL were applied to the water quality model to apply consistency across all MFS ELFs where current scheduled data is used.

5

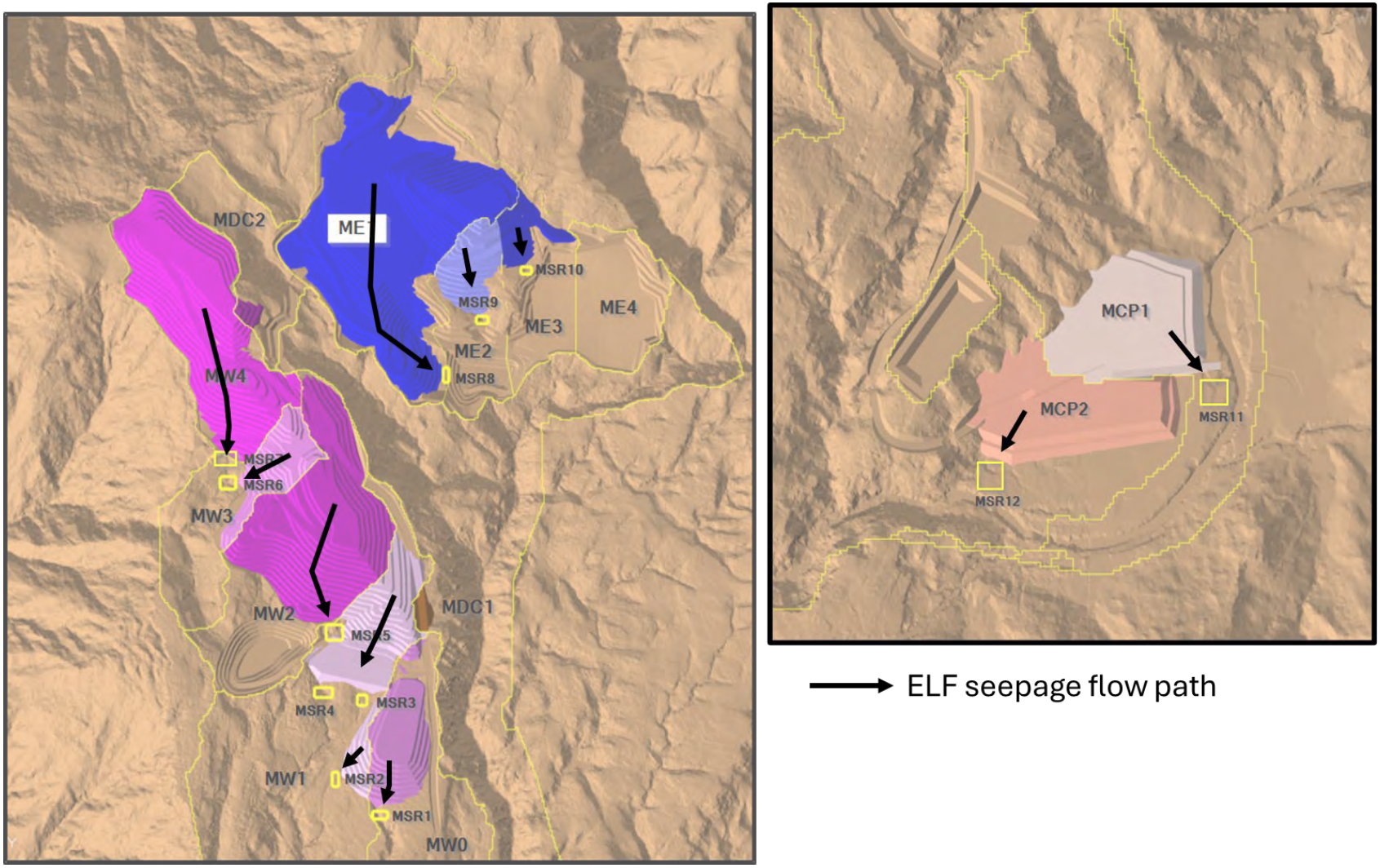

Figure 3: Mt Fred South Project ELF basal sub-catchments and MSR locations (yellow boxes)

Source: pers. comm. Huw Parker (BRL), email dated, 20 December 2024; Jon Gane (email dated 27 February 2025).

Table 2: Proposed Mt Fred South ELF sub-catchment descriptions.

BASAL ELF SUB-CATCHMENT MSR	LCM (m^3)	TONNES	PLAN AREA (m^2)	AVERAGE HEIGHT (m)	AVERAGE S (wt%)
MSR1	898,896	1,828,840	61,571	14.5	0.12
MSR2	126,918	258,219	15,328	12.6	0.12
MSR3	503,500	1,024,392	41,472	12.6	0.12
MSR4	503,525	1,024,443	41,472	12.6	0.12
MSR5	4,003,925	8,146,147	190,019	19.1	0.12
MSR6	605,378	1,231,666	45,097	10.1	0.12
MSR7	2,714,959	5,523,694	202,212	11.9	0.12
MDC1	52,933	107,694	6,033	9.0	0.049
MDC2	35,151	71,516	5,319	6.4	0.049
MSR8	7,438,945	15,141,903	317,705	18.4	0.14
MSR9	498,743	1,015,186	39,758	12.7	0.14
MSR10	152,503	310,419	24,523	8.4	0.14
MSR11	281,450	582,236	29,323	6.6	0.28
MSR12	328,342	679,243	29,350	7.8	0.28
Total	**18,145,167**	**36,945,599**	**1,049,181**	**-**	**-**

Source: pers. comm. [redacted] *(BRL) email dated, 28 March 2025;* [redacted] *(email dated 27 February 2025).*

Yellow cells indicate NAF ELFs.

LCM is based on a conversion factor of 1.2 from BCM

2.6 Upper Waimangaroa Haul Road

The derivation of source terms for the storage of waste rock associated with the construction of the UWHR is provided in a separate report MWM (2026b).

2.7 Background – Barren Valley ELF Water Quality Model

Water quality samples for the Barren Valley ELF (BV ELF), located at the existing Escarpment Mine were collected between 2015 – 2024. Figure 4 provides an example dataset (acidity).

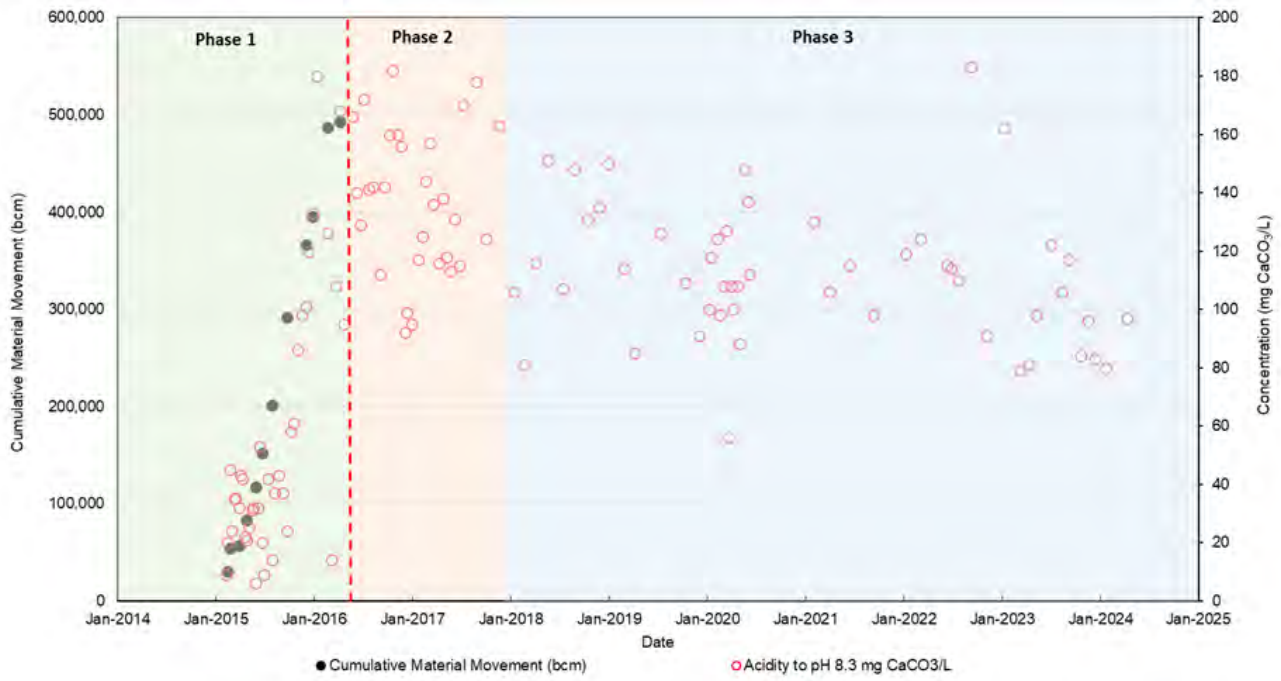

Figure 4: BV-ELF acidity concentration data.

Source: BRL 51279_RPT_Water (water quality excel database).

The red line indicates when the BV ELF underdrain flooded in ~ April 2016.

Green shading indicates Phase 1: Construction Phase.

Yellow shading indicates Phase 2: Stabilisation Phase.

Blue shading indicates Phase 3: Decay Phase.

Three distinct water quality phases were identified for the BV ELF (Figure 4), this was used to derive a water quality model (MWM, 2026a) for other ELFs proposed as part of the BPCP:

Phase 1: Construction Phase

- Low PCOC concentrations that increase with an increasing amount of waste rock placement within the ELF and gradual wetting up of the ELF.
- Generally, peak concentrations coincide with maximum material placement.
- For modelling purposes, during the Construction Phase water quality is calculated on an annual basis the load being driven by annual material placement scheduling and the surface area of the ELF.

Phase 2: Stabilisation Phase

- Flow rates are generally stable as the ELF wets up and then flushes stored oxidation products from the waste rock. For the proposed BPCP, it is assumed the duration of the stabilisation phase for final rehabilitated areas of the ELF also aligns with the duration of the draindown phase (created by the installation of a lower permeability cover system).
- PCOC concentrations were derived from sulfate relationships, observed in the BV ELF drainage (MWM, 2026a). Concentrations of PCOC remain stable.
- The duration of the stabilisation phase is based on the average height of the ELF and aligns with previous studies of the draindown phase duration for the original Escarpment ELF (e.g., Okane Consultants (2014)).
- ELF seepage concentrations are derived from the BV ELF water quality model, which considered the sulfur content and height of the proposed ELFs (MWM, 2026a).
- The majority of stored oxidation products are flushed by the end of the Stabilisation Phase.

Phase 3: Decay Phase

- Phase 3 relates to the decrease in PCOC concentrations from peak concentrations observed in the Stabilisation Phase.
- During this phase, water infiltration remains steady, but the rate of solute generation declines (lesser oxidation, flushing out of stored oxidation products).
- The decay phase is due to:
    - Installation of a cover system (topsoil and forest and shrubland vegetation) that will reduce oxygen flux (MWM, 2026f).
    - Natural decay of acidity loads due to flushing out of stored oxidation products and decreasing oxidation rates of reactive sulfides; and
    - ELF design where rocks > 10 m depth are within a sub-oxic zone and are not generating further acidity due to construction practices that avoid advective airflow.
    - Observed empirical data from Stockton Mine that indicate acidity loads are likely to decrease by 50% from peak concentrations after 10 years (O'Kane, 2015).
    - The model uses a 9.6% decrease per year to align with BV-ELF data. It is noted this approach is conservative as the BV-ELF does not have a cover system in place; hence the decay rate is associated with an uncovered ELF.
    - In the longer term the decay rate transitions to a 0.62% acidity decay rate determined by previous studies (O'Kane, 2015).

Further details on the model are provided in MWM (2026a). The model is used to forecast the water quality from 20 engineered landforms at the ESE and MFS sub-areas.

Placed material progresses through stabilisation and decay stages as rehabilitation occurs, therefore the Construction Phase can include material under stabilisation conditions, or even decay conditions (if

the stabilisation period is less than the construction period). Additionally, the Stabilisation Phase can include material under decay conditions for material rehabilitated earlier in the schedule.

2.8 Estimating ELF Water Quality and Flow Rates

To estimate the water quality for each of the ELF basal sub-catchments associated with the BPCP sub-areas, the model approach presented in MWM (2026a) was used to determine the water quality from the ELF. The following comments are provided:

- An infiltration coefficient of 40% of annual rainfall (MWM, 2026f) was applied to determine average flow rates from each ELF basal sub-catchment over the construction, stabilisation, and closure phases to simplify the modelling process. Infiltration was based on:
    - An average annual rainfall of 5,468 mm/yr[6] for the ESE ELFs.
    - An average annual rainfall of 5,928 mm/yr was used for the MFS ELFs[7].
- Water quality for each ELF was derived using the ELF water quality model (MWM, 2026a) to derive the concentration of PCOC for the construction and stabilisation phase of the ELF.
- An annual PCOC decay coefficient of 9.6% was used for the ELF basal sub-catchment water quality (MWM, 2026a).
- In the long-term, acidity loads are controlled by ongoing flux of oxygen through the cover system. This places a minimum threshold for long term ELF seepage water quality concentrations associated with the Decay Phase at this rate then decays at 0.62% per year based on other studies of long-term rates (O'Kane, 2015).

2.8.1 ELF Basal Sub-catchment Modelling

Estimation of water quality for each of the ELF basal sub-catchments is based on materials schedule data provided by BRL for the rehabilitation model. There is slight variation between individual ELF basal sub-catchment volumes and areas to the final catchment data as provided by BRL. This is due to assignment of material to a catchment based on a grid model for rehabilitation and a string model for the final catchment (pers. comm. J. Gane). The following observations between data for the two models are provided:

- Total volume variation is < 1% for ESE ELF and MFS ELF indicating variation is within blocks assigned to each ELF and not volume of material accounted for in the water quality model.
- Variation in area is < 3% for the total ESE ELF basal sub-catchments area and < 1% for the total MFS ELF basal sub-catchments.
- There is increased variation in area for individual ELF basal sub-catchments which effects flow prediction. Total flow variation from the combined catchments for MFS and ESE is 1% and 2% respectively.

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[6] Average rainfall was derived from the Lake Brazil met station (640 mRL) at the Escarpment Mine.

[7] Average rainfall was derived from the rainfall data is based on the Lake Brazil met station (640 mRL) at the Escarpment Mine, with a multiplication factor applied based on the rainfall-altitude relationship (BRL, 2024).

MSR data is modelled using the final catchment area therefore a slight variation is observed between water quality model inputs and MSR sizing.

2.9 Long Term Acidity Load

In the long term, the ongoing acidity generation risk (and other PCOC) is driven by oxygen flux through the rehabilitated surfaces (with the assumption that advective ingress of oxygen is excluded). BRL have confirmed that the final cover system for all ELFs is shrubland and forest. Cover modelling (MWM, 2026f) suggests that the long-term average diffusive oxygen flux through the cover system could range between ~100 to 230 g/m^2/yr for shrubland and forest, which translates to an acidity load of 1.6 to 3.8 t/ha/yr based on the stoichiometry of pyrite oxidation:

Equation 1: $$FeS_2 + {}^{15}/_4\, O_2 + {}^{7}/_2\, H_2O \; = Fe(OH)_3 + 2H_2SO_4$$

The midpoint between the reported range, 2.7 t/ha/yr, was adopted as a starting point for the BPCP ELFs, with the following adjustments made:

- It is expected that parts of the ELF contain materials that are effectively unreactive and do not contribute to the PCOC load or water chemistry. Price (1997) notes that >75% of the mass in a waste rock landform occurs as coarse particles in which the mineralogy is almost entirely occluded from oxygen and water with drainage chemistry being controlled by a relatively small portion of the mass, which is finer grained particles. Malmström et al. (2000) noted that ~65% of the water in a waste rock stack was mobile and 35% was immobile at the Aitik Copper mine (Sweden). At the Island Copper Mine (Vancouver), Lopez et al. (1997) notes that only 42% of the total area of the waste rock pile contributes to flow. Such studies indicate that 35 – 58% of water interacting in a waste rock landform may be immobile and will not contribute to drainage water chemistry.
    - For this study it is assumed that 65% of the rock contributes to the observed acidity load that will be measured as ELF toe seepage and that oxidation may occur in the other 35% yet the oxidation products are immobile. Based on an initial load of 2.7 t/ha/yr, the long-term loads are assumed to be ~1.8 t/ha/yr with the assumption that parts of the acidity generated is occluded and will not be mobilised.
    - For NAF ELFs, acidity is not expected due to neutralisation of any sulfide mineral oxidation acidity by the inherent acid neutralisation capacity (ANC) of the materials. Hence the acidity load of ~1.8 t/ha/yr is represented by a comparable sulfate load that is obtained from the model (MWM, 2026a). This is then used to forecast annual Zn concentrations (based on the SO_4:Zn relationship derived in MWM, 2026a) to provide an indication of passive treatment duration for NAF ELFs.
- Data from the BV ELF water quality study (MWM, 2026a) indicates that half the acidity that is generated by sulfide mineral oxidation is neutralised by limestone (and ANC) within the ELF. This will also contribute to lower long-term acidity loads reporting from the ELF as toe seepage.
    - Based on a load of ~1.8 t/ha/yr this would suggest that the long-term acidity load could be as low at 0.9 t/ha/yr provided the limestone treatment (and ANC) of the ELF remains effective into the future.

- Two long term acidity models are presented in this report for PAF ELFs using acidity loads derived from oxygen flux to acknowledge that the limestone neutralisation may not be available in the long term:
    - 1.8 t/ha/yr for oxygen flux derived loads (without limestone/ANC benefits).
    - 0.9 t/ha/yr for oxygen flux derived loads with limestone/ANC benefits on acidity loads.
- The derivation of this long-term load provides an estimate of when passive treatment of ELF seepage could be considered.
- Further work could be undertaken to consider the decrease in oxygen, available for sulfide mineral oxidation, due to consumption by organic matter within the soils associated with the cover system and due to the oxidation of organic matter associated with coals. For instance, Bennett et al. (1995) reports that the consumption of oxygen by carbonaceous material must be accounted for in any predicted model. Hence, acid generation rates may be over-estimated in the long term (generating conservative loads that may require treatment). Such studies would not affect forecast potential effects as they are conservative, but could reduce expected project expenditure (i.e., less acidity / PCOC to treat in the long term).
- In the longer-term it is anticipated that the rate of oxygen flux through the cover system will decrease as vegetation becomes established, soils become thicker, and the depth of oxygen ingress to react with pyrite is greater. This will lead to lesser acidity generation rates:
    - A decrease in acidity loads to 0.62% per year is applied to the model once long-term rates are met. This is comparable to the Stockton AMD Liability model for long term acidity decay (O'Kane Consultant Ltd, 2015). Further details of this model are provided in MWM (2026a).
    - The longer-term rate commences at the point the decay model decay matches the long-term acid load derived from oxygen flux.

2.10 MSR Treatment Efficiencies

AMD treatment by MSR technologies is examined in detail in MWM (2026e). Key elements of the model include:

- The size (area) of the MSR, which influences the amount of flow that can be treated (approximately 1.0 L/s of AMD impacted water per 100 m^2).
- A residence time of one day (24 hours) was used to determine the size of the MSR (based on previous studies: MWM, 2026e) and is based on the MSR influent flow rate and the MSR porosity.
- An infiltration coefficient of 40% of rainfall was used to determine flow rates that would enter the MSR (as influent).
- A design factor of 2 is applied to the MSR reactor design footprint. This factor is to account for the installation of a polishing pond in addition to the MSR (i.e., Stage 2 of the passive treatment system). This will ensure that PCOC loads can be managed appropriately including additional

removal of Ni and Zn by adsorption to Fe-hydroxides (at ~pH 7) and treatment of secondary contaminants (e.g., ammoniacal nitrogen, hydrogen sulfide, low oxygen waters, etc).

- These criteria are used by BRL to ensure that space is available during the mine planning process for the MSR treatment systems.
- MSR are designed based on area (i.e., flow rate). Expectations of when MSR can commence are based on long term acidity loads.

The treatment efficiencies for each PCOC through the MSR treatment system are presented in Table 3. A two-stage process is proposed (as discussed in MWM, 2026e):

- Stage 1: MSR treatment to remove PCOC within the MSR substrate.
- Stage 2: MSR polishing pond treatment to remove Zn through adsorption to Fe-hydroxides and treatment of secondary contaminants.

Table 3: MSR treatment efficiencies.

PARAMETER	TREATMENT EFFICIENCIES (%)	REFERENCE MSR
Stage 1: MSR Reactor Treatment		
SO_4	10.4	BV MSR
Al	99.7	BV MSR
Fe	80 [2]	BV MSR
Ni	40.2	BV MSR
Mn	58.6	BV MSR
Cr	-	BV MSR
Cd	1.89	BV MSR
Co	82.8	BV MSR
Cu	96.6	BV MSR
Pb	85.8	BV MSR
Tl	-	-
Zn	63.7	BV MSR
Stage 2: MSR Polishing Pond Treatment of MSR Stage 1 Effluent		
Fe	99	Process flow Ltd (2026)
Ni	12.5	Process flow Ltd (2026)
Zn	59.0	Process flow Ltd (2026)

1. *Note that the MSR will generate high pH and alkalinity that may require adjustment through the Stage 2: MSR polishing pond.*
2. *An efficiency of 80% is used rather than the measured 99.8% to account for the ELF being sub-oxic and some Fe(II) passing through the MSR untreated.*

2.11 Passive Treatment Capacity

Passive systems, in general, can only handle relatively small flows (usually less than 50 L/s) unless a significant area is available for passive treatment to be successful (INAP, 2021). A common reference document (Taylor et al., 2005) provides general criteria for passive treatment (Table 4). However, INAP (2021) note that '*Under neutral to slightly acidic conditions, much higher flows can be treated through passive treatment, especially where sufficient real estate is available and where the concentrations of iron, which is often the largest problematic dissolved constituent, can be decreased through aeration*.'

INAP (2021) also note that "*most successful passive treatment projects are treating less than 1,000 m^3 per day*", however there are two examples where treatment of 6,500 m^3 per day (~75 L/s) was maintained for up to 19 years.

Table 4: General guidelines for selection - active versus passive treatment

TREATMENT SYSTEM	AVERAGE ACIDITY RANGE (mg $CaCO_3$/L)	AVERAGE ACIDITY LOAD (kg $CaCO_3$/day)	AVERAGE FLOW RATE (L/s)	TYPICAL pH RANGE	MAX pH ATTAINABLE
Passive	1 - 800	1 – 150	< 50	>2	7.5 – 8.0
Active	1 – 10,000	1 – 50,000	No defined limit	No defined limit	14

Source: Taylor et al. (2005).

Long term flow rates and acidity loads presented in this report for some ELFs are higher than industry guidance (Table 4). However, the design criteria for MSR are based on the capacity to use a MSR surface area of 100 m^2 to treat 1L/s, which has been validated across multiple MSR operating in New Zealand (MWM, 2026e). Sufficient space has been provided in the conceptual MSR design to accommodate these higher flows. As noted by INAP (2021), area is considered a significant constraint for passive treatment, which has been considered as part of the BPCP mine planning process to accommodate the higher flows.

To identify this treatment capacity risk for each ELF basal sub-catchment, the flow rate and acidity load are highlighted as:

- Green: < ~50 t/yr acidity
- Green: < ~50 L/s average flow rate
- Orange: < ~100 t/yr acidity (two reactors may be required)
- Orange: < ~100 L/s average flow rate
- Red: > ~100 t/yr acidity (multiple reactors may be required)
- Red: > ~100 L/s average flow rate

For the BPCP, it is proposed that passive treatment commences once the decay of the acidity load is comparable to the long-term acidity loads derived from oxygen flux through the cover system. For some smaller ELFs with low sulfur, passive treatment can commence immediately as initial loads are less than long term flux rates and/or within the general bounds for passive treatment (Table 4). For larger ELFs, passive treatment is unlikely for a number of decades until loads decrease significantly. Additional studies, to be undertaken during the early stages of the BPCP, might demonstrate earlier passive treatment is possible.

2.12 Model Clarifications

A number of datasets and assumptions were used to develop the model to derive BPCP ELF seepage water quality. These assumptions are discussed here to provide transparency on the model process, noting that the model is a robust tool to understand AMD risks for ELF seepage water quality. The following notes are provided:

- The ELF water quality model (MWM, 2026a) is a suitable tool to estimate water quality over the longer-term and hence understand AMD risks for the receiving environment. This is because

the model is based on empirical site-specific data scaled to consider risk associated with variable sulfur content and larger quantities of overburden within each ELF. Performance monitoring of the ELF seepage to confirm quality and quantity should be undertaken during the operation phase of the BPCP to confirm model results. Performance monitoring is discussed in the AMD Water Management Plan (BRL, 2026) for these BPCP sub-areas.

- The scaling of the PAF BV ELF data to NAF ELFs is considered conservative as sulfide oxidation rates are higher at lower pH values and this would contribute to higher PCOC concentrations in NAF ELF seepage.
- It is expected, based on 8 years of data from the Barren Valley ELF that the use of limestone and the inherent ANC of the materials provide sufficient neutralisation, neutralising half the acidity generated over the construction, stabilisation, and decay phases of the ELF until passive treatment technologies can be employed.
- It is assumed that the conceptual MSR design and polishing pond are suitable, and treatment efficiencies are appropriate, however these need to be validated through field trials. BRL indicate that a suitable trial ELF is BVE MSR that will be completed early in the Project life.

The water quality model will require regular refinement of predictions during the Operational Phase of the Project. Any variance from the expected water quality may require the models to be recalibrated.

2.13 Uncertainty

The following risks are noted:

- Flow rates in the longer-term will be a function of the final rehabilitation surfaces net percolation rates. It is recommended that performance monitoring of ELF seepage is included in the AMD Water Management Plan.
- MSR treatment capacity is based on average flows. On occasion higher flows can occur from ELFs due to preferential flow, e.g., batter slopes providing faster flow response to rainfall events. MSR often have a by-pass to manage these higher flows. This may represent a risk if the by-pass waters are not neutralised (i.e., within the MSR polishing Pond). Performance monitoring is required.
- MSR treatment and MSR polishing pond efficiencies need to be validated from field trials. If efficiencies are lesser, this may delay the cessation of active treatment.
- MSR treatment capacity for higher flows and/or higher concentrations need to be confirmed and further studies are needed for the development of multiple reactors to increase treatment efficiencies and/or reduce residence times (MWM, 2026e). These trials will be done in the first few years of the Operational Phase. This may allow installation of MSR earlier, whilst loads are high for seepage associated with larger ELFS such as CON and WWH.

2.14 Model Integration

To forecast long term water quality and determine when passive treatment can commence the ELF Water Quality model is coupled with the cover system model. The following data management rules are applied:

- PAF ELF seepage uses the long-term acidity load of 1.8 t/ha/yr (without limestone/ANC benefits). This is a conservative approach assuming limestone/ANC will be consumed and may not be available in the long term. When acidity decay matches this load, the model transitions to the oxygen flux loads for the long term.
- NAF seepage is assumed to be circum-neutral in pH (e.g., > 5) but can still have minor acidity load due to Fe in solution associated with a sub-oxic dump (generated by ELF construction practices to avoid advective oxygen ingress). NAF ELF seepage may require passive treatment for PCOC. To understand the duration of passive treatment Zn concentrations are modelled as an example PCOC.

2.15 Sensitivity Modelling

Outputs from water quality models of the ELF basal sub-catchments are integrated into the water and load balance models for the BPCP. To understand variance from the expected model results due to assumptions / identified risks, a multiplier of +/- 30% is applied to RLF seepage load. This is discussed in MWM (2026c) and MWM (2026d).

3 BVE ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the BVE ELF.

3.1 BVE ELF Model Inputs

The BVE ELF basal sub-catchment water quality model criteria (Table 1) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 22.5 ha, the average rainfall (5,468 mm/yr), and a net percolation rate of 40%, an average flow rate of 15.6 L/s was calculated. These data are presented in Table 5.

Table 5: BVE ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	35.1
	Sulfur content (wt%)	0.48
	Sulfur content 10 m shell (wt%)[1]	0.13
	Area (ha)	22.5
	Total ELF (m^3 LCM)[2]	7,218,400
	10 m shell (m^3 LCM)[2]	1,854,600
Lake Brazil met station	Average rainfall (mm/yr)	5,468
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	15.6

[1] Average sulfur content of NSUL ELF (NAF).

[2] Rounded up to nearest 100 m^3.

3.2 BVE ELF Water Quality

Using the data presented in Table 5 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the BVE ELF (Table 6). Data indicates that the BVE ELF basal sub-catchment would generate an acidity load of approximately 58 t/yr or 2.6 t/ha/yr at the end of the Stabilisation Phase.

Table 6: BVE ELF model source terms and respective loads for FY2036 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	118	58
Alkalinity	0	0
Ca	33.9	16.7
Mg	3.9	1.9
Na	0.04	0.02
K	0.1	0.1
SO_4	203	100
Al	11.4	5.6
Fe	5.3	2.6
Ni	0.2	0.1
Mn	0.4	0.2
Cr	0.007	0.004

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cd	0.0002	0.0001
Co	0.021	0.01
Cu	0.006	0.003
Pb	0.0004	0.0002
Tl	0.0004	0.0002
Zn	0.9	0.4
DOC	0.5	0.2
pH (pH units)	3.4	

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

3.3 BVE ELF Water Quality Model

This section summarises the ELF water quality model for the BVE ELF basal sub-catchment as shown in Figure 5. The following clarifications are provided:

- The stabilisation phase for the BVE ELF has been estimated at ~5.5 years (6 years is applied to the model as a conservative approach).
- Construction is scheduled over 4 years. Rehabilitation is scheduled over the same period with stabilisation conditions commencing as material is rehabilitated. The Construction Phase therefore includes construction and stabilisation conditions. Decay (at 9.6%) for material will commence 6 years from construction for early rehabilitated material, therefore the Stabilisation Phase includes material in stabilisation and decay. The Decay Phase is indicated when all material enters decay conditions ~10 years from commencement of construction.
- If the benefits of inherent ANC and limestone addition are exhausted, acidity loads are modelled at 39.4 t/yr after ~ 10 years post construction. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2058 (MWM, 2026c). A MSR could be installed immediately (i.e., at the end of the stabilisation phase) and this site could be used to test the MSR treatment capacity early in the Project life.
- Discharge from the PPG ELF is directed to the BVE MSR, hence, the BVE MSR will need to be increased in size for the footprint of the PPG ELF.

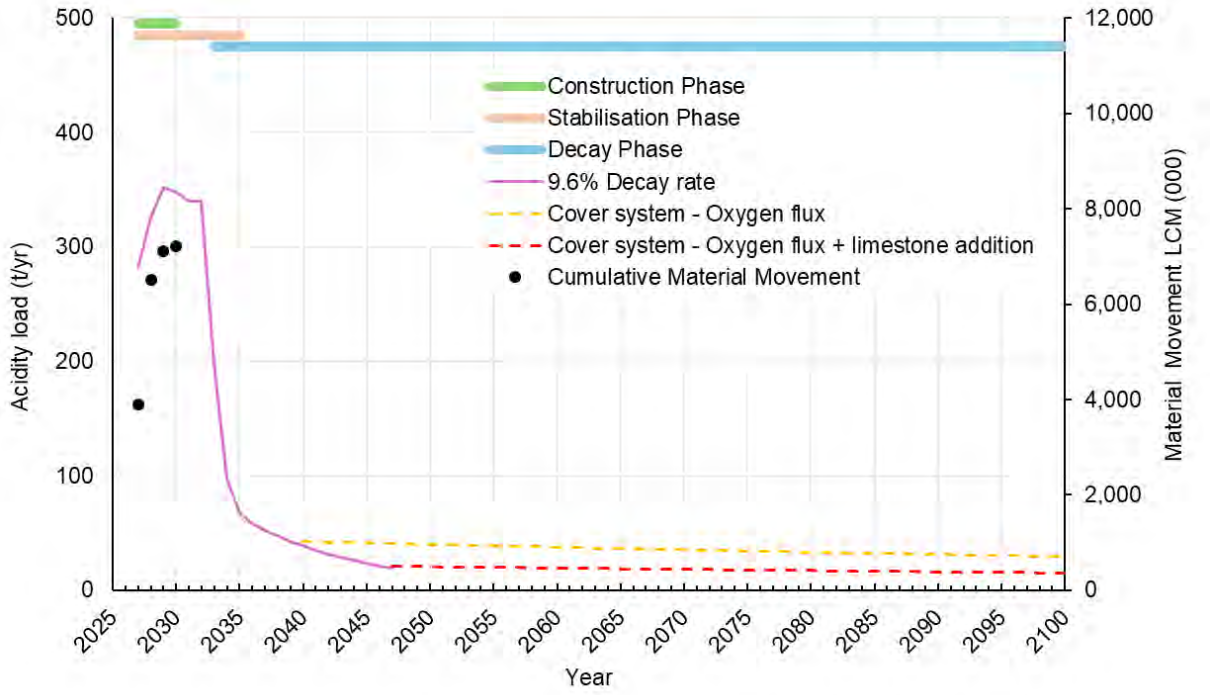

Figure 5: BVE ELF acidity decay.

3.4 BVE ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled BVE ELF basal sub-catchment source term. The recommended MSR for BVE ELF basal sub-catchment are presented in Table 7. The design data are based on loads 10 years after the stabilisation phase (i.e., long term oxygen flux).

Table 7: BVE ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	20.0
Rainfall (mm/yr)	5,468
Infiltration coefficient	0.40
Flow Rate (L/s)	13.9
Acidity load (t $CaCO_3$/yr)[1]	42.7
MSR surface area + polishing pond (m^2)	3,074
MSR surface area (m^2)	1,537
Polishing pond area (m^2)	1,537
MSR depth (m)	1.5
MSR volume (m^3)	2,305
Shells pore volume calc (m^3)	1,199
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2058

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

4 CON ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the CON ELF.

4.1 CON ELF Model Inputs

The CON ELF basal sub-catchment water quality model criteria (Table 1) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 96.9 ha, the average rainfall (5,468 mm/yr), and a net percolation rate of 40%, an average flow rate of 67.2 L/s was calculated. These data are presented in Table 8.

Table 8: CON ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	35.7
	Sulfur content (%)	0.28
	10 m shell sulfur content wt (%)[1]	0.13
	Area (ha)	96.9
	Total ELF (m^3 LCM)[2]	38,890,500
	10 m shell (m^3 LCM)[2]	11,028,500
Lake Brazil met station	Average rainfall (mm/yr)	5,468
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	67.2

[1] *Average sulfur content of NSUL ELF (NAF).*

[2] *Rounded up to nearest 100 m^3.*

4.2 CON ELF Water Quality

Using the data presented in Table 8 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the CON ELF (Table 9). Data indicates that the CON ELF basal sub-catchment would generate an acidity load of approximately 481 t/yr or 5.0 t/ha/yr at the end of the Stabilisation Phase.

Table 9: CON ELF model source terms and respective loads for FY2047 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	227	481
Alkalinity	0	0
Ca	65	138.1
Mg	7	15.7
Na	0.1	0.2
K	0.2	0.5
SO_4	390	827
Al	21.8	46.3
Fe	10.1	21.5
Ni	0.3	0.7
Mn	0.8	1.7

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cr	0.014	0.0
Cd	0.0004	0.0009
Co	0.04	0.1
Cu	0.01	0.024
Pb	0.001	0.002
Tl	0.001	0.002
Zn	1.6	3.5
DOC	0.5	1.1
pH (pH units)	3.1	

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

4.3 CON ELF Water Quality Model

This section summarises the ELF water quality model for the CON ELF basal sub-catchment as shown in Figure 6. The following clarifications are provided:

- The stabilisation phase for the CON ELF has been estimated at ~5.6 years (6 years applied to model as a conservative approach).
- Construction is scheduled over 7 years. Rehabilitation is scheduled over the same period with stabilisation conditions commencing as material is rehabilitated. The Construction Phase therefore includes construction and stabilisation conditions. Decay (at 9.6%) for material will commence 6 years from construction for early rehabilitated material, therefore the Stabilisation Phase includes material in stabilisation and decay. The Decay Phase is indicated when all material enters decay conditions ~13 years from commencement of construction.
- If the benefits of inherent ANC and limestone addition are exhausted, acidity loads are modelled at 170.1 t/yr ~17 years post construction. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2058 (MWM, 2026c). Hence, a MSR could be installed 17 years after the cover system is constructed once long-term acid generation rates are achieved, noting that multiple systems may be required for the acidity load.

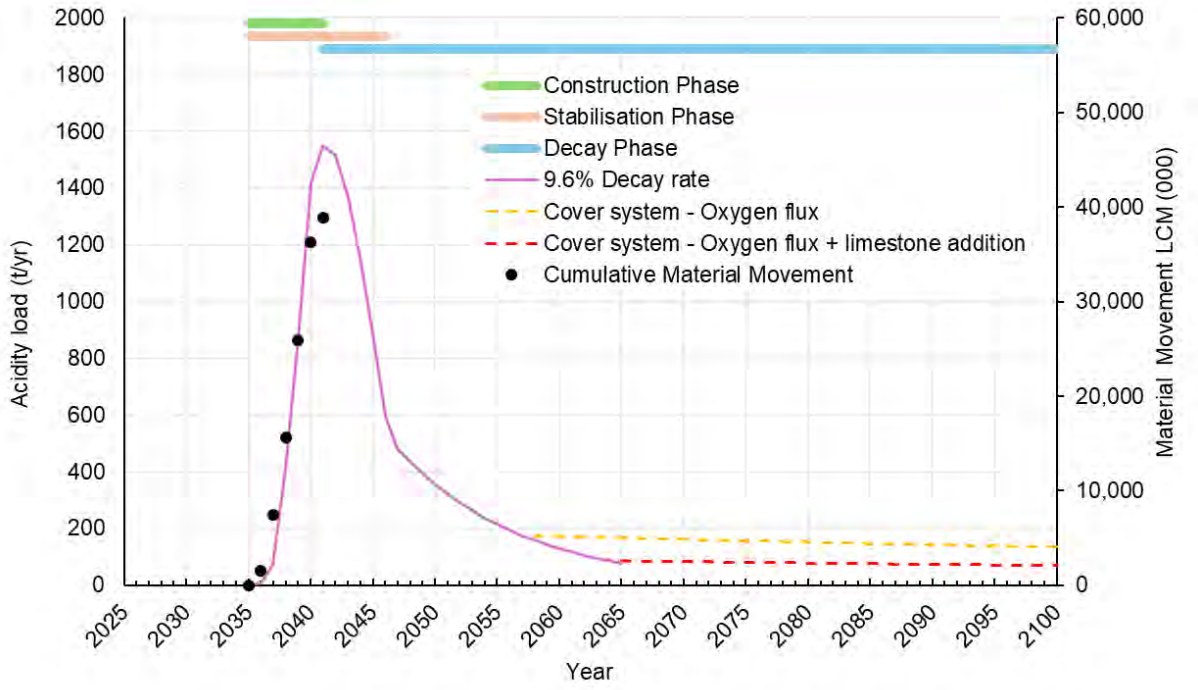

Figure 6: CON ELF acidity decay.

4.4 CON ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled CON ELF basal sub-catchment source term. The recommended MSR for CON ELF basal sub-catchment are presented in Table 10.

Table 10: CON ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	108.6
Rainfall (mm/yr)	5,468
Infiltration coefficient	0.40
Flow Rate (L/s)	75.3
Acidity load (t $CaCO_3$/yr)[1]	174.4
MSR surface area + polishing pond (m^2)	16,679
MSR surface area (m^2)	8,339
Polishing pond area (m^2)	8,339
MSR depth (m)	1.5
MSR volume (m^3)	12,509
Shells pore volume calc (m^3)	6,505
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2058

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

5 NSUL ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the NSUL ELF.

5.1 NSUL ELF Model Inputs

The NSUL ELF basal sub-catchment water quality model criteria (Table 1) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 24.0 ha, the average rainfall (5,468 mm/yr), and a net percolation rate of 40%, an average flow rate of 18.0 L/s was calculated. These data are presented in Table 11. The height of the NSUL ELF varies over the project life, reaching a maximum of 21.1 m during operations and decreasing to 15.49 m at closure in 2044. A source term is created for both; however, the lower height is used to forecast water quality trend after closure. The ELF footprint remains the same.

Table 11: NSUL ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height - Closure (m)	15.49
	Sulfur content (%)	0.13
	10 m shell sulfur content wt (%)[1]	0.13
	Area (ha)	24.0
	Total ELF (m^3 LCM)[1]	5,471,900
	10 m shell (m^3 LCM)[1]	2,088,600
Lake Brazil met station	Average rainfall (mm/yr)	5,468
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	18.0

[1] Rounded up to nearest 100 m^3.

5.2 NSUL ELF Water Quality

Using the data presented in Table 11 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the NSUL ELF (Table 12). AMD is not expected from this NAF ELF, rather NMD. Data indicates that the NSUL ELF basal sub-catchment would generate Fe and Zn loads of approximately 5.2 t/yr and 0.8 t/yr (respectively) during the Stabilisation Phase. Further explanation on how the source term was derived is provided in the source term report (MWM, 2026g).

Table 12: NSUL ELF model source terms and respective loads for FY2036 (Post Stabilisation Phase)

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	25[2]	14.0
Alkalinity	6.2[1]	4
Ca	58.8	33.4
Mg	6.7	3.8
Na	0.07	0.04
K	0.2	0.11
SO_4	352	200
Al	19.7	11.2

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Fe	9.2	5.2
Ni	0.3	0.2
Mn	0.7	0.4
Cr	0.013	0.007
Cd	0.0004	0.0002
Co	0.04	0.02
Cu	0.010	0.006
Pb	0.0007	0.0004
Tl	0.0007	0.0004
Zn	1.5	0.8
DOC	0.5	0.3
pH (pH units)	5.8	3.3

1. *The water quality model is based on the BV ELF. Scaling to NAF ELFs does not work for pH and alkalinity, Hence, pH and alkalinity data from column leach tests are used for NAF seepage water quality (further details in MWM, 2026g).*
2. *Acidity is calculated from Fe concentration and pH.*

5.3 NSUL ELF Long-term PCOC Decay

This section summarises the ELF water quality model for the NSUL ELF basal sub-catchment. Given acidity is not the main issue for a NAF ELF, Zn is plotted to understand long term treatment requirements (Figure 7). The following clarifications are provided:

- The stabilisation phase for the NSUL ELF has been estimated at ~3 years. Construction and rehabilitation are scheduled over 4 years.
- Limestone dosing of the ELF is not required.
- Due to water management scheduling, the MSR starts in 2046 (MWM, 2026c). A MSR could be installed for this ELF from the commencement of the project (year 1) provided sediment is diverted from the MSR treatment system.
- Based on the decay rates of 9.6%, the NSUL ELF will be below the current Escarpment Mine compliance water quality value (RC10193) for Zn (0.012 mg/L for pH >5.5[8]) ~51 years post construction indicating that passive treatment would not be required after that point. Note: downstream dilution needs to be considered in this treatment duration estimate as well as other PCOC.
- The use of the BV ELF as an analogue for a NAF ELF is conservative as lower pH in the BV ELF drives higher reaction rates and the generation of PCOC. This is not expected in a NAF ELF that will be circum-neutral pH. Long term acidity loads due to oxygen flux are unlikely to be the dominant driver of PCOC within a NAF ELF, hence the PCOC decay curves are set to 9.6% decay within the model. If this assumption is incorrect, then a longer passive treatment period is required (i.e., > 51 years).

[8] *Noting that this does not consider hardness modification benefits for the limit*

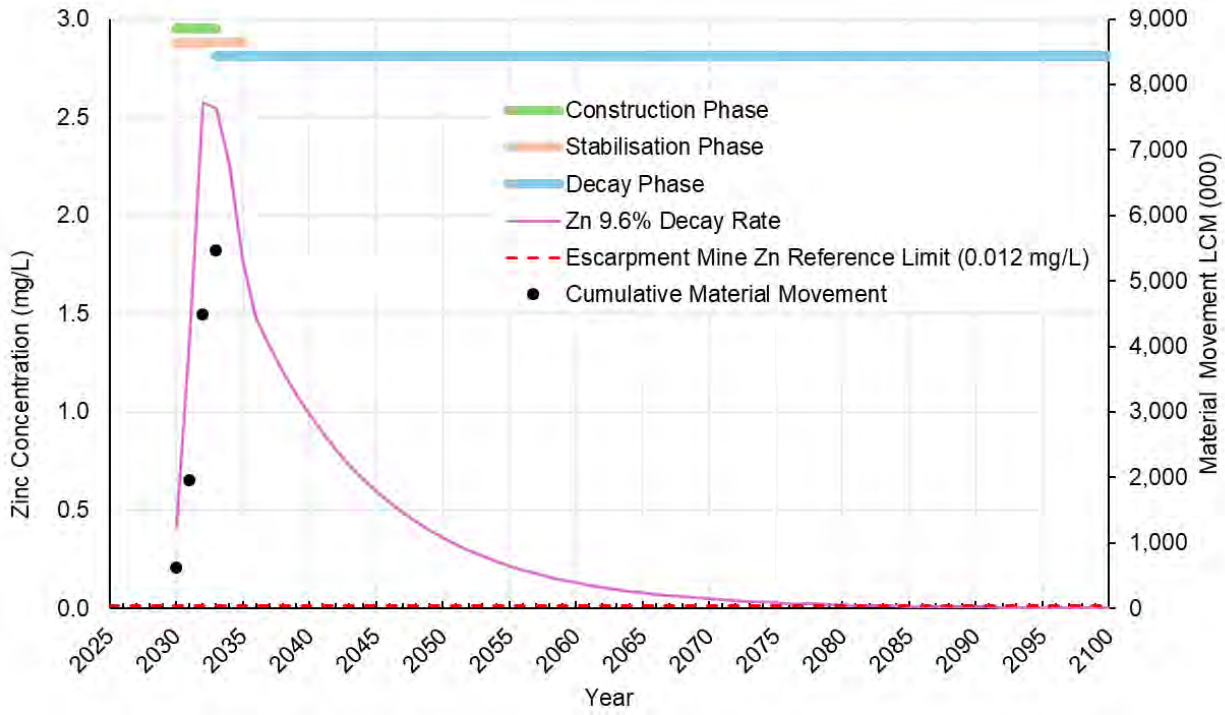

Figure 7: NSUL ELF closure Zn decay.

5.4 NSUL ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled NSUL ELF basal sub-catchment source term. The recommended MSR for NSUL ELF basal sub-catchment are presented in Table 13.

Table 13: NSUL ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	26.0
Rainfall (mm/yr)	5,468
Infiltration coefficient	0.40
Flow Rate (L/s)	18.0
Acidity load (t $CaCO_3$/yr)	21.4
MSR surface area + polishing pond (m^2)	3,988
MSR surface area (m^2)	1,994
Polishing pond area (m^2)	1,994
MSR depth (m)	1.5
MSR volume (m^3)	2,991
Shells pore volume calc (m^3)	1,555
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2046

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity.

6 PPG ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the PPG ELF.

6.1 PPG ELF Model Inputs

The PPG ELF basal sub-catchment water quality model criteria (Table 1) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 3.8 ha, the average rainfall (5,468 mm/yr), and a net percolation rate of 40%, an average flow rate of 2.76 L/s was calculated. These data are presented in Table 14.

Table 14: PPG ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	17.6
	Sulfur content (%)	0.09
	10 m shell sulfur content wt (%)[1]	0.13
	Area (ha)	3.8
	Total ELF (m^3 LCM)[2]	698,200
	10 m shell (m^3 LCM)[2]	330,200
Lake Brazil met station	Average rainfall (mm/yr)	5,468
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	2.76

[1] *Average sulfur content of NSUL ELF (NAF).*

[2] *Rounded up to nearest 100 m^3.*

6.2 PPG ELF Water Quality

Using the data presented in Table 14 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the PPG ELF (Table 15). AMD is not expected from this NAF ELF, rather NMD. Data indicates that the PPG ELF basal sub-catchment would generate Fe and Zn loads of approximately 0.6 t/yr and 0.1 t/yr (respectively) during the Stabilisation Phase. Further explanation on how the source term was derived is provided in the source term report (MWM, 2026g).

Table 15: PPG ELF model source terms and respective loads for FY2033 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	18 [2]	1.6
Alkalinity	6.2 [1]	1
Ca	44.0	3.8
Mg	5.0	0.4
Na	0.06	0.005
K	0.15	0.013
SO_4	263	22.9
Al	14.7	1.3
Fe	6.8	0.6
Ni	0.2	0.018

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Mn	0.6	0.05
Cr	0.009	0.0008
Cd	0.0003	0.00003
Co	0.03	0.002
Cu	0.008	0.0007
Pb	0.0005	0.00005
Tl	0.0005	0.00004
Zn	1.1	0.1
DOC	0.5	0.04
pH (pH units)	5.8 [1]	

1. *The water quality model is based on the BV ELF. Scaling to NAF ELFs does not work for pH and alkalinity, Hence, pH and alkalinity data from column leach tests are used for NAF seepage water quality (further details in MWM, 2026g).*
2. *Acidity is calculated from Fe concentration and pH.*

6.3 PPG ELF Long-term PCOC Decay

This section summarises the ELF water quality model for the PPG ELF basal sub-catchment. Given acidity is not the main issue for a NAF ELF, Zn is plotted to understand long term treatment requirements (Figure 8). The following clarifications are provided:

- The stabilisation phase for the PPG ELF will be for ~2.7 years (3 years is applied as a conservative measure). Construction and rehabilitation are scheduled over 3 years.
- Limestone dosing of the ELF is not required.
- Due to water management scheduling, the MSR starts in 2058 (MWM, 2026c). A MSR could be installed for this ELF from the commencement of the Project (year 1) provided sediment is diverted from the MSR treatment system.
- Based on the decay rates of 9.6%, the PPG ELF will be below the current Escarpment Mine Site compliance value (RC10193) for Zn (0.012 mg/L for pH >5.5[9]) after ~48 years post construction indicating that passive treatment would not be required at that point. Note: downstream dilution needs to be considered in this treatment duration estimate as well as other PCOC.
- The use of the BV ELF as an analogue for a NAF ELF is conservative as lower pH in the BV ELF drives higher reaction rates and the generation of PCOC. This is not expected in a NAF ELF that will be circum-neutral pH. Long term acidity loads due to oxygen flux are unlikely to be the dominant driver of PCOC within a NAF ELF, hence the PCOC decay curves are set to 9.6% decay within the model. If this assumption is incorrect, then a longer passive treatment period is required.
- Discharge from the PPG ELF is directed to the BVE MSR, this reactor may need to be increased for the footprint of the PPG ELF. However, it is modelled individually here in this report.

[9] *Noting that this does not consider hardness modification benefits for the limit*

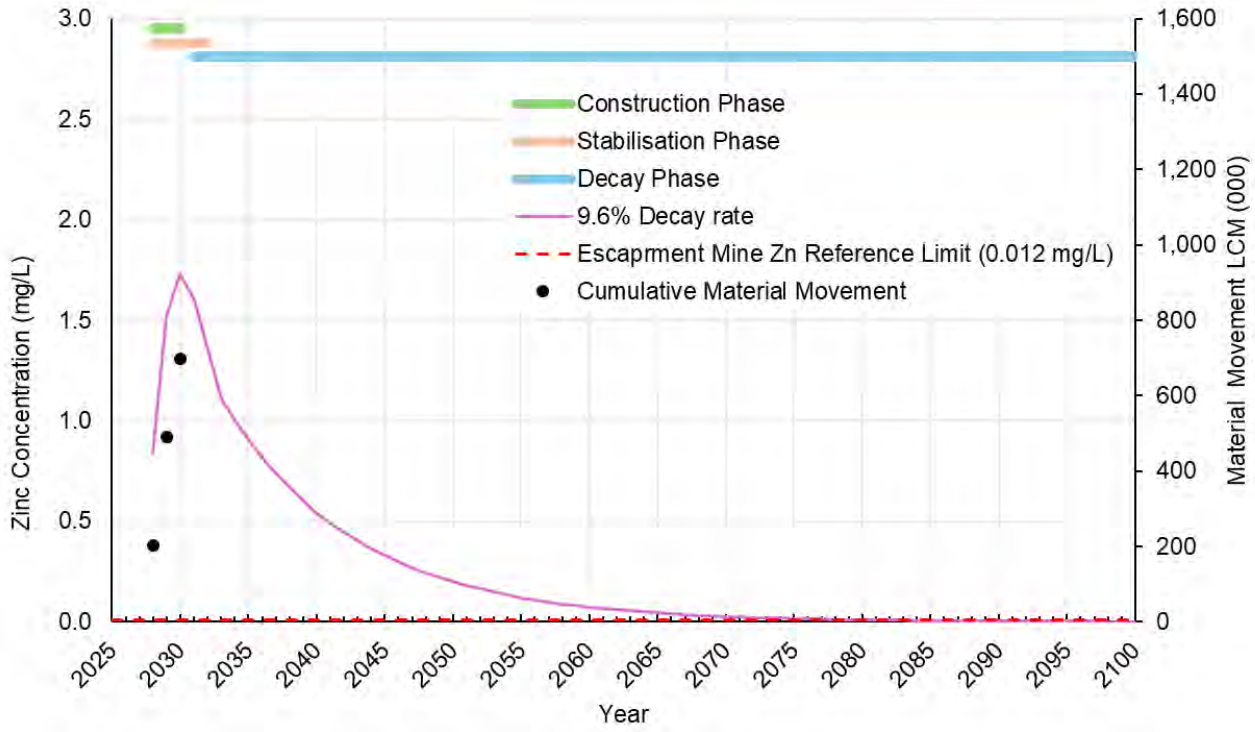

Figure 8: PPG ELF Zn decay.

6.4 PPG ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled PPG ELF basal sub-catchment source term. The recommended MSR for PPG ELF basal sub-catchment are presented in Table 16.

Table 16: PPG ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	4.0
Rainfall (mm/yr)	5,468
Infiltration coefficient	0.40
Flow Rate (L/s)	2.76
Acidity load (t $CaCO_3$/yr)	2.3
MSR surface area + polishing pond (m^2)	611
MSR surface area (m^2)	306
Polishing pond area (m^2)	306
MSR depth (m)	1.50
MSR volume (m^3)	458
Shells pore volume calc (m^3)	238
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2058

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

7 ESC ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the ESC ELF.

7.1 ESC ELF Model Inputs

The ESC ELF basal sub-catchment water quality model criteria (Table 1) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 3.4 ha, the average rainfall (5,468 mm/yr), and a net percolation rate of 40%, an average flow rate of 2.36 L/s was calculated. These data are presented in Table 17.

Table 17: ESC ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	19.5
	Sulfur content (%)	0.34
	10 m shell sulfur content wt (%)[1]	0.13
	Area (ha)	3.4
	Total ELF (m^3 LCM)[2]	613,300
	10 m shell (m^3 LCM)[2]	265,900
Lake Brazil met station	Average rainfall (mm/yr)	5,468
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	2.36

[1] *Average sulfur content of NSUL ELF (NAF).*

[2] *Rounded up to nearest 100 m^3.*

7.2 ESC ELF Water Quality

Using the data presented in Table 17 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the ESC ELF (Table 18). Data indicates that the ESC ELF basal sub-catchment would generate an acidity load of approximately 9.4 t/yr or 2.8 t/yr/ha at the end of the Stabilisation Phase.

Table 18: ESC ELF model source terms and respective loads for FY2031 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	126	9.4
Alkalinity	0	0
Ca	36.1	2.7
Mg	4.1	0.3
Na	0.05	0.003
K	0.12	0.009
SO_4	216	16.1
Al	12.1	0.9
Fe	5.6	0.4
Ni	0.2	0.01
Mn	0.5	0.03

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cr	0.008	0.0006
Cd	0.0002	0.00002
Co	0.02	0.002
Cu	0.006	0.0005
Pb	0.0004	0.00003
Tl	0.0004	0.00003
Zn	0.9	0.07
DOC	0.5	0.04
pH (pH units)	3.3	

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

7.3 ESC ELF Water Quality Model

This section summarises the ELF water quality model for the ESC ELF basal sub-catchment.as shown in (Figure 9). The following clarifications are provided:

- The stabilisation phase for the ESC ELF has been estimated at ~3.0 years.
- Construction is scheduled over 2 years. Rehabilitation is scheduled over the same period with stabilisation conditions commencing as material is rehabilitated. The Construction Phase therefore includes construction and stabilisation conditions. Decay (at 9.6%) for material will commence 3 years from construction for early rehabilitated material, therefore the Stabilisation Phase includes material in stabilisation and decay. The Decay Phase is indicated when all material enters decay conditions ~5 years from commencement of construction.
- If the benefits of limestone addition are exhausted, acidity loads are modelled at 5.9 t/yr ~ 8 years post construction. Passive treatment could commence immediately. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2030 (MWM, 2026c).

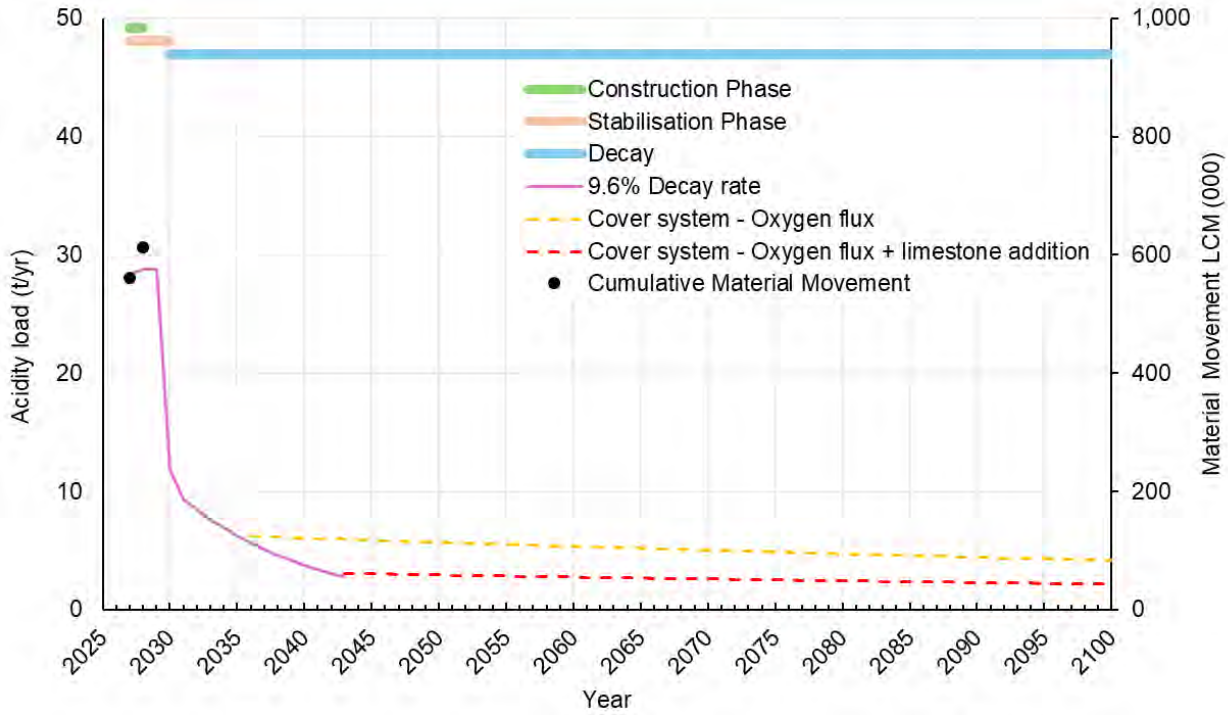

Figure 9: ESC ELF acidity decay.

7.4 ESC ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled ESC ELF basal sub-catchment source term. The recommended MSR for ESC ELF basal sub-catchment are presented in Table 19.

Table 19: ESC ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	3.2
Rainfall (mm/yr)	5,468
Infiltration coefficient	0.40
Flow Rate (L/s)	2.2
Acidity load (t $CaCO_3$/yr)	28.8
MSR surface area + polishing pond (m^2)	489
MSR surface area (m^2)	245
Polishing pond area (m^2)	245
MSR depth (m)	1.5
MSR volume (m^3)	367
Shells pore volume calc (m^3)	191
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2030

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity.

Red: Higher risk with regards to MSR treatment capacity.

8 WWH ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the WWH ELF.

8.1 WWH ELF Model Inputs

The BVE ELF basal sub-catchment water quality model criteria (Table 1) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 170.7 ha, the average rainfall (5,468 mm/yr), and a net percolation rate of 40%, an average flow rate of 118.3 L/s was calculated. These data are presented in Table 20.

Table 20: WWH ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	59.7
	Sulfur content (%)	0.38
	10 m shell sulfur content wt (%)[1]	0.13
	Area (ha)	170.7
	Total ELF (m^3 LCM)[2]	100,017,300
	10 m shell (m^3 LCM)[2]	15,349,800
Lake Brazil met station	Average rainfall (mm/yr)	5,468
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	118.3

[1] *Average sulfur content of NSUL ELF (NAF).*

[2] *Rounded up to nearest 100 m^3.*

8.2 WWH ELF Water Quality

Using the data presented in Table 20 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the WWH ELF (Table 21). Data indicates that the WWH ELF basal sub-catchment would generate an acidity load of approximately 346 t/yr or 2.0 t/yr/ha at the end of the Stabilisation Phase.

Table 21: WWH ELF model source terms and respective loads for FY2050 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	93	346
Alkalinity	0	0
Ca	26.6	99
Mg	3.0	11.3
Na	0.0	0.1
K	0.09	0.3
SO_4	159	594
Al	8.9	33.2
Fe	4.1	15.4
Ni	0.1	0.5
Mn	0.3	1.2

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cr	0.006	0.02
Cd	0.0002	0.001
Co	0.02	0.1
Cu	0.00	0.02
Pb	0.000	0.001
Tl	0.0003	0.001
Zn	0.7	2.5
DOC	0.5	1.9
pH (pH units)	3.5	

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

8.3 WWH ELF Water Quality Model

This section summarises the ELF water quality model for the WWH ELF basal sub-catchment as shown in Figure 10. The following clarifications are provided:

- The stabilisation phase for the WWH ELF has been estimated at ~9.0 years.
- Construction is scheduled over 15 years. Rehabilitation is scheduled over the same period with stabilisation conditions commencing as material is rehabilitated with decay of material commencing 9 years after rehabilitation. The Construction Phase therefore includes construction and stabilisation conditions and includes decay conditions. Decay (at 9.6%) for material will commence 9 years from construction for early rehabilitated material, therefore the Stabilisation Phase includes material in stabilisation and decay. The Decay Phase is indicated when all material enters decay conditions ~24 years from commencement of construction.
- If the benefits of limestone addition are exhausted, acidity loads are modelled at 300 t/yr ~11 years post construction. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2058 (MWM, 2026c). A MSR could be installed 11 years after the cover system is constructed once long-term acid generation rates are achieved, noting that multiple systems may be required to manage projected high acidity and flow values.

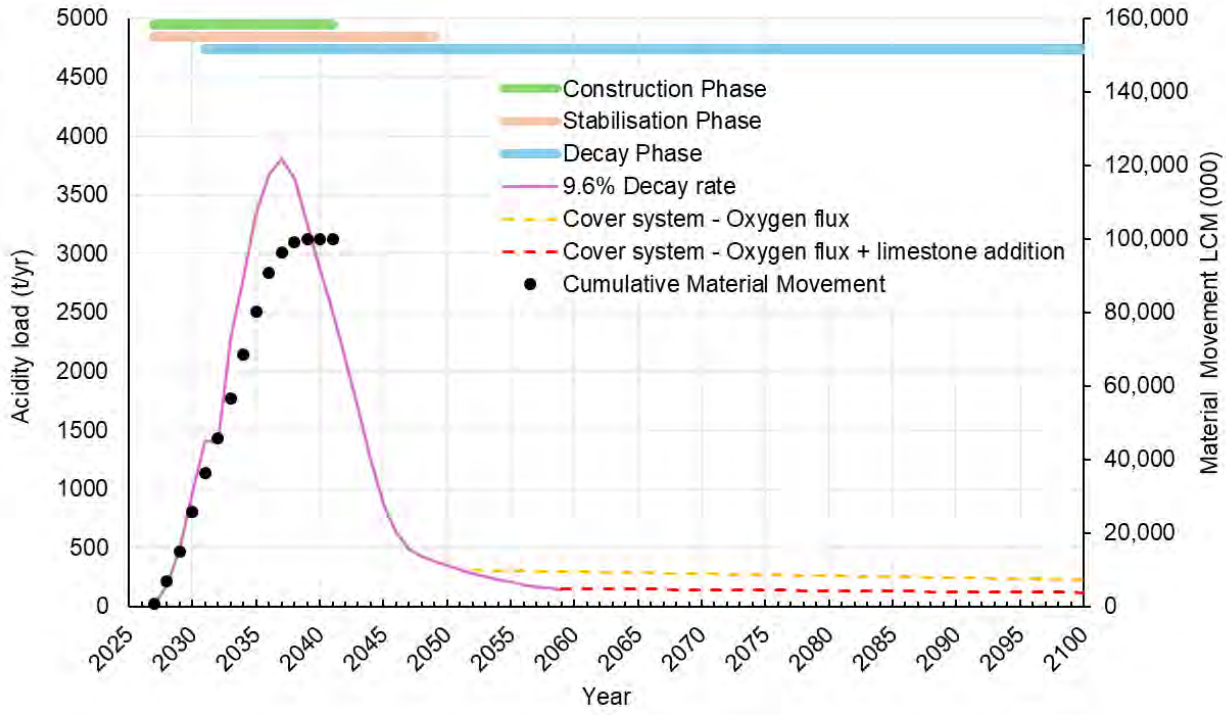

Figure 10: WWH ELF acidity decay.

8.4 WWH ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled WWH ELF basal sub-catchment source term. The recommended MSR for WWH ELF basal sub-catchment are presented in Table 22.

Table 22: WWH ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	169.2
Rainfall (mm/yr)	5,468
Infiltration coefficient	0.40
Flow Rate (L/s)	117
Acidity load (t $CaCO_3$/yr)[1]	310.4
MSR surface area + polishing pond (m^2)	25,982
MSR surface area (m^2)	12,991
Polishing pond area (m^2)	12,991
MSR depth (m)	1.5
MSR volume (m^3)	19,486
Shells pore volume calc (m^3)	10,133
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2058

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

9 MSR1 ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the MSR1 ELF.

9.1 MSR1 ELF Model Inputs

The MSR1 ELF basal sub-catchment water quality model criteria (Table 23) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 6.1 ha, the average rainfall (5,928 mm/yr), and a net percolation rate of 40%, an average flow rate of 4.60 L/s was calculated. These data are presented in Table 23.

Table 23: MSR1 ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	14.5
	Sulfur content (%)	0.12
	10 m shell sulfur content wt (%)	0.16
	Area (ha)	6.1
	Total ELF (m^3 LCM)[1]	898,651
	10 m shell (m^3 LCM)[1]	509,831
Lake Brazil met station	Average rainfall (mm/yr)	5,928
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	4.60

[1] Rounded up to nearest 100 m^3.

9.2 MSR1 ELF Water Quality

Using the data presented in Table 23 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the MSR1 ELF (Table 24). Data indicates that the MSR1 ELF basal sub-catchment would generate an acidity load of approximately 21.7 t/yr or 3.5 t/yr/ha at the end of the Stabilisation Phase.

Table 24: MSR1 ELF model source terms and respective loads for FY2031 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	149	21.7
Alkalinity	0	0
Ca	42.8	6.2
Mg	4.9	0.7
Na	0.05	0.008
K	0.1	0.02
SO_4	256	37.2
Al	14.4	2.1
Fe	6.7	1.0
Ni	0.2	0.03
Mn	0.5	0.08
Cr	0.009	0.001

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cd	0.0003	0.00004
Co	0.03	0.004
Cu	0.007	0.0011
Pb	0.0005	0.00007
Tl	0.0005	0.00007
Zn	1.1	0.2
DOC	0.5	0.1
pH (pH units)	3.3	-

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

9.3 MSR1 ELF Water Quality Model

This section summarises the ELF water quality model for the MSR1 ELF basal sub-catchment as shown in Figure 11. The following clarifications are provided:

- The stabilisation phase for the MSR1 ELF has been estimated at ~2.0 years.
- Construction is scheduled over 2 years. Rehabilitation is scheduled over the same period with stabilisation conditions commencing as material is rehabilitated.
- If the benefits of limestone addition are exhausted, acidity loads are modelled at 10.7 t/yr ~ 9 years post construction. Passive treatment could still commence immediately. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2045 (MWM, 2026d). A MSR could be installed immediately (i.e., at the end of the Stabilisation Phase) if that was required by mine planners

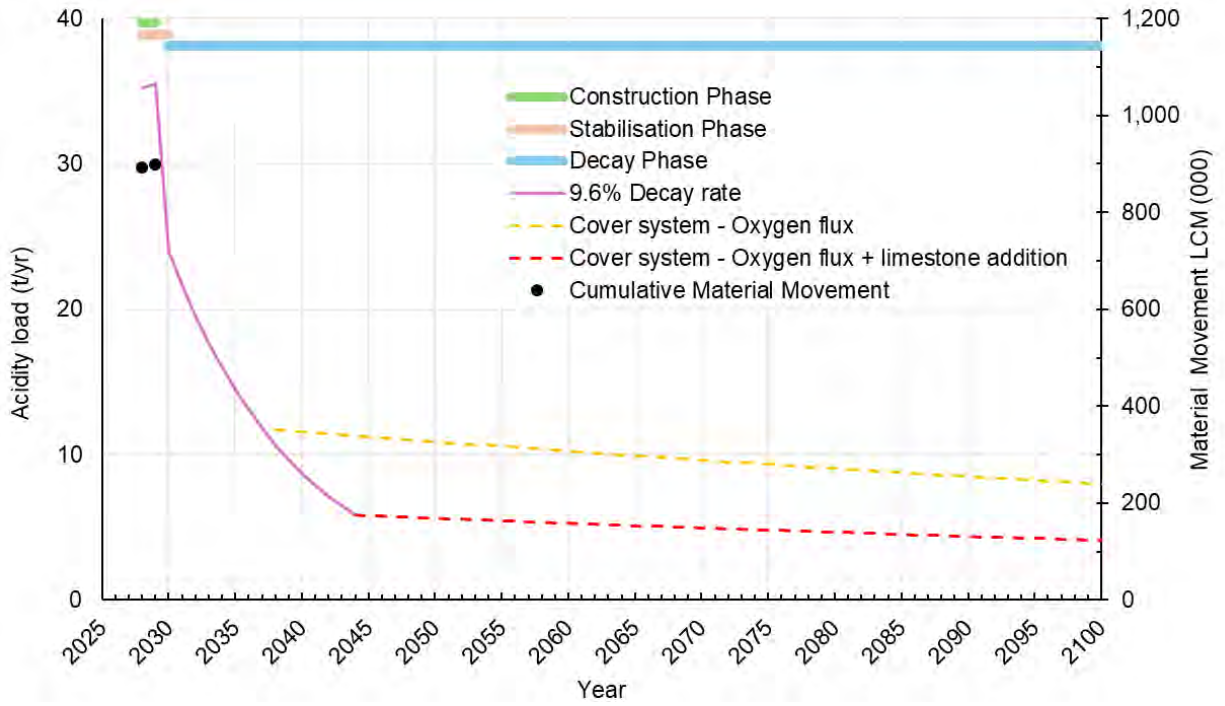

Figure 11: MSR1 ELF acidity decay.

9.4 MSR1 ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled MSR1 ELF basal sub-catchment source term. The recommended MSR for MSR1 ELF basal sub-catchment are presented in Table 25.

Table 25: MSR1 ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	6.2
Rainfall (mm/yr)	5,928
Infiltration coefficient	0.40
Flow Rate (L/s)	4.6
Acidity load (t $CaCO_3$/yr)	24.0
MSR surface area + polishing pond (m^2)	1,025
MSR surface area (m^2)	512
Polishing pond area (m^2)	512
MSR depth (m)	1.5
MSR volume (m^3)	769
Shells pore volume calc (m^3)	400
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2045

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

10 MSR2 ELF BASAL SUB-CATCHMENT

The following section provides the source term for the Construction and Stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the MSR2 ELF.

10.1 MSR2 ELF Model Inputs

The MSR2 ELF basal sub-catchment water quality model criteria (Table 26) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical ELF water quality data (MWM, 2026a).

Based on a catchment area of 1.5 ha, the average rainfall (5,928 mm/yr), and a net percolation rate of 40%, a static flow rate of 1.13 L/s was calculated. These data are presented in Table 26.

Table 26: MSR2 ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	12.6
	Sulfur content (%)	0.12
	10 m shell sulfur content wt (%)	0.16
	Area (ha)	1.5
	Total ELF (m^3 LCM)[1]	126,912
	10 m shell (m^3 LCM)[1]	101,803
Lake Brazil met station	Average rainfall (mm/yr)	5,928
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	1.13

[1] *Rounded up to nearest 100 m^3.*

10.2 MSR2 ELF Water Quality

Using the data presented in Table 26 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the MSR2 ELF (Table 27). Data indicates that the MSR2 ELF basal sub-catchment would generate an acidity load of approximately 4.8 t/yr or 3.2 t/yr/ at the end of the Stabilisation Phase.

Table 27: MSR2 ELF model source terms and respective loads for FY2030 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	134	4.8
Alkalinity	0	0
Ca	38.4	1.4
Mg	4.4	0.2
Na	0.05	0.002
K	0.1	0.00
SO_4	230	8.2
Al	12.9	0.5
Fe	6.0	0.2
Ni	0.2	0.01
Mn	0.5	0.02
Cr	0.008	0.0003

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cd	0.0003	0.00001
Co	0.02	0.001
Cu	0.007	0.0002
Pb	0.0005	0.00002
Tl	0.0004	0.00002
Zn	1.0	0.03
DOC	0.5	0.0
pH (pH units)	3.3	-

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

10.3 MSR2 ELF Water Quality Model

This section summarises the ELF water quality model for the MSR2 ELF basal sub-catchment as shown in Figure 12. The following clarifications are provided:

- The stabilisation phase for the MSR2 ELF has been estimated at ~2.0 years.

Construction is scheduled over 1 year. Rehabilitation is scheduled over the same period therefore the Construction Phase includes construction and stabilisation conditions.

- If the benefits of limestone addition are exhausted, acidity loads are modelled at 2.7 t/yr ~ 8 years post construction. Passive treatment could still commence immediately. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2045 (MWM, 2026d). A MSR could be installed immediately (i.e., during the Stabilisation Phase) if this was required by mine planners.

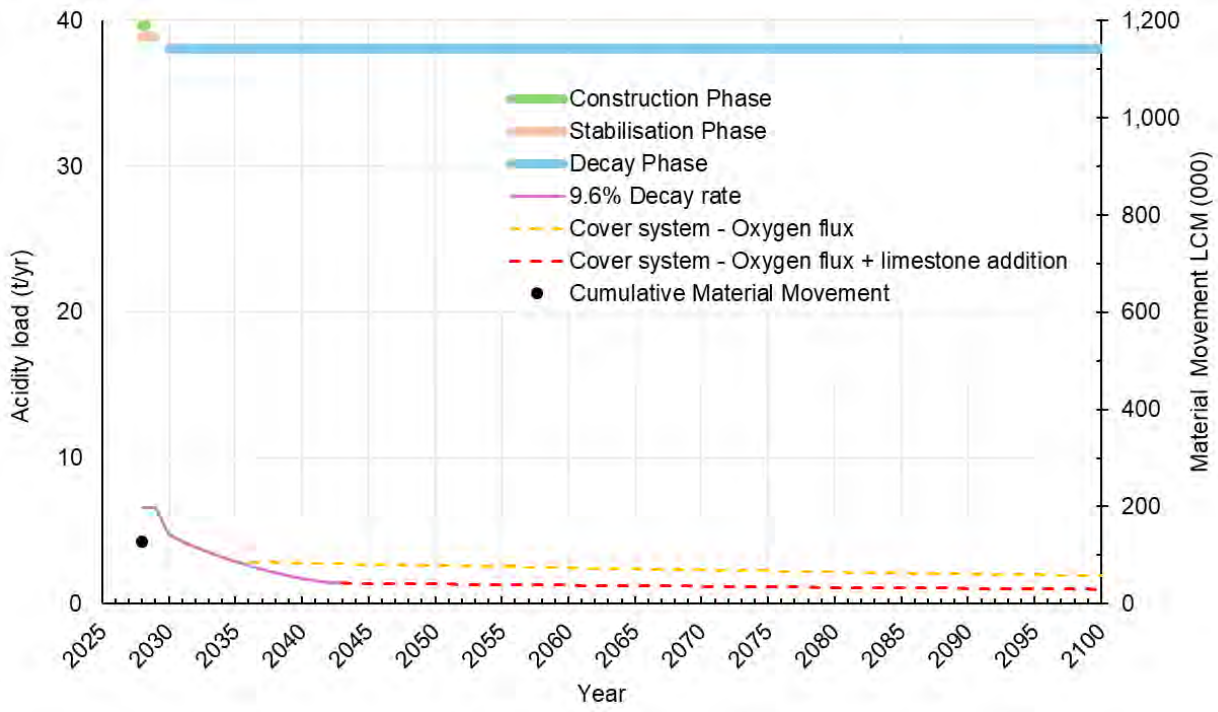

Figure 12: MSR2 ELF acidity decay.

10.4 MSR2 ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled MSR2 ELF basal sub-catchment source term. The recommended MSR for MSR2 ELF basal sub-catchment are presented in Table 28.

Table 28: MSR2 ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	1.5
Rainfall (mm/yr)	5,928
Infiltration coefficient	0.40
Flow Rate (L/s)	1.2
Acidity load (t $CaCO_3$/yr)	6.6
MSR surface area + polishing pond (m^2)	255
MSR surface area (m^2)	128
Polishing pond area (m^2)	128
MSR depth (m)	1.5
MSR volume (m^3)	191
Shells pore volume calc (m^3)	100
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2045

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

11 MSR3 ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the MSR3 ELF.

11.1 MSR3 ELF Model Inputs

The BVE ELF basal sub-catchment water quality model criteria (Table 29) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 2.2 ha, the average rainfall (5,928 mm/yr), and a net percolation rate of 40%, an average flow rate of 1.63 L/s was calculated. These data are presented in Table 29.

Table 29: MSR3 ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	12.6
	Sulfur content (%)	0.12
	10 m shell sulfur content wt (%)	0.11
	Area (ha)	2.2
	Total ELF (m^3 LCM)[1]	148,250
	10 m shell (m^3 LCM)[1]	127,268
Lake Brazil met station	Average rainfall (mm/yr)	5,928
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	1.63

[1] Rounded up to nearest 100 m^3.

11.2 MSR3 ELF Water Quality

Using the data presented in Table 29 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the MSR3 ELF (Table 30). Data indicates that the MSR3 ELF basal sub-catchment would generate an acidity load of approximately 4.1 t/yr or 1.9 t/yr/ha at the end of the Stabilisation Phase.

Table 30: MSR3 ELF model source terms and respective loads for FY2031 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	80	4.1
Alkalinity	0	0
Ca	22.9	1.2
Mg	2.6	0.1
Na	0.03	0.001
K	0.1	0.004
SO_4	137	7.0
Al	7.7	0.4
Fe	3.6	0.2
Ni	0.1	0.01
Mn	0.3	0.01
Cr	0.00	0.0003

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cd	0.0002	0.00001
Co	0.01	0.001
Cu	0.004	0.0002
Pb	0.0003	0.00001
Tl	0.0003	0.00001
Zn	0.6	0.03
DOC	0.5	0.03
pH (pH units)	3.5	-

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

11.3 MSR3 ELF Water Quality Model

This section summarises the ELF water quality model for the MSR3 ELF basal sub-catchment as shown in Figure 13. The following clarifications are provided:

- The stabilisation phase for the MSR3 ELF has been estimated at ~2.0 years.
- Construction is scheduled over 2 years. Rehabilitation is scheduled over the same period with stabilisation conditions commencing as material is rehabilitated.
- If the benefits of limestone addition are exhausted, acidity loads are modelled at 3.8 t/yr ~ 3 years post construction. Passive treatment could still commence immediately. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2045 (MWM, 2026d). A MSR could be installed immediately (i.e., during the Stabilisation Phase) if this was required by mine planners.

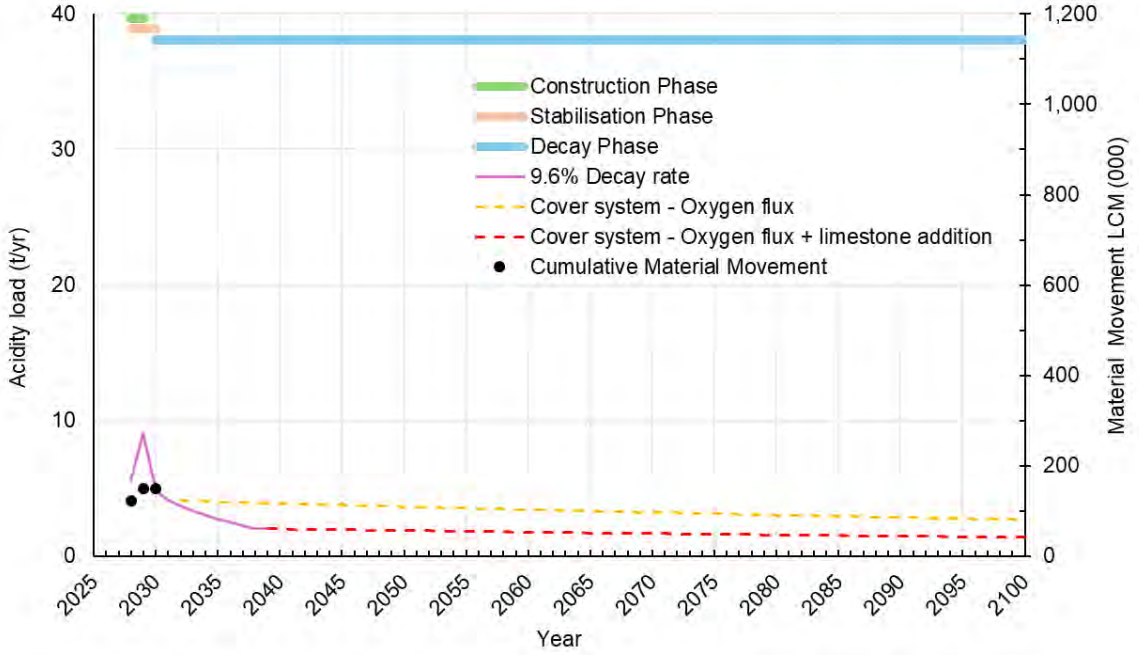

Figure 13: MSR3 ELF acidity decay.

11.4 MSR3 ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled MSR3 ELF basal sub-catchment source term. The recommended MSR for MSR3 ELF basal sub-catchment are presented in Table 31.

Table 31: MSR3 ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	4.1
Rainfall (mm/yr)	5,928
Infiltration coefficient	0.40
Flow Rate (L/s)	3.1
Acidity load (t $CaCO_3$/yr)	4.8
MSR surface area + polishing pond (m^2)	690
MSR surface area (m^2)	345
Polishing pond area (m^2)	345
MSR depth (m)	1.5
MSR volume (m^3)	518
Shells pore volume calc (m^3)	269
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2045

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

12 MSR4 ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the MSR4 ELF.

12.1 MSR4 ELF Model Inputs

The MSR4 ELF basal sub-catchment water quality model criteria (Table 32) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical ELF water quality data (MWM, 2026a).

Based on a catchment area of 6.1 ha, the average rainfall (5,928 mm/yr), and a net percolation rate of 40%, an average flow rate of 4.55 L/s was calculated. These data are presented in Table 32.

Table 32: MSR4 ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	12.6
	Sulfur content (%)	0.12
	10 m shell sulfur content wt (%)	0.057
	Area (ha)	6.1
	Total ELF (m^3 LCM)[1]	3,209,130
	10 m shell (m^3 LCM)[1]	1,813,129
Lake Brazil met station	Average rainfall (mm/yr)	5,928
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	4.55

[1] Rounded up to nearest 100 m^3.

12.2 MSR4 ELF Water Quality

Using the data presented in Table 32 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the MSR4 ELF (Table 33). Data indicates that the MSR4 ELF basal sub-catchment would generate an acidity load of approximately 29.5 t/yr or 1.9 t/yr/ha at the end of the Stabilisation Phase.

Table 33: MSR4 ELF model source terms and respective loads for FY2039 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	206	29.5
Alkalinity	0	0
Ca	59.0	8.5
Mg	6.7	1.0
Na	0.1	0.01
K	0.2	0.03
SO_4	354	50.8
Al	19.8	2.8
Fe	9.2	1.3
Ni	0.3	0.04
Mn	0.7	0.1
Cr	0.01	0.002

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cd	0.000	0.00006
Co	0.04	0.005
Cu	0.01	0.001
Pb	0.001	0.0001
Tl	0.001	0.0001
Zn	1.5	0.2
DOC	0.5	0.1
pH (pH units)	3.1	-

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

12.3 MSR4 ELF Water Quality Model

This section summarises the ELF water quality model for the MSR4 ELF basal sub-catchment as shown in Figure 14. The following clarifications are provided:

- The stabilisation phase for the MSR4 ELF has been estimated at ~2.0 years.
- Construction is scheduled over 3 years. Rehabilitation is scheduled over the same period with stabilisation conditions commencing as material is rehabilitated.
- If the benefits of limestone addition are exhausted, acidity loads are modelled at 10.6 t/yr ~ 13 years post construction. Passive treatment could still commence immediately. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2045 (MWM, 2026d). A MSR could be installed immediately (i.e., during the Stabilisation Phase) if this was required by mine planners.

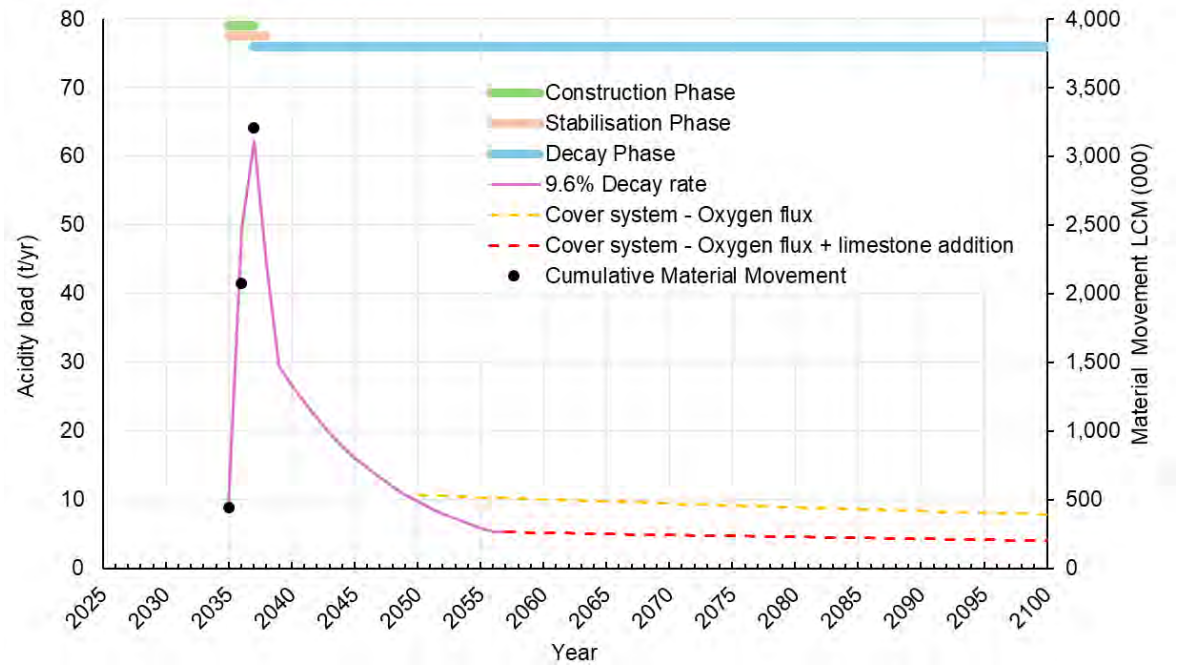

Figure 14: MSR4 ELF acidity decay.

12.4 MSR4 ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled MSR4 ELF basal sub-catchment source term. The recommended MSR for MSR4 ELF basal sub-catchment are presented in Table 34.

Table 34: MSR4 ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	4.1
Rainfall (mm/yr)	5,928
Infiltration coefficient	0.40
Flow Rate (L/s)	3.1
Acidity load (t $CaCO_3$/yr)	44.1
MSR surface area + polishing pond (m^2)	690
MSR surface area (m^2)	345
Polishing pond area (m^2)	345
MSR depth (m)	1.5
MSR volume (m^3)	518
Shells pore volume calc (m^3)	269
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2045

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

13 MSR5 ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the MSR5 ELF.

13.1 MSR5 ELF Model Inputs

The MSR5 ELF basal sub-catchment water quality model criteria (Table 35) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical ELF water quality data (MWM, 2026a).

Based on a catchment area of 18.9 ha, the average rainfall (5,928 mm/yr), and a net percolation rate of 40%, an average flow rate of 14.2 L/s was calculated. These data are presented in Table 35.

Table 35: MSR5 ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	19.1
	Sulfur content (%)	0.12
	10 m shell sulfur content wt (%)	0.047
	Area (ha)	18.9
	Total ELF (m^3 LCM)[1]	4,723,492
	10 m shell (m^3 LCM)[1]	1,736,293
Lake Brazil met station	Average rainfall (mm/yr)	5,928
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	14.2

[1] Rounded up to nearest 100 m^3.

13.2 MSR5 ELF Water Quality

Using the data presented in Table 35 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the MSR5 ELF (Table 36). Data indicates that the MSR5 ELF basal sub-catchment would generate an acidity load of approximately 25 t/yr or 1.3 t/yr/ha at the end of the Stabilisation Phase.

Table 36: MSR5 ELF model source terms and respective loads for FY2040 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	56	25.0
Alkalinity	0	0
Ca	16.0	7.2
Mg	1.8	0.8
Na	0.02	0.01
K	0.05	0.02
SO_4	96	42.9
Al	5.4	2.4
Fe	2.5	1.1
Ni	0.1	0.0
Mn	0.2	0.1
Cr	0.003	0.002

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cd	0.0001	0.00005
Co	0.01	0.004
Cu	0.003	0.001
Pb	0.0002	0.0001
Tl	0.0002	0.0001
Zn	0.4	0.18
DOC	0.5	0.2
pH (pH units)	3.7	-

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

13.3 MSR5 ELF Water Quality Model

This section summarises the ELF water quality model for the BVE ELF basal sub-catchment as shown in Figure 15. The following clarifications are provided:

- The stabilisation phase for the BVE ELF has been estimated at ~3.0 years.
- Construction is scheduled over 8 years. Rehabilitation is scheduled over 9 years with stabilisation conditions commencing as material is rehabilitated.
- If the benefits of limestone addition are exhausted, acidity loads are modelled at 33.2 t/yr ~ 3 years post construction. Passive treatment could still commence immediately. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2045 (MWM, 2026d). A MSR could be installed immediately (i.e., during the Stabilisation Phase) if this was required by mine planners.

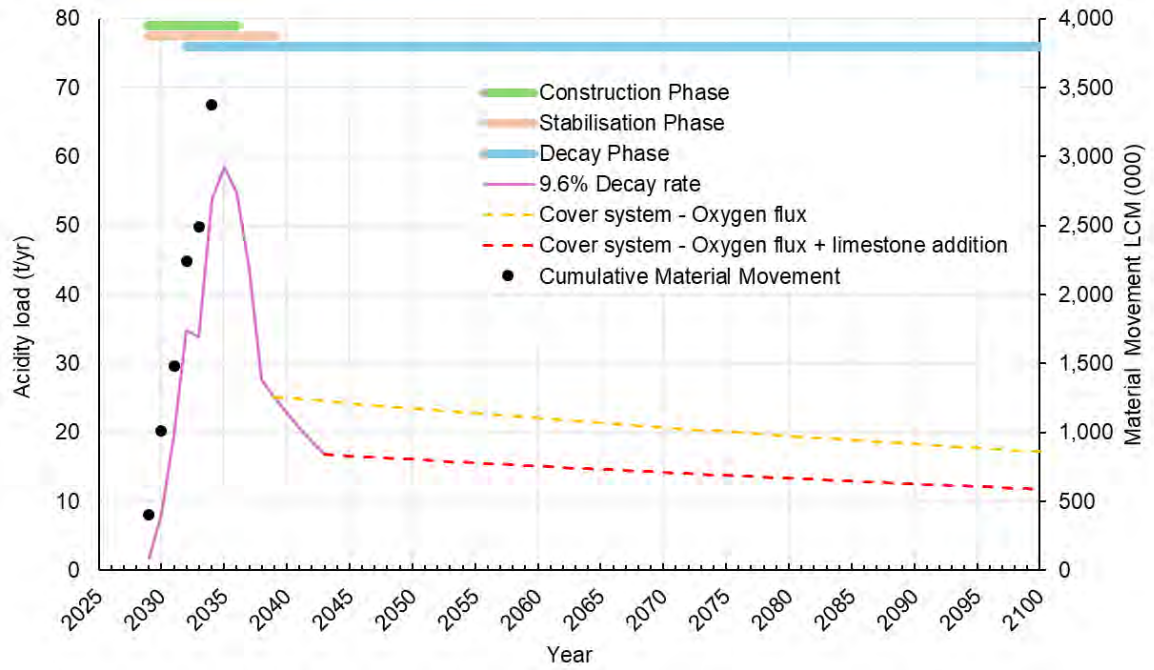

Figure 15: MSR5 ELF acidity decay.

13.4 MSR5 ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled MSR5 ELF basal sub-catchment source term. The recommended MSR for MSR5 ELF basal sub-catchment are presented in Table 37.

Table 37: MSR5 ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	19.0
Rainfall (mm/yr)	5,928
Infiltration coefficient	0.40
Flow Rate (L/s)	14.3
Acidity load (t $CaCO_3$/yr)	27.6
MSR surface area + polishing pond (m^2)	3,163
MSR surface area (m^2)	1,582
Polishing pond area (m^2)	1,582
MSR depth (m)	1.5
MSR volume (m^3)	2,372
Shells pore volume calc (m^3)	1,234
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2045

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

14 MSR6 ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the MSR6 ELF.

14.1 MSR6 ELF Model Inputs

The MSR6 ELF basal sub-catchment water quality model criteria (Table 38) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 4.5 ha, the average rainfall (5,928 mm/yr), and a net percolation rate of 40%, an average flow rate of 3.34 L/s was calculated. These data are presented in Table 38.

Table 38: MSR6 ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	10.1
	Sulfur content (%)	0.12
	10 m shell sulfur content wt (%)	0.047
	Area (ha)	4.5
	Total ELF (m^3 LCM)[1]	605,339
	10 m shell (m^3 LCM)[1]	379,776
Lake Brazil met station	Average rainfall (mm/yr)	5,928
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	3.34

[1] Rounded up to nearest 100 m^3.

14.2 MSR6 ELF Water Quality

Using the data presented in Table 38 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the MSR6 ELF (Table 39). Data indicates that the MSR6 ELF basal sub-catchment would generate an acidity load of approximately 5.5 t/yr or 1.2 t/yr/ha at the end of the Stabilisation Phase.

Table 39: MSR6 ELF model source terms and respective loads for FY2039 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	52	5.5
Alkalinity	0	0
Ca	14.9	1.6
Mg	1.7	0.2
Na	0.02	0.002
K	0.1	0.01
SO_4	89	9.4
Al	5.0	0.5
Fe	2.3	0.2
Ni	0.1	0.01
Mn	0.2	0.02
Cr	0.003	0.0003

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cd	0.0001	0.00001
Co	0.01	0.001
Cu	0.003	0.0003
Pb	0.0002	0.00002
Tl	0.0002	0.00002
Zn	0.4	0.04
DOC	0.5	0.1
pH (pH units)	3.7	-

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

14.3 MSR6 Water Quality Model

This section summarises the ELF water quality model for the MSR6 ELF basal sub-catchment as shown in Figure 16. The following clarifications are provided:

- The stabilisation phase for the MSR6 ELF has been estimated at ~2.0 years.
- Construction is scheduled over 5 years. Rehabilitation is scheduled over 6 years with stabilisation conditions commencing as material is rehabilitated.
- If the benefits of limestone addition are exhausted, acidity loads are modelled at 7.8 t/yr ~ 2 years post construction. Passive treatment could still commence immediately. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2045 (MWM, 2026d). A MSR could be installed immediately (i.e., during the Stabilisation Phase) if this was required by mine planners.

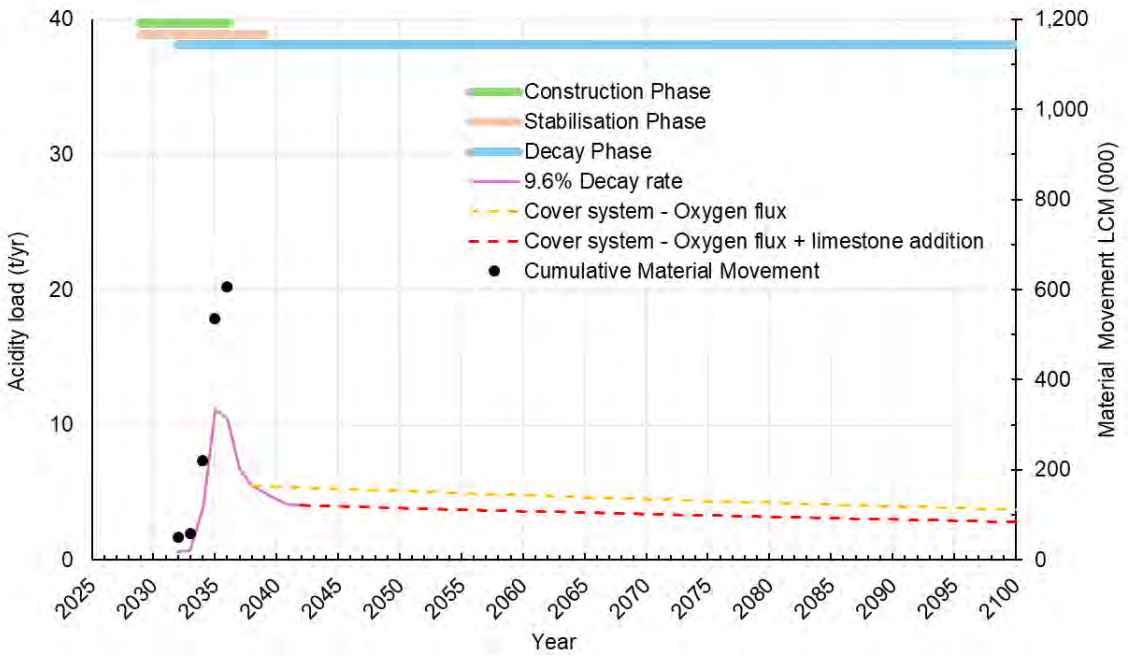

Figure 16: MSR6 ELF acidity decay.

14.4 MSR6 ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled MSR6 ELF basal sub-catchment source term. The recommended MSR for MSR6 ELF basal sub-catchment are presented in Table 40.

Table 40: MSR6 ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	4.5
Rainfall (mm/yr)	5,928
Infiltration coefficient	0.40
Flow Rate (L/s)	3.4
Acidity load (t $CaCO_3$/yr)	5.5
MSR surface area + polishing pond (m^2)	751
MSR surface area (m^2)	375
Polishing pond area (m^2)	375
MSR depth (m)	1.5
MSR volume (m^3)	563
Shells pore volume calc (m^3)	293
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2045

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

15 MSR7 ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the MSR7 ELF.

15.1 MSR7 ELF Model Inputs

The MSR7 ELF basal sub-catchment water quality model criteria (Table 41) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 20.1 ha, the average rainfall (5,928 mm/yr), and a net percolation rate of 40%, an average flow rate of 15.1 L/s was calculated. These data are presented in Table 41.

Table 41: MSR7 ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	11.9
	Sulfur content (%)	0.12
	10 m shell sulfur content wt (%)	0.047
	Area (ha)	20.1
	Total ELF (m^3 LCM)[1]	3,209,130
	10 m shell (m^3 LCM)[1]	1,813,129
Lake Brazil met station	Average rainfall (mm/yr)	5,928
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	15.1

[1] Rounded up to nearest 100 m^3.

15.2 MSR7 ELF Water Quality

Using the data presented in Table 41 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the MSR7 ELF (Table 42). Data indicates that the MSR7 ELF basal sub-catchment would generate an acidity load of approximately 29.6 t/yr or 1.5 t/yr/ha at the end of the Stabilisation Phase.

Table 42: MSR7 ELF model source terms and respective loads for FY2039 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	62	29.6
Alkalinity	0	0
Ca	17.8	8.5
Mg	2.0	1.0
Na	0.02	0.01
K	0.1	0.03
SO_4	107	50.8
Al	6.0	2.8
Fe	2.8	1.3
Ni	0.1	0.04
Mn	0.2	0.1
Cr	0.004	0.002

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cd	0.0001	0.00006
Co	0.01	0.005
Cu	0.003	0.001
Pb	0.0002	0.0001
Tl	0.0002	0.0001
Zn	0.4	0.21
DOC	0.5	0.2
pH (pH units)	3.6	-

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

15.3 MSR7 ELF Water Quality Model

This section summarises the ELF water quality model for the BVE ELF basal sub-catchment as shown in Figure 17. The following clarifications are provided:

- The stabilisation phase for the MSR7 ELF has been estimated at ~2.0 years.
- Construction is scheduled over 3 years. Rehabilitation is scheduled over 4 years with stabilisation conditions commencing as material is rehabilitated.
- If the benefits of limestone addition are exhausted, acidity loads are modelled at 35.3 t/yr ~ 2 years post construction. Passive treatment could still commence immediately. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2045 (MWM, 2026d). A MSR could be installed immediately (i.e., during the Stabilisation Phase) if this was required by mine planners.

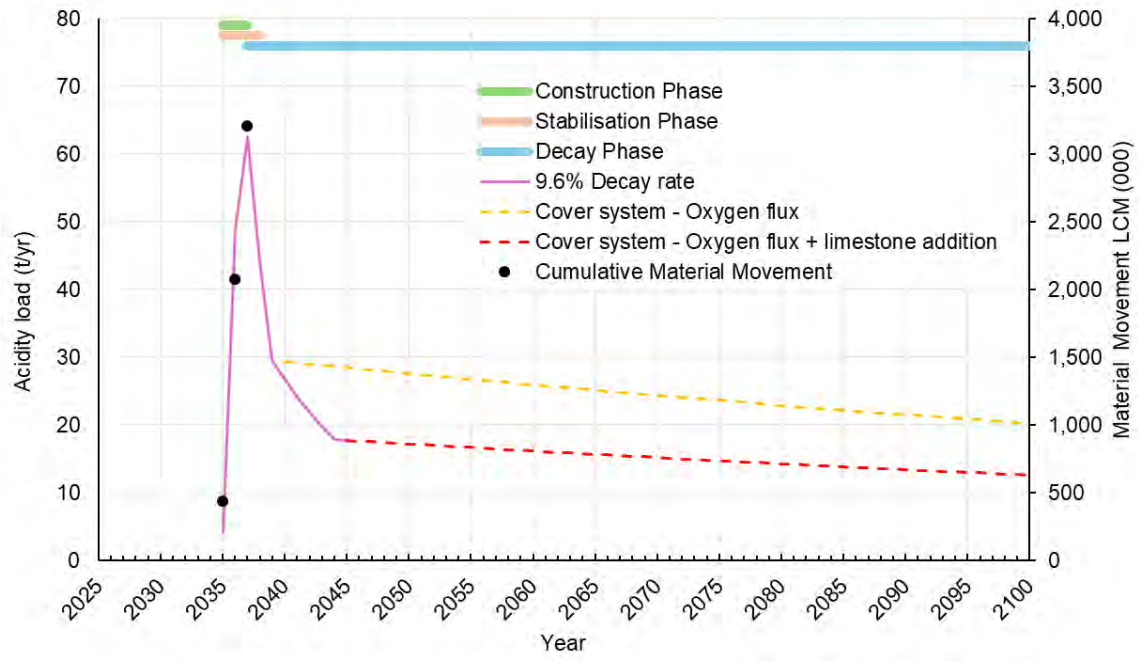

Figure 17: MSR7 ELF acidity decay.

15.4 MSR7 ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled MSR7 ELF basal sub-catchment source term. The recommended MSR for MSR7 ELF basal sub-catchment are presented in Table 43.

Table 43: MSR7 ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	20.12
Rainfall (mm/yr)	5,928
Infiltration coefficient	0.40
Flow Rate (L/s)	15.2
Acidity load (t $CaCO_3$/yr)	44.2
MSR surface area + polishing pond (m^2)	3,366
MSR surface area (m^2)	1,683
Polishing pond area (m^2)	1,683
MSR depth (m)	1.5
MSR volume (m^3)	2,525
Shells pore volume calc (m^3)	1,313
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2045

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

16 MDC1 ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the MDC1 ELF.

16.1 MDC1 ELF Model Inputs

The MDC1 ELF basal sub-catchment water quality model criteria (Table 44) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 0.60 ha, the average rainfall (5,928 mm/yr), and a net percolation rate of 40%, an average flow rate of 0.44 L/s was calculated. These data are presented in Table 44.

Table 44: MDC1 ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	9.0
	Sulfur content (%)	0.049
	10 m shell sulfur content wt (%)	0.047
	Area (ha)	0.6
	Total ELF (m^3 LCM)[1]	52,922
	10 m shell (m^3 LCM)[1]	43,006
Lake Brazil met station	Average rainfall (mm/yr)	5,928
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	0.44

[1] Rounded up to nearest 100 m^3.

16.2 MDC1 ELF Water Quality

Using the data presented in Table 44 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the MDC1 ELF (Table 45). AMD is not expected from this NAF ELF, rather NMD. Data indicates that the MDC1 ELF basal sub-catchment would generate Fe and Zn loads of approximately 0.03 t/yr and 0.004 t/yr (respectively) during the Stabilisation Phase. Further explanation on how the source term was derived is provided in the source term report (MWM, 2026g).

Table 45: MDC1 ELF model source terms and respective loads FY2030 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	5[2]	0.1
Alkalinity	6.2 [1]	0.09
Ca	12.2	0.2
Mg	1.4	0.02
Na	0.02	0.0002
K	0.04	0.001
SO_4	73	1.0
Al	4.1	0.1
Fe	1.9	0.03
Ni	0.1	0.001

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Mn	0.2	0.002
Cr	0.003	0.00004
Cd	0.0001	0.000001
Co	0.01	0.0001
Cu	0.002	0.00003
Pb	0.0001	0.000002
Tl	0.0	0.000002
Zn	0.3	0.004
DOC	0.5	0.01
pH (pH units)	5.8 [1]	-

1. *The water quality model is based on the BV ELF. Scaling to NAF ELFs does not work for pH and alkalinity, Hence, pH and alkalinity data from column leach tests are used for NAF seepage water quality (further details in MWM, 2026g).*
2. *Acidity is calculated from Fe concentration and pH.*

16.3 MDC1 ELF Long-term PCOC Decay

This section summarises the ELF water quality model for the MDC1 ELF basal sub-catchment as shown in Figure 18. The following clarifications are provided:

The stabilisation phase for the MDC1 ELF will be for ~1.0 year. Construction is scheduled over 2 years.

- Limestone dosing of the ELF is not required.
- Due to water management scheduling, the MSR starts in 2029 (MWM, 2026d). A MSR could be installed immediately (i.e., during the Stabilisation Phase). Due to the very small volume of materials in this ELF (Table 44), there may be a scheduling opportunity during the Operational Phase of the BPCP to place low sulfur materials (<0.015 wt% S) such that treatment is not required.
- Based on a decay rate of 9.6%, the MDC1 ELF will be below the current Escarpment Mine Site reference value for Zn (0.012 mg/L for pH >5.5[10]) after ~34 years post construction. The use of materials with lower Zn concentrations (e.g., < 0.015 wt% S: MWM, 2026a) within the 10 m shell of the ELF could negate the need to treat the seepage from this NAF ELF. Note: downstream dilution needs to be considered in this treatment duration estimate as well as other PCOC.
- The use of the BV ELF as an analogue for a NAF ELF is conservative as lower pH in the BV ELF drives higher reaction rates and the generation of PCOC. This is not expected in a NAF ELF that will be circum-neutral pH. Long term acidity loads due to oxygen flux are unlikely to be the dominant driver of PCOC within a NAF ELF, hence the PCOC decay curves are set to 9.6% decay within the model.

[10] *Noting that this does not consider hardness modification benefits for the limit*

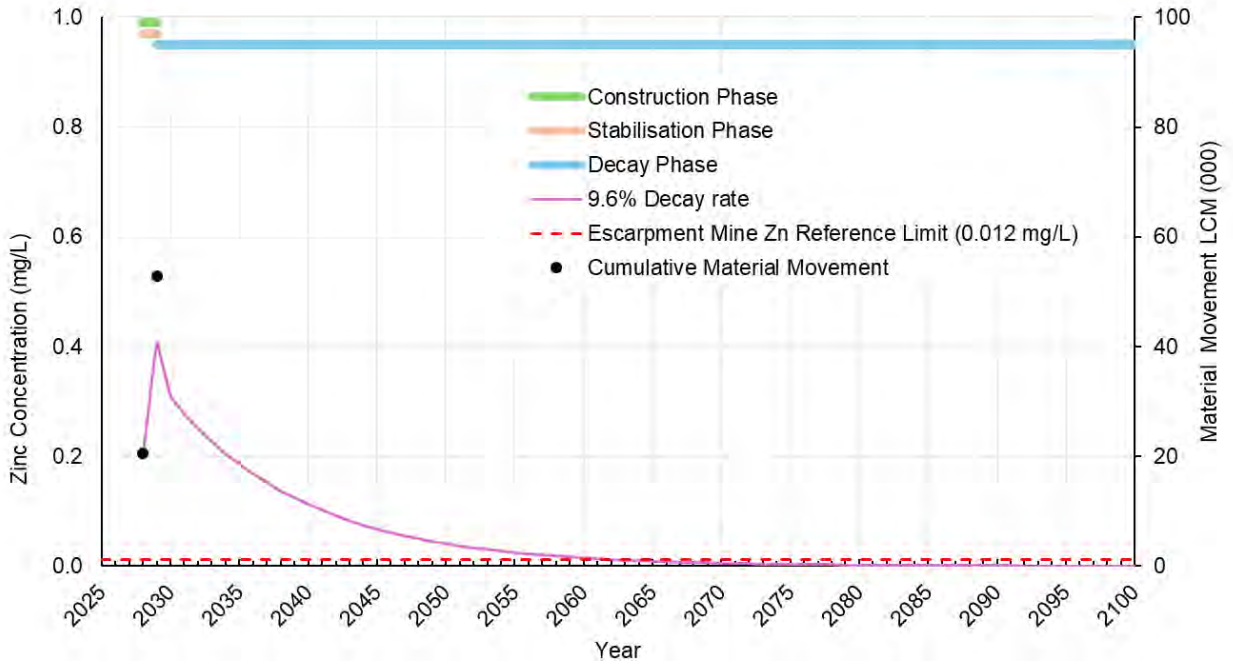

Figure 18: MDC1 ELF Zn decay.

16.4 MDC1 ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled MDC1 ELF basal sub-catchment source term. The recommended MSR for MDC1 ELF basal sub-catchment are presented in Table 46.

Table 46: MDC1 ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	0.6
Rainfall (mm/yr)	5,928
Infiltration coefficient	0.40
Flow Rate (L/s)	0.44
Acidity load (t $CaCO_3$/yr)	0.10
MSR surface area + polishing pond (m^2)	98
MSR surface area (m^2)	49.1
Polishing pond area (m^2)	49.1
MSR depth (m)	1.50
MSR volume (m^3)	73.7
Shells pore volume calc (m^3)	38.3
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2029

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

17 MDC2 ELF BASAL SUB-CATCHMENT

The following section provides the source term for the Construction and Stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the MDC2 ELF.

17.1 MDC2 ELF Model Inputs

The MDC2 ELF basal sub-catchment water quality model criteria (Table 47) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical ELF water quality data (MWM, 2026a).

Based on a catchment area of 0.59 ha, the average rainfall (5,928 mm/yr), and a net percolation rate of 40%, a static flow rate of 0.44 L/s was calculated. These data are presented in Table 47.

Table 47: MDC2 ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	6.4
	Sulfur content (%)	0.049
	10 m shell sulfur content wt (%)	0.047
	Area (ha)	0.51
	Total ELF (m^3 LCM)[1]	35,147
	10 m shell (m^3 LCM)[1]	33,213
Lake Brazil met station	Average rainfall (mm/yr)	5,928
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	0.38

[1] *Rounded up to nearest 100 m^3.*

17.2 MDC2 ELF Water Quality

Using the data presented in Table 47 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the MDC2 ELF (Table 48). AMD is not expected from this NAF ELF, rather NMD. Data indicates that the MDC2 ELF basal sub-catchment would generate Fe and Zn loads of approximately 0.02 t/yr and 0.003 t/yr (respectively), during the Stabilisation Phase. Further explanation on how the source term was derived is provided in the source term report (MWM, 2026g).

Table 48: MDC2 ELF model source terms and respective loads for FY2038 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	5 [2]	0.1
Alkalinity	6.2 [1]	0.07
Ca	10.9	0.1
Mg	1.2	0.01
Na	0.01	0.0002
K	0.04	0.0004
SO_4	66	0.8
Al	3.7	0.04
Fe	1.7	0.02
Ni	0.1	0.001

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Mn	0.1	0.002
Cr	0.002	0.00003
Cd	0.0001	0.000001
Co	0.01	0.0001
Cu	0.002	0.00002
Pb	0.0001	0.000002
Tl	0.0001	0.000001
Zn	0.3	0.003
DOC	0.5	0.01
pH (pH units)	5.8 [1]	-

1. *The water quality model is based on the BV ELF. Scaling to NAF ELFs does not work for pH and alkalinity, Hence, pH and alkalinity data from column leach tests are used for NAF seepage water quality (further details in MWM, 2026g).*
2. *Acidity is calculated from Fe concentration and pH.*

17.3 MDC2 ELF Long-term PCOC Decay

This section summarises the ELF water quality model for the MDC2 ELF basal sub-catchment as shown in Figure 19. The following clarifications are provided:

- The stabilisation phase for the MDC2 ELF will be for ~1.0 year. Construction is scheduled over 2 years.
- Limestone dosing of the ELF is not required.
- Due to water management scheduling, the MSR starts in 2029 (MWM, 2026d). A MSR could be installed immediately (i.e., during the Stabilisation Phase). Due to the very small volume of materials in this ELF (Table 45), there may be a scheduling opportunity during the Operational Phase of the PBCP to place low sulfur materials (<0.015 wt% S) such that treatment is not required.
- Based on a decay rate of 9.6%, the MDC2 ELF will be below the current Escarpment Mine Site reference value for Zn (0.012 mg/L for pH >5.5[11]) after ~32 years. The use of materials with lower Zn concentrations (e.g., < 0.015 wt% S: MWM, 2026a) within the 10 m shell of the ELF could negate the need to treat the seepage from this NAF ELF. Note: downstream dilution needs to be considered in this treatment duration estimate as well as other PCOC.
- The use of the BV ELF as an analogue for a NAF ELF is conservative as lower pH in the BV ELF drives higher reaction rates and the generation of PCOC. This is not expected in a NAF ELF that will be circum-neutral pH. Long term acidity loads due to oxygen flux are unlikely to be the dominant driver of PCOC within a NAF ELF, hence the PCOC decay curves are set to 9.6% decay within the model.

[11] *Noting that this does not consider hardness modification benefits for the limit.*

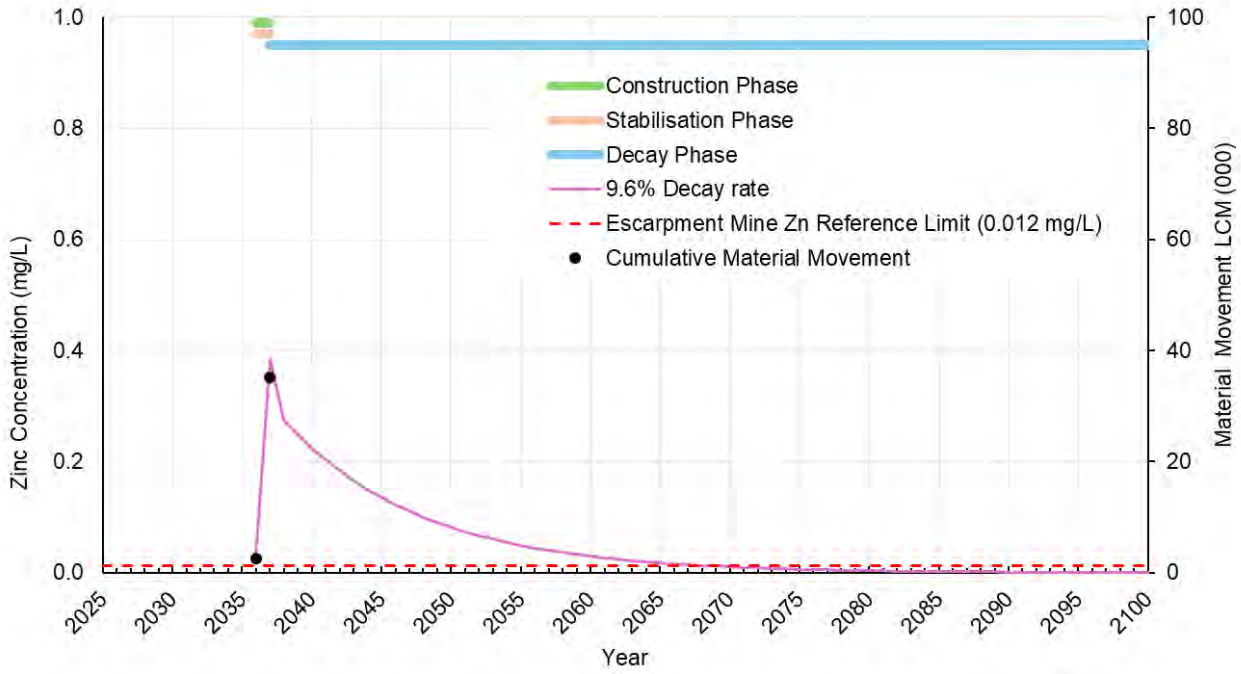

Figure 19: MDC2 ELF Zn decay.

17.4 MDC2 ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled MDC2 ELF basal sub-catchment source term. The recommended MSR for MDC2 ELF basal sub-catchment are presented in Table 49.

Table 49: MDC2 ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	0.5
Rainfall (mm/yr)	5,928
Infiltration coefficient	0.40
Flow Rate (L/s)	0.38
Acidity load (t $CaCO_3$/yr)	0.1
MSR surface area + polishing pond (m^2)	84.9
MSR surface area (m^2)	42.4
Polishing pond area (m^2)	42.4
MSR depth (m)	1.50
MSR volume (m^3)	63.7
Shells pore volume calc (m^3)	33.1
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2038

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

18 MSR8 ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the MSR8 ELF.

18.1 MSR8 ELF Model Inputs

The MSR8 ELF basal sub-catchment water quality model criteria (Table 50) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 31.4 ha, the average rainfall (5,928 mm/yr), and a net percolation rate of 40%, an average flow rate of 23.6 L/s was calculated. These data are presented in Table 50.

Table 50: MSR8 ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	18.4
	Sulfur content (%)	0.14
	10 m shell sulfur content wt (%)	0.05
	Area (ha)	31.4
	Total ELF (m^3 LCM)[1]	7,437,648
	10 m shell (m^3 LCM)[1]	2,735,813
Lake Brazil met station	Average rainfall (mm/yr)	5,928
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	23.6

[1] Rounded up to nearest 100 m^3.

18.2 MSR8 ELF Water Quality

Using the data presented in Table 50 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the MSR8 ELF (Table 51). Data indicates that the MSR8 ELF basal sub-catchment would generate an acidity load of approximately 43.5 t/yr or 1.4 t/yr/ha at the end of the Stabilisation Phase.

Table 51: MSR8 ELF model source terms and respective loads for FY2046 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	58	43.5
Alkalinity	0	0
Ca	16.8	12.5
Mg	1.9	1.4
Na	0.02	0.02
K	0.1	0.04
SO_4	100	74.8
Al	5.6	4.2
Fe	2.6	1.9
Ni	0.1	0.06
Mn	0.2	0.2
Cr	0.004	0.003

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cd	0.0001	0.00008
Co	0.01	0.008
Cu	0.003	0.002
Pb	0.0002	0.0001
Tl	0.0002	0.0001
Zn	0.4	0.3
DOC	0.5	0.4
pH (pH units)	3.7	-

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

18.3 MSR8 ELF Water Quality Model

This section summarises the ELF water quality model for the MSR8 ELF basal sub-catchment as shown in Figure 20. The following clarifications are provided:

- The stabilisation phase for the MSR8 ELF has been estimated at ~3.0 years.
- Construction is scheduled over 6 years. Rehabilitation is scheduled over 7 years with stabilisation conditions commencing as material is rehabilitated.
- If the benefits of limestone addition are exhausted, acidity loads are modelled at ~55.1 t/yr which is reached during the Stabilisation Phase. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2047 (MWM, 2026d). A MSR could be installed 3 years after the cover system is constructed (first year post the Stabilisation Phase) once long-term acid generation rates are achieved.

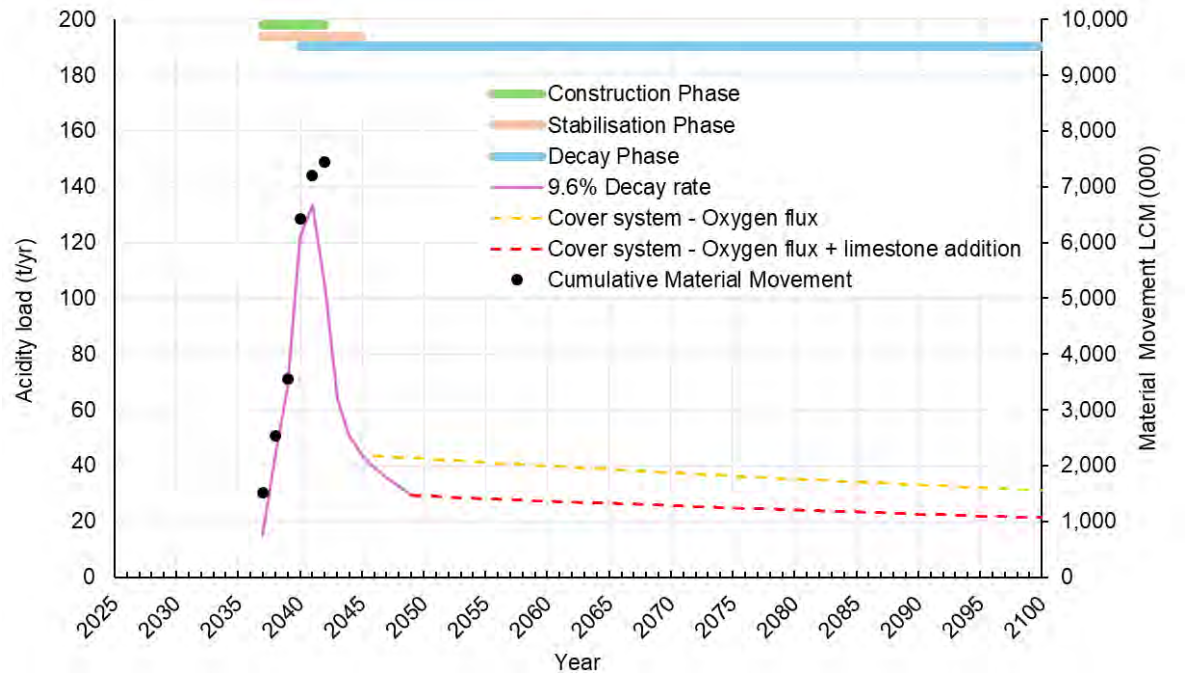

Figure 20: MSR8 ELF acidity decay.

18.4 MSR8 ELF Mussel Shell Reactor Conceptual Design

This section presents the high-level MSR design requirements based on the modelled MSR8 ELF basal sub-catchment source term. The recommended MSR for MSR8 ELF basal sub-catchment are presented in Table 52.

Table 52: MSR8 ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	31.8
Rainfall (mm/yr)	5,928
Infiltration coefficient	0.40
Flow Rate (L/s)	23.9
Acidity load (t $CaCO_3$/yr)	43.5
MSR surface area + polishing pond (m^2)	5,289
MSR surface area (m^2)	2,644
Polishing pond area (m^2)	2,644
MSR depth (m)	1.5
MSR volume (m^3)	3,966
Shells pore volume calc (m^3)	2,063
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2047

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

19 MSR9 ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the MSR9 ELF.

19.1 MSR9 ELF Model Inputs

The MSR9 ELF basal sub-catchment water quality model criteria (Table 53) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 3.8 ha, the average rainfall (5,928 mm/yr), and a net percolation rate of 40%, an average flow rate of 2.9 L/s was calculated. These data are presented in Table 53.

Table 53: MSR9 ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	12.7
	Sulfur content (%)	0.14
	10 m shell sulfur content wt (%)	0.05
	Area (ha)	3.8
	Total ELF (m^3 LCM)[1]	498,713
	10 m shell (m^3 LCM)[1]	330,476
Lake Brazil met station	Average rainfall (mm/yr)	5,928
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	2.9

[1] *Rounded up to nearest 100 m^3.*

19.2 MSR9 ELF Water Quality

Using the data presented in Table 53 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the MSR9 ELF (Table 54). Data indicates that the MSR9 ELF basal sub-catchment would generate an acidity load of approximately 5.2 t/yr or 1.4 t/yr/ha at the end of the Stabilisation Phase.

Table 54: MSR9 ELF model source terms and respective loads for FY2042 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	58	5.2
Alkalinity	0	0
Ca	16.6	1.5
Mg	1.9	0.2
Na	0.02	0.002
K	0.1	0.005
SO_4	100	9.0
Al	5.6	0.5
Fe	2.6	0.2
Ni	0.1	0.01
Mn	0.2	0.02
Cr	0.004	0.0003

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cd	0.0001	0.00001
Co	0.01	0.001
Cu	0.003	0.0003
Pb	0.0002	0.00002
Tl	0.0002	0.00002
Zn	0.4	0.0
DOC	0.5	0.05
pH (pH units)	3.7	-

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

19.3 MSR9 ELF Water Quality Model

This section summarises the ELF water quality model for the MSR9 ELF basal sub-catchment as shown in Figure 21. The following clarifications are provided:

- The stabilisation phase for the MSR9 ELF has been estimated at ~2.0 years.
- Construction is scheduled over 3 years. Rehabilitation is scheduled over the same period with stabilisation conditions commencing as material is rehabilitated.
- If the benefits of limestone addition are exhausted, acidity loads are modelled at 6.7 t/yr ~ 2 years post construction. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2047 (MWM, 2026d). A MSR could be installed immediately (i.e., during the Stabilisation Phase) if this was required by mine planners.

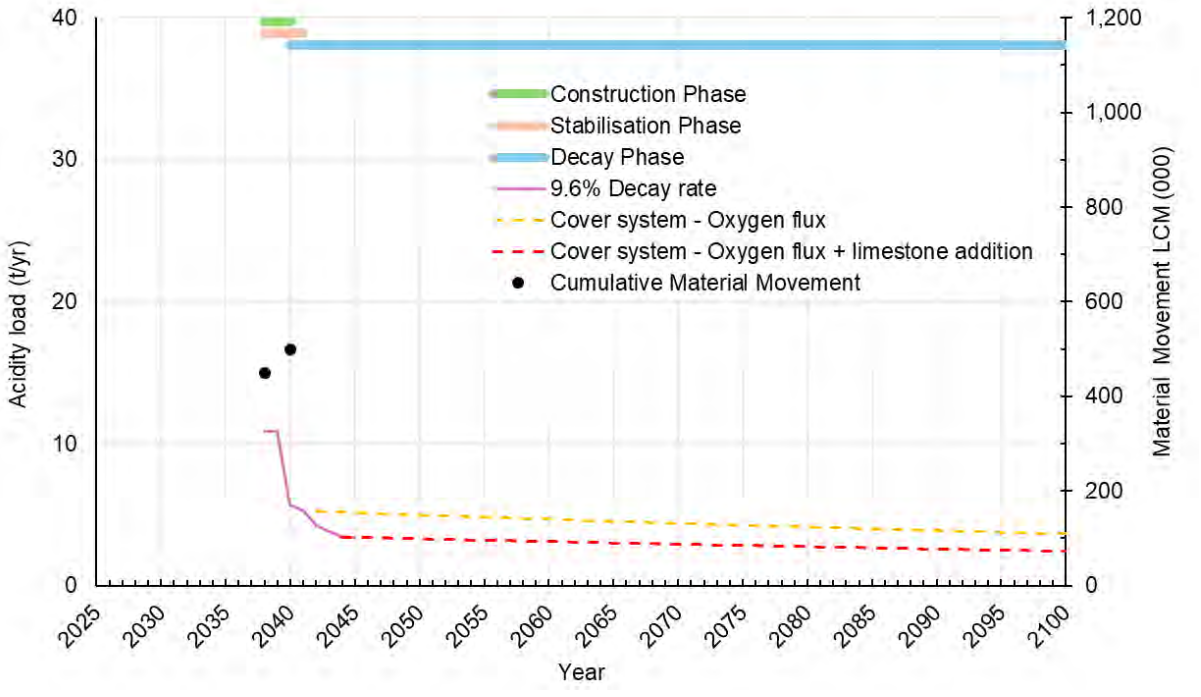

Figure 21: MSR9 ELF acidity decay.

19.4 MSR9 ELF Mussel Shell Reactor Conceptual Design

The following section presents the high-level MSR design requirements based on the modelled MSR9 ELF basal sub-catchment source term. The recommended MSR for MSR9 ELF basal sub-catchment are presented in Table 55.

Table 55: MSR9 ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	4.0
Rainfall (mm/yr)	5,928
Infiltration coefficient	0.40
Flow Rate (L/s)	3.0
Acidity load (t $CaCO_3$/yr)	5.3
MSR surface area + polishing pond (m^2)	662
MSR surface area (m^2)	331
Polishing pond area (m^2)	331
MSR depth (m)	1.5
MSR volume (m^3)	496
Shells pore volume calc (m^3)	258
Residence time (day)	1.00
MSR treatment commencement (year)	2047

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

20 MSR10 ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the MSR10 ELF.

20.1 MSR10 ELF Model Inputs

The MSR10 ELF basal sub-catchment water quality model criteria (Table 56) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 2.4 ha, the average rainfall (5,928 mm/yr), and a net percolation rate of 40%, an average flow rate of 1.8 L/s was calculated. These data are presented in Table 56.

Table 56: MSR10 ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	8.4
	Sulfur content (%)	0.14
	10 m shell sulfur content wt (%)	0.05
	Area (ha)	2.4
	Total ELF (m^3 LCM)[1]	151,707
	10 m shell (m^3 LCM)[1]	132,601
Lake Brazil met station	Average rainfall (mm/yr)	5,928
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	1.8

[1] Rounded up to nearest 100 m^3.

20.2 MSR10 ELF Water Quality

Using the data presented in Table 56 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the MSR10 ELF (Table 57). Data indicates that the MSR10 ELF basal sub-catchment would generate an acidity load of approximately 2.8 t/yr or 1.1 t/yr/ha at the end of the Stabilisation Phase.

Table 57: MSR10 ELF model source terms and respective loads for FY2041 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	48	2.8
Alkalinity	0	0
Ca	13.9	0.8
Mg	1.6	0.1
Na	0.02	0.001
K	0.05	0.003
SO_4	83	4.7
Al	4.6	0.3
Fe	2.2	0.1
Ni	0.1	0.004
Mn	0.2	0.01
Cr	0.003	0.0002

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cd	0.0001	0.000005
Co	0.01	0.0005
Cu	0.002	0.0001
Pb	0.0002	0.00001
Tl	0.0002	0.00001
Zn	0.3	0.02
DOC	0.5	0.03
pH (pH units)	3.7	-

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF(i.e., pH < 4.5).

20.3 MSR10 ELF Water Quality Model

This section summarises the ELF water quality model for the MSR10 ELF basal sub-catchment as shown in Figure 22. The following clarifications are provided:

- The stabilisation phase for the MSR10 ELF has been estimated at ~1.0 year.
- Construction is scheduled over 3 years. Rehabilitation is scheduled over the same period with stabilisation conditions commencing as material is rehabilitated.
- The MSR10 ELF acidity loads will be comparable to the cover system on closure.

Due to water management scheduling, the MSR starts in 2047 (MWM, 2026d). A MSR could be installed immediately (i.e., during the Stabilisation Phase) if this was required by mine planners.

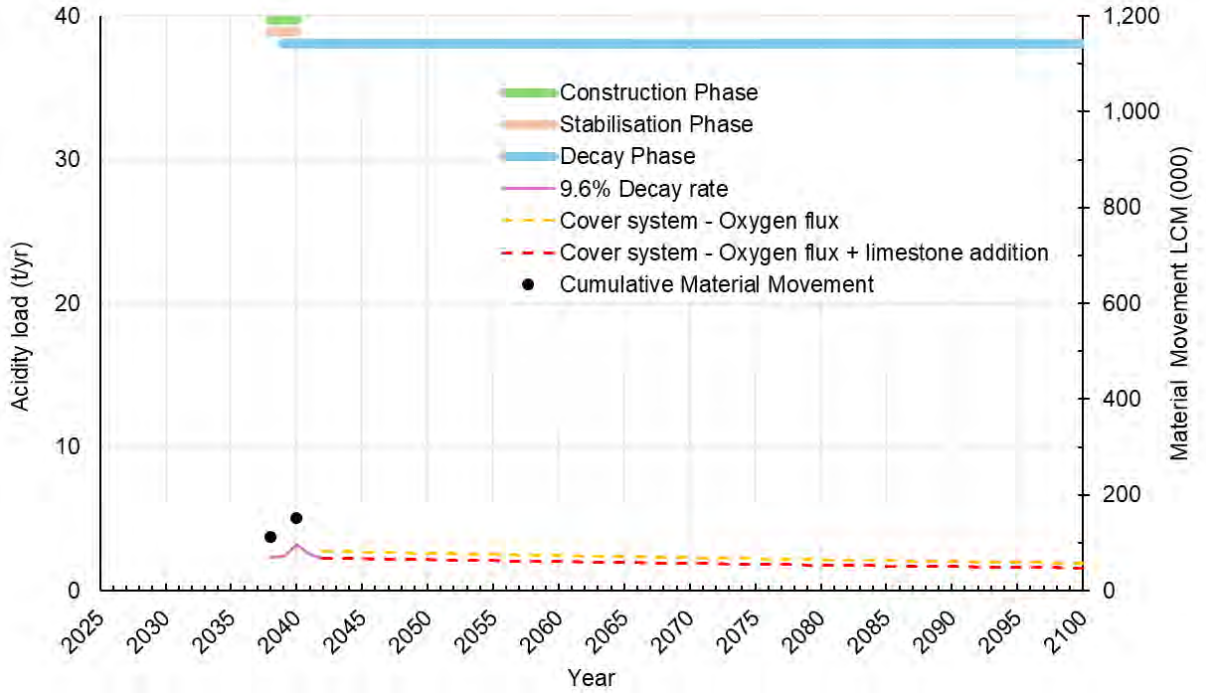

Figure 22: MSR10 ELF acidity decay.

20.4 MSR10 ELF Mussel Shell Reactor Conceptual Design

This section presents the high-level MSR design requirements based on the modelled MSR10 ELF basal sub-catchment source term. The recommended MSR for MSR10 ELF basal sub-catchment are presented in Table 58.

Table 58: MSR10 ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	2.5
Rainfall (mm/yr)	5,928
Infiltration coefficient	0.40
Flow Rate (L/s)	1.8
Acidity load (t $CaCO_3$/yr)	2.8
MSR surface area + polishing pond (m^2)	408
MSR surface area (m^2)	204
Polishing pond area (m^2)	204
MSR depth (m)	1.5
MSR volume (m^3)	306
Shells pore volume calc (m^3)	159
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2047

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

21 MSR11 ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the MSR11 ELF.

21.1 MSR11 ELF Model Inputs

The MSR11 ELF basal sub-catchment water quality model criteria (Table 59) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 2.9 ha, the average rainfall (5,928 mm/yr), and a net percolation rate of 40%, an average flow rate of 2.2 L/s was calculated. These data are presented in Table 59.

Table 59: MSR11 ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	6.6
	Sulfur content (%)	0.28
	10 m shell sulfur content wt (%)	0.116
	Area (ha)	2.9
	Total ELF (m^3 LCM)[1]	291,849
	10 m shell (m^3 LCM)[1]	229,011
Lake Brazil met station	Average rainfall (mm/yr)	5,928
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	2.2

[1] Rounded up to nearest 100 m^3.

21.2 MSR11 ELF Water Quality

Using the data presented in Table 59 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the MSR11 ELF (Table 60). Data indicates that the MSR11 ELF basal sub-catchment would generate an acidity load of approximately 7.8 t/yr or 2.7 t/yr/ha at the end of the Stabilisation Phase.

Table 60: MSR11 ELF model source terms and respective loads for FY2030 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	113	7.8
Alkalinity	0	0
Ca	32.4	2.2
Mg	3.7	0.3
Na	0.04	0.003
K	0.1	0.008
SO_4	194	13.4
Al	10.9	0.8
Fe	5.0	0.3
Ni	0.2	0.01
Mn	0.4	0.03
Cr	0.007	0.0005

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cd	0.0002	0.00001
Co	0.02	0.001
Cu	0.006	0.0004
Pb	0.0004	0.00003
Tl	0.0004	0.00003
Zn	0.8	0.06
DOC	0.5	0.03
pH (pH units)	3.4	-

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

21.3 MSR11 ELF Water Quality Model

This section summarises the ELF water quality model for the MSR11 ELF basal sub-catchment as shown in Figure 23. The following clarifications are provided:

The stabilisation phase for the MSR11 ELF has been estimated at ~1.0 year.

- Construction is scheduled over 2 years. Rehabilitation is scheduled over the same period with stabilisation conditions commencing as material is rehabilitated.
- If the benefits of limestone addition are exhausted, acidity loads are modelled at 5.1 t/yr ~ 6 years post construction. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2029 (MWM, 2026d). A MSR could be installed immediately (i.e., during the Stabilisation Phase) if this was required by mine planners, or water could be transferred to the WTP.

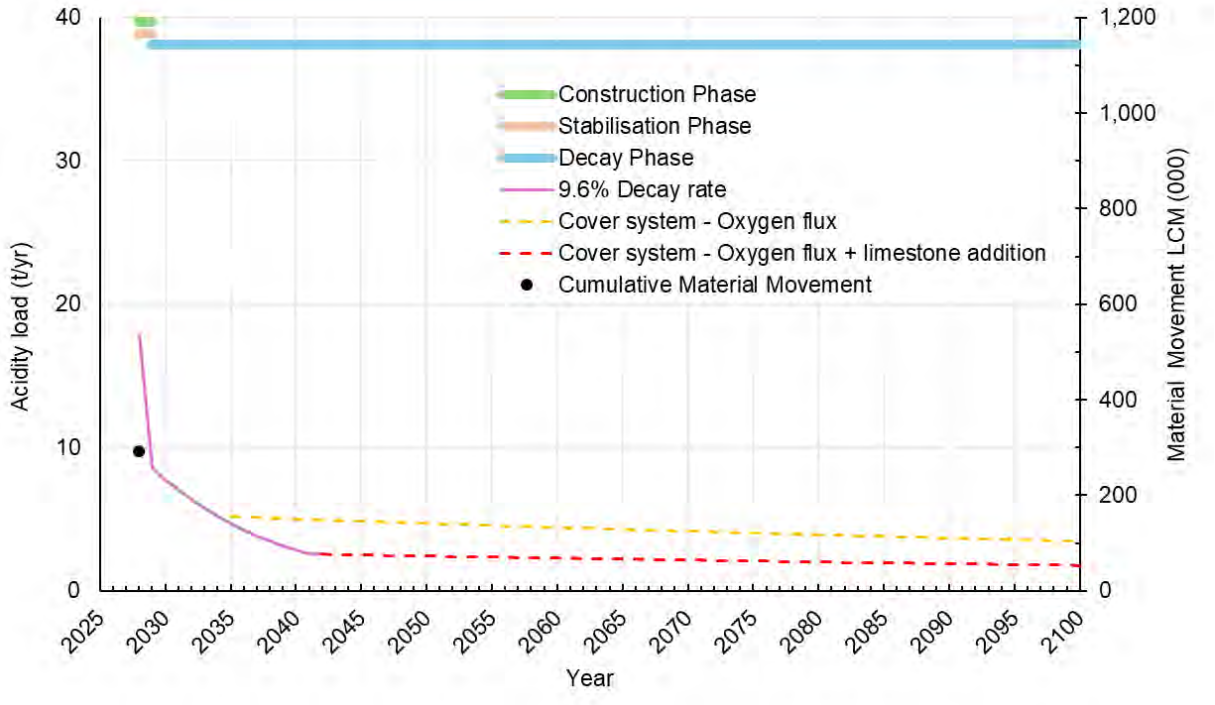

Figure 23: MSR11 ELF acidity decay.

21.4 MSR11 ELF Mussel Shell Reactor Conceptual Design

This section presents the high-level MSR design requirements based on the modelled MSR11 ELF basal sub-catchment source term. The recommended MSR for MSR11 ELF basal sub-catchment are presented in Table 61.

Table 61: MSR11 ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	2.9
Rainfall (mm/yr)	5,928
Infiltration coefficient	0.40
Flow Rate (L/s)	2.20
Acidity load (t $CaCO_3$/yr)	7.8
MSR surface area + polishing pond (m^2)	488
MSR surface area (m^2)	244
Polishing pond area (m^2)	244
MSR depth (m)	1.5
MSR volume (m^3)	366
Shells pore volume calc (m^3)	190
MSR substrate residence time (day)	1.00
MSR treatment commencement (year)	2029

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

22 MSR12 ELF BASAL SUB-CATCHMENT

The following section provides the source term for the construction and stabilisation phases of the ELF water quality model and subsequent MSR sizing based on the ELF design criteria for the MSR12 ELF.

22.1 MSR12 ELF Model Inputs

The MSR12 ELF basal sub-catchment water quality model criteria (Table 62) were used as the basis for determining the flow rate and water quality (and the respective PCOC loads) based on empirical BV ELF water quality data (MWM, 2026a).

Based on a catchment area of 2.9 ha, the average rainfall (5,928 mm/yr), and a net percolation rate of 40%, an average flow rate of 2.2 L/s was calculated. These data are presented in Table 62.

Table 62: MSR11 ELF basal sub-catchment water quality model criteria.

SOURCE	PARAMETER	VALUE
BRL	Height (m)	7.8
	Sulfur content (%)	0.28
	10 m shell sulfur content wt (%)	0.12
	Area (ha)	2.9
	Total ELF (m^3 LCM)[1]	317,942
	10 m shell (m^3 LCM)[1]	236,407
Lake Brazil met station	Average rainfall (mm/yr)	5,928
This report	Infiltration coefficient	0.4
This report	Flow rate (L/s)	2.2

[1] Rounded up to nearest 100 m^3.

22.2 MSR12 ELF Water Quality

Using the data presented in Table 62 and the ELF water quality Model (MWM, 2026a) the predicted water quality at commencement of the Decay Phase was derived for the MSR12 ELF (Table 63). Data indicates that the MSR12 ELF basal sub-catchment would generate an acidity load of approximately 8.0 t/yr or 2.8 t/yr/ha at the end of the Stabilisation Phase.

Table 63: MSR12 ELF model source terms and respective loads for FY2030 (Post Stabilisation Phase).

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Acidity	117	8.0
Alkalinity	0	0
Ca	33.6	2.3
Mg	3.8	0.3
Na	0.04	0.003
K	0.11	0.008
SO_4	201	13.8
Al	11.3	0.8
Fe	5.2	0.4
Ni	0.2	0.01
Mn	0.4	0.03
Cr	0.007	0.0005

PARAMETER	CONCENTRATIONS (mg/L)	LOAD (t/yr)
Cd	0.0002	0.000015
Co	0.02	0.00
Cu	0.006	0.0004
Pb	0.0004	0.00003
Tl	0.0004	0.00003
Zn	0.8	0.06
DOC	0.5	0.03
pH (pH units)	3.4	-

Alkalinity concentrations are presented as 0 mg/L. This is due to the observed alkalinity concentrations from the BV ELF (i.e., pH < 4.5).

22.3 MSR12 ELF Water Quality Model

This section summarises the ELF water quality model for the MSR12 ELF basal sub-catchment as shown in Figure 24. The following clarifications are provided:

The stabilisation phase for the MSR12 ELF has been estimated at ~1.0 year.

- Construction is scheduled over 2 years. Rehabilitation is scheduled over the same period with stabilisation conditions commencing as material is rehabilitated.
- If the benefits of limestone addition are exhausted, acidity loads are modelled at 5.1 t/yr ~ 6 years post construction. Passive treatment could still commence immediately. For conservative modelling purposes and consideration of risk, it is assumed that the limestone/ANC will be consumed and will not be available in the long term.
- Due to water management scheduling, the MSR starts in 2029 (MWM, 2026d). A MSR could be installed immediately (i.e., during the Stabilisation Phase) if this was required by mine planners, or water could be transferred to the WTP.

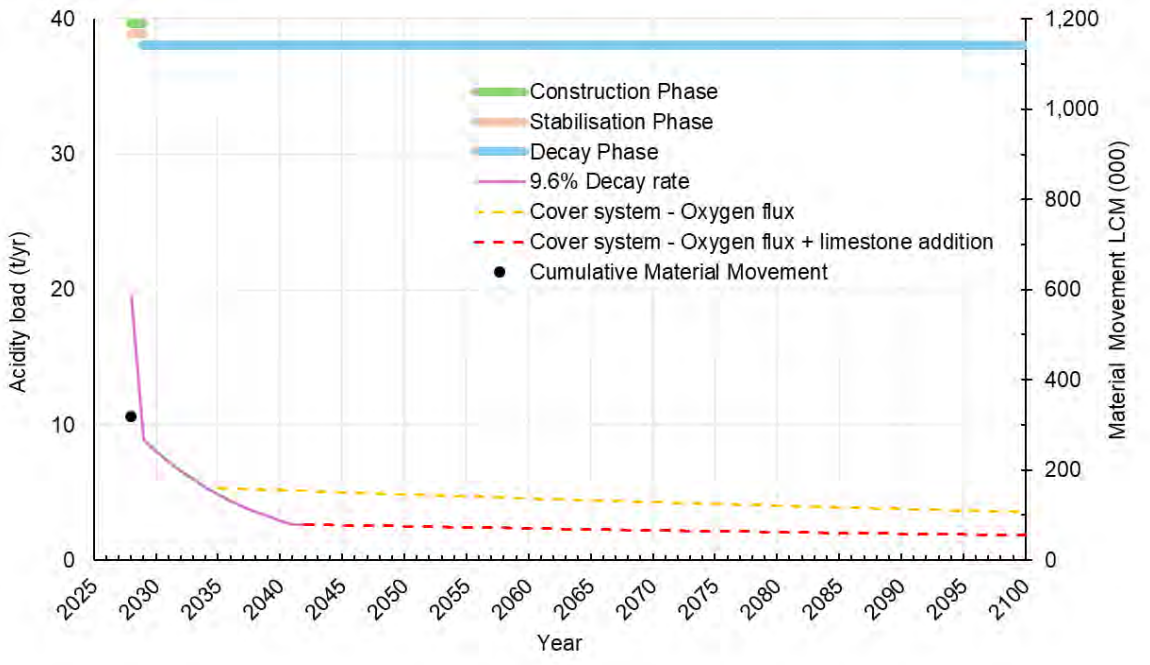

Figure 24: MSR12 ELF key parameter contaminant decay.

22.4 MSR12 ELF Mussel Shell Reactor Conceptual Design

This section presents the high-level MSR design requirements based on the modelled MSR12 ELF basal sub-catchment source term. The recommended MSR for MSR12 ELF basal sub-catchment are presented in Table 64.

Table 64: MSR12 ELF MSR sizing.

PARAMETER	VALUE
ELF Area (ha)	2.9
Rainfall (mm/yr)	5,928
Infiltration coefficient	0.40
Flow Rate (L/s)	2.21
Acidity load (t $CaCO_3$/yr)	8.0
MSR surface area + polishing pond (m^2)	489
MSR surface area (m^2)	244
Polishing pond area (m^2)	244
MSR depth (m)	1.5
MSR volume (m^3)	366
Shells pore volume calc (m^3)	191
MSR substrate residence time (day) (Concentrations in ELF seepage decays at 0.62% per year after 6 years)[1]	1

1. if the limestone was exhausted.

Green: Low risk with regards to MSR treatment capacity.

Orange: Moderate risk with regards to MSR treatment capacity

Red: Higher risk with regards to MSR treatment capacity

23 SUMMARY

23.1 Summary – Acidity Loads

This report summarised the acidity loads for each proposed ELF basal sub-catchment associated with MFS and ESE. The estimated PCOC loads were based on the BV ELF water quality model that was developed to understand water quality expectations for the project and potential AMD risks (i.e., treatment AMD treatment requirements). This provides a reliable estimate of water quality based on known relationships to sulfate in water and measured sulfur within the source hazard materials. Three ELF water quality phases were considered in the modelling:

- Construction Phase
- Stabilisation Phase
- Decay Phase

Maximum acidity loads for each ELF are presented in as a summary in Table 65. Typically, the highest loads occur during the Construction Phase, which is a function of material movement and stored oxidation products being mobilised. Figure 25 and Figure 26 present this data graphically.

These peak acidity loads will be treated in ESE and MFS active WTPs.

Table 65: ELF acidity load summary - ELF Construction Phase.

BASAL ELF SUB-CATCHMENT	PEAK ACIDITY t/yr	FY
BVE	352.6	2029
CON	1551.3	2041
NSUL - Closure	24.1	2033
PPG	2.5	2030
ESC	28.8	2028
WWH	3802.1	2037
MSR1	35.5	2029
MSR2	6.6	2028
MSR3	9.0	2029
MSR4	62.3	2037
MSR5	58.4	2035
MSR6	11.1	2035
MSR7	62.7	2037
MDC1	0.10	2029
MDC2	0.08	2037
MSR8	133.4	2041
MSR9	10.9	2038
MSR10	3.2	2040
MSR11	17.9	2028
MSR12	19.5	2028

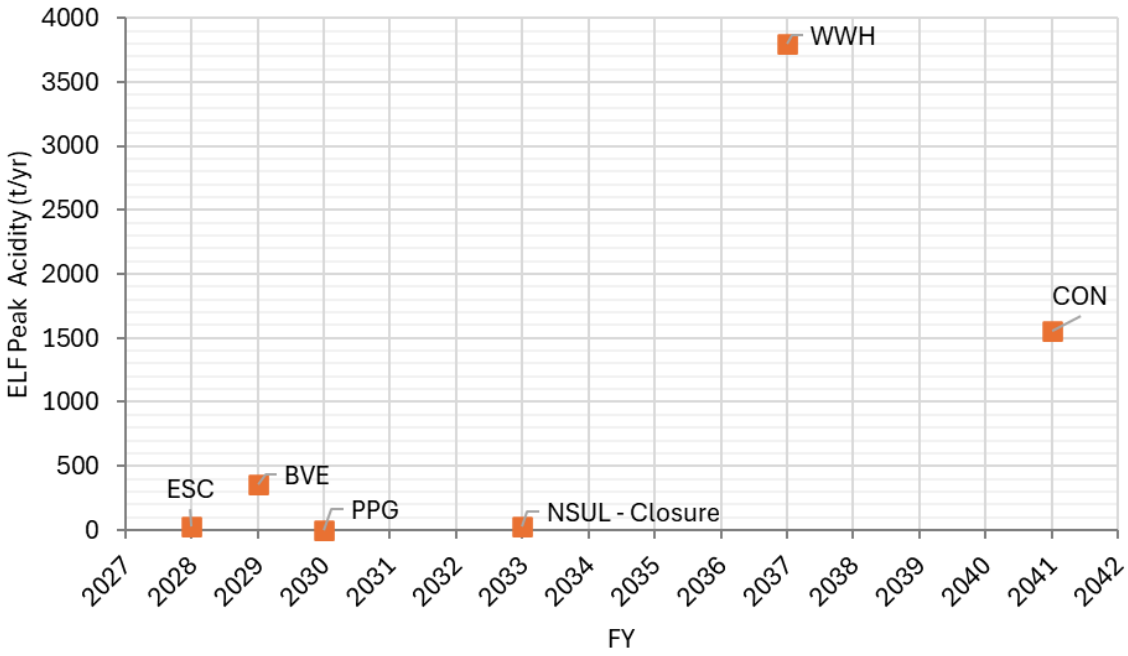

Figure 25: ESE peak ELF acidity loads

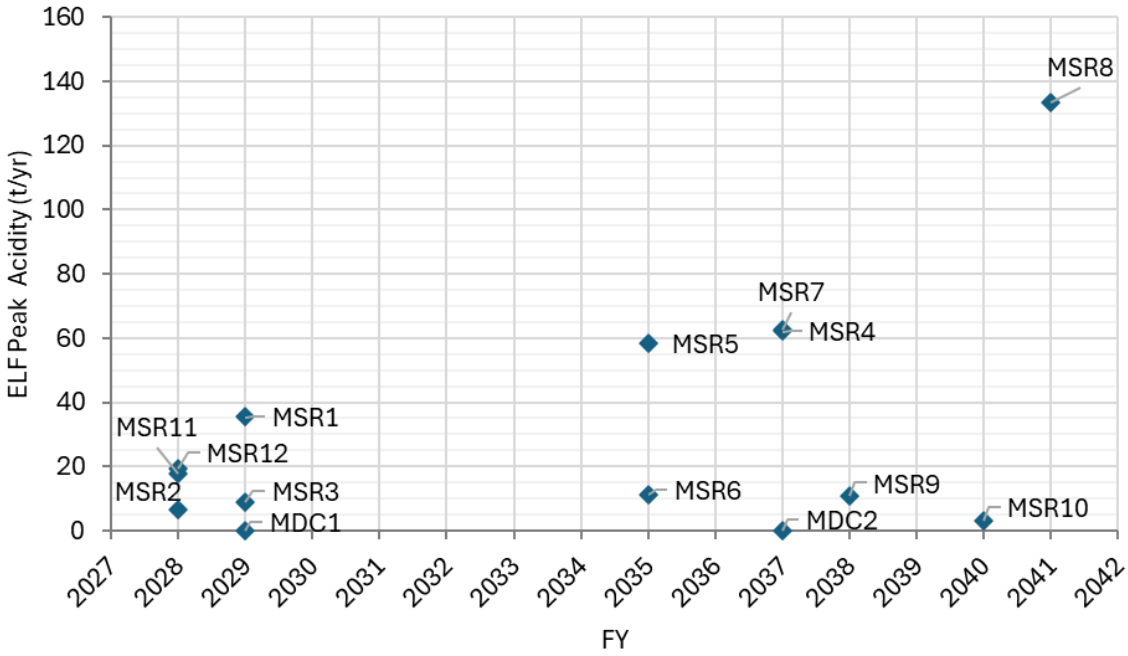

Figure 26: MFS Peak ELF acidity loads

23.2 Summary – Passive Treatment

The proposed approach using MSR to treat AMD impacted waters is based on ~20 years of experience and research with over a decade of operational experience at Stockton as discussed by MWM (2026e). These studies indicate a key design standard of MSR is the surface area. Numerous studies show that for 1 L/s flow, a surface area of ~100 m^2 is required. Space has been provided in mine planning to ensure this key design feature is not compromised.

However, there are potential treatment capacity risks for long term passive treatment of AMD impacted waters associated with ELF basal seepage. Passive treatment capacity risk (based on industry guidance (e.g., INAP, 2021)) for each ELF basal sub-catchment have been assessed to identify that in most cases MSR flows and loads are appropriate except for the larger ELFs. This is discussed below:

Suitable:

- Green: ≤ ~50 t/yr acidity.
- Green: ≤ ~50 L/s average flow rate.

Suitable but two systems may be required:

- Orange: < ~100 t/yr acidity (two reactors may be required) but > 50 t/yr acidity.
- Orange: < ~100 L/s average flow rate (two reactors may be required) but > 50 L/s average flow rate.

Suitable but multiple systems may be required:

- Red: > ~100 t/yr acidity (multiple reactors may be required).
- Red: > ~100 L/s average flow rate (multiple reactors may be required).

Results (Table 66) indicate that two MSR treatment systems may have capacity constraints. Performance monitoring work is recommended to confirm that multiple MSR reactors are effective and/or the use of other technologies that can increase treatment rates / treatment efficiencies are suitable. The timeframe to transition from active treatment to passive treatment will be reconsidered depending on the outcome of operational monitoring of MSR's. If a passive system is found to compromise water treatment, active treatment will be continued.

Water management scheduling provided by BRL has been used to identify the MSR scheduled start dates.

Table 66: MSR treatment capacity summary.

MSR	FLOW RATE (L/S) [1]	ACIDITY LOAD RANGE (t/yr) [2,3]	ACIDITY LOAD AT MSR START DATE (t/yr) [2]	MSR ACTIVATION DATE (FY) [4]	COMMENTS
BVE	13.9	21.1 (42.7)	38.2	2058	No issues anticipated
CON	75.3	86.0 (174.4)	174.4	2058	Potential capacity constraints (flow and load). Consider: 1. Multiple MSR (possibly up to 4) 2. Increased desludging to maintain optimal flow rates 3. Other treatment technologies. 4. Longer term active treatment
NSUL-Closure	18	(14.0)[2]	5.1	2046	No issues anticipated: NAF ELF – treatment for Zn + other PCOC
PPG	2.76	(1.6)[2]	0.1	2058	No issues anticipated: NAF ELF – treatment for Zn + other PCOC
ESC	2.36	3.1 (6.2)	11.9	2030	No issues anticipated

MSR	FLOW RATE (L/S) [1]	ACIDITY LOAD RANGE (t/yr) [2,3]	ACIDITY LOAD AT MSR START DATE (t/yr) [2]	MSR ACTIVATION DATE (FY) [4]	COMMENTS
WWH	117	153.1 (310.4)	299.1	2058	Potential capacity constraints (flow and load). Consider: 1. Multiple MSR (possibly up to 6) 2. Increased desludging to maintain optimal flow rates. 3. Other treatment technologies. 4. Longer term active treatment
MSR1	4.63	5.8 (11.7)	11.2	2045	No issues anticipated
MSR2	1.15	1.4 (2.9)	2.7	2045	No issues anticipated
MSR3	3.12	2.0 (4.1)	3.8	2045	No issues anticipated
MSR4	3.12	5.3 (10.7)	16.1	2045	No issues anticipated
MSR5	14.3	16.7 (25)	24.2	2045	No issues anticipated
MSR6	3.39	4.0 (5.5)	5.3	2045	No issues anticipated
MSR7	15.2	17.7 (29.6)	28.5	2045	No issues anticipated
MDC1	0.45	(0.1)	0.1	2029	No issues anticipated; potential to use low S overburden (i.e., <0.015 wt%) and remove the need for Post Closure Phase passive treatment.
MDC2	0.40	(0.1)	0.1	2038	No issues anticipated; potential to use low S overburden (i.e., <0.015 wt%) and remove the need for Post Closure Phase passive treatment.
MSR8	23.9	29.1 (43.5)	43.3	2047	No issues anticipated
MSR9	2.99	3.4 (5.2)	5.1	2047	No issues anticipated
MSR10	1.84	2.3 (2.8)	2.7	2047	No issues anticipated
MSR11	2.20	2.6 (5.2)	8.6	2029	No issues anticipated
MSR12	2.21	2.6 (5.3)	8.9	2029	No issues anticipated

1. *Final catchment data as provided by BRL in the WLBM*
2. *From BRL rehabilitation model data*
3. *Numbers relate to oxygen flux based on limestone being available (1.35 t/ha/yr) and numbers in brackets represent the potential acidity load if the limestone was exhausted (2.7 t/ha/yr). Numbers are prior to exclusion of occluded zones in the ELF (35%).*
4. *As provided in the WLBMs.*

23.3 Overview

Estimated total flow rates that will require passive treatment for MFS and ESE (Table 66) was determined to be ~300 L/s. Based on MSR sizing this will require ~50,000 m^3 of shells for the construction of these systems.

Other passive treatment technologies are available for passive treatment of AMD waters for the BPCP. Although MSR are the preferred technology (MWM, 2026e), other systems may also be viable and could be assessed during the early phases of the Project.

The completion of the transition from active treatment of all ELF seepage to passive treatment technologies would be in approximately FY 2058 (transition to passive treatment of CON ELF at Stage 20) with transition to passive treatment at MFS in 2047.

The following variables will influence this timeframe:

- Mining rates.
- Accuracy of the models to forecast ELF basal seepage quantity and quality.
- Longer active treatment requirements
- Financial drivers to switch from an existing active treatment plant (sunk capex) to a passive treatment system (new capex), and comparative operating costs.
- The ability to treat higher flow rates, higher acidity loads, and PCOC loads to achieve water quality objectives.
- Passive treatment technology advances over the next few decades.
- Water quality objectives and community expectations.

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25 LIMITATIONS

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

APPENDIX A LIMITATIONS

This Document has been provided by Mine Waste Management Ltd (MWM) subject to the following limitations:

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