BATHURST
RESOURCES LIMITED

Millerton Water and AMD Management Report

Stockton Mine

May 2026

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Introduction

This report presents the technical assessment of the proposed Millerton Block water and acid mine drainage (**AMD**) management at the Stockton mine, developed as part of Bathurst Resources Ltd's (**BRL**) Buller Plateaux Continuation Project (**BPCP or Project**).

Water and AMD management at Stockton mine is a complex process, which involves managing the effects of historic / legacy underground mining activities and contemporary opencast mining activities (discussed in the Stockton mine history of AMD Management and Proposed Future Management (BRL 2026a)).

The long history of mining on the Stockton Plateau means that some waterways have been affected by AMD for over 130 years. It is estimated that over 500 million tonnes of Brunner Coal Measures (**BCM**) waste rock material has been disturbed by underground and opencast mining, resulting in an AMD legacy that requires treatment and which to a large extent was created prior to BRL's ownership of the Stockton mine.

The Millerton Block was extensively disturbed by underground mining from 1890 to 1969, leaving an estimated 369.5 ha network of historic underground workings discharging AMD to multiple streams draining the Millerton Block (including Rudolph, Twins, Granity, Miller, and Mine Catchments). These streams do not currently meet ecological recovery thresholds described in Instream (2026).

Modern opencast mining in the Millerton Block was commenced by Solid Energy New Zealand Ltd in 2010 in the same areas as the historic underground workings. This has reduced the extent of the historic underground workings network to an estimated 271.2 ha in 2025 (with a further reduction in area to 182.5 ha by End of Mine Life (**EOML**) (2033) as part of the BPCP). Opencast mining has also enabled the removal of several remnant fires within the underground workings that had been burning uncontrollably since the 1970's.

In recent years, the Crown has been reviewing practicable economic alternatives to treat AMD on the Stockton Plateau. The current AMD management approach adopted and supported by iwi, the local councils and the Crown is to progressively improve impacted streams with the objective of sustaining mahinga kai values within 3 generations (or 80 years approximately).

To measure AMD improvement / betterment[1] in light of the objective above, the BPCP has adopted 2010 as the reference point for the Millerton Block water quality for the following reasons:

- 50+ years of AMD discharge from the historic underground workings to the Millerton streams has in effect defined the environment up until the commencement of modern open cast mining in 2010;

[1] 'Betterment' is defined as the process of active and progressive improvement of river health over the long-term. Definitions of betterment in the Millerton Block BPCP context are provided in Section 3.2 and quantification betterment reference values are derived in Section 4.4.

- The 2010 reference point enables a high degree of separation between effects of new practices and contemporary AMD sources from the effects of remnant historic underground AMD sources that will remain outside the opencast disturbance footprint post BPCP;
- Acidity loads in 2010 were not influenced by the short-term AMD generation / effects from the use of pit water to cool or extinguish underground fires; and
- Sets the datum from which the trajectory of AMD improvement from contemporary activities can be sensibly measured.

Millerton Block BPCP

Additional scheduled Millerton Block BPCP overburden disturbance post April 2027 is ~ 11,700 kbcm (thousand bank cubic metres). This equates to:

- The final ~28% of material (by volume) used to construct the Millerton ELF; and
- Earthworks required to establish / rehabilitate final landforms and construct permanent pit sumps in each disturbed sub-catchment.

The additional BPCP contribution to Millerton Block disturbance (and therefore acidity load source material) is relatively minor. The majority of the disturbance (~72% by material volume) managed by Millerton water and AMD infrastructure will be from contemporary / opencast activity that pre-dates the implementation of the BPCP (assuming a commencement date of April 2027). This contemporary AMD includes contributions from the Crown / Solid Energy and BRL mining activities.

The water and AMD management approach adopted for the Millerton Block component of the BPCP at the Stockton mine is to separate (both physically and for assessment purposes):

- Water and AMD generated within the contemporary opencast disturbance footprint (to be managed as part of the BPCP (including any BRL and Crown contributions from opencast disturbance between 2010 and April 2027)); and
- Water and AMD generated from remnant historic underground workings located outside the opencast disturbance footprint (not managed as part of the BPCP).

From a water and AMD management perspective, this separation is both:

- Physical – the opencast disturbance footprint mine plans are designed to capture AMD in pit sumps at natural topographic low points in each sub-catchment, enabling physical separation of contemporary AMD from historic AMD generated by remnant historic underground workings in the lower catchments; and
- For effects assessment purposes – different management strategies for AMD generated within the contemporary opencast disturbance footprint versus AMD generated from remnant historic underground workings (outside the opencast disturbance footprint) are proposed.

Objectives

The objectives of this assessment and report are to:

(1) Use the proposed mine plan to develop AMD models to forecast acidity loads, define water quality objectives (including 'betterment'), quantify AMD treatment / management requirements, and forecast concentrations of key water quality indicators at water quality monitoring sites;

(2) Replicate forecasts through three key phases – **Operational Phase** (2027 – EOML (2033), **EOML Phase** (2033 - 2046), and **Closure Phase** (2047 onwards); and

(3) Provide recommendations to ensure appropriate future management approaches through ongoing understanding of AMD including by enabling adaptive management.

Water quality objectives – Betterment concept

The AMD modelling suggests that ongoing AMD discharges from remnant historic underground workings (located outside the BPCP opencast mining disturbance footprint) will prevent water quality improving sufficiently for ecological recovery, as defined by Instream (2026). This applies to all AMD impacted streams draining Millerton Block[2] throughout all Project phases (including to the end of the simulation period in year 2106). Accordingly, time-dependent betterment reference values for acidity load, acidity concentration, and Aluminium (**Al**) concentration at key sites (Twins Stream (T1), Granity Stream (S25), Miller Creek (S24A), Mine Creek (MC1); locations shown in Figure 1) have been developed to guide long term AMD management in these waterbodies. As discussed, the BPCP has adopted 2010 as the reference point for deriving betterment reference values. These betterment reference values estimate what acidity loads and acidity / Al concentrations would have been if:

- The contemporary (i.e., 2010 onwards) opencast mining in Millerton Block had not occurred;
- The Millerton Block historic underground workings had remained at their full 2010 areal extent (369.5 ha); and
- AMD continued to discharge from these historic workings without treatment.

The removal of historic underground workings from within the proposed EOML (2033) opencast disturbance footprint (and associated reduction in acidity load) provides some limited capacity for AMD discharge from the opencast disturbance footprint to streams draining the Millerton Block, while still showing betterment relative to 2010 acidity loads. The potential to offset acidity load is sub-catchment

[2] 'Millerton Block' streams assessed by the AMD model include Twins Stream, Granity Stream, Miller Stream, and Mine Creek. Ngakawau River is not considered a 'Millerton Block' stream. Dissolved Al concentrations at the modelled site 'NRB River' (site modeling assumptions described in Section 7.3) are expected to meet comprehensive ecological recovery criteria by 2034. As such, the Lower Ngakawau River water quality targets are for ecological recovery as opposed to betterment.

specific and depends on the area of workings removed, acidity generation rate of those workings, and long-term AMD generation decay rates.

Sub-catchment specific water and AMD management strategies (supported by best practicable options (**BPO**) assessments) were developed to keep modelled / forecast acidity loads and acidity / Al concentrations below these betterment reference values, post EOML (2033).

As part of the BPCP a further ~88.4 ha of underground workings are scheduled to be removed by EOML (2033), with the majority removed by 2028. This will further reduce the extent of historic AMD sources and remove fuel for fires. A total of 187 ha of underground workings are estimated to be mined out by opencast mining from 2010 to EOML (2033); a ~50% reduction from 369.5 ha pre opencast (2010).

AMD modelling approach

The AMD modelling used for the quantitative effects assessment utilises the extensive Stockton mine records of water quality and flow rate collected over the past ~20 years as analogue data. These data have been compiled and interpreted to develop correlations between annual acidity loads and median annual acidity / Al concentrations at key monitoring sites. These correlations are then used to convert the forecast annual acidity loads to estimates of future annual median acidity and Al concentrations.

Three separate AMD model approaches have been used in this assessment. The approaches are similar in that they all utilise the existing analogue datasets and correlations, but they are different in that:

- **Operational Phase AMD model:** is based on extrapolation of the current effects of mining / acidity load trends incorporating scheduled additional disturbance of overburden, fire suppression ceasing in 2028, development of an operational peak to EOML acidity load transition analogue based on Mangatini Catchment datasets, and AMD treatment;
- **EOML / Closure Phase AMD model**: is based on forecast acidity load yields from domain based final landform surfaces / structures, e.g., Millerton ELF, Coal Floor, and Highwall exposure, etc.; and
- **Lower Ngakawau River AMD model:** is based on specifically derived trends in Al loads for monitoring sites NR and MC1 and also uses the outputs of the Operational Phase and EOML / Closure Phase AMD models.

Water and AMD management strategy and effects

The water and AMD management strategy developed for the BPCP covers the Operational, EOML, and Closure Phases of the BPCP. The final landform design approach of leaving a single engineered landform (Millerton ELF) with the majority of runoff and seepage collected in a single water management structure (MW16 Sump) constructed in the headwater of the site S6 tributary of Mine Creek (EOML configuration shown in Figure 34) enables long term water and AMD management efficiency. Other disturbed areas in Twins, Granity, and Miller catchments (comprising predominantly rehabilitated highwall and coal floor surfaces[3]) are expected to transition to a 'discharge without treatment' management regime at various times during the EOML Phase once water quality improves sufficiently to meet betterment reference values.

The management strategy and AMD models were developed iteratively, with model simulations evaluating:

- Progressive improvement of water quality draining Millerton Block during the Operational Phase. Achieving this outcome will involve:
    - A high degree of acidity load capture in pit sumps (i.e., capture of up to 90th percentile flows in Granity Pit Sumps and 95th percentile flows in Twins Sump), with AMD transfer to the Mangatini Treatment System[4];
    - A high degree of acidity load capture in Miller pit sumps (i.e., capture of up to 90th percentile flows) from 2029 onwards (after fire suppression ceases) and transfer to the Mangatini Treatment System;
    - Staged increase in transfer of AMD collected in the Syncline for treatment at the Mangatini Treatment System (i.e., 40%, 60%, and 75% AMD transferred for treatment through 2026, 2027, and 2028, respectively) to reduce effects on Mine Creek between 2026 and 2028 (with Mine Pit AMD catchment replaced by pit sumps / MW16 Sump from 2029 onwards);
    - Transfer of acidity loads captured in Mine Pit sumps / MW16 Sump to the Mangatini Treatment System (increasing from 75% in 2029 to 80% in 2030 – 2032, once the Syncline is mined out);
    - Progressive removal of historic underground workings within the opencast disturbance footprint (with the majority removed by 2028).
- Further improvement of water quality draining Millerton Block during the EOML / Closure Phases to meet betterment reference values. Achieving this outcome will involve:
    - A high degree of acidity load capture in pit sumps (i.e., capture of up to 90th percentile flows in Granity and Miller Pit Sumps and 95th percentile flows in Twins Sump) with AMD transfer to Mangatini Treatment System until highwall and coal floor acidity loads decay sufficiently for betterment reference values to be met under a 'discharge without treatment' scenario;
    - Transfer of ~80%[5] of 'treatable' acidity load from MW16 Sump to the Mangatini Treatment System during the EOML Phase; and

[3] Cited literature shows highwall acidity loads decay rapidly (>95% decrease in the first 10 years after exposure) compared to ELF decay rates (50% decrease over first 10 years).
[4] The collective 'Mangatini Treatment System' includes all associated AMD collection, alkaline dosing, and AMD sludge capture / sumps, and treated water discharge infrastructure.
[5] These acidity load transfer and treatment targets are equivalent to the minimum degree of AMD treatment / management required for forecast MC1 Al concentrations to meet betterment reference values. The remnant acidity load (~20%) discharged to Mine Creek is equivalent to the modelled reduction in Al load from mining out or cutting off historic underground workings.

- In-sump treatment targeting neutralisation of ~75 – 80%[5] of the MW16 Sump acidity load by alkaline dosing during the Closure Phase.

The AMD modelling suggests that achieving betterment in Mine Creek (site MC1) discharges during the EOML / Closure Phase is sufficient for water quality at the modelled site 'NRB River' to meet comprehensive ecological recovery criteria by 2034 (i.e., annual 75th percentile Al concentration values of < 1 mg/L).

Adaptive Management

There is scope for further refinement and optimisation of Millerton Block water and AMD management through ongoing performance monitoring and adaptive management. It is expected that most alternative scenarios could be adaptively managed utilising the proposed BPCP water and AMD management infrastructure. For example, if the forecast acidity load is underestimated because overburden with atypically high acid potential are encountered:

- Pumping rates and reagent dose rates can be increased; and
- The duration of pump and treat operations can be extended.

Adaptive management processes will also include ongoing refinement of predicted betterment reference values based on performance monitoring in the context of untreated/historic AMD contributions. Instream (2026) propose six-yearly reviews of water quality and ecological effects which may trigger revision of water and AMD management strategies and betterment reference values.

Key recommendations

Operational use of a Millerton Block specific Water and AMD Management Plan is recommended (and this has been prepared STO-ENV-PLN-027). The Millerton Block specific plan aligns with the overall objectives for water and AMD management across Stockton (i.e., aligns with STO-ENV-PLN-016 Stockton AMD Management Plan and STO-ENV-PLN-013 Stockton Water Management Plan), which are to:

- Ensure that AMD affected water is prevented, minimised, and/or treated wherever practicable to minimise associated environmental impacts, reduce ongoing environmental liabilities, and to achieve statutory and non-statutory discharge limits.
- Ensure infrastructure is appropriately designed and fit for purpose, covering design needs in the short term, long term, and for permanent landforms.

The Millerton Block Water and AMD Management Plan should contain operational guidelines that cover the three Project phases for continuity of planning for long term water and AMD management efficiency. It should also acknowledge the need for Millerton Block specific performance monitoring, data interpretation, and reporting requirements for demonstrating water quality betterment over time. These datasets could also be used to refine AMD model assumptions and improve long term water quality forecasting.

Pumping AMD from Millerton to the Mangatini Treatment System is a key part of the Millerton Block water and AMD management strategy. This is expected to increase acidity loads treated in Mangatini Catchment to levels previously treated circa 2015. It is recommended that the effects of this acidity load are managed / assessed:

- From an operational perspective, including sludge generation, dewatering, and disposal requirements (addressed in the Stockton Operational AMD Sludge Management Report (BRL 2025a)): and
- From a water quality perspective, assessing against compliance criteria in Mangatini Stream and Ngakawau River to manage effects, including:
    - Incorporating forecasts of combined Millerton, Mangatini, and St Patrick contributions to Ngakawau River water quality (addressed in the Stockton Mine 80-year Water Quality Forecast (BRL 2026b) and Aquatic Ecology assessment (Instream 2026)); and
    - Benchmarking proposed water quality criteria against existing water quality datasets (Instream 2026)).

1.0 Introduction

1.1 Background

Bathurst Resources Limited 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.

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 BPCP proposes to mine approximately 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.

This report describes an assessment of Millerton Block (at Stockton) water and AMD management through the specified BPCP phases. The assessment process includes development of Millerton Block specific water quality objectives (including betterment reference values) and the subsequent estimation of proposed mine plan effects on acidity load and water quality. Water and AMD management strategies have been developed to manage these effects to meet water quality objectives.

This technical report complements a suite of parallel assessment reports, technical plans, and management plans, that contribute to the assessment of environmental effects for the Stockton component of the BPCP (Instream 2026, GHD 2026), including:

- Stockton 80-year Water Quality Forecast (including equivalent long-term AMD forecasting for Mangatini and St Patrick Catchments (BRL 2026b));
- Water Infrastructure Design Plan (BPCP-ENV-PLN-012);
- Erosion and Sediment Control Plan for Land Disturbance Activities (BPCP-ENV-PLN-013); and
- Stockton Operational AMD Sludge Management Report (BRL 2025a).

This report also directly supports the operationally targeted Millerton Block water and AMD management plan (STO-ENV-PLN-027) and complements the broader Stockton Water Management Plan (STO-ENV-PLN-013) and Stockton AMD Management Plan (STO-ENV-PLN-016).

1.2 Objectives

The objectives of this Millerton Water and AMD management report are to:

(1) Use the proposed mine plan to develop an AMD model to define water quality objectives (including betterment), forecast acidity loads, quantify AMD treatment / management requirements, and forecast concentrations of key water quality indicators at water quality monitoring sites;

(2) Replicate forecasts through the three key Project phases – **Operational Phase** (2027 – EOML), **EOML Phase** (2033 – 2046), and **Closure Phase** (2047 onwards); and

(3) Provide recommendations to ensure appropriate future management approaches through ongoing understanding of AMD including by enabling adaptive management.

This AMD modelling process has been used in conjunction with BPO considerations to develop Millerton Block water and AMD management strategies. These BPOs are described at a broad level (encompassing the entire Millerton Block management strategies (Section 2.5)) and at a sub-catchment specific level (throughout Section 8.0).

1.3 High level assessment approach

The AMD modelling component of the assessment focusses on predicting acidity loads, acidity concentration, and dissolved Aluminium (**Al**) concentration at key receiving waterbodies draining Millerton Block. These are anticipated to be the key parameters for determining:

- Long term AMD treatment requirements / costs (e.g., acid neutralising agent, sludge management, etc.); and
- Long term aquatic ecological recovery.

An annual acidity load and annual median acidity / Al concentration was selected as the basis for quantifying and forecasting water quality in this assessment. This is considered appropriate because:

- Most water quality datasets have a sufficient sample population (due to daily to weekly sampling) for median values to be considered representative of actual annual median water quality values, without further interpretation.
- Day to day water quality is variable at most sites, with an inverse relationship between concentration and flow rate which is primarily driven by rainfall dilution. This assessment is aimed at quantifying the long-term factors driving water quality improvement / recovery (as opposed to short term often cyclic variability). Annual acidity loads and annual median water quality trends are considered more representative of these long-term water quality recovery trends.
- The Stockton mine datasets used in this assessment are known to be influenced by multi-year climate variability. The effects of long-term climate influences (e.g., La Nina / El Nino cycles) and annual rainfall variability have not been quantified with respect to load trends. However, the use of relatively long-term datasets (i.e., 10-20 years for some sites) means that these influences are somewhat inherently included in modelling by virtue of the empirical dataset.

It should be noted that there are several different measures of ‘acidity’ reported by laboratories in the Stockton water quality monitoring database and used in technical assessments. These include:

- Acidity concentration determined (in the laboratory) by titration to pH 4, 5, and 7 end points;
- Acidity concentration determined (in the laboratory) by titration to a phenolphthalein indicator colour change endpoint (pH 8.3); and

- Calculated acidity, based on the concentration of dissolved constituents of AMD but primarily including pH and dissolved iron (**Fe**) and Al.

In general, this assessment uses the acidity concentration determined by laboratory titration to the pH 7 (circum-neutral) end point to provide consistency when quantifying acidity loads and determining correlations between acidity concentration and other parameter (e.g., Al) concentration.

1.4 Exclusions

Total suspended solids (**TSS**) / turbidity are also key effects of mining activities. Proposed compliance criteria for TSS / turbidity are described in Instream (2026) and are supported by either ecological guidelines (managing effects of sediment on aquatic ecology) or use of historic monitoring data for a specific reference period.

Further modelling of TSS / turbidity effects has been excluded from this analysis as their effects are expected to be:

- Relatively short in duration (i.e., a period of years post EOML as final landforms stabilise / revegetation becomes established) compared to AMD effects (i.e., persist for decades post EOML);
- Effectively managed through water management infrastructure, with designs described in the Water Infrastructure Design Plan (BPCP-ENV-PLN-012) and the Erosion and Sediment Control Plan for Land Disturbance Activities (BPCP-ENV-PLN-013; and
- Effectively managed through rehabilitation as described in the Stockton Mine Rehabilitation Stages and Planning Procedure (STO-ENV-PRO-031).

This report assumes that water management infrastructure is designed and constructed appropriately and that it is maintained and serves its intended purpose throughout the assessment period. For example, AMD diversion infrastructure is assumed to effectively divert AMD from final landform surfaces as described in Section 6.2. Similarly, Pit Sump sizing and pump / pipeline infrastructure are assumed to be designed / sized to allow capture of the determined flows and spilling of excess flows as defined for this assessment. Design details (e.g., pipeline specifications, diversion channel sizing, pit sump sizing for sedimentation, pit sump and pump live storage / float switch configuration, etc.) for this infrastructure are not provided in this report or used specifically as a basis for the assessment. These water management infrastructure design details are provided in the Water Infrastructure Design Plan (BPCP-ENV-PLN-012, where water reports to management infrastructure within the mine), Erosion and Sediment Control Plan for Land Disturbance Activities (BPCP-ENV-PLN-013, where runoff / sump discharge reports directly to the receiving waterway), and the Millerton Block water and AMD management plan (STO-ENV-PLN-027).

The effects of water diversion because of temporary (e.g., pumped) or permanent (e.g., catchment change) mining activities on stream flows and ecology are included in (Instream 2026), the BPCP Hydrological Assessment (MWM 2026), and the Stockton BPCP effects assessment (GHD 2026).

2.0 Millerton Overview

2.1 Description of the environment

A broad description of the Stockton Mine (including Millerton Block) is provided in the BPCP Summary Project Description (BRL 2026c) and GHD (2026). Additional introductory Millerton Block details are provided below. Figure 1 shows the Stockton main drainage features and water quality monitoring sites referred to in this report.

2.1.1 Site Location

The Stockton Mine is located on the Stockton Plateau, approximately 20 km northeast of Westport, on the West Coast of New Zealand's South Island. The Millerton Block (shown in Figure 1) occupies the northern portion of the existing Stockton Coal Mining Licence (**CML**). The northern boundary of the Millerton Block is defined by a combination of the existing CML boundary and the norther extent of historic underground workings. The eastern and western boundaries are defined by the existing CML. The southern boundary is formed by the border with Mangatini Catchment, which drains a large portion of Stockton Mine into the Ngākawau River.

Elevation varies across Millerton Block from ~500 to 700 m above sea level. The terrain is rugged with steep slopes and undulating surfaces. Surface water drains across this steep landscape from south to north into smaller creeks and streams. The streams are defined by steep and narrow rocky valleys, slightly opening towards Millerton township.

2.1.2 Waterbodies

The sub-catchments of the main waterbodies draining the Millerton Block are identified in Figure 1.

Granity Stream runs along the western edge of the Millerton Block, while Miller Stream is a tributary of Granity Stream and flows northward across the centre of the Millerton Block. Granity and Miller Streams merge near the Millerton township and Granity Stream then continues to drain into the ocean in Granity township. Granity Stream and the Miller Stream tributaries (east and west) are primarily fed by rainwater runoff from shallow soils and exposed sandstone and granite rock with low permeability. These streams begin within the Stockton mining areas, with flows that increase rapidly in response to rainfall. Granity Stream maintains a higher baseflow from groundwater compared to Miller Stream, likely due to rainwater seeping through surface cracks caused by historic underground mining.

Mine Creek runs along the eastern edge of the Millerton Block. Similar to the other streams, Mine Creek is also fed by rainwater runoff from shallow soils and exposed sandstone and granite rock with low permeability. The Eastern tributary of Mine Creek (S6 tributary) begins within the Stockton mining areas with flows that increase rapidly in response to rainfall. Mine Creek discharges into the Ngakawau River directly east of Ngakawau township, then drains into the ocean.

Twins Stream is located along the south-western edge of the Millerton Block. Twins Stream has a small catchment up on the Stockton Plateau before discharging down the escarpment to drain into the ocean south of Granity township. AMD seeps from historic underground workings (i.e., 3rd West workings) that report to water quality monitoring site T1 cannot be captured (at source / emergence) and treated as they are not located at a specific adit / portal but likely seep via faults to report at T1. Further work via the Land Information New Zealand (**LINZ**)[6] AMD management project is underway to determine if it is practical to treat upper Twins stream AMD from historic workings in the long term.

Rudolph Stream is located south of Twins Stream and receives AMD discharges from unnamed small historic underground workings sources, similar to Twins Stream. A small portion (~0.9 ha) of the upper Rudolph Stream catchment will be cut-off by Twins Pit (scheduled disturbance starts late 2028) and diverted into Twins Stream. This will not result in any new / additional discharge to Rudolph Stream but may result in a change to flows in Rudolph Stream, discussed in (Instream 2026). Given the absence of ecological values in the upper Rudolph Stream the reduction in flow is not considered to have any ecological effects (Instream 2026). New compliance criteria are proposed for Rudolph Stream based on existing water quality datasets described in Instream (2026).

2.1.3 Historic and Current Mining activities

The Millerton Block extent includes the upper reaches of Rudolph Stream, Twins Stream, Granity Stream, Miller Stream, and Mine Creek sub-catchments, as identified in Figure 1. The Millerton Block is characterised by highly fractured sandstone overlying an extensive network of historic underground workings and ongoing opencast operations. Remnant fires continue to burn from the underground coal in several areas and have done so for many decades. All drainage from the Millerton Block either naturally reports to Rudolph Stream, Twins Stream, Granity Stream, Miller Stream, or Mine Creek, is pumped into underground workings for fire suppression, or is pumped to Mangatini Treatment System. The reference level water quality of streams draining areas of Millerton Block already disturbed by mining is highly affected due to discharge of AMD from the historic underground workings and surface run-off over the pyrite rich sandstone. These streams do not currently meet ecological recovery thresholds described in Instream (2026).

[6] LINZ is the Crown agency managing the Crown's project to treat historic AMD liabilities.

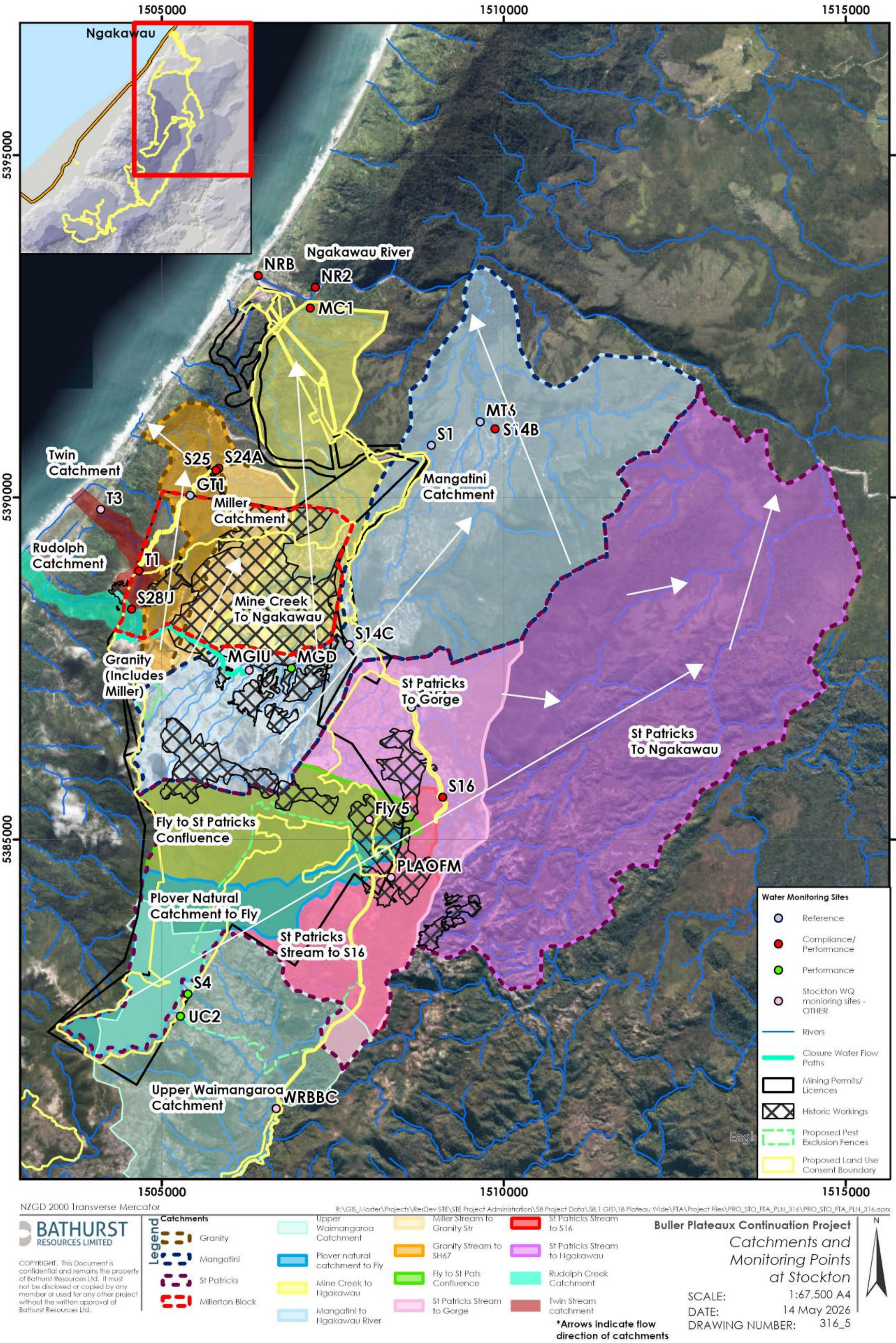

Figure 1. Catchments and Monitoring points at Stockton including Millerton Block.

2.2 Millerton Block BPCP

A description of the proposed Millerton Block mining activity is included in the BPCP Summary Project Description (BRL 2026c). The Millerton Block component of the BPCP includes expansion of Millerton Pit to the North, incorporating opencast expansion in the Twins, Granity, Miller, and Mine Creek sub-catchments. This expansion involves mining through areas of historic underground workings leaving a final landform that includes a single engineered landform (Millerton ELF) with the majority of runoff and seepage collected in a single water management structure (MW16 Sump) constructed in the headwater of the S6 tributary of Mine Creek. Final landform designs for disturbed areas in the Twins, Granity, and Miller headwaters include highwall / coal floor surfaces only.

Water and AMD management is required through all Project phases and is discussed in later sections. The water and AMD management approach adopted for the Millerton Block component of the BPCP is to separate (both physically and for assessment purposes):

- Water and AMD generated within the contemporary opencast disturbance footprint (to be managed as part of the BPCP (including any BRL and Crown contributions from opencast disturbance between 2010 and April 2027)); and
- Water and AMD generated from remnant historic underground workings located outside the opencast disturbance footprint (not managed as part of the BPCP).

From a water and AMD management perspective, this separation is both:

- Physical – the opencast disturbance footprint mine plans are designed to capture AMD in pit sumps at natural topographic low points, enabling physical separation of contemporary AMD from historic AMD generated by remnant historic underground workings in the lower catchments; and
- For effects assessment purposes – different management strategies for AMD generated within the contemporary opencast disturbance footprint versus AMD generated from remnant historic underground workings (outside the opencast disturbance footprint) are proposed.

2.3 Project Phasing

Section 1.2 introduces the three phases covered by this report, being the Operational Phase, EOML Phase, and Closure Phase. These Phases are described in more detail in subsections below.

2.3.1 Operational Phase

The Operational Phase spans the period of:

- Proposed consent commencement from April 2027 (though effects from 2026 onwards are generally discussed / included in AMD modelling calculations, noting that mining activities up until end March 2027 are currently approved); to
- EOML (end 2033) when scheduled coal and overburden extraction cease.

While the Operational Phase extends out to 2033, [redacted] before EOML, as shown in Table 1. Additional [redacted] (thousand bank cubic metres in-situ volume). Using a conversion factor of 1.25[7] this equates to an additional [redacted] This equates to the final [redacted]

The additional BPCP contribution to Millerton Block disturbance (and therefore acidity load source material) is relatively minor. The majority (~72% by material volume) of the disturbance managed by Millerton water and AMD infrastructure will be from contemporary / opencast activity that pre-dates the implementation of the BPCP (April 2027). This contemporary AMD includes contributions from the Crown / Solid Energy and BRL mining activities.

Table 1. Scheduled Millerton life of mine (LOM) Overburden volumes

Year	Scheduled vol. April 2027 to EOML (kbcm*)
2027**	[redacted]
2028	[redacted]
2029	[redacted]
2030	[redacted]
2031	[redacted]
2032	[redacted]
2033 (EOML)	[redacted]
Remaining	[redacted]

* kbcm unit is thousand bank cubic metres in-situ volume. ** 2027 includes scheduled volumes from April 2027 to end of year. Conversion factor of 1.25 applied to convert in-situ bcm volume to bulk volume (m^3) in landform.

2.3.2 EOML Phase

The EOML Phase spans from the end of 2033 to completion of final landform rehabilitation, expected by the end of 2046. Through this period rehabilitation activities will include:

- Final landform shaping;
- Capping and topsoil spreading; and
- Vegetation planting, or vegetation direct transfer (**VDT**), and ongoing maintenance.

The effect of final landform rehabilitation on Millerton ELF (resulting in a 50% reduction in acidity loads over the 10 years following rehabilitation (discussed further in section 6.3.4)) is linearly applied for AMD

[7] This factor is used to convert the pre-mining in-situ volume of un-disturbed rock within the proposed pit shell to the mined / disturbed volume of rock used for ELF sizing.

load modelling across the 2033 to 2056 period (i.e., 10 years after final rehabilitation in 2046), and conservatively assumes progressive rehabilitation prior to 2033 is negligible.

Throughout the EOML period surface runoff and AMD collected in Twins, Granity, and Miller Pit Sumps will be progressively discharged to natural catchments as water quality improvement allows (i.e., once the betterment reference values are met, which are described in section 3.2). The AMD captured in MW16 Sump will be pumped to the Mangatini Treatment System throughout the EOML phase.

2.3.3 Closure Phase

The Closure Phase runs from 2047 onwards when the Stockton mine is expected to be rehabilitated (with respect to landform rehabilitation / revegetation) and the site is transferred back to the Crown [redacted] Commencement of alkaline dosing of MW16 AMD in-sump (from 2047 onwards) is a key milestone throughout the Closure Phase.

2.4 Millerton Block Water and AMD management strategy

Elements of the Millerton Block Water and AMD management strategy are described below.

- During stripping of the vegetation and construction of the main sumps, stormwater will be collected in sediment treatment systems and discharged to the natural catchment (Described in the Erosion and Sediment Control Plan for Land Disturbance Activities (BPCP-ENV-PLN-013)).
- Diversions around work areas will be constructed both to separate clean water and minimize the quantity of water reporting to the water management systems. Clean water diversions will be directed towards natural catchments.
- Once overburden removal commences, potentially AMD impacted minewater will either be diverted to existing in pit sumps or to interim sumps constructed within the overburden. Water from these sumps will be pumped to the Mangatini Treatment System and discharged to Mangatini Stream.
- An increase in the transfer of AMD (including fire suppression water) captured at the Drainage Control Adit (**DCA**) stopping (DCA described in Section 5.1.3) to the Mangatini Treatment System from 2026 to 2028 will be used to improve Mine Creek water quality (until the Syncline area is mined out by the end of 2028). This will be followed by a period of AMD capture in Mine Pit sumps / MW16 Sump and transfer to the Mangatini Treatment System from 2029 onwards with MW16 Sump fully commissioned by 2032/33.
- Mining out a further ~88.4 ha of underground workings from 2026 to 2033 (with the majority removed by 2028), reducing the historic AMD source and removing fuel for fires. A total of 187 ha of underground workings are estimated to be mined out by opencast mining from 2010 to EOML (2033), a ~50% reduction from 369.5 ha pre opencast (2010);
- Ceasing operational fire suppression in 2028 will reduce flow volumes through historic underground workings and additional flushing of acidity.

- Sealing portals in historic underground workings to reduce water flow into workings, particularly where workings intersect pit sumps (e.g., sealing the DCA portal in MW16 Sump).
- Constructing and commissioning the ~718,900 m^3 MW16 Sump in the void created by mining out overburden above the Syncline area.
- Designing operational and final landforms with pit sumps at topographical low points in each area of disturbance to capture AMD for management (including MW16 Sump to collect seepage / runoff from the major Millerton ELF), including:

  - Sedimentation treatment of sediment laden water prior to discharge to manage receiving environment TSS and turbidity; and
  - Collection of the majority of AMD impacted water from the opencast disturbance footprint (using surface and sub-surface collection drains) to enable either pumping to the Mangatini Treatment System or in-sump alkaline dosing at MW16 Sump.

- Minimising the volume of potentially acid forming (**PAF**) waste rock in ELF's in the upper Twins, Granity, and Miller catchments to:

  - Reduce long term acidity loads in these sub catchments; and
  - To concentrate PAF waste rock in Millerton ELF and maximise capture of resultant AMD in the MW16 Sump for treatment.

- Final landform design strategy minimising the areal footprint of Millerton ELF and leaving coal floor and highwall areas permanently exposed. This final landform design strategy:

  - Minimises the footprint of Millerton ELF, reducing potential AMD seepage volumes; and
  - Incorporates highwall / coal floor surface types in the final landform, with relatively rapid acidity load decay to reduce long term treatment requirements.

- Constructing the Millerton ELF to incorporate AMD minimisation techniques and staged final landform rehabilitation / revegetation (completed by 2046) including lift heights of 2 – 5 m, ~125 ha non-acid forming (**NAF**) granite capping, and rehabilitation of 'native ecosystems' across all PAF stored in Millerton ELF. This brings total granite capping across all Millerton closure surfaces to ~144 ha.
- Configuring sumps to allow natural overtopping via engineered spillways (designed to a 1 in 100-year event) to the receiving environment once water quality criteria are met to minimise long term pumping requirements.
- Utilising the Mangatini Sump for AMD treatment / low density sludge (**LDS**) management until 2046, while Millerton Block rehabilitation occurs and MW16 Sump acidity loads are in a rapid decay phase.

- Transitioning to MW16 Sump AMD treatment by alkaline slurry dosing in sump (via slurry pipeline from Lime dosing plant 1 (**LDP1**)) from 2047 onwards. This is timed to occur towards the end of the Millerton ELF rehabilitation rapid acidity load decay phase.

This strategy provides infrastructure to collect most of the water and new AMD generated from the Millerton Block opencast disturbance footprint. The AMD capture and treatment strategy has been set to allow:

- Sediment sump and pump sizing to capture up to 90th percentile flows[8] (pump capacity for Operational Phase and EOML landform sumps defined in Section 5.2.1 and 6.4.1, respectively) and controlled spilling of the remaining >90th percentile flows (justification discussed further in Section 2.5), consistent with the AMD model approach to AMD management at Stockton, with:
  - High flow events (>90th percentile) typically infrequent and relatively short duration (discussed further in Section 2.5).
- Flexible degrees of AMD treatment during all Project phases, enabling partial treatment and:
  - Progressive improvement of water quality draining Millerton Block (where AMD is captured and transferred to Mangatini Treatment System) during the Operational Phase;
  - Water quality to return to the betterment reference values (calculated relative to a 2010 Millerton Block water quality reference point prior to opencast mining commencing) at key downstream sites by EOML (2033);
  - Water quality at the modelled site 'NRB River'[9] to meet comprehensive ecological recovery criteria (i.e., annual 75th percentile Al concentration values of < 1 mg/L) by 2034;
  - Efficient utilisation of AMD treatment and AMD sludge management infrastructure; and
  - Progressive improvement in water quality long-term as part of the 80-year recovery programme.

Long-term treatment of Millerton ELF acidity loads (as part of the 80-year water quality recovery strategy) is anticipated to be required for Mine Creek to continue to meet betterment reference values.

2.5 Best practicable water and AMD management options

In developing this strategy BRL have considered / discussed best practicable options to inform water and AMD management. BRL considered key factors including:

- Ability to meet Millerton Block specific betterment reference values (concept defined in Section 3.2 and values derived in Section 4.4) and ecological recovery thresholds determined by Instream (2026);

[8] Exception is Twins Sump with pump sizing to capture up to 95th percentile flows and spill >95th percentile flows.
[9] 'NRB River' site modeling assumptions described in Section 7.3.

- Minimising the duration of water diversion between catchments (e.g., minimising water takes and pumping costs);
- Minimising the duration that rapidly decaying highwall and coal floor AMD is pumped to the Mangatini Treatment System;
- Avoiding treatment of moderate to large acidity loads in pit sumps (excluding MW16 Sump post 2047) to reduce AMD sludge management and potential secondary geochemical reactions (e.g., precipitation generating turbidity) if treated water was discharged into otherwise untreated streams;
- Utilising temporary minor AMD treatment by alkaline dosing (e.g., NaOH) at remote sumps (or alternatively by passive treatment (systems not designed / assessed under BPCP)) to meet betterment reference values for relatively short periods of time (e.g., Minor treatment of AMD between 2041 and 2046 at Twins Sump is proposed to manage discharge Al concentrations after pumping to the Mangatini Treatment System ceases while highwall and coal floor acidity loads decay);
- Minimising the amount of high volume / relatively low acidity concentration water reporting to treatment systems to reduce flow diversion, pumping costs, neutralant usage, LDS generation, etc. and improve efficiency; and
- Integrating water / AMD management milestones with rehabilitation and mine closure milestones (e.g., transition to LINZ administration).

Where required, BPO are discussed on a sub-catchment basis in Section 8.0. However, an overarching assumption in all BPO is that flows higher than the 90th percentile (95th percentile at Twins) will be spilled from sumps. This is consistent with the Okane (2015) assumption that the 'treatable' component of total acidity load is defined as:

- The acidity load associated with flows up to 90th percentile flow rates; and
- Equates to ~75% of total acidity load.

The remaining 25% of acidity loads associated with flow rates greater than the 90th percentile are not included in estimates of 'treatable' acidity loads as their effects are assumed to be minor. Existing monitoring datasets from Stockton mine show:

- There is significant dilution of acidity and Al concentration during high flow conditions despite loads being high, as shown at the Mangatini Inlet Untreated water quality monitoring site (**MGIU**) (Figure 2), which is [redacted] and reflects the effects of dilution on untreated AMD;
- TSS and turbidity at the key downstream monitoring site NR (in the lower Ngakawau River downstream of St Patrick and Mangatini Catchment discharges) is already elevated during high flow conditions (Figure 3);

- The expectation that high flow events (>90th percentile) are typically infrequent and of a relatively short duration, as supported by an event duration frequency assessment in lower Mine Creek (Figure 6, Figure 7, and associated text); and
- Modelled water quality and ecological recovery is based on annual median and 75th percentile concentration statistics, which may not be influenced significantly by water quality during high flow (90th percentile) periods.

It should be noted that these high flows (>90th percentile) will be alkaline dosed for acidity neutralisation during the Closure Phase (Post 2047 when alkaline slurry is dosed to drains on Millerton ELF upstream of MW16 Sump), but not diverted into the MW16 Sump for sedimentation. This is similar to the current Mangatini alkaline dosing system where all flows are lime (**CaO**) dosed but flows greater than the 70th percentile bypass Mangatini Sump for sedimentation.

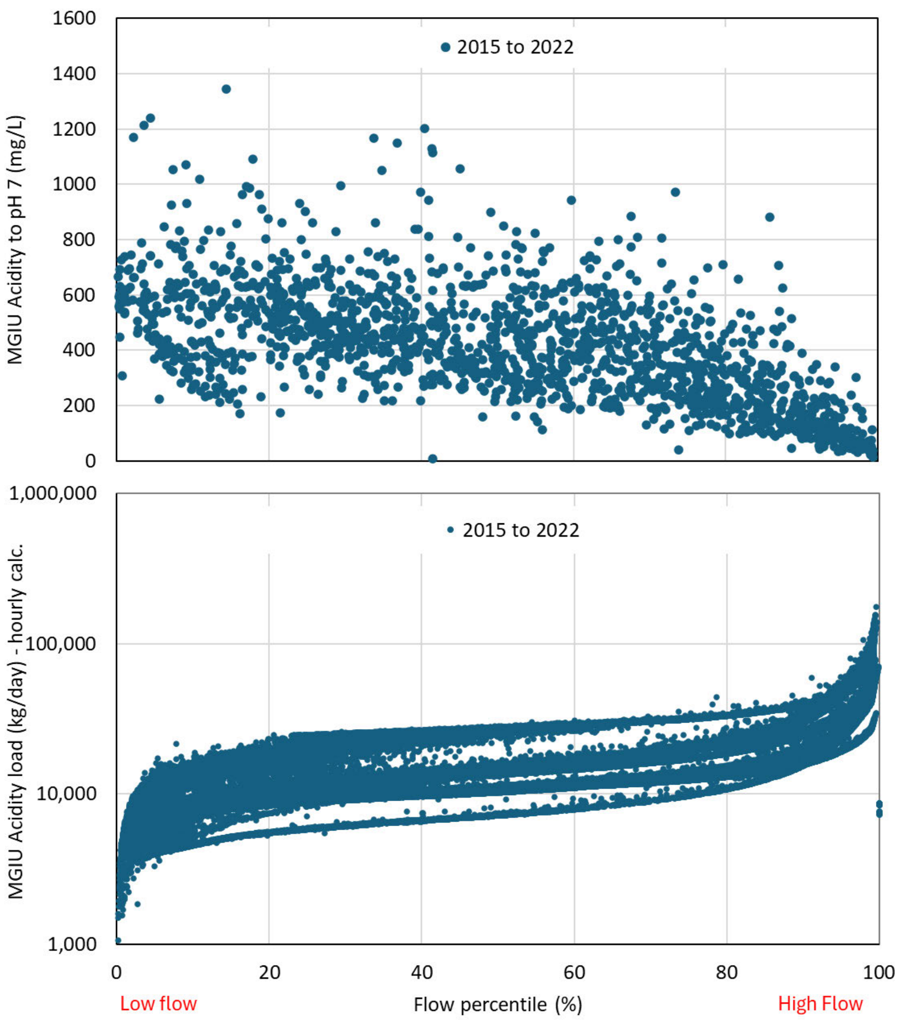

Figure 2. MGIU acidity concentration and daily acidity load by flow percentile (Dataset: 2015 to 2025).

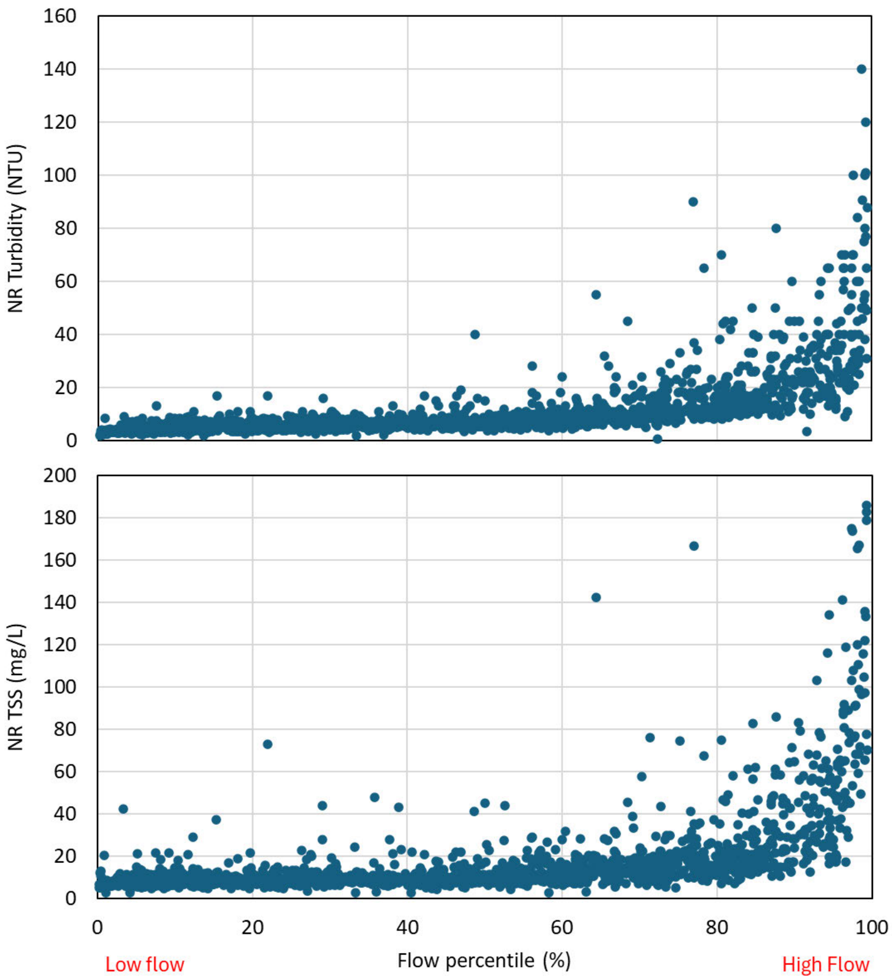

Figure 3. NR turbidity and TSS versus flow percentile (dataset: 2015 to 2023. After 2023 NR flow monitoring site was lost due to a slip)

An example flow distribution for the Mangatini untreated (MGIU) site is shown in Figure 4. This shows the majority (~70%) of the cumulative flow volume theoretically departs site during greater than 90th percentile flow conditions. Designing infrastructure to capture AMD at up to 90th percentile flows equates to capture of ~43% of the total flow volume (with the remaining 57% bypassed during very high flow conditions). Further increasing the design flow capture percentile (i.e., to values > 90th percentile) to increase AMD capture during these high volume and relatively low acidity concentration periods is likely to reduce overall AMD management / treatment efficiency during low to moderate (i.e., < 90th percentile) flow conditions by shortening residence times / reducing the effectiveness of live storage.

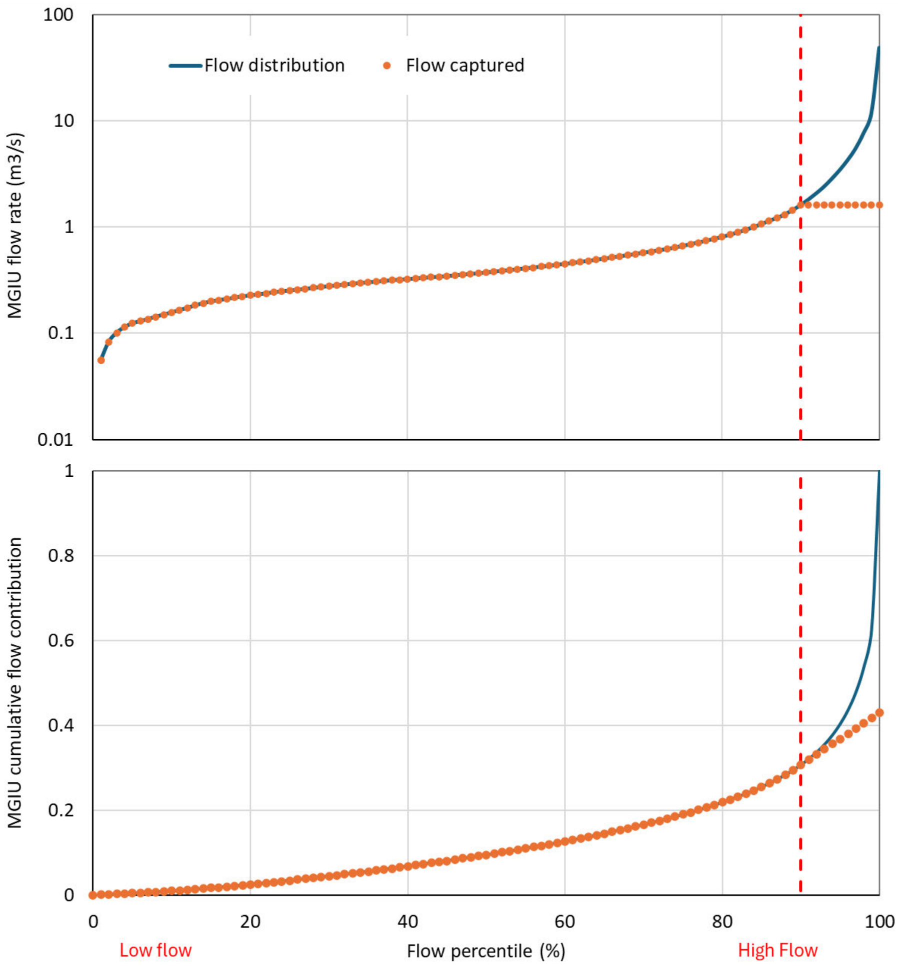

Figure 4. MGIU flow distribution (by percentile) and cumulative contribution to flow

The dilution effect during these high flow events is captured by sensor data at S6 during a 155 mm rain event in Figure 5. An increase in pH was observed (from pH 3.4 to 4.0) which coincided with an approximately order of magnitude decrease in electrical conductivity (**EC**). This decrease in EC would have corresponded with a proportional decrease in the concentration of Al and other constituents of AMD, indicating that bypass flows will have relatively low contaminant concentrations.

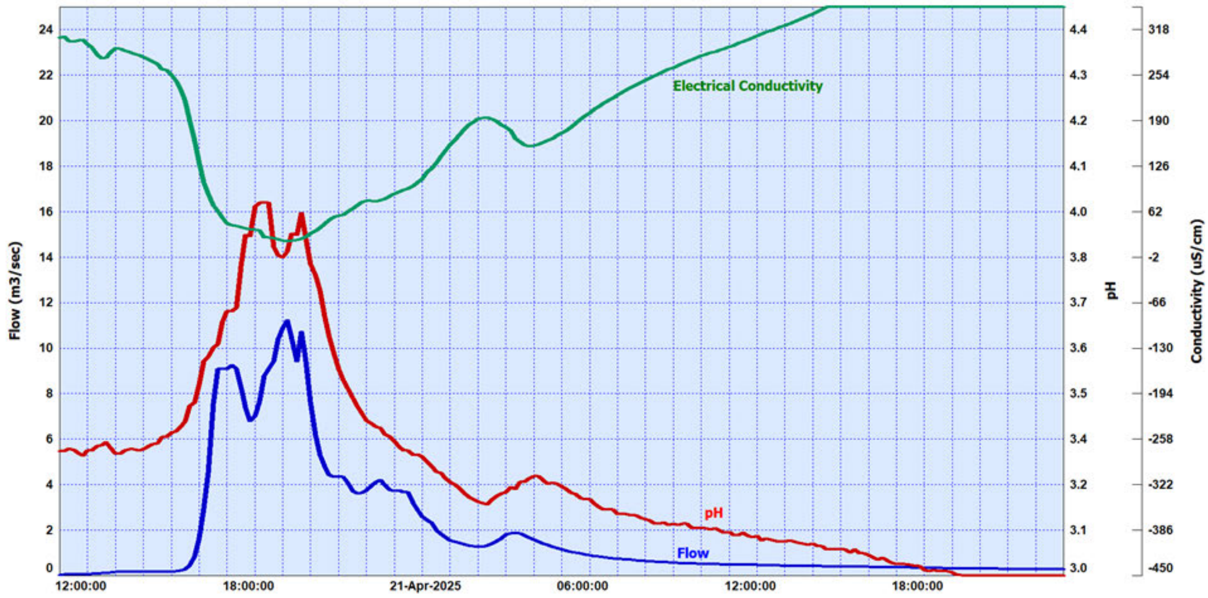

Figure 5. Sensor data at Site S6 illustrating dilution effect during a 155 mm/day rain event, including Flow rate (blue line), pH (red line), and EC (green line).

Continuous flow monitoring sensor data have been reviewed to quantify the frequency that flow rate exceeds a given percentile for a period of time. Relevant data for the flow rate monitoring site in lower Mine Creek (Mine Creek above Steep Creek (**MASC**)), which is analgous to MC1 flow rate, have been used to illustrate the short duration of these high flow events. The MASC flow rate record (including data from 2013 to present) is shown in Figure 6. This dataset was processed to quantify the percentage of events exceeding the 90th percentile flow rate that lasted for greater than 24 and 48 hour periods. This assessment showed that:

- 4% of events that exceed the 90th percentile flow rate lasted for longer than 24 hours; and
- 0.8% of events that exceed the 90th percentile flow rate lasted for longer than 48 hours.

This analysis suggests that pit sump spill events nominally occuring 10% of the time (i.e., flows > 90th percentile) are likely to be short duration, with only 4% of those spill events lasting longer than 24 hours (i.e., less than two spill events per year lasting longer than 24 hours). This indicates that under the proposed bypass frequency pit sump spill events will generally be short duration.

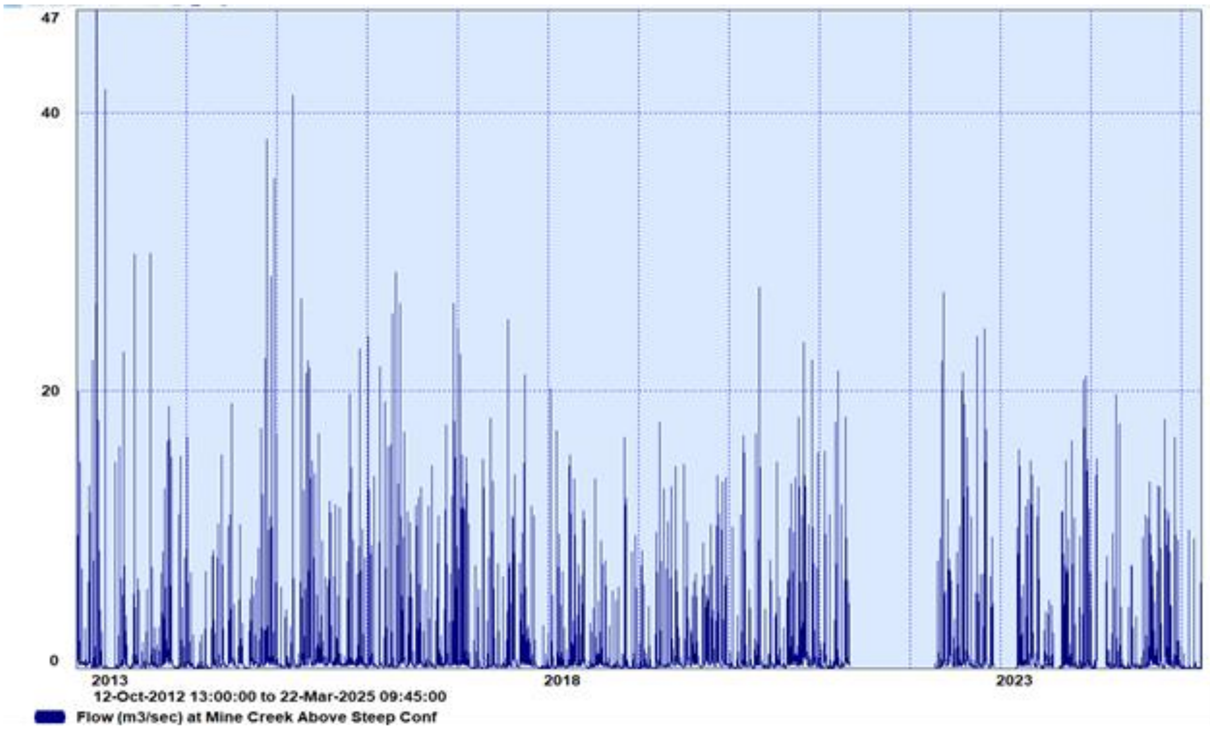

Figure 6. Lower Mine Creek (MASC) continuous flow rate record

Example plots showing flow rate records for two events that exceeded the 90th percentile flow condition at MASC for periods of 24 and 48 hours are shown in Figure 7.

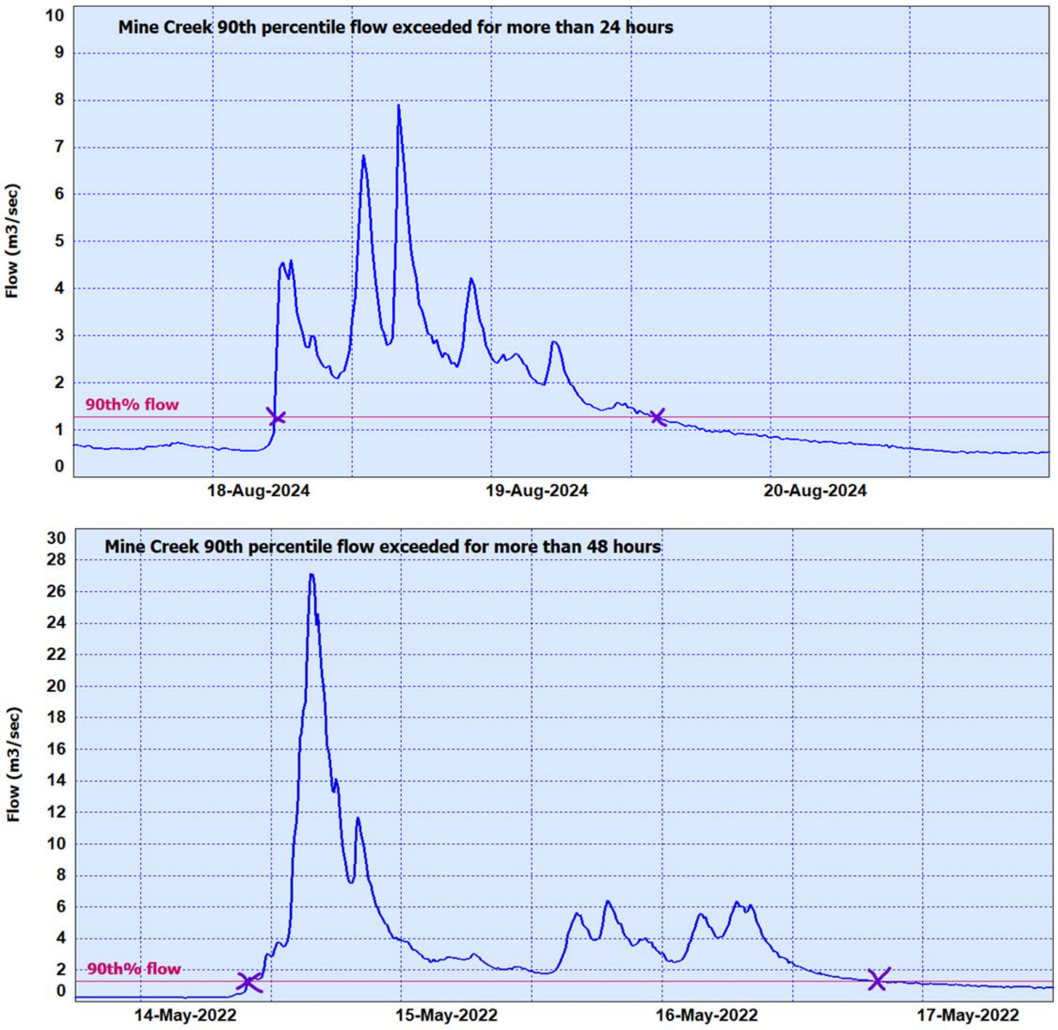

Figure 7. Example flow records for two events exceeding 90th percentile flow rate at Mine Creek MASC.

3.0 Water Quality Objectives

The water quality in sub-catchments draining Millerton Block is impacted by historic and current mining activities, including fire suppression (ceasing in 2028). Water quality and ecological effects are discussed in Instream (2026) and has led to development of Stockton specific water quality guideline thresholds for assessing ecological recovery (described in section 3.1.1).

The ongoing AMD discharges from remnant underground workings (located outside / downstream of the BPCP / Millerton Block opencast mining disturbance footprint) are expected to prevent water quality improving sufficiently for ecological recovery in upper Twins Stream (at T1), Granity Stream (at S25), Miller Stream (at S24A), and Mine Creek (at S6, S23, and MC1). Accordingly, water quality betterment is the objective for these waterbodies. Alternative water quality betterment reference values have been developed to guide AMD improvement for Millerton Block AMD management (described in 3.2).

The exception is the lower Ngakawau River, which is expected to meet ecological recovery thresholds within the BPCP. AMD load modelling includes a modelled site 'NRB River', which is theoretically located downstream of the Mine Creek confluence with Ngakawau River (i.e., in the Ngakawau Estuary tidal zone) but is modelled / analysed to remove any tidal dilution influence. Modelling indicates NRB River will meet annual 75th percentile Al concentration values of < 1 mg/L (and therefore meet the threshold for comprehensive ecological recovery) from 2034 onwards (discussed further in Section 8.5).

3.1 Stream health measures

3.1.1 Ecological recovery thresholds

Instream (2026) discuss the ecological effects of AMD at Stockton Mine and develop thresholds for ecological recovery. The focus for many AMD impacted BCM streams is on recovery from their current impacted state.

Dissolved Al and pH were identified as suitable proxies for the gross effects of AMD by Instream (2026). Dissolved Al was selected as the key indicator of AMD impacts for AMD modelling for the following reasons:

- Major constituents of Stockton mine AMD include hydrogen ion (measured as pH) and Lewis acidity (dissolved Al and Fe), as quantified for pre-treatment Mangatini Catchment AMD in Figure 42. During neutralisation (or dilution) pH increases causing precipitation of Fe and Al as amorphous hydroxides (and sometimes more complex minerals). Typically, Fe concentrations decrease sharply in the range pH 3-3.5, whereas Al concentrations decrease sharply between pH 4-4.5. A solubility minima is reported for Al at about 4.5 (INAP 2009). This means that in partially neutralised or recovering streams Al is a more informative indicator for residual acidity / water quality recovery than Fe or total acidity.
- Al is routinely monitored at a wide range of sites across Stockton. This enables effective concentration comparisons across sites and mass balanced contaminant load models to be developed to simulate treatment and / or downstream mixing of AMD waters. The geochemistry of these processes is generally well understood and represented in models.
- Al is a common parameter used in previous AMD impact assessments / models across Stockton. This enables the key results of different technical studies to be incorporated into this document.
- Al is one of the most commonly available measures of water quality at sites that have paired ecological data allowing the development of threshold criteria in Instream (2026).

Instream (2026) combined aquatic invertebrate and water quality data to derive recovery thresholds for individual taxa and overall invertebrate communities in impacted waterways. Collectively this method indicated that from an Al perspective:

- Ecological recovery will begin at Al concentrations of less than 2.8 mg/L; and
- Ecology will return to unimpacted / comprehensive ecological recovery status at residual Al concentrations of less than 1 mg/L.

The annual 75th percentile Al concentration value is being compared against these criteria for other catchments draining the Stockton Plateau (e.g., Mangatini and St Patrick Catchments). As discussed, betterment reference values are required for most of the streams draining Millerton Block. However, ecological recovery thresholds have been used for assessing the Lower Ngakawau River (at the modelled site 'NRB River'), where annual 75th percentile Al concentration values of < 1 mg/L are anticipated from 2034 onwards.

Once the comprehensive ecological recovery threshold is met the ecological recovery focus shifts to mahinga kai criteria (which is focussed on tissue sampling of mahinga kai and recreational harvest species), as described by Instream (2026). AMD effects relative to mahinga kai criteria have not been included in this assessment.

3.2 Targets – Betterment

The definition of 'betterment' in the context of the BPCP is (*italicised*):

The term betterment has been applied to rivers in New Zealand (i.e., Waikato River) that have experienced long term anthropogenic contamination. It is recognised that managed improvement will take 3 generations (80-100 years) and require a collective, sustained, and sustainable effort between stakeholders.

Betterment is the process of active and progressive improvement of river health over the long-term.

The betterment pathway for a given waterbody is marked by a combination of discrete events and long-term decay in AMD sources. Performance monitoring is used to track short- to medium-term water quality improvements along the betterment pathway. These improvements are site / project specific, but contribute to overall long-term recovery.

To measure AMD improvement, the BPCP has adopted 2010 as the reference point for the Millerton Block water quality betterment reference value calculations, for the following reasons:

- 50+ years of AMD discharge from the historic underground workings to the Millerton streams has in effect defined the environment up until the commencement of modern open cast mining in 2010;
- 2010 reference point enables a high degree of separation between effects of new practices and contemporary AMD sources from the effects of remnant historic underground AMD sources that will remain outside the opencast disturbance footprint post BPCP;
- Acidity loads in 2010 were not influenced by the short term AMD generation / effects from the use of pit water required to cool or extinguish underground fires; and
- Sets the datum from which the trajectory of AMD improvement from contemporary activities can be sensibly measured.

Water and AMD generated within the contemporary opencast disturbance footprint will be managed collectively as part of the BPCP (including any pre-April 2027 BRL and Crown contributions). Separating

AMD generated within the opencast disturbance footprint into fractions generated pre- and post-April 2027 is unlikely to be feasible / practicable.

Time-dependent betterment reference values for acidity load, acidity concentration, and Al concentration have been developed for key sites to guide long term AMD management and as targets for comparison with performance monitoring data. The betterment reference values derived for each sub-catchment (T1, S25, S24A, S23, S6, and MC1) estimate what acidity loads and acidity / Al concentrations would have been if:

- The contemporary (i.e., 2010 onwards) opencast mining in Millerton Block had not occurred;
- The Millerton Block historic underground workings had remained at their full 2010 areal extent (369.5 ha); and
- AMD continued to discharge from these historic workings without treatment.

The betterment reference value calculation process and reference values for key sites are presented in Figure 23 and described further in Section 4.4.1. Sub-catchment specific water and AMD management strategies were developed to keep the AMD modelled / forecast long term acidity loads and acidity / Al concentrations below the betterment reference values post EOML (2033).

The removal of substantial areas of underground workings in the Millerton Block (commenced in 2010 and continued as part of the BPCP) contributes to betterment if that results in a reduction in acidity loads from remnant underground workings (quantified in Section 4.4.2). The removal of these historic underground workings from within the proposed EOML (2033) opencast disturbance footprint (and associated reduction in acidity load) provides some limited capacity for AMD discharge from the opencast disturbance footprint to streams draining the Millerton Block, while still showing betterment relative to 2010 acidity loads. The potential to offset acidity load is sub-catchment specific and depends on the area of workings removed, acidity generation rate of those workings, and long-term decay.

An example of a water and AMD management strategy achieving betterment (within the Millerton Block context) as modelled is provided for site MC1 at EOML (2033):

(1) The **potential effect** of uncontrolled AMD discharge from Millerton Block at MC1 in year 2033 is an annual median Al concentration of 47.9 mg/L.

(2) The **managed effect** under a scenario where 80% of the 'treatable' acidity load captured in MW16 Sump in year 2033 is transferred to the Mangatini Treatment System is an annual median Al concentration of 13.3 mg/L.

(3) The **betterment reference** value (derivation process described in Section 4.4) for MC1 in year 2033 is an annual median Al concentration of 13.7 mg/L.

Betterment is deemed to have been achieved at MC1 in year 2033 as the forecast median annual managed effect Al concentration (13.3 mg/L) is lower than the betterment reference value Al concentration (13.7 mg/L).

4.0 General AMD modelling approach

Separate AMD modelling approaches have been used for the Operational Phase (Section 5.0), the EOML / Closure Phases (Section 6.0), and the Lower Ngakawau River (Section 7.0). The approaches are similar in that they utilise the extensive Stockton Mine records of water quality and flow rate collected over the past ~20 years as analogue data. The approaches are different in that:

- Operational Phase AMD modelling is based on extrapolation of the current effects of mining / measured **total acidity load** trends incorporating scheduled additional disturbance of overburden and AMD treatment. This is appropriate as there is already extensive contemporary opencast disturbance across the Millerton Block and associated monitoring datasets showing the effects of these activities. Much of the remaining Operational Phase comprises a continuation of current activities.
- EOML / Closure Phase AMD modelling is based on forecast **treatable acidity load** yields from domain based final landform surfaces / structures, e.g., Millerton ELF, Coal Floor, and Highwall exposure. This is appropriate once mining disturbance ceases and the final landform surface exposures and reactive ELF volume landform stabilise. AMD modelling during this phase focusses on AMD decay from these well-defined surfaces / ELF volumes over the long term.
- Lower Ngakawau River is based on specifically derived trends in Al loads for NR and MC1 and the outputs of the Operational Phase and EOML / Closure Phase models. This is appropriate due to the specific tidal influence on the Lower Ngakawau River, which does not apply to other sites.

It should be noted that the acidity loads used in the Operational Phase and EOML / Closure Phase AMD models are somewhat different. The Operational Phase AMD model is based on measured acidity loads calculated across the full dataset and is effectively equivalent to 100% of the **total acidity load**. The EOML / Closure Phase AMD model is based on **treatable acidity loads** (as described in Section 2.5), which is equivalent to the 75% of the total acidity load captured at <90th percentile flows (and does not include the 25% of acidity load discharged during >90th percentile flow conditions. The transition from the Operational Phase model to the EOML Phase model is described in 5.1.2. The use of 'treatable' acidity load for the EOML / Closure Phase modelling enables the long-term AMD generation and decay rates in Gandy and Younger (2007) and Okane Consultants (2015) to be used (discussed in Section 6.3.4).

This section (Section 4.0) discusses the AMD modelling factors that are common to all three models, including compilation and interpretation of extensive historic monitoring datasets to develop correlations between annual acidity loads and median annual acidity / Al concentrations at key monitoring sites, though lower Ngakawau River correlations are derived in Section 7.0. These correlations are used to convert the forecast annual acidity loads to estimates of future annual median acidity and Al concentrations. This approach utilises existing analogue datasets and a forecasting model based on acidity load as opposed to developing a water balance load model that relies on individual concentration source terms for different domains / AMD generating surfaces to forecast acidity loads and water quality.

4.1 Historic water quality data compilation

Historic electrical conductivity (EC), acidity, and Al concentration datasets were compiled for key Millerton monitoring sites (S23, S24A, S25, S6, Twins (T1) and Mine Creek (MC1)).

4.1.1 Granity, Miller, and Mine water quality Sites

Data were extracted from databases and cleaned to remove anomalies. Most sites included regular (weekday) sampling EC measurements from 2006 to current, however acidity and Al analysis was not completed regularly / routinely prior to 2018. Site specific correlations between conductivity and acidity / Al concentration were developed and used to synthesise acidity and Al concentration data for periods where only electrical conductivity measurements are available. These parameters are generally well correlated when fitted to ‘All data’, however the low acidity and Al concentration sample count in the 2010 and pre-2010 datasets may affect the reliability of correlations when applied to early datasets. Example correlations for S23 are shown in Figure 8.

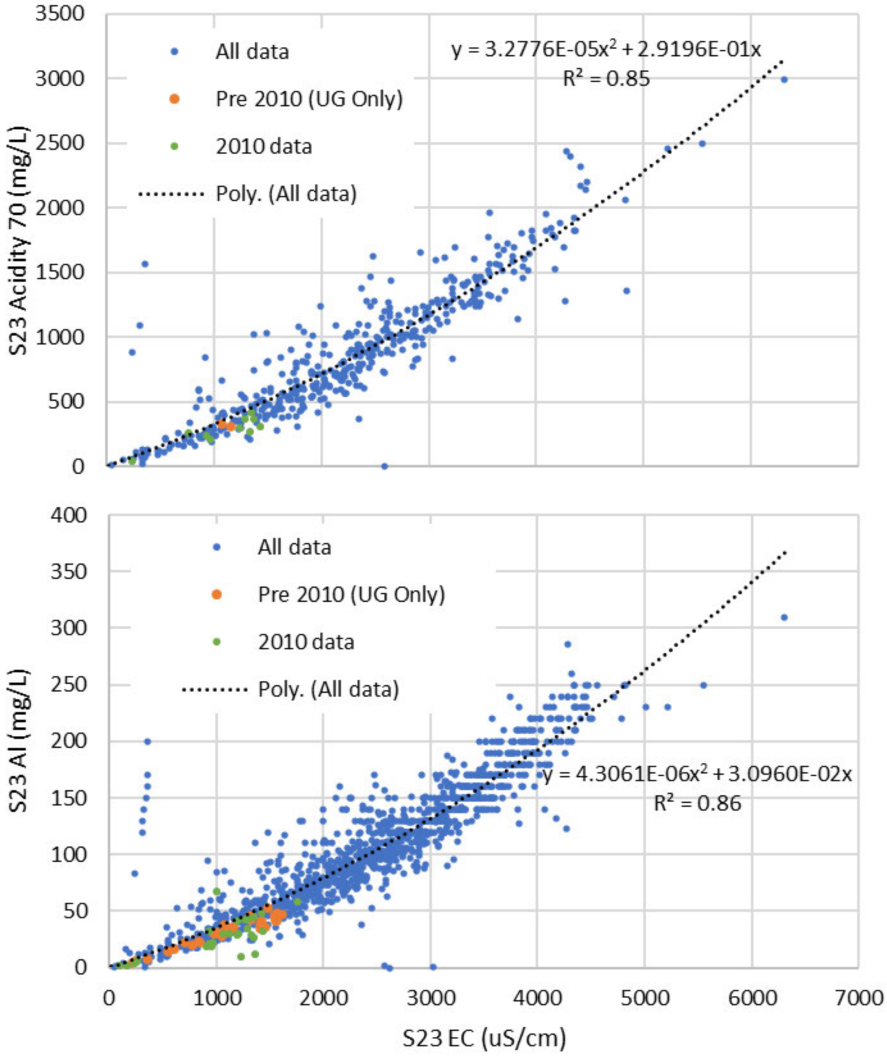

Figure 8. S23 correlation between EC and Acidity / Al concentration

An example of the resulting synthesised retrospective long term acidity and Al concentration for S23 is shown in Figure 9. These synthesized datasets provide a more comprehensive record of the effects of mining (particularly the effects of ongoing mining and increased fire suppression in recent years) than the measured datasets alone provide.

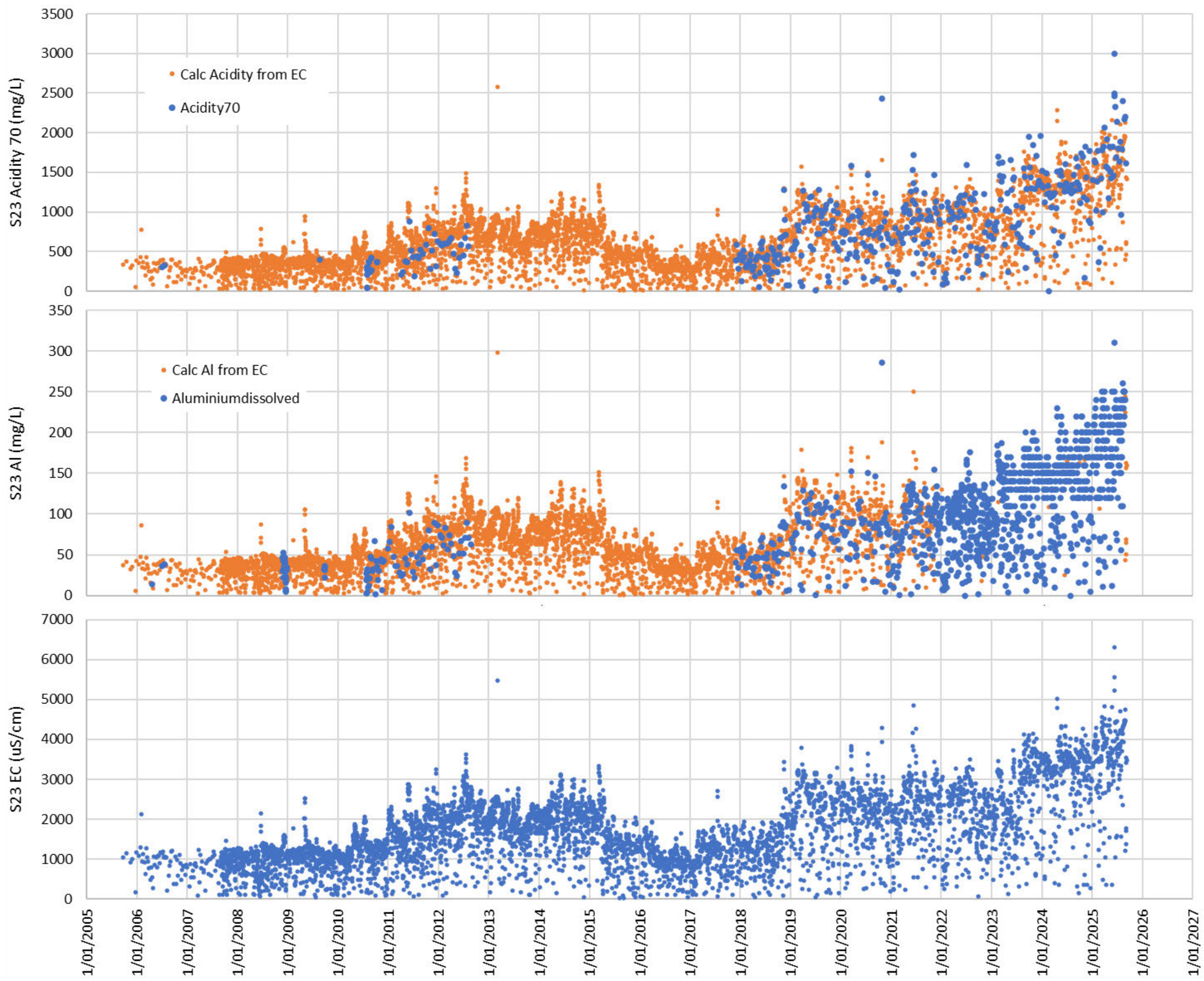

Figure 9. Synthesised long term S23 water quality record – Blue dots are measured values and orange dots are estimated from EC correlation. Acidity70 = Titrated acidity to pH 7.

The synthesised long term water quality records for each site were then combined with measured data (where available) into a combined dataset. Measured concentration values were prioritised over synthesized concentrations in the compositing process. Median annual acidity and Al concentrations were then calculated using the combined dataset to reflect the long-term trends in water quality (Table 2). The ‘count’ columns in Table 2 show that the data synthesising process increased Al and acidity sample counts at the S23 site from ~50 samples to ~250 – 350 samples for some years, and provided estimated acidity and Al concentrations through 2013 to 2016 where no measured data were available.

The measured sample count and additional sample count generated through the synthesising process at S23 was similar for the other sites S25, S24A, S6, and MC1. Combined historical annual median acidity concentration data are shown in Table 3.

Table 2. S23 Median annual acidity and Al concentrations (calculated on measured and combined (incl. synthesised) datasets).

	Median annual acidity (measured)		Median annual Al (measured)		Median annual acidity (combined)		Median annual Al (combined)	
	Meas. Acidity	Count	Meas Al	Count	Acidity	Count	Al	Count
Unit	(mg/L)		(mg/L)		(mg/L)		(mg/L)	
2025	1,690	37	185	158	1555	169	180	169
2024	1,270	51	150	240	1295	249	150	249
2023	1,118	52	130	245	970	246	130	247
2022	863	51	92	236	843	239	92	240
2021	852	57	89	120	814	245	87	245
2020	718	51	78	57	803	250	89	250
2019	850*	50	86	49	844	239	91	239
2018	392	50	46	51	414	242	46	242
2017	394	5	40	5	392	246	43	246
2016	-	0	-	0	322	248	35	248
2015	-	0	-	0	505	284	55	284
2014	-	0	-	0	718	350	79	350
2013	-	0	-	0	677	359	75	359
2012	594	16	64	17	709	355	78	355
2011	437	19	47	26	558	360	61	360
2010	284	20	30	28	374	370	41	360
2009	400	1	32	5	360	361	39	360
2008	-	0	35	29	350	344	37	344
2007	-	0	-	0	302	144	33	144
2006	319	2	36	3	302	49	33	49

* Fire suppression begins in Mine Creek / S23 tributary in 2019

4.1.2 Twins water quality sites

Historic Twins Stream water quality data are available from datasets submitted to regulators supporting [redacted] This dataset included water quality results and acidity load estimates for site T1 (Figure 10), located in the tributary of Twins stream which:

- Is currently impacted by AMD seeps from historic Stockton underground workings that are likely to report to T1 via fault flow paths (as opposed to a specific adit discharge point); and
- Is also downstream of the proposed Twins BPCP opencast disturbance area and Twins Sump.

Thus, T1 is considered the representative site for monitoring historic and proposed future (BPCP) effects of mining in Twins Catchment. The effects of the neighbouring [redacted] on Twins Stream are measured at T2 while the effects of all activities are measured at T3.

Figure 10. Twins Stream T1, T2, and T3 monitoring site locations

The dataset submitted by [redacted] (and subsequently updated to end of 2021) spanned 2013 to 2021 and included:

- Weekly measured conductivity and pH values; and
- Monthly Al and Fe concentration.

This dataset was processed by:

- Calculating acidity concentrations using measured pH, Fe, and Al (monthly data);
- Deriving correlations between conductivity and measured Al / calculated acidity concentrations; and
- Synthesising a composite long-term acidity and Al concentration dataset.

Some outlying data were omitted from the EC versus Al / calculated acidity correlations as shown in Figure 11 (only 'EC screened' data included in correlations). The reason for these anomolies is not clear but could relate to calibration issues, sample mis-labeling, or some other factor. The fact that the EC anomolies are persistent across correlations with calculated acidity, Al, and sulfate suggests that it is the EC values that are anomolous as opposed to variability in geochemical processes. The resulting long term combined T1 water quality datasets are shown in Figure 12.

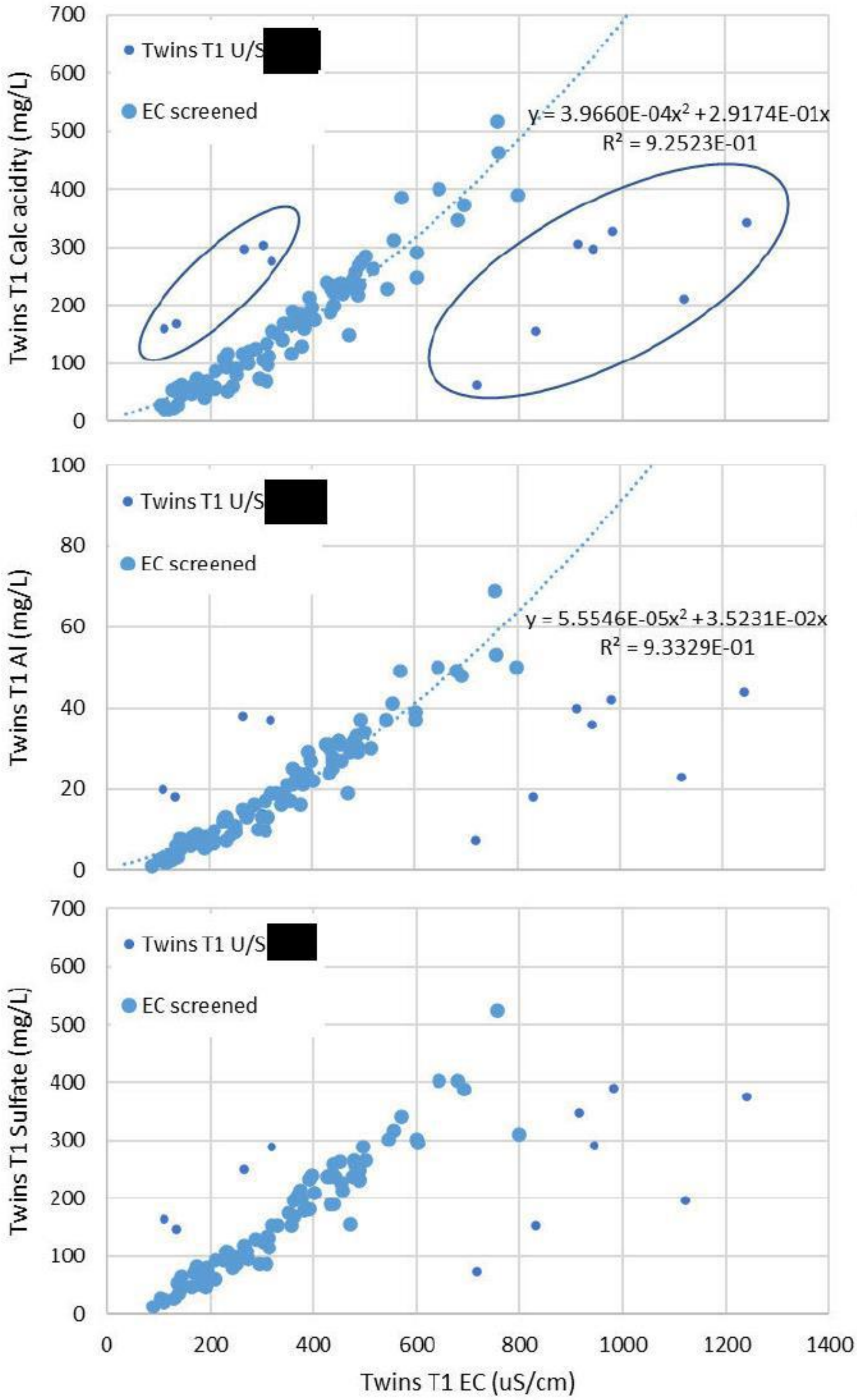

Figure 11. T1 correlation between EC and calculated Acidity / Al concentration

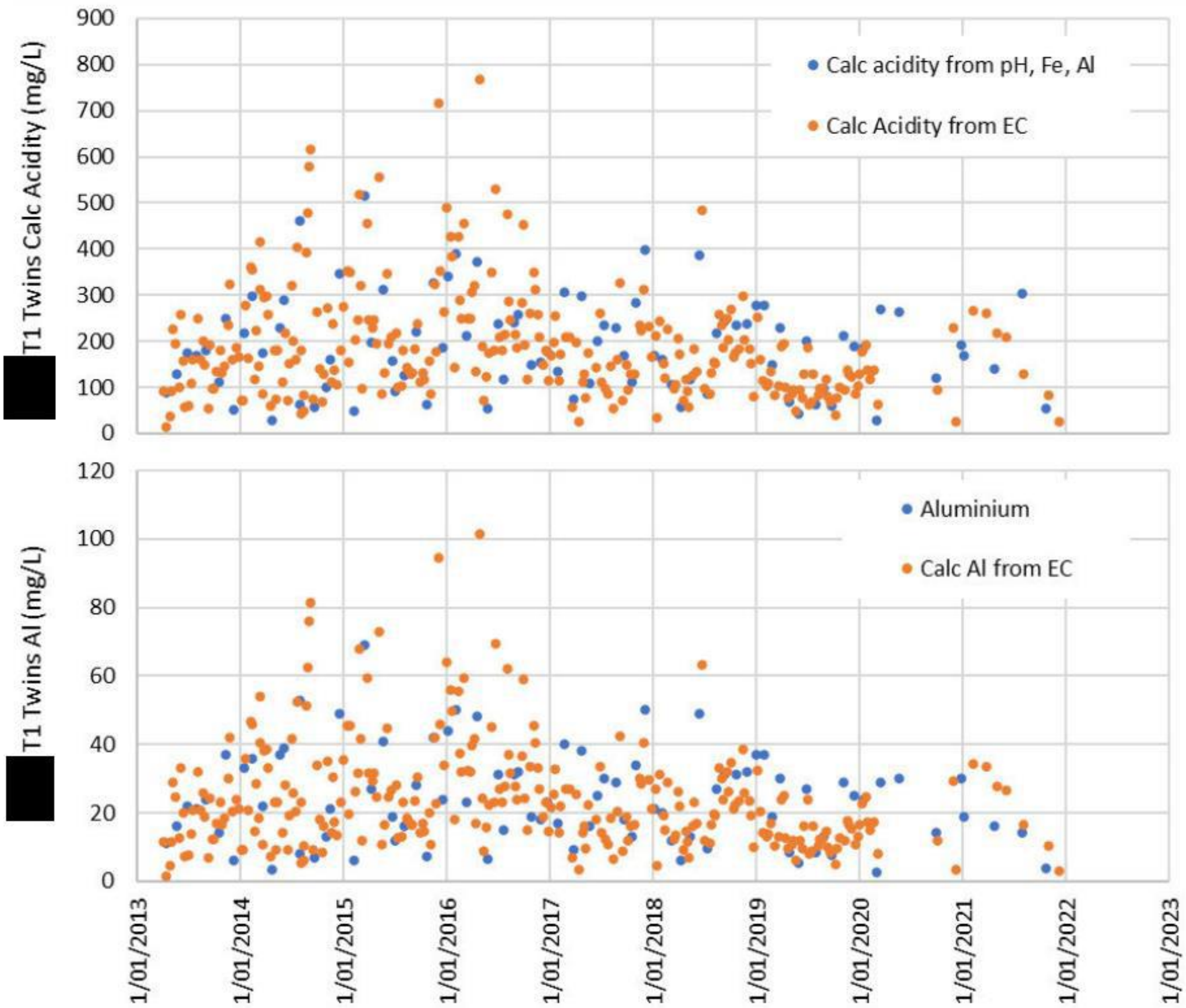

Figure 12. Synthesised long term T1 water quality record – Blue dots are measured / calculated values and orange dots are estimated from EC correlation.

As discussed, the Twins at T1 analysis is based on a 2013 – 2021 dataset. Subsequent data collected by [redacted] between 2022 and 2025 are also available but at a lower sampling frequency. BRL commenced regular (weekly) sampling at T1 in October 2025. Recent (2025/26) data suggest concentrations (and possibly loads) have decreased between 2020/21 and 2025/26 (Figure 13). The cause of this decrease is uncertain, with climate variability or natural decay being possible contributors. Ongoing monitoring of Twins Stream is recommended to support an improved water quality reference level dataset.

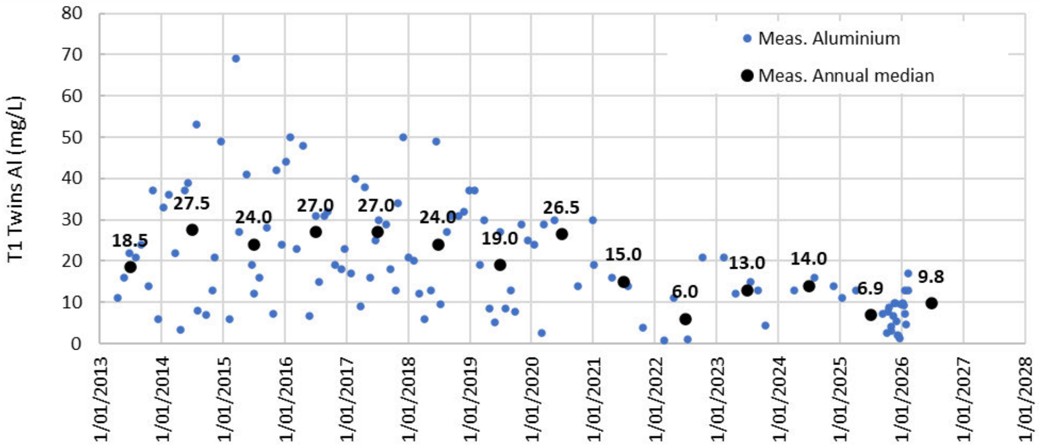

Figure 13. Measured long term T1 water quality record – including recent measured data and annual median of 'measured' values

4.1.3 Mine Creek Mouth (MC1)

The Mine Creek mouth monitoring site (**MC1**) is located on Mine Creek just above the confluence with Ngakawau River. The MC1 monitoring dataset spans late 2004 to late 2021, when access to the monitoring site was blocked by slip debris. The regular MC1 monitoring suite included EC and Al concentration but acidity analysis was uncommon. The sample count for EC and Al was similar, so EC data was not used to extend / synthesise additional Al concentration estimates. As the acidity record only spans a short period of the EC record a synthetic acidity record was not created for MC1 using EC measurements.

MC1 calculated acidity concentrations were estimated by scaling acidity from Al concentration data using the S23 relationship of *Acidity conc = Al conc / 0.108* (Figure 14). This approach recognises that S23 is the major contributor to MC1 acidity load (as shown in Table 4), as opposed to S6 which is a minor contributor. Figure 15 shows the correlation between MC1 acidity and Al concentration for the limited available measured data (majority of samples collected in 2005) and using the S23 Acidity vs Al relationship (which results in a linear relationship). The correlation between MC1 acidity and Al concentration is strong in both the measured and calculated datasets, with some outliers in the low measured acidity range. These outliers have not been investigated further.

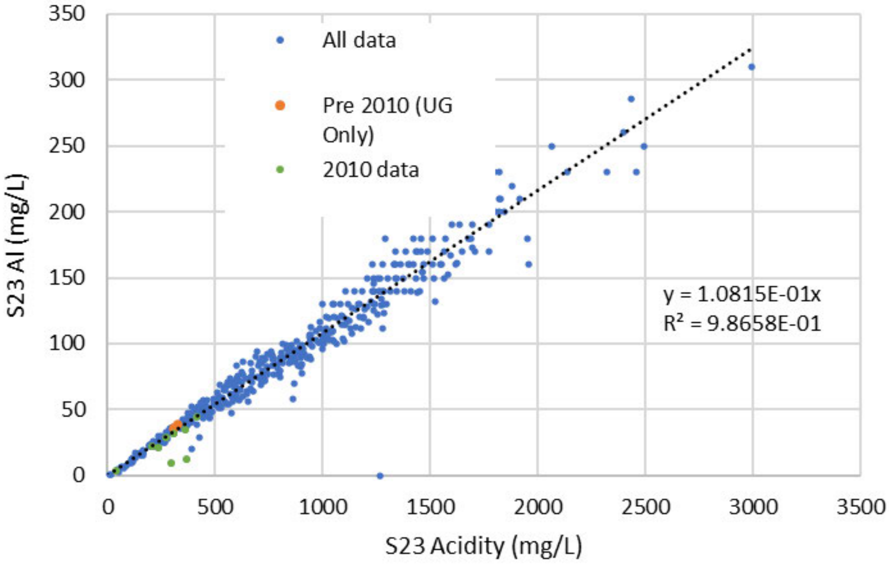

Figure 14. S23 correlation between acidity and Al concentration

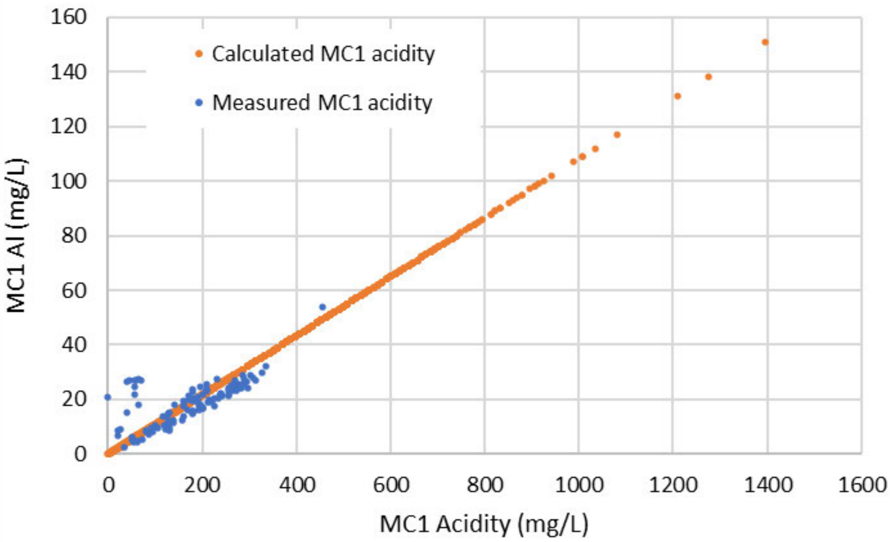

Figure 15. MC1 acidity versus Al correlation

The resulting MC1 water quality monitoring dataset is shown in (Figure 16).

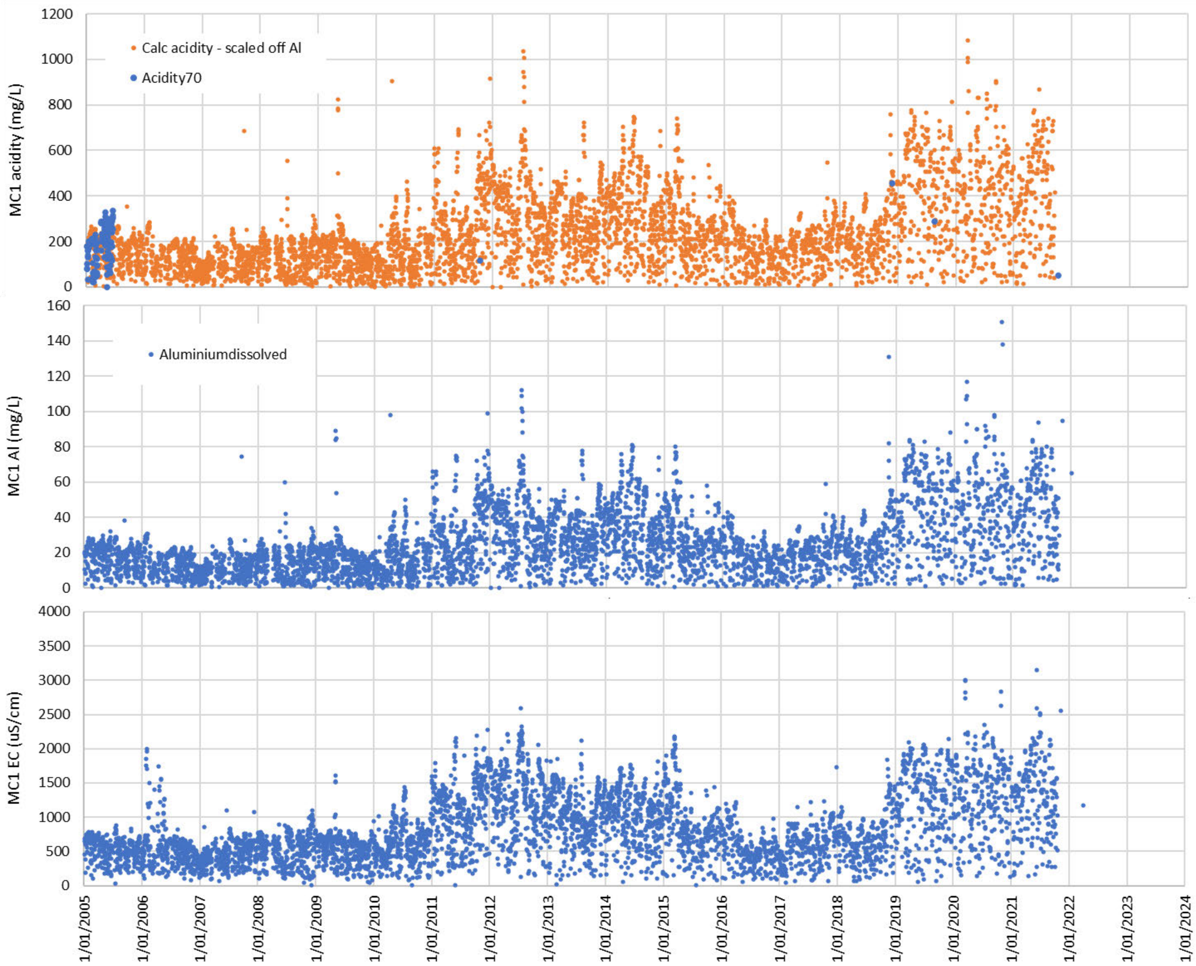

Figure 16. MC1 WQ monitoring dataset

4.1.4 Combined historic annual median concentration values

A summary of annual median acidity concentrations for key sites used in modelling is provided in Table 3.

Table 3. Historic annual median acidity concentration for Millerton Block sites

Year	T1	S25	S24A	S23	S6	MC1*
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
2006		58		302	71	113
2007		47		302	79	103
2008		56		350	76	129
2009		80	339	360	73	139
2010		102	343	374	73	120
2011		103	437	558	95	250
2012		101	496	709	121	310
2013	153	127	495	677	124	277
2014	180	112	508	718	124	305
2015	195	80	386	505	132	240
2016	243	42	243	322	74	157
2017	167	54	293	392	77	176
2018	169	45	372	414	84	203
2019	100	50	673	844	98	444
2020	137	55	649	803	105	407
2021	168	50	684	814	111	391
2022		58	803	843	68	368
2023		54	897	970	121	511
2024		73	1007	1295	136	488
2025		93	1066	1555	74	588

* Values shown in black text calculated from measured MC1 Al concentration data, values shown in red text back calculated from acidity loads.

4.2 Historic load data

4.2.1 Granity, Miller, and Mine acidity loads

Historic annual acidity loads have been extracted from:

- MWM (2025) for the period 2006 to 2009 (black text in Table 4, scaled up for acidity to pH 5 to acidity to pH 7); and
- From continuous flow and EC datasets from ~2010 to present (red text in Table 4).

MWM (2025) estimates of acidity load (2006 to 2009) are largely reliant on estimated acidity concentrations (scaled using conductivity) and concurrent stream flow rate measurements. It is not clear how representative these datasets are of the full range in flows, and loads may be underestimated if high flow conditions are not accurately represented. The effects of long-term climate influences (e.g., La Nina / El Nino) and annual rainfall variability have not been quantified with respect to load trends. Gaps in the S24A and S6 conductivity data sets were filled by scaling S24A and S6 loads proportionally to S23 loads. Additional assessments of pre-opencast underground workings acidity loads are recommended if alternative methods can be developed to incorporate such variability, as loads through this period are important for developing betterment reference values.

Subsequent estimates of acidity load from continuous flow and EC datasets are used from 2010 onwards where records are considered more reliable. The method for estimating acidity loads typically included:

- 2010 to 2020 – Interpolation method, where the instantaneous acidity load was calculated at the time of grab sample collection (by multiplying acidity concentration by flow rate) and loads between sample events was linearly interpolated and summed to give a total annual acidity load; and
- 2011 – 2025 – Regression method, where the correlation between acidity concentration and EC (independently derived for each year) was used to develop a continuous acidity concentration record and combined with the continuous flow record to calculate total annual acidity load.

Annual acidity loads used in modelling are summarised in Table 4. Table 4 shows the variability in acidity load at water monitoring sites over time, particularly S23 and S24A. This includes changes from the:

- Pre-2010 period where historic underground workings caused effects; to the
- Post-2010 period where opencast mining and associated activities (e.g., fire suppression which associated workings draining predominantly to S23 and S24A catchments) also contributed to effects.

Millerton AMD has been pumped to the Mangatini Treatment System sporadically throughout the open cast period (though pumped volumes have been small / negligible in recent years since 2019) and those loads are not included in Table 4. The acidity concentration of AMD used for fire suppression has also varied over time. This makes accurate quantification of the relative contribution of different AMD generating activities (e.g., ELF construction, fire suppression, etc.) and AMD surface types (e.g., pit highwalls, coal floor) difficult during the operational phase. These factors and relative contributions are therefore not included in the AMD model for the Operational Phase.

4.2.2 Twins acidity load estimates

The acidity load reporting to Twins Stream at T1 has been estimated by two methods.

Firstly, using a [redacted] dataset comprising 7 samples with concurrent acidity concentration and flow rate data collected between February and March 2014. These data provide an indicative equivalent annual T1 acidity load in the range of 10 to >40 t/year (Figure 17).

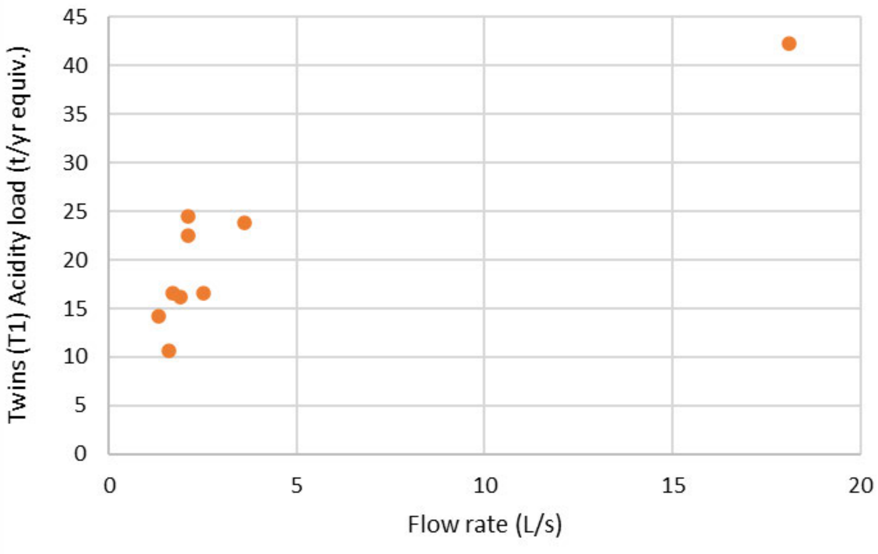

Figure 17. Twins (T1) spot sample acidity load data converted to t/year equivalence

Secondly, there is an estimated 3.62 ha of historic underground workings reporting to T1 currently (2025). Assuming these workings generate AMD at the average Millerton Block underground workings acidity generation rate of 10.6 t/ha/year (as defined in Table 22), the T1 acidity load in 2025 would be equivalent to ~38 t/yr.

There is general agreement between the two T1 acidity load estimates. The T1 acidity load estimate of 38 t/year in 2025 is used for AMD modelling purposes.

4.2.3 Combined annual acidity load

Annual acidity loads used in modelling are summarised in Table 4. MC1 acidity load was estimated by adding S23 and S6 loads together, assuming negligible additional acidity load enters Mine Creek below these sites.

Table 4. Estimated Historic Millerton Block acidity loads.

Year	T1	S25*	S24A*	S23*	S6*	MC1**
	(t/year)	(t/year)	(t/year)	(t/year)	(t/year)	(t/year)
2006		123	2,025	1,821	323	2,143
2007		160	1,858	1,671	297	1,968
2008		172	2,245	2,019	368	2,386
2009		205	1,574	1,635	215	1,850
2010		262	1,994	1,248	317	1,565
2011		200	2,901	2,642	545	3,187
2012		184	3,316	4,238	546	4,784
2013	41	234	2,775	1,713	513	2,226
2014	41	204	2,948	2,766	874	3,640
2015	41	169	2,414	2,591	913	3,504
2016	40	109	1,813	2,208	661	2,869
2017	40	97	1,307	1,911	538	2,449
2018	40	98	1,815	1,928	399	2,327
2019	40	106	3,071	5,583	506	6,089
2020	39	103	2,888	4,304	752	5,056
2021	39	173	4,418	5,927	709	6,636
2022	39	244	5,492	4,813	429	5,242
2023	39	174	4,894	5,841	1,425	7,266
2024	39	181	5,323	6,306	640	6,946
2025	38	506	5,934	8,109	257	8,366

* Values shown in black text quantified by MWM (2025), red text derived from continuous records, ** MC1 load = S23 + S6.

4.3 Acidity load to acidity / Al concentration correlation

4.3.1 Historic acidity load versus acidity concentration correlation

Despite the variability in acidity load between 2006 and 2025 at several Millerton Block sites, there is a correlation between acidity load and median annual acidity concentration at downstream monitoring sites. These catchment specific correlations have been quantified and are combined with modelled post EOML / long term acid load forecasts to estimate downstream acidity concentrations. Correlation development involved plotting the annual acidity load estimates in Table 4 against the median annual acidity concentrations in Table 3.

The annual median acidity concentration, acidity load, and correlation between acidity load and acidity concentration for each site is shown in Figure 18. A linear trendline has been fitted to the acidity load versus acidity concentration plots, with y-axis intercept set to 0. These correlations are used to convert a modelled annual acidity load to a modelled annual median acidity concentration. For example, a modelled S24A acidity load 2,000 t/year is equivalent to an annual median acidity concentration of 350 mg/L. These correlations are used in all three AMD models.

The correlation is generally good (particularly for sites S23 and S24A, which have relatively high acidity loads). This suggests that the magnitude of acidity load discharged from disturbed areas has a proportional effect on downstream median annual acidity concentration, regardless of whether the disturbed area is in an historic underground workings phase or operational phase.

Data for S25 prior to 2015 were excluded from trend fitting as sample counts were low and concentrations appeared to be overestimated.

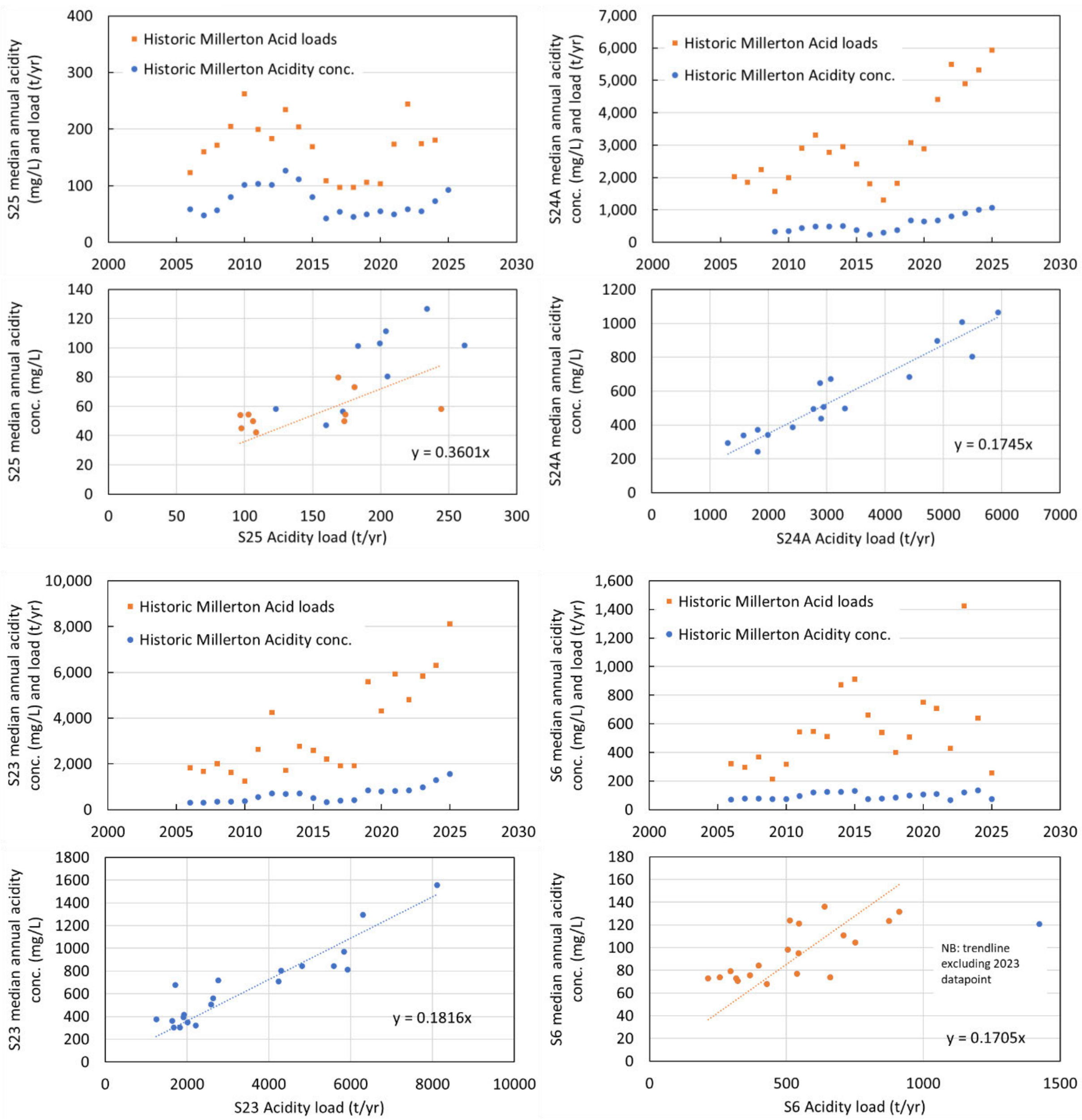

Figure 18. Millerton Block median annual acidity concentration and load; timeseries and correlation plots

The Figure 18 correlations between acidity load and acidity concentration are expected to be specific to each catchment and will be influenced by catchment specific interactions between disturbed and undisturbed areas. These correlations between acidity load and acidity concentration at these sites are assumed to remain constant through the remaining LOM and post closure.

Comprehensive flow rate and acidity load data for Twins Stream (at T1) are not available. As discussed in Section 4.2.2, Twins Stream acidity load was estimated based on the underground workings area (the 2025 area of workings estimated at 3.62 ha and acidity generation rate assumed to be 10.6 t/ha/yr), as shown in Figure 19. This is plotted against the available acidity concentration data (with the trendline forced through 0,0) to develop a correlation for modelling. It should be noted that this trendline fitting is not based on statistics (the annual T1 acidity loads used are estimated based on the area of historic underground workings reporting to T1). The T1 acidity concentration and load are assumed to vary linearly in a similar manner to the other Millerton sites shown in Figure 18.

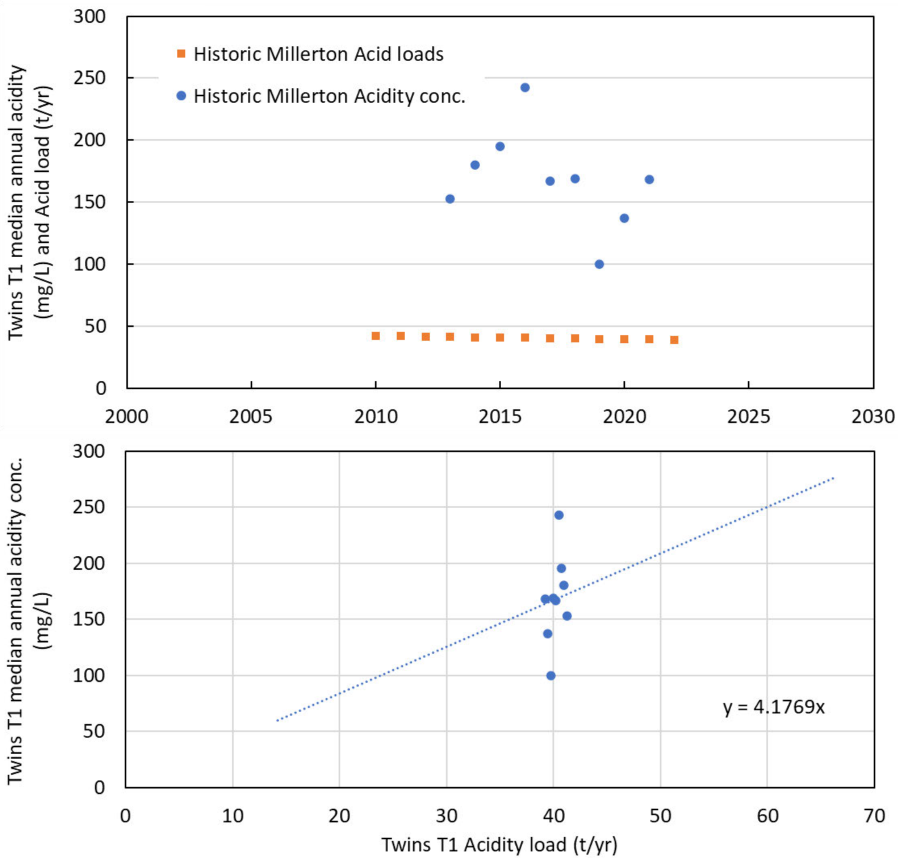

Figure 19. Twins (T1) estimated median annual acidity concentration and load; timeseries and correlation plots

4.3.2 Acidity concentration versus Al concentration correlation

There is a correlation between acidity concentration and Al concentration at all Millerton Block water quality monitoring sites. Site specific correlations (Figure 20) were derived and used to estimate median annual Al concentration based on forecast median annual acidity concentration. Specifically, these correlations are used to convert a modelled acidity concentration to a modelled Al concentration. For example, a modelled S24A annual median acidity concentration of 350 mg/L is equivalent to an annual median Al concentration of 37.5 mg/L. These correlations are used in all three AMD models.

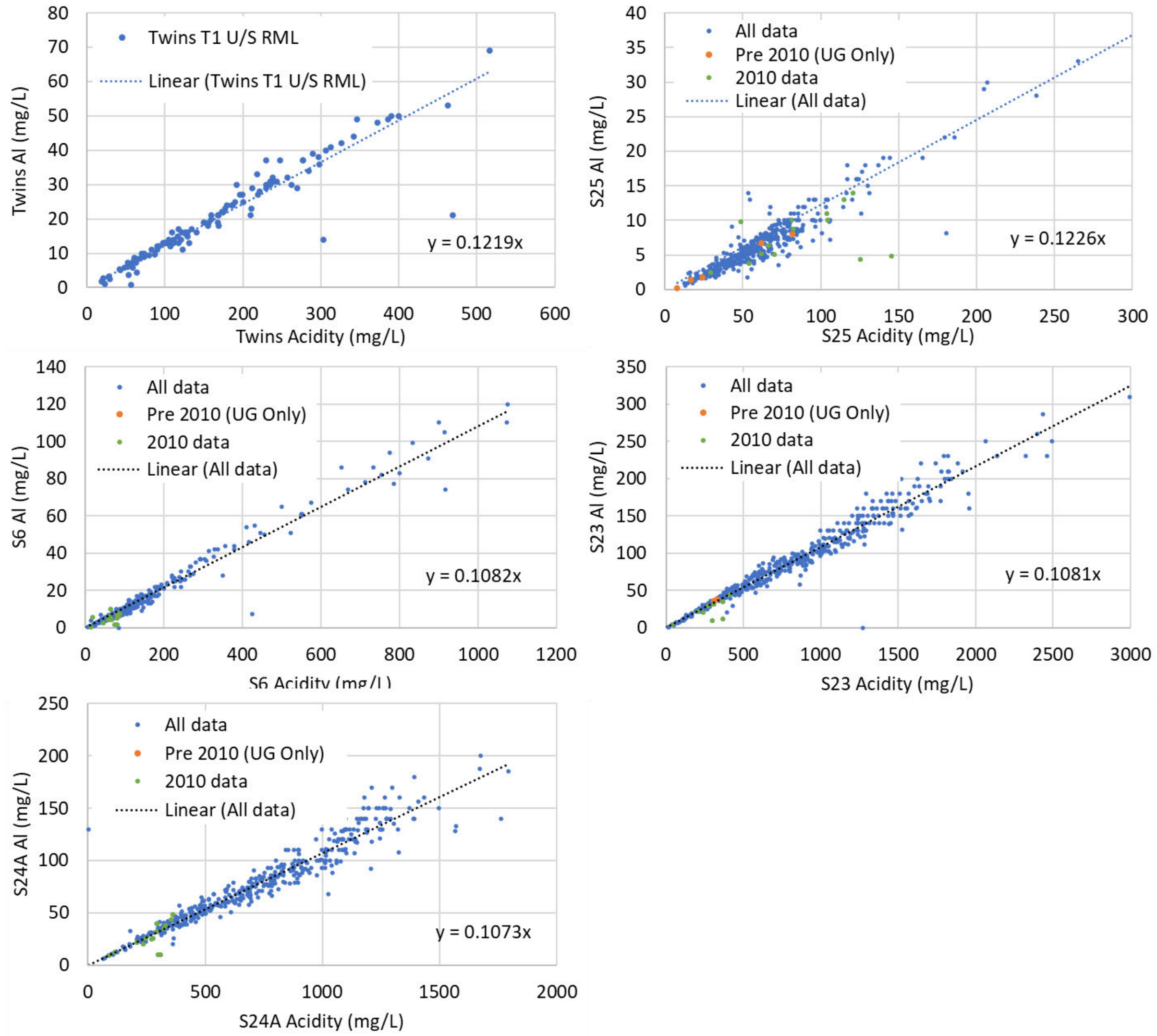

Figure 20. Acidity concentration versus Al concentration correlation

4.3.3 MC1 historic acid load and WQ

As discussed, the long term MC1 water quality records include data for:

- Historic MC1 acid loads, calculated as S23 + S6 (assuming minimal AMD inputs below S23 and S6); and
- Historic MC1 median annual Al concentrations – which are calculated from real data.

Historic MC1 calculated acidity concentrations were estimated by scaling acidity from Al concentration data using the S23 relationship of *Acidity conc. = Al conc. / 0.108* (discussed in Section 4.1.3).

The calculated acidity concentrations were plotted against the theoretical MC1 Acidity load (calculated from S23 + S6) to develop a relationship for calculating acidity concentrations from loads at MC1 (Figure 21).

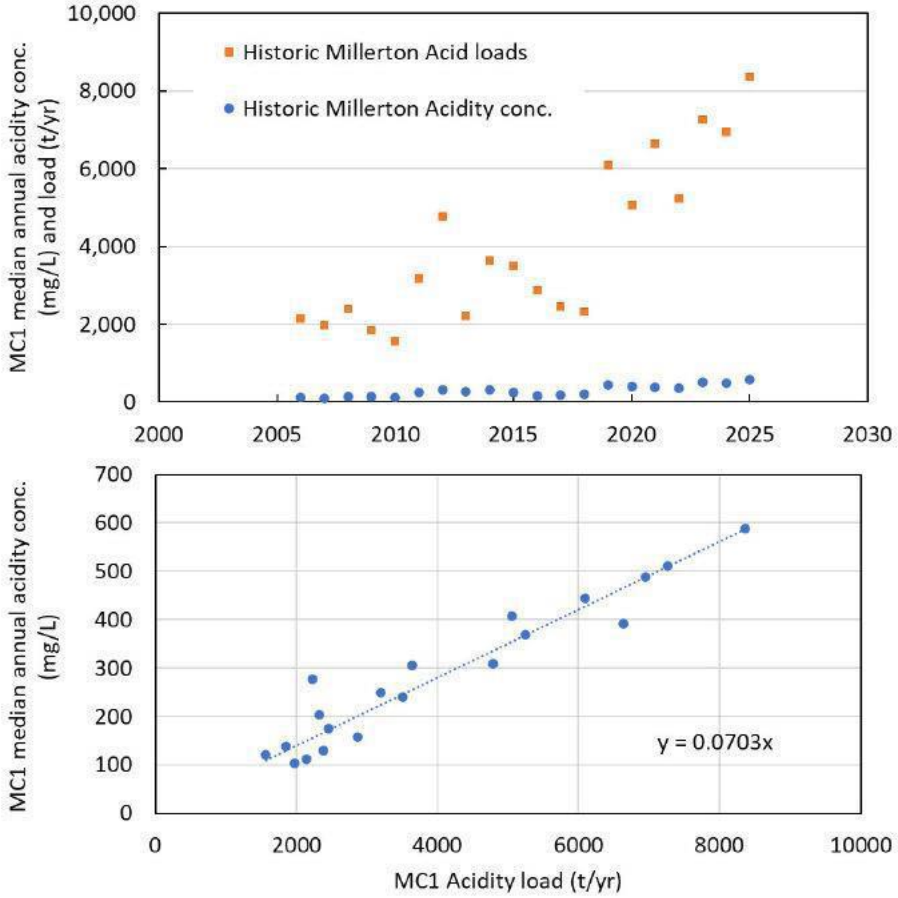

Figure 21. MC1 estimated median annual acidity concentration and load; timeseries and correlation plots. MC1 loads calculated from sum of S23 and S6 annual acidity load.

4.3.4 Combined acidity load to concentration correlations

A summary table of the correlations used to convert acidity loads to concentrations is shown in Table 5. This includes converting:

(1) Modelled annual acidity loads to annual median acidity concentrations; and

(2) Modelled annual median acidity concentrations to annual median Al concentrations.

Table 5. Summary of Acidity load to acidity / Al concentration conversion factors derived in Section 4.3.

Conversion	Unit	T1	S25	S24A	S23	S6	MC1
Acidity load to Acidity conc.	mg/L Acidity per t/year acid load	4.177	0.360	0.175	0.182	0.171	0.070
Acidity conc. to Al conc.	mg/L Al per mg/L acidity	0.126	0.123	0.107	0.108	0.108	0.108

An example of the conversion process is provided below for S24A:

(1) An annual acidity load of 2,000 t/year at S24A equates to an annual median acidity concentration of 350 mg/L; and

(2) The annual median acidity concentration of 350 mg/L equates to an annual median Al concentration of 37.5 mg/L.

4.4 Betterment reference

This section describes derivation of betterment reference values for streams draining the Millerton Block. These betterment reference values are sub-catchment specific and are derived based on estimated acidity loads derived from underground workings in each sub-catchment in 2010 (prior to contemporary opencast mining.

Sub-catchment specific acidity load generation rates were derived for underground workings in each sub-catchment. These acidity generation rates were then used to derive the acidity loads produced by remnant historic underground workings at EOML (2033). The reduction in historic underground workings acidity load is used as an offset in AMD modelling, enabling some acidity load discharge from the contemporary opencast disturbance footprint, while still achieving betterment.

4.4.1 Betterment reference values

Betterment reference values have been provided for key sites to guide long term water and AMD management. The betterment reference values estimate what acidity loads and acidity / Al concentrations could have been if no opencast mining occurred in Millerton Area and the historic underground workings continued to discharge AMD without treatment. The betterment reference values were calculated by:

- Quantifying the pre-opencast (using data collected between 2006-09 / 2010) acidity load at each water quality monitoring site generated by uncontrolled / untreated historic underground workings;
- Forecasting long term acidity load at each water quality monitoring site generated by underground workings (assuming the full 2010 extent remained permanently) with adjustment for acidity load decay at a rate of 0.62%/year to derive time-dependent betterment reference values for acidity loads; and
- Estimating proportional acidity and dissolved Aluminium concentrations at downstream monitoring sites, to derive time-dependent betterment reference values for acidity and Al concentrations.

The 0.62%/year acidity load decay rate has been assumed for underground workings to align with long term decay rates in Stockton Mine engineered landforms (Gandy and Younger 2007). The effect of fire suppression means that accurately quantifying decay rates (using data collected since opencast mining commenced (i.e., post 2010)) for the historic Millerton underground workings has not been attempted, with fluctuations in effects due to fire suppression is likely to mask any long-term decay from the workings themselves.

Forecast future acidity loads and water quality (post EOML) are compared to the betterment reference values to determine AMD management requirements. The betterment reference value calculation is based on acidity load (including decay). Annual median betterment reference values for acidity and Al concentrations are scaled off betterment acidity loads using the correlations derived in section 4.3.

The exception to this calculation process is the S6 betterment reference values for acidity concentration, which are based on measured data. The S6 acidity load : concentration ratio underestimates acidity concentration (shown in Figure 22) during low acidity load conditions. S6 betterment reference values for Al concentration is scaled off acidity concentration.

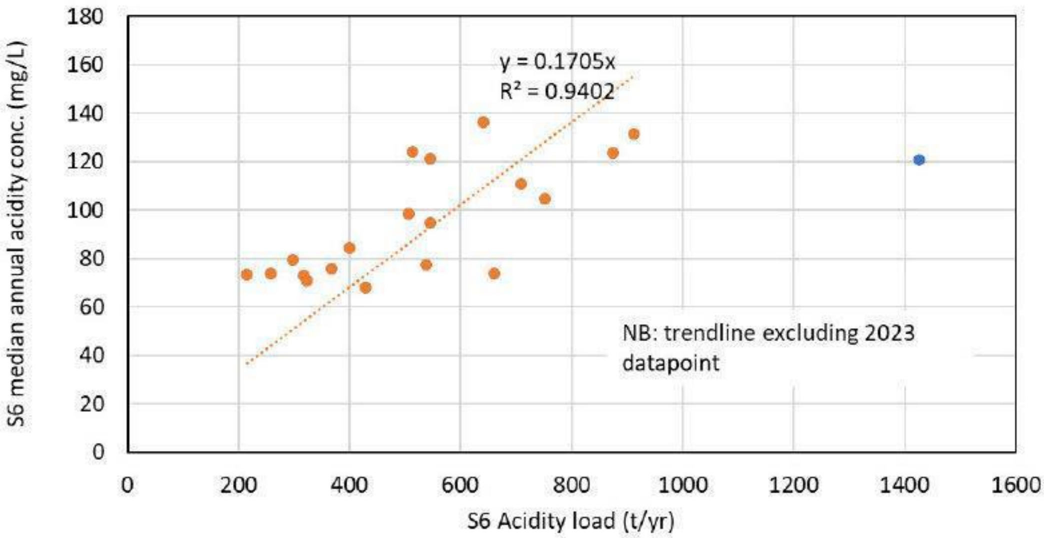

Figure 22. S6 acidity load versus median annual acidity concentration correlation

The betterment reference values for acidity load, acidity and Al concentration for each site are summarised in Table 6.

The area of underground workings in 2010 that report to each sub-catchment has been estimated from digitised historic records. The pre-opencast acidity load for each sub-catchment is derived from Table 4. Sub-catchment specific underground workings acidity generation rates were then derived and align with anecdotal observations that some areas of Millerton Block generate more acidity than others. These are used in AMD modelling (Section 6.3.5) to forecast the residual acidity load generated by remnant underground workings as the pit expands.

Table 6. Site specific betterment reference values: 2006-09 pre opencast

Parameter	Units	Twins (T1)	S25	S24A	S23	S6	*MC1+*
		Pre-opencast (2006–09 / 2010) betterment reference value					
UG Area (2010)	(ha)	3.6	22	125	152	67	*n/a*
UG acid gen. rate (2010)	(t/ha/yr)	11.6	7.6	15.9	11.7	4.5	*n/a*
Acidity load	(t/year)	42	165	1,994	1,786	300	*2,087*

Acidity conc.*	(mg/L)	175	59	348	325	75***	*147*
Al conc.**	(mg/L)	22	7.3	37	35	8.1	*16*

+ MC1 (Lower Mine Creek) load is sum of S23 and S6, * Median annual acidity concentration derived from site specific Acidity load : Al conc. correlation (Table 5), ** Median annual Al concentration derived from site specific Acidity conc. : Al conc. correlation (Table 5). *** S6 acidity betterment reference values based on measured data (not Acidity load : Acidity conc. ratio).

The betterment reference values for annual acidity loads from 2010 were decayed at 0.62%/year for a nominal 80-year period from 2027 onwards (Figure 23). Median annual acidity and Al concentration betterment reference values were also derived using the decayed acidity loads and Table 5 correlations.

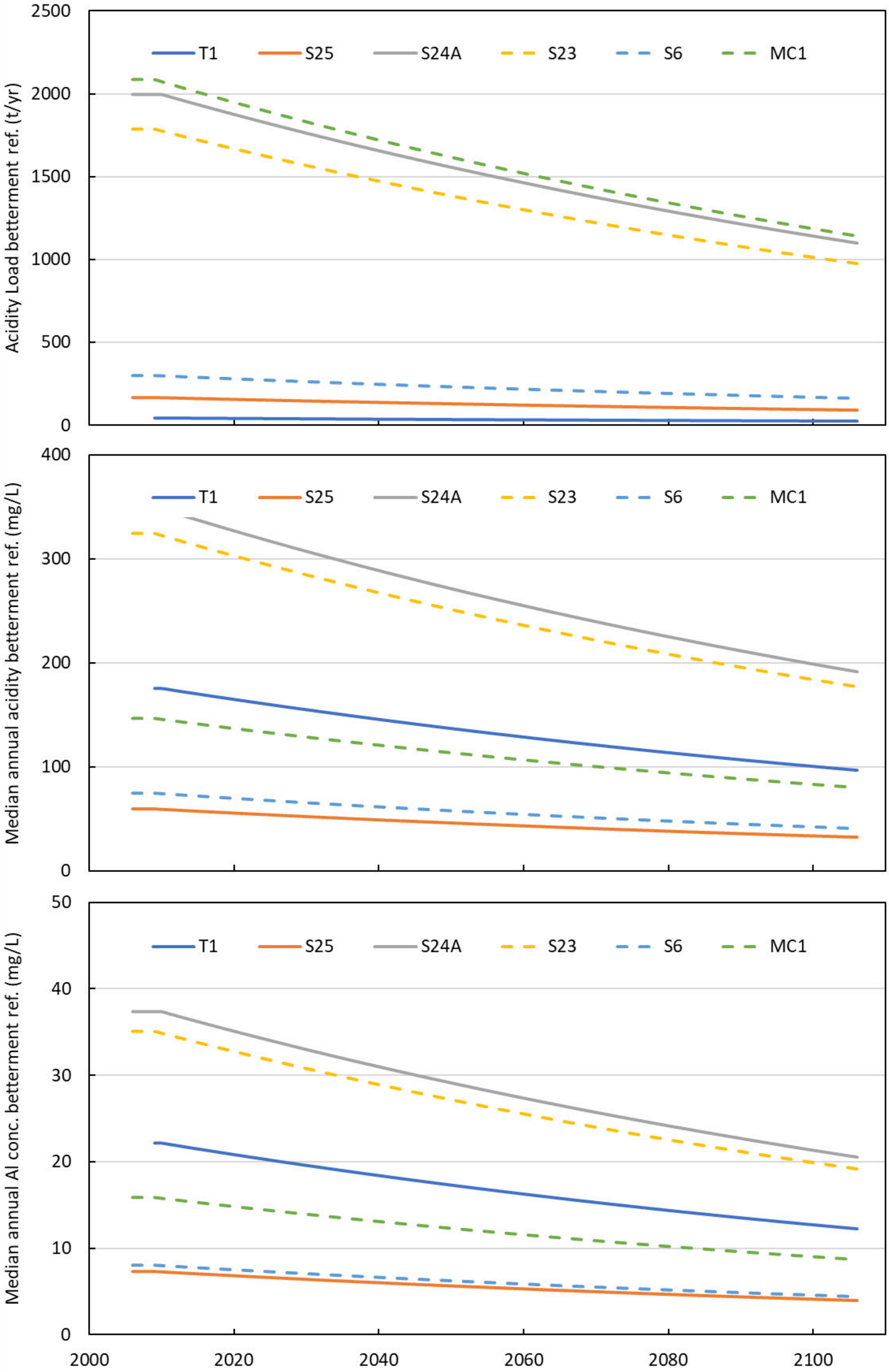

Figure 23. Betterment reference values for acidity load and acidity / Al concentration. MC1 = S23 + S6

4.4.2 Indicative acidity load offset

The betterment reference values derived in Section 4.4.1 have been used to estimate an indicative maximum acidity load offset for each sub-catchment at EOML (2033). This acidity load offset is proportional to the area of workings that are mined out between 2010 and EOML (2033). The 2010 to EOML (2033) time frame was selected because this covers the period of contemporary opencast mining within the Millerton Block. Water and AMD generated within the contemporary opencast disturbance footprint will be managed collectively as part of the BPCP (including any pre-April 2027 BRL and Crown contributions). Table 7 provides:

- Estimates of underground workings acidity loads at 2010 and 2033 excluding the effect of Millerton Block opencast and removal of mined out workings. As the area of underground workings remains constant, the difference in 2010 and 2033 acidity loads is due to the assumed underground workings decay rate (i.e., 0.62%/year); and
- Estimates of underground workings acidity loads at 2033 including the effect of Millerton Block opencast and removal of mined out workings. This estimate incorporates the reduced area of underground workings, sub-catchment specific underground workings acidity load generation rates (Table 6), and long-term decay.

The difference between the sub-catchment specific underground workings acidity load estimates excluding and including Millerton Block opencast is used to quantify a maximum acidity load offset. This acidity load offset is proportional to the maximum acidity load that can be discharged from the opencast disturbance footprint to specific streams draining the Millerton Block without exceeding the betterment reference values.

Table 7. Sub-catchment specific EOML (2033) acidity load offset values, proportional to removal of historic underground workings.

Waterbody (Site)	UG workings acidity load – without Millerton Block opencast			UG workings acidity loads – with Millerton Block opencast		Max. acidity load offset
	Area (ha)	2010 Acid load (t/year)	2033 Acid load (t/year)	Area (ha)	2033 Acid load (t/year)	2033 Acid load (t/year)
Twins (T1)	3.6	38	36	3.3	33	3.2
Granity (S25)	22	165	143	12	80	63
Miller (S24A)	125	1,994	1,728	68	938	791
Mine (S23)	152	1,786	1,548	32	330	1,218
Mine (S6)	67	300	260	67	260	0
*Mine (MC1)**	*219*	*2,087*	*1,809*	*99*	*590*	*1,218*

* MC1 areas and acidity loads calculated from S23 + S6.

It should be noted that the maximum acidity load offset is time variable due to the influence of decay.

The values in Table 7 are described as indicative maximum acidity load offset values as they are not specifically used in the AMD model / calculation process. Rather, the modelling process involved adjusting water and AMD management approaches to ensure 'managed effect' values remained below betterment reference values (described further in Section 6.1) to deliver a greater improvement in water quality.

5.0 Operational Phase AMD modelling

The Operational Phase is described as the period from consent commencement (April 2027) to EOML (2033). As discussed, the Operational Phase AMD modelling is based on extrapolation of the current effects of mining / acidity load trends incorporating scheduled additional disturbance of overburden (including through the 2026 to end March 2027 period) and proposed AMD treatment. The Operational Phase modelling involves two stages:

(1) Acidity load generated by the entire Millerton Block is estimated from 2026 to EOML, including a scenario for load reduction due to proposed treatment; and

(2) An indicative estimate of acidity loads reporting to each sub-catchment is provided based on a series of key scheduling milestones / assumptions. This assessment will be refined through the Annual Work plan processes once activities commence and more detailed stage planning is developed.

The Operational Phase water management is shown in Figure 24.

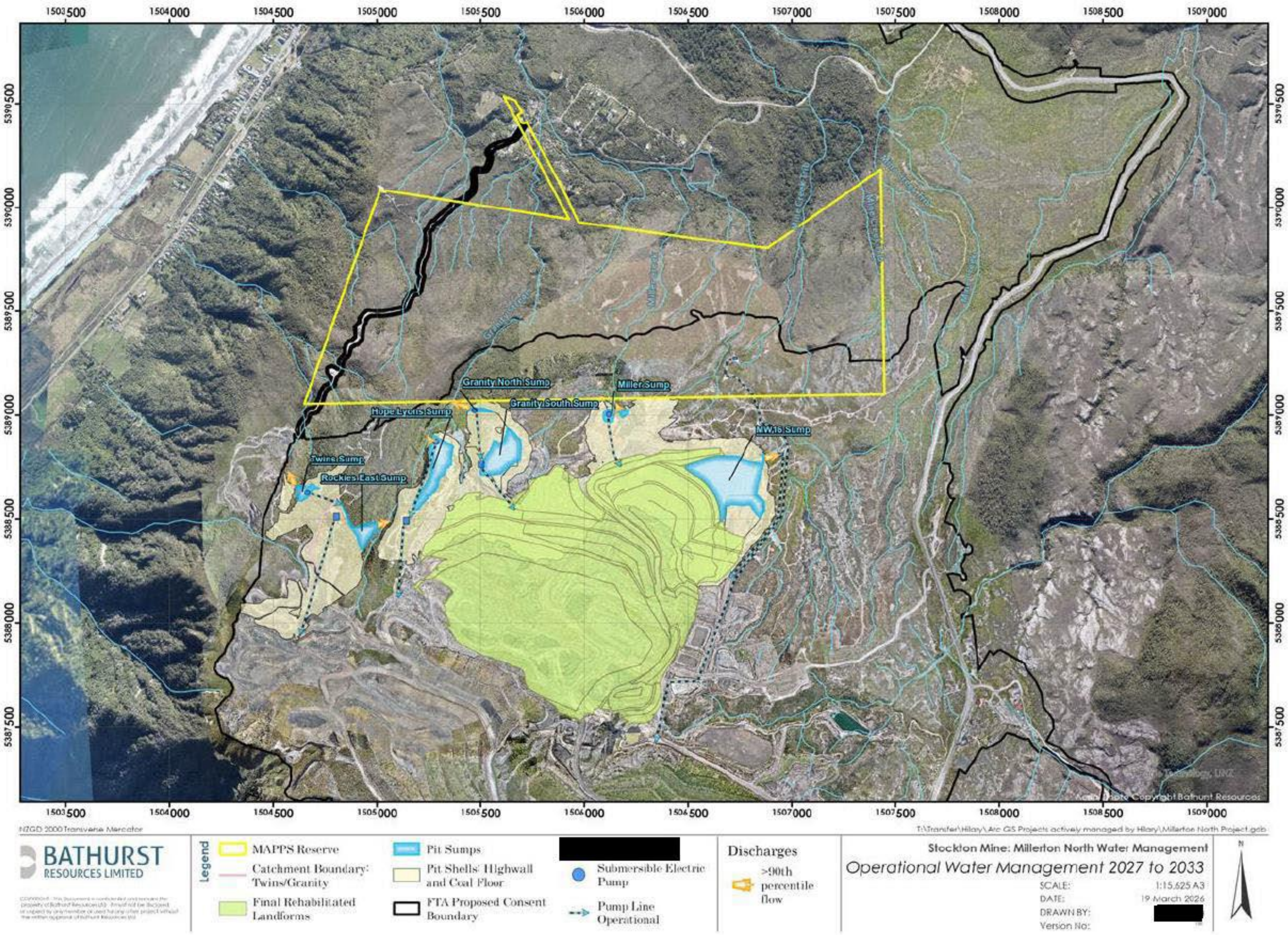

Figure 24. Operational Phase water management

5.1 Millerton Block acidity load

5.1.1 Extrapolation to 'peak' acidity load (2028)

An estimate of overall acidity load generated from the Millerton Block (including cumulative contributions from all sub-catchments (i.e., Twins, Granity, Miller, and Mine)) during the Operational Phase is provided. The overall acidity load estimate over the remaining LOM has been extrapolated from measured 2025 acidity loads using remaining rock volumes in the mining schedule and offset by nominal allocations for Millerton Pit Sump acidity loads to be pumped to the Mangatini Treatment System. These estimated Operational Phase acidity loads are then compared to independently calculated acidity loads for EOML (2033) onwards (derivation described in Section 6.0).

The Millerton Block Operational Phase acidity load extrapolation is based on:

- Trends in the estimated total cumulative annual acidity load reporting to S25, S24A, S23, and S6 sites in historic datasets; and
- Extrapolation of recent increasing acidity load trends since 2019, which show acidity loads increasing at a rate equivalent to 0.25 t extra acidity load per kbcm of additional Millerton Block disturbance (Table 8). This is calculated based on:
    - An increase in Total Millerton acidity load of 5,541 t/year (from 9,266 t/year in 2019 to 14,807 t/year in 2025); and
    - Cumulative new disturbance of Millerton / Rockies rock through this period of 22,560 kbcm.

The theoretical extrapolated Millerton Block acidity load for each year over the remaining LOM is summarised in Table 8. It should be noted that this acidity load includes all the associated effects of mining, including fire suppression.

Fire suppression is expected to cease in 2028 and cause a significant reduction in acidity load in receiving sub-catchments (discussed in Section 5.1.3.1). This is due to two key factors:

(1) Fire suppression water is currently sourced from Millerton Pit sumps and is AMD. Using this water for fire suppression effectively transfers pit sump acidity loads to underground workings acidity loads. As fire suppression decreases, the AMD collected in Millerton Pit sumps will increasingly be sent to the Mangatini Treatment System as opposed to being pumped into underground workings (for fire suppression) and ultimately reporting to streams draining Millerton Block.

(2) Fire suppression will currently be flushing secondary products of acid generation from adits, drives, waste, and fractured rock underground. This process will further increase acidity loads from the historic underground workings as the additional volume of water flowing through the workings will be increasing this flushing effect.

While new disturbance does occur in years 2029 and onwards, the effect of stopping fire suppression and increasing overall Millerton AMD treatment is expected to be greater than the effect of the new disturbance of relatively small rock volumes from 2029 onwards.

Table 8. Total Millerton assumed additional acidity load over remaining LOM

Year	New disturbance volume (kbcm/yr)	Extrapolated additional acid load (t/yr)	Extrapolated Total Millerton Block acid load (t/yr)
2019	-	-	9,266
2025	-	-	14,807*
2026	4,657	1,144	15,951
2027	4,347	1,068	17,019
2028	4,405	1,082	**18,101****
2029	2,406		***
2030	1,015		***
2031	486		***
2032	118		***
2033 (EOML)	0		***

* 2025 total Millerton acidity load value of 14,807 t/year used to goal seek the new disturbance rate of 0.25 t extra acidity load per kbcm of new disturbance relative to 2019 acidity loads. ** Maximum expected Millerton acid load as fire suppression ceases in 2028. NB: red values are scheduled new disturbance or extrapolated acidity loads. *** Expected Post-2028 acidity loads estimated later in this section (i.e., Post cessation of fire suppression).

It should be noted that the BPCP component of additional rock disturbance scheduled from April 2027 to the peak load occurring in 2028 is ~ 7,676 kbcm (calculated Table 1). The BPCP contribution to the 2028 acidity load would theoretically equate to ~1,919 t/year, approximately 10% of the forecasted 18,101 t/year peak load in 2028. Thus, the additional BPCP contribution to Millerton Block acidity load is relatively minor.

Forecast Millerton Block acidity loads post 2028 are derived later in this section and incorporate the effects of acidity load decline observed in Mangatini Catchment.

5.1.2 Transition to EOML load (2033)

The resulting extrapolated total Millerton Block acidity load (to 2028) is compared to the independently calculated Millerton Block forecast EOML acid load, which includes the loads reporting to Twins, Granity, Miller, and Mine sub-catchments. The separate EOML AMD modelling methodology is described in Section 6.0.

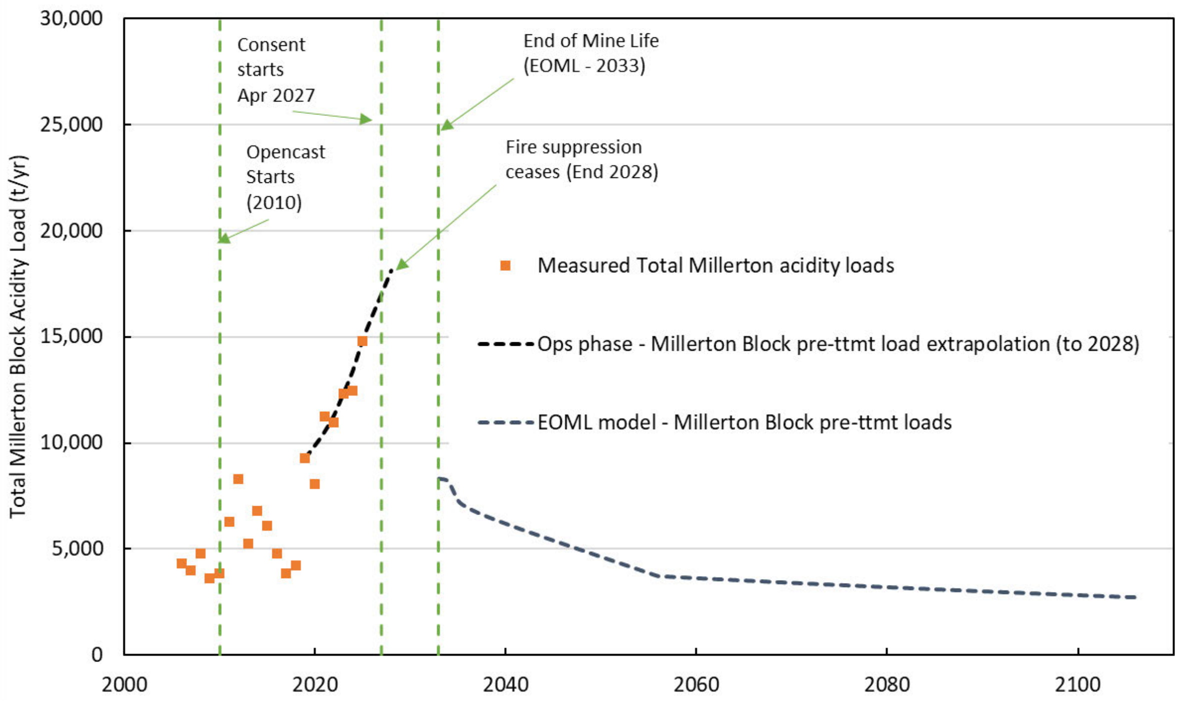

Figure 25. Historic and extrapolated Millerton Block acidity load over remaining LOM and forecast EOML onwards

Figure 25 shows there is a significant difference between:

- The peak extrapolated 2028 total Millerton Block acidity load (~18,100 t/year), after which fire suppression ceases and new disturbance decreases significantly; and
- The independently forecast EOML (2033) total Millerton acidity load (~8,300 t/year).

This reduction in the pre-treatment Millerton Block acidity load (from the extrapolated maximum in 2028 to EOML (2033) or shortly thereafter) is expected due to a combination of:

- Significant reduction in fire suppression activities (anticipated 2028) and associated reduction in flow rates through workings and therefore acidity loads flushed from workings;
- Effects of ELF construction techniques, i.e., incorporating 2 – 5 m lift heights;
- Transition from active construction angle of repose tiphead surfaces to final landform surfaces;
- Ceasing of new disturbance / continual exposure of fresh highwall and coal floor surfaces;
- Transition from a continuously disturbed active mine to a final landform (prior to rehabilitation) towards EOML; and
- The initial effects of any progressive rehabilitation and encapsulation of PAF materials with the NAF cap completed prior to 2033.

In addition, the forecast EOML acidity loads are based on the ‘treatable (concept described in Section 2.5)’ component of Millerton ELF acidity loads (which equate to 75% of the total acidity load from that structure), whereas the extrapolated Operational Phase acidity loads are based on measured / total acidity loads, which includes the high flow (>90th percentile) component that would spill from sumps without AMD treatment.

It is expected that the total Millerton Block acidity load will transition from the active mining / Operational Phase peak levels (2028 - ~18,100 t/year) to the rehabilitation / EOML Phase levels in a similar pattern to what has been observed in Mangatini catchment. To quantify this transition MGIU acidity loads were calculated by developing an acidity (to pH 7) correlation / regression with flow rate (Figure 26 – data fitted with a power trendline) and then using the flow rate record to develop a continuous acidity concentration record. The acidity loads were then calculated from these two datasets (i.e., continuous acidity concentration and flow rate).

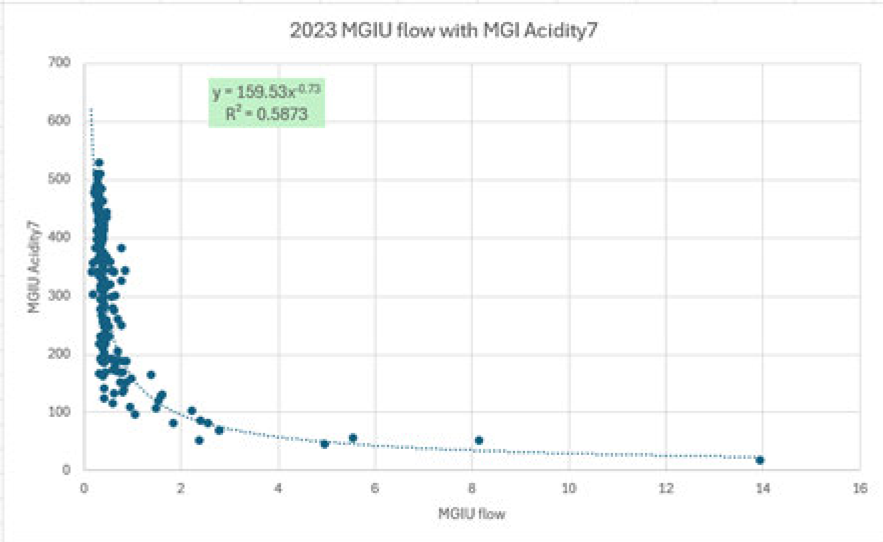

Figure 26. MGIU 2023 acidity concentration and flow rate regression

The untreated acidity concentration and load for Mangatini Catchment (as measured at site MGIU) has decayed as shown in Figure 27 datasets. Through this period active mining decreased and rehabilitation / revegetation increased. Fitting an exponential trendline to these datasets shows a decay rate of median annual MGIU acidity concentration and annual acidity load of 10.2 and 12.6 %/year, respectively.

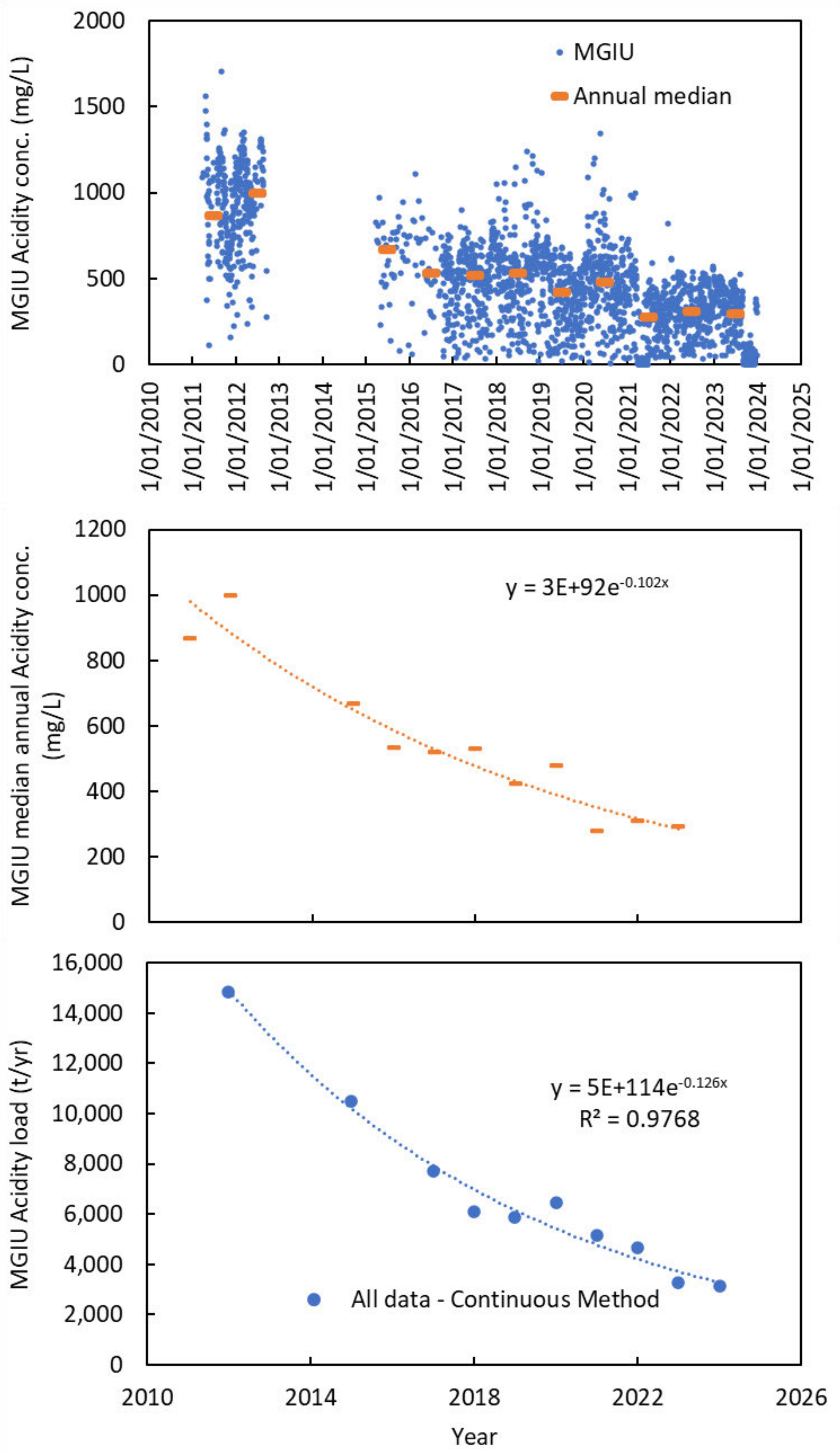

Figure 27. Long-term MGIU acidity concentration trends and annual acidity load decay.

Applying the 12.6 %/year acidity load decay rate to the estimated 2028 Millerton acidity load of ~18,100 t/year suggests that if Millerton acidity loads followed the Mangatini trend, a 2028 acidity load of ~18,100 t/year would decay to ~5,100 t/year by 2038, over a nominal 10-year period (Figure 28 and annual pre-treatment acidity loads summarised in Table 12). That decayed load is lower than the EOML AMD model estimated 2038 acidity load of ~6,500 t/yr. Thus, the Mangatini analogue does suggest a transition of the magnitude from extrapolated 2028 acidity loads to the long term EOML model acidity loads is possible. The Mangatini analogue also suggests that there is general agreement between the independently calculated:

- Extrapolated Operational Phase acidity loads (modelling described in this section, using 'total' measured acidity loads); and
- EOML modelled acidity loads (modelling described in section 6.0, using 'treatable' acidity loads).

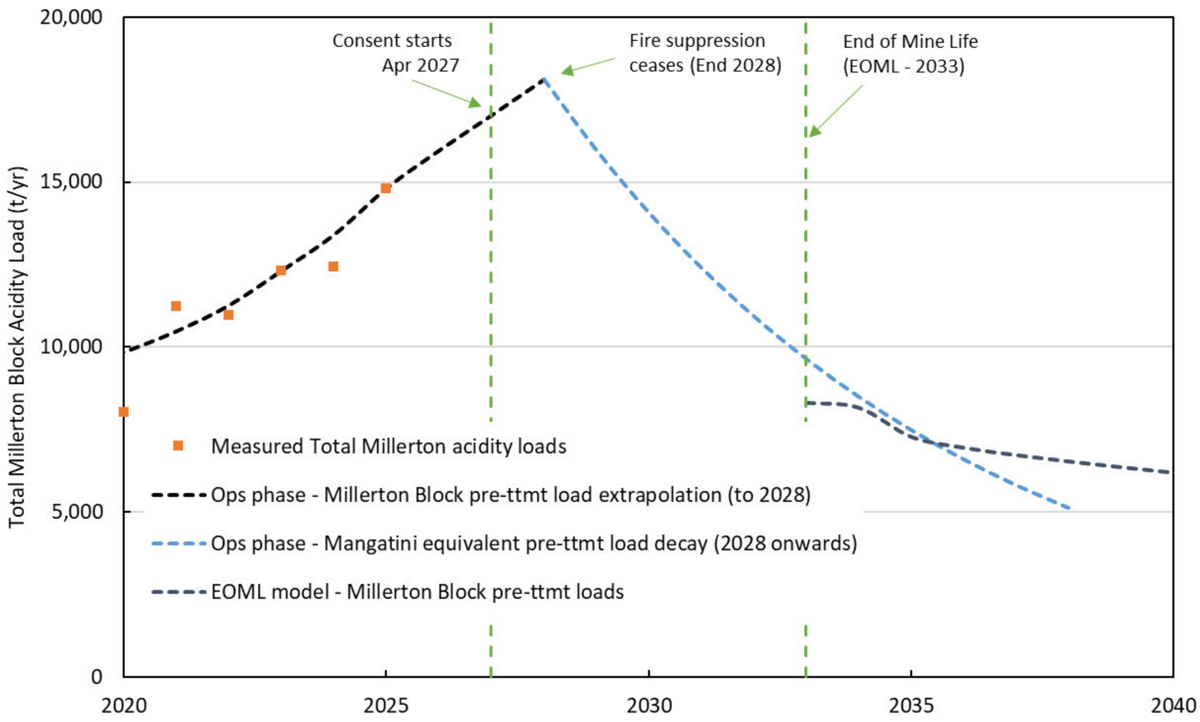

Figure 28. Modelled Millerton Block acidity load incorporating Mangatini equivalent acidity load decay trajectory (2028 to 2038)

The Mangatini equivalent acidity load decay trajectory is also plotted in Figure 29 over the full simulation period (to year 2106).

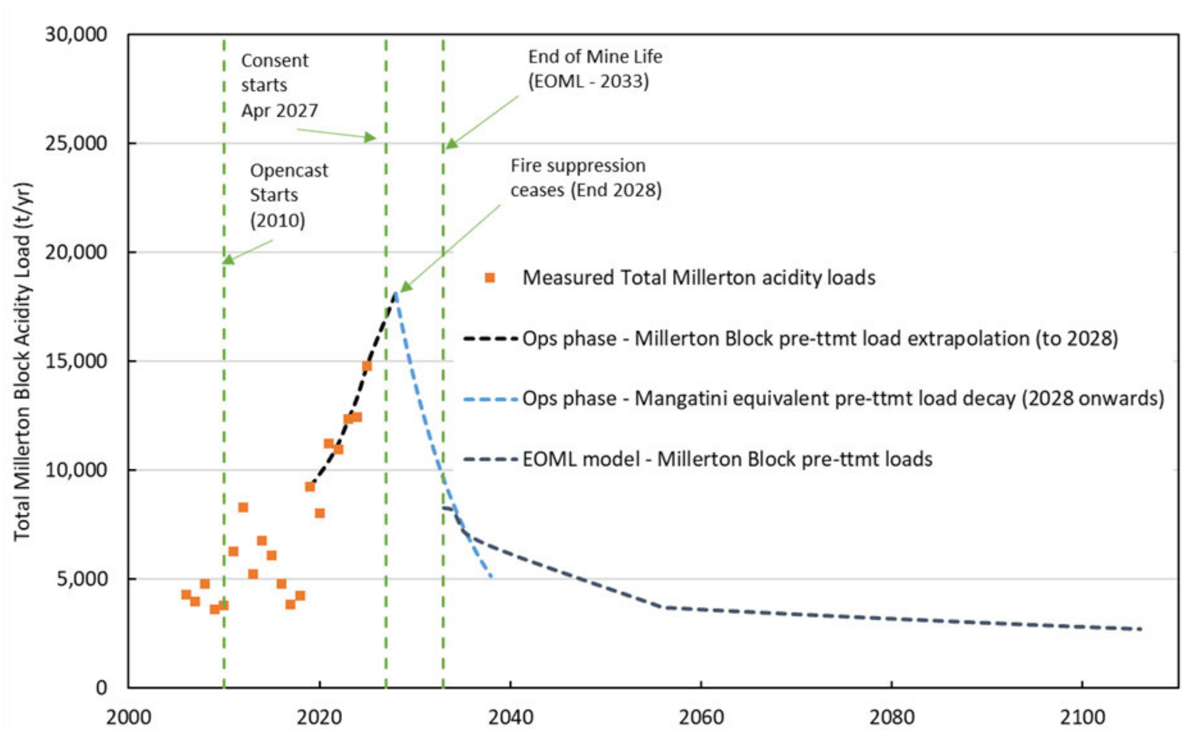

Figure 29. Historic and extrapolated Millerton Load over remaining LOM and Mangatini equivalent acidity load decay trajectory (2028 onwards)

The Mangatini concentration decay analogue supports this transition without requiring the development of a complex model incorporating the effects of decay in multiple different AMD sources (e.g., fire suppression, transition from continual disturbance / active pit to final landform, etc.). As such, this complexity has been omitted from the AMD model.

5.1.3 Acidity load for treatment

Nominal estimates of acid load pumped from Millerton Pit Sumps to the Mangatini Treatment System have been made for forecasting lime and LDS management requirements. These loads are based on calculated acidity loads pumped into underground workings in the S23 tributary for fire suppression. These acidity loads are partially captured via the Syncline and DCA stopping and transferred via the existing pumping system to the Mangatini Treatment System until fire suppression ceases / the Syncline area is mined out and replaced by Mine Pit sumps / MW16 Sump.

The Millerton DCA was constructed during historic underground mining to drain a naturally forming syncline in the coal floor (Figure 30). The flows collected at the Syncline and discharged through the DCA are assumed to represent the combined flows from the S23 component of underground workings that will be removed as the Mine Pit progresses through the Syncline over the remaining LOM. Electric centrifugal pumps at the DCA stopping will manage underground water reporting through from the syncline as required through the Operational Phase. An increase in the transfer of AMD (including fire suppression water) from the DCA stopping to the Mangatini Treatment System from 2026 to 2028 will be used to improve Mine Creek water quality.

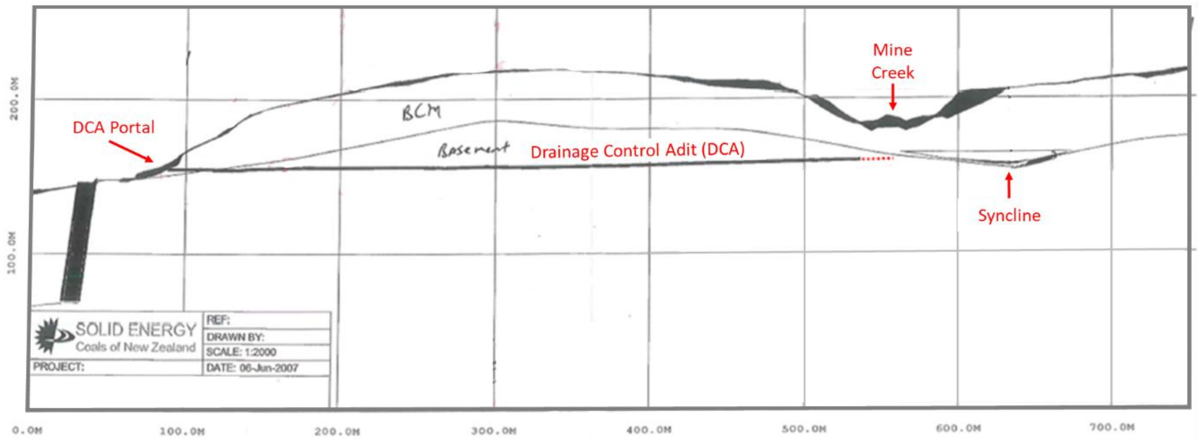

Figure 30. Long section through Millerton Syncline and Drainage Control Adit (modified from original).

5.1.3.1 Fire Suppression acidity load

Remnant fires continue to burn coal from the historic underground workings in several areas and have done so for many decades (Crown liability). AMD impacted water from the Millerton main pit sump is pumped into the workings (to cool or extinguish fires) for fire suppression. Fire suppression currently consumes most of the mine affected water captured in Millerton pit sumps to treat or extinguish the underground mine fires, when required.

Operational fire suppression is expected to be completed by the end of 2028 as fires in the mining pit areas are cooled and mined out. Prior to opencast mining in the Millerton block there were 12 historic fires burning underground (Crown liability). It is expected that there will be only 1 or 2 fires remaining at EOML located outside of the opencast disturbance footprint, as discussed in Section 6.3.5 and shown in Figure 39. These fires will continue to burn in areas outside of the pit area and may need cooling as required. Through the Operational Phase the water source for fire suppression will predominately continue to be pit water supplemented by Duncan's Sump or the DCA as required.

In recent years (since 2021) fire suppression water has been sourced from Millerton Pit Sumps and has acidity concentrations varying between ~1,000 and ~2,500 mg/L (Figure 31). The acidity data shown as the red series were fitted with a polynomial trendline to approximate concentration fluctuations over time. These acidity concentrations were multiplied by monthly average fire suppression pump flow rates (Figure 31) to estimate the acidity load pumped into underground workings to control the historic fires.

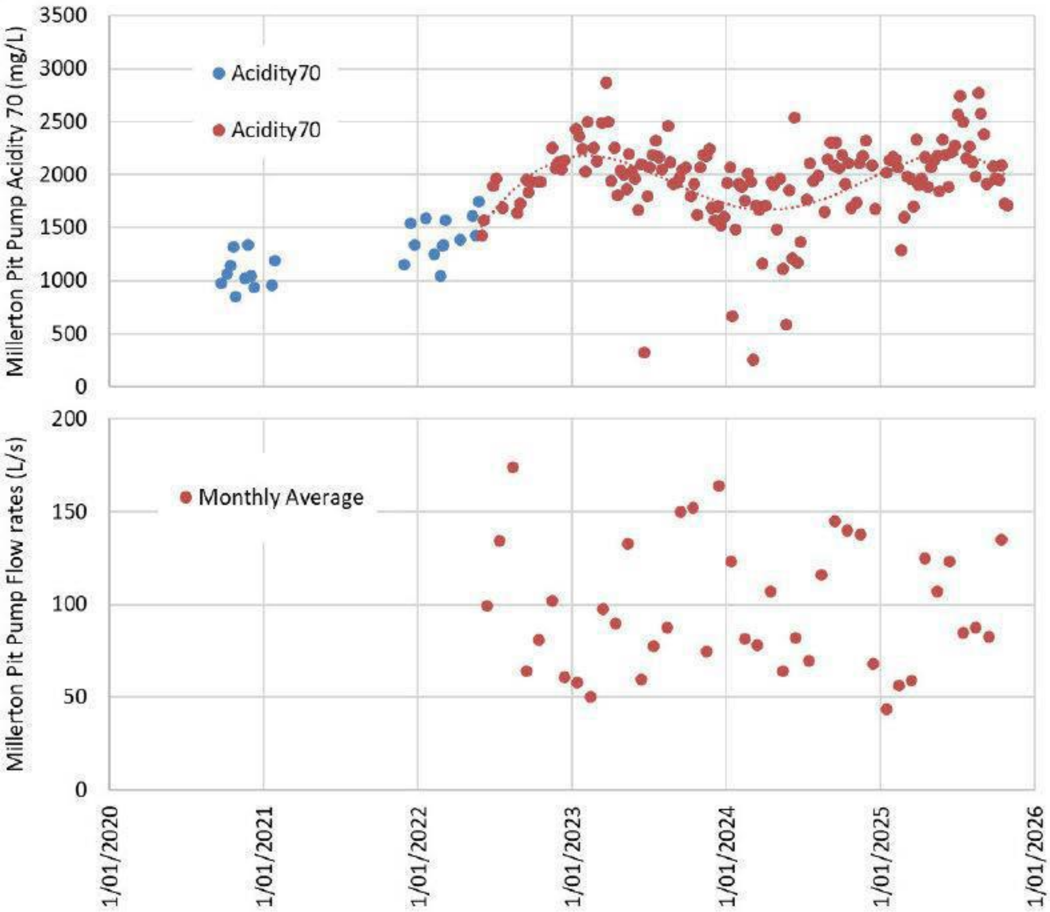

Figure 31. Millerton Pit Pump acidity concentration and fire suppression pump flow rate. Acidity70 = Titrated acidity to pH 7.

Estimates of annual acidity load (reporting to pit sumps) and pumped into the underground workings for fire suppression are summarized in Table 9, and have been equivalent to ~6,000 t/year for the past four years. Fire suppression water is predominantly pumped into underground workings that report to the S23 tributary of Mine Creek and Miller Stream (S24A), with an estimated split of 60% (or ~3,600 t/year) to S23 workings and 40% (or ~2,400 t/year) to S24A workings.

Table 9. Millerton Pit Sump fire suppression acidity load pumped into underground workings

Year	Pro-rata annual acid load (t/yr)
2022	5,998
2023	6,092
2024	5,565
2025	5,981

It is expected that an additional acidity load is generated by pumping water into underground workings, as the additional flow mobilises 'flushes' additional acidity load from the workings. A mass balance on the average S23 and S24A acidity loads between 2022-2025 (Table 10) shows that there is an unquantified contribution to acidity load at both sites. This imbalance suggests that cumulatively up to ~3,000 t/year of additional acidity load might currently be flushed from underground workings due to the extra fire suppression flow volumes. This is likely to be caused by gradual weathering of rocks in the underground mine / collapsed strata and flushing of stored acidity during the process of extinguishing the fires.

Table 10. Unquantified acidity load mass balance for 2025 at S23 and S24A

AMD component	Unit	S23	S24A
Total (Ave 2022-25)	**(t/year)**	**6,267**	**5,411**
Pumped Fire sup. water	(t/year)	3,600	2,400
UG load (2025)	(t/year)	981	1,399
Unquantified (including flushing from workings)	*(t/year)*	*1,686*	*1,612*

The effect of this up to ~3,000 t/year contribution to acidity load has not been incorporated into AMD modelling as there may be other potential causes / contributors to the unquantified load. It is therefore possible that the AMD modelling may be underestimating the reduction in acidity load that will occur once fire suppression ceases. However, there may be other factors contributing to the ~3,000 t/year acidity load imbalance in Table 10, including:

- Unknown / unquantified AMD generation sources / processes; or
- Inaccuracies / variability in the acidity concentration, flow rate, and acidity load datasets used in calculations.

However, as shown in Figure 28, there is already general agreement between the independently modelled Operational Phase and EOML / Closure Phase acidity loads, without factoring in any further load reduction due to the fire suppression flushing effect.

5.1.3.2 Nominal Operational Phase acidity load for treatment

Nominal estimates of Operational Phase acidity load pumped from Millerton Pit Sumps to the Mangatini Treatment System have been made for forecasting lime (CaO) and LDS management requirements. These nominal loads use the ~6,000 t/year Millerton Pit sump acidity load estimate from Table 9 as the basis for the 2026 load. It should be noted that actual acidity loads sent for treatment through 2026 – 2028 will depend on the amount of pit sump water needed for fire suppression and potential AMD transfer rates from the Syncline (that can be captured and pumped to the Mangatini Treatment System).

As discussed, the 'treatable' acidity load is defined as the proportion of acidity load in flows up to the 90th percentile and equates to 75% of the total acidity load. The acidity loads in Table 11 that are captured in sumps and pumped for treatment are equivalent to 'treatable' acidity loads. The effect of removing these 'treatable' acidity loads from these pit sumps will be greater than a proportional decrease in remnant acidity load, as it equates to a high degree of AMD capture for treatment at low to moderate flow conditions. This may lead to overestimation of the downstream annual median and 75th percentile acidity and Al concentration, as during these flow conditions there will be a high degree of AMD capture / treatment occurring for AMD derived from within the Opencast disturbance footprint. During these periods downstream water quality is likely to be more dependent on the effect of remnant historic underground workings discharges as the major remaining AMD source.

For modelling the effect of AMD pumping to the Mangatini Treatment System through the Operational Phase, the treated acidity loads are converted to equivalent 'Total' acidity loads (by dividing by 0.75) to calculate remnant loads in the receiving catchments. This conversion is an approximation to fit with the structure of the AMD model used for this assessment. More accurately modelling this effect is likely to require a more complex model (e.g., daily time step, development of flow rate dependent water quality source terms, etc.). It is recommended that adaptive management and performance monitoring are used to manage these effects operationally.

Table 11. Nominal estimates of Millerton Pit Sump acid loads pumped to the Mangatini Treatment System

Year	Nominal Millerton Pit acid load treated (t/year)	Equivalent 'Total' acidity load reduction in catchment (t/year)
2026*	6,000 (3,000**)	4,000
2027*	7,000 (5,000**)	6,667
2028*	7,500	10,000
2029	8,000	10,667
2030	7,500	10,000
2031	7,000	9,333
2032	6,000	8,000

* Treated 2026 – 2028 loads expected to depend on fire suppression requirements and potential transfer rates for treatment. The 6,000 t/year starting value for 2026 is based on the estimate of Millerton Pit Sump acidity load currently pumped into underground workings for fire suppression. ** Lower estimates of treated acidity loads were used for AMD modelling in 2026 and 2027 (to be conservative) to account for the potential for a greater fire suppression water demand or less fire suppression water transfer for treatment.

The remnant untreated acidity loads discharging from the Millerton Block have been calculated for the operational and EOML phases, as described below:

- Operations phase – deducting the Table 11 'Equivalent 'Total' acidity load reduction in catchment' from the '*Ops phase*' pre-treatment acidity load estimates for a given year. For calculation purposes the 2026 and 2027 Millerton Pit Sump equivalent 'Total' acidity load reduction was conservatively assumed to be 4,000 and 6,667 t/year to allow for a greater fire suppression demand / less fire suppression water capture and transfer for treatment. Operational Phase remnant acidity load sources include untreated AMD from disturbed areas (i.e., loads not pumped to the Mangatini

Treatment System varying from 20% to 60% of the 'total' load depending on year) and ongoing AMD discharges through historic underground workings; and

- EOML phase – Calculating the cumulative untreated AMD discharged from Millerton Block (derived using modelling process in Section 6.0) across all sub-catchments, including Millerton ELF, coal floor / highwall, and remnant underground workings contributions. EOML Phase remnant acidity load sources include the untreated acidity load bypassing MW16 Sump (equivalent to ~20% of the treatable acidity load), ongoing AMD discharges through historic underground workings, and minor contributions from rehabilitated highwall / coal floor areas.

The resulting estimate of Millerton Block acidity loads discharged through the Operational and EOML Phases are shown in Figure 32. This forecast shows an overall decrease (relative to 2025 levels) in remnant untreated load discharging the Millerton Block from 2026 onwards (represented by the *'Ops phase – Millerton Block remnant untreated loads'* series).

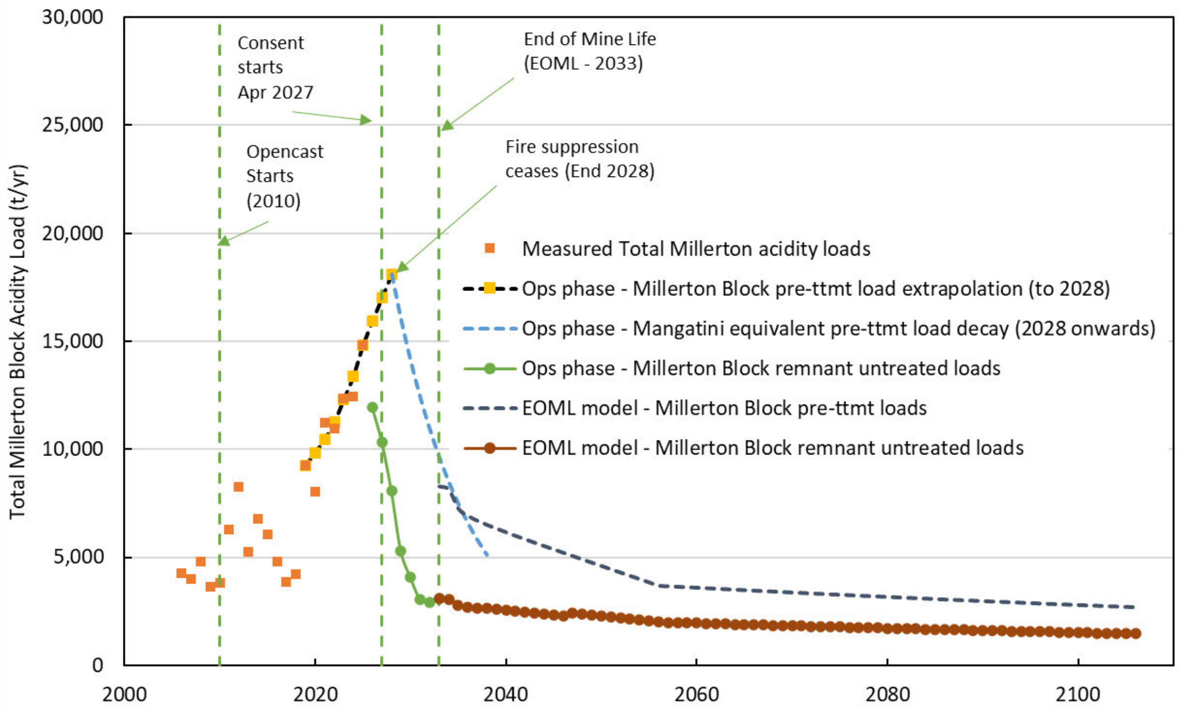

Figure 32. Historic and extrapolated Millerton Block acidity load over remaining Operational and EOML phases and remnant untreated loads.

The forecast pre-treatment and remnant untreated acidity load discharged from the Millerton Block is summarised in Table 12.

Table 12. Forecast Millerton Block Operational Phase pre-treatment and remnant untreated acidity load

Year	Pre-treatment acidity load (t/year)	Remnant untreated acidity load (t/year)
2025	14,807	14,807
2026*	15,951	11,951
2027*	17,019	10,352
2028*	18,101	8,101
2029	15,958	5,291
2030	14,069	4,069
2031	12,403	3,070
2032	10,935	2,935
2033	8,299	3,105

* Treated 2026 – 2028 loads expected to depend on fire suppression requirements and potential transfer rates for treatment.

The estimated Millerton Block acidity loads shown in Figure 32 are specific to the modelling assumptions described. The load trajectories could change due to factors, including:

- Changes to Mine Plans, increasing or decreasing the volume or timing of material disturbance and subsequent acidity load peaks and decay;
- Changes to key catchment cut-off dates affecting Miller Stream (S24A) and Mine Creek (S6) acidity loads;
- Changes to fire suppression cessation timeframes;
- Changes to acidity loads pumped to the Mangatini Treatment System; and
- The effect of removing the 'treatable' component of acidity load on remnant 'total' acidity loads is different from modelling assumptions.

While these modelled outcomes are sensitive to changes in these factors (and will be adaptively managed as described in Section 8.6), the significant increase in Millerton AMD treatment during the Operational Phase coinciding with fire suppression requirements decreasing and new disturbance decreasing is expected to lead to a reduction in remnant / untreated AMD discharging Millerton Block over the remaining LOM, relative to current (2025) levels.

5.2 Sub-catchment acidity load

A further estimate of acidity loads reporting to each sub-catchment through the Operational Phase has been developed to show the effects of proposed water and AMD management.

5.2.1 Operational Phase Sub-catchment AMD management description

AMD management through the Operational Phase at the sub-catchment level (i.e., individually within Twins, Granity, Miller, and Mine Catchments) will continue to be complex, including:

- Managing both sediment and AMD impacts on water;
- Progressive construction of in-pit sumps and pumping infrastructure as the disturbance footprint expands;
- Temporary and permanent diversion of water between catchments as pits expand, highwall / coal floor drainage paths are created, and final landforms are established;
- Balancing the need for fire suppression water with downstream AMD impacts, particularly in Miller Stream where fire suppression water cannot be re-captured / transferred for treatment;
- Capturing and pumping AMD to the Mangatini Treatment System from pit sumps; and
- Managing syncline / DCA water quality during MW16 Sump construction and commissioning.

Notwithstanding these complexities, there are two key milestones throughout the Operational Phase that have major impacts on water and AMD management, including:

- Cessation of operational fire suppression in 2028; and
- Consolidation of most of the opencast disturbance footprint into the MW16 Sump / Mine Creek S6 tributary, including Millerton ELF seepage and surface flows, also in 2028.

These milestones have been used to develop forecasts of sub-catchment effects through the Operational Phase in conjunction with the Millerton Block acidity load forecast and nominal AMD treatment schedule. This assessment distributes the remnant untreated acidity load derived in Table 12 across the sub-catchments based on expected water and AMD management throughout the Operational Phase. The effect of these milestones on the acidity load generated in each sub-catchment is described conceptually below and summarised in Table 14.

- Twins Catchment – Open-pit disturbance is assumed to occur throughout the Operational Phase but the resulting additional acidity loads have been included in the neighbouring Granity Stream (S25) Catchment for simplicity.
- Granity (S25) Catchment – Ongoing disturbance results in 25% of the extrapolated additional acidity load (quantified in Table 8) being generated in S25 Catchment until 2028. From 2029 onwards S25 acidity loads decay linearly to EOML model levels. AMD collected in pit sumps will be pumped to the Mangatini Treatment System throughout the Operational Phase, such that remnant acidity loads reporting to S25 are equivalent to the contribution from historic underground workings located outside the opencast disturbance footprint.
- Miller (S24A) Catchment - Ongoing disturbance and fire suppression results in 37.5% of the extrapolated additional acidity load (quantified in Table 8) being generated / reporting to S24A

Catchment until 2028. This AMD will continue to be used for fire suppression and acidity loads cannot be re-captured / transferred for treatment. From 2029 onwards most of the opencast disturbance footprint is cut-off from Miller Catchment by pit expansion and permanent diversion drains. From 2029 onwards AMD collected in Miller Pit sump will be pumped to the Mangatini Treatment System, such that remnant acidity loads reporting to S24A are equivalent to the contribution from historic underground workings located outside the opencast disturbance footprint.

- Mine (S23) Catchment - Ongoing disturbance and fire suppression results in 37.5% of the extrapolated additional acidity load (quantified in Table 8) being generated / reporting to S23 Catchment by 2028. For modelling purposes a staged increase in acidity load capture through the Syncline / DCA pumping system and transfer to the Mangatini Treatment System was assumed, i.e., 40%, 60%, and 75% acidity load transferred through 2026, 2027, and 2028, respectively. From 2029 onwards the opencast disturbance footprint is cut-off from Mine Creek S23 Catchment as the Syncline is mined out and the DCA (and other portals) are sealed. From 2029 onwards AMD reporting to S23 is equivalent to the contribution from remnant historic underground workings located outside the opencast disturbance footprint.
- Mine (S6) Catchment – Ongoing opencast disturbance and fire suppression is assumed to have a minimal effect on the S6 tributary of Mine Creek until 2028. From 2029 onwards most of the opencast disturbance footprint (including the Millerton ELF) is diverted to Mine Pit sumps / MW16 Sump in the S6 tributary. AMD captured in the Sumps is pumped to the Mangatini Treatment System (equivalent to ~75% of treatable load in 2029 and ~80% of treatable load for 2030 onwards while remaining loads are discharged to Mine Creek S6 tributary. Acidity loads are projected to decay steadily, such that MC1 meets betterment reference values from EOML (2033) onwards.

Operational Phase pit Sump Pumps will be a mix of electric submersibles, diesel centrifugal and electric centrifugal depending upon application and location. Pumps are sized for a 90th percentile rainfall event (95th percentile event in Twins Pit Sump). The maximum pumped water take from in-pit sumps during the Operational phase has been calculated (Table 13). Pumping routes will either be directly to Mangatini or staged via MW16 Sump to Mangatini. From there, Millerton AMD will be treated as per the Mangatini Sump management plan (GHD 2018; GHD 2024 update).

Table 13. Operational phase (2027 – 2033) maximum pumped water takes by Sump / Catchment

Catchment (taken from)	Sump (taken from)	Sump (pumped to)	Max flow rate take (L/s) (2027 – 2033)
Twins (T1)	Twins	Mangatini	72
Granity (S25)	Rockies	Mangatini	68
Granity (S25)	Hope Lyons	Mangatini	35
Granity (S25)	Granity North	Mangatini	13
Granity (S25)	Granity South	Mangatini	30
Miller (S24a)	Miller	Mangatini	32
Mine (S6)	Mine Pit / MW16	Mangatini	319

Table 14. Operational Phase key Operational Phase water and AMD management milestone dates used for modelling

	Current	Operational Phase							EOML
	2025	2026	2027	2028	2029	2030	2031	2032	2033
Twins (T1)	Measured loads – basis for 2026 loads	Load increase captured in Granity calcs Pump pit sumps to Mangatini Treatment System (via Granity). **Residual loads @ T1 remnant UG workings**							EOML model
Granity (S25)		25% of Millerton Block Load increase Pump pit sumps to Mangatini Treatment System **Residual loads @ S25 remnant UG workings**			Linear load decrease – 2028 peak to EOML model Pump pit sumps to Mangatini Treatment System **Residual loads @ S25 remnant UG workings**				
Miller (S24A)		37.5% of Millerton Block Load increase Pump to workings for fire suppression – not captured or treated **Residual loads @ S24A increase**			Load diverted to S6 tributary by ELF design / cutoff drains, with 2029 – 2032 potential loads at EOML levels Pump pit sump to Mangatini Treatment System (via MW16) **Residual loads @ S24A remnant UG workings**				
Mine (S23)		37.5% of Millerton Block Load increase Pump to workings for fire suppress Transfer ~40% - 75% of load (up to ~200L/s) at DCA (pump to Mangatini Treatment System) **Residual loads @ S23 proportional to ~60% - 25% load not transferred**			Nothing reporting – Catchment cutoff by MW16 Pit / sealed DCA **Residual loads @ S23 remnant UG workings**				
Mine (MW16 / S6)		Pit Sumps captured at Syncline / S23 catchment **Residual loads @ S6 remnant UG workings**			Millerton ELF load directed to MW16 Sump Pump pit sumps / MW16 Sump to Mangatini Treatment System **Residual loads @ S6 calculated by mass balance** (Total Millerton Block post-ttmt minus sum of tribs.)				
Nominal treated load (t/year)*		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Equivalent load reduction (t/year)*		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

NB: Calculations use the 2025 acidity loads as the basis for 2026 loads. Red text identifies how additional load increase through to 2028 is attributed to sub-catchments. Green text identifies sub-catchment acidity load treatment assumptions. **Bold** text describes the residual loads used for mass balance / calculating post treatment loads. * Values taken from Table 11.

5.2.2 Operational Phase Sub-catchment acidity load calculations

A mass balance acidity load calculation was used to estimate remnant sub-catchment acidity loads. Separate calculations were used for the 2026-28 period and 2029-2032 period. These calculations are described in the following sub-sections.

5.2.2.1 2026-28 sub-catchment acidity load calculation

The mass balance calculation for the 2026 – 2028 period assumed that:

- A high degree of pit sump acidity load capture and transfer for treatment from T1 and Granity Pits, such that acidity loads reporting to T1 and S25 were equivalent to loads from remnant historic underground workings located outside of the opencast disturbance footprint.
- No treatment of AMD reporting to Miller Creek S24A due to the need for ongoing fire suppression using pit sump water.
- Staged increase in AMD capture and transfer at Mine Creek reduced S23 acidity loads by 40%, 60%, and 75% through 2026, 2027, and 2028, respectively.
- No change to Mine Creek S6 acidity loads from 2025 levels.

5.2.2.2 2029-32 sub-catchment acidity load calculation

The mass balance calculation for the 2029 – 2032 period assumed that:

- A high degree of pit sump acidity load capture and transfer for treatment from T1, Granity, and Miller Pits, such that acidity loads reporting to T1, S25, and S24A were equivalent to loads from remnant historic underground workings located outside of the opencast disturbance footprint.
- Opencast disturbance footprint is cut-off from Mine Creek S23 Catchment, such that acidity loads reporting to S23 were equivalent to loads from remnant historic underground workings located outside of the opencast disturbance footprint.
- Staged increase in acidity load captured in Mine Pit sumps / MW16 Sump transferred to the Mangatini Treatment System from 75% in 2029 to 80% in 2030 – 2032, such that acidity loads reporting to S6 were equivalent to spilled loads from MW16 Sump (~25% to 20% of load) and contributions from remnant historic underground workings located outside of the opencast disturbance footprint.

This modelling approach resulted in some variability between the Operational Phase nominal target acidity load transferred from Millerton to the Mangatini Treatment System (specified in Table 11) and the mass balance calculated acidity load (Table 15). However, given this difference was relatively minor and the significant number of variables potentially influencing the model outcomes (i.e., the magnitude of acidity generation, timing of operational changes affecting load production, accuracy of comparing 'treatable' and 'total' acidity loads, etc.) the nominal target acidity loads are considered appropriate for planning purposes at this stage.

Table 15. Comparison of nominal Operational Phase AMD treatment targets and modelled mass balance acidity load removal

	Operational Phase Millerton AMD treatment targets		Modelled treatment
Year	Nominal Millerton Pit acid load treated (t/year)	Equivalent 'Total' acidity load reduction in catchment (t/year)	Mass balance 'actual' reduction in field (t/year)
2026	3,000	4,000	4,120*
2027	5,000	6,667	6,336
2028	7,500	10,000	8,252
2029	8,000	10,667	11,108*
2030	7,500	10,000	10,236*
2031	7,000	9,333	8,875
2032	6,000	8,000	7,672
2033	Assessed using EOML AMD model		

* Modelled exceedance of nominal acidity load treatment targets considered acceptable for planning purposes at this stage.

The resulting sub-catchment specific forecasts of Operational Phase acidity load pre-treatment and acidity load post-treatment / remnant load are summarised in Figure 33, and shows the following key acidity load transitions between 2028 and 2029:

- Twins (T1) and Granity (S25) acidity loads are managed to prevent any increase in acidity load (and therefore acidity and Al concentration) throughout the Operational Phase.
- Miller Stream (S24A) acidity load increases through to 2028 due to ongoing fire suppression but decreases significantly in 2029 as the opencast disturbance footprint is cut-off from Miller Stream / diverted to Mine Pit sumps / MW16 Sump.
- Mine Creek (S23) tributary acidity loads decrease from 2026 to 2028 due to a staged increase in AMD transfer (to the Mangatini Treatment System) from the Syncline using the existing DCA pump system. S23 acidity loads decrease further in 2029 after the DCA is sealed and the opencast disturbance footprint is effectively cut-off from S23 tributary.
- Mine Creek (S6) acidity load increases from 2029 onwards after the opencast disturbance footprint (including the Millerton ELF) is diverted to Mine Pit sumps / MW16 Sump in the S6 tributary.
- Activities in Mine Creek tributaries (S23 and S6) are managed such that lower Mine Creek (MC1) shows an overall reduction in acidity load through the Operational Phase (relative to 2025 levels) despite the final landform water management diverting most AMD into the S6 tributary.

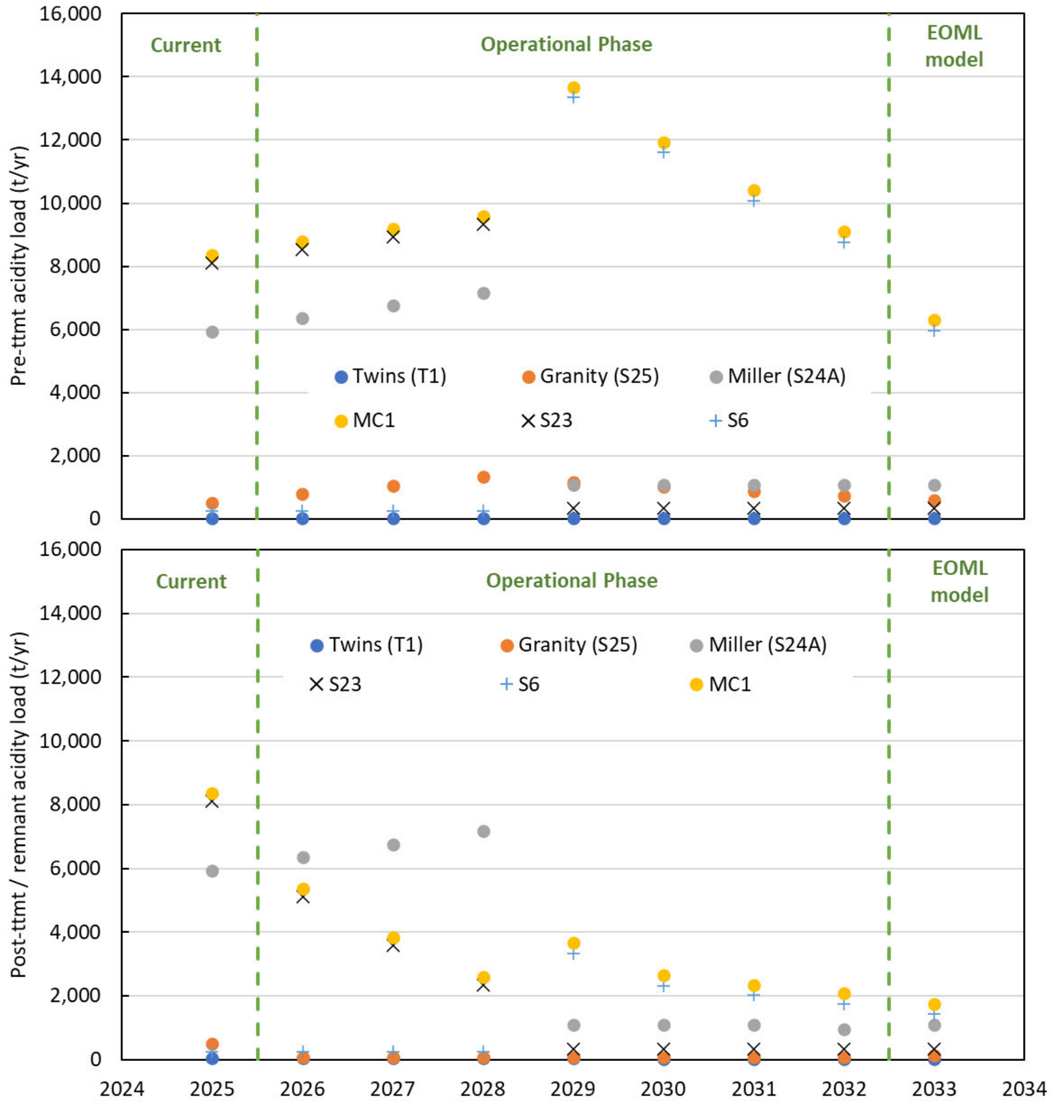

Figure 33. Forecast sub-catchment Operational Phase acidity load pre- and post-treatment.

The modelled effects of Operational Phase AMD management on annual median acidity and Al concentration are shown in section 8.0, to reduce duplication and provide greater context in conjunction with EOML forecasts.

The estimated Operational Phase Millerton Block acid loads suggest sub-catchment effects between the current time (2025) and 2033 may increase or decline in each catchment. Estimates of sub-catchment effects on water quality will also be refined through the Annual Work Plan processes once activities commence.

6.0 EOML / Closure Phase AMD modelling

As discussed, a different AMD modelling approach has been used for the EOML and Closure Phases of the BPCP. Detailed final landform designs have been developed for the Millerton Block as part of the BPCP. Most of these final landform surfaces / structures will be constructed during the Operational Phase, though final landform reshaping and revegetation / rehabilitation of Millerton ELF is not scheduled for completion until 2046 (with the Closure Phase commencing in 2047).

The EOML / Closure Phase AMD modelling is based on forecast acidity load yields from domain based final landform surfaces / structures, e.g., Millerton ELF, Coal Floor, and Highwall exposure. For modelling purposes the final landform is assumed to be constructed by 2033 and revegetated / rehabilitated by 2046. Relevant acidity load generation rates for these final landform surfaces / structures have been derived / modified for this assessment using a range of literature, existing technical reports, and historic monitoring datasets.

The EOML / Closure Phase AMD modelling involved three stages:

(1) Development of a final landform design for the opencast disturbance footprint in Millerton Block to align water and AMD management strategies;

(2) Potential acidity loads were forecast for sub-catchments based on final landform structures / surfaces, including AMD generation decay rates; and

(3) Water and AMD management requirements to achieve betterment at key monitoring sites (T1, S25, S24A, and MC1) were developed. This included defining the expected period for pumping pit sumps for treatment and when pit sump discharge to natural sub-catchment waterbodies would be possible (within betterment reference values).

Best practicable options were used as part of the final landform design process. Broad factors governing BPO are described in Section 2.5. BPO's on a sub-catchment specific basis are discussed in Section 8.0 and presented alongside acidity load / water quality predictions.

This assessment will be refined through the Annual Work plan processes once activities commence and performance monitoring data become available, particularly for determining remnant acidity loads for historic underground workings located outside of the opencast disturbance footprint and any performance monitoring implications for achieving betterment.

6.1 Approach

The EOML / Post Closure acidity loads are quantified for each sub-catchment at EOML (2033) using the following process:

(4) Each sub catchment area is mapped for final landform / EOML AMD generating surface / landform types, including:

a. Undisturbed surface catchment area

b. Disturbed surface catchment area, including:

i. Highwall

ii. Coal Floor

iii. Engineered landform (ELF) (area and reactive rock volume), assuming granite capping and rehabilitation across full area

iv. Sumps (not AMD generating)

c. Remnant historic underground workings area.

(5) Specific AMD generation rates are then applied to the AMD generating surface areas / ELF volumes to generate the forecast acidity load for each sub-catchment.

The EOML acid load in each sub-catchment is quantified on a tonnes per year (t/yr) basis. Forecast acidity loads are then calculated on a yearly basis going forward, with generation rates decreased over time as a function of:

- Rehabilitation and long-term acidity generation decay for Millerton ELF;
- Long term acidity generation decay for remnant historic underground workings; and
- Decay for highwall and coal floor surfaces.

The site-specific correlation between annual acidity load and annual median acidity and Al concentration derived in section 4.3 is then used to estimate residual acidity and Al concentration at downstream monitoring sites over time.

Acidity and Al concentrations are generally modelled conservatively (i.e., no secondary geochemical reactions after waters mixing, etc.), except as described in section 6.4 for partial AMD treatment scenarios. While this is a simplifying assumption for modelling purposes, these complex geochemical reactions / effects may already be inherently included in site specific correlations between acidity loads and acidity / Al concentrations developed using extensive existing monitoring datasets.

The EOML / Closure Phase AMD modelling process forecasts two key values to inform water and AMD management:

- **Potential Effect** – indicating the potential effect of uncontrolled AMD discharge generated within the sub-catchment to the receiving environment; and
- **Managed Effect** – indicating the expected effect of residual AMD discharge to the receiving environment with AMD management occurring (e.g., pumping pit sumps to the Mangatini Treatment System, Alkaline dosing in MW16 Sump, etc.).

These forecast values have been used to optimise water and AMD management for each sub-catchment, to determine:

(1) The degree of AMD management / treatment required significantly reduce acidity loads such that the 'managed effect' acidity loads and acidity / Al concentrations to fall below the corresponding betterment reference values; and

(2) The future date when AMD management / treatment can cease, such that the 'potential effect' of any remnant AMD does not cause acidity loads and acidity / Al concentrations to exceed the corresponding betterment reference values, and pit sumps can discharge naturally to receiving sub-catchment waterbodies.

Proposed water management infrastructure configuration for the EOML and Closure Phases are shown in Figure 34 and Figure 35, respectively. The EOML Phase figure (Figure 34) shows the water management and pumping infrastructure as it will exist at EOML (2033). This allows for continued pumping of pit sumps to the Mangatini Treatment System as required to achieve betterment. The Closure Phase figure (Figure 35) shows the configuration once pumping from Twins, Miller, and Granity Catchments ceases (and these pit sumps discharge to receiving waterbodies) and in-sump alkaline dosing to MW16 Sump has commenced.

6.2 Final Landform (EOML)

6.2.1 AMD generating surfaces / structures

A summary of key AMD generating surfaces and structures included in the EOML / Closure Phase AMD model are quantified in Table 16. These areas / volumes apply from EOML and are shown in water management figures (e.g., Figure 35). Highwall and Coal Floor areas are identified collectively as 'Pit Shells' for simplicity.

Table 16. AMD generating surfaces / structures

Catchment	Pit / Sump	Highwall	Coal Floor	ELF area	ELF volume
		(m^2)	(m^2)	(m^2)	(m^3)
Twins	Twins (T1)	34,300	73,100	-	-
Granity	Hope Lyons	56,200	25,700	-	-
	Granity South	3,900	49,200	21,800	34,800
	Granity North	28,600	10,600	-	-
	Rockies	41,900	161,400	-	-
Miller	Miller	50,300	45,000	-	-
Mine	Mine (S6 – Millerton East ELF (filter beds etc.))*	-	-	58,800	295,100
	Mine (S6 – MW16 Sump)	55,100	29,100	1,249,200	53,447,100**

* Millerton East ELF filter bed sumps not shown in Figure 34, ** Scheduled disturbance from April 2027 to EOML is 11.7 Mbcm, equivalent to 14.7 Mm^3 material using a 1.25 conversion factor, which equates to the final ~28% of material used to construct the ~53.4 Mm^3 Millerton ELF.

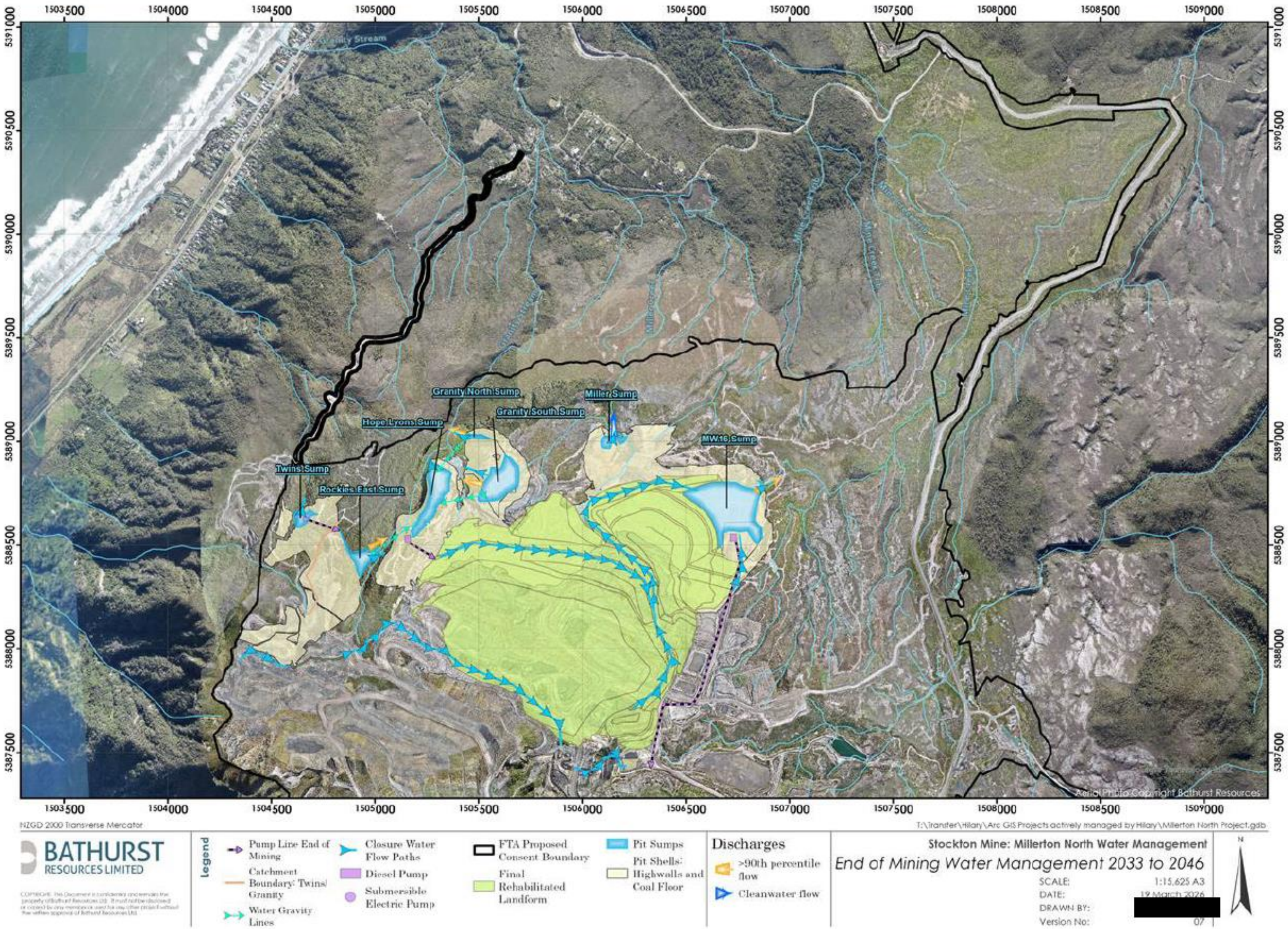

Figure 34. EOML water management 2033 to 2046

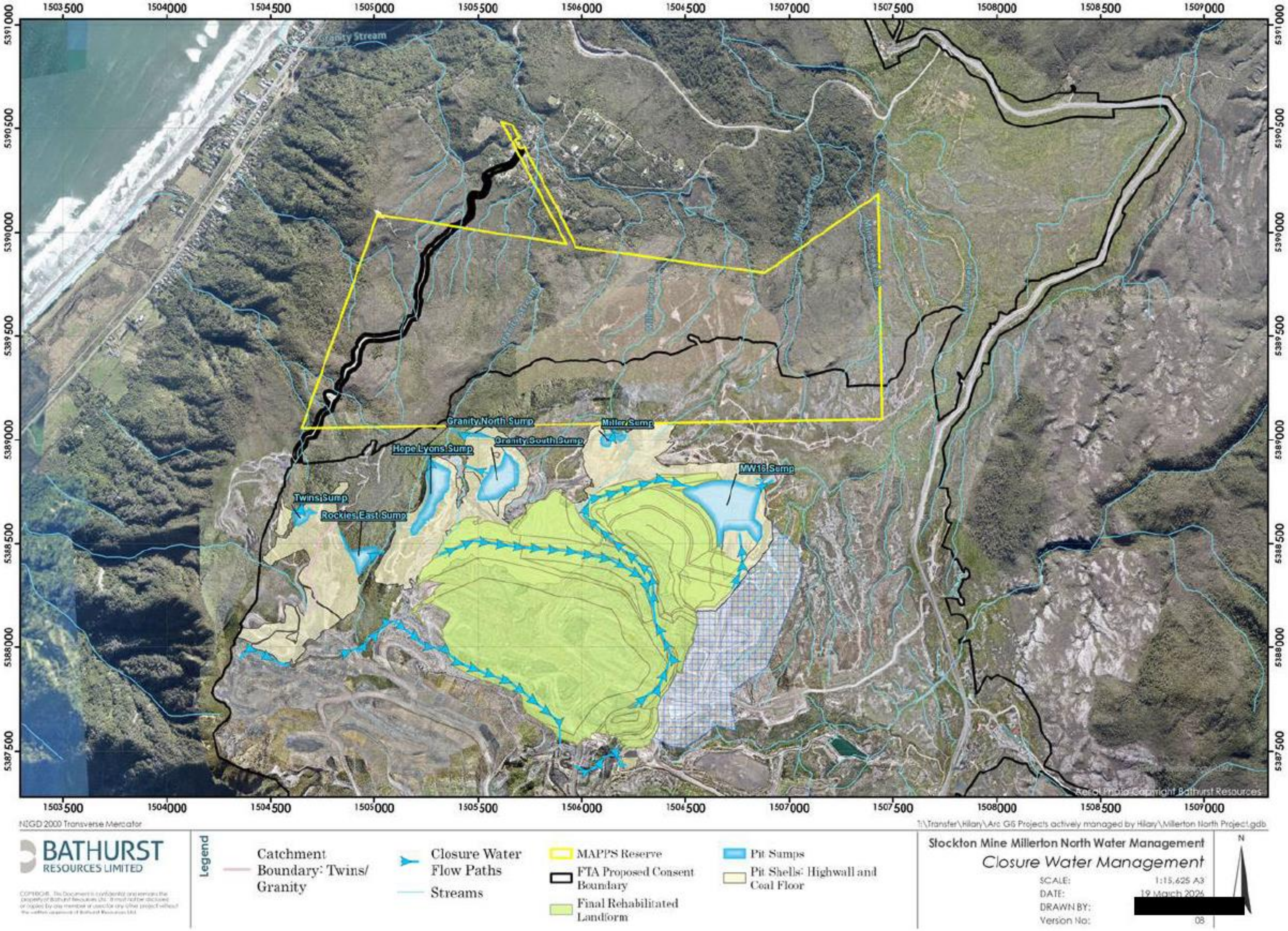

Figure 35. Closure Water Management

6.2.2 Millerton Engineered Landform (ELF)

The ~125 ha Millerton ELF is the major waste rock storage structure in the Millerton Block and will be constructed as per guidelines in the Acid and Metalliferous Drainage Environment Management Plan (BRL 2024). Key elements of this construction plan are:

- Bottom-up construction in 2 – 5m high lifts, with traffic compaction of each lift.
- Final landform design to enable water management to capture and treat (if required) any seepages from the ELF's and other final landform surfaces (e.g., highwall, coal floor) within the Millerton Block opencast disturbance footprint; and
- Progressive granite capping and rehabilitation.

The Millerton ELF will contain approximately 53.4 Mm^3 of waste rock. In addition to waste rock the Millerton ELF will also contain:

- Coal fines;
- Wash plant rejects;
- Dewatered AMD treatment sludge (produced at Stockton by alkaline dosing to sumps);
- Dewatered AMD treatment sludge (produced at ESE and MFS by active water treatment plants);
- Spent mussel shell reactor sludge (including a combination of AMD precipitates and unreacted shell substrate); and
- Sediment treatment pond slops.

The effect of incorporating these materials into the Millerton ELF has not been investigated individually from a water quality / AMD perspective as it is assumed that these material types are already contributing to the AMD loads and water quality in the datasets used to develop the Millerton ELF AMD model, i.e., these effects are already included in Mangatini and Millerton Catchment AMD characteristics and operational water quality datasets. Further discussion on AMD sludge disposal is provided in BRL (2025a), which notes laboratory and field trials undertaken by BRL (interpreted in MWM, 2021) suggest that dewatered AMD sludge co-disposal with ELFs is an appropriate disposal option. There remains a risk of elevated leachate contaminant concentrations (primarily Co, Mn, Ni, and Zn) from areas of LDS co-disposal. Overall, the magnitude of LDS co-disposal material volumes versus PAF material volumes stored at the landform scale is expected to make the risk of LDS-derived contaminant load mobilisation relatively low. All sludge disposal cells will be situated upstream of treatment sumps, so any leachate from LDS sludge co-disposal will be captured and treated.

BRL (2025a) have estimated the total dewatered AMD sludge volume to be disposed in Millerton ELF is ~673,000 m^3. This will be a combination of CaO neutralised sludge (with a dewatered solids content ~10%) and MgO neutralised sludge (with a dewatered solids content ~30%). BRL (2025a) estimates indicate the relative contributions of CaO and MgO AMD sludges will be ~56% and ~44% (by volume), respectively, such that the combined AMD sludge solids content would be ~19%. On a dry basis the AMD sludge mass disposed in Millerton ELF would therefore be ~116,000 t relative to the ~100 Mt

Millerton ELF. Additional AMD sludge volume contributions from the McCabes Treatment System (estimated at ~4,300 m^3 / year for a period of 2-3 years) and MW16 Sump (which has sufficient capacity for long term storage in-sump) are assumed to be negligible.

The Millerton ELF surface and sub-surface drains are designed to divert the majority of runoff and seepage AMD to Mine Pit sumps / MW16 Sump for management / treatment. Sub-surface drains will require site specific detailed design (considering factors such as final coal floor surface areas, topography, etc.). The AMD collection drain on the surface of the Millerton ELF (alignment shown by the 'Closure water flow paths' line in Figure 34 and Figure 35) will be engineered and constructed throughout the EOML Phase to cope with the selected rainfall event, as per the Water Infrastructure Design Plan (BPCP-ENV-PLN-012). Detailed designs, including the sharp junction where the Western branch meets the South – North branch, will be developed.

The existing Rockies West diversion drain above the Millerton Block will remain in place permanently to carry water from upper Rockies, Webb, and 4-West areas to Mangatini Sump for AMD treatment.

6.2.3 Sumps

Sediment treatment sumps may be constructed downstream of active rehabilitation areas to capture sediment and discharge clean water to the natural catchment.

Major sumps will form in the natural low points of each remaining pit area. These sumps will be retained for long term / Closure water and AMD management purposes. Final landform sump spillways will be designed to a 1 in 100-year event, as per the Erosion and Sediment Control Plan for Land Disturbance Activities (BPCP-ENV-PLN-013). Detailed designs will be confirmed based on final catchment, topography, and engineering assessments. The expected volume and surface area for each sump is listed in Table 17.

Table 17. Final landform / permanent pit sumps

Catchment	Pit / Sump	Sump area (m2)	Sump volume (m^3)
Twins	Twins (T1)	5,580	16,300
Granity	Hope Lyons	27,230	151,800
	Granity South	27,640	158,500
	Granity North	2,200	7,100
	Rockies	11,630	71,000
Miller	Miller	5,200	10,700
Mine	Mine (S6 – MW16 Sump)	70,410	718,900

These sumps will either provide storage for pumping to treatment systems or settling for sediment prior to discharge to the natural catchment based upon water chemistry. As runoff reporting to these sumps is predominately from highwalls and coal floors, TSS is expected to be low once surfaces stabilise, and comparable to natural sandstone pavement runoff. MW16 Sump will receive the Millerton final ELF runoff and will manage the TSS generated through the construction and rehabilitation activities.

Small dams may be required to achieve the required water volume capacity. These will be designed and constructed as per New Zealand Society of Large Dams (NZSOLD) Guidelines. No classifiable dams will be constructed as part of closure water management.

6.2.4 Historic underground workings

Underground workings will be managed in pit with water restricted from entering obvious portals. Due to the fractured nature of the subsurface and unknown stoppings or collapses within the workings, knowing the exact water paths throughout the workings is not possible. Accordingly minimising water infiltration to the underground workings is the optimal management method. Exposed portals will be sealed with an earth bund where there is a risk of pit water being released into them. Where applicable, open portals will also be sealed around the perimeter of the Millerton ELF to limit air ingress into the ELF thereby reducing AMD production over long term. Sealing of downstream (egress) portals or over areas of surface fracturing for AMD control is not proposed as part of the BPCP due to access constraints and to minimise disturbance.

The preliminary design of a Pit Boundary Seal is discussed in Section 6.2.4.1, and is assumed to prevent any additional flow / acidity flushing through the workings from water captured within the opencast disturbance footprint. Effectively sealing portals to these historic underground workings (particularly within sump footprints) will reduce long term acidity loads.

The estimated reduction in area of historic underground workings from pre-opencast (2010) to EOML (2033) for the key sub-catchments is shown in Table 18. The area of underground workings to be removed from the current (2025) to EOML area is also quantified.

Table 18. Reduction in area of Historic Underground Workings from pre-opencast (2010) to EOML (2033).

Catchment	Site	UG workings area			UR workings reduction	
		Pre-opencast (2010)	Current (2025)	EOML (2033)	Pre-opencast to EOML	Current to EOML
		(ha)	(ha)	(ha)	(% reduction)	(% reduction)
Granity	S25	21.8	12.9	12.3	44%	5%
Miller	S24A	125.1	96.3	67.9	46%	30%
Mine	S23	152.4	91.8	32.5	79%	65%
Mine	S6	66.5	66.5	66.5	0%	0%
Mine	*MC1**	*218.9*	*158.4*	*99.0*	*55%*	*37%*
Twins	T1	3.62	3.62	3.30	9%	9%
Total		**369.5**	**271.2**	**182.5**	**51% (187 ha removed)**	**33% (98 ha removed)**

* MC1 areas calculated from S23 + S6.

Part of the ~119.9 ha of underground workings removed from the S23 catchment between 2010 and EOML includes 41.9 ha of underground workings that currently report to S23 that will be intersected by Mine Pit and drain to MW16 Sump (as opposed to being mined out). The extent of these workings is shown in Figure 36.

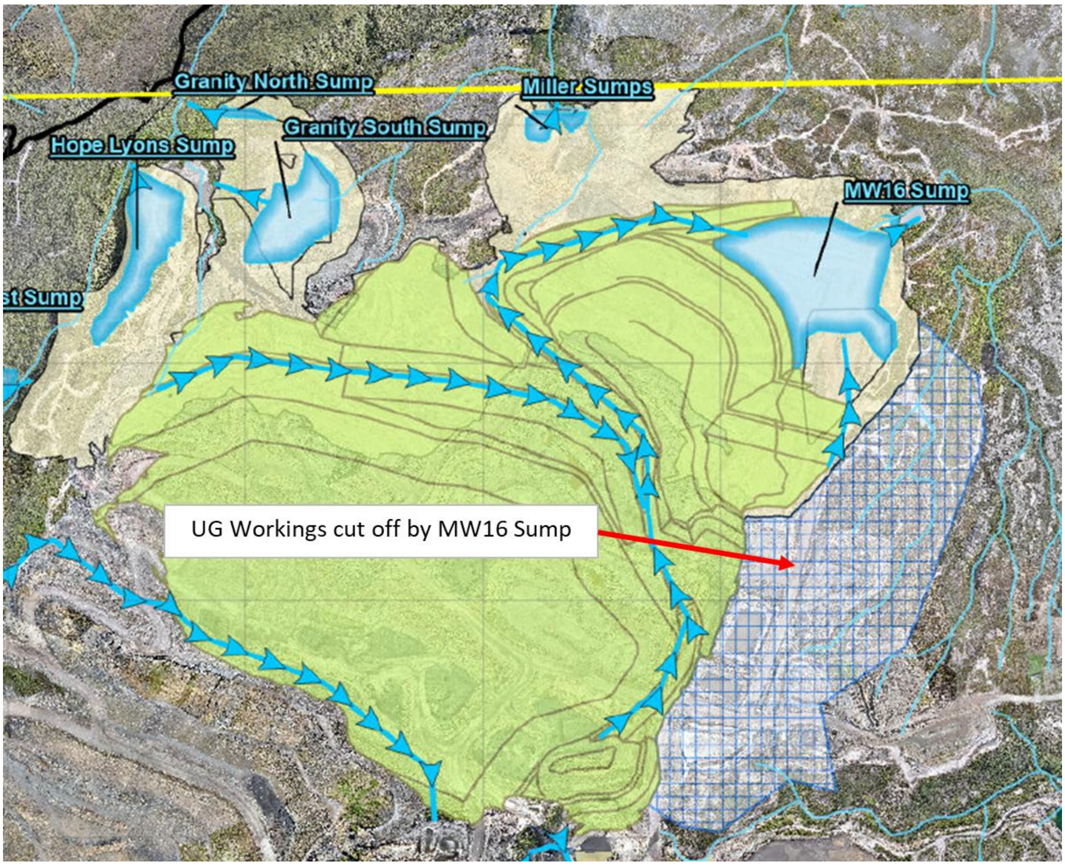

Figure 36. UG workings intersected by Mine Pit and diverted to MW16 Sump.

6.2.4.1 Design of a Pit Boundary Seal

The proposed pit boundary does not mine out all the historic underground workings. Along the west, north and east boundaries it is anticipated that historic workings will be encountered in the boundary walls. Seepage flow directions (based on anticipated coal floor topography) suggest that seepage could escape from the Millerton ELF via the underground workings if appropriate measures are not included in the mine design.

A preliminary feasibility-level design of a pit-boundary seal is detailed in the URS, (2009) **Part 3 – Preliminary Geotechnical Design of the Pit Boundary Seal**. (Modified here to fit with this Millerton Water and AMD Management Plan) The URS report assesses the feasibility of preventing seepage from entering the underground workings, specifically addressing the following:

- Identification of regions that will require the placement of an impermeable seal;
- Identification of regions where groundwater flow/seepage along the coal floor may need to be redirected;
- Preliminary design of the impermeable seals; and
- Preliminary specification for placement and compaction.

Any seepage from the waste material within the Millerton ELF is expected to drain along the base of the final landform. This seepage will be directed to the MW16 Sump, located in the lowest point of the pit.

Where pit floor drainage falls towards the margins of the final landform, seepage will need to be redirected towards the MW16 Sump, or seals will need to be constructed to prevent seepage from entering the underground workings.

A combination of an engineered seal across underground workings and pit floor drains can be used to maximise the proportion of seepage directed to MW16 Sump for treatment. It is anticipated that seepage from most of the landform will naturally flow towards MW16 by gravity (excluding a small proportion reporting to Granity South Sump (equivalent to less than 0.1% of the Millerton ELF by rock volume, which is forecast to produce a minor ~3 t/year acidity load)). This additional load is already included in the S25 water quality betterment calculations.

A preliminary design for the seal is presented in URS (2009). The design includes reshaping the pit wall using bulk fill and constructing a compacted low permeability layer against the bulk fill.

Construction of drainage channels across the pit floor could reduce the requirement for pit seals. This study has not designed a layout for pit floor drains, but has presented some examples of a drainage configuration that would aid seepage drainage.

A wedge of bulk fill material may also need to be constructed over old underground workings in other parts of the pit perimeter. This will reduce the risk of collapse propagating up into the final landform and resulting in settlement of the capping layer. In these areas a boundary seal may also be required (even though seepage flow directions are toward the final landform) to reduce the ingress of oxygen into the bulk fill.

6.3 Domain specific acid load generation rates

This section describes the derivation of domain specific acidity load generation rates used in AMD modelling. These rates are derived from a combination of literature, technical reports, and historic monitoring datasets. These rates (including the decay component) are all critical to modelled outcomes for water and AMD management at different times throughout the forecasting period. As such, continued refinement of the rates used in modelling is recommended as more information becomes available.

6.3.1 Undisturbed surface catchment

AMD generation rates from undisturbed surface catchments are assumed to be negligible, relative to the contribution from disturbed catchments. The effect of naturally occurring elevated acidity and Al in Brunner Coal Measures streams is assumed to:

- Already be reflected in existing acid load / water quality datasets; and
- Be negligible relative to current (and betterment reference values) levels of acidity and Al.

6.3.2 Highwall

Highwall acidity load forecasts are based on values presented in site trials (Mackenzie 2008) and literature (Pope 2018).

Mackenzie (2008) quantified acidity loads at the Millerton Road Cutting, where drains collect runoff from a ~1 ha area of exposed BCM highwall. The cutting is located near the Millerton Block and excavated material had an average maximum potential acidity (MPA) of 57.3 kg/t (equivalent to a sulfur content of 1.9 wt.% (assuming negligible Acid Neutralising Capacity)) and is therefore assumed to be representative of Millerton highwalls. Average annual acidity loads of ~15.2 t/ha/year was derived from the BCM section of highwall after 1-2 years of exposure / weathering.

Pope et al. (2018) compiled wall wash data from highwall wash trials at a number of sites across the West Coast. Surfaces tested included both BCM and Paparoa Coal Measures (PCM) with surfaces exposed for periods ranging from 3 days to 138 years prior to testing. The Pope et al. (2018) wall wash methodology applies 500 mL of water to a 0.25 m^2 area of highwall, which is equivalent to an irrigation rate of 2mm directly on the highwall surface. For a nominal Millerton Pit highwall surface (with 45^o batter face, 15 m bench height, and 5 m bench width) the overall slope angle is 37^o. The wall wash irrigation rate of 2mm directly on the sloped highwall surface is therefore equivalent to a ~2.5 mm rain event across the overall highwall slope and is therefore likely to represent 'first flush' acidity concentrations.

Pope et al. (2018) fitted averaged wall wash acidity concentration data with a power function trendline to describe long term concentration decay from exposed highwalls (Figure 37).

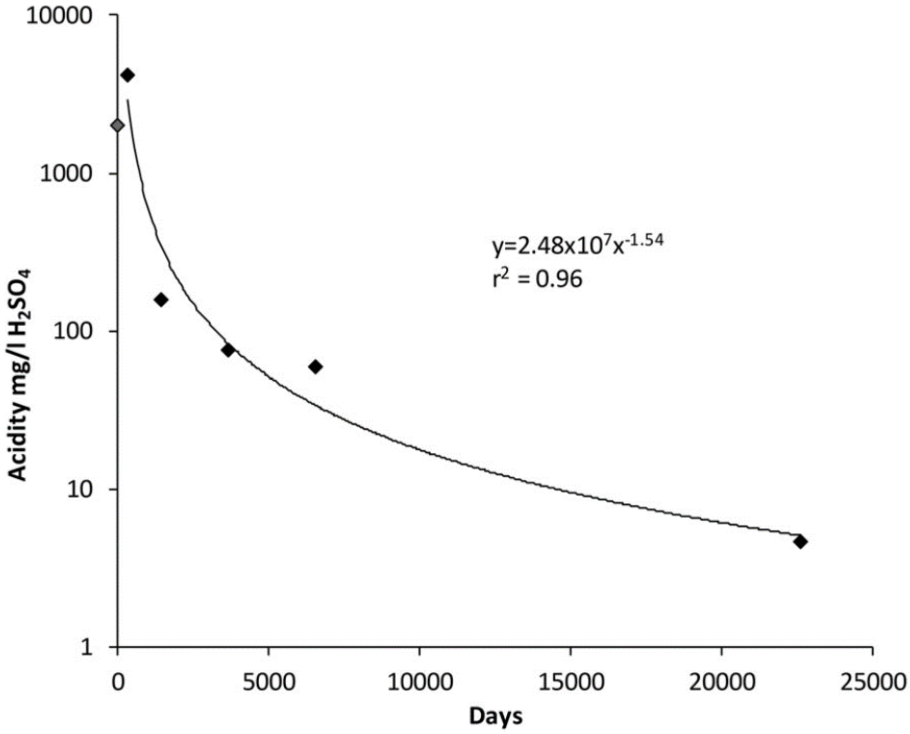

Figure 37. Highwall wash acidity concentration versus exposure duration

This acidity concentration relationship is relevant to the Millerton long term acid load model for two reasons.

Firstly, Pope et al. (2018) decay curve appears to corroborate Mackenzie (2008) acid loads for freshly exposed BCM highwall acidity loads. Assuming the highwalls provide a constant load AMD source (i.e., highwall runoff concentrations are diluted proportional to rainfall intensity), the first flush (2.5 mm rain event) acidity concentrations at years 1 and 2 could be scaled down by a factor of ~4 to estimate acidity concentrations during an average daily rainfall event (10.8 mm/day based on an average Millerton rainfall of 3,945 mm/year (Millerton Met Station)). This can then be converted to an acidity load per unit area, assuming 100% runoff from highwall catchments. The resulting annual acidity load for years 1-2 (i.e., 26 – 9 t/ha/year in Table 19) corroborates the ~15.2 t/ha/year rate derived by Mackenzie (2008) Grand Canyon highwall BCM which had been exposed for 1-2 years.

Table 19. Derivation of freshly exposed highwall annual acidity load from Pope et al. (2018).

Decay year	'First flush' acidity (mg/L)	Average daily rainfall acidity (mg/L)	Annual acidity load (t/ha/year)
1	2,806	651	26
2	965	224	9

Secondly, the Pope et al. (2018) acidity concentration decay curve has been used to represent long term acidity load decay from highwalls in the Millerton Block. This was done by using the concentration decay curve in Figure 37 to create an acid load decay scalar (Table 20), normalised against year 1 acidity concentrations. The decayed annual acidity load was then calculated using the nominal year 1 acidity load of 26 t/ha/yr. Decay rates were extrapolated beyond the 10 year period shown in Table 20 using the Figure 37 power function.

Table 20. Derivation of highwall acidity load decay scalar and annual acidity load decay

Decay year	Pope (2018) 'First flush' acidity (mg/L)	Concentration decay scalar	Annual acidity load (t/ha/yr)
1	2,806	1.0	26
2	965	0.34	8.8
3	517	0.18	4.7
4	332	0.12	3.0
5	235	0.08	2.2
6	178	0.06	1.6
7	140	0.05	1.3
8	114	0.04	1.0
9	95	0.03	0.9
10	81	0.03	0.7

For highwall acidity load modelling purposes, the end of mine life (EOML) is assumed to occur at the end of 2033. Year 1 highwall acidity load rates of 26 t/ha/year are used to calculate 2034 acid loads, and loads are subsequently decreased / decayed in successive years. This is a conservative assumption as it is likely final landform highwall exposure will occur earlier than EOML, with most peak highwall acid loads occurring during the Operational Phase. Highwall runoff will be diverted to pit sumps and captured for treatment or controlled discharge, as defined in Section 6.4.

Highwall acidity load generation rates are assumed to be constant across the Millerton area and are not modified for site-specific highwall sulfur content.

6.3.3 Coal Floor

Coal floor acidity load decay trends are assumed to be similar to highwall decay trends. Coal floor runoff samples collected in the Rockies Area were used to calibrate the Pope et al. (2018) highwall concentration decay trend to represent coal floor acidity load decay. The runoff samples were collected from coal floor in the Rockies Area that had been exposed for approximately 6 years (determined from coal floor sign-off records). Samples represent 'first flush' and were collected after 1.8 mm of rainfall following a ~5-day dry period. Acidity concentrations of the two samples were 35 and 68 mg/L, with the 68 mg/L result used (conservatively) for modelling.

A scaling factor was derived to estimate average daily rainfall (10.8 mm/d) coal floor runoff acidity concentrations from the Pope et al. (2018) dataset. This assumed both highwall and coal floor surfaces produce runoff with a constant acidity load, with concentration diluted proportional to rainfall volume. The scaling factor calculation included:

- Year 6 Pope et al. (2018) wall wash (2.5 mm rainfall equivalent) acidity concentration of 178 mg/L equates to an average daily rainfall runoff acidity concentration of 41.2 mg/L (for the average 10.8 mm/d rain event); and
- Year 6 coal floor runoff (1.8 mm rainfall equivalent) sampled acidity concentration of 68 mg/L equates to an average daily rainfall runoff acidity concentration of 11.3 mg/L (for the average 10.8 mm/d rain event).

The resulting highwall to coal floor acidity load scaling factor was calculated as 0.27, based on the ratio of average daily rainfall acidity concentrations (i.e., 41.2 mg/L / 11.3 mg/L). This implies that coal floor acidity loads and concentrations are equivalent to 27% of highwall acidity loads and concentrations, for a given exposure / weathering period. Indicative coal floor acidity generation rates are shown in Table 21

Table 21. Derivation of coal floor acid load decay

Decay year	Highwall acid load (t/ha/yr)	Scaled coal floor acid load (t/ha/yr)
1	26	7.1
2	8.8	2.4
3	4.7	1.3
4	3.0	0.8
5	2.2	0.6
6	1.6	0.4
7	1.3	0.4
8	1.0	0.3
9	0.9	0.2
10	0.7	0.2

For coal floor acidity load modelling purposes, the EOML is also assumed to occur at the end of 2033. Year 1 coal floor acidity load rates of 7.1 t/ha/year are used to calculate 2034 acid loads, and loads are subsequently decreased / decayed in successive years. This is a conservative assumption as it is likely final landform coal floor exposure will occur earlier than EOML with most peak coal floor acid loads occurring during the operational phase. Coal floor runoff will be diverted to pit sumps and captured for treatment or controlled discharge, as defined in Section 6.4.

Coal floor acidity load generation rates are assumed to be constant across the Millerton area and are not modified for site-specific coal floor sulfur content.

6.3.4 Engineered Landform (ELF)

A review of AMD liabilities for the Stockton Coal Mine was completed in 2015 (Okane Consultants 2015). Okane Consultants (2015) derived 'treatable' acidity load generation rates for overburden disturbed in Mangatini (and Millerton) catchments, calculated at an annual timestep. These rates were quantified based on measured stream acidity loads (units of t/year) compared to cumulative disturbance (units of tonnes of rock). These acidity load generation rates were then used for estimating future apportionment of AMD liability.

Okane Consultants (2015) also quantified the decrease in acidity load following cover installation / rehabilitation. This 50% decrease was built into AMD liability models as a step change 10 years after the cover was constructed. The model also used an exponential acidity load decay of 0.62% per annum for waste rock dumps, which was applied on a catchment scale. This was based on the work of Gandy and Younger (2007), who used data from the Stockton Egypt Field Trials (Egypt trial pads) to derive long term rates for acidity decay.

The long-term (Post EOML) acidity load generated by Millerton ELF has been calculated using these rates. This assumes that:

- New disturbance in Mangatini / Millerton catchments generates additional 'treatable' acidity load at a rate of 0.094 t/kbcm/year;
- Acidity load decreases by 50% in the 10 years following rehabilitation; and
- Acidity load decreases at a long term rate of 0.62%/yr.

The treatable component of total acidity load is defined as:

- The acidity load associated with flows up to 90th percentile flow rates; and
- Equates to ~75% of total acidity load.

The remaining 25% of acidity load theoretically generated by Millerton ELF at flow rates greater than the 90th percentile are not quantified in this assessment. The effects of AMD during high flow conditions are assumed to be minor due to dilution and the relatively short duration of events, as discussed in Section 2.5.

These high flow periods are also assumed to have a minimal effect on the annual median and 75th percentile acidity and Al concentrations that are used as the basis of this assessment. In addition, these high flows (>90th percentile) will be alkaline dosed (but not diverted into MW16 Sump for sedimentation) during the Closure Phase (2047 onwards) when Millerton AMD is treated in MW16 Sump.

Acidity load calculations assume that rehabilitation starts at the EOML (2033) and continues at a constant rate to 2046. The effect of rehabilitation is assumed to linearly decrease ELF acid loads by 50% over the 23 years between 2033 and 2056 (i.e., 10 years after final rehabilitation in 2046). A further compounded 13% decrease in acid load due to long term decay (at a rate of 0.62%yr) over the 23 years is also incorporated. This combines for an overall 63% reduction from modelled EOML (2033) ELF acidity loads by 2056 for Millerton ELF.

6.3.5 Underground workings

MWM (2025) reviewed and quantified acidity (**acidity to pH 5**) loads in Millerton Catchment for a range of different source types. This included deriving annual acidity loads at key AMD impacted monitoring sites downstream of historic underground workings. MWM (2025) estimated that acidity load for years 2006 to 2009 (prior to significant opencast mining in Millerton area) was ~3,600 t/year (**acidity to pH 5**) and was attributed to the historic ~350 ha of historic underground workings present at 2010. This equates to an underground workings acidity load generation rate of ~10 t/ha/yr.

These estimates have been further interpreted to derive sub-catchment specific estimates of underground workings acidity load generation rates. The estimates have also been scaled up to convert:

- Acidity load to pH 5 (as quantified in MWM (2025)); to

- Acidity load to pH 7, used for this assessment.

A scaling factor of 1.186 was used for the conversion and is based on the ratio of measured acidity to pH 5 versus acidity to pH 7 for key Millerton Block sites, as per Figure 38.

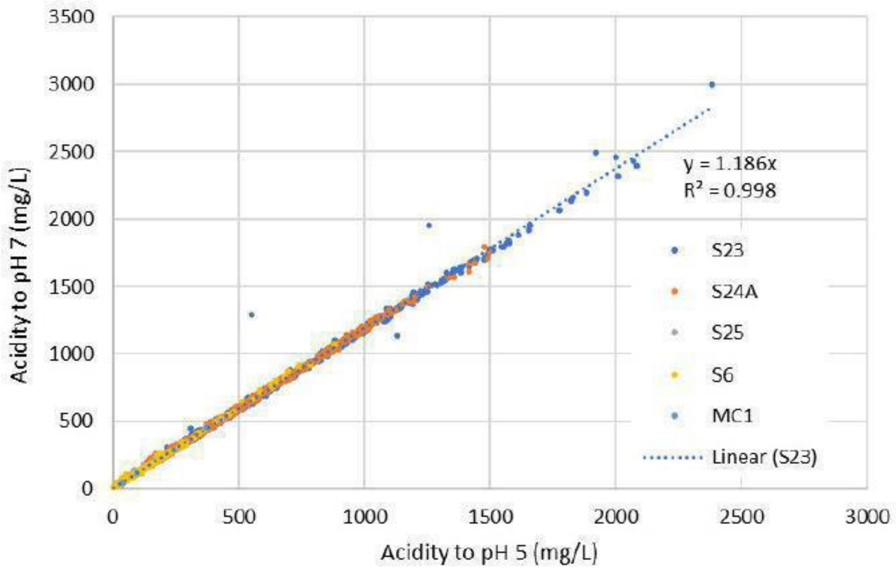

Figure 38. Acidity (pH 5) scaler to acidity (pH 7) from Millerton datasets

Average 2006 to 2009 acidity load in each sub-catchment was compared to the estimated area of underground workings in 2010 to determine these sub-catchment specific rates, as summarised in Table 22.

Table 22. Catchment specific underground workings acidity load generation rates.

Site	2006-09 acidity pH 7 load (t/year)	2010 UG workings area (ha)	Acidity load generation rate (t/ha/year)		
			2010	2025	2033
S6	300	67	4.5	4.1	3.9
S23	1,786	152	11.7	10.7	10.2
S24A	1,994*	125	15.9	14.5	13.8
S25	165**	22	7.6	6.9	6.6
Combined	**4,246**	**366**	**11.6**	**10.6**	**10.1**
Twins	Not quantified	3.6	11.6	10.6	10.1

* Estimate based on 2010 acid loads due to insufficient data between 2006-09 period. ** The S25 2006-09 acidity load from MWM (2025) was used (equivalent to acidity to pH 5) to provide a better fit with measured concentrations in later datasets.

It should be noted that Table 22 underground workings acidity load generation rates were derived prior to opencast mining. Quantifying the underground workings acidity load being generated currently is complicated by factors associated with fire suppression, including:

- Variable, but overall increased, volumes of water flowing through the UG workings as additional water is pumped into workings to suppress fires. Increased flow rate typically causes an increase in acidity load as acid salts are leached from workings. Fire suppression pump rates are variable, with a ~100 L/s long term average since mid-2022. This is significant (often up to 50% of base flow) given median flow rates at key sites S23 and S24A downstream of fire suppression areas are 103 and 178 L/s, respectively, through the operational period; and
- Variable acidity concentration of water pumped into underground workings for fire suppression, with pit sump acidity loads added to UG workings acidity loads when AMD from pit sumps is used for fire suppression.

The Post EOML / Closure Phase remnant underground workings acid load estimates are calculated using the remnant underground workings area and sub-catchment specific generation rates in Table 22. Long term underground workings acidity loads are assumed to decay at the same rate as waste rock ELFs (i.e., 0.62%/year).

As discussed, the proposed Pit Boundary Seal is assumed to prevent any significant additional flow / flushing of acidity through the remnant historic underground workings due to water captured within the opencast disturbance footprint.

Operational fire suppression will cease prior to EOML (anticipated end date 2028) as fires in the mining pit areas will have been removed. Fires will remain in areas outside of the pit area and may need cooling/extinguishing as required. These areas of potential fires are identified in Figure 39.

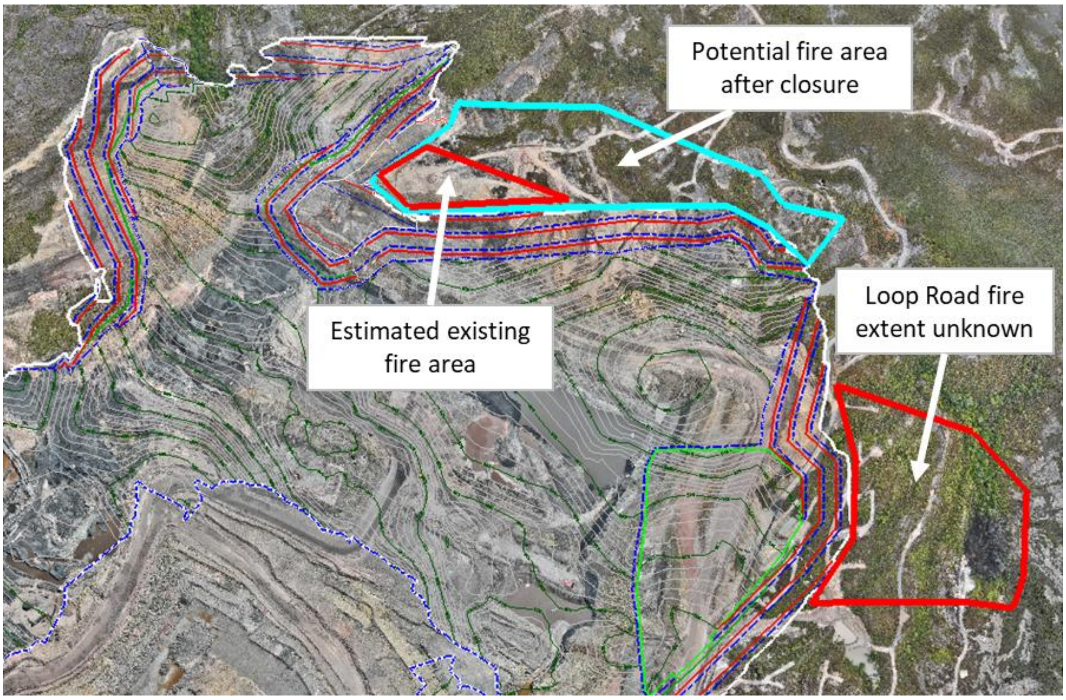

Figure 39. Potential fire areas post EOML

Provision for pumps and pipelines will be made at EOML based on the underground fire situation. There is the potential for the Crown to fund pumps and pipelines for the suppression of these fires if required beyond the existing 2044 fire suppression consent (RC09028) expiry. The effect of fire suppression (post EOML) on downstream acidity loads and acidity / Al concentrations has not been quantified. If needed, fire suppression water would be sourced from Mangatini Sump or MW16 Sump (after in-sump alkaline dosing commences) through the EOML / Closure Phase to minimize acidity loads.

6.4 Incorporation of AMD management / treatment

This section describes how the modelled 'potential effect' acidity loads are reduced to reflect AMD management / treatment and derive remnant 'managed effect' acidity loads in each sub-catchment.

6.4.1 Pit sump AMD capture and Pump to Mangatini Treatment System

The maximum pumped water take from in-pit sumps during the EOML phase has been calculated (Table 23). During the EOML Phase pumping will be staged from each pit to ultimately report to the MW16 Sump, from there pumping will occur to the Mangatini Treatment System (with treatment as per Mangatini Sump management plan (GHD 2018; GHD 2024 update)).

Table 23. EOML (2033 – 2047) maximum pumped water takes by Sump / Catchment

Catchment (taken from)	Sump (taken from)	Sump (pumped to)	Max flow rate taken (L/s)	Pumping ceases
Twins (T1)	Twins	Rockies	72	2040
Granity (S25)	Rockies	MW16 / Mangatini	68	2037
Granity (S25)	Hope Lyons	MW16 / Mangatini	35	2037
Granity (S25)	Granity North	MW16 / Mangatini	13	2037
Granity (S25)	Granity South	MW16 / Mangatini	30	2037
Miller (S24a)	Miller	-	0*	2033
Mine (S6)	MW16	Mangatini	319	2047

* Miller Sump discharge directly to Miller Stream from EOML within betterment reference values.

It is assumed that if the 'treatable' component of acidity load collected in pit sumps is captured and pumped to another catchment for controlled discharge or treatment (i.e., up to 90th percentile flows), the effect of any high-flow (>90th percentile) AMD derived from active pit, highwall, or coal floor runoff on downstream acidity loads and annual median acidity and Al concentrations is negligible. This includes the effect of sporadic spilling during rain events when flow rates exceed the 90th percentile (95th percentile at Twins Sump). This assumption applies to operation of the sumps in Twins, Granity, and Miller catchments.

AMD collected in pit sumps and pumped to Mangatini Treatment System is discharged via Mangatini Stream to Ngakawau River. Through the EOML Phase (2033 to 2046) a nominal ~80% of the 'treatable' acidity load collected in MW16 Sump will be pumped to the Mangatini Treatment System, while the remaining 20% is discharged to S6 without treatment. This proportion of MW16 Sump acidity load discharge to S6 without treatment is expected to maintain MC1 Al concentrations at the betterment reference values between 2033 and 2046. Pumping in other pit sumps (i.e., Miller, Granity) is expected to cease as summarised in Table 23, once AMD concentrations stabilise / decrease to levels low enough for discharge to meet betterment reference values.

Any AMD sources outside the sump sub-catchment that are subject to controlled discharge (e.g., Twins T1 catchment underground workings) will discharge naturally to the receiving environment.

6.4.2 In-Sump (MW16) AMD Treatment – Post 2047

AMD treated in MW16 Sump (from 2047 onwards) will discharge to the S6 tributary of Mine Creek and ultimately discharge to Ngakawau River via MC1. The degree of AMD treatment at MW16 sump is the key variable influencing betterment of Mine Creek post 2047. Different treatment percentage scenarios were modelled to optimise treatment targets and achieve betterment. This scenario modelling is not presented, but remnant underground workings in both S6 and S23 Mine Creek tributaries are expected to be sufficient to prevent ecological recovery at MC1 even under full treatment of MW16 Sump scenarios. The nominal ~75% in-sump treatment (post 2047) scenario of MW16 Sump acidity loads was developed to result in long term MC1 Al concentrations comparable to the MC1 betterment reference values. The effects of modelled AMD treatment are described in the following sections.

6.4.2.1 Treated AMD acidity to Al correlation

The effect of AMD treatment on water quality has been assessed using LDP1 / Mangatini Sump AMD treatment performance monitoring data. This data was used to develop an acidity vs Al concentration calculator used to determine the degree of Al removal under partial acidity treatment scenarios (e.g., for a 75% treatment scenario).

Acidity is predominantly comprised of pH, Fe, and Al acidity. The current AMD treatment process involves dosing with alkalinity (e.g., CaO slurry) to neutralize these components of acidity. Future AMD treatment by MgO dosing is assumed to be similar. For modelling purposes, the sequence of acidity component neutralisation is assumed to be:

- Hydrogen ion acidity (as measured by pH) is neutralised first;
- Fe acidity is neutralised by hydrolysis, forming insoluble Fe precipitates when pH increases above ~3.5; and
- Al acidity is neutralised by hydrolysis, forming insoluble Al precipitates when pH increases above ~4.5.

The sequential nature of acidity neutralisation means that Al removal is not directly proportional to acidity neutralisation. A large proportion of hydrogen ion (pH) and Fe acidity is removed before there is any reduction in the Al concentration. This is demonstrated in a subset of the MGIU monitoring dataset, where upstream dosing using CaO slurry resulted in partial neutralisation of MGIU acidity. The Fe and Al concentrations of MGIU samples with pH > 4 have been separated in Figure 40, and show the sequential (pH dependent) removal of Fe prior to Al compared against typical / median un-dosed MGIU concentrations at pH ~3. Indicative Fe and Al neutralisation pathways have been sketched over the dataset.

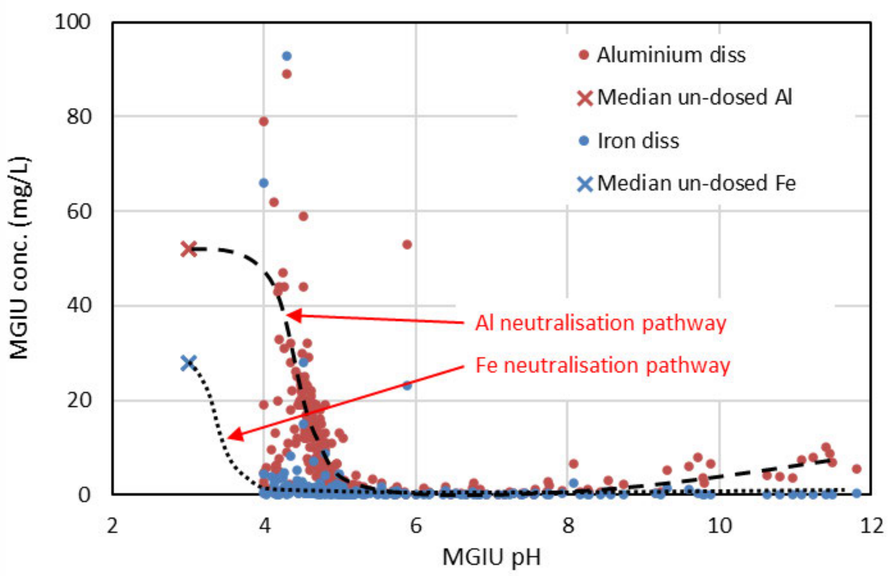

Figure 40. Partially treated MGIU Al and Fe concentration.

To model partial AMD treatment (e.g., 75% treatment) a series of calculations were required to determine the ratio of residual Al concentration to residual acidity concentration, for a given degree of treatment.

MGIU data were reviewed to determine the relative contribution of pH, Fe, and Al components of acidity over a range of different acidity concentrations. This process involved:

Firstly, determining whether calculated acidity was a good analogue for measured acidity. The calculated acidity uses the following equation:

$$Calc.acidity = 50 \times \left(\frac{3 \times Fe}{56} + \frac{3 \times Al}{27} + 1000 \times 10^{-pH}\right)$$

Where *Calc. acidity, Fe, and Al* are in units mg/L.

Figure 41 shows there is a good correlation between measured and calculated acidity concentration at MGIU. The linear trendline gradient indicates that the calculated acidity concentration is slightly higher (~5%) than the measured acidity concentration.

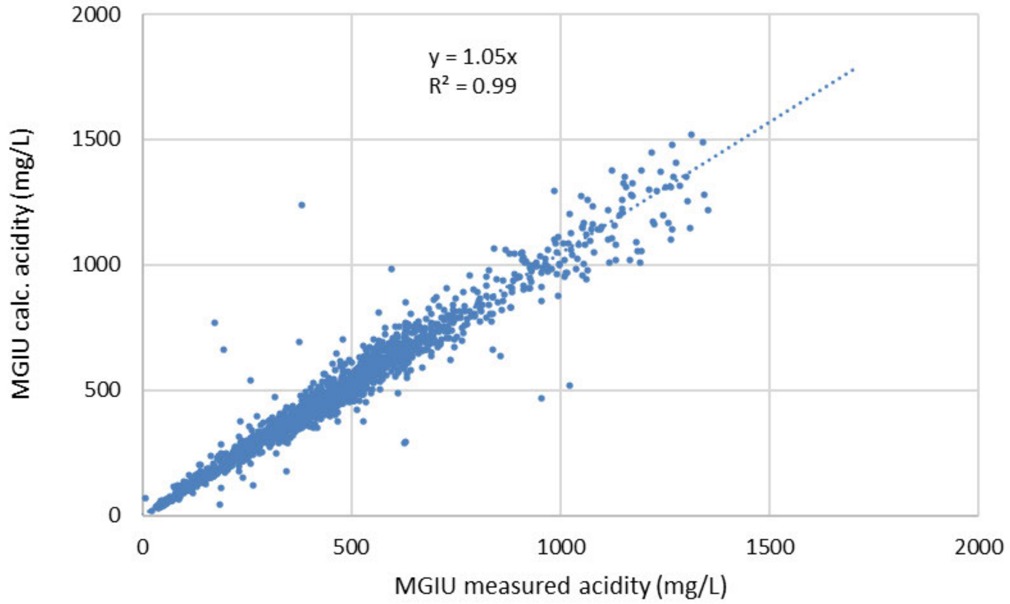

Figure 41. MGIU measured versus calculated acidity concentration.

Secondly, the theoretical contribution of pH, Fe, and Al to total calculated acidity was determined for each datapoint where measured values of all three parameters were available (Figure 42). This dataset showed that the proportion of acidity contributed by each component was non-linear over the full range of MGIU acidity values.

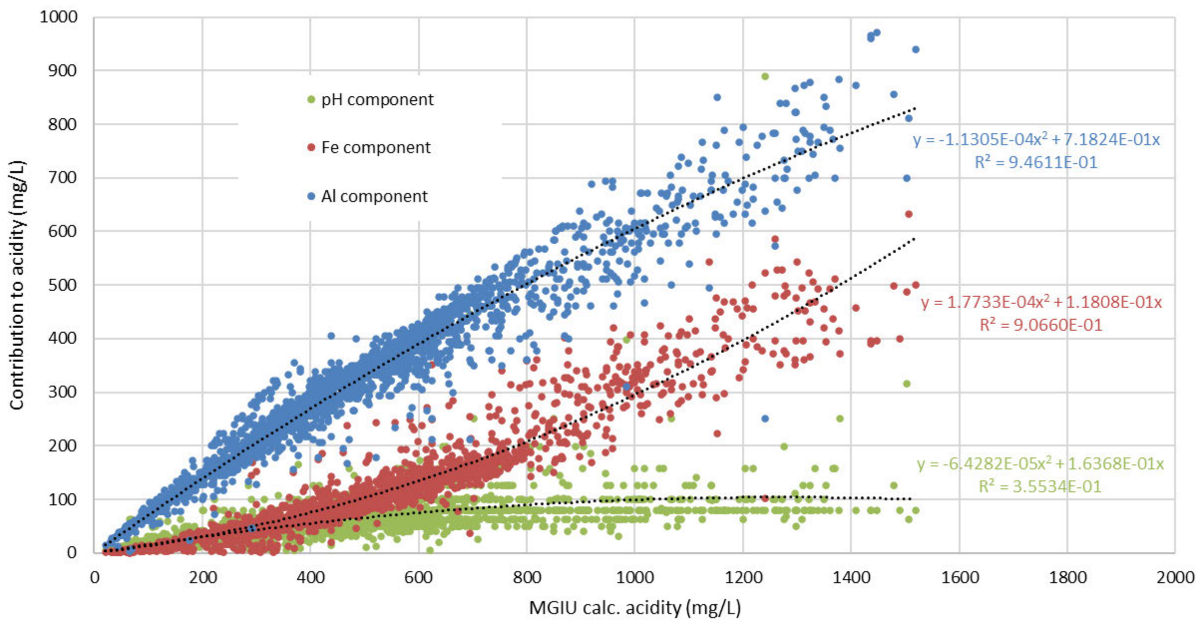

Figure 42. Relative contribution of pH, Fe, and Al to calculated acidity.

The polynomial trendlines from Figure 42 were used to calculate the contribution to acidity (as a percentage) of each pH, Fe, and Al component of acidity in Figure 43. Figure 43 shows that a 75% treatment of acidity scenario:

- Would result in effectively full neutralisation of both the pH and Fe components of acidity; and
- Neutralisation of a large proportion of the Al component of acidity.

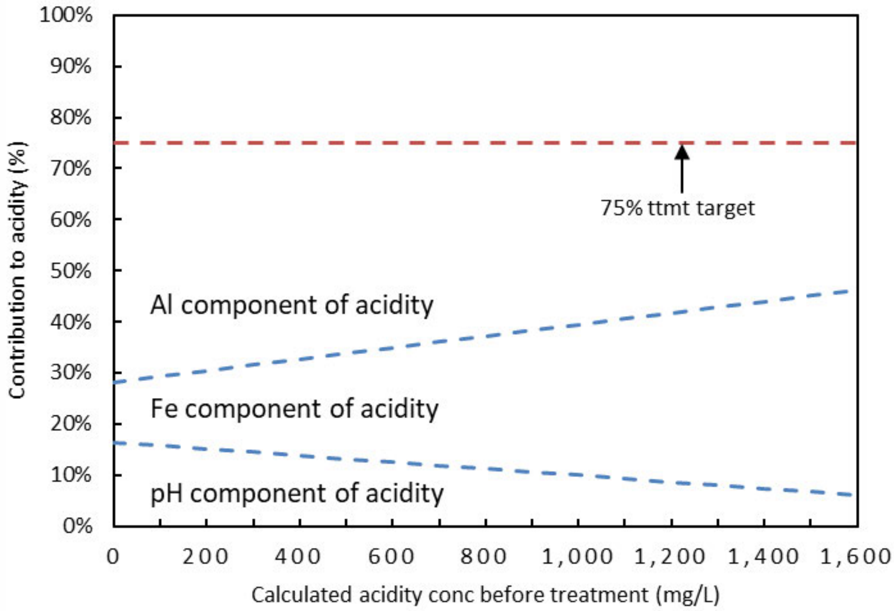

Figure 43. pH, Fe, and Al contribution to acidity (percentage) versus calculated acidity (untreated).

The key implication of Figure 43 is that while the contribution of pH, Fe, and Al acidity in untreated AMD varies significantly, under a 75% treatment scenario (required to meet long term Al concentration betterment reference values at MC1) the residual calculated acidity concentration will theoretically be directly proportional to the residual Al concentration, regardless of the original untreated acidity concentration, i.e., the ratio of residual Al to acidity concentration would be constant.

Thirdly, the calculated acidity concentration (for a given level of treatment) was converted back to Al concentration using the following equation:

$$Al = \left(\frac{Calc.acidity}{50}\right) \times \frac{27}{3}$$

For modelling purposes the calculated Al values were then plotted against a theoretical *residual acidity incl. other metals* concentration value (Figure 44). The *residual acidity (incl. other metals)* values assume that an additional 5% of the original pre-treatment calculated acidity concentration would still be present post treatment due to unhydrolysed metals with a higher minimum solubility pH (e.g., Mn, Co, Ni, Zn, etc.). Example calculations for the datapoint in the red circle in Figure 44 relates to an untreated calculated acidity of 16,000 mg/L, and:

- 75% treatment reduces calculated acidity to 400 mg/L;
- plus an additional 80 mg/L for ‘other metals’; brings
- *residual acidity (incl. other metals)* to 480 mg/L.

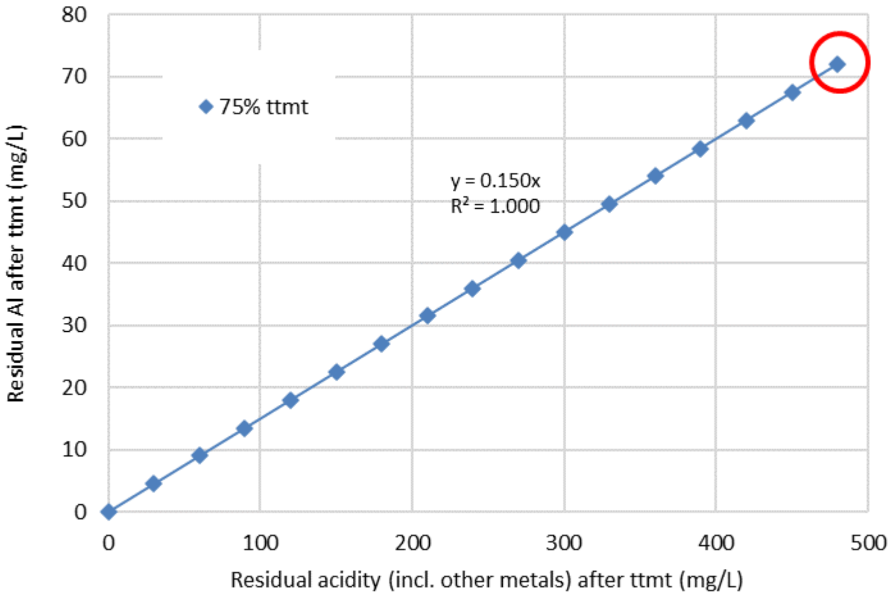

Figure 44. Residual acidity and Al concentration correlation after 75% treatment.

The trendline shown in Figure 44 is used to estimate residual Al concentration for a given residual acidity concentration for the proportion of AMD treated to 75%, i.e., residual Al concentration (mg/L) = 15% of residual acidity concentration value (mg/L).

6.4.2.2 Mixing treated water and untreated AMD

The effect of discharging partially treated (i.e., 75% treatment) water into the S6 tributary was assessed through the following process.

(1) Acidity loads for AMD sources within S6 catchment reporting to MW16 Sump for treatment were separated from AMD sources that do not report to MW16 Sump for treatment;

(2) MW16 Sump acidity load was decreased proportional to the treatment scenario (75% treatment equates to a 75% reduction in acidity load);

(3) The remnant MW16 Sump acidity load was then added to the acidity load of other untreated AMD sources in S6 catchment (e.g., remnant historic underground workings, Millerton East ELF, etc.);

(4) The S6 catchment acidity load was converted to acidity concentration at S6 using the previously derived S6 catchment acidity load : acidity concentration correlation (Figure 18);

(5) Al concentration at S6 was estimated by factoring in the different Al : acidity ratios for untreated and treated AMD. This is necessary as the treated AMD has a different Al : acidity ratio to untreated AMD. The two ratios used were:

    a. Untreated S6 AMD (0.108 mg/L Al per mg/L Acidity – from Figure 20; and

    b. 75% treatment of MW16 Sump AMD (0.15 mg/L Al per mg/L Acidity) – from Figure 44.

The proportion of acidity load derived from untreated versus treated (75% treatment scenario) sources was used to calculate the scenario specific Al : Acidity ratio, to more fairly represent residual Al concentrations after partial treatment. For the 75% treatment scenario this resulted in a combined S6 ratio of 0.14 mg/L residual Al per mg/L residual Acidity.

The process was duplicated to assess the effect of different MW16 Sump treatment scenarios at MC1.

7.0 Lower Ngakawau River effects assessment

The lower Ngakawau River is an important site for long term water recovery as it includes the effect of Mine Creek discharges (as well as the combined effects of St Patrick and Mangatini Streams). An additional AMD model was developed for the Lower Ngakawau River to reflect the differences in geochemistry and utilise historic monitoring data.

7.1 Lower Ngakawau River site description

The NRB monitoring site is located at the state highway bridge on the Ngakawau River, approximately 150 m from the sea (shown in Figure 1 and Figure 45). The NRB site is influenced by factors including:

- Residual Al loads in Ngakawau River (measured at NR), including the effects of treated AMD discharge from the Mangatini Treatment System (via LDP1) and the McCabes Treatment System (via lime dosing plant 2 (**LDP2**)) catchments;
- Currently untreated AMD loads discharging from Mine Creek (Calculated at Mine Creek Mouth (MC1) and including the contribution from both S23 and S6 tributaries);
- Untreated AMD loads from other historic mining areas in greater Ngakawau Catchment (e.g., Charming Creek, Old Fly Creek workings, etc.); and
- Tidal influences.

The relative location of the existing water quality monitoring sites is provided in Figure 45 for context. Historic monitoring data for site 'NB' was collected at a site equivalent to 'NRB' in Figure 45.

Figure 45. Lower Ngakawau River monitoring sites.

Historic Al and pH data at Lower Ngakawau River monitoring sites (NB and NR Estuary) are shown in (Figure 46). Historic acidity concentration data at NRB are unavailable, but acidity is expected to be low (and has not been modelled) considering the site typically has circum-neutral pH.

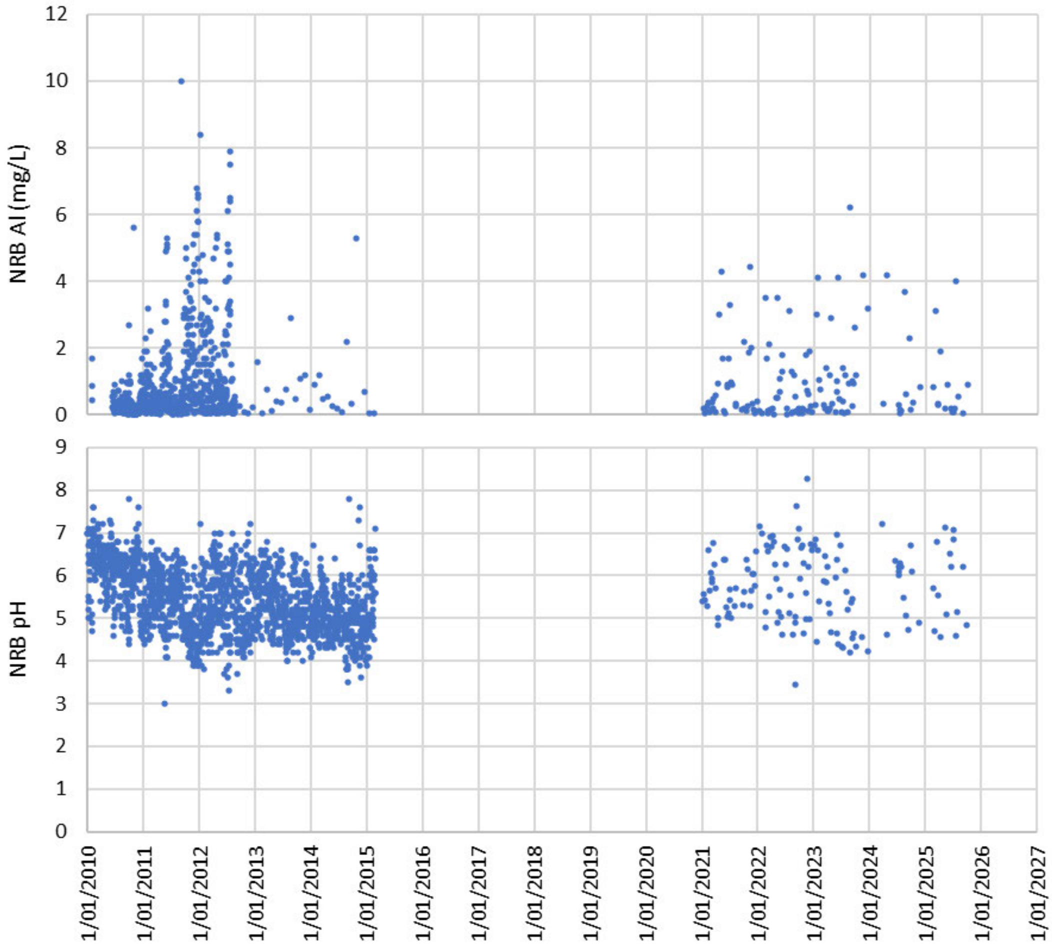

Figure 46. NB (2010 – 2015) and NR Estuary (2021 onwards) Al concentration and pH timeseries.

7.2 NRB monitoring data

There are two sets of water quality monitoring data that are relevant to the NRB site, including:

- 'NB' collected between 2010 and 2015; and
- 'NR Estuary' ongoing since 2021.

The Al concentration statistics for these datasets are summarised in Table 24.

Table 24. NB / NR Estuary Al concentration statistics

Site		NB / NR Estuary annual percentile Al conc			Average Al	Count
		50%ile	75%ile	90%ile		
NR Estuary	2025	0.34	0.9	2.6	0.91	15
	2024	0.35	1.2	3.6	1.1	12
	2023	0.95	1.4	3.8	1.4	34
	2022	0.21	1.2	1.9	0.77	41
	2021	0.34	1.0	2.4	0.89	39
NB	2014	0.55	1.1	2.2	1.1	11
	2013	0.62	1.1	1.6	0.83	12
	2012	0.54	1.8	3.4	1.3	230
	2011	0.49	1.2	2.9	1.0	346
	2010	0.21	0.4	0.7	0.35	200

Key statistics from the NRB Al monitoring dataset are shown in Figure 47, and indicate that annual median and 75th percentile Al concentrations have been relatively stable over time.

Figure 47. NRB annual median and 75%ile Al concentrations.

7.3 Modelled 'NRB River' effects assessment

The effects of Millerton Water and AMD Management on water quality at a modelled site (NRB River) capturing NR + MC1 loads (i.e., located downstream of the Mine Creek / Ngakawau River confluence but upstream of any tidal dilution influence) have been assessed. This calculation assumed:

- NRB River Al loads are equivalent to the sum of NR and MC1 Al loads; and
- The NRB River correlation between Al load and Annual median and 75th percentile Al concentration is the same as the correlation at NR (i.e., excludes the minor potential for 'dilution' by additional flow volume from Mine Creek and any tidal influence).

7.3.1 Historic NR Al load versus Al concentration

The available NR monitoring dataset was used to calculate Al loads at time of water quality sampling (Table 25). For periods where there were insufficient flow rate data for annual Al load estimates to be made (red values in Table 25) the Al load has been estimated using the correlation between median annual Al concentration and Al load (Figure 48). The derived Al loads are shown in Figure 48 as blue datapoints and measured Al loads are shown in orange.

Table 25. NR estimated Al load and annual median / 75%ile concentrations

	NR Al load*	NR annual median Al	NR annual 75%ile Al	NR Al sample count
2007	363	0.367	0.8445	315
2008	277	0.28	0.425	347
2009	376	0.38	0.61	360
2010	347	0.25	0.42	362
2011	283	0.24	0.43	357
2012	508	0.26	0.51	357
2013	632	0.65	1.4	353
2014	680	0.74	1.9	349
2015	523	0.54	0.87	290
2016	446	0.45	0.68	245
2017	336	0.41	0.685	243
2018	399	0.446	0.66	239
2019	420	0.47	0.64	244
2020	464	0.49	0.77	249
2021	475	0.4	0.57	244
2022	272	0.275	0.43	240
2023	218	0.22	0.4	243
2024	178	0.18	0.35	244
2025	158	0.16	0.32	197

* Estimated NR Al load datapoints shown in red text.

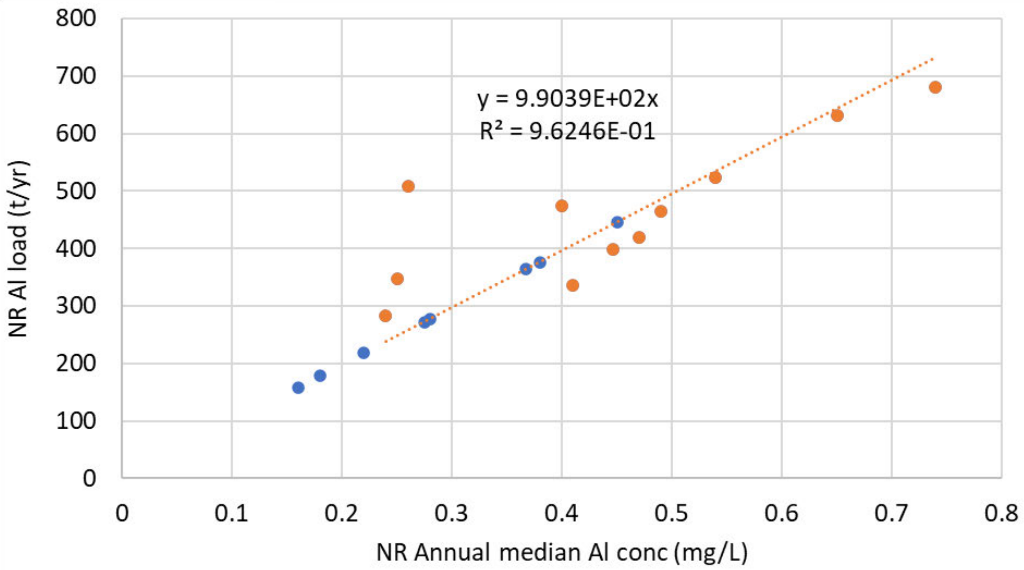

Figure 48. NR Al load versus annual median Al concentration.

Figure 49 shows the correlation between NR Al load versus annual median and 75th percentile Al concentrations. The data are fitted with linear trend lines forced through the origin.

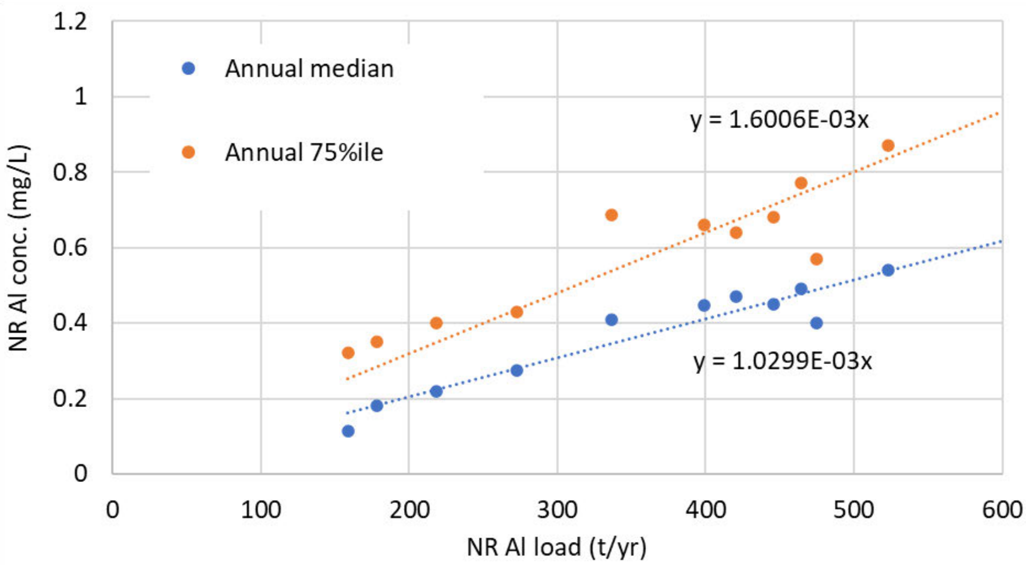

Figure 49. Correlation between NR Al load and annual median / 75%ile Al concentration.

7.3.2 NRB River Al load estimates

The NRB River Al load estimates are calculated by adding the Al load from NR and MC1 (including contributions from S23 and S6) together. This process is repeated for the historic dataset and extrapolated over the long term. The NRB River Al load calculation assumes that Al loads are conservative and any geochemical reactions that occur due to the mixing of the NR and MC1 waters do not change Al loads (and therefore concentrations) after mixing.

The historic NR + MC1 Al loads are calculated using:

- Annual NR Al loads, as derived in Table 25; and
- Annual MC1 Al loads, the sum of historic S23 and S6 Al loads calculated using historic acidity loads and the acidity concentration to Al concentration conversion ratios for S23 and S6, derived in Figure 20.

The combined NRB River (NR + MC1) Al loads summarised in Table 26.

Table 26. Historic dataset NRB River Al load and concentration estimate.

Year	Al Load (t/yr)		
	NR	MC1	NRB River (NR + MC1)
2007	363	213	**576**
2008	277	258	**535**
2009	376	200	**576**
2010	347	169	**516**
2011	283	345	**627**
2012	508	517	**1,026**
2013	632	241	**873**
2014	680	394	**1,074**
2015	523	379	**902**
2016	446	310	**756**
2017	336	265	**601**
2018	399	252	**651**
2019	420	659	**1,079**
2020	464	547	**1,011**
2021	475	718	**1,193**
2022	272	567	**839**
2023	218	786	**1,004**
2024	178	751	**930**
2025	158	905	**1,063**

The future forecasts of NR + MC1 Al loads are calculated using:

- The **potential effect estimate** used an extrapolation of the NR Al load decay trend (excluding the effect of Millerton AMD being pumped to the Mangatini Treatment System) over the long term and assumed that forecast MW16 acidity loads were discharged to Mine Creek without treatment. The NR Al load extrapolation assumes that NR Al loads decay linearly from ~178 t/yr in 2026 to ~170 t/yr at EOML (2033), at a rate of 0.62%/yr. The 178 t/yr Al load value for 2026 was selected based on the ~178 t/yr Al load measured in 2024 (Table 26) and an assumption that now that major Stockton

Mine contributors of Al load to NR are largely treated (e.g., Mangatini Treatment System via LDP1 and McCabes Treatment System via LDP2) ongoing reductions in NR Al load would be due to long term load decay only.

- Separate extrapolations of NR Al loads were made for the **Managed effect** scenario. For the Operational Phase (2026 – 2033) 2033 NR Al load was assumed to return to ~450 t/yr, which is comparable to when AMD loads reporting to the Mangatini Treatment System for treatment were relatively high and included pumping AMD from Millerton (Figure 50). The Al load in subsequent years (i.e., 2034 and onwards) was decayed at a rate proportional to the effect of Millerton ELF rehabilitation (scaled off MW16 acidity load decay in the EOML AMD model). The remnant Al load contributed from S23 and S6 were proportional to untreated AMD loads not captured / pumped to the Mangatini Treatment System, as determined by the Operational and EOML / Post Closure AMD models.

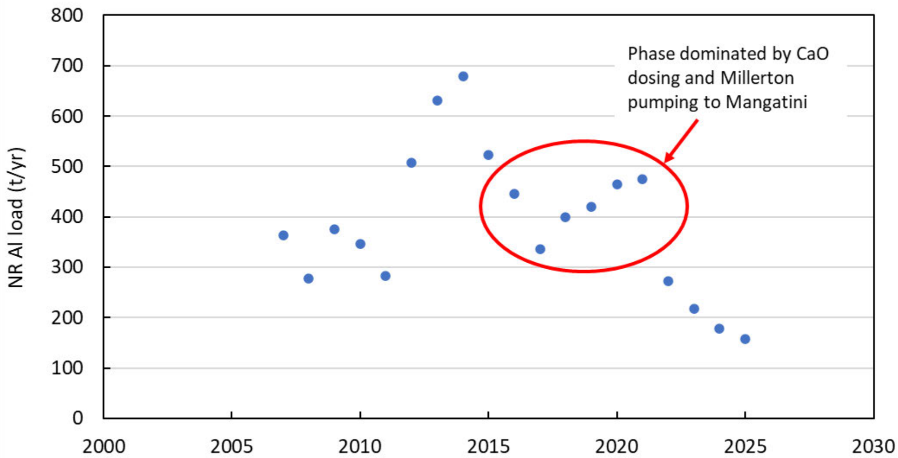

Figure 50. NR Al load over time.

- For the period post 2047 when 75% of AMD is treated in MW16 Sump by alkaline dosing:
    - The NR Al load is returned to the long-term Al load decay trend / trajectory; and
    - S23 and S6 discharge Al loads were scaled off projected Acidity loads for the ~75% treatment scenarios, which was equivalent to approximately 60% reduction in MW16 Sump contribution to S6 Al loads.

The resulting Al load and Al concentration forecasts (concentration forecasts were calculated by converting Al load forecasts to median and 75th percentile Al concentrations using the correlation in Figure 49) for different potential and managed effect scenarios are summarised in Section 8.0.

8.0 Modelled acid load and water quality results

The results of AMD load and water quality modelling for Operational and EOML / Post Closure Phases are summarized for each sub-catchment in the following sections. These summaries incorporate the modelled effect of:

- Proposed mine development including changes to catchments, fire suppression, and creation of new AMD generating structures (e.g., Millerton ELF) and surfaces (e.g., Highwall, coal floor) that will exist at EOML; and
- Staged AMD management from 2026 onwards through increased pumping of Millerton AMD to the Mangatini Treatment System or alkaline dosing at MW16 Sump from 2047 onwards.

The AMD and water quality modelling process details are described in Section 4.0 to 7.0.

The results of acidity load and median annual acidity and Al concentrations modelling are summarised in separate figures for each sub-catchment. Each figure includes several series showing:

- **Historic** measurements / estimates of historic loads / concentrations;
- The **betterment reference** line, extrapolated from 2006 – 09 values through to EOML and for an 80-year period thereafter. The betterment reference line is used as a maximum load / concentration value for modelled acidity loads and acidity / Al concentrations, at a given point in time. Water and AMD management strategies were developed to deliver improved water quality by reducing the forecast 'Managed effect' acidity loads and acidity / Al concentrations (post EOML) below the betterment reference values;
- **Potential Effect line** – indicating the potential effect of uncontrolled AMD discharge generated within the sub-catchment to the receiving environment;
- **Managed Effect line** – indicating the expected effect of residual AMD discharge to the receiving environment with AMD management occurring (e.g., pumping pit sumps to the Mangatini Treatment System, Alkaline dosing in MW16 Sump, etc.); and
- Key milestone dates for AMD management are also shown, including Opencast start date (2010), EOML (2033), and when pumping can cease / Pit Sumps naturally discharge to receiving environment within the betterment reference values (between 2033 and 2047 depending on catchment).

The relationship between the **betterment reference** line and **managed effect** line dictates the level and duration of AMD treatment required to improve water quality and achieve betterment.

8.1 Twins Stream (T1)

The forecast effect of mining the Millerton Block (including cumulative effects from historic and contemporary operations) on Twins Stream (at T1) acidity load and median annual acidity and Al concentrations is shown in Figure 51 and Figure 52, respectively. As discussed in Section 4.1.2, the Twins Stream at T1 analysis is based on the 2013 – 2021 dataset. Additional data (including recent 2025/26 data collected by BRL) suggest concentrations (and possibly loads too) have decreased 2022 and

2025/26. This change in water quality is not expected to affect the Twins AMD management strategy and Twins at T1 compliance criteria will be set as discussed in Instream (2026).

Twins Sump pump capacity is sized to capture up to 95th percentile flows and transfer AMD to Mangatini Treatment System or Granity Catchment, with only the >95%ile proportion of flow spilled to Twins Stream. The higher degree of flow capture is proposed at Twins Sump to further reduce spill frequency.

8.1.1 Twins Stream AMD model observations

Twins AMD management consists of:

- Collecting Active Pit, Highwall, and Coal Floor AMD in Twins Sump which is pumped out of Twins Catchment to:
  - The Mangatini Treatment System during the Operational Phase and until 2037; and then
  - Rockies Sump for controlled discharge to Granity Stream until 2040.
- Controlled diversion of AMD discharging Twins Catchment historic underground workings (within the area of disturbance) to T1 to maintain the current level of AMD impact throughout the Operational Phase and until 2040. The AMD seeps reporting to T1 currently do not emerge at a single adit, so they may continue to report to T1 without requiring construction of a controlled diversion. As such, management of the historic AMD reporting to T1 will be better defined during the Operational Phase; and
- Diversion of all flows (including rehabilitated highwall and coal floor, remnant historic workings, etc.) to Twins Sump between 2041 and 2046, but incorporating minor AMD treatment by alkaline dosing (e.g., NaOH) in-sump (or alternatively by passive treatment (systems not designed / assessed under BPCP)) to meet betterment reference values, and discharge by natural spilling via engineered spillway (design to be confirmed) to Twins Stream above T1.
- Natural spilling from Twins Sump to Twins Stream within betterment reference values from 2047 onwards without pumping / treatment.

Key observations for modelled AMD effects on Twins Stream (T1) include:

- Removal of underground workings in Twins Catchment is minimal (< 10% removed), which creates a limited capacity for additional AMD discharge while showing betterment. This removal of underground workings will occur during the Operational Phase, resulting in minor betterment prior to EOML.
- Designing / implementing methods to collect and divert underground workings discharge currently reporting to T1 away from the proposed pit sump catchment to ensure the existing T1 water quality remains similar to current will require development. This may involve supplementing underground workings discharge flows with a small volume of treated Twins Sump flow (e.g., utilising alkaline (e.g., NaOH) dosing, or some other system to be determined) to meet betterment reference values

and compliance criteria (to be derived on 2025/26 concentration datasets) through the Operational Phase.

- The managed effect curve incorporates the effects of a combination of:
  - Pit Sump pumping out of Twins Catchment likely until end of 2040 (while Highwall and Coal Floor acidity loads decay rapidly); and
  - Minor AMD treatment in-sump until end of 2046 (utilising alkaline (e.g., NaOH) dosing, or some other system to be determined) to meet betterment reference values and compliance criteria (to be derived on 2025/26 concentration datasets). AMD modelling indicates that in-sump treatment would target neutralisation of <3 t/year acidity load in 2041 with no treatment required in 2046.

  These management options will be used to control Twins Sump water quality sufficiently to allow natural discharge to Twins Stream (above T1)) within betterment reference values at T1.
- Modelled Twins Sump water quality meets the betterment reference values without pumping or treatment from 2046 onwards.

It should be noted that the increase in Twins 'Potential acidity' through the Operational Phase has not been calculated separately. The additional potential acidity load generated in Twins Pit Sumps has been included in calculations for the Granity Catchment (S25) pit sumps.

It is proposed that adaptive management and performance monitoring are used to manage Twins Catchment AMD effects operationally. For the Twins Catchment this is likely to involve:

- Ongoing refinement of predicted betterment reference values based on performance monitoring in the context of untreated/historic AMD contributions; and
- Extending the duration of proposed AMD management (e.g., pump pit sumps to the Mangatini Treatment System, Granity Catchment for controlled discharge, or minor in-sump treatment) to allow for additional highwall and coal floor acidity load decay until discharge within betterment reference values becomes possible.

8.1.2 Twins Stream Best Practicable Option

Developing the Twins Catchment water and AMD management strategy involved BPO considerations / discussions. The goal of the Twins BPO was to deliver improved water quality such that the 'managed effect' of AMD discharges remained at or below the betterment reference values. The major EOML contributors to Twins acidity load were identified as highwall and coal floor, which are modelled to decay relatively quickly, such that the modelled potential effect of uncontrolled AMD discharge decreased to betterment reference values by 2046, without requiring ongoing management.

AMD management options available for maintaining betterment were either:

- Pumping pit sump AMD to the Mangatini Treatment System ; or
- Treating pit sump acidity loads in-pit due to relatively low Twins acidity loads.

The BPO for Twins AMD management was identified as:

- Pump Twins Sump AMD to Rockies Sump for:
  - Transfer to the Mangatini Treatment System through the Operational Phase and until 2037 while highwall and coal floor acid loads are high;
  - Controlled discharge to Granity Stream until 2040 while highwall and coal floor acidity loads are moderate (and can be discharged within betterment reference values at S25).
- Transition to partial AMD treatment in-sump from 2040 until end of 2046 (utilising alkaline (e.g., NaOH) dosing, or some other system to be determined) while highwall and coal floor acid loads are relatively low, but still sufficient to exceed betterment reference values at T1. Treatment requirements to be confirmed at EOML. Partial treatment in-sump is preferred as it:
  - Reduces pumping requirements;
  - Reduces diversion between catchments;
  - Reduces the volume of relatively low acidity concentration AMD being pumped into the Mangatini Treatment System; and
  - Maintains net acidic discharge water quality to minimise LDS management and secondary geochemical reactions (generating turbidity) if fully treated water mixed with untreated AMD further down Twins Stream.
- Natural spilling of Twins Sump to Twins Stream from 2047 onwards within the betterment reference values.

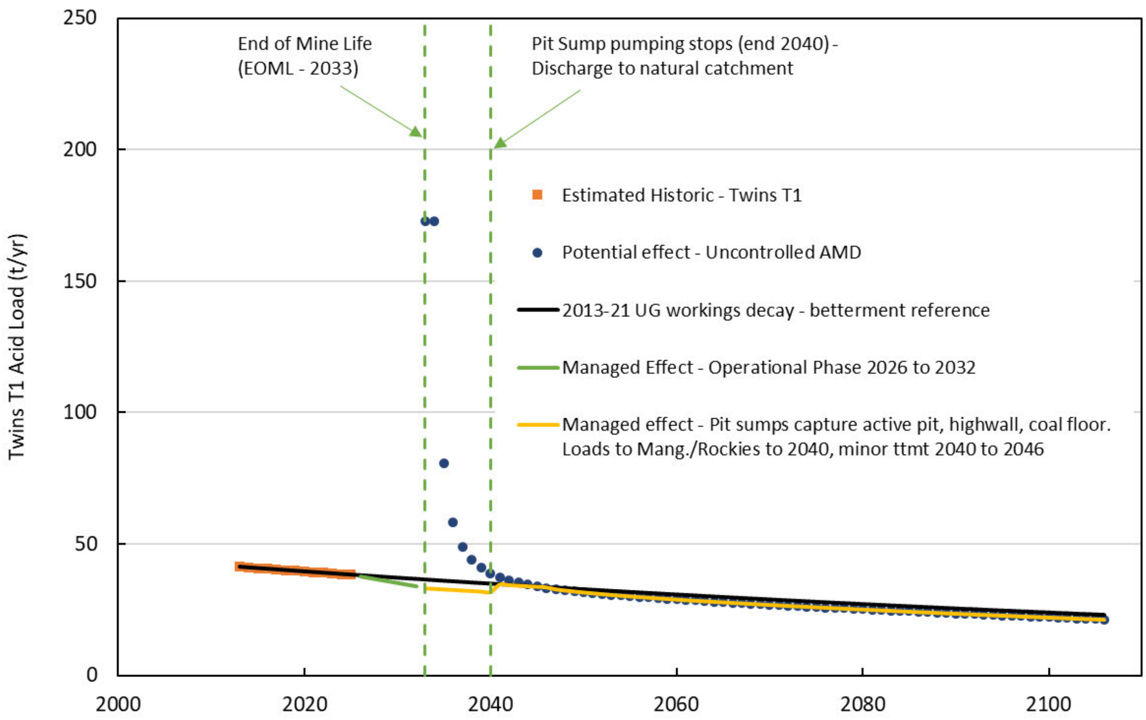

Figure 51. Estimated historic and forecast Twins Stream (T1) acidity load. NB: 'potential effect' through Operations Phase included in Granity Catchment calculations, not quantified for T1 specifically.

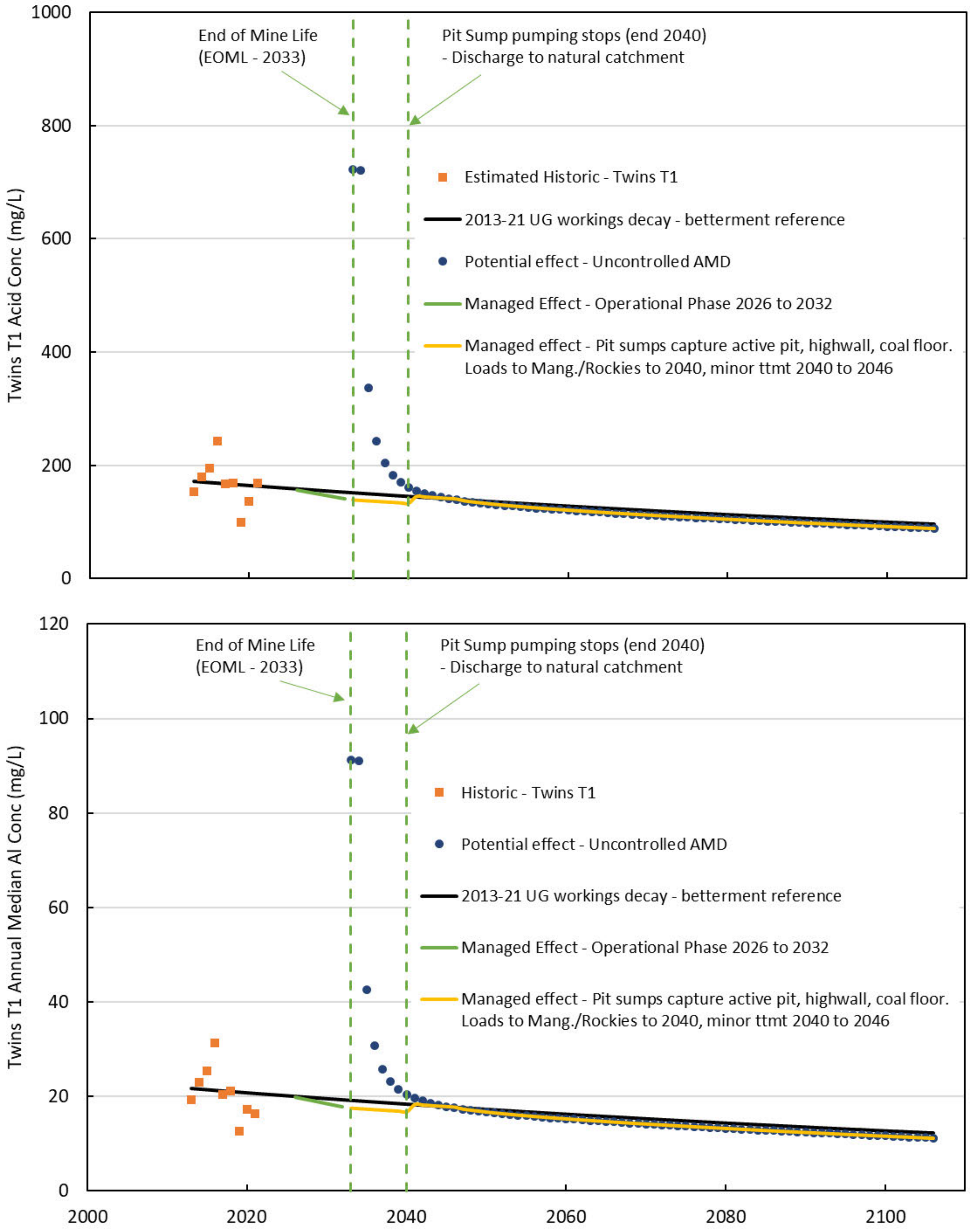

Figure 52. Estimated historic and forecast Twins Stream (T1) acidity and Al concentration. NB: 'potential effect' through Operations Phase included in Granity Catchment calculations, not quantified for T1 specifically

8.2 Granity Stream (S25)

The forecast effect of mining the Millerton Block (including cumulative effects from historic and contemporary operations) on Granity Stream (at S25) acidity load and median annual acidity and Al concentrations is shown in Figure 53 and Figure 54, respectively.

8.2.1 Granity Stream AMD model observations

Granity Catchment (including contributions from Rockies, Hope Lyons, and Granity Pits) AMD management consists of:

- Collecting Active Pit, Highwall, and Coal Floor AMD in a series of pit sumps (Rockies Sump (permanently diverted to Granity Stream catchment), Hope Lyons, Granity North, and Granity South) which are pumped out of Granity Catchment to the Mangatini Treatment System during the Operational Phase and until 2037; and
- Diversion of all surface flows (including rehabilitated highwall, coal floor, and minor seepage from the portion of Millerton ELF that drains to Granity South Sump) Post-2037 to Pit Sumps and discharge via engineered spillway (design to be confirmed) to Granity Stream above S25.

Key observations for modelled AMD effects on Granity Stream (S25) include:

- Removal of underground workings in Granity Catchment is moderate (~44% removed relative to 2010 extent), which creates capacity for a small additional AMD load to be discharged while showing betterment.
- The significant areas of highwall and coal floor exposed across Rockies, Hope Lyons, and Granity Pits contribute to relatively high acidity loads for the first few years following EOML. These loads decay rapidly such that natural spilling of pit sumps to Granity Stream from 2038 within betterment reference values is expected.
- The managed effect line includes the effect of pumping Twins Sump AMD into Rockies Sump and discharging to Granity Stream from 2038 to 2040. Twins pumping causes the Managed Effect line to exceed the Potential effect line slightly (as the Potential effect line only includes AMD sources within Granity (S25) Catchment), but the Managed Effect line does not exceed the betterment reference values. Alternatively, Twins Sump AMD could continue being pumped to the Mangatini Treatment System, if required, to maintain the S25 betterment if Twins acidity loads remain high, though this is not the preferred option as discussed in the Twins BPO (Section 8.1.2).
- From 2038 onwards, natural spilling of pit sumps to Granity Stream above S25 is expected to show a long-term betterment.

It is proposed that adaptive management and performance monitoring are used to manage Granity Catchment AMD effects operationally. For the Granity Catchment this is likely to involve:

- Ongoing refinement of predicted betterment reference values based on performance monitoring in the context of untreated/historic AMD contributions; and

- Extending the duration of proposed AMD management (e.g., pump pit sumps (including Twins Sump) to the Mangatini Treatment System) to allow for additional highwall and coal floor acidity load decay until discharge within betterment reference values becomes possible. This may include a phase where only the higher risk sumps (of the 5 sumps reporting to Granity Catchment) continue to be pumped for treatment, while lower risk sumps are allowed to discharge to Granity Stream at an earlier date.

8.2.2 Granity Stream Best Practicable Option

Developing the Granity water and AMD management strategy involved BPO considerations / discussions. The goal of the Granity BPO was to deliver improved water quality such that the 'Managed Effect' of AMD discharges was at or below the betterment reference values. The major EOML contributors to Granity acidity load were identified as highwall and coal floor (including contributions from Twins Sump), which are modelled to decay relatively quickly, such that the modelled potential effect of uncontrolled AMD discharge decreased to betterment reference values by 2038 (including the effect of Twins Sump loads) without management / treatment.

AMD management options available for maintaining betterment were either:

- Pumping pit sump AMD to the Mangatini Treatment System; or
- Treating pit sump acidity loads in-pit.

The BPO for Granity AMD management was identified as:

- Pump pit sump AMD to the Mangatini Treatment System until 2037 while highwall and coal floor acid loads are high.
- Natural spilling of pit sumps to Granity Stream from 2037 onwards within the betterment reference values.

In-sump treatment is not the preferred option as the treatment duration would be relatively short (highwall and coal floor acid loads decay rapidly), to avoid LDS / AMD sludge management, and to avoid downstream geochemical reactions (generating turbidity).

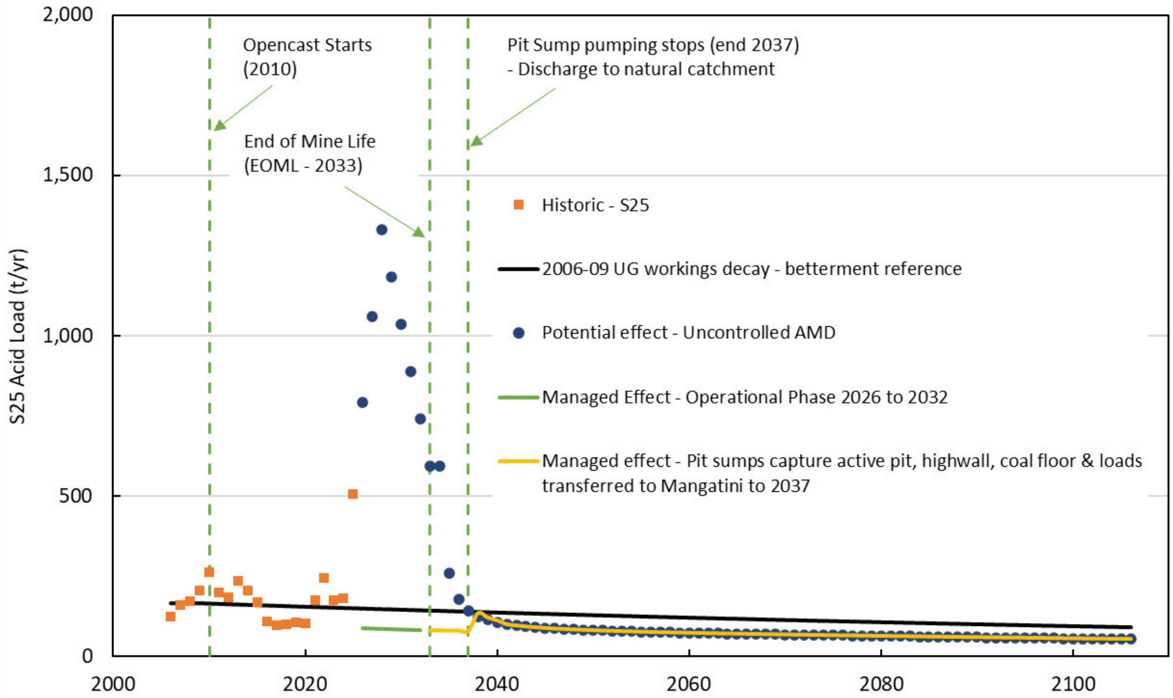

Figure 53. Historic and forecast Granity Stream (S25) acidity load.

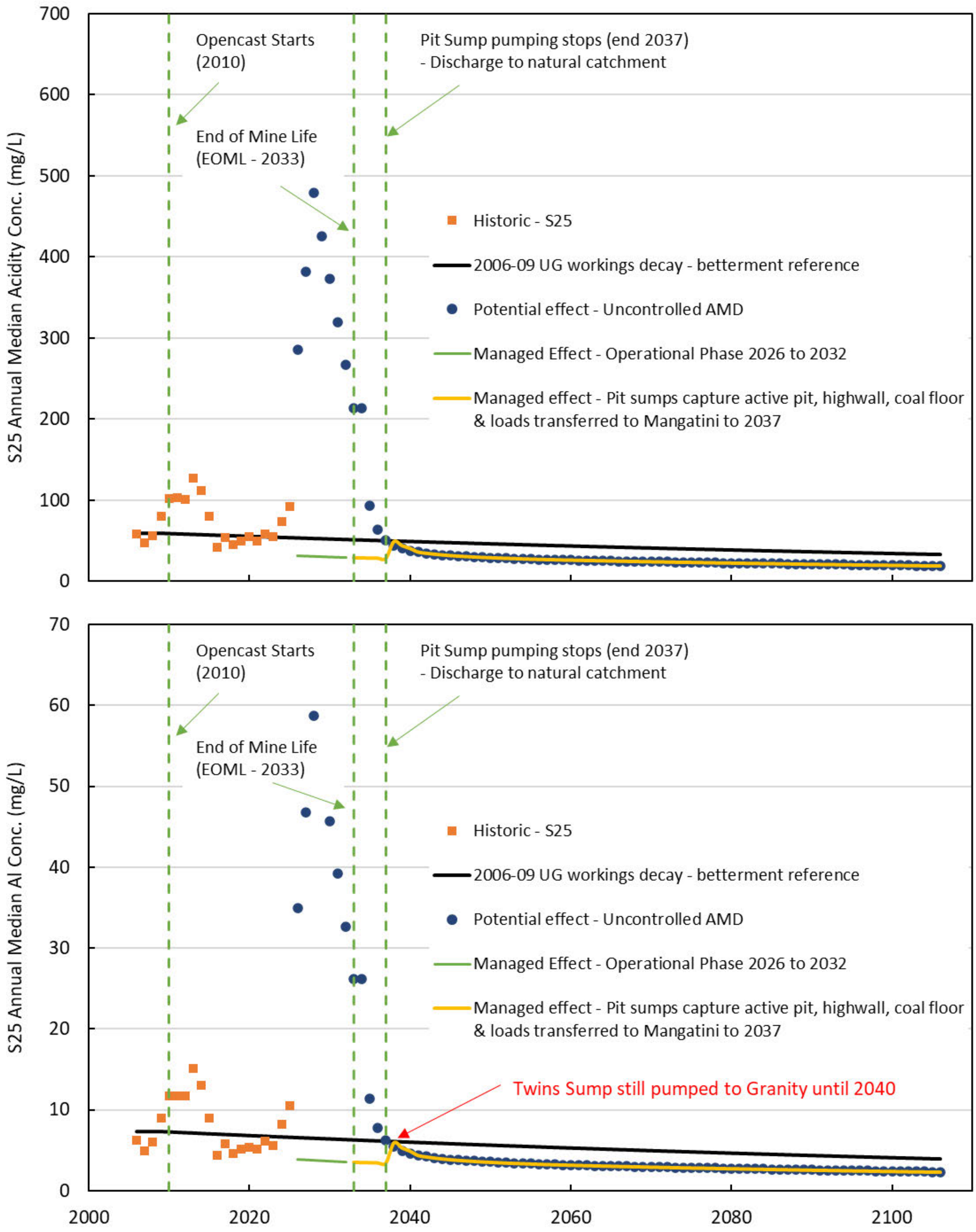

Figure 54. Historic and forecast Granity Stream (S25) acidity and Al concentration.

8.3 Miller Stream (S24A)

The forecast effect of mining the Millerton Block (including cumulative effects from historic and contemporary operations) on Miller Stream (at S24A) acidity load and median annual acidity and Al concentrations is shown in Figure 55 and Figure 56, respectively.

8.3.1 Miller Stream AMD model observations

Miller Pit AMD management consists of:

- Collecting Active Pit, Highwall, and Coal Floor AMD in Miller Sump which is pumped out of Miller Catchment to the Mangatini Treatment System during the Operational Phase and until 2033; and
- Post-2033 Miller Sump discharges by natural spilling to Miller Stream above S24A.

Key observations for modelled AMD effects on Miller Stream (S24A) include:

- Removal of underground workings in Miller Catchment is moderate (~46% removed). However, as the 2010 Miller underground workings are extensive and generate AMD at a high rate, the removal of underground workings is expected to cause significant betterment in S24A acidity loads and water quality.
- The areas of highwall and coal floor exposed in the Miller Catchment final landform are small and contribute a minor acidity load at EOML relative to the reduction in acidity load through underground workings removal. As such, natural discharge of Miller Pit Sump water to Miller Stream from EOML (2033) within betterment reference values is expected.

It is proposed that adaptive management and performance monitoring are used to manage Miller Catchment AMD effects operationally. For the Miller Catchment this is likely to involve:

- Ongoing refinement of predicted betterment reference values based on performance monitoring in the context of untreated/historic AMD contributions; and
- Extending the duration of proposed AMD management (e.g., pump pit sumps to the Mangatini Treatment System).

Miller Catchment AMD management was not subject to a sub-catchment specific BPO.

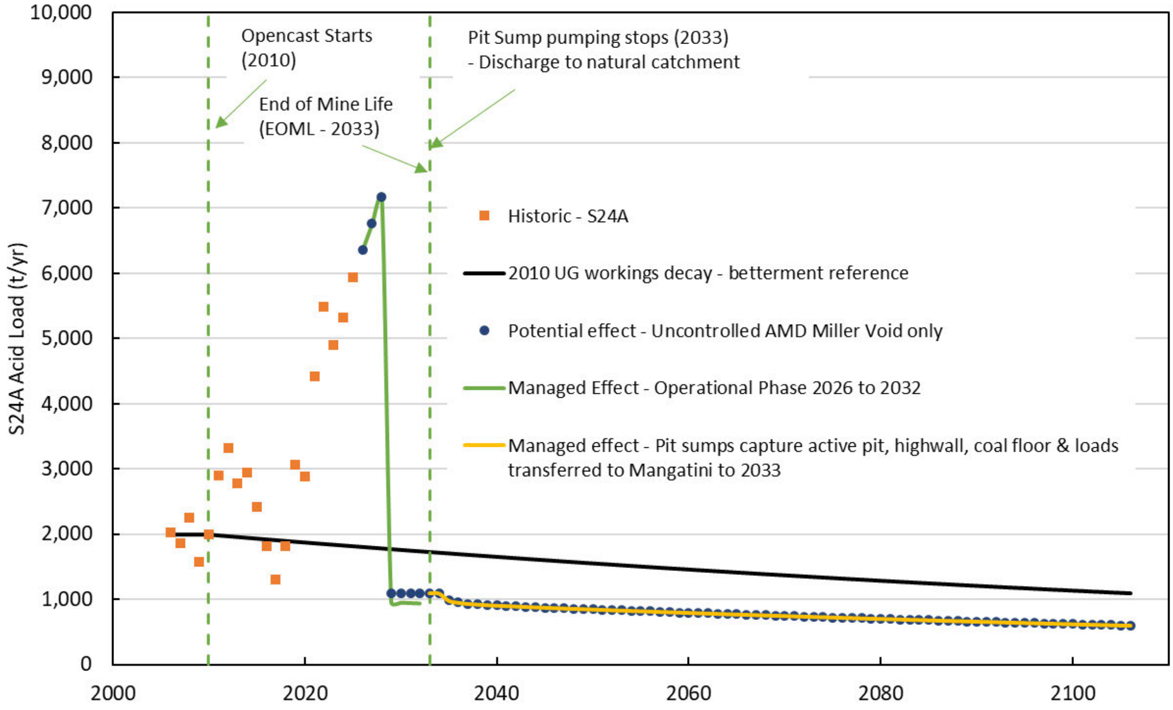

Figure 55. Historic and forecast Miller Stream (S24A) acidity load.

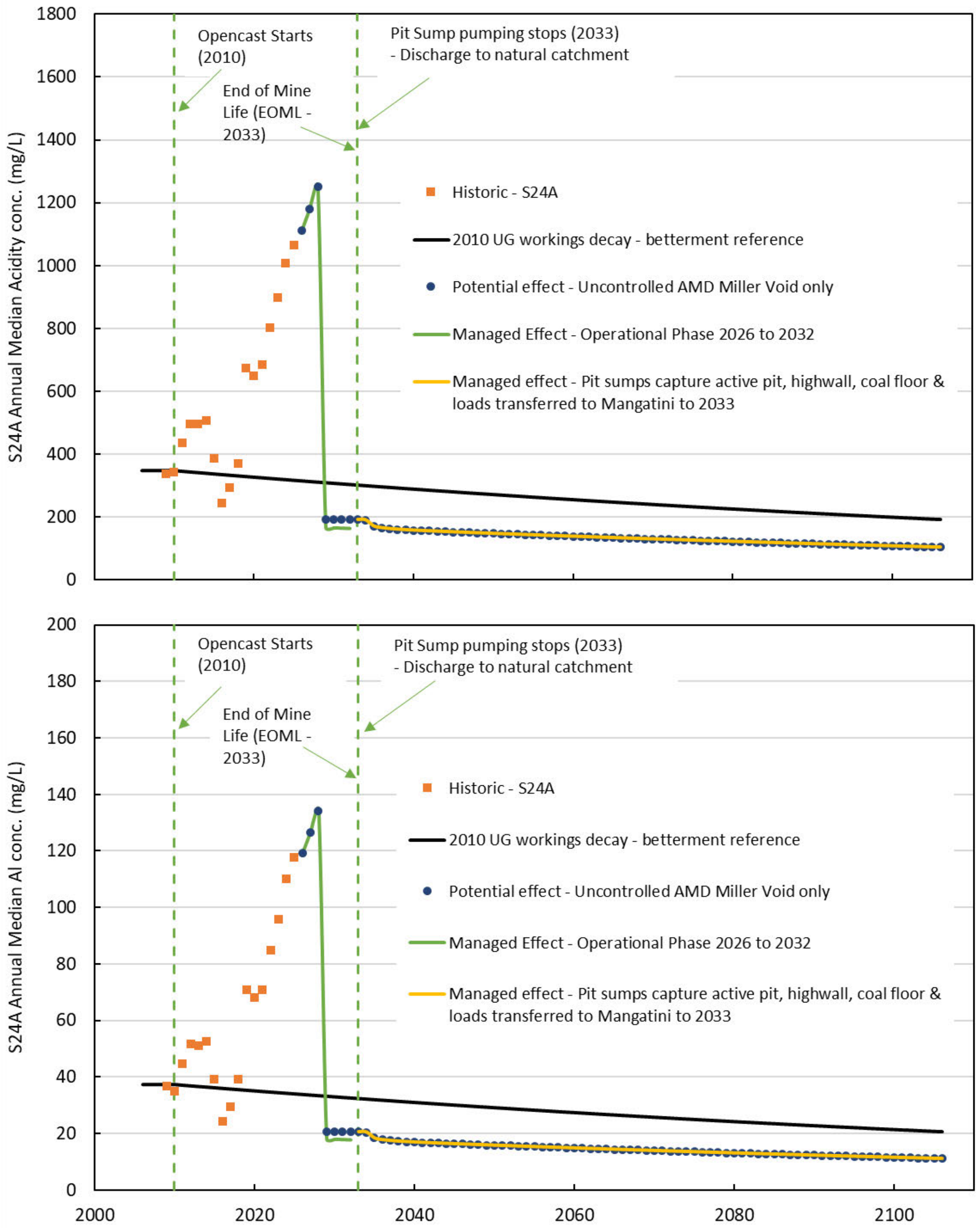

Figure 56. Historic and forecast Miller Stream (S24A) acidity and Al concentration.

8.4 Mine Creek (S23, S6, MC1)

The forecast effect of mining the Millerton Block (including cumulative effects from historic and contemporary operations) on Mine Creek (at MC1) acidity load and median annual acidity and Al concentrations is shown in Figure 57 and Figure 58, respectively.

8.4.1 Mine Creek (MC1) AMD model observations

Millerton ELF is the major Millerton Block engineered landform and is located in the Mine Creek catchment. Mine Creek AMD management consists of:

- Collecting AMD (including capture of fire suppression water) at the Syncline and pumping to the Mangatini Treatment System via the existing adit pump and pipeline system.
- Collecting AMD from Active Pit, Highwall, Coal Floor, Millerton ELF, and discharge from ~42 ha of underground workings intersected by Mine Pit, which is collected in Mine Pit sumps / MW16 Sump.
- From EOML (2033) to 2046 ~80% of the MW16 Sump acidity load is pumped to the Mangatini Treatment System with the remaining 20% of load discharged to Mine Creek untreated; and
- Post-2047 MW16 AMD is alkaline dosed in-sump targeting ~75% treatment with treated AMD discharging to the S6 tributary of Mine Creek.

Key observations for modelled AMD effects on Mine Creek (MC1) include:

- Removal of underground workings in Mine Creek (MC1) Catchment is moderate (~55% removed). These workings are removed from areas expected to be reporting to S23, which have a higher acidity load generating rate than underground workings reporting to S6. As such, the removal of underground workings creates significant capacity for betterment at MC1.
- A decrease in Acidity load and acidity / Al concentration at MC1 (relative to 2025 levels) is expected through the Operational Phase due increased pumping of Millerton AMD to the Mangatini Treatment System and the transition from active mining to EOML and is discussed in section 5.2;
- Construction of the ~53 Mm^3 Millerton ELF adds a significant AMD source to the catchment, with management required to match the betterment reference values, including:
  - ~80% of acid load to be pumped to the Mangatini Treatment System between EOML and 2046; and
  - ~75 - 80% degree of in-sump AMD treatment from 2047 onwards.
- The modelled MC1 Al concentration meets the betterment reference values from 2053 onwards using the nominal 75% treatment scenario. The slight exceedance of the Al betterment reference values in years 2047 to 2052 will be prevented operationally with a slightly higher degree of treatment (e.g., ~80% in 2047, ~79% in 2048, etc.) at MW16 Sump. Similarly, the Al betterment reference values in years 2053 to 2057 could be met with a slightly lower degree of treatment (e.g., 70% from 2057 onwards). The water quality forecasts for in-sump alkaline dosing in this AMD model use a constant degree of treatment (i.e., 75%) throughout for simplicity and actual AMD treatment rates will be adaptively managed operationally.

- The discrepancy between modelled acidity and Al concentrations through the treatment process is due to an assumption that the pH and Fe components of acidity are fully neutralised (with Fe converted to insoluble oxy-hydroxide precipitates) before any removal of Al occurs (discussed in Section 6.4.2. Hence, in a partial treatment scenario the percentage Al reduction will be lower than the percentage of acidity reduction.

From 2053 onwards, natural spilling of treated AMD from MW16 Sump is expected to show a long-term betterment provided a minimum 75% treatment is maintained.

Under the proposed MW16 Sump AMD management regime (~80% of acid load to be pumped to the Mangatini Treatment System between EOML and 2046 and ~75% degree of in-sump AMD treatment from 2047 onwards) some deterioration of S6 water quality is anticipated. This is offset by a significant improvement in S23 tributary water quality, such that the overall Mine Creek (measured at MC1) shows betterment from EOML (2033). The results of AMD modelling at S23 and S6 tributaries are included in Appendix 1.

It is proposed that adaptive management and performance monitoring are used to manage Mine Catchment AMD effects operationally. For the Mine Catchment this is likely to involve:

- Ongoing refinement of predicted betterment reference values based on performance monitoring in the context of untreated/historic AMD contributions;
- Adapting the MW16 Sump AMD management strategy to improve outcomes; potentially including:
    - Increasing the amount of AMD transferred for treatment during the Operational Phase, which is a balance between fire suppression requirements and the acidity load that can be captured in the Syncline / DCA and transferred to the Mangatini Treatment System.
    - Increasing the proportion of 'treatable' MW16 Sump acidity load transferred to the Mangatini Treatment System through the EOML Phase to > 80% (to reduce the residual untreated loads reporting to MC1).
    - Increasing the degree of treatment during Closure Phase in-sump alkaline dosing to > 75 – 80% (to reduce residual untreated loads reporting to MC1).
    - Reducing the amount of Millerton AMD pumped to the Mangatini Treatment System if negative effects on Mangatini Stream or Ngakawau River (e.g., at NR) are detected.
    - Changing dates of key AMD management milestones as required – e.g., increasing / shortening the duration of Millerton AMD treatment at the Mangatini Treatment System.
    - Prioritise Millerton ELF rehabilitation / revegetation to effectively shorten the acidity load decay period.

8.4.2 Mine Creek Best Practicable Option

Developing the Mine Creek water and AMD management strategy involved BPO considerations / discussions. The goal of the Mine Creek BPO was to deliver improved water quality such that the

'Managed Effect' of AMD discharges was at or below the betterment reference values at a given point in time. The major EOML contributor to Mine Creek acidity load is the Millerton ELF, which is modelled to decay relatively slowly, such that long term active treatment will be required to meet the betterment reference values. The specific BPO objective was to partially treat MW16 Sump AMD loads to minimise long term pumping requirements, AMD sludge management, etc. while maintaining Al betterment at MC1. Remnant underground workings discharging to S6 and S23 Mine Creek tributaries are expected to be sufficient to prevent ecological recovery to the 75^{th} percentile Al < 1 mg/L criteria, regardless of the contribution from the opencast disturbance footprint. Additional AMD treatment (associated with the Crown project to treat remnant historic underground workings discharges) would be required to achieve ecological recovery.

The Millerton ELF has been designed as per the Stockton AMD Management Plan (STO-ENV-PLN-016) to minimise acidity loads. Additional AMD management options available for maintaining betterment were either:

- Pumping MW16 Sump AMD to the Mangatini Treatment System; or
- Treating MW16 Sump AMD in-pit with AMD sludge management.

The BPO for MW16 Sump AMD management was identified as:

- Reducing effects on Mine Creek during the Operational Phase by recovering AMD (including fire suppression water) collected in the Syncline / DCA.
- Designing and contouring Millerton ELF such that the majority of AMD reports to MW16 Sump. This approach:
  - Utilises the natural syncline to form the large (718,900 m^3) MW16 water and AMD management sump;
  - Provides a single location for long term Millerton Block AMD management, with Millerton ELF the major contributor; and
  - Allows other sub catchments (e.g., Twins, Granity, and Miller) with rapidly decaying highwall and coal floor AMD surfaces (and no ELFs) to naturally discharge relatively soon after EOML;
- Pumping the MW16 Sump AMD to the Mangatini Treatment System until year 2046. This approach
- Utilises the existing Mangatini Treatment System infrastructure (including MG Quarry, Mumm's Sump (under construction), and Mangatini Sump) when MW16 Sump acidity loads are relatively high;
- Aligns with scheduled rehabilitation of Millerton ELF continuing until year 2046, meaning the MW16 Sump operates primarily as a sediment and AMD collection sump while rehabilitation is ongoing. This is expected to lead to more efficient operation of MW16 Sump as AMD precipitates / sludge will not be generated through this period when sediment loads from rehabilitation areas may be relatively high.

- Transitioning to AMD treatment by alkaline dosing in MW16 Sump from year 2047 onwards. This approach:
    - Ends pumping of Millerton ELF / Mine Creek flows to the Mangatini Treatment System once the ELF revegetation / rehabilitation phase ends. This will reduce associated pumping costs and transfer of water between catchments;
    - Utilises the drains flowing into MW16 Sump for alkaline dosing / mixing channels and MW16 Sump itself for AMD precipitate / sludge capture, which enables high flow (>90th percentile) acidity to be neutralised (but without sedimentation in MW16 Sump);
    - Allows Millerton Block AMD to be managed independently of Mangatini Block AMD;
    - Reduces acidity loads reporting to the Mangatini Treatment System, which may improve residual water quality in Mangatini Stream and Ngakawau River upstream of the Mine Creek confluence.

Ultimately this is considered the BPO as both Mangatini and Millerton Blocks will have operational alkaline dosing and large AMD sediment capture sumps that can be operated independently or together to provide more operational flexibility to water and AMD management.

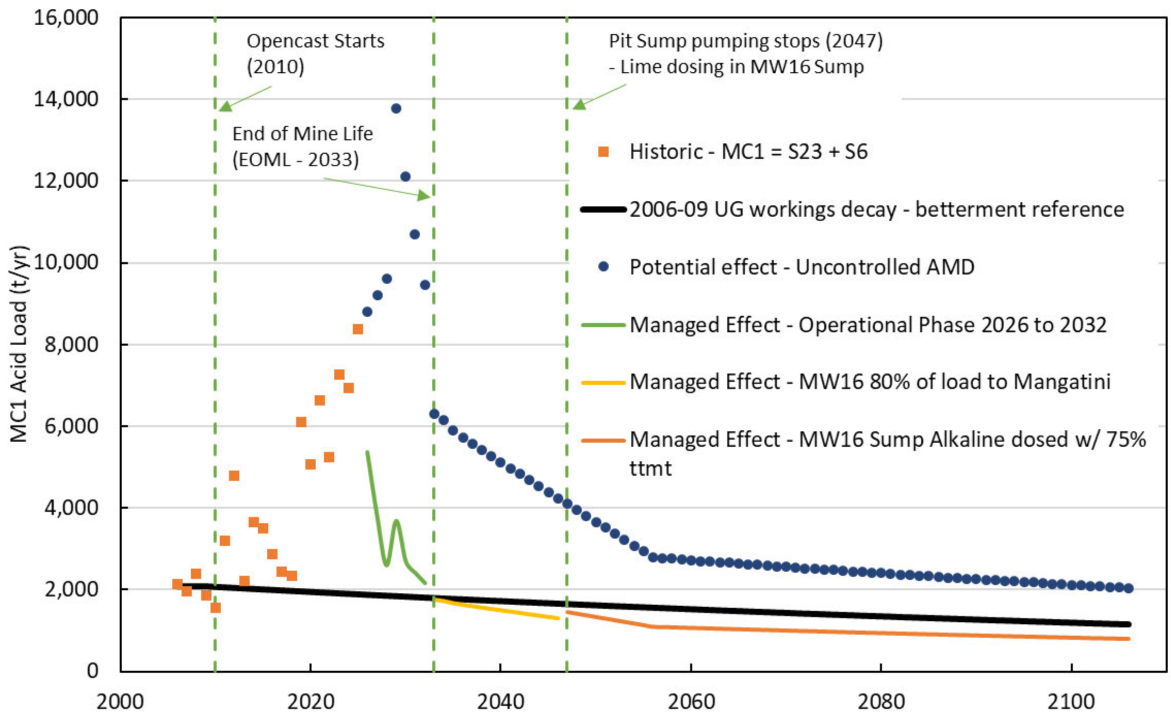

Figure 57. Historic and forecast Mine Creek (MC1) acidity load.

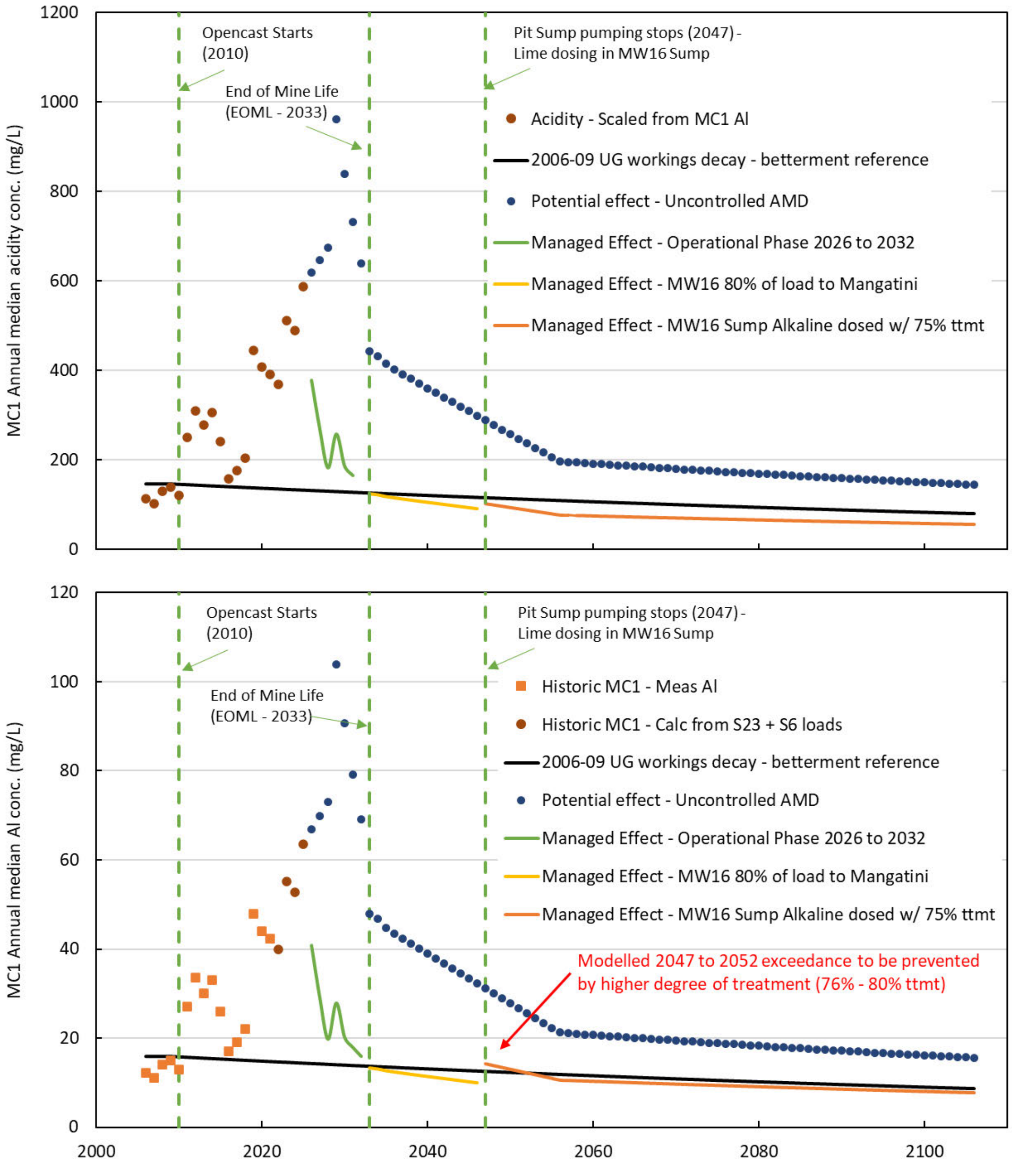

Figure 58. Historic and forecast Mine Creek (MC1) acidity and Al concentration. NB: Higher degree of in-sump AMD treatment (e.g.,~80% in 2047, ~79% in 2048, etc.) at MW16 Sump anticipated to maintain betterment from EOML onwards. Forecasts use a constant degree of treatment (i.e., 75%) throughout for simplicity.

8.5 Lower Ngakawau River (NRB River)

The forecast effect of mining the Millerton Block (including cumulative effects from historic and contemporary operations) on the Lower Ngakawau River are described in this section. The AMD modelling process for lower Ngakawau River was different to the other sites. This process is described in detail in Section 7.0. Lower Ngakawau River modelling focussed on Al loads and concentrations as the lower Ngakawau River is circum-neutral meaning that acidity / Al correlations will be weak.

Dissolved Al concentrations are also likely to be variable due to geochemical changes and tidal influences.

To address this variability / unpredictability an analysis of Al load and concentration at a modelled site located immediately downstream of the Ngakawau River / Mine Creek confluence (referred to as 'NRB River') was undertaken. NRB River is intended to approximately represent the effect of AMD at Ngakawau River Bridge without the effect of tidal influence and geochemical reactions that may occur due to mixing.

The forecast effect of Millerton water and AMD management on NRB River Al load and annual median / 75th percentile Al concentrations is shown in Figure 59 and Figure 60, respectively.

8.5.1 Lower Ngakawau River AMD model observations

Millerton ELF and MW16 Sump AMD management are the key factors influencing modelled NRB River Al loads and concentrations. Treatment of other major potential Al sources to the Ngakawau River (e.g., Mangatini and St Patrick catchments) is assumed to be ongoing throughout the modelled period, with the effect from other catchments decreasing as modelled in the 80-year forecast (BRL 2026b)

Key observations for modelled AMD effects at NRB River include:

- While the 'Potential Effect' line does suggest there is potential for increased Al concentrations in the Lower Ngakawau River, the Managed Effect line shows that during the Operational Phase (and within the proposed and modelled water and AMD management strategy) the Al concentration at NRB is expected to remain similar / decrease slightly relative to levels seen throughout the Millerton Opencast phase (i.e., since 2010).
- The 'Managed effect' scenario including pumping 80% of the MW16 AMD load to the Mangatini Treatment System (years 2033 to 2046) results in a NRB River 75th percentile Al concentration of < 1 mg/L at 2034, which meets the water quality criteria (focussing on Al concentration) for ecological recovery (Instream 2026). The NRB River 75th percentile Al concentration in subsequent years decays steadily.
- The 'Managed effect' scenario including alkaline dosing to MW16 Sump targeting 75% treatment of AMD (year 2047 onwards) results in further decreases in 75th percentile Al concentrations.
- The residual Al load and concentrations decay rate decreases from 2056 onwards, as the Millerton ELF AMD load decay transitions from:
  - Relatively rapid decay due to the effects of rehabilitation; to
  - Relatively slow long term decay rate of 0.62% per year.

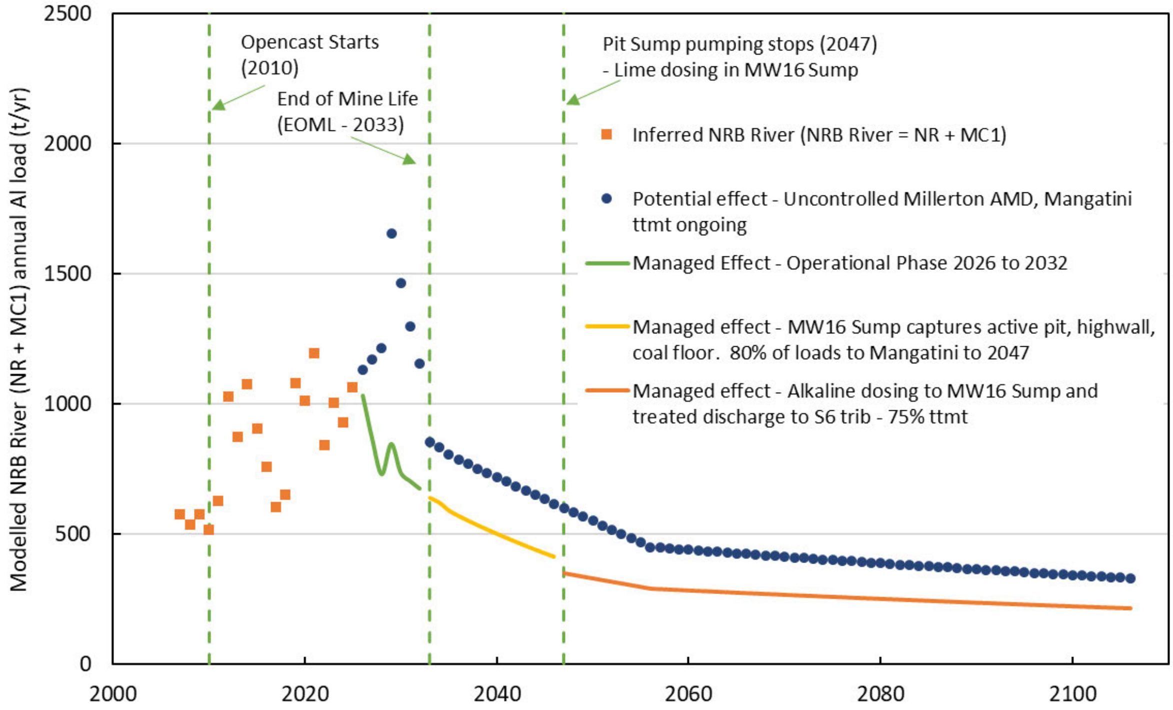

Figure 59. Inferred historic and forecast modelled NRB River site Al load contributed from NR + MC1.

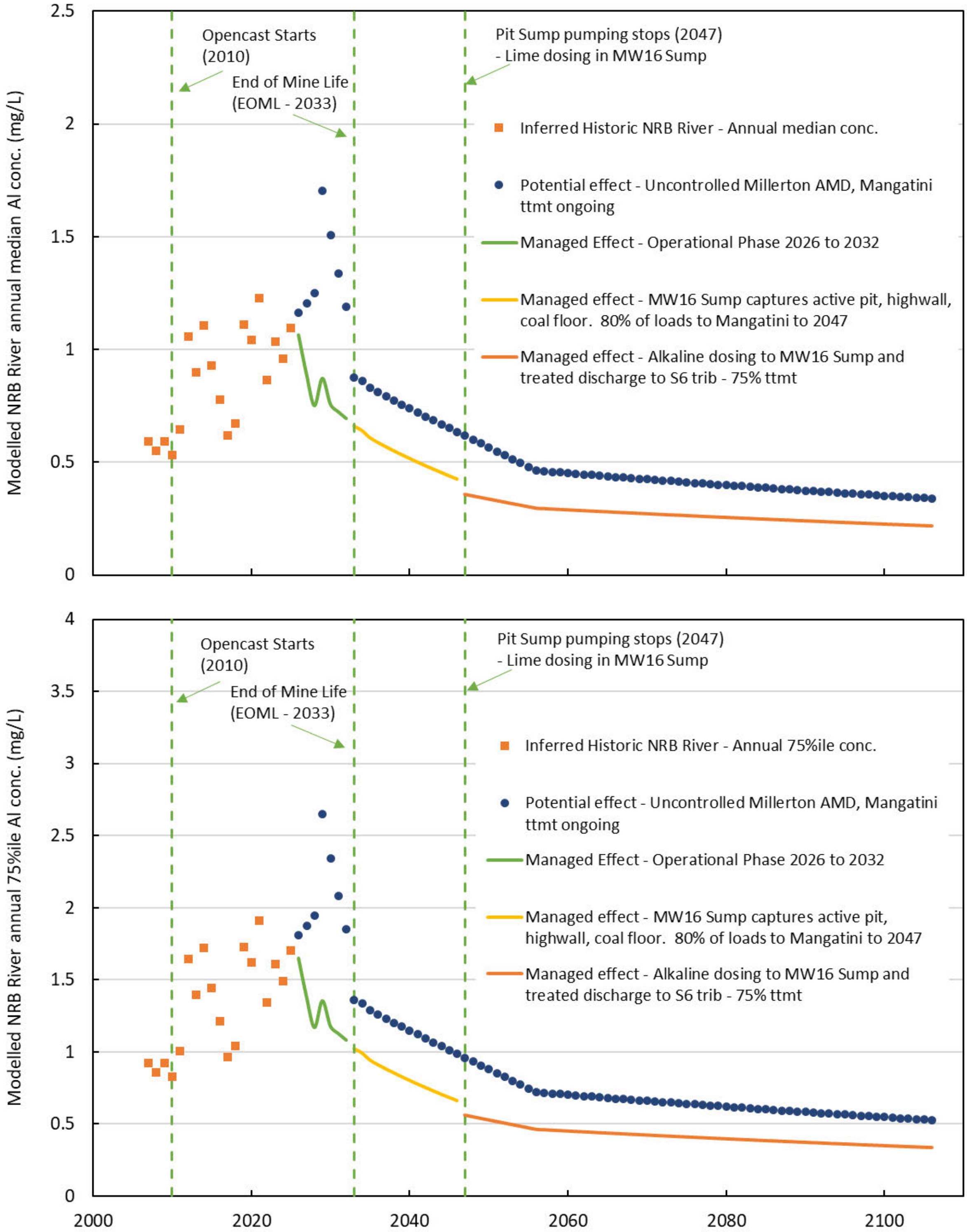

Figure 60. Inferred historic and forecast modelled NRB River site annual median and 75%ile Al concentrations

8.5.2 Implications for NRB

From 2034 onwards, the modelled NRB River site is expected to meet the threshold for comprehensive ecological recovery based on 75th percentile Al concentration < 1 mg/L, under ‘Managed effects’ scenarios. A mahinga kai focus will be applied to NRB monitoring from EOML onwards.

It should be noted that the inferred modelled NRB River site median and 75th percentile Al concentrations in Figure 60 are calculated from Al loads (described in section 7.0) and differ from measured NRB concentrations (combined from actual measured values at NR Estuary and NB sites show in Figure 61).

Figure 61. Lower Ngakawau River monitoring sites.

A comparison of actual measured annual median and 75th percentile NB and NR Estuary Al concentration against the calculated NRB (NR + MC1) Al loads for the available historic monitoring dataset is shown in Figure 62. These data are overplotted by the NR Al load versus annual median and 75th percentile Al concentration correlations (derived in Table 25). This comparison shows that typically the measured NRB Al concentration is lower than the equivalent modelled NRB River Al concentration would be, for a given Al load (i.e., the modelled NRB River Al concentrations are conservative due to removal of geochemical reactions / tidal effects).

In-lieu of a quantitative assessment of an NRB Al concentration forecast, Figure 62 suggests that post EOML under 'Managed effect' scenarios, where NRB River Al loads remain < ~600 t/year, the NRB annual 75%th percentile Al concentration would also be less than 1 mg/L.

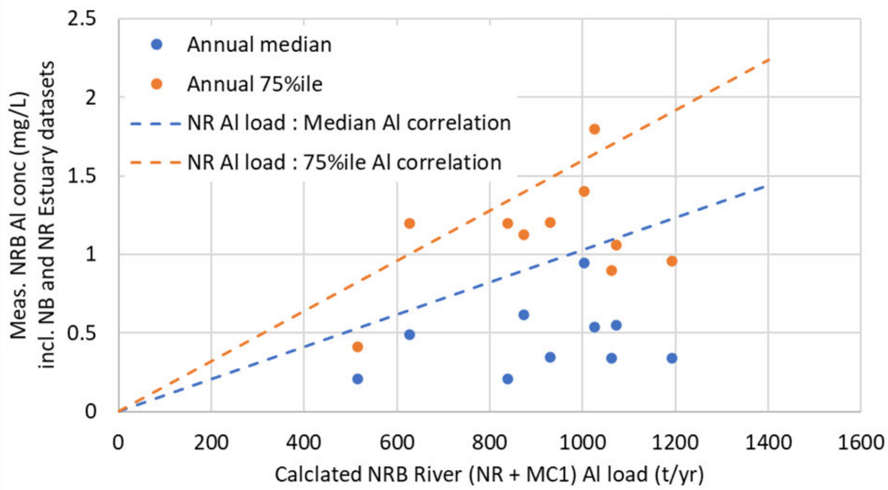

Figure 62. NRB Al concentration versus NRB Al load compared to NR Al concentration vs NR Al load correlation.

This assessment is based on conservatively modelled dissolved Al concentrations compared against an ecological recovery threshold also derived for dissolved Al concentrations. This assessment does not include the potential toxicity modifying factor (**TMF**) influence on Al concentrations, such as pH, hardness, and dissolved organic carbon (**DOC**), which could provide a more accurate indication of likely effects on aquatic ecology. Further, the geochemical effects of waters mixing in the Lower Ngakawau River under different AMD management and treatment scenarios developed through the Operational, EOML, and Closure Phases, and the resulting effect on Al and TMF's has not been undertaken.

Aquatic ecology surveys are proposed for the Lower Ngakawau River and it is recommended that the results of these surveys be compared against current use of dissolved Al ecological recovery thresholds to validate or adjust the assessment approach.

8.6 Adaptive Management Options

The forecast acidity loads and acidity / Al concentrations summarised in Section 8.0 are subject to the specific modelling assumptions described in Sections 4.0 to 7.0. Sensitivity testing and alternative 'optimistic' or 'conservative' scenario modelling has not been undertaken. Scenario modelling may not significantly change the proposed Millerton Block water and AMD management strategy, given such a large amount of the disturbance required to achieve final landform has already occurred (i.e., additional overburden disturbance post April 2027 is ~ 11,700 kbcm and equates to the final ~28% of material used to construct the Millerton ELF).

Descriptions of potential sub-catchment specific adaptive management options are provided in the previous sub-sections to Section 8.0. These adaptive management options are largely accommodated within the already proposed water and AMD management infrastructure, which could still be appropriate even if the magnitude of forecast acidity loads is underestimated or the decay rates are too optimistic. Adaptive management options include:

- Ongoing refinement of predicted betterment reference values based on performance monitoring in the context of untreated/historic AMD contributions;

- Re-casting the time frame for transitions in water and AMD management and therefore the timeframes for water quality betterment occurring, to respond to mine plan changes / delays;
- Extending the duration of proposed AMD management, for example:
    - Continue pumping AMD collected in Pit Sumps to the Mangatini Treatment System for treatment if highwall and coal floor acidity load decay rates are not as rapid as forecast;
    - Continue pumping MW16 AMD to the Mangatini Treatment System if acidity loads remain high or rehabilitation / revegetation is delayed; and
    - Extending the period of temporary AMD management by minor alkaline dosing in pit sumps (e.g., Twins Sump) if required to meet water quality targets.
- Increasing the proportion of Millerton Block AMD managed / treated, for example:
    - Increase the proportion of AMD captured in pit sumps that is transferred to the Mangatini Treatment System through modification of pumping infrastructure / utilisation of live storage in pit sumps;
    - Increase the proportion of AMD transferred from the Syncline / DCA to improve Mine Creek water quality between 2026 and 2028;
    - Increase the proportion of AMD transferred from MW16 Sump to the Mangatini Treatment System (to greater than ~80%) throughout the Operational and EOML Phases to reduce remnant load in Mine Creek; and
    - Increase the degree of AMD treatment (to greater than ~75 – 80%) at MW16 Sump during the in-sump alkaline dosing phase (post 2047).
- Managing the effects of Millerton AMD treatment at Mangatini (through modification of Mangatini Sump AMD management) on Mangatini Stream and Ngakawau River water quality:
    - Reducing the amount of Millerton AMD transferred to the Mangatini Treatment System if negative effects on Mangatini Stream or Ngakawau River (e.g., at NR) are detected;
    - Increase the degree of AMD treatment / lime dosing rates in the Mangatini Treatment System to increase pH and reduce remnant Al concentrations; and
    - Increase treatment of minor AMD tributaries that report to Mangatini Stream (e.g., Duncans Sump, Ford Creek) downstream of the Mangatini Treatment System.
- Prioritise Millerton ELF rehabilitation / revegetation (over rehabilitation of other disturbed areas at Stockton mine) to effectively shorten the acidity load decay period.

The Millerton Block water and AMD management processes will also need to be able to adapt to external changes, including:

- Further development of ecological recovery thresholds, including transition to mahinga kai criteria;
- Changes / improvements in AMD management / treatment technologies, including sludge management; and

- Commissioning of additional LINZ administered water and AMD management infrastructure.

8.7 Summary of model outputs

A summary of key AMD model outputs has been provided for use in aquatic ecology assessments (Instream 2026) and for operational Stockton AMD sludge management planning (BRL 2025a).

8.7.1 Acidity loads pumped to the Mangatini Treatment System

Mine water (AMD) captured in the Millerton Pits and Syncline / DCA will be pumped to the Mangatini Treatment System. Acidity loads transferred during the Operational and EOML Phases are summarised in Table 27. Operational Phase estimates have not been broken down into contributions by sub-catchment due to the simplifying assumptions made for modelling (e.g., additional Twins Catchment acidity loads incorporated in Granity Catchment estimates).

At the Mangatini Treatment System, AMD will be dosed in open channels upstream of LDS / sediment capture sumps. Mangatini Quarry and Mumm's Sump will be used for primary settling prior to water being directed to the Mangatini Sump. LDS produced as a result of AMD treatment will be addressed as per the Mangatini Sump Management Plan (GHD 2018; GHD 2024 update) and the Stockton Operational AMD Sludge Management Report (BRL 2025a) describes sludge management for the BPCP application. LDP1 will be used and this has sufficient capacity to treat the additional acidity from Millerton pits.

Table 27. Acidity load pumped from Millerton to the Mangatini Treatment System

Phase	Year	Acidity Load by Catchment (t/year)			Total load (t/year)
		Twins	Rockies, HL, Granity	Mine / MW16	Treated load
Operational Phase	2026	3,000			**3,000**
	2027	5,000			**5,000**
	2028	7,500			**7,500**
	2029	8,000			**8,000**
	2030	7,500			**7,500**
	2031	7,000			**7,000**
	2032	6,000			**6,000**
EOML Phase	2033	140	513	4,542	**5,194**
	2034	140	513	4,429	**5,081**
	2035	48	178	4,231	**4,457**
	2036	26	97	4,097	**4,219**
	2037	17	63	3,975	**4,055**
	2038			3,858	**3,858**
	2039			3,742	**3,742**
	2040			3,627	**3,627**
	2041			3,513	**3,513**
	2042			3,399	**3,399**
	2043			3,286	**3,286**
	2044			3,172	**3,172**
	2045			3,059	**3,059**
	2046			2,946	**2,946**

8.7.2 Acidity loads treated in MW16 sump

Mine water from the Millerton ELF will be treated at MW16 Sump during the Closure Phase (2047 onwards). Magnesium Oxide (MgO) slurry will be piped from LDP1 to a mixing tank located within the ELF footprint. Dosing will be automated based on untreated water pH with the dosing pipeline discharging into the mixing channels. This alkaline slurry dosing of AMD is a similar process to what has been developed and used successfully at the Mangatini Treatment System since 2015.

All MW16 flows will be MgO dosed before flowing into MW16 Sump. As such, the treated water discharged from MW16 Sump during high flow / spill events (>90%ile flows) will contain AMD precipitates. This is a similar process to Mangatini Sump bypass events, which occur nominally at greater than 70th percentile flowrates. BRL are not proposing controlled decant / pumped AMD Sludge discharge from MW16 Sump to Mine Creek (but do propose retaining consent for controlled LDS discharge from Mangatini Sump).

AMD sludge accumulated within the MW16 Sump will be managed in a similar way to Mangatini Sump. Use of MgO as the neutralant for all AMD treatment (from 2033 onwards) is expected to generate a much denser AMD Sludge (denser than the current CaO dosing LDS product). The expected MW16 Sump treated acidity load and AMD sludge generation is summarised in Table 28. This assumes in-sump MgO slurry dosing commences in 2047. An AMD sludge generation rate of 3.4 m^3 per tonne of acid neutralised was used in calculations and is based on assessments in BRL (2025a).

Table 28. Acidity load treated by alkaline dosing to MW16 Sump and AMD sludge generation

Year	MW16 Sump – Treatable Acidity load (t/year)	MW16 Sump – Treated Acidity load (75% of treatable) (t/year)	AMD Sludge generation (m^3)*
2047	3,540	2,602	8,848
2048	3,399	2,497	8,489
2049	3,258	2,391	8,129
2050	3,116	2,285	7,770
2051	2,975	2,180	7,411
2052	2,834	2,074	7,052
2053	2,693	1,969	6,693
2054	2,552	1,863	6,334
2055	2,411	1,758	5,976
2056	2,269	1,652	5,617
2057**	2,255	1,642	5,582

* AMD sludge generation rate equivalent to 3.4 m^3 AMD sludge per t acidity neutralised, ** Modelled acidity loads and AMD sludge volumes decay at a constant 0.62%/year from 2057 onwards.

The MW16 Sump AMD sludge generation rates (derived in Table 28 and extended out to year 2106) are expected to equate to ~313,000 m^3 by year 2106. This AMD sludge volume is significantly less than the MW16 Sump volume (~718,900 m^3). The Stockton operational AMD sludge management report (BRL 2025a) states that active AMD sludge management at MW16 Sump is not required or incorporated into this assessment.

8.7.3 Summary of modelled water quality at key dates

A summary of estimated and forecasted acidity loads and acidity / Al concentrations at key milestone dates are shown in Table 29. Forecasted values typically vary linearly between these dates from EOML onwards). Long term (beyond 2057) loads and concentrations typically decrease linearly at a rate equivalent to 0.62%/yr.

Table 29. Summary of forecasted acidity loads and acidity / Al concentrations at key milestone dates.

Year	2025	2033	2038	2046	2047	2057	2106
Milestone	'Current'	EOML	Granity pumping to Mang. ceases	Millerton ELF rehab. Complete, Twins ttmt ceases	MW16 in-sump ttmt starts	Millerton ELF rehab. effect ceases	80-year forecast
	Acidity load (t/yr)						
T1	38*	33	32	34	33	30	21
S25	506	80	135	86	84	74	53
S24A	5,934	1098	922	868	862	809	596
S23	8,109	330	320	304	302	284	210
S6	257	1,424	1,241	994	1,141	798	588
MC1	8,366	1,753	1,561	1,299	1,443	1,082	798
	Annual median acidity concentration (mg/L)						
T1	325*	282	273	285	279	252	181
S25	93	29	49	31	30	27	19
S24A	1,066	192	161	151	150	141	104
S23	1,555	60	58	55	55	52	38
S6	74	243	212	170	195	136	100
MC1	588	123	110	91	101	76	56
	Annual median Al concentration (mg/L)						
T1	41*	36	35	36	35	32	23
S25	11	3.6	6.0	3.8	3.7	3.3	2.3
S24A	118	21	17	16	16	15	11
S23	180	6.5	6.3	6.0	5.9	5.6	4.1
S6	7	26	23	18	27	19	14
MC1	64	13	12	10	14	11	8
NRB River** – Ann. median	1.1	0.66	0.55	0.43	0.36	0.30	0.22
NRB River** – Ann. 75%ile	1.7	1.0***	0.86	0.66	0.56	0.46	0.34

* T1 'current' annual median acidity and Al concentration estimated from 2013 – 2021 dataset due to insufficient recent data, ** All 'NRB River' Al concentration estimates based on a modelled site below Ngakawau River and Mine Creek confluence. ***NRB River annual 75%ile Al concentration expected to fall below 1 mg/L in 2034.

8.7.4 Summary of six-yearly betterment reference values

A summary of forecasted annual median Al concentration betterment reference values at six-yearly intervals (from consent commencement in 2027) are shown in Table 30. These values have been extracted from the model for comparison against actual performance monitoring data as part of the proposed six-yearly water quality thresholds review, described in Instream (2026). Figure 63 identifies the six-yearly values extracted into Table 30.

Table 30. Forecasted six-yearly Al betterment reference values.

		Six-yearly interval Al betterment reference values (mg/L)			
Project Year	Calendar Year	T1 Annual Median	S25 Annual Median	S24A Annual Median	MC1 Annual Median
Commencement	2027	20.0	6.5	33.6	14.2
6	2032	19.3	6.3	32.6	13.8
12	2038	18.6	6.1	31.4	13.2
18	2044	18.0	5.9	30.2	12.8
24	2050	17.3	5.6	29.1	12.3
30	2056	16.7	5.4	28.1	11.8
36	2062	16.1	5.2	27.0	11.4
42	2068	15.5	5.0	26.0	11.0
48	2074	14.9	4.9	25.1	10.6
54	2080	14.4	4.7	24.2	10.2
60	2086	13.8	4.5	23.3	9.8
66	2092	13.3	4.3	22.4	9.5
72	2098	12.8	4.2	21.6	9.1
78	2104	12.4	4.0	20.8	8.8

* Note: Millerton Block water and AMD management strategies are not expected to meet betterment reference values during the Operational Phase – Achieving betterment only applies from EOML (2033) onwards.

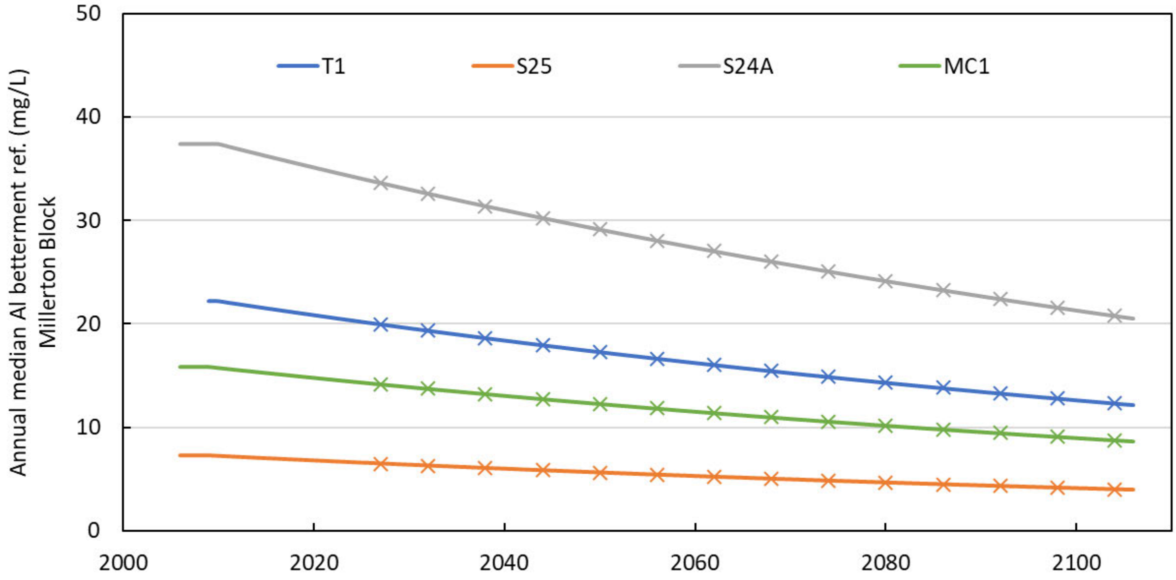

Figure 63. Annual median Al betterment reference values. The 'X' points identify the six-yearly values extracted in Table 30.

8.8 AMD modelling limitations

As discussed previously, AMD modelling limitations include:

- The AMD modelling does not consider day-to-day or cyclic / seasonal variability in AMD generation processes. The modelling is intended to forecast long term trends in water quality (based on long term analogue monitoring datasets) and the effects of major changes to water and AMD management.
- The AMD modelling uses relationships between annual acidity loads and annual acidity / Al concentrations. These relationships are based on large water quality and flow rate empirical data sets that are specific to the key sites used for assessments. These relationships are well correlated across a wide range of load and concentrations for most sites, including initial datasets dominated by historic underground workings effects and recent datasets that include both contemporary opencast and historic workings effects. However, these correlations may not fully represent the effect of proposed future water and AMD management. For example, capture and treatment of up to 90th percentile flow AMD volumes may significantly reduce residual contaminant concentrations during low to median flow conditions. That could in turn change the correlation between annual acidity loads and residual median annual acidity / Al concentration. Similarly, the effect of the un-captured historic underground workings on downstream concentration may change due to capture of upstream surface flows. A forecasting water balance load model that uses individual concentration source terms for different domains / AMD generating surfaces could provide additional insight into these potential effects.
- Changes to the flow regime as landforms evolve (e.g., active pit and fire suppression hydraulic regime in Mine Creek transitioning to Millerton ELF / MW16 Sump hydraulic regime) is not incorporated into AMD modelling.

- The AMD modelling does not quantify the effects of short-term exposure during > 90th percentile spill events (95th percentile for Twins Sump) on streams draining the Millerton Block. This assessment could be required as Millerton Block streams approach ecological recovery.
- Potential influences of long-term climate change are not included in this assessment.

9.0 Conclusions

Water and AMD management at Stockton mine is a complex process, which involves managing the effects of historic / legacy underground mining activities and contemporary opencast mining activities (discussed in the Stockton mine history of AMD Management and Proposed Future Management (BRL 2026a)). To measure AMD improvement, the BPCP has adopted 2010 as the reference point for the Millerton Block water quality.

The water and AMD management approach adopted for the Millerton Block component of the BPCP at the Stockton mine is to separate (both physically and for assessment purposes):

- Water and AMD generated within the contemporary opencast disturbance footprint (to be managed as part of the BPCP (including any BRL and Crown contributions from opencast disturbance between 2010 and April 2027)); and
- Water and AMD generated from remnant historic underground workings located outside the opencast disturbance footprint (not managed as part of the BPCP).

This assessment report has identified several key points for Millerton Block water and AMD management, as described below.

Additional overburden disturbance post April 2027 is ~ 11,700 kbcm. This equates to the final ~28% of material used to construct the Millerton ELF. Thus, the additional BPCP contribution to Millerton Block disturbance (and therefore acidity load) is relatively minor. The majority (~72%) of the disturbance (and therefore acidity load) managed by Millerton water and AMD management infrastructure is generated from contemporary / opencast mining disturbance that pre-dates the BPCP.

There will be a significant amount of historic underground workings removed through the opencast mining process (i.e., ~51% reduction in area from 370 ha in 2010 to ~183 ha at EOML (2033)). However, AMD modelling suggests that ongoing AMD discharges from remnant historic underground workings (located outside the opencast mining disturbance footprint and Project boundaries) will prevent water quality improving sufficiently for ecological recovery in upper Twins Stream (at T1), Granity Stream (at S25), Miller Stream (at S24A), and Mine Creek (at S6, S23, and MC1). Accordingly, time-dependent betterment reference values for acidity load, acidity concentration, and Al concentration have been developed to guide long term AMD management in these waterbodies (in the context of the Millerton Block component of the BPCP). The betterment reference values estimate what acidity loads and acidity / Al concentrations could have been if no opencast mining occurred in Millerton Block and the historic underground workings continued to discharge AMD without treatment. Sub-catchment specific water and AMD management strategies were developed to keep the AMD modelled / forecast long term acidity loads and acidity / Al concentrations below these betterment reference values post EOML (2033).

The water and AMD management strategy developed for the BPCP covers the Operational, EOML, and Closure Phases of the Project. The strategy was developed to deliver:

- Progressive improvement of water quality draining Millerton Block (where AMD is transferred to Mangatini Treatment System) during the Operational Phase. Achieving this outcome will involve:

  - Capture of acidity loads in Twins, Granity, and Miller Pit sumps (from 2029 onwards for Miller Pit after fire suppression ceases) and transfer to the Mangatini Treatment System; and
  - Staged increase in transfer of AMD collected in the Syncline to the Mangatini Treatment System (i.e., 40%, 60%, and 75% transferred through 2026, 2027, and 2028, respectively) to reduce effects on Mine Creek between 2026 and 2028; and
  - Transfer of acidity loads captured in MW16 Sump to the Mangatini Treatment System (increasing from 75% in 2029 to 80% in 2030 – 2032)

- Further improvement of water quality draining Millerton Block during the EOML / Closure Phases to meet betterment reference values. Achieving this outcome will involve:

  - A high degree of pit sump acidity load capture and transfer for treatment from Twins, Granity, and Miller Pits while highwall and coal floor acidity loads decay sufficiently for betterment reference values to be achieved under a 'discharge without treatment' scenario;
  - Transfer of ~80% of 'treatable' acidity load from MW16 Sump to the Mangatini Treatment System during the EOML Phase; and
  - In-sump treatment of ~75 – 80% of the MW16 Sump acidity load by MgO dosing during the Closure Phase.

The design approach of leaving a final landform that includes a single engineered landform (Millerton ELF) with the majority of runoff and seepage collected in a single water management structure (MW16 Sump) constructed in the headwater of the S6 tributary of Mine Creek enables long term water and AMD management efficiency. Other disturbed areas in Twins, Granity, and Miller catchments (comprising predominantly rehabilitated highwall and coal floor surfaces) are expected to transition to discharge without treatment at various times during the EOML Phase.

The AMD modelling suggests that achieving betterment in Mine Creek (site MC1) discharges during the EOML / Closure Phase is sufficient for water quality at the modelled site 'NRB River' to meet comprehensive ecological recovery criteria by 2034 (i.e., annual 75th percentile Al concentration values of < 1 mg/L).

The AMD modelling used in this assessment is based on extensive site-specific datasets suitable for prediction of future AMD scenarios in the BPCP Millerton Block project area. Analogue monitoring data was collected from adjacent previous and current mining operations (Mangatini Catchment) which are a similar scale to Millerton Block activities. Data are linked, processed, and projected forward by peer reviewed interpretations and assumptions. Adaptive management is in place to provide scope for changes in mine plans or to provide additional improvement in water quality where possible and to manage remaining uncertainty in modelling and projections.

There is scope for further refinement and optimisation of this assessment through performance monitoring and adaptive management. It is expected that most alternative scenarios could be adaptively managed utilising the proposed water and AMD management infrastructure. Similarly, ongoing refinement of predicted betterment reference values based on performance monitoring in the context of untreated/historic AMD contributions may be required.

10.0 Recommendations

Operational and compliance monitoring are described in Instream (2026) and GHD (2026).

Additional recommendations identified through this technical assessment include:

- Create and maintain / improve the Millerton Block specific water and AMD management plan that covers Project phases to ensure continuity of planning (addressed in the Millerton Block water and AMD Management Plan (STO-ENV-PLN-027)).
- Quantify the effects of additional Millerton acidity load reporting to the Mangatini Treatment System including sludge generation, dewatering, and disposal requirements (addressed in the Stockton Operational AMD Sludge Management Report (BRL 2025a)).
- Manage the effects of additional Millerton acidity load reporting to the Mangatini Treatment System from a water quality perspective, by assessing against compliance criteria in Mangatini Stream and Ngakawau River, including benchmarking criteria against existing water quality datasets (addressed in the Aquatic Ecology assessment (Instream 2026)).
- Continue monitoring at the sites discussed in this report (T1, S25, S24A, S23, S6, MC1, NR, NRB, S14C, S14B), including flow rate, acidity concentration, and Al concentration, where possible. These datasets capture the key parameters used in this AMD model (enabling further model updates / refinement);
- Ensure monitoring regimes capture data that enables robust assessment of water and AMD management performance relative to betterment reference values; and
- Ensure monitoring regimes capture data that enables targeted quantification of key milestones in AMD management, for example:
    - The effect of AMD capture and transfer from the Syncline / DCA on S23 acidity loads and water quality;

- The effect of Twins catchment reduction on T1 acidity loads and water quality;
- The effect of fire suppression cessation on S23 and S24A acidity loads and water quality;
- The effect of opencast catchment cut-off on S23 and S24A acidity loads and water quality;
- The general effect of removing 'treatable' acidity load from a given catchment on remnant acidity loads and annual median / 75th percentile remnant acidity and Al concentrations.

- Refine Operational Phase AMD model assumptions to reflect changes in mine planning, fire suppression, AMD treatment rates, scheduled overburden stripping rates, etc. and update forecasts through the Annual Work plan processes.
- Continue performance monitoring related to EOML Phase AMD model assumptions and adjust or improve monitoring regimes where possible and as mining progresses.

Aquatic ecology surveys are proposed for the Lower Ngakawau River and it is recommended that the results of these surveys be compared against current use of dissolved Al ecological recovery thresholds to strengthen the assessment approach.

11.0 Acronyms

Acronym	Definition
Acidity	Acidity to pH 7
AEE	Assessment of environmental effects
Al	Aluminium
AMD	Acid Mine Drainage
bcm	Bank cubic metres
BCM	Brunner Coal Measures
BPCP	Buller Plateau Continuation Project
BPO	Best Practicable Option
BRL	Bathurst Resources Limited
CaO	Calcium Oxide – acidity neutralising agent
CML	Coal Mining Licence
DCA	Drainage Control Adit
EC	Electrical Conductivity
ELF	Engineered Landform
EOML	End of Mine Life
Fe	Iron
FTA	Fast Track Approval
ha	Hectare (unit of area)
LDP1	Lime Dosing Plant 1 – Mangatini Catchment
LDP2	Lime Dosing Plant 2 – St Patrick Catchment
LDS	Low Density Sludge
LINZ	Land Information New Zealand
LOM	Life of Mine
MASC	Mine Creek above Steep Creek – flow rate monitoring site
MPA	Maximum Potential Acidity
NAF	Non-acid Forming
NaOH	Sodium hydroxide – acidity neutralising agent
NZSOLD	NZ Society of Large Dams
PAF	Potentially Acid Forming
PCM	Paparoa Coal Measures
RML	Rockies Mining Limited
TSS	Total suspended solids
UG	Underground
VDT	Vegetation Direct Transfer

12.0 References

BPCP-ENV-PLN-012 Water Infrastructure Design Plan. 2026.

BPCP-ENV-PLN-013 Erosion and Sediment Control Plan for Land Disturbance Activities. 2026.

BRL 2025a. Stockton Operational AMD Sludge Management Report. 2025.

BRL 2026a. Acid Mine Drainage. History of AMD Management and Proposed Future Management. 2026.

BRL 2026b. Stockton Mine 80-year Water Quality Forecast. 2026.

BRL 2026c. Buller Plateaux Continuation Project. Project Description Summary. 2026.

Gandy and Younger 2007. Predictive Modelling of Waste Rock Leaching at Stockton Mine. Hydrogeochemical Engineering Research and Outreach Institute for Research on Environment and Sustainability Newcastle University, UK issued July 2007.

GHD 2018. BT Mining Limited – Mangatini Sump Management Plan. Report for BT Mining Limited – Mangatini Sump Project, 5137163. June 2018.

GHD 2024. Mangatini Sump Management Plan – Council Update. Memorandum (Internal use only), 12533107. 8 October 2024.

GHD 2026. Stockton water management and assessment of effects on waterways and water users from the BPCP Stockton mining activities. 2026.

INAP 2009. The International Network for Acid Prevention (INAP), 2009. Global Acid Rock Drainage Guide (GARD Guide). http://www.gardguide.com/

Instream 2026. Buller Plateaux Aquatic Ecology: history, thresholds and long-term management. Instream Consulting Client Report for BRL. 2026.

Mackenzie, A., 2008. Quantification of Millerton Road Cut ARD Generation Rates. Unpublished report for Solid Energy New Zealand Limited. 9 pp and accompanying Microsoft Excel file.

MWM 2025. Millerton acidity load model – Stockton Mine. Technical report prepared for BRL. J-NZ0223-002-R-Rev0. Dated 21 December 2025.

MWM 2026. Buller Plateaux Continuation Project Hydrological Assessment. March 2026.

O'Kane Consultants Ltd., 2015. Acid Mine Drainage Liabilities – Stockton and Cypress Operations. Technical report prepared for Solid Energy New Zealand Ltd. Report No. 949/01-01. Dated July 2015.

Pope, J., Christenson, H., Gordon, K., Newman, N., Trumm, D., 2018a. Decrease in acid mine drainage release rate from mine pit walls in Brunner Coal Measures. New Zealand Journal of Geology and Geophysics, Vol. 61, No. 2, 195–206.

Pope, J., Christenson, H., Gordon, K., Newman, N., Trumm, D., 2018b. Erratum: Decrease in acid mine drainage release rate from mine pit walls in Brunner Coal Measures. New Zealand Journal of Geology and Geophysics, Vol 61, No. 4, page 578.

[redacted]. Water Management Plan and Appendices. Submitted to West Coast Regional Council as part of Resource Consent application (RC1005). November 2020.

STO-ENV-PLN-016 Stockton AMD Management Plan. 2026.

STO-ENV-PLN-013 Stockton Water Management Plan. 2026.

STO-ENV-PLN-027 Millerton Block Water and AMD Management Plan. April 2026.

STO-ENV-PRO-031 Rehabilitation Stages and Planning Procedure. May 2025 version.

URS 2009. Millerton L5 Geotechnical Part 3. Preliminary Geotechnical Design of Pit Boundary Seal. Report prepared for Solid Energy New Zealand. 23 December 2009. Report ref. 42169667.

Gandy, C.J., Younger, P.L., 2007. Predictive Modelling of Waste Rock Leaching at Stockton Mine. Report to Solid Energy New Zealand Ltd by the Hydrogeochemical Engineering Research and Outreach Institute for Research on Environment and Sustainability, Newcastle University, UK.

Appendix I: Millerton Block EOML AMD Model

Mine Creek S6 and S23 forecasts

Forecast Acidity load and acidity / Al concentrations for Mine Creek area are assessed at MC1. The MC1 forecasts are presented in the water management plan, but S6 and S23 tributary forecasts are presented in this section (Figure 64 to Figure 67) to show the effects on Upper Mine Creek tributaries. The key effects on the Upper Mine Creek tributaries are:

- A significant decrease in S23 tributary acidity loads and acidity / Al concentrations due to an ~80% reduction in the area of historic underground workings draining to S23, from ~152 ha to 32.5 ha and MW16 sump 'cutting off' S23 tributary from the Millerton Opencast disturbance footprint; and
- An increase in S6 acidity loads and acidity / Al concentrations due to construction of Millerton ELF in the S6 tributary headwaters and:
    - Discharge of ~20% of MW16 acidity load untreated to S6 tributary during the AMD pumping to the Mangatini Treatment System phase (until 2046); and
    - Discharge of partially treated AMD (~75% treatment) from MW16 Sump to S6 tributary from 2047 onwards.

The effects on these tributaries combine such that overall MC1 Al concentrations meet the betterment reference values long term (post 2047).

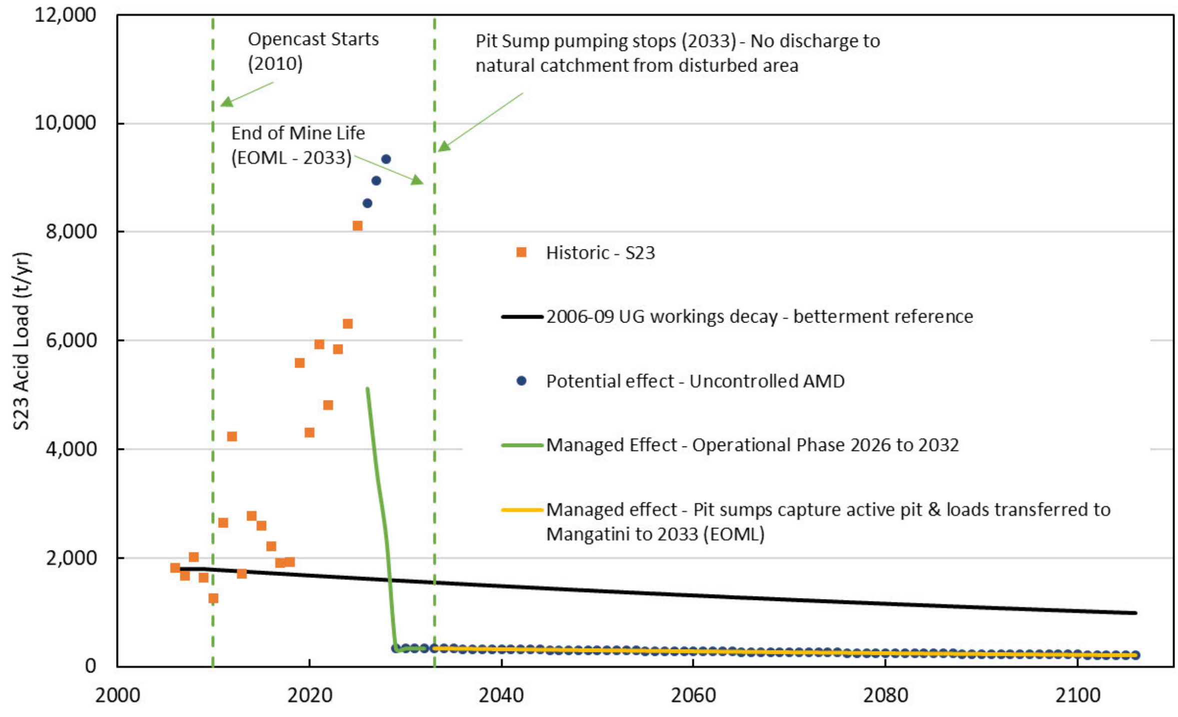

Figure 64. Forecast Mine Creek (S23 tributary) Acidity load

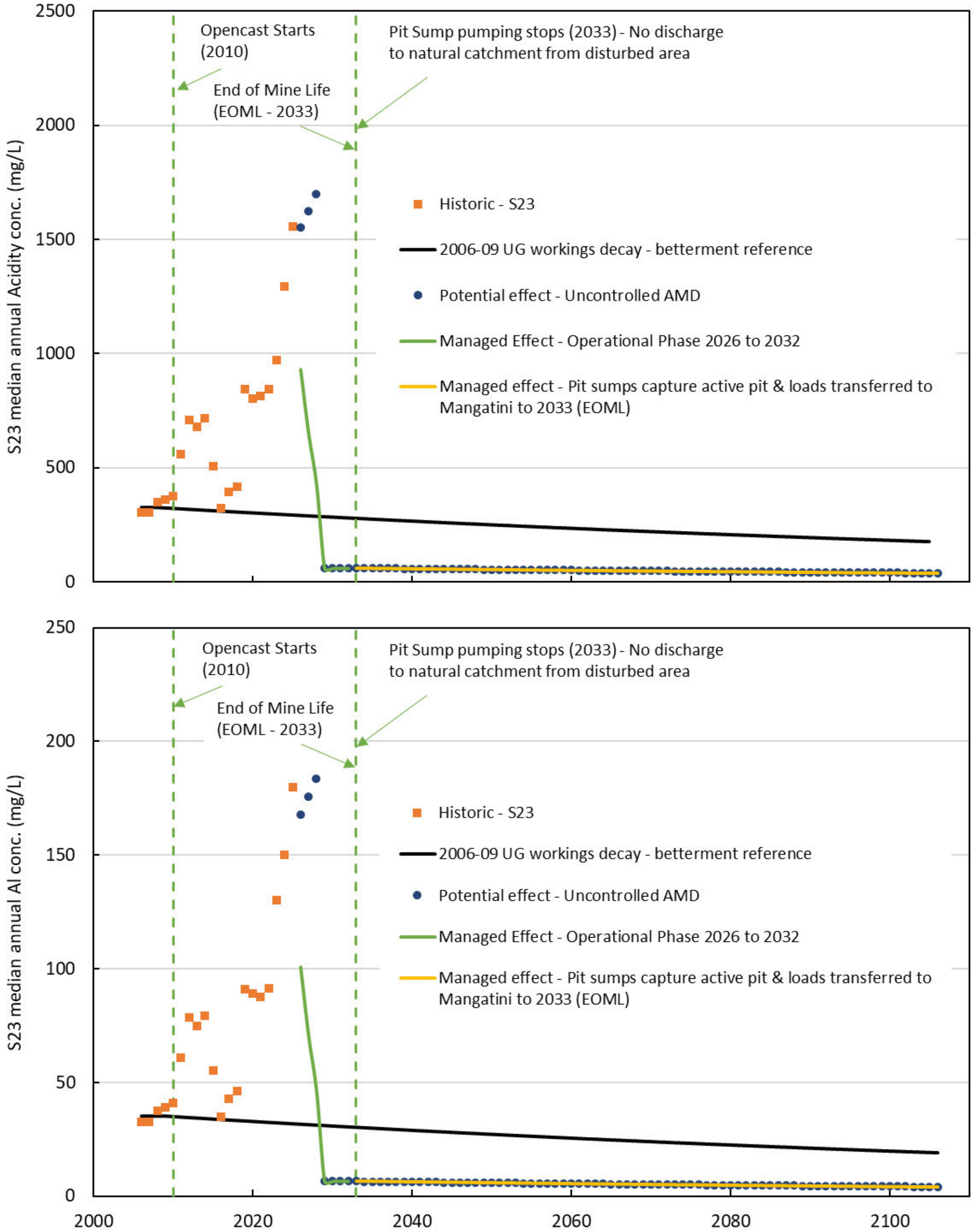

Figure 65. Forecast Mine Creek (S23 tributary) acidity and Al concentration.

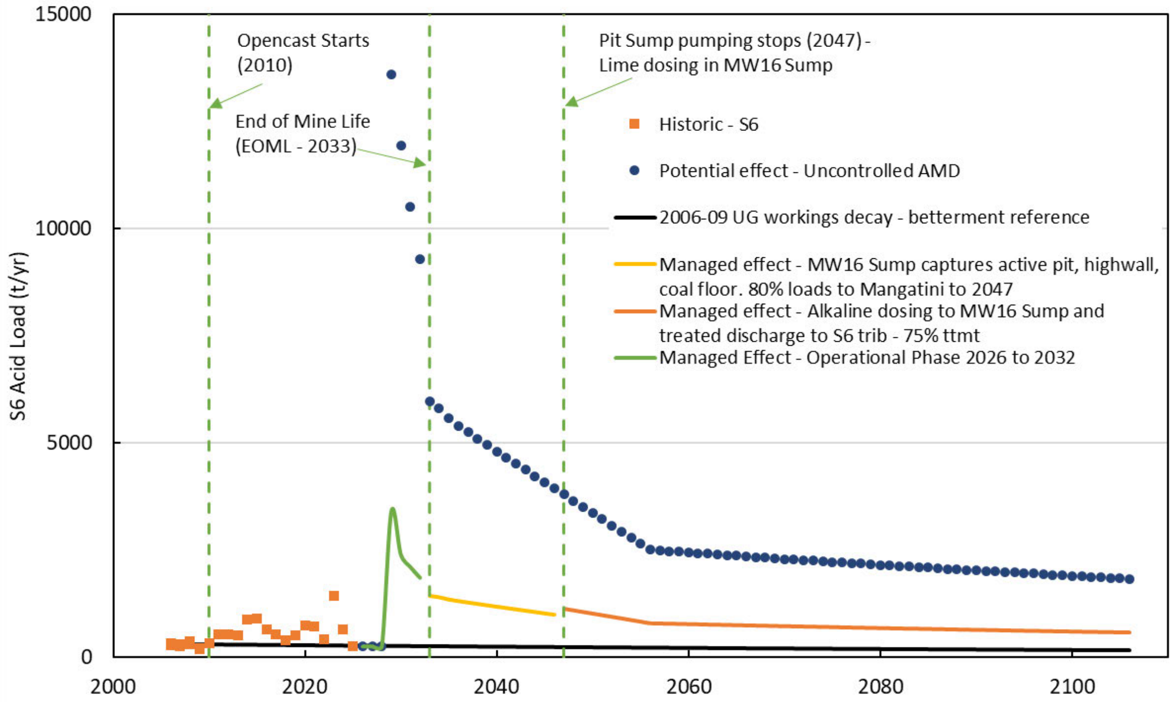

Figure 66. Forecast Mine Creek (S6 tributary) Acidity Load

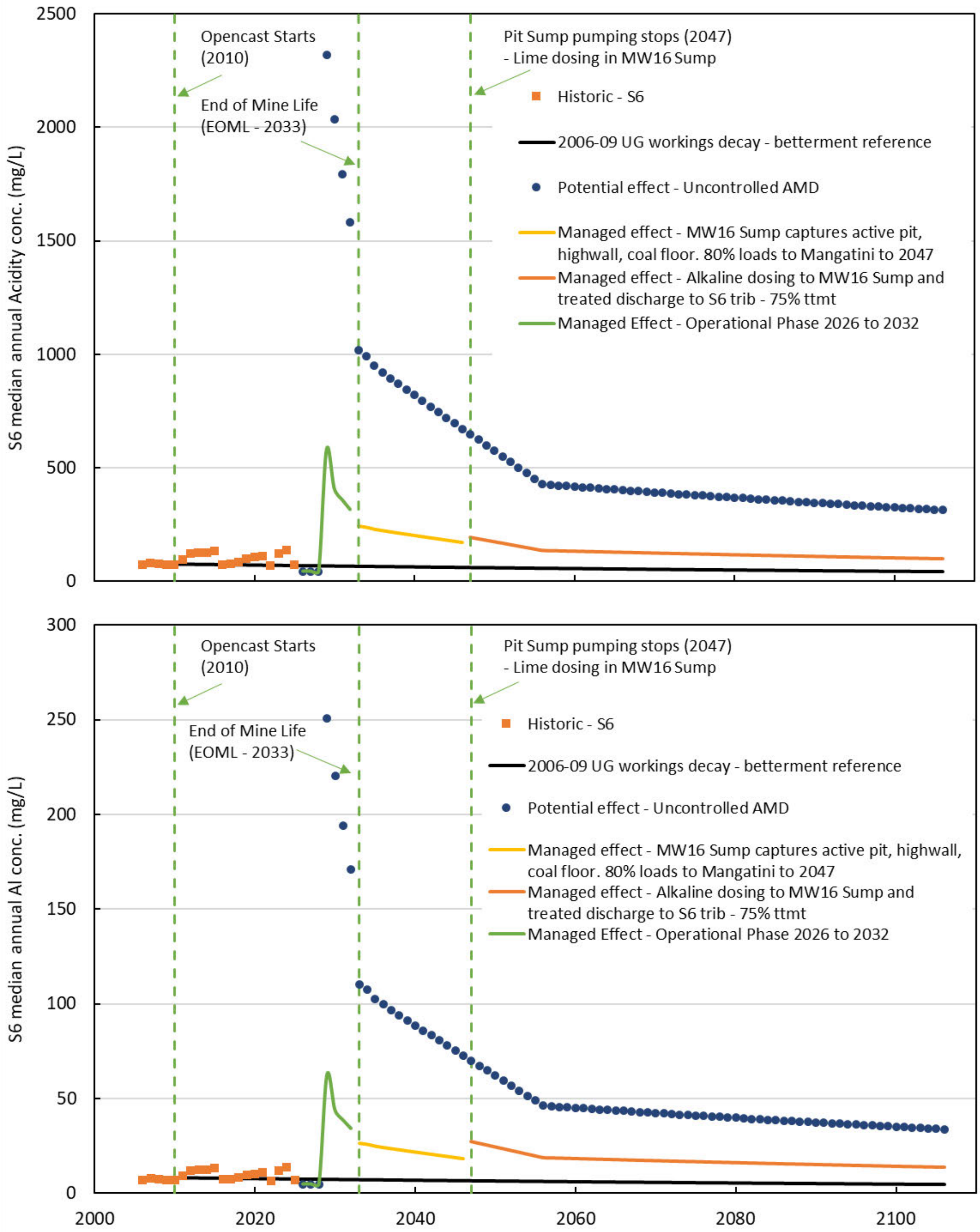

Figure 67. Forecast Mine Creek (S6 tributary) acidity and Al concentration