# SARAJI EAST MINING LEASE PROJECT

Environmental Impact Statement

## Appendix E-1
Surface Water Quality
Technical Report

BHP Mitsubishi Alliance

Prepared for
BM Alliance Coal Operations Pty Ltd
ABN: 67 096 412 752

AECOM

# Saraji East Mining Lease Project

## Surface Water Quality Technical Report

29-Aug-2024

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# Saraji East Mining Lease Project

## Surface Water Quality Technical Report

Client: BM Alliance Coal Operations Pty Ltd

ABN: 67 096 412 752

Prepared by

**AECOM Services Pty Ltd**
Turrbal and Jagera Country, Level 8, 540 Wickham Street, PO Box 1307, Fortitude Valley QLD 4006, Australia
T +61 1800 868 654 F + www.aecom.com
ABN 46 000 691 690

29-Aug-2024

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# Abbreviations

| | |
|---|---|
| AEP | Average Exceedance Probability |
| AHD | Australian Height Datum |
| BMA | BM Alliance Coal Operations Pty Ltd |
| CHPP | Coal Handling and Preparation Plant |
| DEHP | Department of Environment and Heritage Protection |
| DERM | Department of Environment and Resource Management |
| DES | Department of Environment and Science |
| DES manual | Manual for assessing consequence categories and hydraulic performance of structures (DES, 2016) |
| EA | Environmental Authority |
| EIS | Environmental Impact Statement |
| EPP (Water) | Environmental Protection (Water and Wetland Biodiversity) Policy 2019 |
| EP Act | Environmental Protection Act 1994 |
| ha | hectares |
| IRC | Isaac Regional Council |
| kL | kilolitres |
| kL/h | kilolitres per hour |
| km | kilometres |
| $km^2$ | square kilometre |
| kV | kilovolts |
| L/d | litres per day |
| LGA | Local Government Area |
| m | metre |
| $m^3$ | cubic metres |
| $m^3$/d | cubic metres per day |
| $m^3$/s | cubic metres per second |
| MD | Moderately Disturbed |
| MIA | Mine Infrastructure Area |
| ML | Mining Lease |
| ML/d | mega litres per day |
| ML/year | mega litres per year |
| MLA | Mining Lease Application |
| mm | millimetres |
| MR Act | Mineral Recourses Act 1989 |
| Mt | million tonnes |
| Mtpa | million tonnes per annum |
| PMF | Probable Maximum Flood |
| PMP | Probable Maximum Precipitation |

| | |
|---|---|
| QR | Queensland Rail |
| RMP | Rehabilitation Management Plan |
| ROM | Run-Of-Mine |
| ROP | Fitzroy Basin Resource Operations Plan April 2009 |
| STP | Sewage Treatment Plant |
| t | tonnes |
| t/yr | tonnes per year |
| the Project | Saraji East Mining Lease Project |
| ToR | Terms of Reference |
| tph | tonnes per hour |
| SDM | Slightly-to-moderately disturbed |
| Water Act | Water Act 2000 |
| WQO | Water Quality Objectives |
| WRP | Water Resource (Fitzroy Basin) Plan 1999 |
| WMP | Waste Management Plan |
| WTP | Water Treatment Plant |

# Executive Summary

BM Alliance Coal Operations Pty Ltd (BMA) has commissioned AECOM Australia Pty Ltd (AECOM) to recommence and finalise the environmental approvals for the Saraji East Mining Lease Project (the Project).

The Project Site is bound by Exploration Permit for Coal (EPC) 837, EPC 2103, Mining Lease Application (MLA) 70383, MLA 70459, Mining Lease (ML) 1775, ML 70142 and ML 1782. The Project Site encompasses approximately 11,427 hectares (ha) of land.

Mining and the infrastructure required to support the Project is not proposed within the full extent of the Project Site with direct impacts constrained to a smaller area of some 3,348 ha within MLA 70383, MLA 70459, ML 70142 and ML 1775. This area is referred to as the Project Footprint.

This surface water quality technical report provides an overview of existing surface water quality for the Project and assesses potential impacts to the environmental values of these surface waters as defined by the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP (Water)). This report was designed to inform the Environmental Impact Statement (EIS) process for the Project. The assessment methodology was developed to meet the requirements outlined in the final Project Terms of Reference (ToR) document (DEHP 2017).

The Project is located within the headwaters of the Isaac-Connors sub catchment of the Fitzroy Basin. A number of watercourses have been identified within or adjacent to the Project Site, namely: Boomerang Creek, Plumtree Creek, Hughes Creek, One Mile Creek, Spring Creek, and Phillips Creek. These are all tributaries of the Isaac River.

Environmental values for the receiving waters in the Project Site were specified in Schedule 1 of EPP (Water) in September 2011 for the Isaac River sub-basin of the Fitzroy Basin. The following environmental values have been identified:

- Aquatic ecosystems
- Stock watering (e.g. cattle) human consumer (e.g. of wild or stocked fish)
- Primary recreation (e.g. swimming)
- Secondary recreation (e.g. sailing, fishing)
- Visual appreciation (e.g. picnic, bushwalking)
- Drinking water (e.g. raw water supplies taken from river)
- Cultural and spiritual values (e.g. traditional customs).

Regionally the Isaac/Connors River System also provides a potable water supply (after treatment).

Relevant water quality objectives (WQO) for the Project Site were identified from the EPP (Water), local reference data and the Water Quality Guidelines (ANZG 2018). Water quality data from 2012 to 2021 was derived from data collected for Receiving Environment Monitoring Programs or water quality trend assessments.

Data showed a high variability of physico-chemical WQ parameters within and between streams traversing the project site (Boomerang, Hughes, Spring and One Mile Creeks). These ephemeral watercourses represent moderately disturbed aquatic habitats as defined by the Queensland Government (2022). Due to high variability of WQ parameters and deviations from the WQ guideline values as outlined in EPP 2019 (Water Isaac River 1301) and ANZG (2018), site specific, or sub-regional WQOs were developed.

Without adequate management and mitigation programs, the project has the potential to have an adverse impact on ephemeral surface water resources during construction, operation and decommissioning. The following impacts to surface water were assessed and management measures proposed:

- Erosion and sedimentation

- Chemicals and contaminants
- Release of mine affected water
- Water management system failures
- Subsidence
- Flooding of mine areas

During construction it is expected that the main areas of potential impact are activities associated with the development of mine infrastructure, building of access roads and stream crossings, and earth moving activities. These activities may lead to increased potential for erosion and sediment mobilisation to surface waterways. In addition, these activities increase the potential for water quality deterioration through chemical and fuel spills. To mitigate erosion and sedimentation, control practices will be applied to construction works and mining operations, in accordance with International Erosion Control Association Best Practice Erosion & Sediment Control guidelines (IECA, 2008). To manage the threat of chemical spills during construction and operation, chemical storage and handling will be performed in accordance with AS 1940 and AS 3780. The release of mine affected water into receiving surface waters is expected to be a potential impact on water quality if not managed appropriately. Therefore, the development of a mine water management system has been undertaken and is discussed in this report, with more detail provided in the Mine Water Balance Technical Report (AECOM, 2024).

Preliminary capacity estimates for all mine water management system (WMS) dams have been determined based on Design Storage Allowance (DSA) requirements, Extreme Storm Storage (ESS) requirements and a Water Balance Model (WBM) developed for the proposed mine development.

DSA and ESS requirements were developed based upon a preliminary Consequence Category Assessment (CCA) for the site, with a consequence category of ‘significant’ developed for all dams containing MAW, excepting the Underground Portal Area Sump (which was assessed as comprising a ‘low’ consequence category structure).

The WBM modelled the expected operational performance of the WMS, subject to a range of potential scenarios, including baseline climate conditions, potential climate change conditions, and temporary inoperability of water transfer infrastructure. The WBM utilised climate sequences generated for the site location, utilising a stochastic process, to produce 500 realisations of 20 year duration. The WBM results indicate that the system operates generally in deficit, where ongoing sourcing of MAW from the various site dams persistently draws down runoff reporting to the WMS, and generally maintains a low overall water inventory excepting in response to very wet conditions. Accordingly, the system can accommodate the expected inflows to the system (pit sump, rainfall, runoff, treated effluent, MAW) without the risk of uncontrolled releases (spills). Similarly, the WMS system is not reliant on licensed release(s).

Whilst uncontrolled spills and licensed release(s) are not expected / required, a licensed release point for the Process Water Dam is being sought, as a tool to manage MAW inventory levels for unforeseen conditions as a contingency. An example of a contingency scenario might involve unusual climatic conditions (i.e. rainfall) exceeding the DSA / ESS containment criteria for the MAW structures. The proposed licensed release point would discharge to Boomerang Creek during high flow conditions. The proposed release point would principally be utilised as a water management strategy to avoid uncontrolled discharge (spills) from MAW dams.

As licensed releases were not modelled to be required in the WBM, a stress test scenario of the WBM was specifically developed to produce spills – to allow assessment of potential licensed water release characteristics. This scenario involved halving all expected water sourcing requirements and it is noted that this scenario is not expected to occur.

Using this stress test scenario it was concluded that licensed release of mine affected water (MAW) can be feasibly achieved without exceeding trigger levels for event-based releases in downstream waterways. Based on these results, the likelihood of licensed releases occurring is very low, and if they were to occur it is not expected that there would be any residual impacts.

Potential adverse impacts may arise during the operational phase of the Project due to water management system infrastructure malfunctions (storages, pipes, pump failure) and flooding of the mine area, leading to a release of MAW into the environment. To mitigate this risk, the WMS concept was developed to retain MAW at the MIA storm water system or within the WMS if flooding or water infrastructure failure would occur. Therefore, the external environmental impact is expected to be minimal.

Stream beds of Boomerang and Hughes Creek will be likely subject to subsidence over longwall panels, causing depressions in the landscape and surface cracking. These effects will initially impact water quality and quantity through increased erosion and water attenuation. Impacts of subsidence will reduce over time as bed load sediments fill in the depressions. An adaptive management framework is suggested to mitigate and minimise subsidence impacts.

During decommissioning the main areas of potential impact arise from transfer system failures during dewatering activities and increased erosion and sediment mobilisation potential during earthworks activities to establish a final landform for the sites. It is proposed that the likelihood of transfer system failures is low due to the established infrastructure and transfer capacities of the WMS at the existing Saraji Mine to which remaining MAW will be transferred. Erosion and sedimentation issues linked to decommissioning and landform reconstruction will be managed in accordance with IECA (2008).

Development of a water quality monitoring program is proposed within this report, designed to measure the effectiveness of the impact mitigation measures implemented during the Project. Based on the implementation of recommended management and mitigation measures and validation through monitoring programs, the residual risk of the Project having adverse impacts on receiving surface waters is expected to be minor.

# 1.0 Introduction

BM Alliance Coal Operations Pty Ltd (BMA) commissioned AECOM Australia Pty Ltd (AECOM) to recommence and finalise the environmental approvals for the Saraji East Mining Lease Project (the Project).

The Project Site is bound by Exploration Permit for Coal (EPC) 837, EPC 2103, Mining Lease Application (MLA) 70383, MLA 70459, Mining Lease (ML) 1775, ML 70142 and ML 1782. The Project Site encompasses approximately 11,427 hectares (ha) of land. Mining and the infrastructure required to support the Project is not proposed within the full extent of the Project Site with direct impacts constrained to a smaller area of some 3,348 ha within MLA 70383, MLA 70459, ML 70142 and ML 1775. This area is referred to as the Project Footprint. The Project Site and Project Footprint are shown in Figure 1.

This surface water quality technical report provides an overview of existing surface water quality for the Project and assesses potential impacts to the environmental values of these surface water bodies as defined by the Environmental Protection (Water and Wetland Biodiversity) Policy 2009 (EPP (Water)). This report was designed to inform the Environmental Impact Statement (EIS) process for the Project. The assessment methodology was developed to meet the requirements outlined in the final Project Terms of Reference (ToR) document (DEHP, 2017). Potential impacts to surface water hydrology are assessed separately in the Project Hydrology, Hydraulics and Geomorphology Technical Report (Alluvium 2023).

## 1.1 Project overview

BMA proposes to develop a greenfield single-seam underground mine development on MLA 70383 commencing from within ML 1775 (the Project).

The Project has been designed to utilise the existing approved Saraji Mine infrastructure, such as electricity lines, water supply pipelines, coal handling and preparation plant (CHPP), haul roads, workshops and warehouses, wherever practical. The Project will require upgrades to existing mine infrastructure and additional mine infrastructure. As such, the Project also includes a new CHPP, 66 kilovolt (kV) powerline, water pipeline and associated mine infrastructure area (MIA) and a new rail spur and balloon loop; each of which is proposed to be located on the existing Saraji Mine. A new infrastructure and transport corridor will be constructed on MLA 70383 and MLA 70459 to accommodate the reconfiguration of existing power and water networks and internal access roads. The key features of the Project are shown in Figure 1.

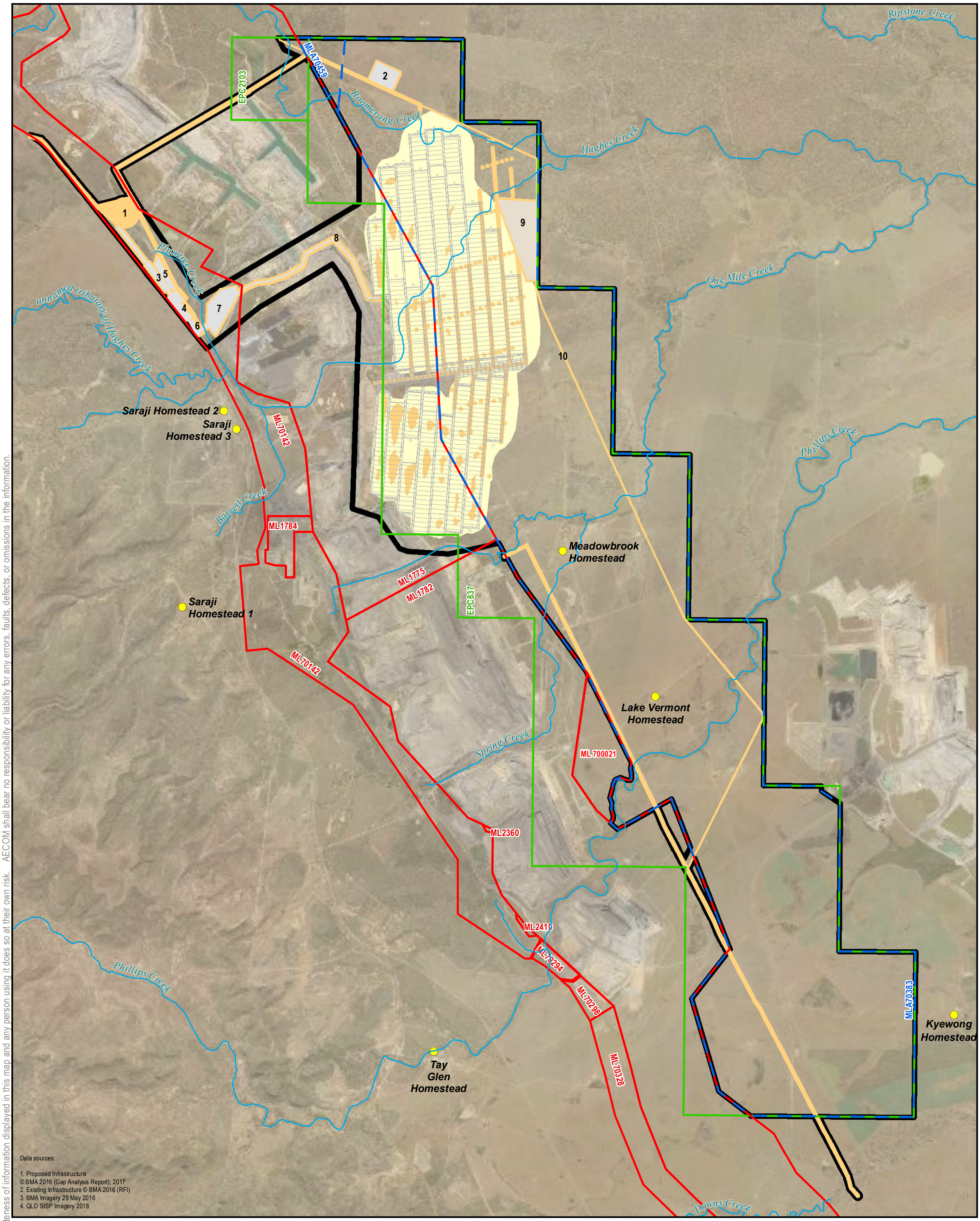
The Project will mine up to 11 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal and produce up to eight Mtpa of metallurgical product coal for the export market over a life of approximately 20 years.

## 1.2 Overview of the surface water receiving environment

The Project is located within the Isaac Regional Council (IRC) Local Government Area (LGA), approximately 30 kilometres (km) north of Dysart and approximately 170 km south-west of Mackay in Queensland.

The site topography comprises gently undulating country, descending to alluvial plains. The area is located within the Isaac River catchment (covering an area of approximately 19,000 square kilometres ($km^2$)), with all mine affected water (MAW) potentially released into Isaac western upland tributaries. These catchments form part of the larger Fitzroy Basin. The Fitzroy River Basin extends from north of Nebo in the north to Injune in the south, Rockhampton in the east and Clermont in the west. The Fitzroy River Basin has a catchment area of over 140,000 $km^2$ and includes the majority of the Bowen Basin area. The Fitzroy River basin eventually discharges into the Coral Sea east of Rockhampton, at the southern end of the Great Barrier Reef.

An overview of the Fitzroy River catchment and the Isaac River sub-catchment is provided in Figure 2.




**LEGEND**

- Project Site
- Project Footprint - Indirect Impact
- Project Footprint - Direct Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground layout
- Surface Infrastructure
- Watercourse
- Homestead

**Surface Infrastructure**

1 Rail Loading Balloon Loop
2 Process Water Dam
3 Product Stockpiles
4 CHPP
5 Raw Water Dam
6 ROM Pad
7 Future MIA
8 Conveyor
9 Construction Village
10 Transport and Infrastructure Corridor

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**Figure 1**
**Project Site and Footprint**

**Environmental Impact Statement**
**Saraji East Mining Lease Project**

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP Mitsubishi Alliance

DATE: 29/05/2024 VERSION: 1



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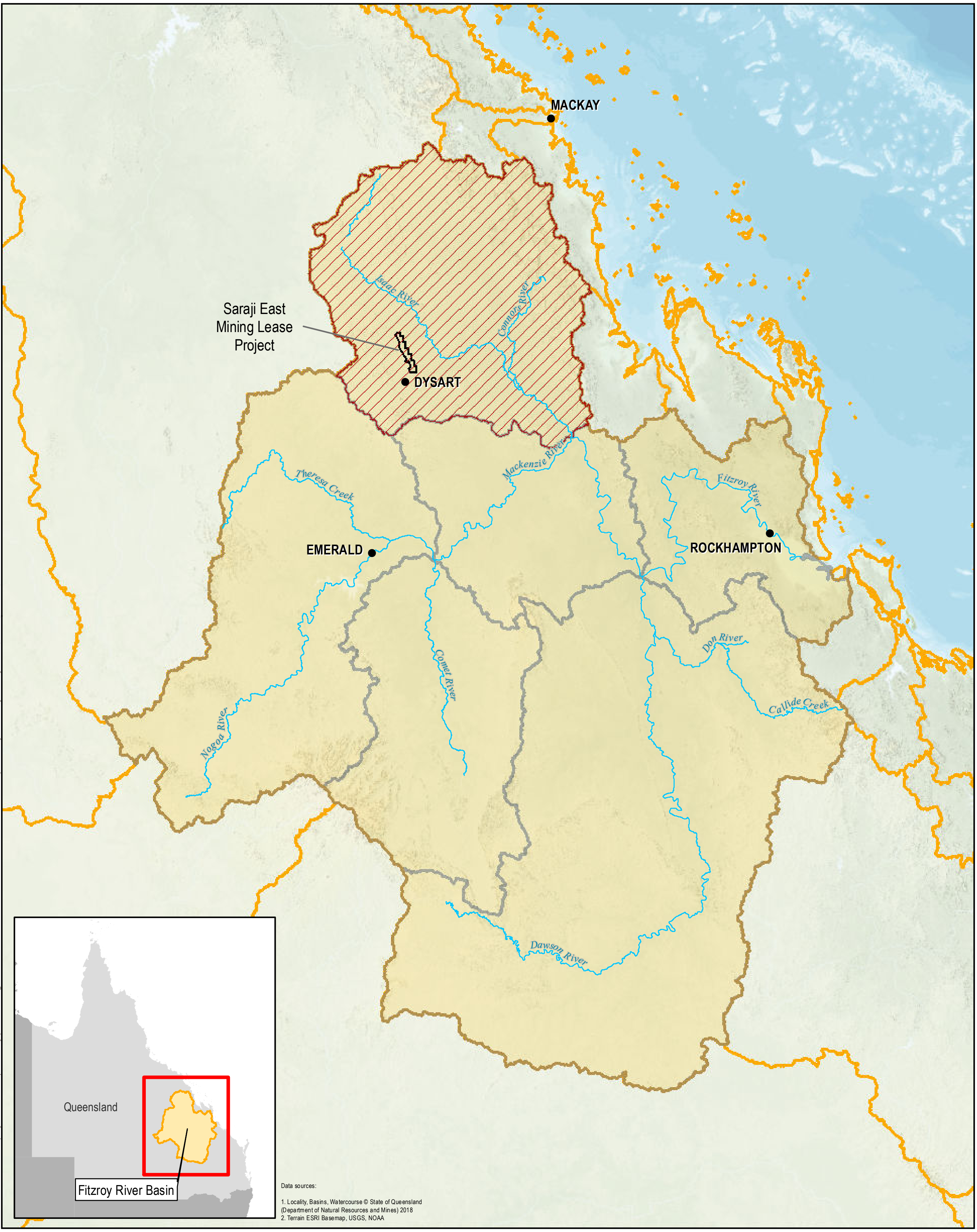



**LEGEND**

- Locality
- Watercourse
- Isaac River Catchment
- Tenement
- Fitzroy River Basin
- Drainage Basin

N

**Figure 2**
**Fitzroy River Basin**

**Surface Water Technical Report**
**Saraji East Mining Lease Project**

0 25 50 100
Kilometres

Scale: 1:3,000,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP Mitsubishi Alliance

DATE: 15/11/2022 VERSION: 3

The Project's ML/MLA extent covers several waterways including Hughes, One Mile, Phillips, Spring, Plumtree and Boomerang Creeks shown in Figure 3. These creeks are diverted through the Peak Downs and Saraji Mines. Running approximately 8 km to the south of the Project Site is Phillips Creek, a large watercourse with a total catchment area of 452 $km^2$. Phillips Creek is diverted through the existing Saraji Mine site within the downstream reaches; however, the Project Site does not extend into the Phillips Creek catchment.

The watercourses within the Project Site are ephemeral in nature and provide seasonal habitat for aquatic fauna and flora. The aquatic ecosystems are considered to be moderately disturbed from current mining and grazing activities and are classified accordingly in the EPP (Water) and mapped by the Queensland Government (2022). Stream substrates are dominated by coarse sand in all creeks across the site (Gauge Industrial and Environmental, 2014).

The dominant land use upstream of the proposed mine site is beef cattle grazing and native bushland. Tree clearing has occurred over time to improve pastures. There is also mining activity upstream of the Project Site and the Isaac River has been dammed upstream through the construction of Burton Gorge Dam. The catchments are therefore not in pristine condition and are susceptible to the impacts of existing land use activities. Existing land uses downstream of the Project Site include mining, grazing (modified pastures) and dryland cropping, as described in the Project Hydrology, Hydraulics and Geomorphology Technical Report (Alluvium, 2023).

## 1.3 Assessment methodology

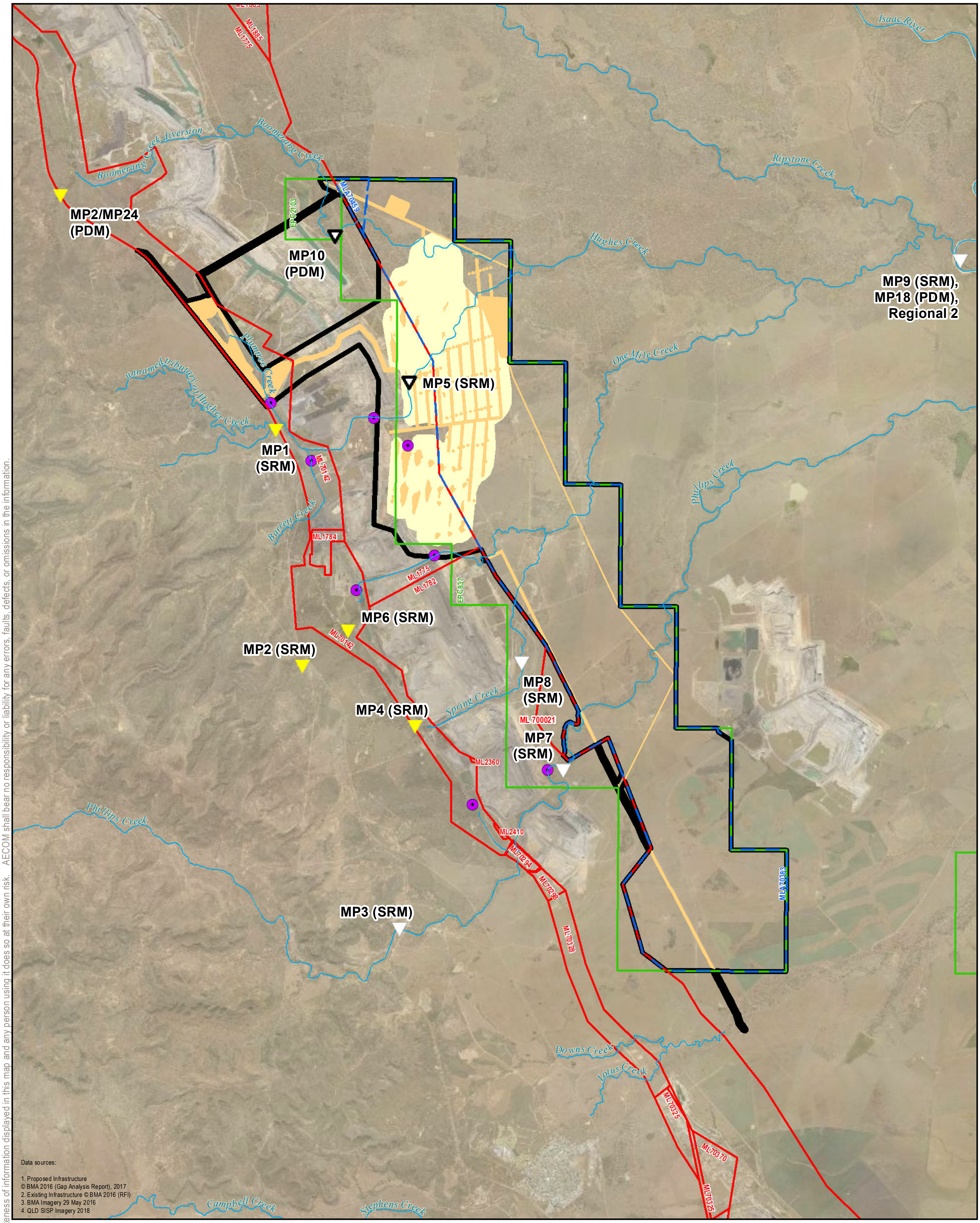
The assessment methodology identified environmental values with potential to be impacted by the Project and preventative and mitigation measures to demonstrate that the Project will not result in degradation of water quality related values. The surface water quality assessment involved the following steps:

1. Identification of the environmental values of surface waters within the Project Site and immediately downstream that may be affected by the Project (refer to Section 3.1)
2. Definition of relevant water quality objectives (WQOs) applicable to the environmental values (refer to Section 4.1)
3. Characterisation of the quality of surface waters within the area (refer to Section 1.1)
4. Identification of the quantity, quality, location and timing of all potential and/or proposed release of contaminants (such as controlled water releases to surface water streams) from water and waste water from the Project (refer to Section 1.1)
5. Assessment of the likely impact of any releases on all relevant environmental values of the surface water receiving environment (refer to Section 5.0)
6. Assessment of how the WQO and performance outcomes will be achieved, monitored and audited, and how corrective actions will be managed (refer to Section 6.0).

### 1.3.1 Information sources

Water quality datasets used in this assessment comprise monitoring data from locations monitored as part of receiving environment monitoring programs (REMP) for Saraji Mine (SRM) and Peak Downs Mine (PDM) between July 2012 and July 2022, dependent on location. Data was collected and assessed for the following purposes**:**

- From upstream of any mining activity to develop sub-regional WQOs.
- From downstream of the existing Saraji Mine to assess the existing baseline conditions of the Project Site.




**LEGEND**

- Project Footprint - Indirect Impact
- Project Footprint - Direct Impact
- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- Existing mine water release point
- Existing environment (for EIS)
- Future monitoring of mining impacts
- Background data (used for water quality objectives)

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**Figure 3**
**Existing monitoring and release points**

**Environmental Impact Statement**
**Saraji East Mining Lease Project**

0 0.75 1.5 3
Kilometres

Scale: 1:150,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

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# 2.0 Legislative framework and guidelines

## 2.1 Water Act 2000 (Qld)

The use of water for activities such as irrigation, stock water, drinking water and industrial use are regulated under the *Water Act 2000* (Qld) (Water Act). The Water Act provides a basis for the planning and allocation of Queensland water resources, which in turn must make allowances for the provision of water purely for the support of the natural processes that underpin the ecological health of natural river systems, that is, environmental flows. The watercourses potentially affected by the Project are subject to protection under the Water Act, which regulates the extraction of water from these watercourses and works that might disturb bed and banks of each watercourse.

A number of watercourses identified under the Water Act flow through the Project Site, including Boomerang Creek, One Mile Creek, Hughes Creek, Plumtree Creek, Spring Creek and Phillips Creek. Of these streams, only Boomerang Creek, Plumtree Creek and Hughes Creek intersect the underground mining panels and the predicted area of subsidence.

The Water Act prescribes the process for preparing Water Resource Plans (WRP) and Resource Operation Plans (ROP) which are specific for catchments within Queensland. Under this process, the WRP identifies a balance between waterway health and community needs and are applied on a catchment scale. The WRP establishes Environmental Flow Objectives that are of importance for waterway health and sets Water Allocation Security Objectives which are important to maintain water availability for community needs. The ROP provides the operational details on how this balance can be achieved. The WRP and ROP determine conditions for granting water allocation licences, permits and other authorities, as well as rules for water trading and sharing. The WRP and ROP applicable to the Project are detailed below.

### 2.1.1 Fitzroy Basin Water Resource Plan

The Project is located within the Fitzroy Basin. The Water Resource (Fitzroy Basin) Plan was finalised in 1999, but was amended in 2005 to address overland flow water management and was again updated in 2011 (Queensland Government, 2011).

### 2.1.2 Fitzroy Basin Resource Operations Plan

The Fitzroy Basin ROP came into force in January 2004 and was amended in October 2011 (Revision 3) (DNRM, 2015). It details how the objectives of the Water Resource (Fitzroy Basin) Plan will be met on an operational level, and defines strategies to support the WRP’s overall goals for water entitlement security and ecological health.

In general, it provides the basis and rules for trading of water allocations, allows for unallocated water to be identified and allocated and also details operating rules for the use of water management infrastructure such as weirs and dams. The Nogoa Mackenzie, Lower Fitzroy, and Fitzroy Barrage Supplemented Water Supply Schemes operate within the wider Fitzroy Basin catchment.

## 2.2 Environmental Protection (Water and Wetland Biodiversity) Policy 2019

The quality of Queensland waters is protected under the EPP (Water and Wetland Biodiversity) 2019 (the EPP (Water)). The EPP (Water) achieves the objectives of the *Environmental Protection Act 1994* (EP Act) to protect Queensland waters while supporting ecologically sustainable development. Queensland waters include water in rivers, streams, wetlands, lakes, groundwater aquifers, estuaries and coastal areas.

The EPP (Water) seeks to protect and enhance the suitability of Queensland waters for various beneficial uses. The Queensland Department of Environment and Science (DES) (formerly the Department of Environment and Heritage Protection (DEHP)) hold responsibility for administering the EPP (Water).

The policy identifies environmental values for waters in Queensland and guides the setting of WQOs to protect the environmental values of any water resource. Water quality guidelines or objectives are the minimum levels required to protect all of the beneficial uses of a waterway (DERM, 2009). In accordance with the EPP (Water), environmental values, water quality guidelines and WQOs for the Fitzroy Basin were established (DEHP, 2011).

The document that is of relevance to the Project Site's receiving environment is the *EPP (Water) Isaac River Sub-basin Environmental Values and Water Quality Objectives* (DEHP, 2011).

To derive site specific (sub-regional) WQOs, the methods outlined in the *Queensland Water Quality Guidelines 2009* (DEHP, 2009), the *Qld Deciding aquatic ecosystem indicators and local water quality guideline values 2022* (DES, 2022*)* and the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018) were applied.

## 2.3 Regulated structures

The *Water Supply (Safety and Reliability) Act 2008* (WSSR Act) sets out the requirements for referable dams. Generally, these relate to dams that exceed certain height and volume criteria which defines the scope of failure impact assessment (FIA) required to determine the population at risk in the event of dam failure.

All structures which are dams or levees associated with the operation of an ERA environmentally relevant activity (ERA) are generally required to have their consequence category assessed in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures* (DES, 2016) (the DES manual). Assessment is based on the potential environmental harm that would result from a number of failure event scenarios including seepage, overtopping and dam break. Each scenario is assessed against three assessment criteria - potential harm to humans, general environmental harm and general economic loss or property damage with the potential consequence category for each criteria being either low, significant or high. The consequence category of a structure is hence the highest consequence category determined under any of the assessment criteria for each failure scenario.

A preliminary consequence category assessment (CCA) is presented in Table 10 of the Project's Mine Water Balance Technical Report (AECOM, 2024) with a comprehensive CCA to be completed following detailed design of the structures. Should the rating of dams change during detailed design, the associated performance and management criteria may also change.

Conditions for design, operation and auditing of regulated structures will be included in the Environmental Authority (EA) for the Project, designed according to specific hydrologic and hydraulic performance criteria set out in the DES manual, and inspected annually by a suitably qualified professional.

# 3.0 Surface water environmental values

## 3.1 Environmental values

Environmental values for water are the qualities of water that make it suitable for supporting aquatic ecosystems and human water uses. These environmental values need to be protected from the effects of habitat alteration, waste releases, contaminated runoff and changed flows to ensure healthy aquatic ecosystems and waterways that are safe for community use. Different waters may have different environmental values. The range of environmental values and the waters to which they can potentially apply are listed in.

**Table 1 Environmental value definitions. Source: DEHP (2011)**

| Environmental Value | Description |
|---|---|
| Aquatic ecosystem | A community of organisms living within or adjacent to water, including riparian or foreshore area (EPP (Water), Schedule 2).<br>The intrinsic value of aquatic ecosystems, habitat and wildlife in waterways and riparian areas. For example, biodiversity, ecological interactions, plants, animals, key species (such as turtles, platypus, seagrass and dugongs) and their habitat, food and drinking water.<br>Waterways include perennial and intermittent surface waters, groundwaters, tidal and non-tidal waters, lakes, storages, reservoirs, dams, wetlands, swamps, marshes, lagoons, canals, natural and artificial channels and the bed and banks of waterways. |
| Irrigation | Suitability of water supply for irrigation. For example, irrigation of crops, pastures, parks, gardens and recreational areas. |
| Water supply/use | Suitability of domestic water supply, other than drinking water. For example, water used for laundry and produce preparation. |
| Stock watering | Suitability of water supply for production of healthy livestock. |
| Aquaculture | Health of aquaculture species and humans consuming aquatic foods (such as fish, molluscs and crustaceans) from commercial ventures. |
| Human consumption of aquatic foods | Health of humans consuming aquatic foods, such as fish, crustaceans and shellfish from natural waterways. |
| Primary recreation | Health of humans during recreation which involves direct contact and a high probability of water being swallowed, for example, swimming, surfing, windsurfing, diving and water-skiing.<br>Primary recreational use, of water, means full body contact with the water, including, for example, diving, swimming, surfing, water-skiing and windsurfing. |
| Secondary recreation | Health of humans during recreation which involves indirect contact and a low probability of water being swallowed, for example, wading, boating, rowing and fishing. |
| Visual recreation | Amenity of waterways for recreation which does not involve any contact with water. For example, walking and picnicking adjacent to a waterway.<br>Visual recreational use water means viewing the water without contact with it. |
| Drinking water supply | Suitability of raw drinking water supply. This assumes minimal treatment of water is required, for example, coarse screening and/or disinfection. |
| Industrial use | Suitability of water supply for industrial use. For example, food, beverage, paper, petroleum and power industries. Industries usually treat water supplies to meet their needs. |
| Cultural and spiritual values | Indigenous and non-indigenous cultural heritage. For example:<br>Custodial, spiritual, cultural and traditional heritage, hunting, gathering and ritual responsibilities<br>Symbols, landmarks and icons (such as waterways, turtles and frogs)<br>Lifestyles (such as agriculture and fishing).<br>Cultural and spiritual values of water means its aesthetic, historical, scientific, social or other significance, to the present generation or past or future generations. |

The Project Site is located in the far upstream headwaters of the Fitzroy Basin and relatively high in the headwaters of the Isaac River sub-catchment. The major watercourses within the receiving environment include the upper to middle reaches of Hughes Creek, One Mile and Phillips Creeks.

The Project is located in the upper to middle reaches of Hughes, One Mile, and Phillips Creek, with water quality monitoring locations at approximately 180 m to 360 m AHD (Australian Height Datum) elevation. The upstream sites exhibit typical freshwater upland stream characteristics, whereas the downstream sites have characteristics of both upland and lowland freshwater streams.

The QWQG (DEHP, 2009) defines upland freshwater streams as “small (first, second and third order) upland streams with moderate to fast flows due to steep gradients. Substrate usually cobbles, gravel or sand – rarely mud.” The definition of lowland freshwater streams is “larger (third, fourth and fifth order or greater), slow-flowing and meandering streams and rivers with gradient very slight. Substrates rarely cobble and gravel, more often sand, silt or mud” (DEHP, 2009).

## 3.2 Scheduled Isaac River sub-catchment environmental values

Environmental values for waters in the Isaac River sub-basin are published in the DEHP 2011 document entitled ‘Environmental Protection (Water) Policy 2009 Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River)’. The following environmental values have been identified for the Isaac Western Uplands Tributaries sub-catchment (within which the Project Site is located):

- Aquatic ecosystems
- Stock watering (high) (e.g. cattle)
- Human consumer (e.g. of wild or stocked fish)
- Primary recreation (e.g. swimming)
- Secondary recreation (e.g. sailing, fishing)
- Visual appreciation (e.g. picnic, bushwalking)
- Drinking water (e.g. raw water supplies taken from river)
- Cultural and spiritual values (e.g. traditional customs).

## 3.3 Existing water users

The Project Site is within the Isaac River catchment. The Lower Fitzroy and Fitzroy Barrage Water Supply Schemes are located 250 km downstream of the confluence with the Isaac River. They have 28,621 mega litres (ML) and 62,335 ML of allocated water, respectively. The total catchment area of these tributaries upstream and within the Project Site is about 590 km$^2$, this equates to less than 0.4% of the total catchment area for these water supply schemes (142,665 km$^2$).

It should also be noted that the ROP explanatory notes state that the western tributaries of the Isaac River are significantly drier than those to the north, with annual rainfall less than 600 millimetres (mm) in the west and less than 1,600 mm in the north. This suggests that creeks in the vicinity of the mine (Phillips, Boomerang, Hughes and One Mile Creeks) provide a relatively small contribution to the water allocations in the Fitzroy River Basin.

According to QLD Globe mapping, land use within a range of 100 km downstream of the Isaac River – Boomerang Creek confluence mainly consists of grazing and cropping with minor areas being utilised for irrigated perennial horticulture.

Existing surface water users have been identified through a search of the Department of Resources (DOR) database on surface water extraction licences near to the Project Site prior to the confluence with the Isaac River. The search revealed five surface water licences, consisting of two licences for stock watering purposes downstream of the site, with the remaining three licences belonging to BMA to divert a watercourse and for site water management of the existing Saraji Mine. The stock licences are all located within 8 km of the downstream extent of the Project Site. A summary of these licences is provided in Table 2 and illustrated in Figure 4.

**Table 2 Surface water extraction licences for stock watering**

| Lot/Plan | Creek | Purpose |
|---|---|---|
| 9/CNS98 | Ripstone Creek | Stock watering. Property has access to Boomerang Creek downstream. |
| 11/KL135 | Ripstone Creek | Stock watering. Isaac River catchment upstream of the site. |

Lake Vermont Meadowbrook mining site which is situated about 9000 m south of the Saraji mine is owned by Bowen Basin Coal Pty Ltd (BBC) on mining leases (ML) 70331, ML 70477 and ML 70528 under the approval of the Environmental Authority (EA) Permit No. EPML00659513. An extension of the existing Lake Vermont coal mine is in the works and BBC is currently in the process of submitting an environmental impact statement to DES. The Terms of Reference for this project submitted to DNRME in April 2020 outline the need for identification of any approval or allocation for water that would be needed under the Water Act 2000, hence any likely water extraction permits from the site cannot be confirmed at the time of this EIS.

Of note is that three unnamed gullies traverse Lake Vermont mine site. These generally drain in a north-easterly direction to the floodplain of the Isaac river that flows south-easterly. The Northern section of Lake Vermont Mine drains north to Phillips Creek that in turn drains east to Isaac river.

The Lake Vermont REMP report (BHP, 2020) outlines the environmental values for watercourses such as rivers and creeks on and in the surrounds of the project site. For the waterways of relevance for the Lake Vermont site, environmental values included:

- Suitability for crop irrigation
- Suitability for aquaculture (Isaac western upland tributaries only)
- Suitability for drinking water supplies
- Suitability for primary and secondary contact recreation
- Suitability for visual recreation
- Suitability for human consumers of wild, stocked fish, shellfish, crustaceans
- Protection of cultural and spiritual values
- Suitability for industrial use
- Suitability for stock watering
- Suitability for farm supply use.

## 3.4 Existing BMA water supply network

Water supply (MAW and raw water) for the Project will be provided via the water network allocations supplying Saraji Mine, however the Project water management system (WMS) has been designed to operate self-sufficiently with the benefits of being connected to the broader BMA network to allow water sharing where beneficial.

Under normal operating conditions, the majority of the Project water supply would be MAW and the Project mine water system will operate independently of the existing Saraji Mine water system. However, should sufficient Project MAW not be available for CHPP process and dust suppression, MAW or raw water may be imported from the existing Saraji Mine water system, following water quality testing to confirm that water is of an appropriate quality for the intended use. Similarly, where additional water demands at the existing Saraji Mine need to be met, water that satisfies water quality testing may be exported from the Project to SRM.

The initial water demand increase on the existing BMA water supply network associated with the Project is in the order of 2.39 mega litres per day (ML/d) for the first year of the project. A daily water demand of 6.29 ML will be required for the period from year 2 to year 21 of the project (AECOM 2023).

BMA holds allocations of water from the Fitzroy and Burdekin water catchments and numerous licences to take water across BMA's mine sites. For more details regarding site water management as part of the proposed WMS refer Section 6.5.

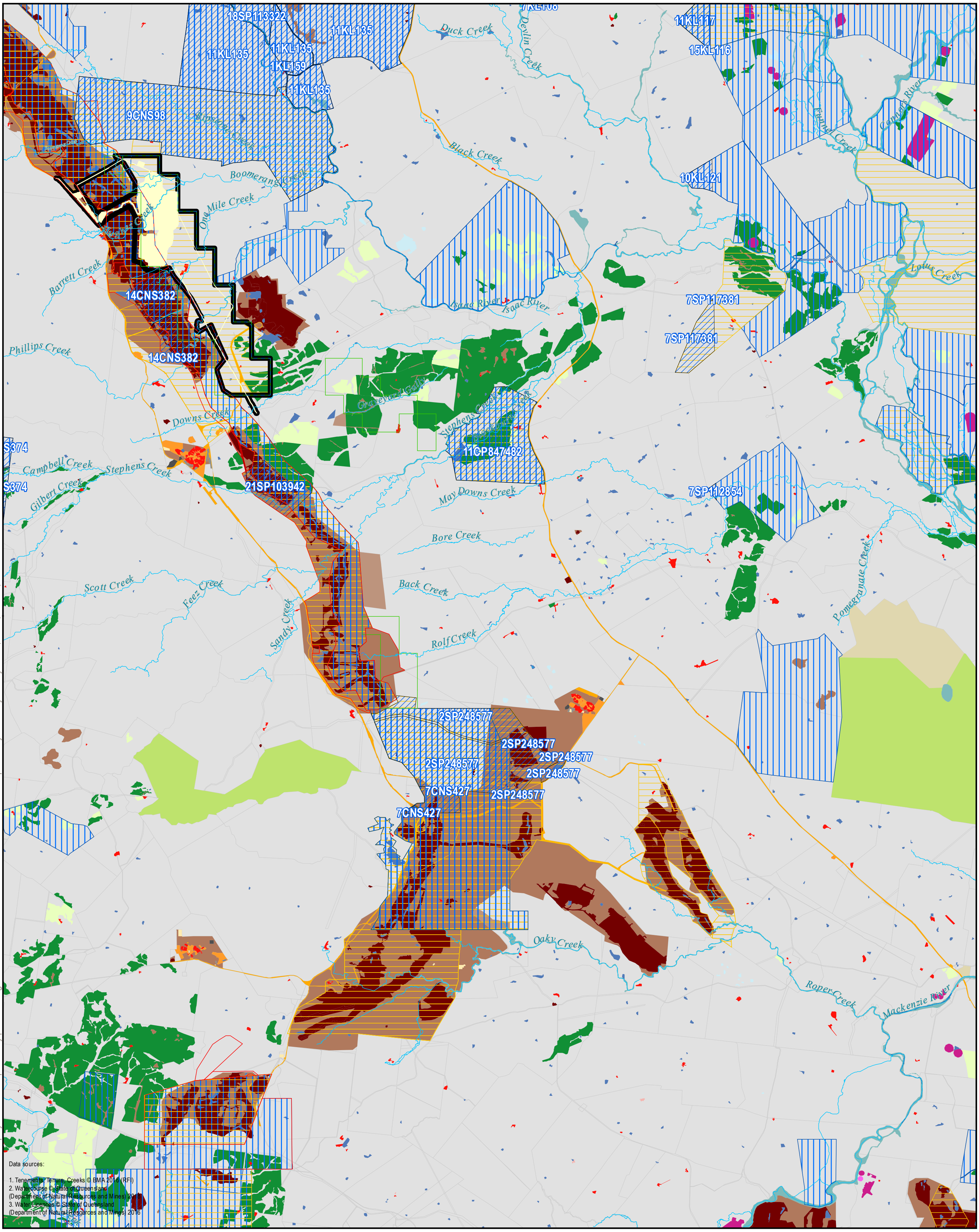
### 3.4.1 Project WMS

For the Project, water will be managed through a series of existing diversion drains and dams designed to contemporary standards to comply with regulatory requirements. Runoff from undisturbed areas will be segregated from disturbed areas to convey clean water downstream.

The water from the raw water dam will be used to supply a proportion of water demands of the Project, including dust suppression and a proportion of demand from the CHPP. Raw water from existing BMA surface water allocations will be piped to the Project Site in a raw water dam to supply clean water, including the water requirements of the CHPP and longwall mining equipment as well as to supplement site water demands as required.

This raw water demand forms a very small portion of the overall site water use and includes:

- Water treated for potable uses (drinking, washrooms).
- A small quantity of water required for the CHPP. While most of the water demand for the CHPP is met through recycled MAW, a minor component (typically 3 per cent) of the CHPP water use requires raw water.






**LEGEND**

- Project Site
- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- Cadastre
- Existing Water User

**Water Licence Authorisation Type**

- Licence to Take Water
- Licence to Interfere

**Land Use**

- Nature conservation
- Managed resource protection
- Other minimal use
- Production native forests
- Grazing modified pastures
- Cropping
- Grazing irrigated modified pastures
- Irrigated cropping
- Intensive animal production
- Manufacturing and industrial
- Residential and farm infrastructure
- Services
- Utilities
- Transport and communication
- Mining
- Waste treatment and disposal
- Lake
- Reservoir/dam
- River
- Marsh/wetland

N

**Figure 4**
**Surface Water Extraction Licences**

Surface Water Technical Report
Saraji East Mining Lease Project

0 3.5 7 14
Kilometres

Scale: 1:500,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

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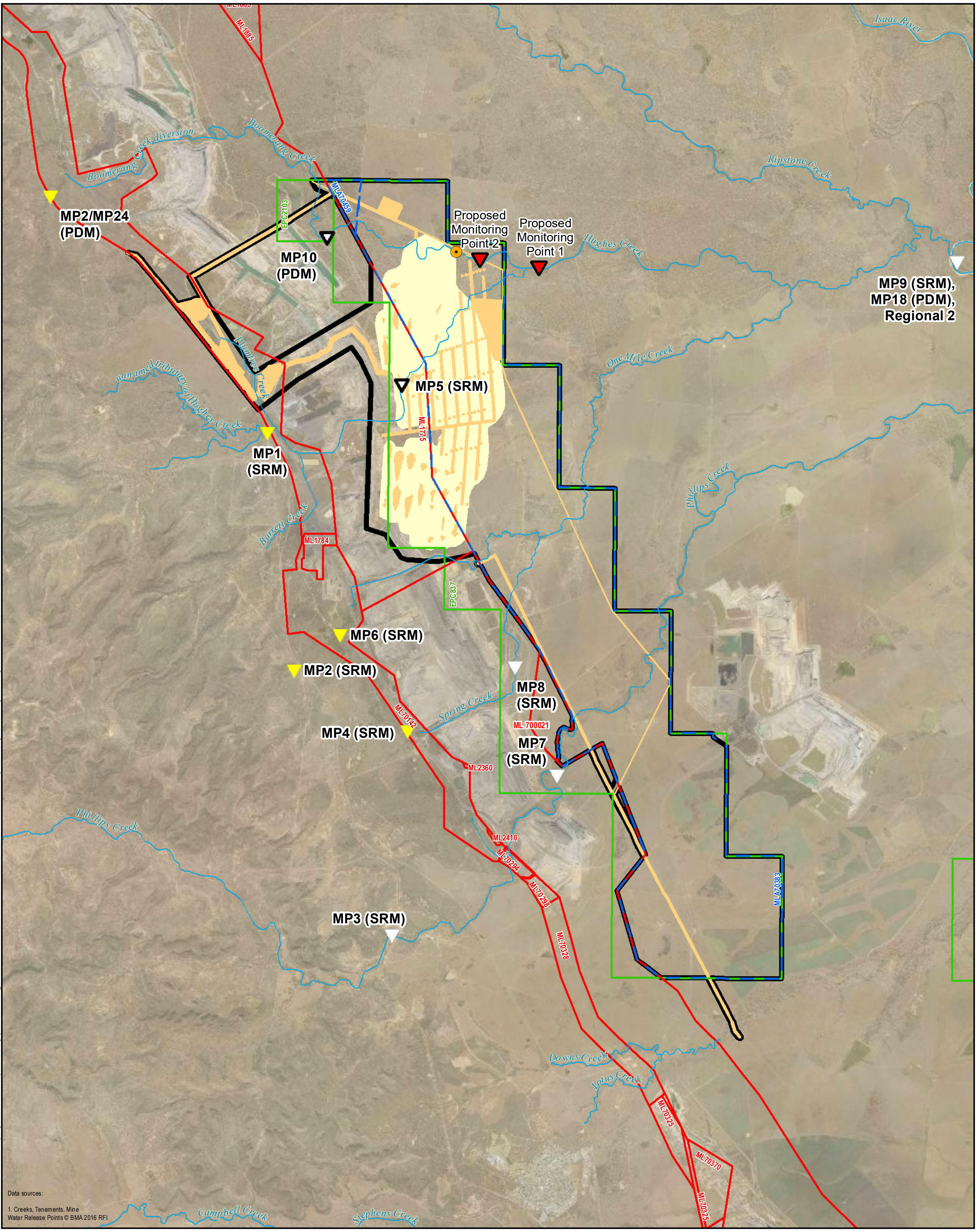
# 4.0 Existing water quality

## 4.1 Developing site-specific water quality objectives

Historic water quality data for the catchment upstream of Saraji East and upstream of the existing mines were compared to WQOs outlined in *ANZG 2018* and *EPP 2019 (Water Isaac River 1301)*. Due to significant differences in measured water quality background parameters between this sub-regional catchment and the set WQOs for the regional catchment, it was considered appropriate to develop site specific WQOs (Table 3).

Methodology for the development of site specific or sub-regional WQOs is outlined in Appendix B and data sampling locations for site specific WQOs development are presented in Figure 5. Default (existing) guidelines values are presented alongside the site specific WQOs wherever these are different from the developed WQO.




**LEGEND**

- Project Site
- Project Footprint - Indirect Impact
- Project Footprint - Direct Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- Indicative Proposed Monitoring Point Location
- Indicative Proposed Mine Water Release Point
- Existing environment (for EIS)
- Future monitoring of mining impacts
- Background data (used for water quality objectives)

N

**Figure 5**
**Data sampling locations upstream of mining used to develop sub-regional Water Quality Objectives**
**Environmental Impact Statement**
**Saraji East Mining Lease Project**

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Kilometres

Scale: 1:150,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

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**Table 3 Developed sub-regional WQOs for the Boomerang-Hughes Creek catchment.**

| Parameter | Unit | Developed WQO | Existing Guideline Value (GLV) | Guideline Source |
|---|---|---|---|---|
| **Water quality objectives to protect aquatic ecosystem environmental values** | | | | |
| Total suspended solids | mg/L | Existing GLV retained | 55 | EPP (Water) (2019) |
| Turbidity | NTU | Existing GLV retained | 50 | EPP (Water) (2019) |
| Electrical conductivity | µS/cm | Existing GLV retained | 720 | EPP (Water) (2019) |
| Sulfate | mg/L | Existing GLV retained | 25 | EPP (Water) (2019) |
| pH | - | 6.5-8.0 | 6.5-8.5 | EPP (Water) (2019) |
| Ammonia | µg/L | 40 | 20 | EPP (Water) 2019 |
| Nitrate | µg/L | 288<br>(High flow) | 60 (low flow) | EPP (Water) (2019) |
| Kjeldahl nitrogen | µg/L | 916 (Low flow)<br>1440 (High flow) | 420 | EPP (Water) (2019) |
| Total nitrogen | µg/L | 1174 (Low flow)<br>2420 (High flow) | 420 | EPP (Water) (2019) |
| Filterable reactive phosphorus | µg/L | Existing GLV retained | 20 | EPP (Water) (2019) |
| Total phosphorus | µg/L | Existing GLV retained | 50 | EPP (Water) (2019) |
| Dissolved oxygen | % | 37-86 | 85-110 | Developed Objective<br>EPP (Water) (2019) |
| | **Metals (Dissolved)** | | | |
| Aluminium | µg/L | NA | 5,000 | EPP Water (2011) Stock watering** |
| | µg/L | Existing GLV retained | 55 | ANZG (2018)* |
| Arsenic | µg/L | NA | 500 | EPP Water (2011) Stock watering** |
| | | Existing GLV retained | 13 | ANZG (2018)* |
| Chromium | µg/L | NA | 1,000 | EPP Water (2011) Stock watering** |
| | µg/L | Existing GLV retained | 1 | ANZG (2018)* |
| Copper | µg/L | NA | 400 | EPP Water (2011) Stock watering** |
| | µg/L | 1 | 1.4 | (ANZG 2018)* |
| Iron | µg/L | 214 | Not provided | |
| Molybdenum | µg/L | NA | 150 | EPP (Water) (2011) Stock watering** |
| | µg/L | Existing GLV retained | 34 | ANZG (2018)* |

| Parameter | Unit | Developed WQO | Existing Guideline Value (GLV) | Guideline Source |
|---|---|---|---|---|
| **Water quality objectives to protect aquatic ecosystem environmental values** | | | | |
| Nickel | µg/L | NA | 1,000 | EPP (Water) (2011) Stock watering** |
| | µg/L | 1.2 | 11 | Developed Objective (ANZG 2018) |
| Selenium | µg/L | NA | 20 | EPP (Water) (2019) Stock watering |
| | µg/L | Existing GLV retained | 5 | ANZG (2018)* |
| Uranium | µg/L | NA | 200 | EPP (Water) (2019) Stock watering |
| | µg/L | Existing GLV retained | 0.5 | ANZG (2018)* |
| Zinc | µg/L | NA | 20,000 | EPP (Water) (2019) Stock watering |
| | µg/L | Existing GLV retained | 8 | ANZG (2018)* |

*ANZG trigger values for toxicants applied to slightly-moderately disturbed systems

**ANZECC guideline still applicable as ANZG has not been updated for stock watering.

## 4.2 Interpretation and assessment of water quality

The above WQOs and the method for deriving site-specific WQOs were designed by the Queensland Government for purposes of setting targets that would allow catchment managers to make improvements to the water quality of the catchment over the long-term. Because of this intent, they are a very conservative measure. Applying the 40$^{th}$ percentile rule for best available moderately disturbed reference sites means that the designed subregional WQO will be exceeded 60% of the time without any influence of the proposed project. Additionally, the QWQG (DES 2022) requires that wherever the 40 percentile value of a developed site-specific parameter falls within 1 standard error (SE) of the *ANZG 2018* or *EPP2019* WQO (2 SE if high variability between sites), the default WQO has to be applied. Hence site-specific data must vary significantly from the default WQOs for a different background value to be defensible. Therefore, it is unlikely that any data set of local water quality data would comply with these sub-regional WQOs in the short term and these should be regarded as a guideline and not as trigger or threshold values.

For the purposes of understanding if water quality data from local samples is likely within the variability representative of the sub-regional catchment, the data was also compared to the 80$^{th}$ percentile of the WQO data set. The 80$^{th}$ percentile is a criteria used for application to undisturbed reference sites for which the selected WQO sites meet the criteria: within 20 km upstream there is no intensive agriculture, major extractive industry, major urban area, significant point source wastewater and seasonal flow regime not greatly altered by regulation or abstraction, and the sites used to develop sub-regional WQOs do meet these criteria. A table presenting the combined 80$^{th}$ percentile values for the assessed watercourses and how these compare to developed site specific WQOs is attached in Appendix B.

For the purpose of monitoring impacts of the Project on the receiving environment, a Receiving Environment Monitoring Plan (REMP) will be developed. More details regarding REMP are presented in Section 7.2.More details regarding REMP are presented in Section 7.2.

## 4.3 Data management, interpretation and quality

A number of watercourses identified under the Water Act flow through the Project Site, including Boomerang Creek, One Mile Creek, Hughes Creek, Plumtree Creek, Spring Creek and Phillips Creek.

Sampling locations for the upper reaches of Boomerang Creek, Hughes Creek, One Mile Creek and Spring Creek (Upstream sites Figure 5) were used to develop sub-regional WQOs based on contribution to Boomerang/Hughes Creek catchment.

Plumtree Creek was not assessed as this stream has no catchment upstream of the Project, the headwaters having been developed by the existing Saraji mine, and no water quality data was available.

Environmental background values were derived from downstream sampling points at Phillips Creek, Isaac River and Spring Creek (Environmental Background sites, Figure 6).

Appendix A describes data sources and presents raw data tables analysed for sub-regional WQO development. Appendix B details data sources, statistical analysis methodology and box plots presenting WQ parameters for assessed watercourses.

In Appendix B Tables, Graphs and figures have been created to visualize and compare the statistical summaries, including:

- Influence of seasonality, rainfall and flow regime
- Differences in water quality between watercourses
- Comparison between developed objectives and environmental background conditions.

The locations of the monitoring points and their location relative to the proposed release location for mine affected water is described in Table 4. The existing water quality data was compared against the WQOs listed in Table 3 to identify water quality parameters of concern.

**Table 4 Water quality sample locations for the Saraji REMP relative to proposed release locations.**

| Site Name | Approximate location relative to release locations for mine affected water from Saraji East |
|---|---|
| Hughes Creek upstream (MP1 SRM) | 4,000 m upstream |
| Hughes Creek downstream (MP5 SRM) | 2,000 m downstream |
| One Mile Creek upstream (MP2 SRM) | 6,000 m upstream |
| One Mile Creek downstream (MP6 SRM) | 2,000 m downstream |
| Boomerang Creek upstream (MP2 / MP24 PDM) | 12,000 m upstream |
| Boomerang Creek downstream (MP10 PDM) | 3,000 m upstream |
| Phillips Creek upstream (MP3 SRM) | 9,000 m upstream |
| Phillips Creek downstream (MP7 SRM) | 1,000 m downstream |
| Isaac River Soleh Nolem downstream (SNDS) (MP9 SRM / MP18 PDM / Regional 2) | 24,000 m downstream |

### Monitoring site justification

The IESC guidelines outline the need for sufficient data in order to quantify and characterise impacts to water resources from coal seam mining activities either direct, indirect or cumulative. Hence, the selection of monitoring sites for Saraji East Mine was based on the following:

- Monitoring locations upstream of mining to characterise the condition of the receiving environment unimpacted by mining.
- Establishment of test monitoring sites downstream of the proposed mine to adequately identify and quantify water quality impacts. Water courses potentially impacted by the Project include Boomerang Creek, Hughes Creek, One Mile Creek, and the Isaac River. Phillips Creek, and Spring Creek will not have any mining activity within their catchments and are not likely to be impacted.
- Assessing whether any area of potential subsidence would have water quality impacts.

Data summaries of watercourses that occur within the mining lease but are not subject to impacts from subsidence or mining have been presented for the purposes of understanding the existing environment only.

- Proximity of monitoring sites to access infrastructure such as gazetted roads and road reserves to facilitate access to monitoring sites for sampling procedures
- Other considerations such as whether the site is within a groundwater drawdown location or mining tenement have been accounted for.

## 4.4 Sites within the mining lease unimpacted by mining

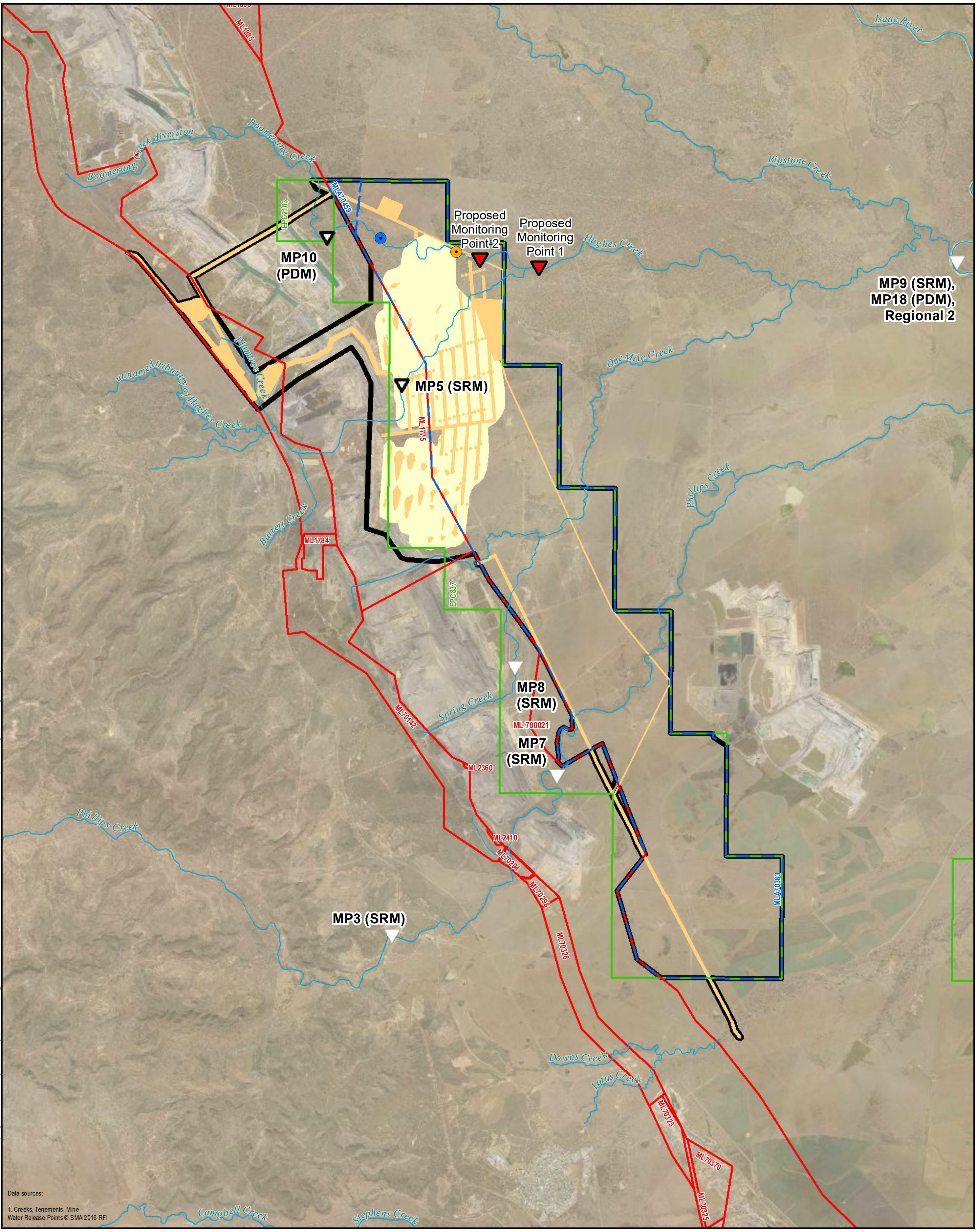
Data from sites unlikely to be directly impacted by mining activities was reviewed to assess the condition of streams that are within the mining lease (MP7, MP8, MP9/18), and for sites located in the vicinity of the actual underground mining footprint (MP5) (Figure 6). Data from unimpacted sites provides environmental background data for comparison of WQ before the Project commences.

Most of the median values of recorded parameters at the environmental background sites were within or below the developed sub-regional WQOs. However, median values for Turbidity, TSS, Sulfur, Ammonia, Copper and Nickel exceeded the developed sub-regional WQOs (Table 5). This could be due to the different geology, lithology and soil characteristics of Isaac River and Phillips creek compared to the rest of the streams. Other possible factors could be varying discharge rates and dissimilar land use upstream. Statistical analysis reinforces this difference as there was a statistically significant difference for these parameters between upstream (Figure 5) and background sites (Figure 6**)**. Fewer exceedances of WQOs were present for sites within the actual mining extent (Turbidity, Sulfur, and Nickel, Table 5). This possibly represents more accurately the conditions in the Boomerang Hughes Creek catchment. Deviations from site specific WQOs could be due to the availability of only one stream (Hughes Creek) compared to the combined data of four watercourses within the sub-regional catchment utilised for WQO development.

**Table 5 Comparison between developed sub-regional WQOs and Environmental Background values from unimpacted sites south of proposed Saraji East Underground Mining Project.**

| Analyte | Developed Sub-Regional WQO | Env. Background | WQ within footprint of the extent of underground mining | Guideline adopted for Sub-Regional WQOs |
|---|---|---|---|---|
| pH | 6.5-8.0 | 7.8 | 7.6 | Developed (Sub-Catchment Specific) |
| EC (µS/cm) | 720 | 490 | 686 | EPP (Water) (2019) |
| Turbidity (NTU) | 50 | 319 | 183 | EPP (Water) (2019) |
| DO% | 37-86 | 77.7 | 27 | Developed (Sub-Catchment Specific) |
| TSS (mg/L) | 55 | 271 | 41 | EPP (Water) (2019) |
| $SO_4$ (mg/L) | 25 | 42 | 84 | EPP (Water) (2019) |
| Ammonia (µg/L) | 40 | 50 | 10 | Developed (Sub-Catchment Specific) |
| Nitrate (µg/L) | 60 low flow<br>288 high flow | 170 | 132 | Developed (Sub-Catchment Specific) |
| Total Organic (Kjeldahl) Nitrogen as N (µg/L) | 916 low flow<br>1,440 high flow | 600 | 800 | Developed (Sub-Catchment Specific) |

| Analyte | Developed Sub-Regional WQO | Env. Background | WQ within footprint of the extent of underground mining | Guideline adopted for Sub-Regional WQOs |
|---|---|---|---|---|
| Total Nitrogen as N (µg/L) | 1,174 low flow<br>2,420 high flow | 1,350 | 1,300 | Developed (Sub-Catchment Specific) |
| Total Phosphorus as P (µg/L) | 50 | 50 | 45 | EPP (Water) (2019) |
| Reactive Phosphorus as P (µg/L) | 20 | ND | ND | EPP (Water) (2019) |
| Al (µg/L) | 55 | 35 | 16 | ANZG (2018) |
| As (µg/L) | 13 | ND | ND | ANZG (2018) |
| Cr (µg/L) | 1 | ND | ND | ANZG (2018) |
| Cu (µg/L) | 1 | 2 | 1 | Developed (Sub-Catchment Specific) |
| Fe (µg/L) | 214 | 80 | 60 | Developed (Sub-Catchment Specific) |
| Mo (µg/L) | 34 | 1 | 1 | ANZG (2018) |
| Ni (µg/L) | 1.2 | 2 | 2 | Developed (Sub-Catchment Specific) |
| Se (µg/L) | 5 | ND | ND | ANZG (2018) |
| U (µg/L) | 0.5 | ND | ND | ANZG (2018) |
| Zn (µg/L) | 8 | ND | ND | ANZG (2018) |




**LEGEND**

- Project Site
- Project Footprint - Indirect Impact
- Project Footprint - Direct Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- Indicative Proposed Monitoring Point Location
- Indicative Proposed Mine Water Release Point
- Indicative Proposed Flow Gauging Station
- Existing environment (for EIS)
- Future monitoring of mining impacts

N

**Figure 6**
**Monitoring Points**

**Environmental Impact Statement**
**Saraji East Mining Lease Project**

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Kilometres

Scale: 1:150,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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## 4.5 Summary of surface water quality

Sub-regional WQOs have been developed using upstream data over the period from 01/07/2012 to 18/03/2021. Sites unlikely to be impacted by mining were assessed and median values were derived from designated sites (thin black triangles) over the period from 01/07/2012 to 18/07/2021. This data was provided by BMA.

Sub-regional WQOs were developed in accordance with the *QWQG 2009 & 2022* and *ANZG 2018* as described in Section 4.1. Water quality data throughout the catchment shows high variability for parameters within streams and between streams. To assess for significant differences, statistical tests have been applied. Wherever differences between streams or flow regimes were significant, amendments to the WQOs according to the relevant guidelines were made (Sections 4.1). It is important to emphasize that the developed sub-regional WQOs are intended to be used as guidelines for catchment managers to set targets for long-term water quality improvements.

A summary of each of the parameters assessed, the resultant percentiles from the data set and an explanation of WQO derivation is displayed in Appendix B.

# 5.0 Impacts to surface water

This chapter outlines possible impacts of project activities likely to impact surface water and water bodies within its vicinity (Table 6). Identified impacts are broadly divided in construction and operational phase and include the following:

- Erosion and sedimentation
- Chemicals and contaminants
- Release of mine affected water
- Subsidence
- Flooding of mine areas
- Cumulative impacts.

**Table 6 Potential impacts to surface water quality during construction and operation of proposed project**

| Activity/ source | Pollutants or factors of concern | Potential surface water quality impact (without mitigation) |
|---|---|---|
| Erosion and sedimentation potentially to occur during construction<br>• Construction of mine portal<br>• Erection of accommodation village<br>• Developing gas drainage<br>• Building raw water dam and process water dam<br>• Installation of powerlines<br>• Construction of MIA<br>• Construction of CHPP<br>• Creation of rail loop and load out facility<br>• Building vent shafts<br>• Construction of water pipelines.<br><br>The construction of the above-mentioned items will involve the following civil works<br>• Compaction and associated geotechnical works<br>• Civil earthworks, including piling and foundation construction<br>• Construction of powerline and connection network<br>• Trenching and laying of reticulated services and any other underground pipelines and services<br>• Hard stand construction including extensive earthworks and excavation works<br>• Progressive re-vegetation of embankments, disturbed areas and open channel drains where practical. | Sediment, nutrients, contaminants, gross pollutants | • Sediments could smother receiving waterways impacting aquatic ecosystems<br>• Increased turbidity, lower dissolved oxygen levels, and increases in toxicant concentrations could impact aquatic ecosystems<br>• Nutrients associated with sediments could lead to algal blooms and aquatic weed growth, which could impact aquatic ecosystems, recreation, irrigation, livestock, and aquatic foods<br>• Surplus in sediment load could alter geomorphology of creek beds and impact streamflow behaviour<br>• Reduced visual amenity could result from turbid water and visible gross pollutants, impacting recreation and visual amenity. |

| Activity/ source | Pollutants or factors of concern | Potential surface water quality impact (without mitigation) |
|---|---|---|
| Leakage or spills from chemicals and/or contaminants during construction<br>• Temporary refuelling facilities<br>• Temporary chemical storage facilities (including oil and waste oil)<br>• Installation and operation of the incidental mine gas system<br>• Temporary vehicle washdown areas<br>• Construction and commissioning of permanent fuel and chemical storage facilities. | Hydrocarbons, oil and grease, hydraulic fluids, other hazardous chemicals | • Oil sheen on water surface could impact amenity or recreation<br>• Increases in toxicant concentration could lead to lethal impact on biota in aquatic ecosystems, harm livestock downstream, and contaminate aquatic foods |
| Release of MAW into surface water environment<br>• During extreme wet seasons, licensed release of MAW from Process Water Dam (PWD) into Boomerang Creek might occur | Increased salinity, toxicants, altered pH | • Increases in toxicant concentrations, salinity and alterations in pH could impact aquatic ecosystems have potentially lethal impacts on aquatic biota |
| Potential water management system failures<br>• Pump or pipe failures causing overflows or seepage<br>• Dam breaks | Increased salinity, toxicants, altered pH | • Increases in toxicant concentrations, salinity and alterations in pH could impact aquatic ecosystems have potentially lethal impacts on aquatic biota |
| Erosion and sedimentation during operation<br>• Operation of mine gas infrastructure – access tracks, gas well pads will be exposed to erosion | Sediment, nutrients, contaminants, gross pollutants | • Sediments could smother receiving waterways impacting aquatic ecosystems.<br>• Increased turbidity, lower dissolved oxygen levels, and increases in toxicant concentrations could impact aquatic ecosystems.<br>• Nutrients associated with sediments could lead to algal blooms and aquatic weed growth, which could impact aquatic ecosystems, recreation, irrigation, livestock, and aquatic foods.<br>• Surplus in sediment load could alter geomorphology of creek beds and impact streamflow behaviour<br>• Reduced visual amenity could result from turbid water and visible gross pollutants, impacting recreation and visual amenity. |

| Activity/ source | Pollutants or factors of concern | Potential surface water quality impact (without mitigation) |
|---|---|---|
| Subsidence due to underground mining activities<br>• Formation of subsidence depressions over longwall panels induce erosion through changes in geomorphology<br>• Surface cracking could lead to gully formation and increased erosion<br>• Changed geomorphology impacts stream flow and overland flow<br>• Ponding in subsidence depressions. | Sediment increase or decrease, stream flow alterations,<br>Alterations to water quality and quantity | • Sediments could smother receiving waterways impacting aquatic ecosystems<br>• Increased turbidity, lower dissolved oxygen levels, and increases in toxicant concentrations could impact aquatic ecosystems<br>• Nutrients associated with sediments could lead to algal blooms and aquatic weed growth, which could impact aquatic ecosystems, recreation, irrigation, livestock, and aquatic foods<br>• Alterations to aquatic and riparian ecosystems due to changes in stream flow characteristics<br>• Instability of creek banks inducing erosion and impacting riparian and aquatic ecosystems<br>• Changing environmental conditions on floodplain through geomorphological changes and ponding. |
| Flooding of mine areas<br>• If flooding of the underground mine area should occur, contaminants could be potentially released into the surface water environment | Hydrocarbons, chemicals, toxicants, sediment | • Oil sheen on water surface could impact amenity or recreation<br>• Increases in toxicant concentration could lead to lethal impact on biota in aquatic ecosystems, harm livestock downstream, and contaminate aquatic foods<br>• Increased turbidity, lower dissolved oxygen levels, and increases in toxicant concentrations could impact aquatic ecosystems<br>• Increases in toxicant concentrations, salinity and alterations in pH could impact aquatic ecosystems have potentially lethal impacts on aquatic biota |

| Activity/ source | Pollutants or factors of concern | Potential surface water quality impact (without mitigation) |
|---|---|---|
| Decommissioning<br>• Dewatering of water storage dams<br>• Earthworks to remove infrastructure<br>• Rehabilitation measures. | Increased salinity, toxicants, altered pH, Sediment, nutrients, contaminants, gross pollutants | • Increases in toxicant concentrations, salinity and alterations in pH could impact aquatic ecosystems have potentially lethal impacts on aquatic biota<br>• Sediments could smother receiving waterways impacting aquatic ecosystems<br>• Increased turbidity, lower dissolved oxygen levels, and increases in toxicant concentrations could impact aquatic ecosystems<br>• Nutrients associated with sediments could lead to algal blooms and aquatic weed growth, which could impact aquatic ecosystems, recreation, irrigation, livestock, and aquatic foods<br>• Surplus in sediment load could alter geomorphology of creek beds and impact streamflow behaviour<br>• Reduced visual amenity could result from turbid water and visible gross pollutants, impacting recreation and visual amenity. |

## 5.1 Construction phase

For EIS related impact assessment purposes, it is assumed that the construction phase will commence in FY 2023 (Year 1) and continue for a period of 2 years. Construction work is divided into Year 1 and Year 2 activities as outlined below.

Year 1

- Construction of mine portal
- Erection of accommodation village
- Developing gas drainage
- Building raw water dam and process water dam.

Year 2

- Installation of powerlines
- Construction of MIA
- Construction of CHPP
- Creation of rail loop and load out facility
- Building vent shafts
- Construction of water pipelines

The construction of the above mentioned items will involve the following civil works:

- Compaction and associated geotechnical works
- Civil earthworks, including piling and foundation construction
- Construction of powerline and connection network
- Trenching and laying of reticulated services and any other underground pipelines and services
- Hard stand construction including extensive earthworks and excavation works
- Progressive re-vegetation of embankments, disturbed areas and open channel drains where practical.

### 5.1.1 Erosion and sedimentation

Implications to surface water quality from erosion and sedimentation could possibly arise from the following construction activities.

- Earthmoving
- Stripping of topsoil
- Stockpiling of run of mine unprocessed material and product
- Vegetation removal
- Trenching for pipelines
- General earth works.

At certain times during construction, bare earth and uncovered stockpiles will be present that may generate silt and contaminant-laden runoff. Vegetation clearance, ground disturbance and soil compaction associated with the construction of the Project may also expose soils. Sediment mobilised during construction activities may enter surface water runoff during rainfall events and discharge to watercourses. Sediment exposed or generated during construction may also be carried by wind into surface water bodies.

Suspended sediments in the water column reduce light penetration, consequently affecting the primary productivity of aquatic ecosystems. Such impacts may compound effects from the already high turbidity concentrations in the receiving waterways. Concentrations of suspended solids at best available reference sites were highly variable and in the case of Hughes Creek often well above the applicable WQO for upper Isaac River catchment waters (55 mg/L). Hughes Creek and also Boomerang Creek can be quite turbid in their existing condition. While a large, long-term increase in suspended solids may further degrade aquatic ecosystems, short term increases in storm events are unlikely to have any significant impact.

Deposition of suspended sediment within watercourses can lead to geomorphological changes within the streams. However, given the relatively high existing sediment loads that have already influenced the bed characteristics of these streams, short-term impacts from runoff from construction areas during storm events is unlikely to significantly change the geomorphological characteristics of these streams.

Sediments mobilised by erosion may have other contaminants associated with sediment particles including heavy metals derived from the local geology. When sediment particles containing heavy metals enter water, the metals may, under certain conditions, be released into the water column and become bioavailable. This in turn can affect the health of aquatic plants and animals and potentially impact other environmental values.

The water quality results indicate that the majority of metals detected are bound to sediment particles, since total metal concentrations are typically much higher than dissolved metal concentrations. Metals released from sediments to the water column can be influenced by lower pH; however, pH results indicate that surface water pH is generally within the range of 6.5 to 9.0, thus minimising this mechanism for metal release from sediment particulates.

Controls will be installed prior to and during construction in accordance with Australian Standards and International Erosion Control Association Best Practice Erosion & Sediment Control guidelines (IECA, 2008). With erosion and sediment controls in place, the quantities of sediment likely to be mobilised from construction activities is likely to be low.

### 5.1.2 Chemicals and contaminants

Contaminants may be mobilised during construction activities through chemical and fuel spills from:

- temporary refuelling facilities
- temporary chemical storage facilities (including oil and waste oil)
- installation and operation of the incidental mine gas system
- temporary vehicle washdown areas
- construction and commissioning of permanent fuel and chemical storage facilities.

The main areas where aqueous waste streams may be produced will be associated with the construction of the MIA. However, there is also a possibility that contaminant spills may occur during construction of internal access roads.

Accidental spills of fuel stored on-site or any other chemicals used during construction could enter the drainage lines and waterways.

The main potential impact on surface water quality will arise from accidental spills and leaks. The main contaminants of concern in this regard are fuels and oils. While some other chemicals will be utilised during construction, the quantities and natures of these chemicals is such that the risk of significant environmental harm in the event of a spill is low.

Small quantities of aqueous waste will be generated from removal of stormwater and contaminants from bunded areas and sumps. Provided this is treated in accordance with the management measures outlined below, this should not cause any impact on surface water quality.

Without appropriate mitigation measures, potentially contaminated drainage generated through these activities could enter into drainage lines, altering the physical and chemical characteristics of the receiving waters. This in turn may have acute or chronic toxicity effects on aquatic plants and animals. These pollutants can also have the potential to be a public health and safety issue if moderate to large quantities are released directly to watercourses.

The significance of potential impacts on surface waters will depend on the quantity and nature of contaminants as well as whether the contaminants are directly released to surface waters. If spills or leaks occur in construction areas, contaminants will either soak into soils or be captured by sediment containment devices and/or permanent stormwater systems.

## 5.2 Operational phase

Mining operations associated with the Project will involve the following activities:

- dewatering and degassing target coal seams
- underground longwall operations
- coal handling, preparation (screening and washing) and transportation.

All mine water from dewatering the underground mine and from incidental mine gas production would be stored and managed through the proposed mine WMS; this system has been developed to minimise the likelihood of uncontrolled spills. Licensed releases would be triggered before uncontrolled spills would occur. These releases can be the consequence of extreme and rare weather events, and would likely present under high flow conditions. Modelling results presented in AECOM's Project Mine Water Balance Technical Report (AECOM, 2024) demonstrate that the need for licensed releases would be extremely low.

### 5.2.1 Releases of mine affected water

The proposed Water Management System (WMS) is documented in detail within the Project Mine Water Balance Technical Report (AECOM, 2024).

The proposed WMS dams have been developed to meet containment criteria for MAW dams for a 5% AEP wet season criterion, consistent with a preliminary consequence category of 'significant'. This containment criteria is a design storage allowance, which is the storage volume to be made available in each dam upon the commencement of the wet season (1 November) each year. The design storage allowance is the sum of all catchment runoff, direct rainfall over the dam and process water inflows over the critical wet period (three months duration) and assuming no evaporative or runoff losses. Preliminary assessment has sized the Process Water Dam (PWD) as the primary receiving water storage for MAW across the operation, to contain all inflows up to the 5% AEP criterion without controlled or uncontrolled releases, based on 500 stochastic climate sequences generated for the site location, including considerations of potential future climate change sequences.

The developed concept is based on historical climate data and the assumed mine operating conditions. The influence of flooding and subsequent pumping from the highwall entry pit was considered in the water balance modelling with minimal risks of uncontrolled releases. An indicative release point at Boomerang Creek is proposed in the event that a controlled release is required Figure 3.

The PWD was assessed to hold a capacity of 125 ML and modelling indicates that it would contain less than 40 ML of mine affected water during general operating conditions, with volumes accumulating to up to 100 ML in wetter than average rainfall scenarios. The spill probability of the PWD was assessed to be < 0.2% which indicates that no spill was modelled during the 500 different climate scenarios. Detailed information about PWD parameters is described in Section 4.8 of the Project Mine Water Balance Technical Report (AECOM, 2024). This assessment concluded that the developed concept MAW total dam storage includes adequate contingent volume to contain all inflows to the system (pit sump, rainfall, runoff, treated effluent, MAW) such that managed releases are not planned as a tool to actively manage MAW inventory levels for all scenarios up to a 5% AEP wet season. The results demonstrate that the WMS has sufficient capacity to manage the expected inventories of water. Additionally, modelling indicates that containment criteria for the proposed storage structures are satisfied.

#### 5.2.1.1 Release of mine affected water during extreme weather events

Uncontrolled spills from the process water dam are extremely unlikely and would only occur when the MAW inventory exceeds 100 per cent of capacity (125 ML). In such conditions:

- MAW salinity concentrations in the Process Water Dam are predicted to be highly variable and influenced by the volume of water stored within it. The modelled salinity is generally between 600 and 2000 mg/L, and EC is expected to be between 1,500 µS/cm and 4,700 µS/cm according to the Mine Water Balance Technical Report (AECOM, 2024).
- Releases from the mine WMS to the receiving environment may be required if conditions are wetter than the provisions made for in the storage allowance (i.e. wetter than 5% AEP wet season). The proposed WMS includes provision for the PWD to include a licensed release point on Boomerang Creek (Figure 3). The proposed release point has been included as a conservative management approach, as it would only be required in very rare to extreme rainfall conditions. BMA may utilise licensed releases (refer Section 6.1) as a water management strategy in preference to uncontrolled discharge from MAW dams.

### 5.2.2 Water management system failures

The proposed WMS has been developed as a concept with adequate capacity to avoid releases. Preliminary assessment has sized the MAW dams according to the hydraulic criteria described in the *Manual for assessing consequence categories and hydraulic performance of structures* (DES, 2016) for a ‘significant’ consequence category.

Storage dams will be managed in accordance with the DES *Manual for assessing consequence categories and hydraulic performance of structures* (2016) and WMS infrastructure in accordance with BMA operational requirements.

The process water dam will be located in MLA 70383. A new pipeline will be co-located with the powerline on the western extent of the Project Site. Runoff from disturbed areas of the Project, including the new MIA, the CHPP, stockpiles, rail loop and spur, will be collected from disturbed areas and transferred via the pipeline to the process water dam. The pipeline will include an extension to a discharge point at Boomerang Creek, which could be used for licensed discharges if required.

If a WMS system failure were to occur, this could potentially lead to discharge of MAW to the receiving environment in locations where mine water is able to migrate from the containment area into

Boomerang and/or Hughes Creek. This has potential for adverse water quality impacts for downstream receiving waters, ecosystems and water users.

Potential failures include:

- A network of pipes and pumps will be used to transfer water to the process water dam and these facilities have the potential for failure.
- Failure to contain – seepage: Storage embankment failure caused by piping failure (potentially resulting from poor construction of embankment maintenance) or overtopping.
- Failure of pumps could result in an accumulation of MAW upstream of the pump location and/or (depending on water volumes, system configuration and system storage capacity) an overflow towards downstream surface waters may occur.

A temporary pump failure scenario of up to seven days was modelled for significant rainfall events (>100 mm of rainfall for up to three days) (AECOM, 2024). Results present indiscernible WMS performance differences in stored water volume inventories. This suggests that the system is adequately designed to retain MAW within the WMS in the event of temporary pump failures, reducing the likelihood of impacts to receiving waters.

### 5.2.3 Erosion and sedimentation

During operation, land disturbing activities may result in increased erosion potential and mobilisation of sediment to surface waters. Erosion may also occur around diversion drains. Erosion and sediment mobilisation can lead to detrimental impacts on downstream water quality and aquatic habitats. The installation and operation of incidental mine gas management infrastructure poses the most significant risk in terms of mobilisation of sediment, as disturbance will occur across the area of the underground mine footprint, and access tracks and gas well pads will remain exposed for some time.

Boomerang, Hughes, One Mile, Spring and Phillips Creek have high turbidity concentrations upstream of the Project. Therefore, relatively small sediment inputs from mine-related activities are unlikely to cause significant changes to water quality and to the aquatic ecology.

As for construction, controls will be installed during operation in accordance with International Erosion Control Association Best Practice Erosion & Sediment Control guidelines (IECA, 2008). With design and mitigation measures in place, water quality impacts associated with erosion and sedimentation on the downstream creeks are expected to be minimal.

### 5.2.4 Subsidence

The Project Subsidence Report (Minserve, 2022) and the Project Hydrology, Hydraulics & Geomorphology Report (Alluvium, 2023) present the effects of subsidence over longwall panels on surface water quality and the receiving environment. Land surface deformation is likely to occur over longwall panels resulting in surface troughs, development of surface cracks and buckling.

Subsidence models in the Project Subsidence Report (Minserve, 2022) suggest that Boomerang Creek and Plumtree Creek are subject to subsidence of low intensity whilst Hughes Creek exhibits subsidence at larger volumes. However, Figure 7 below suggests that areas of increased subsidence for Hughes Creek appear localised on the two most western panels along the stream bed, whereas the rest of the creek bed is subject to only minor levels of subsidence. This might be taken into consideration when the Project goes into the phase of detailed planning and amendments to the aforementioned long wall panels may be proposed to reduce impacts of subsidence on Hughes Creek.

More details regarding subsidence are discussed in the Project Subsidence Report (Minserve, 2022) and Hydrology, Hydraulics & Geomorphology Report (Alluvium, 2023).

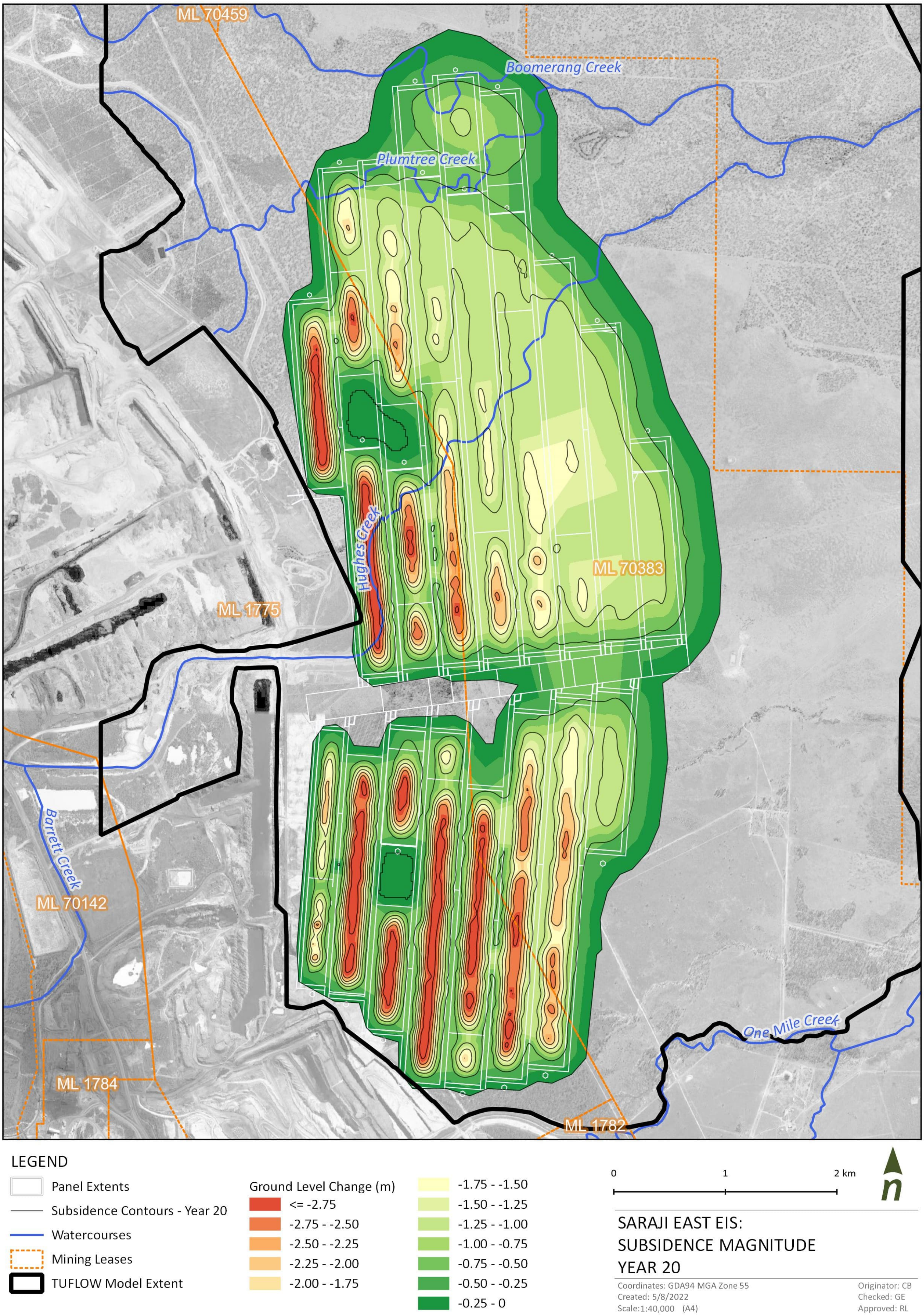


Figure 7. Predicted subsidence depths below existing surface (Year 20)

#### 5.2.4.1 Predicted geomorphic response of surface water systems to subsidence

The potential impacts of mining on the geomorphology of the streams within the Project area are described in Hydrology, Hydraulics & Geomorphology Report (Alluvium, 2023). The following is a summary of the aspects of that report relating to water quality.

Gradual infilling of subsidence in stream beds will occur as longwall panels are installed. Boomerang and Plumtree Creek systems exhibit higher bed sediment transport capacities upstream compared to downstream, which will likely lead to increased sediment accumulation in the subsided areas downstream. Hughes Creek presents contrasting conditions with higher sediment transport capacities in the sections of the creek that will be impacted by subsidence. This might induce instabilities in its upstream reach. Watercourses will likely be subject to local incision and bank erosion over pillar zones between panels. Infilling will occur as flow events commence, but the time required for the present bed grade level to be re-established depends on number of subsided panels and sediment transport capacity of the stream. Due to the elevated erosion rate in the upper reaches, sediment supply will be unlikely an issue and infilling of subsidence depressions will be associated with events large enough to transport that bedload. Subsidence is likely to create in-stream pools which are considered to have a beneficial environmental impact through creation of aquatic habitats.

The floodplains could be impacted if flow paths or overland flows drop into subsided depressions, causing incision and gully development in locally steep terrain. It is predicted that these scenarios only impact minor flow paths while larger flow paths are likely to continue along their original course. Subsidence impacts are predicted to be local and minor however, alterations to natural flow regimes due to ponding in subsided areas (as assessed in the Project Subsidence Ponding Assessment (BMA, 2023)) will be mitigated by providing adaptive drainage management described in detail in the Project Subsidence Management Plan (BMA, 2024b), Section 4.2. Impacted locations are discussed in detail and presented in Figure 3.18 of Hydrology, Hydraulics and Geomorphology Technical Report (Alluvium, 2023). Water quality in subsidence ponds is likely to be variable over time but following a pattern similar to natural pools in these landscapes. Initial inflows will be from surface water runoff and hence relatively low in salinity but potentially containing suspended solids collected from the catchment. As water is ponded in the altered (subsided) topography, it is lost through evaporation and the concentration of salts and any dissolved contaminants are expected to increase over time, as is observed in ponds formed in existing waterways on the Project Site. There may also be changes to other physicochemical characteristics which, are expected to be consistent with changes in naturally ponded areas.

Bed load starvation will potentially impact Boomerang and Hughes Creek downstream of the mine, elevating the risk of bank erosion in these areas. Erosion of downstream reaches will occur until sediment loads infill the subsided depressions upstream and the sediment supply returns to the existing load. The Hughes Creek system will likely be impacted downstream of the Project area up to the Boomerang Creek confluence, for a period of years and possibly decades.

The subsidence resulting from the Project's underground mining may create surface cracks likely resulting in erosion responses in colluvial and alluvial sediments. Cracks in erodible sediment pose the greatest threat when orientated downslope and have the potential to cause rill erosion or gully formation. Section 3.2.6 in Hydrology, Hydraulics and Geomorphology Technical Report (Alluvium, 2023) states that surface cracks will likely develop in the area around Hughes creek, where some relief is already present and differential subsidence between pillars and longwall panels is likely to occur. These cracks have the potential to expand where lighter textured soils are present and runoff is concentrated to the crack. Over the entirety of the Project site, areas of low relief and high sand content will unlikely display enlargement of cracks in case of their emergence. An exposure of surface waters to groundwater through created cracks is unlikely as impacted groundwater resources are separated from surface waters due to low permeable sediments, reducing the potential of groundwater infiltrating alluvium and surface water flows, as described in the Project Ground Water Modelling Technical Report (SLR, 2023).

#### 5.2.4.2 Impacts on water quality downstream through flow alteration

The reduction in flows due to the ponding within subsided areas also has the potential to impact on water quality downstream through reduced flows and hence less dilution after dry spells.

According to section 3.3.2 in Hydrology, Hydraulics and Geomorphology Technical Report (Alluvium, 2023), minor alterations to flow behaviour will be expected due to subsidence. The general effects will likely include a slight reduction in total flow through the site, and a flow delay due to an increased attenuation capacity of instream ponding. This could potentially lead to an overall reduced water quantity downstream resulting in decreased dilution, increased turbidity and higher concentration of nutrients. Adaptive drainage management to mitigate ponding on floodplains is suggested to reduce impacts on natural flow regimes. For instream ponding, impacts on water quality are expected to be minor and of short duration as over time, pools and channel beds will fill in, and ephemeral wetlands will slowly accrete. Figure 8 exhibits the differences between present flow and year 20 flow of Hughes Creek after the Project commenced (Alluvium, 2023).

During rare high rainfall events (1% AEP), flooding is likely to occur between Boomerang and Hughes Creek, resulting in more frequent flow events in the lower reach of Plumtree Creek. Flooding of these areas also likely leads to mobilisation of sediment and associated nutrients. However, these processes already occur and expected alterations through subsidence are likely to be minor outside of extreme weather events.

The subsided landscape will likely develop residual ponding and this can be mitigated with adaptive drainage management to drain water into natural streams. Alterations to stream flows will revert over time to their original states as subsided depressions in creek beds fill in. The time this will take depends on number of subsided panels in relation to flow regimes and transport capacity of the creeks.

In summary, it is expected predicted subsidence over longwall panels can impact surface water quality of watercourses present on the Project site, however it is expected that these impacts will be minor and can be further alleviated through appropriate design and mitigation measures outlined in the Project Subsidence Management Plan (BMA, 2024b) (SMP) (refer to section 6.2 and Hydrology, Hydraulics and Geomorphology Technical Report).

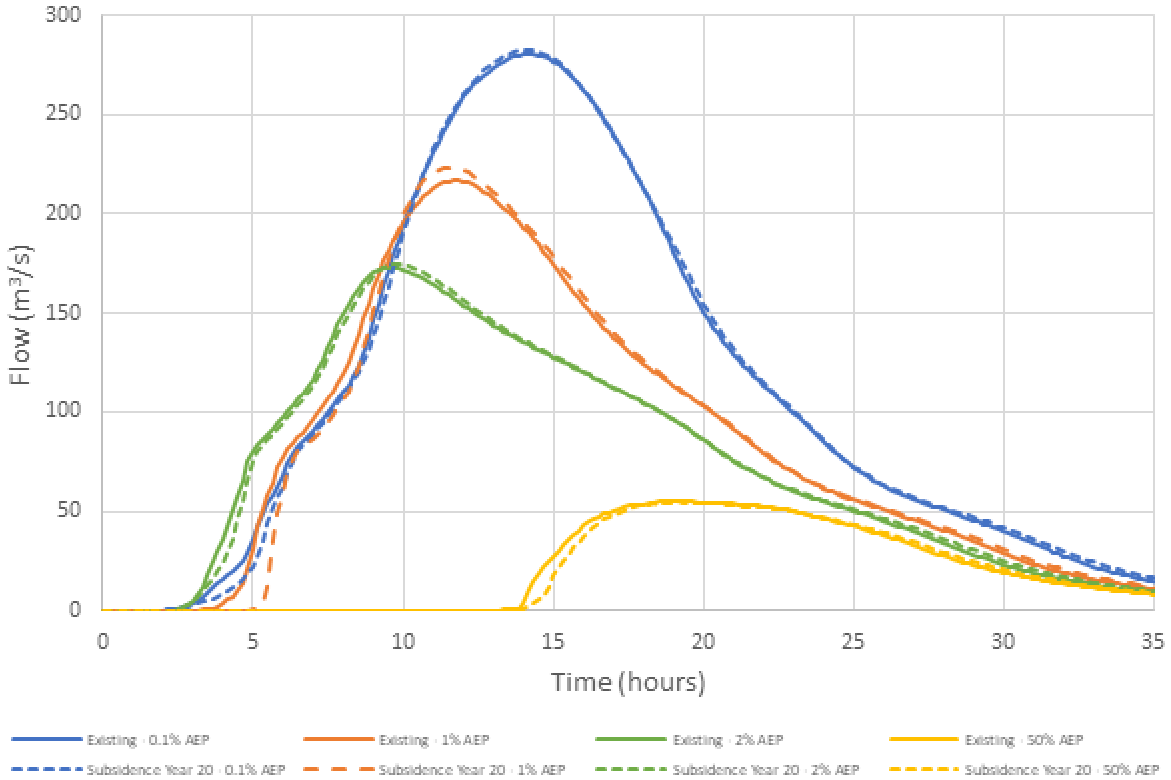


**Figure 8 Hydrographs displaying different flows for Hughes Creek for different AEP scenarios downstream of confluence (Hydrology, Hydraulics and Geomorphology Technical Report).**

### 5.2.5 Chemicals and contaminants

Across the project lifecycle, sites that use chemicals on site primarily include MIA, CHPP, warehouses and workshops.

Diesel fuel will be stored at the MIA. Refuelling facilities will also be located at fuel storages and some mobile refuelling of equipment involved in incidental mine gas management activities may take place across the mine footprint.

Small quantities of chemicals for use in water and wastewater treatment will also be stored at the MIA, CHPP and accommodation village. Small quantities of oils and oily wastes will also be stored at the MIA and CHPP associated with vehicle and equipment maintenance. All fuel and chemical storages will be designed and operated in accordance with Australian Standards (AS), including AS 1940 and AS 3780.

Minor spills and leaks of fuels and oils may occur across the mine footprint from refuelling and operation of equipment involved in installation and operation of incidental mine gas management infrastructure. Likely quantities of fuel or oils that may be spilled would be low, typically in the order of 10 L to 20 L. If spills occur to soils, mobilisation of contaminants to surface waters is unlikely to reach a receiving aquatic environment and hence unlikely to result in any significant water quality degradation. Spills occurring within or immediately adjacent to watercourses may cause localised water quality degradation, but due to the small volumes involved, this is likely to be short lived.

### 5.2.6 Licensing water management infrastructure

The process water dam will receive saline water from gas drainage and returns from the underground mining equipment, with concentrations that have the potential to exceed the guideline thresholds for some water quality parameters. It is therefore anticipated that the process water dam will be classified as a regulated dam and will need to be designed and licensed accordingly. The remaining dams on-site are unlikely to be considered regulated dams as they are unlikely to exceed the water quality guidelines as they will contain either raw water or local run-off. The management of water in these dams will be managed under the mine WMS, and is discussed in detail in the Project Mine Water Balance Technical Report (AECOM, 2024).

### 5.2.7 Flooding of mine areas

The hydrology report produced by Alluvium (2023) does not depict flooding impacts of project areas comprising mine infrastructure under 50% AEP, 2% AEP, 1% AEP or 0.1% AEP scenarios. However, if flooding of the underground mine should occur, floodwaters may be contaminated with:

- Hydrocarbons from residues of fuel and oils on land surfaces and from oily wastes stored in the MIA
- Chemicals from chemical stores (if these are inundated) and from waste storage areas
- Particulates from coal dust and other sediment present on land surfaces.

The release of the contaminated flood waters will be processed via the WMS described in the corresponding Project Mine Water Balance Technical Report (AECOM, 2024).

### 5.2.8 Wastewater

Main sources of waste with the potential to generate wastewaters originate from the mine water dams, product coal stockpile, CHPP, ROM Stockpile and MIA. These have the potential to generate wastewaters, which could lead to contamination and toxicity in receiving environments. These wastewaters are to be treated before discharge into the PWD.

Effluent wastewater would be generated from the production of sewage effluent and sludge that would be produced by site infrastructure such as the accommodation village, and offices. If not treated and disposed of appropriately, these wastewaters could lead to contamination and toxicity in receiving environments. Effluent wastewater would be treated and discharged to the PWD. Any sludge generated, and sewage from temporary workers accommodation village would be pumped by licensed contractor and transported to a local council sewage treatment plant.

## 5.3 Decommissioning phase

The decommissioning phase will involve the following activities:

- Dewatering of water storage dams which would not be suitable for ongoing beneficial use

- Earthworks associated with the removal of infrastructure on the site and commencement of rehabilitation measures in accordance with Rehabilitation Management Plan (BMA, 2024a)**.**

The MAW dam will need to be dewatered at decommissioning as would the incidental mine gas production water dam, should it contain any water. Both dams can be pumped into the adjacent mine complex's WMS using existing water transfer systems. The dams would then need to be decommissioned so that it does not capture water in future. As the quantities of water to be transferred are small, and as existing equipment will be used, it is unlikely that any accidental release to the environment would occur during this activity.

The release of contaminated water from a pipeline failure during decommissioning has the potential to have adverse impacts on water quality within the receiving environment and may compromise downstream environmental values. However, the likelihood of failure, and the quantities potentially involved are low and significant environmental impact is unlikely.

# 6.0 Mitigation and management measures

This section emphasises on mitigation and management measures of discussed impacts on the surface water environment.

**Table 7 Summary of potential impacts and proposed management/mitigation measures**

| Project Phase | Potential Impact | Proposed management/mitigation measures | Proposed monitoring |
|---|---|---|---|
| Construction | Erosion and Sedimentation through working activities related to the construction of the project infrastructure leading through increased turbidity and nutrient concertation in receiving waters | Management according to IECA (2008) as outlined in Section 6.3 of this report | To be outlined in Construction Environmental Management Plan. Proposed monitoring is outlined in Section 7.0 |
| Construction | Spillage of Chemicals and Contaminants used for construction leading to contamination of receiving waters with hydrocarbons, oil, hydraulic fluids and other hazardous chemicals | Storage, operations, and handling in accordance with AS 1940, AS 3780 and as outlined in Section 6.4 of this report | To be outlined in the Construction Environmental Management Plan |
| Operation | Release of mine affected water could increase levels of salinity and contaminants in receiving waters | The WMS has been developed consistent with Queensland guidelines for regulated structures and preliminary consequence category of 'significant' for MAW containing structures. Accordingly, MAW structures will be managed according to the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (DES, ESR/2016/1933). The capacity of the MAW structures has been developed such that uncontrolled releases (spills) are unlikely. Licensed release(s) are proposed to allow the management of MAW in wet season or rainfall conditions exceeding licensed conditions. Licensed release(s) allows for a controlled management of excess MAW, during periods of flow in downstream waterways, to maximise dilution and minimise impact from MAW. | Regulated structures will be monitored in accordance with the Site Water Management Plan (SWMP) to be developed and the Model water conditions for coal mines in the Fitzroy Basin. The SWMP will specify:<br>• regular inspection frequencies by site personnel, including pre wet season and post wet season inspections.<br>• Periodic inspection by 3rd parties (dam safety inspections)<br>Regulated structure water volume and water quality monitoring. |

| Project Phase | Potential Impact | Proposed management/mitigation measures | Proposed monitoring |
|---|---|---|---|
| Operation | Water management system failure could lead to increased salinity and contaminant levels in receiving waters | Failures can be contained within the MIA dam and the mine's WMS | Mine affected water monitoring will be automated and managed in accordance with the site's WMP |
| Operation | Spillage of Chemicals and Contaminants used for construction leading to contamination of receiving waters with Hydrocarbons, oil, hydraulic fluids and other hazardous chemicals | Storage, operations, and handling in accordance with AS 1940, AS 3780 and as outlined in Section 6.4 of this report | Incident reports |
| Operation | Subsidence induced geomorphological changes leading to alterations in sediment transport, stream flow, water quantity and potentially increased turbidity | Implementation of adaptive management framework as outlined in the Project Subsidence Management Plan (BMA, 2024b). This will involve the installation of drainage channels to drain ponded areas. | Ongoing subsidence monitoring will occur as outlined in Subsidence Management Plan (BMA, 2024b), Section 6.2. |
| Operation | Flooding of underground mine resulting in floodwaters with high salinity and contaminant concentration | Unlikely to occur<br>Contaminated flood waters will be treated via the mine's WMS | Monitored and managed in accordance with the site's water management system |
| Operation | Wastewater | Wastewater will be treated and blended with water within the PWD. Mitigation measures outlined in Section 6.7 of this report. | Regular water quality sampling of treated wastewater is proposed. The basis for the treatment and use will be in accordance with Australian Guidelines for Water Recycling (NRMMC 2006). |
| Operation | Dewatered water volumes are expected to exceed water quality criteria for downstream waterways. | All dewatering volumes are proposed to be managed within the WMS, which is purposed as a containment system.<br>Water transfers to be managed under a Site Water Management Plan (SWMP, 7.1) | SWMP monitoring requirements for regulated structures for pre and post regulatory wet season requirements for regulated structures.<br>Ongoing water balance modelling for MAW containment adequacy |

## 6.1 Licensed release of mine affected water

All mine water produced during the operation phase would be stored and managed through the proposed mine WMS, which has been developed to minimise the likelihood of uncontrolled spills.

Assessment of the hydraulic performance of the WMS has been undertaken, as outlined in the Project's Mine Water Balance Technical Report (AECOM, 2024). Modelling of a variety of scenarios indicated that there would be no spills from site dams. Notwithstanding, BMA are pursuing a licensed release point, located at the PWD, to allow for contingent management of MAW for unforeseen conditions. Consideration of licensed release has been developed according to the Model water conditions for coal mines in the Fitzroy Basin (DES, ESR/2015/1561).

A stress test scenario, which forces accumulation of water volumes leading to release of MAW was developed. A stress test scenario is a computer simulated scenario that is extremely unlikely to occur but is necessary to test the limiting parameters of the system. The scenario was based on assumptions outlined in Table 8.

**Table 8 Assumptions used in Mine Water Balance Report for MAW Release Scenario**

| Aspect | Value |
|---|---|
| Flow Conditions | High flow stream conditions |
| Waterway Zone | Zone 2 |
| End of Pipe Electrical Conductivity Limit ($EC_{end\ of\ pipe}$) | < 10,000 uS/cm |
| In Stream Electrical Conductivity Limit ($EC_{in\text{-}stream}$) | 700 uS/cm |
| Proposed Release Rate | Minimum of:<br>• 100 L/s<br>• 8% of flow rate in Boomerang Creek |
| Boomerang Creek Minimum Flow Rate | 0.1 $m^3/s$ |
| Isaac River (Deverill Station MP19) Minimum Flow Rate | 3.0 $m^3/s$ |

According to the *Model mining conditions* (DES 2017, ESR/2016/1936), the release of MAW at release monitoring locations (Figure 6) must not exceed the release limits stated in Table 9 and Table 10. Using the stress test scenario, it was estimated that licensed releases would meet the EC requirements of less than 10,000 µS/cm, with modelled concentrations as follows:

- Boomerang Creek <660 uS/cm
- Hughes Creek <450 uS/cm.

Based on the results of the modelling undertaken for the mine water balance, the likely requirement for licensed releases is very low, and if they were to occur it is not expected that there would be any residual impacts.

Licensed releases in the Isaac River catchment must be approved by the Department of Environment and Science to minimise the occurrence of mines in proximity to each other discharging at the same time. Additionally, BMA are involved in the ongoing development of the 'BHP Real-Time Forecasting System (RTFS) – Hydrologic, Hydrodynamic and Water Quality Models' (Water Technology & Deltares, 2021) which models the potential water quality in the receiving environment for releases originating from the central mines region, including Goonyella Riverside, Caval Ridge, Peak Downs, Saraji (existing), Norwich Park, Daunia and Poitrel mines. It is envisioned that the Project would be included within this assessment in the next periodic update of the RTFS tool.

**Table 9 Mine affected water release limits based on *Model Mining Conditions* (2017)**

| WQ Parameter | Release limits | Monitoring frequency |
|---|---|---|
| Electrical conductivity(µS/cm) | < 10,000 | Daily during release – the first sample must be taken within two hours of commencement of release or as soon as safe access permits |
| pH (pH Unit) | 6.5 (minimum)<br>9.0 (maximum) | |
| Turbidity (NTU) | 50[1,2] | |

*1 GLV EPP Water (2019) (Isaac River 1301)*
*2 Current limit or limit derived from suspended solids limit and demonstrated correlation between turbidity to suspended solids historical monitoring data for dam water*

**Table 10 Mine affected water release contaminant trigger investigation levels based on *Model mining conditions* (DES 2017)**

| Toxicant | Trigger Levels (µg/L) | Monitoring frequency |
|---|---|---|
| Aluminium | 55 | A soon as possible after commencement of release and when safe access permits, thereafter weekly during release – one sample per week required |
| Arsenic | 13 | |
| Cadmium | 0.2 | |
| Chromium | 1 | |
| Copper | 2 | |
| Iron | 300 | |
| Lead | 4 | |
| Mercury | 0.2 | |
| Nickel | 11 | |
| Zinc | 8 | |
| Boron | 370 | |
| Cobalt | 90 | |
| Manganese | 1,900 | |
| Molybdenum | 34 | |
| Selenium | 10 | |
| Silver | 1 | |
| Uranium | 1 | |
| Vanadium | 10 | |
| Ammonia | 900 | |
| Nitrate | 1,100 | |
| Petroleum Hydrocarbons (C6-C9) | 20 | |
| Petroleum Hydrocarbons (C10-C36) | 100 | |
| Fluoride (total) | 2,000 | |
| Suspended Solids (mg/L) | 55[1] | |
| Sulfate ($SO_4^{2-}$) (mg/L) | 250[2] | |

*1 Current limit or limit derived from suspended solids limit and demonstrated correlation between turbidity to suspended solids historical monitoring data for dam water*
*2 Protection of drinking water Environmental Value*

## 6.2 Subsidence

The potential impacts of subsidence on water quality through alterations in sediment transport, flow behaviour and erosion leading to increased turbidity and nutrient concentrations require mitigation. According to Hydrology, Hydraulics and Geomorphology Technical Report (Alluvium, 2023), managing the potential impacts of subsidence requires multiple complementary approaches, which may include adaptive management of existing issues, development of a subsidence management plan and monitoring of actual impacts as the Project progresses. An adaptive management framework has been developed and is outlined in Subsidence Management Plan (BMA, 2024b). This approach accommodates for the complexity involved with stream processes and the unpredictability of subsidence in terms of severity and timing.

Adaptive management is described by the following principles:

- **assess the risk –** potential subsidence risks are identified and assessed (Section 5, Subsidence Management Plan (BMA, 2024b))
- **identify mitigation measures –** mitigation measures are listed alongside potential subsidence risks (Section 5, Subsidence Management Plan (BMA, 2024b))
- **implement mitigation measures –** the Trigger Action Response Plan (TARP) stipulates when individual mitigation measures should be implemented (Section 5, Subsidence Management Plan (BMA, 2024b))
- **monitor key subsidence parameters –** the subsidence monitoring program outlines the pre- and post-subsidence monitoring methodologies, parameters and frequencies (Section 6, Subsidence Management Plan (BMA, 2024b))
- **evaluate effectiveness of implemented mitigation measures –** the evaluation, and reporting on the effectiveness of implemented mitigation measures (Section 7, Subsidence Management Plan (BMA, 2024b))
- **adjust plans and/or practices –** provisions for adjusting plans and/or practices (Section 7, Subsidence Management Plan (BMA, 2024b)).

The prepared Subsidence Management Plan (BMA, 2024b) includes the following key components:

- Predicted Subsidence
- Potential Impacts
- Subsidence Management
- Risk Assessment and Preliminary TARP
- Monitoring
- Reporting

## 6.3 Erosion and sediment control

Erosion and sediment control practices will be applied to construction works and mining operations, in accordance with International Erosion Control Association Best Practice Erosion & Sediment Control guidelines (IECA, 2008) to mitigate the generation of sediment and its transport to waterways. Measures will be prepared by a *Suitably Qualified Person.*

Areas of disturbed or exposed soil will be managed to reduce sediment mobilisation and erosion. The following general mitigation measures are proposed:

- An erosion and sediment control plan will be prepared and executed
- Erosion and sediment control protection measures will be installed prior to the commencement of land disturbance activities. Sediment control structures, such as sediment ponds, will be designed and constructed on site to trap runoff
- Permanent stormwater management systems will be installed as early as possible in the construction program
- Diversion bunds will be constructed to divert clean water flows around the construction site where practical
- Erosion and sediment control structures will be regularly inspected and maintained
- Topsoil will be stockpiled away from drainage lines to protect it from erosion by surface water runoff
- Dust suppression measures will be implemented
- Vehicle washdown will take place in designated areas away from flood plains and drainage lines

- Water from vehicle washdown areas will be treated to remove seeds, oils and other contaminants before reuse for dust suppression or other on-site use or directed to the mine complex water management system for reuse
- Road crossings of streams will be stabilised to minimise wash outs and bank erosion. Stabilisation may include placement of matting along banks
- Regular inspections of road and pipeline alignments will be undertaken to ensure that disturbed surfaces are stable and not subject to concentration of flows or erosion. Repair works will be undertaken proactively to mitigate erosion from occurring or worsening.

The operational areas will be inspected regularly to check that stormwater management systems are effective and concentration of flow or scouring is not occurring.

Detailed design of the MIA and CHPP will address design of stormwater collection and retention systems to ensure that stormwater can be captured and adequately treated.

## 6.4 Chemicals and contaminants

The storage of chemicals and fuel on-site will be kept to minimum levels. Storage units will be bunded as per AS 1940 and staff will be trained in appropriate chemical handling and emergency management procedures.

The following general mitigation measures are required to manage impacts of spills and leaks of fuels, oils and other contaminants on receiving waters:

- Temporary and permanent fuel storage areas to be designed in accordance with AS 1940 *The storage and handling of flammable and combustible liquids*. This includes provision for secondary containment.
- Chemical storage areas to be designed and operated in accordance with AS 3780 *The storage and handling of corrosive substances*
- Refuelling to occur within contained, hardstand areas in accordance with AS 1940 wherever possible. Where this is not possible, refuelling activities should be located away from streams and drainage lines and be closely supervised, with a spill kit available that is capable of containing spills of around 100 L.
- Storage and refuelling areas to be located away from areas subject to stormwater inundation
- Storage and refuelling areas to be designed to minimise the ingress of clean stormwater either from overland flow or incidental rainfall
- Spill clean-up kits are to be located in appropriate locations, based on the risk of a spill occurring and potential volume of material that might be spilled at the particular location
- Instructions on spill containment and clean-up to be available at refuelling locations and in vehicles where there is a moderate risk associated with spill events
- Spills are to be contained and cleaned up immediately to mitigate the mobilisation of pollutants in drainage lines or watercourses
- Bunds and sumps should be emptied after each rainfall event. Water and oily water from fuel and oil storage areas removed from bunds and sumps should be treated through an oil water separator and then reused for dust suppression or other on-site use. Water and other contaminants from other chemical storage areas should be treated through on-site wastewater treatment plants and then utilised in dust suppression or irrigated in accordance with the site Environmental Authority.
- Items are not to be stored or placed within bunds or sumps
- Contaminants and major spills will be collected by a licensed waste collection and transport contractor for disposal at an offsite licensed facility
- Wastewater from vehicle washdown areas should be directed through oil and grease separators and effluent utilised for dust suppression or other use, or directed to the mine complex water management system for reuse.

## 6.5 Site water management

The objectives of the WMS of the Project are to:

- Achieve optimal reliability of water supply for coal processing and dust suppression.
- Minimise the risk of flooding to the underground workings thereby maximising operability and workforce safety.
- Minimise the take from the surface water allocation.
- Direct water from undisturbed areas away from Project operations.
- minimise uncontrolled releases from the sites.

The Project will adopt the following principles to achieve these objectives:

- Runoff from undisturbed areas of the Project Site and its vicinity will be diverted away from disturbed areas by diversion bunds and drains which will drain via diverted creeks and natural watercourses of Hughes and Boomerang Creek.
- Runoff from disturbed areas of the Project will be diverted away from undisturbed areas and pumped to the process water dam and used preferentially to satisfy the Project's, dust suppression and CHPP process water demands.
- Raw water from BMA's surface water allocations will be piped to the Project Site and used to satisfy the Project's potable water and longwall mining equipment demands. Raw water will be used to supplement CHPP make-up water as required.

Preliminary capacity estimates for all mine WMS dams and the water transfer network have been determined through water balance assessment using historical climate conditions and conceptual operational rules (AECOM, 2024). For the purpose of this assessment, a conservative approach has been adopted to sizing of each conceptual mine WMS storage such that:

- The sizing of the regulated structures is consistent with the hydraulic criteria outlined within the Manual for assessing consequence categories and hydraulic performance of structures (DES, ESR/2016/1933).
- Licensed release of MAW to the receiving environment is not required within the normal operation of the WMS.
- Capacities are sufficient to mitigate the uncontrolled (spillway) discharge of MAW to the receiving environment.

The proposed WMS has been developed as a concept to minimise the uncontrolled release of MAW via spillways into receiving waters. The preliminary dam capacities presented are relevant to the input data, assumptions and adopted operational rules. However, any open system has the potential for uncontrolled discharge of MAW as a result of rainfall and climatic conditions exceeding the containment and hydraulic criteria for the dams. The current preliminary consequence category of the MAW dams is 'significant'. As such, BMA will be seeking authority and licence conditions to conduct the controlled release of MAW from the Project Site. The indicative location for licensed release of MAW is located on Boomerang Creek downstream of the proposed PWD. Spillway discharges (uncontrolled) from the process water dam are also proposed to be directed to Boomerang Creek. Controlled releases are preferred as these allow the discharge of MAW via discharge point within the release limits stated in Table 9 and Table 10, whereas these limits might be exceeded in uncontrolled spillway discharges.

The following mitigation strategies will be considered to address MWS failure risk:

- Mine water storages will be designed with consideration given to the predictions of the water balance model which considers all inputs and outputs, and which has run through a long-term period of climatic data to test storage capacities particularly in high rainfall wet season. If such discharge were to occur this would only be during rare and large events, therefore any release would be subject to dilution and would be similar to the receiving environment
- All dams for the Project will be constructed in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (DES, ESR/2016/1933). Pipes

and pump systems to be designed with consideration to volume requirements predicted from water balance modelling and designed by a suitably qualified engineer

- Regular inspections of mine water storages, pipeline, drain, bund and levees will be undertaken particularly in relation to integrity of constructed embankments.
- Mitigation solution for pump failure include standby pumps and diesel generator, additional pipeline segments in place for repairs, regular inspections.

**Water transfers with Saraji Mine**

The Project's raw water supply will be linked to the existing Water Management System for Saraji Mine. While it is planned to reuse MAW whenever possible, raw water is still required for those consumptive demands for which MAW is not suitable, or for when supplies of MAW are unavailable.

BMA operates a water pipeline network in Central Queensland, servicing its mines, landholders and towns. BMA holds contractual rights to approximately 10,000 mega litres per year (ML/yr) of water from the Burdekin Pipeline (owned by SunWater) as a supply source for BMA operations in the vicinity of Moranbah. In addition, BMA has a water allocation of 6,200 ML/yr from the Eungella Dam that is also available for use in BMA operations in the Moranbah vicinity. In securing its water rights, BMA has allowed for the current and potential future use of water from these sources at the Saraji Mine and for growth options associated with MLA 70383.

In relation to the proposed activities on MLA 70383, BMA will prepare, update and maintain a Water Management Plan. The Plan will recognise that water to be used for Project operations will be sourced via an off-take from the existing water pipelines developed to support BMA's current and future mining operations, along with various other purposes. Further, this Plan will recognise that water will be sourced from the Eungella Dam and/or the Burdekin Pipeline. The Project will have an internal BMA allocation to draw water from as part of the BMA-related water allocations.

These allocations are held by BMA directly or indirectly via contractual arrangements with SunWater in accordance with the Burdekin Water Resource Plan and the *Water Act 2000* (Water Act).

BMA also holds allocations of water from the Fitzroy and Burdekin water catchments and numerous licences to interfere with and take water across BMA's mine sites.

## 6.6 Mine dewatering

The following mitigation and management measures apply to dewatering of water storage dams for operational requirements, such as maintenance:

- Mine dewatering is conveyed into the Mine Water Balance (MWB) MAW system and the adjacent mine complex's WMS using existing water transfer systems. Water transfers to be managed under a Site Water Management Plan (SWMP, Section 7.1). Water transfers to be managed under a Site Water Management Plan (SWMP, Section 7.1).
- Ensuring that pipe and pump network is operating properly before commencing dewatering.
- A post-mining monitoring program will be developed to address the recovery of groundwater drawdown impacts observed during operation.
- Potential groundwater drawdowns from mine dewatering are expected to have minor impacts on surface waters, as these mostly ephemeral in nature and are separated from the predicted impacted groundwater resources by low permeable sediments.
- Largest predicted drawdown extents are expected not to discharge into the area down gradient of the Isaac River, nor do draw down cones extend to the Isaac River.

## 6.7 Wastewater management

The Project Mine Water Balance Technical Report (AECOM, 2024) outlines the relative treatment and disposal routes for effluents generated on-site. Main sources of waste originate from the mine water dams, product coal stockpile, CHPP, ROM Stockpile and MIA. As outlined in the MWB schematic

(Figure 9**),** these are to be treated to the appropriate water quality standards before discharge into the PWD.

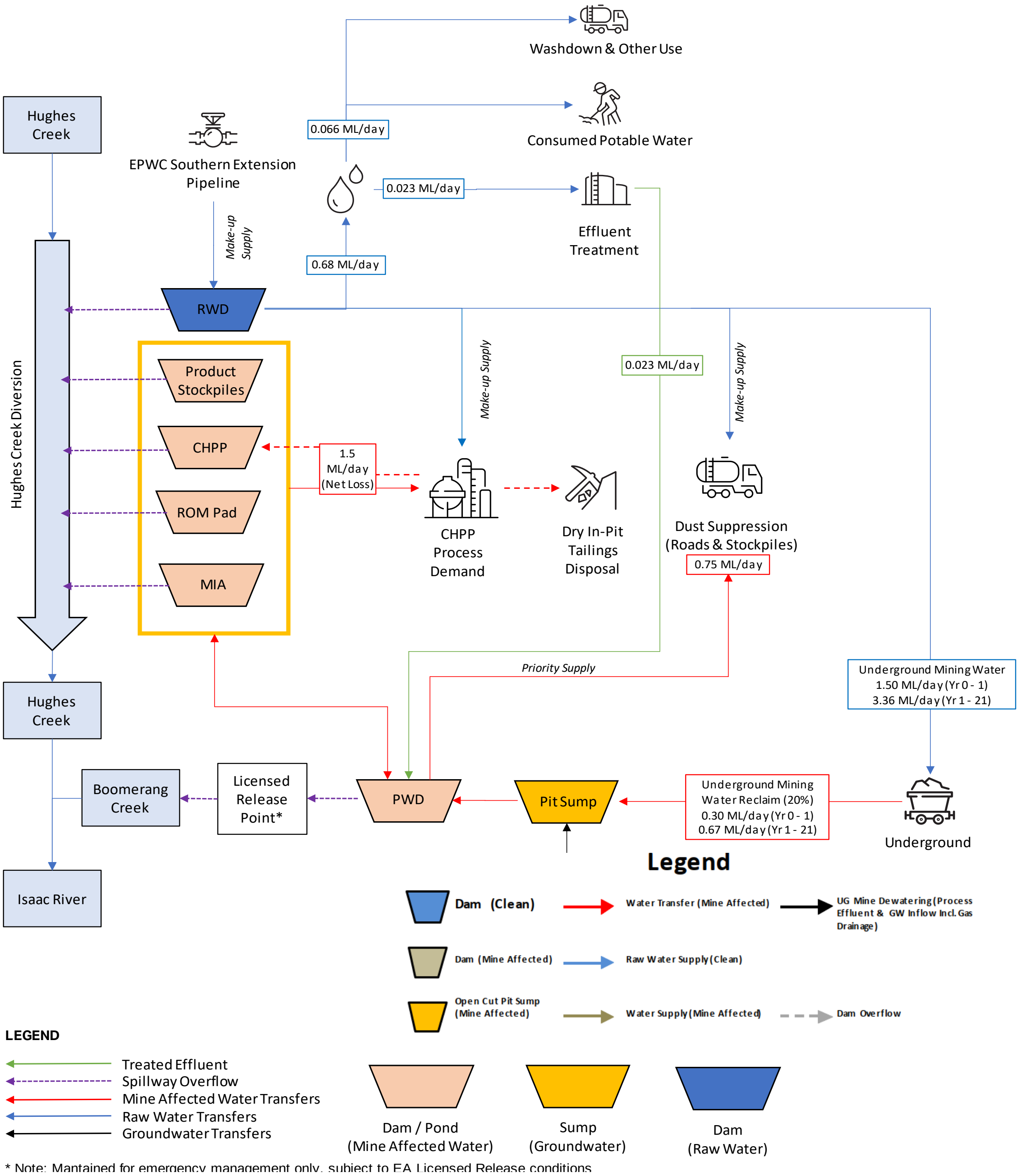


**Figure 9 Conceptual Mine WMS – Model Schematic**

For effluent wastewater generation, Table 11 provides estimates for potential effluent generation on-site. Wastewater generation per equivalent population per day has been judged in accordance with 02-2014-3.1 Gravity Sewerage Code of Australia (Water Services Association of Australia, 2014). The wastewater treatment would provide for elimination of any residual pathogen contaminants from wastewater. Water would be treated to Class B standard, which is considered as suitable for industrial uses such as wash down water and dust suppression, as defined by the Queensland Government Public Health Regulation (2018). Treated wastewater will be discharged to the PWD and therefore will be diluted with the balance of the mine affected water of the operation. Estimates identify approximately 0.023ML/day of effluent generated in comparison to the PWD modelled to hold up to 40 ML during general operating conditions and 100 ML in wetter than average rainfall conditions.

BMA is committed to the safety and education of their employees and limits access to areas that have been exposed to Class B treated wastewater.

The Australian Guidelines for Water Recycling (NRMMC 2006) should be used as the basis for the treatment and use of treated wastewater.

**Table 11 Summary of effluent generation volumes**

| | |
|---|---|
| **Approx. Workforce** | 500 |
| **Equivalent Population** | 125* |
| **Wastewater generation per EP** | 180 |
| **Approx. Effluent generation (ML/year)** | 8.22* |
| **Approx. Effluent generation (ML/day)** | 0.023 |

* *The workforce equivalent population has been adjusted to account for a 12 hour shift on a 4 week roster rotation.*

**Based on a 365.25 day calendar year*

It is further expected for the construction workforce for Saraji Mine to peak at approximately 350 EP for which the estimated peak wastewater load from the operation of the construction camp is estimated at 63 KL/day. Hence, sewage effluent and sludge would be produced by site infrastructure such as the accommodation village, and offices. It is anticipated that 400 ML of effluent and 240 tonnes of sludge would be produced. Any sludge produced, as well as sewage from temporary workers accommodation village would be pumped by licensed contractor and transported to a local council sewage treatment plant.

The mine site produces typical mine site waste including general liquid and solid wastes, as described in Chapter 15 Waste of Project EIS (BMA, 2024), waste categories have been broken down into:

1. Regulated waste: these include commercial, industrial waste of a type or containing a constituent of a type defined in Section 42 of Schedule 9, Part 1, Column 1 of the EP Regulation) requiring specific controls or actions for handling and disposal to manage certain physical or chemical properties of those wastes. These mainly pertain to flammable, combustible, corrosive or hazardous constituents such as clinical waste, grease trap waste, lead acid batteries, hydrocarbon waste, paints, resins, solvents, detergents. Risks to the environment would be through minimising waste by producing/procuring only the amount necessary. Collection onsite and stored in a regulated area. Removal would be via transportation offsite by authorised regulated waste contractor and disposal by a regulated waste receiver.
2. General waste: these allude to wastes that are not defined as regulated waste under legislation and include those that may or may not be decomposed, recycled or composted. These may include food scraps, aluminium cans, paper, glass, plastics, textiles, timber offcuts, glass. These would be subject to collection and segregation onsite, followed by transportation by a waste contractor for offsite recycling. Collection and storage measures would limit the potential for these to be entrained in site runoff.
3. Recyclables such as cleared vegetation, excavation materials, concrete, timber, scrap metal, steel offcuts, bricks, aggregate, sand. These would be reused on site where possible and any materials not suitable for reuse will be transported by a waste contactor off site for recycling. Collection and storage measures would limit the potential for these to be entrained in site runoff.

# 7.0 Monitoring and Plans

## 7.1 Site Water Management Plan

Appropriate management of surface water resources will involve the application of a Site Water Management Plan (SWMP), which will be developed during the detailed design phase in accordance with the *Model water conditions for coal mines in the Fitzroy basin* (DES, ESR/2015/1561). The SWMP will provide for effective management of actual and potential environmental impacts resulting from water management associated with the mining activity carried out.

- Principles and objectives of Site Water Management across the Project.
- Outlines the chemicals and contaminants of concern involved in the Project
- Water management system for the Site
- Measures to manage and prevent saline drainage
- Measures to manage and prevent acid rock drainage
- Contingency procedures for emergencies
- Development of an Erosion and Sediment Control Plan
- Ongoing monitoring requirements of regulated structures proposed as part of the development
- Ongoing water balance modelling, MAW containment adequacy
- Pre and Post Regulatory Wet Season requirements for regulated structures.

## 7.2 Receiving Environment Monitoring Program

### 7.2.1 Monitoring during construction

The potential for impacts during construction will be managed through development and implementation of the Construction Environmental Management Plan. This would include a Surface Water Management Sub-plan outlining the Construction REMP. Monitoring of the receiving water during construction would be in accordance with the REMP outlined below.

The REMP will be developed and implemented prior to construction. The aim of the REMP is to monitor and assess the potential impacts of the controlled and uncontrolled releases of construction water and associated contaminants to the environment. This will provide the basis for evaluating whether the discharge limits have been successful in maintaining or protecting receiving environment values over time. For the purposes of the REMP, the receiving environment is the waters of Boomerang Creek, Hughes Creek, One Mile Creek, Phillips Creek and Spring Creek. The REMP encompasses any sensitive receiving waters or environmental values downstream of the authorised construction activity that will potentially be affected by construction works.

Content of the REMP will follow DES guidelines (DES, 2014), (DES, (2018a) and DES (ESR/2015/1561) to include the following sections:

- Description of the project activities, and water management system in place
- Location of release points for discharge of construction water
- Location of REMP Monitoring Points as recommended for wider regional REMP for the Fitzroy Basin (FRREMP) (Figure 5, Figure 6, Table 12)
- Description of the receiving waters including suitably scaled maps, description of environmental values and developed WQOs
- Include baseline data on surface water flows and quality, trigger levels for investigations and a monitoring program.

- Frequency and timing of sampling required in order to reliably assess ambient conditions and to provide sufficient data to derive site specific background reference values in accordance with the Queensland Water Quality Guidelines 2006.
- Monitoring of WQ parameters in potentially affected waterways (upstream and downstream of impact).
- Utilisation of monitoring points established for other BMA operations where applicable.
- Monitoring will be undertaken in accordance with the Monitoring and Sampling Manual – Environmental Protection (Water) Policy 2009 (DES, 2018b) (or guideline current at the time of construction). Field monitoring equipment, such as electrical conductivity and pH meters will be calibrated. QA/QC laboratory samples will be collected. All external laboratories will be National Association of Testing Authorities (NATA) accredited for the analytical procedures they are performing.
- Quality Assurance/Quality Control procedures will be developed and described for all aspects of the monitoring program, including field sampling, transport, laboratory analysis and data handling.

### 7.2.2 Monitoring during operation

BMA is committed to participation in the FRREMP together with adjacent Saraji and Peak Downs mines as outlined in *Fitzroy Coal Mine Receiving Water Monitoring for Regulation – Efficiency Review and Gap Analysis* (2018). This includes the utilisation of existing monitoring locations, shared data management, coordination of releases between mines, as well as combined mitigation and response procedures. This commitment will be made for the operational and post closure phase of the project. The *Fitzroy Basin Regional Receiving Environment Monitoring Program Guideline* (ESR/2023/6463) outlines and governs the following key points for participants:

- DES and Participant agree on a list of provisional monitoring sites to offer for inclusion in FRREMP
- The FRREMP Program Manager will assign monitoring conditions
- Conditional FRREMP design document and contract
- Data management and reporting in accordance with created FREMP design document
- Annual Report reviewed by DES in accordance with the requirements of the FRREMP design document.
- Annual operational review including the following key aspects
  - review of the monitoring locations, parameters and data to identify any necessary changes to the design document
  - identify any improvements for inclusion in the program design
  - confirm participation and local monitoring sites for the following year
  - review any report recommendations.

Monitoring of MAW dam water levels will be automated and dam water levels will be managed in accordance with the site water management to minimise uncontrolled releases (refer to Section 5.2).

Where safety and access permit, the receiving water will be monitored at upstream and downstream locations during process dam release events. Monitoring will also be carried out during normal operation of the mine to in accordance with the FRREMP design document.

According to the *Fitzroy Coal Mine Receiving Water Monitoring for Regulation Project Report* (DES, 2018a), there are three main monitoring requirements within coal mines, namely:

- Monitoring within the mine site and mine water releases, which typically compare data to limits and triggers, i.e. Release Point monitoring (Section 6.1). Under the Model Mining Conditions (DES 2017), the indicators that should be monitored at release points, and release limits must include electrical conductivity (EC), pH, turbidity (Table 9). These contaminants were determined to be the major contaminants of concern for release of mine-affected water in the Fitzroy Basin. Other indicators to be monitored end-of-pipe include contaminants presented in Table 10. A flow gauging station will be installed upstream of the discharge monitoring point to account for flow rates during events.

- Monitoring upstream and downstream of the mine release site during periods of mine water releases, also referred to as Receiving Environment monitoring. Triggers or limits will be applied to this monitoring for key indicators to ensure downstream water quality does not exceed levels authorised in the approval (Figure 5, Figure 6, Table 12).
- Monitoring of upstream, downstream and the broader receiving waters during periods of base and event flow, also referred to as REMPs. The purpose of this monitoring is to assess the overall condition of the system downstream of mining operations. Water quality is compared to water quality objectives and relevant guidelines (Figure 5, Figure 6, Table 12).
- Installation of a continuous monitoring station for pH and EC downstream of the release (downstream of mixing zone, location to be confirmed with a mixing assessment)

Additionally, BMA will implement the Subsidence Management Plan (BMA, 2024b) to manage impacts on landform, surface water, groundwater, ecology and infrastructure prior to subsidence impacts. The Plan will outline specific, measurable, achievable, relevant and time-bound (SMART) controls for mitigation and rehabilitation and include monitoring for erosion and sedimentation as well as surface cracking across the subsidence impacted areas.

**Table 12 Proposed Monitoring locations for FRREMP**

| Monitoring Point ID | Easting (GDA94) | Northing (GDA94) | Monitoring Point Name |
|---|---|---|---|
| **Background data (used for water quality objectives)** | | | |
| MP1 (SRM) | 630293 | 7524061 | Hughes Upstream US |
| MP2 (SRM) | 631096 | 7516901 | One Mile US |
| MP2 (PDM) | 623739 | 7531218 | Boomerang US / MP24 |
| MP4 (SRM) | 634518 | 7515056 | Spring Downstream DS |
| MP6 (SRM) | 632488 | 7517976 | One Mile DS |
| **Existing environment (for EIS)** | | | |
| MP3 (SRM) | 634054 | 7508913 | Phillips US |
| MP5 (SRM) | 634346 | 7525530 | Hughes DS |
| MP7 (SRM) | 639027 | 7513729 | Phillips DS |
| MP8 (SRM) | 634603 | 7515079 | Spring US |
| MP9 (SRM) | 651114 | 7529225 | Isaac DS / MP18 (PDM) / Regional 2 |
| MP10 (PDM) | 632087 | 7529980 | Boomerang DS |
| **Future monitoring of mining impacts** | | | |
| MP5 (SRM) | 634346 | 7525530 | Hughes DS |
| MP10 (PDM) | 632087 | 7529980 | Boomerang DS |
| **Proposed monitoring point location** | | | |
| Proposed 1 | 638483 | 7529068 | DS Confluence Hughes Creek – Boomerang Creek |
| Proposed 2 | 636701 | 7529300 | DS Boomerang Creek |
| **Indicative proposed mine water release point** | | | |
| Discharge Location | 635984 | 7529559 | MAW Discharge Point - Boomerang Creek |

A Trigger Action Response Plan (TARP) will be developed to identify the corrective actions and responses required in the event that operations result in exceedances in surface water quality or adverse changes in stream health. Trigger level investigation levels also outlined in (DES, ESR/2015/) are presented in Table 13.

**Table 13 Receiving water monitoring analytes and trigger investigation levels for continuous monitoring according to *Values adopted from Model water conditions for coal mines in the Fitzroy Basin* (DES, ESR/2015/)**

| Analyte (Physico-chemical) | Trigger investigation level | Monitoring Frequency |
|---|---|---|
| Electrical conductivity (µS/cm) | 1,000 | Real-time monitoring<br><br>Grab samples if telemetry disabled<br><br>Grab samples at commencement of MAW release and weekly thereafter (Subject to safety and accessibility concerns) |
| pH | 6.5 – 8.5 | |

## 7.3 Trigger Action Response Plan

Actions that would be taken in response to an exceedance of water quality criteria are outlined in Table 14, including the timing, responsibilities and reporting requirements.

A TARP will be developed prior to construction, as part of the Water Management Plan, with the primary objective of providing trigger values based on the REMP framework for further investigation and outlining the corrective actions and responses required in the event that:

a. monitoring identifies the potential for an exceedance of water quality objectives or overtopping of water storages

b. water quality monitoring identifies an exceedance of water quality objectives or an adverse change in stream health; or

c. overtopping of the process water dam spillway occurs.

Under normal conditions the mine will operate as a closed system, so discharges to the downstream catchment are considered unlikely to occur. If an exceedance occurs, mine water dam overtopping or compromised stream health, the TARP will specify corrective actions and responses required in the event of exceedances.

In general, no action will be required if:

- Water quality at release location (end of pipe) does not exceed trigger levels and release limits specified in Table 9 and Table 10
- Water quality in the receiving environment does not exceed trigger levels and release limits specified in Table 10**.**
- Receiving environment water quality downstream of released MAW is below tested levels upstream
- Water quality measured at REMP monitoring locations downstream (medians) are within upstream 80$^{th}$ percentile values or WQOs.

The TARP will apply to the construction, operation and decommissioning stages of the Project. Site-specific water quality objectives or trigger values will be developed for the Project in line with the REMP. The TARP may also include ground condition, vegetation cover, erosion and other rehabilitation completion criteria.

**Table 14 Preliminary response plan for exceedance of water quality objectives as part of the Water Management Plan to be developed**

| Trigger | Responses | | Timing | Outcome / Reporting |
|---|---|---|---|---|
| **Water quality monitoring at discharge point identifies exceedance of release limits or release trigger values** | **Step 1** | If quality characteristics of a release event exceed any of the trigger levels specified in Table 9 of this report, downstream results in the receiving waters must be compared to all trigger values specified in the tables.<br>• If trigger values downstream are not exceeded no further action needs to be taken<br>• If trigger values are exceeded in the downstream environment, downstream values must be compared with data from background monitoring sites upstream of the project<br>• if downstream values are < background (upstream) site data, no action needs to be taken<br>• if results are > than background site values, an investigation is to be initiated (Step 2) | As soon as practicable, once the exceedance is identified | Record exceedance in the REMP<br><br>If downstream data > background site data, holder of EA must notify administering authority within 14 days of receiving the results. |
| | **Step 2** | Review potential causes of exceedance via the following:<br>• Visual inspection of potential diffuse sources (e.g. seepage from reject disposal areas or waste rock dumps). Where a potential source of an exceedance is identified, samples should be collected for testing where feasible and practicable<br>• Visual inspection of site infrastructure to identify any visible damage (e.g. a damaged pipe or broken monitoring equipment)<br>• Visual inspection of site equipment and plant, and review of maintenance records<br>Review of recent weather and rainfall data (Note that some physico chemical parameters such as conductivity and turbidity may be influenced by rainfall). | As soon as practical following step 1 | Document correspondence in the site Environmental Management System<br>Carry out incident reporting requirements in the EA<br><br>Record additional water quality testing results in the REMP |
| | **Step 3** | If it is identified that the exceedance is a result of construction or operation of the Project and has resulted in the release of contaminants not in accordance, or reasonably expected to be not in accordance with the EA,<br>➔ BMA must notify DES by written notification within 24 hours of becoming aware, or in accordance with the EA conditions at the time.<br>Actions need to be taken to prevent environmental harm | If the exceedance meets reporting requirements, notify DES within 24 hours of becoming aware | Document correspondence in the site Environmental Management System<br>Carry out incident reporting requirements in the EA |

| Trigger | | Responses | Timing | Outcome / Reporting |
|---|---|---|---|---|
| **Overtopping of process dam or uncontrolled discharge via spillway** | **Step 1** | Determine impact on receiving waters:<br>Carry out water quality testing of potentially impacted downstream water bodies to assess if water quality downstream exceeds any of the trigger levels specified in table 8 and 9 of this report,<br>➔ If trigger values downstream are not exceeded no further action needs to be taken<br>➔ If trigger values are exceeded in the downstream environment, downstream values must be compared with data from background monitoring sites upstream of the project<br>➔ If downstream values are < background (upstream) site data, no action needs to be taken<br>➔ If results are > than background site values, an investigation is to be initiated (Step 2) | Carry out water quality testing as soon as reasonably possible (where safety and access permits) | Record water quality testing results in the REMP |
| | **Step 2** | If it is identified that overtopping has resulted in the release of contaminants exceeding the release limits or contaminant trigger values, BMA must notify DES by written notification within 24 hours of becoming aware. | If the release of contaminants meets reporting requirements, notify DES within 24 hours of becoming aware | Document correspondence in the site Environmental Management System<br>Carry out incident reporting requirements |
| **Water quality monitoring at downstream location identifies exceedance of trigger values for the receiving environment** | **Step 1** | To be addressed by the REMP | As per the REMP | As per the REMP |

# 8.0 Conclusion

This section summarises the key findings of the surface water technical report for the Saraji East Underground Mining lease project.

**Environmental Values**

The proposed Saraji East Underground Mine is located in the far upstream headwaters of the Fitzroy Basin and relatively high in the headwaters of the Isaac River sub-catchment. Four water upland freshwater streams have been identified within the receiving environment of the project. These include Boomerang Creek, Hughes Creek, One Mile, Spring Creek.

The Environmental values for these watercourses have been identified with the protection of aquatic ecosystems being the category that requires the most stringent criteria for water quality objectives.

**Baseline Water Quality, Quantity and Water Quality Objectives**

The baseline hydrological condition of the waterways at the site location has been assessed as comprising:

- ephemeral watercourses, with nil to negligible flow expected during normal conditions.
- located within 'moderately disturbed' catchments, due to significant mining operations (located immediately upstream of the project location) and minor agricultural activity in the broader catchment.
- subject to high sediment loads during flow events, and have highly variable water quality.

These waterways are located hydraulically up-gradient of the Isaac River, which is a scheduled river system under the Queensland Environment Protection (Water) Policy 2009, and is located within the Fitzroy River basin.

A comparison of the regional WQOs within the *Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No.130 (part) including all waters of the Isaac River Sub-basin (including Connors River)* (DEHP, 2011) was completed against reference water quality data at the project location. It was concluded that the baseline site specific water quality (within the ephemeral creeks) is significantly different to regional water quality (Isaac River), particularly: Ammonia, Kjeldahl nitrogen, Total nitrogen, Dissolved oxygen, Nickel.

Accordingly, a detailed analysis of water quality data was completed to develop site-specific Water Quality Objectives (WQOs). These WQOs were developed according to guideline approaches such as DEHP (2009), ANZG (2018) and DES (2022), and were based upon an analysis of the best available reference data at the site location. Consistent with the intent of the Queensland Water Quality Guidelines (DES 2022) and ANZG (2018) guidelines, the developed site specific WQOs are purposed for long-term improvement of waterway quality.

The need to utilise licensed releases is not expected, however a licensed release point has been included for contingent management of water storages in unforeseen conditions under high flow conditions. The potential impact from licensed releases was assessed in a stress test scenario in the Mine Water Balance Technical Report (AECOM, 2024) which considered electrical conductivity (uS/cm) as the limiting pollutant. The modelling of this scenario predicted no significant impact. Discharge criteria and trigger values for the unlikely case of a discharge, have been developed in accordance with Model water conditions for coal mines In the Fitzroy basin, existing EAs of adjacent BMA mines and 80$^{th}$ percentile values of background water quality where appropriate.

A REMP and TARP have been developed in accordance with DES guidelines (DES, 2014), (DES, (2018a) and DES (ESR/2015/1561) prior to construction, as part of the Water Management Plan, with the primary objective of providing trigger values based on the REMP framework for further investigation and outlining the corrective actions and responses if detrimental impacts to surface water quality and stream health are imminent.

### Surface Water Risks and Mitigations

To understand the potential risks to surface water due to the project development, a review of the proposed operations was completed, with key risks identified for the construction and operational phase. Subsequently, mitigation(s) and management measures have been developed for each risk identified. Summary of risks and mitigations are outlined in Table 15.

**Table 15 Risks and Mitigations**

| Aspect | Risk(s) | Mitigation(s) |
|---|---|---|
| *Construction Phase* | | |
| Erosion and Sediment Mobilisation | Erosion and Sedimentation leading to increased turbidity and nutrient concertation in receiving waters | Management according to guidelines for erosion and sediment control (IECA 2008) |
| Chemicals and Contaminants of Concern | Spillage of Chemicals and Contaminants leading to contamination of receiving waters | Storage, operations, and handling as per Australian standards<br>Construction Environmental Management Plan |
| *Operational Phase* | | |
| Chemicals and Contaminants of Concern | Spillage of Chemicals and Contaminants leading to contamination of receiving waters | Storage, operations, and handling as per Australian standards<br>Incident reports |
| Subsidence | Geomorphological changes leading to alterations in sediment transport, stream flow, water quantity and increased turbidity | Implementation of adaptive management framework and proposed Subsidence Management Plan (BMA, 2024b).<br>Ongoing subsidence monitoring and review. |
| Erosion and Sediment Mobilisation | Erosion and Sedimentation leading to increased turbidity and nutrient concertation in receiving waters | Management according to guidelines for erosion and sediment control (IECA 2008) |
| Mine Affected Water | Release of mine affected water could increase levels of salinity and contaminants in receiving waters | WMS<br>Licensed Release |
| Mine Dewatering | Dewatering activities reduce capacity of MAW storages, resulting in unnecessary licensed releases | Mine dewatering is conveyed into the MWB MAW system and the adjacent mine complex's WMS using existing water transfer systems.<br>Water transfers managed under a SWMP<br>Ongoing water balance modelling for MAW containment adequacy. |
| Wastewater | Wastewaters from mining or effluent streams could lead to contamination and toxicity in receiving environments. | Effluent wastewater would be treated and discharged to the PWD.<br>Any sludge generated, and sewage from temporary workers accommodation village would be pumped by licensed contractor and transported to a local council sewage treatment plant. |

**Performance Monitoring, Management and Response Plans**

In addition to the proposed mitigation(s) developed for the identified risks, appropriate management of surface water resources will involve the development of Plan documentation, which will be developed during the detailed design phase, including:

A **Site Water Management Plan** (SWMP) to manage contaminants and containment in regulated water structures.

**Receiving Environment Monitoring Program** (REMP) to identify potential impacts to surface waters during operation and licensed releases. **Trigger Action Response Plan** (TARP) to specify corrective actions in the event of trigger exceedances.

**Subsidence Management** as outlined in the Subsidence Management Plan (BMA, 2024b) to mitigate the potential impact of subsidence on streams and infrastructure.

In summary, the assessed impacts to surface water potentially could affect surface water quality and aquatic ecosystems. However, impacts can be largely mitigated by applying proposed mitigation/management measures and the developed conceptual WMS. The REMP together with the implementation of a TARP will provide comprehensive corrective actions and responses for impacts to water quality. As such it is expected that construction and operation of the proposed underground mine will likely have little impact on surface water quality in the Boomerang – Hughes Creek catchment and the Isaac River.

# 9.0 References


ADWG (2004) Australian Drinking Water Guidelines 6, National Water Quality Management Strategy, National Health and Medical Research Council.

AECOM (2024). Saraji East Mining Lease Project – Mine Water Balance Technical Report.

Alluvium (2023) Technical Report: hydrology, hydraulics and geomorphology. Saraji East Mining Lease Project by Alluvium Consulting Australia for AECOM, QLD 4006. August 2022.

ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand.

ANZG (2018) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and Agricultural and Resource management Council of Australia and New Zealand. Available at: www.waterquality.gov.au/anz-guidelines

BHP Report for Phillips Creek Diversion (2019)

BMA (2023) Saraji East Mining Lease Project – Subsidence Ponding Assessment

BMA (2024) Saraji East Mining Lease Project - Waste

BMA (2024a) Saraji East Mining Lease Project – Rehabilitation Management Plan

BMA (2024b) Saraji East Mining Lease Project – Subsidence Management Plan

Brown, T.E., Morley, A.W., Sanderson, N.T., Tait, R.D (1983) Report on a large fish kill resulting from natural acid water conditions in Australia. Journal of Freshwater Biology, 22: 333-50.

Bureau of Meteorology (2008). Daily Gauged Rainfall Data. Available at: www.bom.gov.au

Chessman, B.C. (1995). Rapid assessment of rivers using macroinvertebrates: a procedure based on habitat-specific sampling, family level identification and a biotic index. Australian Journal of Ecology 20: 122-129.

CQU (2016). Saraji Mine Trend Report 2011-2016. Central Queensland University.

Department of Environment and Heritage Protection (DEHP) (2009). “Queensland Water Quality Guidelines”, DEHP. Brisbane.

Department of Environment and Heritage Protection (DEHP) (2011). “Environmental Protection (Water) Policy 2009 Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River), available at: https://environment.des.qld.gov.au/water/policy/pdf/plans/fitzroy_isaac_river_wqo_290911.pdf

Department of Environment and Heritage Protection (DEHP) (2016). “Manual for assessing consequence categories and hydraulic performance of structures”, publication number ESR/2016/1933, available at: https://www.ehp.qld.gov.au/assets/documents/regulation/era-mn-assessing-consequence-hydraulic-performance.pdf

Department of Environment and Heritage Protection (DEHP) (2017). “Final terms of reference for an environmental impact statement – Saraji East Mining Lease Project. Department of Environment and Heritage Protection, May 2017.

Department of Environment and Heritage Protection (DEHP) (undated). TOR guideline – Water. Undated. https://www.ehp.qld.gov.au/management/impact-assessment/eis-processes/eis-tor-support-guidelines.html

Department of Environment and Resource Management (DERM) (2007). Queensland Urban Drainage Manual (QUDM), Second Edition Volume II, 2007

Department of Environment and Resource Management (DERM) (2009). A study of the cumulative impacts on water quality of mining activities in the Fitzroy River Basin, Department of Environment and Resource Management, Queensland Government.

Department of Environment and Resource Management (DERM) (2009b). Conditions for Coal Mines in the Fitzroy Basin – Approach to Discharge Licensing (Version 10). Department of Environment and Resource Management, Queensland Government.

Department of Environment and Resource Management (DERM) (2010). Historical Monitoring Data – WaterShed, Available online at: http://www.derm.qld.gov.au/watershed/index.html

Department of Environment and Resource Management (DERM) (2010a). Maps of declared upstream and downstream limits.

Department of Environment and Science (DES) (2013) (ESR/2015/1561). Guideline. Model Water Conditions for Coal Mines in the Fitzroy Basin. Department of Environment and Science, Queensland Government.

Department of Environment and Science (DES) (2014). Receiving environment monitoring program guideline, Department of Environment and Science, Queensland Government.

Department of Environment and Science (DES) (2017). Guideline: Mining. Model mining conditions. ESR/2016/1936 • Version 6.02 • Effective: 07 MAR 17. Department of Environment and Science, Queensland Government.

Department of Environment and Science (DES) (2018a). Fitzroy Coal Mine Receiving Water Monitoring for Regulation – Efficiency Review and Gap Analysis

Department of Environment and Science (DES) (2018b). Monitoring and Sampling Manual – Environmental Protection (Water) Policy 2009, Available online at: https://environment.des.qld.gov.au/__data/assets/pdf_file/0031/89914/monitoring-sampling-manual-2018.pdf

Department of Environment and Science (DES) (2022). Guideline. Environmental Protection (Water and Wetland Biodiversity) Policy 2019. Deciding aquatic ecosystem indicators and local water quality guidelines 2022.

Department of Natural Resource Management (DNRM) (2007). Declared Upstream and Downstream Limits, Department of Natural Resources and Water.

Department of Natural Resources and Mines (2015). Fitzroy Basin Resource Operations Plan, available at: https://www.dnrm.qld.gov.au/__data/assets/pdf_file/0003/298650/fitzroy-rop-amendment-2015.pdf

Dunlop, J.E. and McGregor, G. (2007). Setting water quality guidelines for salinity and sediments in freshwater streams in Queensland, Natural Resource Sciences, Department of Natural Resources & Water, Brisbane (http://www.wqonline.info/products/infoanddata.html#TechnicalReports).

EPA (1996). Environmental Guidelines for Major Construction Sites, Environment Protection Authority Publication 480, Victoria.

Fitzroy River Basin Resource Operations Plan April 2009 (ROP) (2009).

FRC Environmental (2017). Saraji East Mining Lease Project Environmental Impact Statement: Aquatic Ecology Assessment. Prepared for AECOM on behalf of BMA.

GAUGE Industrial & Environmental (2014). Receiving Environment Monitoring Program (REMP). Annual report – June 2013. BMA Saraji Mine. Final Report

Hart (2008). Review of the Fitzroy River Water Quality Issues, Report to Queensland Premier by Professor Barry Hart. November 2008.

Hart, B. T. Ottaway, E.M., Noller, B.N. (1987). Magela Creek System, Northern Australia. I. 1982-83 Wet-season quality. Australian Journal of Marine and Freshwater Research, 38: 261-268.

Huynh, T. and Hobbs, D., 2019. Deriving site-specific guideline values for physico-chemical parameters and toxicants. Report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Canberra

Hydrobiology (2016). 2014/2015 Receiving Environment Monitoring Programme Annual Report – Saraji Mine

IECA (2008). Best Practice Erosion and Sediment Control. International Erosion Control Association (Australasia), Picton NSW.

Institution of Engineers Australia (1987). Australian rainfall and runoff: a guide to flood estimation. Vol. 2. The Institution of Engineers, Australia, 1987

Kefford, B.J., Dunlop, J.E., Horrigan, N,. Zalizniak, L., Hassell, K.L., Prasad, R., Choy, S. and Nugegoda, D. (2006). Predicting salinity-induced loss of biodiversity, Project No. RMI 12, Final Report to Land and Water Australia. Canberra (http://www.wqonline.info/products/infoanddata.html#TechnicalReports).

Lucas, R., Crerar, J., Hardie, R., Merritt, J., Kirsch, B (2009). Isaac River cumulative impact assessment of mining developments. Water in Mining Conference Proceedings, p.156-163 September 2009, Perth.

Minserve (2022). Technical Report – Subsidence over Longwall Panels – Saraji East Underground Mine

Pusey, B.J., Kennard, M.J. and Arthington, A.H. (2004). Freshwater Fishes of North-Eastern Australia. CSIRO Publishing, Collingwood, Victoria.

Natural Resource Management Ministerial Council (2006). National Water Quality Management Strategy Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase1), available at: https://www.waterquality.gov.au/sites/default/files/documents/water-recycling-guidelines-full-21.pdf

Queensland Government (2011). Water Resource (Fitzroy Basin) Plan 2011, available at: https://www.legislation.qld.gov.au/view/pdf/2014-06-27/sl-2011-0283

Queensland Government (2018). Public Health Regulation 2018, available at: https://www.legislation.qld.gov.au/view/pdf/asmade/sl-2018-0117

Queensland Government (2022). QGlobe Data Layer: Environment/Water and wetland biodiversity/Environmental Protection Policy management intent = MD (moderately disturbed for all subcatchments of Saraji Mine to the Isaac River). Accessed 7 November 2022.

Queensland Health (2002). Guidelines to minimise mosquito and biting midge problems in new development areas

Queensland Health. (2020). Guideline for low-exposure recycled water schemes. https://www.health.qld.gov.au/public-health/industry-environment/environment-land-water/water/quality/recycled-water. Accessed 24 April 2024

SLR (2023) Saraji East Mining Lease Plan - Ground Water Modelling Technical Report

Waddington & Associates (2002). Research into the impacts of mine subsidence on the strata and hydrology of river valleys and development of management guidelines for undermining cliffs, gorges and river systems. ACARP research project no. C9067.

Water Act 2000 (QLD) (2000).

Water Resource (Fitzroy Basin) Plan 1999 (QLD) (1999).

Water Technology & Deltares (2021). *BHP Real-Time Forecasting System (RTFS) – Hydrologic, Hydrodynamic and Water Quality Models*

WP Software (1994). RAFTS XP, Runoff and Flow Training Simulation with XP Graphical Interface.

WSSR Act (2008). Water Supply (Safety and Reliability) Act 2008. Queensland.

# Appendix A

## Data sources, sample sizes and raw data analysed for WQO development

The available water quality data were derived from several data sources for a ten year period from 01/07/2012. These data included water quality data which was collected for REMP reporting for the Saraji Mine (SRM, between 2012 and 2021) and Peak Downs Mine (PDM, between 2012 and 2020). Raw data from 2010 to 2021 was provided by BMA and analysed by AECOM. This data was analysed to develop site specific WQOs and is presented in Table 16.

## Table 16 Raw data for Boomerang-Hughes Creek catchment used for development of sub-regional WQO

| Site | Month | Rainfal in mm | Flow | Date | pH | EC | Turbidity | DO% | SS | SO4 | Ammonia | Nitrate | Total Kjeldahl Nitrogen as N | Total Nitrogen as N | Total Phosphorus as P | Reactive Phosphorus as P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boomerang (MP24 PDM) | JUL | 56.4 | Flow | 3/07/2021 | 6.74 | 78.6 | 7190 | | 1360 | 4 | 140 | 370 | | | | |
| Boomerang (MP24 PDM) | JAN | 95.7 | Flow | 6/01/2021 | 8.59 | 153.08 | 7180 | | 177 | 7 | 130 | 2700 | | | | |
| Boomerang (MP24 PDM) | MAR | 194.4 | Flow | 17/03/2021 | 7.58 | 70 | 322 | | 1200 | 2 | 6 | 413 | 3100 | 3500 | 510 | 0.99 |
| Boomerang (MP24 PDM) | MAR | 194.4 | Flow | 18/03/2021 | 6.67 | 399.9 | 268 | | 75 | 34 | 110 | 330 | | | | |
| Boomerang (MP24 PDM) | MAR | 306.2 | Flow | 30/03/2017 | 8.06 | 100 | | | | 4 | 130 | 880 | | | | |
| Boomerang (MP24 PDM) | NOV | 99 | Flow | 4/11/2016 | | | | | | 6 | | | | | | |
| Boomerang (MP24 PDM) | NOV | 99 | Flow | 4/11/2016 | 5.93 | 59 | 543 | | 146 | 6 | 80 | 240 | | | | |
| Boomerang (MP24 PDM) | JUL | 130.8 | Flow | 18/07/2016 | | | | | | 6 | | | | | | |
| Boomerang (MP24 PDM) | JUL | 130.8 | Flow | 18/07/2016 | 5.56 | 82 | 175 | | 88 | 6 | 120 | 840 | | | | |
| Boomerang (MP24 PDM) | JUL | 130.8 | Flow | 16/07/2016 | | | | | | 4 | | | | | | |
| Boomerang (MP24 PDM) | JUL | 130.8 | Flow | 16/07/2016 | 6.33 | 61.9 | 365 | | 318 | 4 | 50 | 910 | | | | |
| Boomerang (MP24 PDM) | FEB | 142.8 | Flow | 8/02/2016 | | | | | | 5 | | | | | | |
| Boomerang (MP24 PDM) | JAN | 113.4 | Flow | 30/01/2016 | | | | | | 10 | | | | | | |
| Boomerang (MP24 PDM) | JAN | 113.4 | Flow | 26/01/2016 | | | | | | 10 | | | | | | |
| Boomerang (MP24 PDM) | JAN | 149.2 | Flow | 22/01/2015 | 7.36 | 56 | 1080 | | 580 | | 50 | 300 | | | | |
| Boomerang (MP24 PDM) | DEC | 232.2 | Flow | 13/12/2014 | 6.65 | 176 | 1980 | | 998 | | 20 | 450 | | | | |
| Boomerang (MP24 PDM) | JAN | 144.2 | Flow | 17/01/2014 | 7.32 | 120 | 336 | | 85 | | 20 | 220 | | | | |
| Boomerang (MP24 PDM) | APR | 129.8 | Flow | 11/04/2013 | 8.6 | 262 | | | | | | | | | | |
| Boomerang (MP24 PDM) | APR | 129.8 | Flow | 11/04/2013 | 8.6 | 262 | | | | 7 | 20 | 80 | | | | |
| Boomerang (MP24 PDM) | MAR | 41.6 | Flow | 4/03/2013 | 8.2 | 129.7 | | | | | | | | | | |
| Boomerang (MP24 PDM) | MAR | 41.6 | Flow | 4/03/2013 | 8.2 | 130 | | | | 7 | 40 | 10 | | | | |
| Boomerang (MP24 PDM) | JAN | 274.2 | Flow | 28/01/2013 | 7.84 | 105 | | | | | | | | | | |
| Boomerang (MP24 PDM) | JAN | 274.2 | Flow | 27/01/2013 | 8.17 | 102 | | | | 8 | | | | | | |
| Boomerang (MP24 PDM) | JAN | 274.2 | Flow | 25/01/2013 | 6.8 | 78.4 | | | | 1 | | | | | | |
| Boomerang (MP24 PDM) | JAN | 274.2 | Flow | 25/01/2013 | 6.8 | 78.4 | | | | 1 | 50 | 940 | | | | |
| Boomerang (MP24 PDM) | JUL | 89.2 | Flow | 19/07/2012 | 8.04 | 154 | | | 7 | 1 | | | | | | |
| Boomerang (MP24 PDM) | JUL | 89.2 | Flow | 18/07/2012 | 7.86 | 127 | | | 10 | 1 | | | | | | |
| Boomerang (MP24 PDM) | JUL | 89.2 | Flow | 18/07/2012 | 6.86 | 124 | 132 | | 10 | 1 | 140 | 20 | | | | |
| Hughes (MP1 SRM) | DEC | 121.8 | Flow | 23/12/2020 | 7.5 | 100 | | 74.3 | 3700 | 3 | 10 | 400 | 4200 | 4600 | | 9.99 |
| Hughes (MP1 SRM) | DEC | 121.8 | Flow | 26/12/2020 | 6.9 | 115 | | 87.1 | 4320 | 4 | 30 | 240 | 6300 | 6500 | | 9.99 |
| Hughes (MP1 SRM) | JAN | 95.7 | Flow | 6/01/2021 | 7.37 | 271 | | | 1780 | 6 | 40 | 490 | 3200 | 3700 | 0 | 170 |
| Hughes (MP1 SRM) | MAR | 194.4 | Flow | 17/03/2021 | 7.02 | 99 | | 54 | 1410 | 3 | 60 | 940 | 3800 | 4700 | 0 | 9.99 |
| Hughes (MP1 SRM) | JUL | 95.7 | Flow | 13/01/2021 | 6.74 | 198 | | | 6 | 8 | 80 | 870 | 800 | 1700 | | 30 |
| Hughes (MP1 SRM) | MAR | 194.4 | Flow | 16/03/2021 | 7.25 | 118.4 | | 35.4 | 4700 | 2 | 70 | 300 | 9400 | 9700 | | 20 |
| Hughes (MP1 SRM) | MAR | 38 | Flow | 6/03/2020 | 8.49 | 124.5 | 2360 | | 1650 | 5 | 80 | 780 | 4300 | 5100 | 920 | |
| Hughes (MP1 SRM) | FEB | 138.2 | Flow | 27/02/2020 | 7 | 394.4 | 3120 | | 1940 | 4 | 20 | 10 | 5200 | 5600 | 1570 | |
| Hughes (MP1 SRM) | FEB | 138.2 | Flow | 8/02/2020 | 6.81 | 325 | 3300 | 72.9 | 2310 | 141 | | | | | | |
| Hughes (MP1 SRM) | JAN | 178.2 | Flow | 28/01/2020 | 6.62 | 189 | | 55.41 | | | | | | | | |
| Hughes (MP1 SRM) | APR | 42.2 | Flow | 1/04/2019 | 7.41 | 141.5 | 286 | 90.8 | 16 | 8 | 20 | 10 | 700 | 700 | 110 | |
| Hughes (MP1 SRM) | JAN | 109 | Flow | 10/01/2019 | 7.35 | 113.4 | | 104.3 | | 6 | | | | | | |
| Hughes (MP1 SRM) | OCT | 52 | Flow | 31/10/2018 | 6.41 | 736 | | 54.21 | | 6 | | | | | | |
| Hughes (MP1 SRM) | MAR | 15.2 | No Flow | 19/03/2018 | | | | | 28 | 5 | 376 | 2 | 1870 | 1870 | 51 | 10 |
| Hughes (MP1 SRM) | FEB | 200 | Flow | 27/02/2018 | 7.84 | 152 | | | | 6 | | | | | | |
| Hughes (MP1 SRM) | MAR | 306.2 | Flow | 31/03/2017 | 7.02 | 145 | | | | 13 | | | | | | |
| Hughes (MP1 SRM) | NOV | 99 | Flow | 4/11/2016 | 6.45 | 130 | | | | 12 | | | | | | |
| Hughes (MP1 SRM) | JUL | 130.8 | Flow | 16/07/2016 | 7.03 | 71 | | | | 8 | | | | | | |
| Hughes (MP1 SRM) | MAR | 77.6 | No Flow | 2/03/2016 | 7.17 | 392 | 12.3 | 31.3 | 47 | 86 | 13 | 390 | 100 | 980 | 43 | 1 |
| Hughes (MP1 SRM) | FEB | 142.8 | Flow | 9/02/2016 | 7.35 | 184 | | | | 11 | | | | | | |
| Hughes (MP1 SRM) | FEB | 142.8 | Flow | 4/02/2016 | 7.48 | 154 | | | | 9 | | | | | | |
| Hughes (MP1 SRM) | JAN | 113.4 | Flow | 27/01/2016 | 6.58 | 118.1 | | | | 4.99 | | | | | | |
| Hughes (MP1 SRM) | MAR | 41.6 | Flow | 20/03/2013 | 6.88 | 663 | 84 | | 13 | 20 | 4.99 | 4.99 | | | | |
| Hughes (MP1 SRM) | JAN | 274.2 | Flow | 25/01/2013 | 6.24 | 123.1 | 364 | | 1500 | 6 | | | | | | |
| One Mile (MP2 & MP6 SRM) | DEC | 121.8 | Flow | 23/12/2020 | 6.42 | 62 | | 53.5 | 471 | 1 | 9.99 | 610 | 2400 | 3000 | | 9.99 |
| One Mile (MP2 & MP6 SRM) | DEC | 121.8 | Flow | 26/12/2020 | 6.38 | 80 | | 76.1 | 106 | 4 | 110 | 600 | 2500 | 3100 | | 9.99 |
| One Mile (MP2 & MP6 SRM) | MAR | 194.4 | Flow | 17/03/2021 | 6.01 | 61.2 | | 17.1 | 28 | 2 | 50 | 790 | 1400 | 2200 | 0 | 9.99 |
| One Mile (MP2 & MP6 SRM) | JAN | 95.7 | Flow | 13/01/2021 | 6.43 | 164 | | | 4.99 | 9 | 40 | 690 | 800 | 1500 | | 9.99 |
| One Mile (MP2 & MP6 SRM) | MAR | 38 | Flow | 12/03/2020 | 7.69 | 177.8 | 35.9 | | 5 | 9 | 9.99 | 560 | 800 | 1400 | 60 | |
| One Mile (MP2 & MP6 SRM) | MAR | 38 | Flow | 6/03/2020 | 8.05 | 136.9 | 179 | | 105 | 5 | 80 | 2280 | 1700 | 4000 | 130 | |
| One Mile (MP2 & MP6 SRM) | FEB | 138.2 | Flow | 27/02/2020 | 6.7 | 450 | 163 | | 46 | 6 | 40 | | 1300 | 3300 | 280 | |
| One Mile (MP2 & MP6 SRM) | JAN | 178.2 | Flow | 28/01/2020 | 6.94 | 362 | | 60.6 | | | | | | | | |
| One Mile (MP2 & MP6 SRM) | APR | 42.2 | No Flow | 30/04/2019 | 6.66 | 151.6286 | 59.22 | 45.68571 | 6 | 4 | 145 | 1.99 | 450 | 450 | 4.99 | 0.99 |
| One Mile (MP2 & MP6 SRM) | APR | 42.2 | Flow | 1/04/2019 | 6.29 | 98.3 | 233 | 61 | 31 | 8 | 60 | 90 | 1200 | 1300 | 120 | |
| One Mile (MP2 & MP6 SRM) | MAR | 209.4 | Flow | 19/03/2019 | 6.53 | 115.72 | 779.656 | 3.9 | 92 | 5 | 20 | 1.99 | 1090 | 1090 | 443 | 1 |
| One Mile (MP2 & MP6 SRM) | JAN | 109 | Flow | 10/01/2019 | 6.21 | 81.3 | | 84 | | 6 | | | | | | |
| One Mile (MP2 & MP6 SRM) | FEB | 200 | Flow | 27/02/2018 | 6.86 | 132 | | | | 9 | | | | | | |
| One Mile (MP2 & MP6 SRM) | MAR | 306.2 | Flow | 31/03/2017 | 5.95 | 100 | | | | 8 | | | | | | |
| One Mile (MP2 & MP6 SRM) | FEB | 80.8 | Flow | 20/02/2013 | 6.95 | 491 | 79.6 | | 28 | 17 | 45 | 64 | | | | |
| Spring (MP4 SRM) | DEC | 121.8 | Flow | 26/12/2020 | 7.2 | 451 | | 39.8 | 387 | 80 | 80 | 20 | 4800 | 4800 | | 9.99 |
| Spring (MP4 SRM) | MAR | 194.4 | Flow | 17/03/2021 | 6.92 | 471.9 | | 16.3 | 226 | 78 | 390 | 180 | 1600 | 1800 | 0 | 9.99 |
| Spring (MP4 SRM) | MAR | 38 | Flow | 17/03/2020 | 7.8 | 463.4 | 22.4 | 103.9 | 10 | 14 | | | 800 | 800 | 40 | |
| Spring (MP4 SRM) | FEB | 138.2 | Flow | 28/02/2020 | 6.68 | 519.8 | 550 | | 53 | 9 | 40 | 10 | 1400 | 1800 | 280 | |
| Spring (MP4 SRM) | APR | 42.2 | Flow | 1/04/2019 | 7.37 | 181.6 | 609 | 72.3 | 73 | 24 | 10 | 10 | 1500 | 1500 | 320 | |
| Spring (MP4 SRM) | JAN | 109 | Flow | 10/01/2019 | 7.82 | 162.1 | | 91.6 | | 9 | | | | | | |

| Site | Month | Rainfal in mm | Flow | Date | Al | As | Cr | Cu | Fe | Mo | Ni | Se | U | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boomerang (MP24 PDM) | JUL | 56.4 | Flow | 3/07/2021 | 470 | 0.99 | 0.99 | 1 | 360 | 0.99 | 1 | 9.99 | 0.99 | 5 |
| Boomerang (MP24 PDM) | JAN | 95.7 | Flow | 6/01/2021 | 60 | 0.99 | 0.99 | 0.99 | 100 | 0.99 | 1 | 9.99 | 0.99 | 4.99 |
| Boomerang (MP24 PDM) | MAR | 194.4 | Flow | 17/03/2021 | 870 | 0.99 | 0.99 | 0.99 | 780 | 0.99 | 2 | 9.99 | 0.99 | 4.99 |
| Boomerang (MP24 PDM) | MAR | 194.4 | Flow | 18/03/2021 | 0.99 | 1 | 0.99 | 2 | 50 | 3 | 3 | 9.99 | 0.99 | 4.99 |
| Boomerang (MP24 PDM) | MAR | 306.2 | Flow | 30/03/2017 | 430 | | 1 | 1 | 260 | | 2 | 10 | 1 | 5 |
| Boomerang (MP24 PDM) | NOV | 99 | Flow | 4/11/2016 | | | | | | | | | | |
| Boomerang (MP24 PDM) | NOV | 99 | Flow | 4/11/2016 | 830 | 1 | 1 | 3 | 600 | 1 | 1 | 10 | 1 | 5 |
| Boomerang (MP24 PDM) | JUL | 130.8 | Flow | 18/07/2016 | | | | | | | | | | |
| Boomerang (MP24 PDM) | JUL | 130.8 | Flow | 18/07/2016 | 1370 | 1 | 1 | 1 | 660 | 1 | 1 | 10 | 1 | 5 |
| Boomerang (MP24 PDM) | JUL | 130.8 | Flow | 16/07/2016 | | | | | | | | | | |
| Boomerang (MP24 PDM) | JUL | 130.8 | Flow | 16/07/2016 | 1050 | 1 | 1 | 1 | 540 | 1 | 1 | 10 | 1 | 5 |
| Boomerang (MP24 PDM) | FEB | 142.8 | Flow | 8/02/2016 | | | | | | | | | | |
| Boomerang (MP24 PDM) | JAN | 113.4 | Flow | 30/01/2016 | | | | | | | | | | |
| Boomerang (MP24 PDM) | JAN | 113.4 | Flow | 26/01/2016 | | | | | | | | | | |
| Boomerang (MP24 PDM) | JAN | 149.2 | Flow | 22/01/2015 | 990 | 1 | 1 | 1 | 580 | 1 | 1 | 10 | 1 | 5 |
| Boomerang (MP24 PDM) | DEC | 232.2 | Flow | 13/12/2014 | 600 | 1 | 1 | 1 | 430 | 1 | 2 | 10 | 1 | 5 |
| Boomerang (MP24 PDM) | JAN | 144.2 | Flow | 17/01/2014 | 600 | 1 | 1 | 1 | 380 | 1 | 3 | 10 | 1 | 5 |
| Boomerang (MP24 PDM) | APR | 129.8 | Flow | 11/04/2013 | | | | | | | | | | |
| Boomerang (MP24 PDM) | APR | 129.8 | Flow | 11/04/2013 | 320 | | | 2 | 270 | | 1 | 10 | 1 | 5 |
| Boomerang (MP24 PDM) | MAR | 41.6 | Flow | 4/03/2013 | | | | | | | | | | |
| Boomerang (MP24 PDM) | MAR | 41.6 | Flow | 4/03/2013 | 650 | | | 1 | 400 | | 1 | 10 | 1 | 16 |
| Boomerang (MP24 PDM) | JAN | 274.2 | Flow | 28/01/2013 | | | | | | | | | | |
| Boomerang (MP24 PDM) | JAN | 274.2 | Flow | 27/01/2013 | | | | | | | | | | |
| Boomerang (MP24 PDM) | JAN | 274.2 | Flow | 25/01/2013 | | | | | | | | | | |
| Boomerang (MP24 PDM) | JAN | 274.2 | Flow | 25/01/2013 | 180 | | | 2 | 160 | | 2 | 10 | 1 | 5 |
| Boomerang (MP24 PDM) | JUL | 89.2 | Flow | 19/07/2012 | | | | | | | | | | |
| Boomerang (MP24 PDM) | JUL | 89.2 | Flow | 18/07/2012 | | | | | | | | | | |
| Boomerang (MP24 PDM) | JUL | 89.2 | Flow | 18/07/2012 | 120 | | | 1 | 130 | | 1 | 10 | 1 | 5 |
| Hughes (MP1 SRM) | DEC | 121.8 | Flow | 23/12/2020 | 80 | 0.99 | 2 | 2 | 80 | 0.99 | 0.99 | 10 | 0.99 | 4.99 |
| Hughes (MP1 SRM) | DEC | 121.8 | Flow | 26/12/2020 | 900 | 0.99 | 0.99 | 1 | 1080 | 0.99 | 1 | 10 | 0.99 | 4.99 |
| Hughes (MP1 SRM) | JAN | 95.7 | Flow | 6/01/2021 | 20 | 0.99 | 0.99 | 2 | 60 | 0.99 | 0.99 | 10 | 0.99 | 4.99 |
| Hughes (MP1 SRM) | MAR | 194.4 | Flow | 17/03/2021 | 100 | 0.99 | 0.99 | 1 | 320 | 0.99 | 2 | 10 | 0.99 | 4.99 |
| Hughes (MP1 SRM) | JUL | 95.7 | Flow | 13/01/2021 | 9.99 | 0.99 | 0.99 | 0.99 | 80 | 0.99 | 1 | 10 | 0.99 | 4.99 |
| Hughes (MP1 SRM) | MAR | 194.4 | Flow | 16/03/2021 | 80 | 0.99 | 0.99 | 1 | 170 | 0.99 | 2 | 10 | 0.99 | 4.99 |
| Hughes (MP1 SRM) | MAR | 38 | Flow | 6/03/2020 | 9.99 | 0.99 | 0.99 | 1 | 50 | 0.99 | 1 | 10 | 0.99 | 4.99 |
| Hughes (MP1 SRM) | FEB | 138.2 | Flow | 27/02/2020 | 9.99 | 0.99 | 0.99 | 0.99 | 50 | 0.99 | 2 | 10 | 0.99 | 4.99 |
| Hughes (MP1 SRM) | FEB | 138.2 | Flow | 8/02/2020 | 20 | | 0.99 | 0.99 | 70 | | | | 0.99 | 4.99 |
| Hughes (MP1 SRM) | JAN | 178.2 | Flow | 28/01/2020 | | | | | | | | | | |
| Hughes (MP1 SRM) | APR | 42.2 | Flow | 1/04/2019 | 1880 | 0.99 | 1 | 2 | 1360 | 0.99 | 2 | 10 | 0.99 | 4.99 |
| Hughes (MP1 SRM) | JAN | 109 | Flow | 10/01/2019 | 1610 | | 0.99 | 2 | 880 | | | | 0.99 | 4.99 |
| Hughes (MP1 SRM) | OCT | 52 | Flow | 31/10/2018 | 790 | | 0.99 | 1 | 480 | | | | 0.99 | 4.99 |
| Hughes (MP1 SRM) | MAR | 15.2 | No Flow | 19/03/2018 | 9.99 | 5 | 0.99 | 0.99 | 90 | 0.99 | 4 | 10 | 1 | 13 |
| Hughes (MP1 SRM) | FEB | 200 | Flow | 27/02/2018 | 260 | | 0.99 | 0.99 | 370 | | | | 0.99 | 4.99 |
| Hughes (MP1 SRM) | MAR | 306.2 | Flow | 31/03/2017 | 680 | | 0.99 | 1 | 600 | | | | 0.99 | 4.99 |
| Hughes (MP1 SRM) | NOV | 99 | Flow | 4/11/2016 | 480 | | 0.99 | 2 | 360 | | | | 0.99 | 4.99 |
| Hughes (MP1 SRM) | JUL | 130.8 | Flow | 16/07/2016 | 800 | | 0.99 | 0.99 | 530 | | | | 0.99 | 4.99 |
| Hughes (MP1 SRM) | MAR | 77.6 | No Flow | 2/03/2016 | 9.99 | 0.99 | 0.99 | 2 | 50 | 1 | 5 | 10 | 4 | 4.99 |
| Hughes (MP1 SRM) | FEB | 142.8 | Flow | 9/02/2016 | 670 | | 0.99 | 2 | 370 | | | | 0.99 | 50 |
| Hughes (MP1 SRM) | FEB | 142.8 | Flow | 4/02/2016 | 150 | | 0.99 | 0.99 | 160 | | | | 0.99 | 4.99 |
| Hughes (MP1 SRM) | JAN | 113.4 | Flow | 27/01/2016 | 180 | | 0.99 | 2 | 180 | | | | 0.99 | 4.99 |
| Hughes (MP1 SRM) | MAR | 41.6 | Flow | 20/03/2013 | 9.99 | 0.99 | 0.99 | 0.99 | 32 | 0.99 | 0.99 | 1 | 0.49 | 0.99 |
| Hughes (MP1 SRM) | JAN | 274.2 | Flow | 25/01/2013 | 670 | | 0.99 | 2 | 700 | | | | 0.49 | 0.99 |
| One Mile (MP2 & MP6 SRM) | DEC | 121.8 | Flow | 23/12/2020 | 330 | 0.99 | 1 | 2 | 250 | 0.99 | 2 | 9.99 | 0.99 | 4.99 |
| One Mile (MP2 & MP6 SRM) | DEC | 121.8 | Flow | 26/12/2020 | 940 | 0.99 | 0.99 | 1 | 800 | 0.99 | 2 | 9.99 | 0.99 | 4.99 |
| One Mile (MP2 & MP6 SRM) | MAR | 194.4 | Flow | 17/03/2021 | 750 | 0.99 | 0.99 | 1 | 660 | 0.99 | 2 | 9.99 | 0.99 | 4.99 |
| One Mile (MP2 & MP6 SRM) | JAN | 95.7 | Flow | 13/01/2021 | 40 | 0.99 | 0.99 | 0.99 | 120 | 0.99 | 2 | 9.99 | 0.99 | 4.99 |
| One Mile (MP2 & MP6 SRM) | MAR | 38 | Flow | 12/03/2020 | 30 | 0.99 | 0.99 | 0.99 | 100 | 0.99 | 2 | 9.99 | 0.99 | 4.99 |
| One Mile (MP2 & MP6 SRM) | MAR | 38 | Flow | 6/03/2020 | 120 | 0.99 | 0.99 | 1 | 260 | 0.99 | 2 | 9.99 | 0.99 | 4.99 |
| One Mile (MP2 & MP6 SRM) | FEB | 138.2 | Flow | 27/02/2020 | 60 | 0.99 | 0.99 | 1 | 210 | 0.99 | 3 | 9.99 | 0.99 | 4.99 |
| One Mile (MP2 & MP6 SRM) | JAN | 178.2 | Flow | 28/01/2020 | | | | | | | | | | |
| One Mile (MP2 & MP6 SRM) | APR | 42.2 | No Flow | 30/04/2019 | 1490 | 2 | 1 | 0.99 | 3390 | 0.99 | 2 | 9.99 | 0.99 | 4.99 |
| One Mile (MP2 & MP6 SRM) | APR | 42.2 | Flow | 1/04/2019 | 4010 | 1 | 2 | 2 | 2360 | 0.99 | 3 | 9.99 | 0.99 | 4.99 |
| One Mile (MP2 & MP6 SRM) | MAR | 209.4 | Flow | 19/03/2019 | 3000 | 1 | 2 | 3 | 1570 | 0.99 | 3 | 9.99 | 0.99 | 4.99 |
| One Mile (MP2 & MP6 SRM) | JAN | 109 | Flow | 10/01/2019 | 1900 | | 0.99 | 2 | 970 | | | | 0.99 | 4.99 |
| One Mile (MP2 & MP6 SRM) | FEB | 200 | Flow | 27/02/2018 | 1460 | | 0.99 | 1 | 810 | | | | 0.99 | 6 |
| One Mile (MP2 & MP6 SRM) | MAR | 306.2 | Flow | 31/03/2017 | 1330 | | 1 | 1 | 760 | | | | 0.99 | 4.99 |
| One Mile (MP2 & MP6 SRM) | FEB | 80.8 | Flow | 20/02/2013 | 9.99 | 1 | 0.99 | 0.99 | 800 | 0.99 | 0.99 | 0.99 | 0.49 | 0.99 |
| Spring (MP4 SRM) | DEC | 121.8 | Flow | 26/12/2020 | 9.99 | 0.99 | 0.99 | 1 | 60 | 0.99 | 3 | 9.99 | 0.99 | 4.99 |
| Spring (MP4 SRM) | MAR | 194.4 | Flow | 17/03/2021 | 9.99 | 0.99 | 0.99 | 1 | 49.99 | 1 | 2 | 9.99 | 0.99 | 4.99 |
| Spring (MP4 SRM) | MAR | 38 | Flow | 17/03/2020 | 30 | 2 | 0.99 | 2 | 110 | 0.99 | 4 | 9.99 | 0.99 | 4.99 |
| Spring (MP4 SRM) | FEB | 138.2 | Flow | 28/02/2020 | 9.99 | 0.99 | 0.99 | 0.99 | 49.99 | 0.99 | 2 | 9.99 | 0.99 | 4.99 |
| Spring (MP4 SRM) | APR | 42.2 | Flow | 1/04/2019 | 1550 | 0.99 | 0.99 | 2 | 1290 | 0.99 | 3 | 9.99 | 0.99 | 4.99 |
| Spring (MP4 SRM) | JAN | 109 | Flow | 10/01/2019 | 1300 | | 0.99 | 2 | 790 | | | | 0.99 | 4.99 |

**Table 17 Descriptive values and percentiles for water courses in the Boomerang – Hughes Creek Catchment**

| Percentiles | pH | EC | Turbidity | DO% | SS | SO4 | Ammonia | Nitrate | Total Kjeld | Total Nitro | Total Phospho | Reactive Phos | Al | As | Cr | Cu | Fe | Mo | Ni | Se | U | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **20th** | 6.53 | 98.3 | 103.2 | 37.16 | 14.2 | 4 | 20 | 10 | 800 | 1320 | 2.994 | 2.798 | 20 | 0.99 | 0.99 | 0.99 | 84 | 0.99 | 1 | 9.99 | 0.99 | 4.99 |
| **30th** | 6.69 | 109.2 | 175.4 | 50.374284 | 29.8 | 4.992 | 23 | 80 | 1178 | 1500 | 41.2 | 9.99 | 62 | 0.99 | 0.99 | 1 | 133 | 0.99 | 1 | 9.99 | 0.99 | 4.99 |
| **40th** | 6.86 | 123.1 | 261 | 54.168 | 69 | 6 | 40 | 240 | 1400 | 1800 | 52.8 | 9.99 | 144 | 0.99 | 0.99 | 1 | 242 | 0.99 | 2 | 9.99 | 0.99 | 4.99 |
| **Median** | 6.975 | 131 | 329 | 60.6 | 92 | 6 | 50 | 330 | 1600 | 2200 | 110 | 9.99 | 380 | 0.99 | 0.99 | 1 | 360 | 0.99 | 2 | 10 | 0.99 | 4.99 |
| **60th** | 7.25 | 153.08 | 400.6 | 72.42 | 186.8 | 7.4 | 60 | 413 | 2188 | 3220 | 128 | 9.99 | 654 | 0.99 | 0.99 | 1 | 440 | 0.99 | 2 | 10 | 0.99 | 4.99 |
| **80th** | 7.82 | 271 | 1620 | 85.86 | 1390 | 10 | 110 | 790 | 4120 | 4680 | 369.2 | 9.998 | 1026 | 1 | 1 | 2 | 786 | 1 | 3 | 10 | 1 | 5 |
| **95th** | 8.4175 | 486.225 | 5822 | 102.67 | 3561 | 69.2 | 144.75 | 940 | 5970 | 6230 | 985 | 58 | 1883 | 2 | 1.35 | 2 | 1391.5 | 1 | 3.9 | 10 | 1 | 7.05 |
| **Standard Error** | 0.086952 | 18.69376 | 358.5455 | 5.668987225 | 176.8101 | 2.85424 | 12.465866 | 87.23565 | 403.065 | 405.1018 | 88.46978586 | 9.306636116 | 101.6244 | 0.108925 | 0.031421 | 0.07268 | 76.75825 | 0.052142 | 0.147053 | 0.289045 | 0.053879 | 0.810821 |
| | | | | | | | | | | | | | | | | | | | | | | |
| **20th Boomerang** | 6.684 | 78.4 | 268 | #NUM! | 36 | 1.2 | 20 | 192 | 3100 | 3500 | 510 | 0.99 | 168 | 0.99 | 0.99 | 1 | 154 | 0.99 | 1 | 9.99 | 0.99 | 4.998 |
| **20th Hughes** | 6.668 | 116.24 | 124.4 | 50.28 | 23.2 | 4.396 | 14.4 | 10 | 800 | 1700 | 8.6 | 9.99 | 9.99 | 0.99 | 0.99 | 0.99 | 64 | 0.99 | 0.992 | 10 | 0.99 | 4.99 |
| **20th One Mile** | 6.274 | 81.04 | 63.296 | 28.534284 | 6 | 4 | 20 | 51.598 | 800 | 1258 | 15.992 | 1 | 52 | 0.99 | 0.99 | 0.99 | 234 | 0.99 | 2 | 9.99 | 0.99 | 4.99 |
| **20th Spring** | 6.92 | 181.6 | 233.44 | 35.1 | 44.4 | 9 | 28 | 10 | 1280 | 1360 | 24 | 9.99 | 9.99 | 0.99 | 0.99 | 1 | 49.99 | 0.99 | 2 | 9.99 | 0.99 | 4.99 |
| **30th Boomerang** | 6.8 | 79.62 | 322 | #NUM! | 81 | 4 | 42 | 252 | 3100 | 3500 | 510 | 0.99 | 342 | 0.997 | 0.99 | 1 | 262 | 0.997 | 1 | 10 | 1 | 5 |
| **30th Hughes** | 6.852 | 121.22 | 245.6 | 54.147 | 45.1 | 5 | 20 | 79 | 1870 | 1870 | 34.4 | 9.99 | 20 | 0.99 | 0.99 | 0.99 | 80 | 0.99 | 1 | 10 | 0.99 | 4.99 |
| **30th One Mile** | 6.388 | 98.64 | 75.524 | 46.467139 | 28 | 4.9 | 40 | 82.2 | 1003 | 1370 | 48.998 | 5.495 | 114 | 0.99 | 0.99 | 0.999 | 259 | 0.99 | 2 | 9.99 | 0.99 | 4.99 |
| **30th Spring** | 7.06 | 316.3 | 338.96 | 46.3 | 57 | 11.5 | 37 | 10 | 1420 | 1560 | 36 | 9.99 | 9.99 | 0.99 | 0.99 | 1 | 54.995 | 0.99 | 2.2 | 9.99 | 0.99 | 4.99 |
| **40th Boomerang** | 7.044 | 100.8 | 336 | #NUM! | 87.4 | 4 | 50 | 318 | 3100 | 3500 | 510 | 0.99 | 454 | 1 | 1 | 1 | 324 | 1 | 1 | 10 | 1 | 5 |
| **40th Hughes** | 6.98 | 128.9 | 317.2 | 54.93 | 1428 | 6 | 24 | 264 | 3200 | 3700 | 46.2 | 9.99 | 80 | 0.99 | 0.99 | 1 | 146 | 0.99 | 1 | 10 | 0.99 | 4.99 |
| **40th One Mile** | 6.426 | 109.432 | 112.96 | 51.937142 | 28 | 5.2 | 40 | 372 | 1156 | 1460 | 84 | 9.99 | 414 | 0.99 | 0.99 | 1 | 680 | 0.99 | 2 | 9.99 | 0.99 | 4.99 |
| **40th Spring** | 7.2 | 451 | 444.48 | 59.3 | 65 | 14 | 48 | 12 | 1460 | 1680 | 88 | 9.99 | 9.99 | 0.99 | 0.99 | 1 | 60 | 0.99 | 2.6 | 9.99 | 0.99 | 4.99 |
| **80th Boomerang** | 8.194 | 153.816 | 1980 | #NUM! | 830.8 | 7 | 130 | 886 | 3100 | 3500 | 510 | 0.99 | 894 | 1 | 1 | 2 | 584 | 1 | 2 | 10 | 1 | 5 |
| **80th Hughes** | 7.394 | 303.4 | 2968 | 87.84 | 2866 | 11.6 | 78 | 722 | 5200 | 5600 | 758 | 26 | 746 | 0.99 | 0.99 | 2 | 572 | 0.99 | 2 | 10 | 0.99 | 4.99 |
| **80th One Mile** | 6.942 | 214.64 | 222.2 | 70.06 | 105 | 9 | 80 | 710 | 1840 | 3140 | 250 | 9.99 | 1654 | 1 | 1 | 2 | 1210 | 0.99 | 3 | 9.99 | 0.99 | 4.99 |
| **80th Spring** | 7.8 | 471.9 | 585.4 | 94.06 | 258.2 | 78 | 204 | 84 | 2240 | 2400 | 296 | 9.99 | 1300 | 1.192 | 0.99 | 2 | 790 | 0.992 | 3.2 | 9.99 | 0.99 | 4.99 |
| **95th Boomerang** | 8.5995 | 262 | 7185 | #NUM! | 1264 | 10 | 140 | 1468 | 3100 | 3500 | 510 | 0.99 | 1146 | 1 | 1 | 2.3 | 696 | 2.1 | 3 | 10 | 1 | 8.3 |
| **95th Hughes** | 7.806 | 636.14 | 3246 | 98.225 | 4453 | 79.4 | 213.2 | 901.5 | 7850 | 8100 | 1375 | 121 | 1539 | 2.7945 | 0.999 | 2 | 1060 | 0.9945 | 4.45 | 10 | 0.999 | 12.199 |
| **95th One Mile** | 7.798 | 462.3 | 615.6592 | 81.235 | 288.5 | 11.8 | 127.5 | 1609.5 | 2455 | 3685 | 394.1 | 9.99 | 3353.5 | 1.5 | 2 | 2.35 | 2720.5 | 0.99 | 3 | 9.99 | 0.99 | 5.3435 |
| **95th Spring** | 7.815 | 507.825 | 603.1 | 101.44 | 354.8 | 79.5 | 343.5 | 156 | 4160 | 4200 | 314 | 9.99 | 1487.5 | 1.798 | 0.99 | 2 | 1165 | 0.998 | 3.8 | 9.99 | 0.99 | 4.99 |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| **20th of 20th** | 6.5104 | | | | | | | | | | | | | | | | | | | | | |
| **30th of 30th** | | 96.738 | | | 43.39 | 4.81 | | | | | | | | | 0.99 | | 77.4995 | | 1 | 9.99 | 0.99 | 4.99 |
| **40th of 40th** | | 113.3256 | | | 69.48 | 5.36 | | | | | | | | | 0.99 | | 181.6 | 0.99 | 1.2 | 9.992 | 0.99 | 4.99 |
| **80th of 80th** | 7.9576 | 370.8 | 2375.2 | #NUM! | 1644.88 | 38.16 | 159.6 | 787.6 | 3940 | 4340 | 609.2 | 16.394 | 1441.6 | 1.0768 | 1 | 2 | 958 | 0.9952 | 3.08 | 10 | 0.994 | 4.994 |
| **95th of 95th** | 8.481825 | 616.8928 | 6594.15 | #NUM! | 3974.65 | 79.485 | 323.955 | 1588.275 | 7296.5 | 7515 | 1245.25 | 104.3485 | 3081.325 | 2.645025 | 1.85 | 2.3425 | 2487.175 | 1.9347 | 4.3525 | 10 | 0.99985 | 11.61415 |
| **Count total** | 66 | 66 | 28 | 23 | 43 | 65 | 42 | 41 | 27 | 27 | 19 | 17 | 58 | 38 | 54 | 58 | 58 | 38 | 43 | 43 | 58 | 58 |
| **CountBoomerang** | 22 | 22 | 11 | 0 | 13 | 22 | 15 | 15 | 1 | 1 | 1 | 1 | 15 | 10 | 11 | 15 | 15 | 10 | 15 | 15 | 15 | 15 |
| **Count Hughes** | 23 | 23 | 7 | 10 | 14 | 23 | 12 | 12 | 11 | 11 | 7 | 8 | 23 | 12 | 23 | 23 | 23 | 12 | 12 | 12 | 23 | 23 |
| **Count One mile** | 15 | 15 | 7 | 8 | 11 | 14 | 11 | 10 | 10 | 10 | 7 | 6 | 14 | 11 | 14 | 14 | 14 | 11 | 11 | 11 | 14 | 14 |
| **Count Spring** | 6 | 6 | 3 | 5 | 5 | 6 | 4 | 4 | 5 | 5 | 4 | 2 | 6 | 5 | 6 | 6 | 6 | 5 | 5 | 5 | 6 | 6 |

## Sampling size

Referring to *Table 4.4.2* in the QLD WQ GL 2009, if 3 or more reference sites are available, 12 or more data samples need to be presented in a minimum time period of 12 month (preferably 24 month). And a minimum interim dataset can be developed with as little as 8 samples per site. None of the sampling sites can offer the required number of sampling size for all parameters. The tables below (Table 18, Table 19) show sample sizes for used sites, with green highlighted values indicating values in the range of an interim dataset and red numbers representing insufficient data according to the guidelines. However, considering the total number of samples, the data set is sufficient to derive statistically valid and robust objectives. Samples have been taken over a period of ten years and variability of flow regimes, seasonality as well as difference between reference sites have been taken into account. In summary, this allowed us to generate Sub-regional WQO reflecting the general conditions of the catchment, even though sample sizes of some parameters and sites are under the recommended amount of data.

**Table 18 Upstream data (yellow triangles) number of samples for development of sub-regional WQOs**

| | pH | EC | Turbidity | DO% | SS | $SO_4$ | Ammonia | Nitrate | Total Kjeldahl Nitrogen as N | Total Nitrogen as N | Total Phosphorus as P | Reactive Phosphorus as P | Al | As | Cr | Cu | Fe | Mo | Ni | Se | U | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Count total | 66 | 66 | 28 | 23 | 43 | 65 | 42 | 41 | 27 | 27 | 19 | 17 | 58 | 38 | 54 | 58 | 58 | 38 | 43 | 43 | 58 | 58 |
| Count Boomerang | 22 | 22 | 11 | 0 | 13 | 22 | 15 | 15 | 1 | 1 | 1 | 1 | 15 | 10 | 11 | 15 | 15 | 10 | 15 | 15 | 15 | 15 |
| Count Hughes | 23 | 23 | 7 | 10 | 14 | 23 | 12 | 12 | 11 | 11 | 7 | 8 | 23 | 12 | 23 | 23 | 23 | 12 | 12 | 12 | 23 | 23 |
| Count One Mile | 15 | 15 | 7 | 8 | 11 | 14 | 11 | 10 | 10 | 10 | 7 | 6 | 14 | 11 | 14 | 14 | 14 | 11 | 11 | 11 | 14 | 14 |
| Spring | 6 | 6 | 3 | 5 | 5 | 6 | 4 | 4 | 5 | 5 | 4 | 2 | 6 | 5 | 6 | 6 | 6 | 5 | 5 | 5 | 6 | 6 |

Green highlighted values mark sample sizes qualifying for interim data set, red numbers highlight insufficient sample sizes between July 2012 and July 2021.

**Table 19 Environmental background data (thin black triangles) number of samples for comparison**

| | pH | EC | Turbidity | DO% | SS | $SO_4$ | Ammonia | Nitrate | Total Kjeldahl Nitrogen as N | Total Nitrogen as N | Total Phosphorus as P | Reactive Phosphorus as P | Al | As | Cr | Cu | Fe | Mo | Ni | Se | U | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Count total | 63 | 64 | 30 | 22 | 39 | 60 | 36 | 36 | 23 | 24 | 17 | 16 | 53 | 33 | 49 | 52 | 53 | 32 | 37 | 38 | 53 | 53 |
| Count Phillips | 28 | 28 | 11 | 9 | 13 | 23 | 9 | 9 | 9 | 9 | 6 | 6 | 23 | 10 | 23 | 23 | 23 | 9 | 10 | 10 | 23 | 23 |
| Count Spring | 11 | 12 | 5 | 9 | 9 | 11 | 8 | 8 | 9 | 9 | 5 | 6 | 11 | 9 | 11 | 11 | 11 | 9 | 9 | 9 | 11 | 11 |
| Count Isaac | 24 | 24 | 14 | 4 | 17 | 26 | 19 | 19 | 5 | 6 | 6 | 4 | 19 | 14 | 15 | 18 | 19 | 14 | 18 | 19 | 19 | 19 |

Green highlighted values mark sample sizes qualifying for interim data set, red numbers highlight insufficient sample sizes between July 2012 and July 2021.

# Appendix B

## Methodology for development of sub-regional WQOs

To derive WQOs for this sub-regional catchment, parameters and monitoring locations were chosen in accordance with *Deriving site-specific guideline values for physico-chemical parameters and toxicants* (Huynh & Hobbs 2019), Section 4 in the *Queensland Water Quality Guidelines 2009 (DEHP* 2009*)* and the combined guidelines of *Qld Deciding aquatic ecosystem indicators and local water quality guideline values 2022* and *Environmental Protection Policy 2019* (DES, 2022). Sites would meet the criteria for undisturbed reference sites as outlined in *DEHP* (2009) *Table 4.4.1,* namely:

- No intensive agriculture with 20 km upstream
- No major extractive industry within 20 km upstream
- No major urban area within 20 km upstream
- No significant point source wastewater within 20 km upstream
- Seasonal flow regime not greatly altered. This may be by abstraction or regulation further upstream than 20 km.
- However, due to impact from livestock and grazing upstream (Aerial/Satellite Images on QGlobe (Queensland Government 2022, and Hydraulics, Hydrology and Geomorphology Technical Report, Alluvium (2022)), the more conservative classification of moderately disturbed waters was adopted as described in DES (2022) *section 5.2.4*. This classification also aligns with the Queensland Government data layers available on QGlobe (Queensland Government 2022), which classify these streams as moderately disturbed. The locations used to develop the sub-regional WQOs are shown in Figure 5.

Therefore, sub-regional WQOs were developed based on the rules for 'best available reference sites of moderately disturbed waters as outlined in DES (2022) *section 5* as follows:

The 40$^{th}$ percentile of the dataset for each parameter (excepting 20$^{th}$ and 80$^{th}$ percentile for pH and dissolved oxygen (DO)) was used to develop sub-regional WQOs for best available reference sites as outlined in DES (2022) *section 5.2.1.1.*

When data between different sites was highly variable and showed statistically significant differences, the 40$^{th}$ percentile of the 40$^{th}$ percentile of all watercourses was selected as the WQO

For pH and DO the 20$^{th}$ percentile of the 20$^{th}$ percentile and 80$^{th}$ percentile of the 80$^{th}$ percentile were used as outlined in DEHP (2009) *section 4.3.5*

Dissolved metals (toxins) were assessed against *ANZG 2018* WQOs for slightly to moderately disturbed fresh waters (protection level 95%). Where values exceeded the *ANZG 2018* default guideline values, the 40$^{th}$ percentile or the 40$^{th}$ percentile of the 40$^{th}$ percentile was applied (Q*WQG 2022 sections 5.1.2 & 5.2.1.1, QWQL 2009 section 4.3.5*)

Tables presenting the workings are displayed in Appendix B.

Variations in seasonality and flow regimes were taken into account. Whenever, a parameter displayed a statistically significant difference between low flow (LF) and high flow (HF), data sets were split and the 30$^{th}$ percentile was applied to HF data whilst the 40$^{th}$ percentile was used for LF conditions (DES, 2022*; Appendix 1)*. The threshold value differentiating high flow and low flow conditions was calculated at 1.46m$^3$/s (cumecs). Details regarding flow regime differentiation are presented in detail in section 4.6.1 of this report. Tables 15 and 16 exhibiting the development of sub-regional WQOs for the Boomerang – Hughes Creek Catchment.

| Physico-chemical Parameters | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Analyte** | **EPP 2019 GLV** | **20th%** | **40th%** | **Median** | **80th%** | **20th% of 20th%** | **40th% of 40th%** | **80th% of 80th%** | **SE** | **Proposed** | **Explanation** |
| **pH** | 6.5-8.5 | 6.53 | 6.86 | 6.975 | 7.82 | **6.51** | | **7.96** | 0.09 | **6.5-8** | 20th%ile of 20th%ile within GLV +/- 2SE, 80th%ile of 80th%ile < GLV – 2SE |
| **EC** (µS/cm) | **720** | 98.3 | 123.1 | 131 | 271 | | **118.36** | | 98.3 | **720** | 40th%ile of 40%ile < GLV - 2SE but due to varied catchment activity and highly variable data, default guideline retained |
| **Turbidity** (NTU) | **50** | 103.2 | 79,6 40th% LF or 311 30th% HF | 329 | 1620 | | | | 77.5 LF / 560 HF | **50** | LF & HF within GLV +/- 1SE |
| **DO%** | 85-110 | **37.16** | 54.168 | 60.6 | **85.86** | | | | 5.67 | **37-86** | 20th%ile < GLV - 1SE, 80th%ile < GLV - 1SE |
| **TSS** (mg/L) | **55** | 14.2 | 69 | 92 | 1390 | | 43.39 / 44.68 | | 36.4 LF / 255 HF | **55.00** | LF & HF within GLV +/- 2SE |
| $SO_4$ (mg/L) | **25** | 4 | 6 | 6 | 10 | | **5.28** | | 2.85 | **25** | 40th%ile of 40%ile < GLV - 2SE but due to varied catchment activity and highly variable data, default guideline retained |
| **Ammonia** (µg/L) | 20 | 20 | **40** | 50 | 110 | | | | 12.47 | **40.00** | 40%ile > GLV + 1SE |
| **Nitrate** (µg/L) | **60** | 10 | 12 40th% LF or **288 30th% HF** | 330 | 790 | | | | 65.5 LF / 121 HF | **60 LF / 288 HF** | LF within GLV +/- 1SE<br>HF > GVL + 1SE |
| **Total Kjeldahl Nitrogen as N** (µg/L) | 420 | 800 | **916 40th% LF or 1440 30th% High HF** | 1600 | 4120 | | | | 367 LF / 621 HF | **916 LF 1440 HF** | LF and HF > GLV + 1SE |
| **Total Nitrogen as N** (µg/L) | 500 | 1320 | **1174 40th% LF or 2420 30th% HF** | 2200 | 4680 | | | | 367 LF / 572 HF | **1174 LF 2420 HF** | LF and HF > GLV + 1SE |
| **Total Phosphorus as P** (µg/L) | **50** | 2.994 | 52.8 | 110 | 369.2 | | | | 88.47 | **50.00** | 40th%ile within 1SE |
| **Reactive Phosphorus as P** (µg/L) | **20** | ND | ND | ND | ND | ND | ND | ND | ND | **20.00** | |

**Table 20 Development of sub-regional WQOs for physico-chemical parameters for Boomerang – Hughes Creek Catchment.**

**Table 21 Development of sub-regional WQOs for dissolved metals in Boomerang – Hughes Creek Catchment.**

| Dissolved metals | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Analyte** | **ANZG 2018 GLV** | **20th%ile** | **40th%ile** | **Median** | **80thile** | **40th% of 40th%** | **SE** | **Proposed** | **Explanation** |
| **Al** (µg/L) | 55 | 20 | 144 | 380 | 1026 | | 101.62 | **55** | Within GLV +/- 1SE |
| **As** (µg/L) | **13** | ND | ND | ND | ND | ND | ND | **13** | |
| **Cr** (µg/L) | **1** | ND | ND | ND | ND | ND | ND | **1** | |
| **Cu** (µg/L) | **1.4** | 0.99 | **1** | 1 | 2 | | 0.07 | **1** | 40th%ile < GLV - 1SE |
| **Fe** (µg/L) | No guideline | 84 | 242 | 360 | 786 | **213.6** | 76.76 | **214** | No GLV, therefore, 40$^{th}$%ile of 40$^{th}$%ile |
| **Mo** (µg/L) | **34** | ND | ND | ND | ND | ND | ND | **34** | |
| **Ni** (µg/L) | 11 | 1 | 2 | 2 | 3 | **1.2** | 0.15 | **1.2** | 40$^{th}$%ile of 40$^{th}$%ile < GLV - 2SE |
| **Se** (µg/L) | **5** | ND | ND | ND | ND | ND | ND | **5** | |
| **U** (µg/L) | **0.5** | ND | ND | ND | ND | ND | ND | **0.5** | |
| **Zn** (µg/L) | **8** | ND | ND | ND | ND | ND | ND | **8** | |

A comparison between developed WQOs based on the 40th percentile and the 80th percentile values is provided in Table 22. The 80th percentile values can be used in the future for the purposes of comparing discrete water quality samples, to determine if conditions in the receiving environment are likely to be outside of the range of typical conditions.

The 80th percentile values for the waterways upstream of mining activity indicate that these streams are high in suspended solids, are turbid, high in nutrients such as nitrogen and phosphorus, and have elevated concentrations of some metals such as aluminium, iron and nickel.

**Table 22 Comparison of developed sub-regional WQOs to 80th percentile values for Boomerang-Hughes Creek catchment**

| Parameter | Unit | Adopted Sub-regional WQO | 80 percentile from Best Available Reference Sites |
|---|---|---|---|
| **Water quality objectives to protect aquatic ecosystem environmental values** | | | |
| Total suspended solids (TSS) | mg/L | 55 | 95 (low flow)<br>1405 (high flow, 70th%ile) |
| Turbidity | NTU | 50 | 336 (low flow)<br>2056 (high flow, 70th%ile) |
| Electrical conductivity (EC) | µS/cm | 720 | 271 |
| Sulfate ($SO_4$) | mg/L | 25 | 10 |
| pH | - | 6.5-8.0 | NA |
| Ammonia (as nitrogen) | µg/L | 40 | 110 |
| Oxidised nitrogen | µg/L | 60 (low flow)<br>288 (high flow) | 458 (low flow)<br>800 (high flow, 70th%ile) |
| Organic nitrogen | µg/L | 916 (low flow)<br>1440 (high flow) | 2294 (low flow)<br>4120 (high flow, 70th%ile) |
| Total nitrogen | µg/L | 1174 (Low Flow)<br>2420 (High Flow) | 2774 (low flow)<br>4680 (high flow, 70th%ile) |
| Filterable reactive phosphorus | µg/L | 20 | NA |
| Total phosphorus | µg/L | 50 | 369 |
| Dissolved oxygen (DO) | % saturation | 37-86 | NA |
| **Metals (Dissolved)** | | | |
| Aluminium | µg/L | 55 | 1026 |
| Arsenic | | 13 | NA |
| Chromium | µg/L | 1 | NA |
| Copper | µg/L | 1 | 1 |
| Iron | µg/L | 214 | 1391 |
| Molybdenum | µg/L | 34 | NA |
| Nickel | µg/L | 1.2 | 3 |
| Selenium | µg/L | 5 | NA |
| Uranium | µg/L | 0.5 | NA |
| Zinc | µg/L | 8 | NA |

## Data analysis

Data was analysed utilising Jamovi statistical software, and differences in water quality between seasonality, flow regimes and water courses were assessed. Data was tested for normality and equal variance of residuals. If assumptions for parametric tests were not met, transformations were applied. If these were unsuccessful, corresponding non-parametric tests were performed. The total number of samples was sufficient to allow for deriving statistically valid and robust objectives. Data have been collected over a period of ten years and through variability of flow regimes, seasonality as well as differences between reference sites have been taken into account. In summary, this allowed for the generation of Sub-regional WQOs reflecting the general conditions of the catchment.

### Physio-chemical water quality

The following section provides a summary of existing background water quality data at the best available reference sites upstream, and compares the data to applicable default guidelines (DES 2022) and allows comparison between streams. For each water quality parameter, box and whisker plots showing the minimum, 20th percentile, median, 80th percentile and maximum values are presented (see Figure 10 for an example).

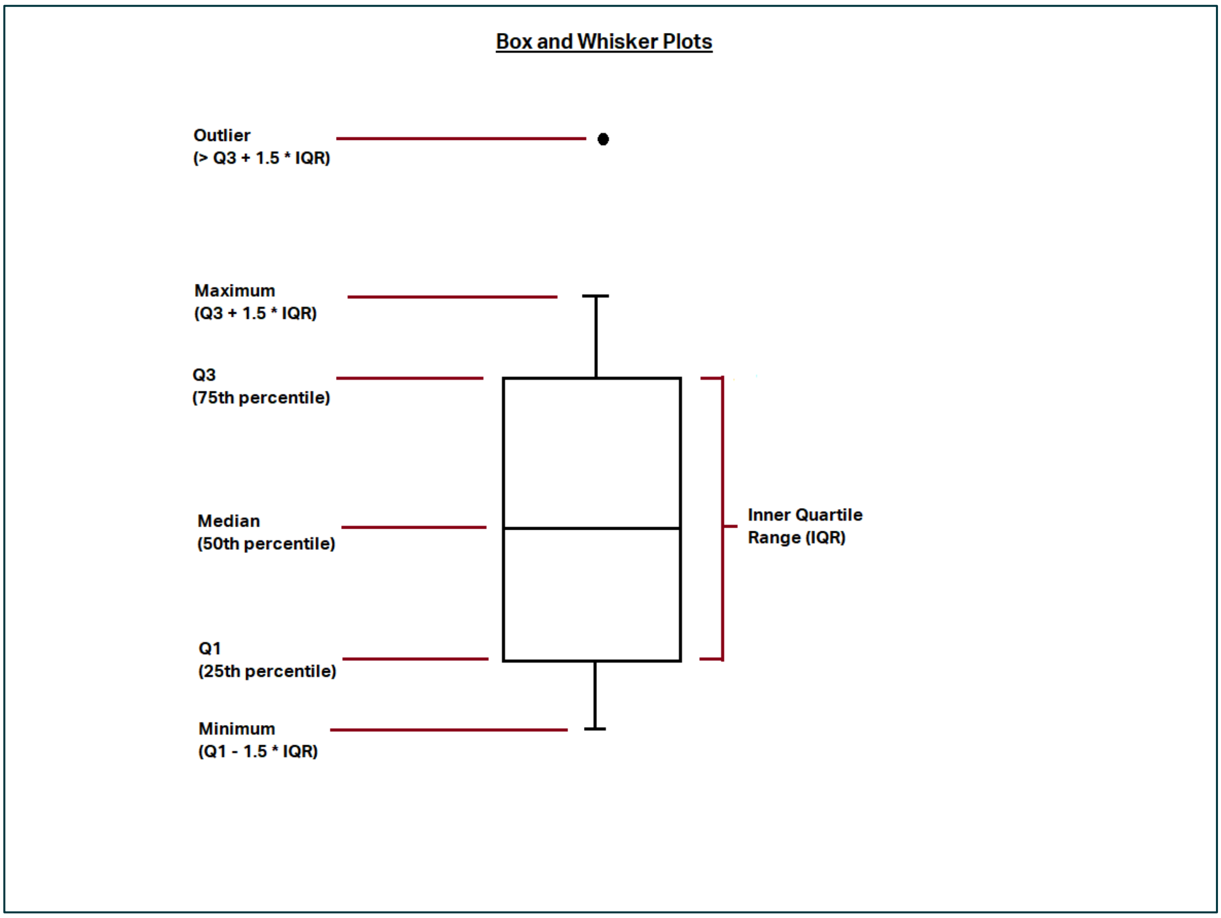


**Figure 10 Example box and whisker plot structure**

## Total suspended solids

Total suspended solids (TSS) water quality data at best available reference sites is summarised in Figure 11. The selected WQO for TSS is the default guideline value of 55mg/L (red line). Data exhibits high variation between sites (Kruskal-Wallis: $\chi^2 = 817$, df = 3, p = 0.043), especially between Hughes Creek and the other streams. Statistically significant variation between high flow and low flow data has been taken into account (Section 4.6.1). As both, low flow (green line) and high flow (blue line) values lie within 2 SE of the default guideline value therefore, the default value was retained and adopted as the WQO.

Hughes Creek had generally a higher variability and higher concentrations of TSS than the other streams. Most of the data exceeds the adopted guideline and therefore the 80$^{th}$ percentile (brown line) could be a more reasonable measure for short term assessments of water quality impacts. A more detailed discussion displaying differences between the 80$^{th}$ percentile for low flow data and 70$^{th}$ percentile for high flow data is described in section 4.6.1.

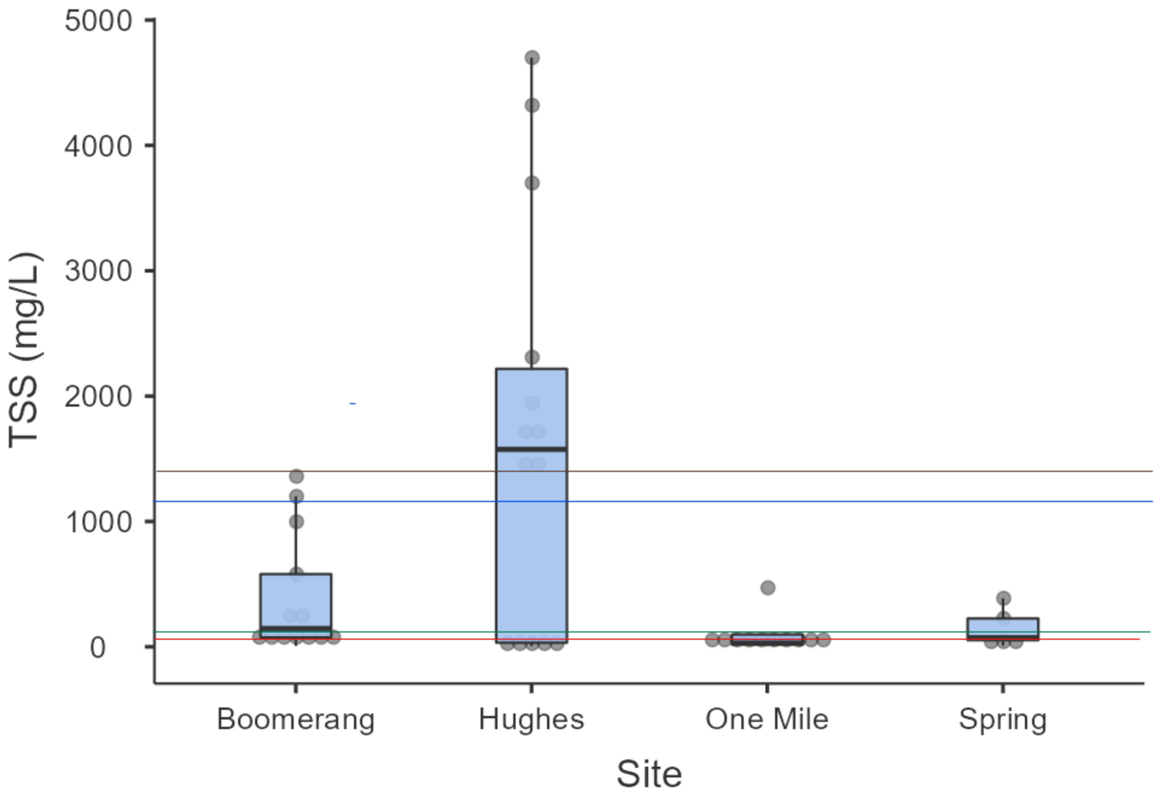


**Figure 11 Statistical summary of total suspended solids**

The red line represents the adopted sub-regional WQO (55mg/L) ; the green line represents WQO + 2SE of low flow data; Blue line represents WQO + 2SE of high flow data.

### Dissolved Oxygen

Dissolved Oxygen (DO) data at best available reference sites is summarised in Figure 12 below. The adopted WQO range for DO is 37% (20th percentile) – 86% (80th percentile) (red lines). Data exhibits no statistically significant variation between water courses (One-Way ANOVA: $F = 795$, $df = 2$, $p = 0.48$) or between flow regimes. The adopted WQO was further than 1SE (green lines) away from the default guideline values for DO (85-110) and was therefore selected as new sub-regional WQO. No DO data was available for Boomerang Creek and the watercourse could therefore not be included in the analysis. DO values for all other streams fall mainly within the new WQO range.

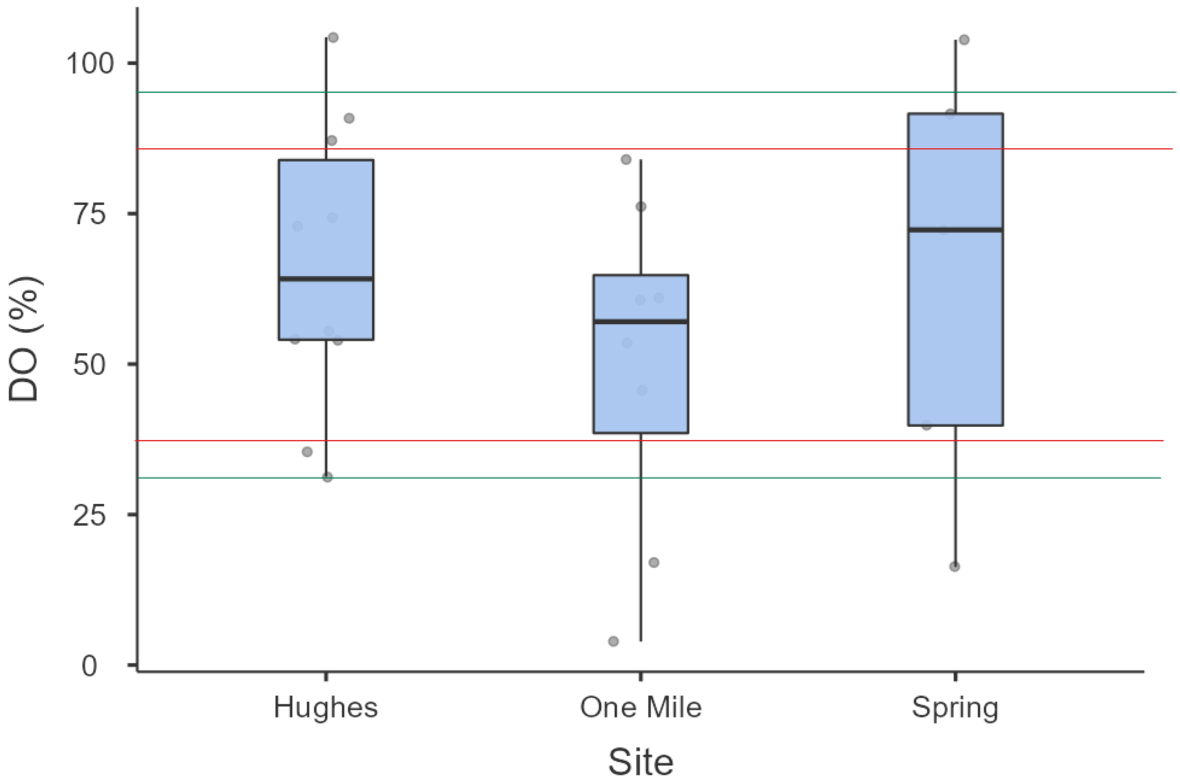


**Figure 12 Statistical summary of DO in %**

Red lines represents the developed sub-regional guideline range (37% - 86%); green lines represent WQO + 1SE for the upper boundary and WQO - 1SE for the lower boundary.

**Turbidity**

Turbidity levels at best available reference sites is provided in **Figure 13 Statistical summary of turbidity** below. The adopted WQO is the EPP (Water) (2019) default guideline value of 50NTU (red line). The data shows no statistically significant variation between streams (Kruskal-Wallis: $\chi^2 = 4.93$, df = 3, p = 0.177) but significant variation between high and low flow regimes (Section 4.6.1). However, both the high flow (30$^{th}$ percentile, blue line) and low flow (40$^{th}$ percentile, green line) values were within one SE of the Regional default guideline value, so the default has been retained as the WQO.

Median turbidity is similar between sites but Hughes and Boomerang Creek exhibit greater variation with higher values compared to One Mile and Spring Creek. Most of the data exceeds the developed guideline and the 80th percentile (brown line) could be a more reasonable measure to assess potential future project impacts. A more detailed discussion of the 80$^{th}$ percentile for low flow data and 70$^{th}$ percentile for high flow data is described in Section 4.6.1.

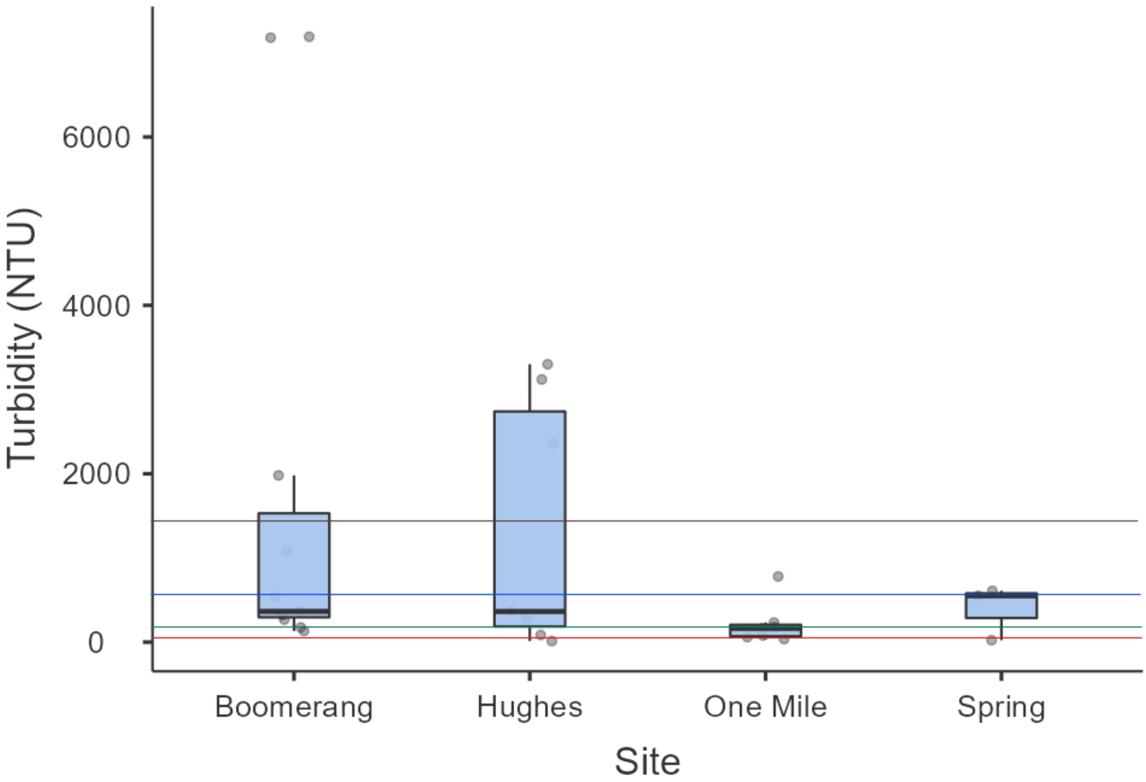


**Figure 13 Statistical summary of turbidity**

Red line represents the developed sub-regional guideline (50NTU); green line represents WQO + 1SE of low flow data; Blue line represents WQO + 1SE of high flow data. The brown line displays the 80th percentile and the green line the 40th percentile of the combined stream data.

### Electrical conductivity

Electrical conductivity at best available reference sites is provided in **Figure 14 Statistical summary of EC** in µS/cm . The selected WQO is 720µS/cm (red line) is the default value in *EPP 2019 (Water*). There is high variability between sites (Kruskal-Wallis: $\chi^2 = 14.49$, df = 3, p = 0.002) but no statistical significant difference between flow regimes.

Recorded values were mostly below the default WQO (40$^{th}$ percentile = green line 80$^{th}$ percentile = brown line) however, adoption of the higher default guideline value (720µS/cm) allows for the high variation in the wider catchment for this parameter. Generally, Spring Creek had the highest EC values with a significant larger median compared to the other water courses.

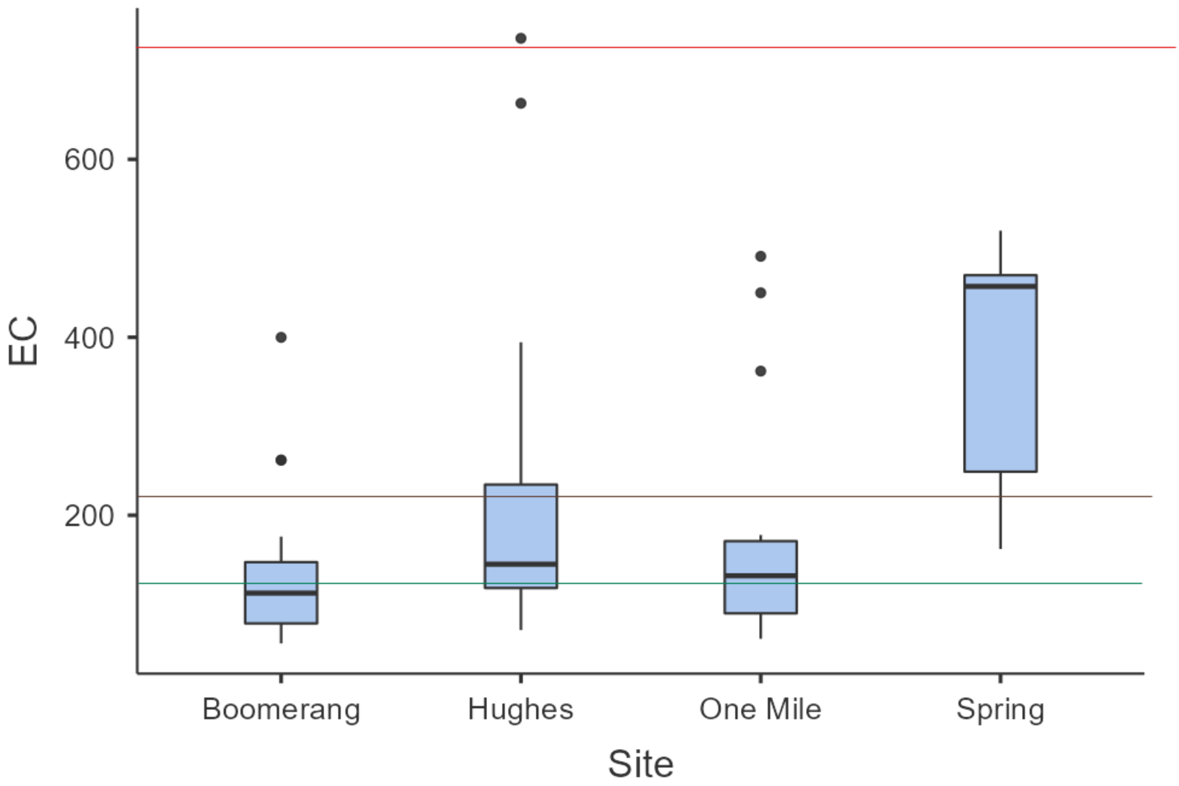


**Figure 14 Statistical summary of EC in µS/cm**

Red line represents the regional default guideline value (720µS/cm). The brown line displays the 80th percentile and the green line the 40th percentile of the combined stream data.

### Sulfate ($SO_4$)

Data for Sulfate at best available reference sites is provided in Figure 15 below. The selected WQO is the regional default guideline value of 25mg/L (red line). There is some variability of Sulfate between sites but no significant difference between flow regimes. Most data for Boomerang, Hughes and One Mile Creeks fell within the 80th percentile (brown line) with the exception of Spring Creek, which had higher Sulfate concentrations compared to the rest. Similar to EC, the default guideline was adopted to allow for the high variability of Sulfate within the sub-regional and regional catchment.

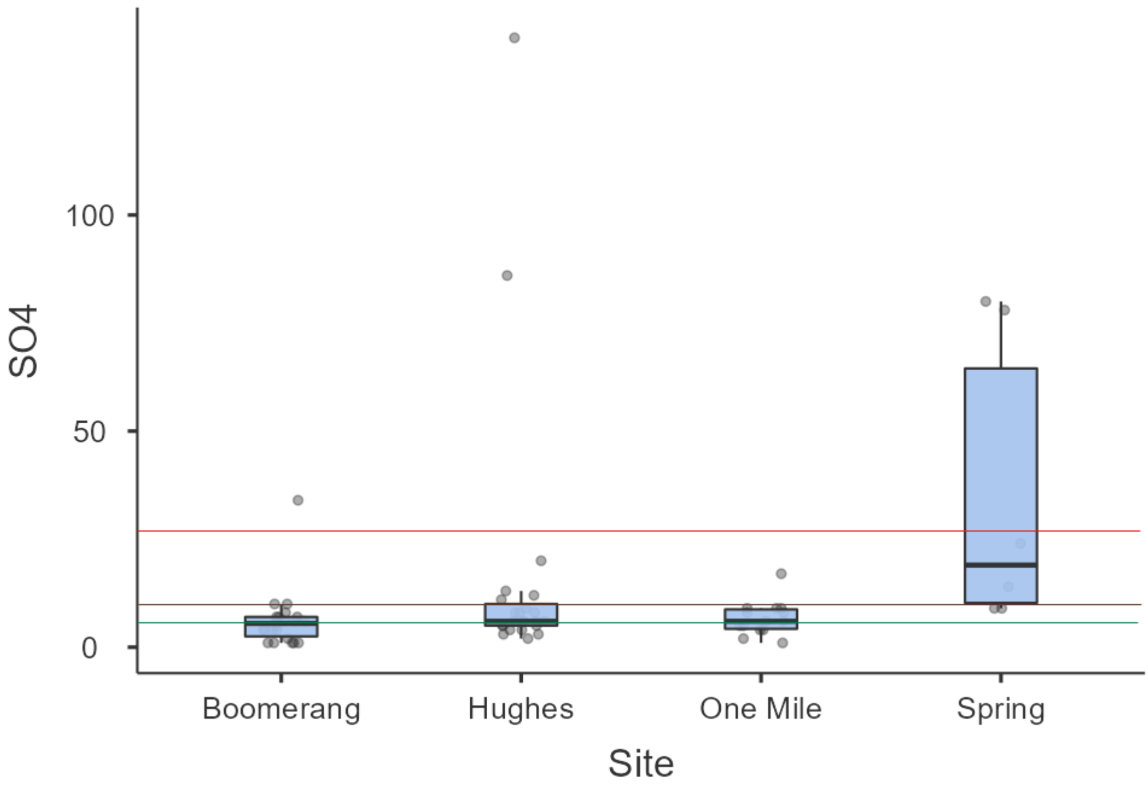


**Figure 15 Statistical summary of Sulfate in mg/L**

Red line represents the selected GLV (25mg/L). The brown line displays the 80th percentile and the green line the 40th percentile of the combined stream data.

**pH**

Data for pH at best available reference sites is provided in Figure 16 below. The adopted WQO range for pH is the 6.5 – 8.0. Data exhibits a statistical significant variation between water courses (One-Way ANOVA: F = 3.64, df = 3, p = 0.003) but no significant differences between flow regimes. The 20th percentile of the 20th percentile (lower boundary, lower red line) and the 80th percentile of the 80th percentile (upper boundary, upper red line) of were applied. The green lines in the graph display 2SE +/- the WQO range.

Boomerang creek exhibits the largest variation of pH, exceeding the upper WQO range in some cases, whilst One Mile Creek's pH lies under the lower range boundary approximately 50% of the time. pH for Hughes and Spring Creek remains mainly within the adapted WQO range.

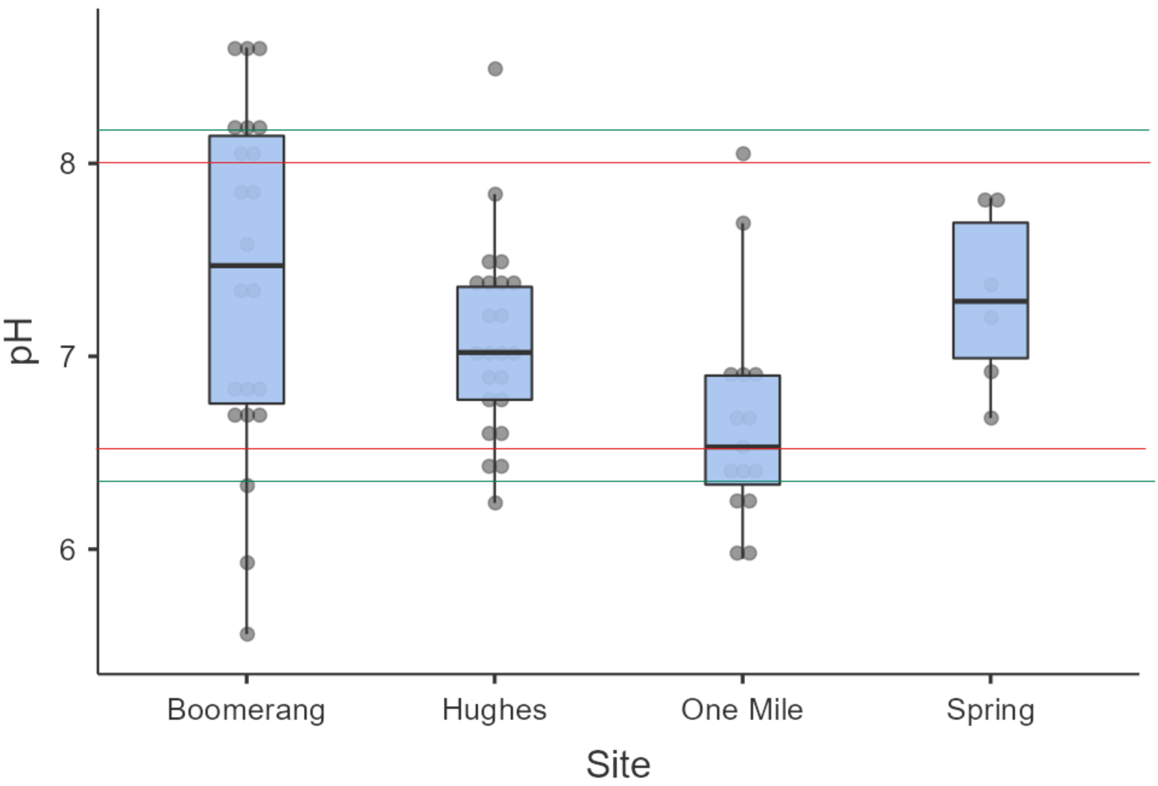


**Figure 16 Statistical summary of pH**

Red line represents the developed sub-regional WQO range (20thpercentile of the 20th percentile = 6.5 and 80th percentile of the 80th percentile = 8); green line represents WQO + 2SE for the upper boundary and WQO - 2SE for the lower boundary

### Ammonia

Ammonia concentrations at best available reference sites is provided in Figure 17 below. The adopted WQO for Ammonia is 40µg/L (red line). The new objective was adopted as it was more than 1SE (green line) away from the default guideline value of 20µg/L (not shown). There is no statistically significant difference between different streams (Kruskal-Wallis: $\chi^2 = 1.94$, df = 3, p = 0.584) or flow regimes. The median values of the four streams are relatively similar but Boomerang Creek and Spring Creek exceed the adopted WQO in large parts of the data. Therefore, the 80th percentile (brown line) could be a more reasonable measure to compare the impact of the project on WQ in the catchment.

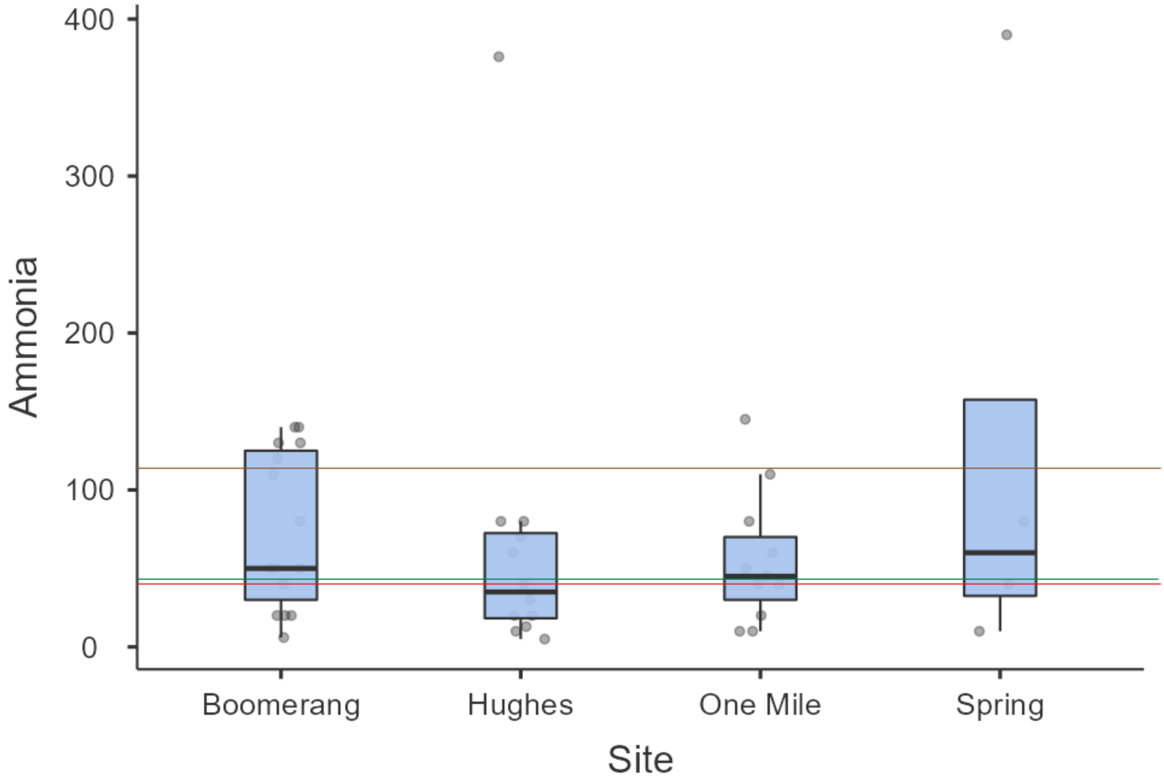


**Figure 17 Statistical summary of Ammonia**

Red line represents the developed sub-regional WQO (40µg/L), green line represents WQO + 1SE., green line represents WQO + 1SE. The brown line depicts the 80th percentile of the combined stream data.

**Nitrate**

Nitrate concentration at best available reference sites is provided in Figure 18. The adopted WQO for Nitrate is 60µg/L for low flow conditions (red line) and 288µg/L for high flow conditions (purple line). Low flow WQO is the same as the default guideline value whilst the high flow WQO is more than 1 SE away from the default guideline value. There is no statistically significant difference for Nitrate between different streams (Kruskal-Wallis: $\chi^2 = 4.77$, df = 3, $p = 0.19$), but there is a high variability between flow regimes with higher concentrations generally present during high flow events (details in Section 4.6.1).

Only little data was available for Spring Creek. Boomerang, Hughes and One Mile Creek display similar concentrations of nitrate, however they exceed the adopted WQO in most of the samples. The 80th percentile (brown line) could be a more reasonable measure to account for WQ impacts from the project. A more detailed separation displaying the 80$^{th}$ percentile for low flow data and 70$^{th}$ percentile for high flow data is described in section 4.6.1.

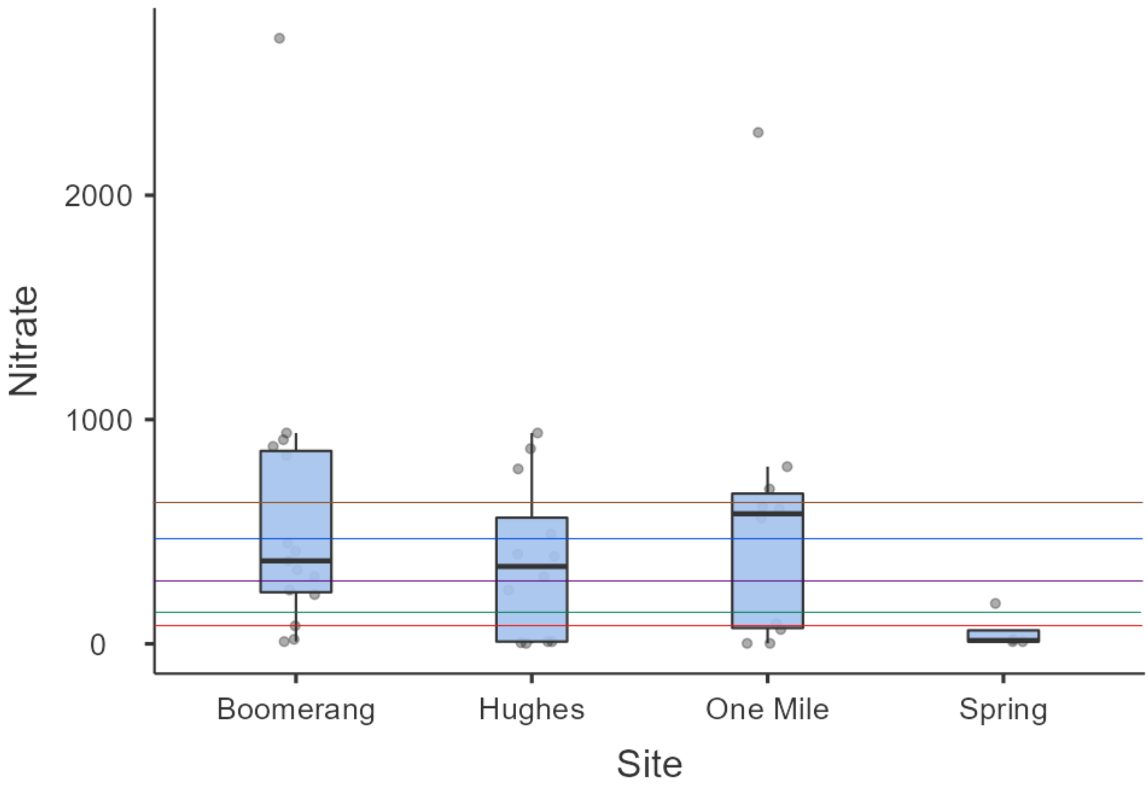


**Figure 18 Statistical summary of Nitrate**

Red line represents the incorporated regional default guideline for low flow (60 µg/L), green line represents WQO low flow + 1SE low flow, the purple line displays the developed WQO for high flow (288 µg/L) and the blue line symbolises WQO high flow + 1SE high flow. The brown line depicts the 80th percentile of the combined stream data.

**Organic (Kjeldahl) Nitrogen**

Kjeldahl Nitrogen data at best available reference sites is provided in Figure 19 below. The adopted WQOs for Kjeldahl Nitrogen are 916µg/L for low flow conditions (red line) and 1440µg/L for high flow conditions (purple line). For comparison the default guideline value for Kjeldahl Nitrogen is 420µg/L (not shown), which is more than one SE away from both WQOs. There is no statistically significant difference for Kjeldahl Nitrogen between different streams (Kruskal-Wallis: $\chi^2 = 4.60$, df = 3, p = 0.204), but there is a high variability between flow regimes (Section 4.6.1). Most data values collected for streams exceed the low flow WQO whilst the high flow WQO is mainly exceeded by Hughes and Boomerang Creek. Hughes Creek especially, shows high variability in this parameter whilst Boomerang Creek is limited to only a single data point. The 80$^{th}$ percentile (brown line) would be a better criteria for comparison to account for such high variability and to determine the impacts of the project on the WQ of theses streams. A more detailed discussion displaying the 80$^{th}$ percentile for low flow data and 70$^{th}$ percentile for high flow data is described in section 4.6.1.

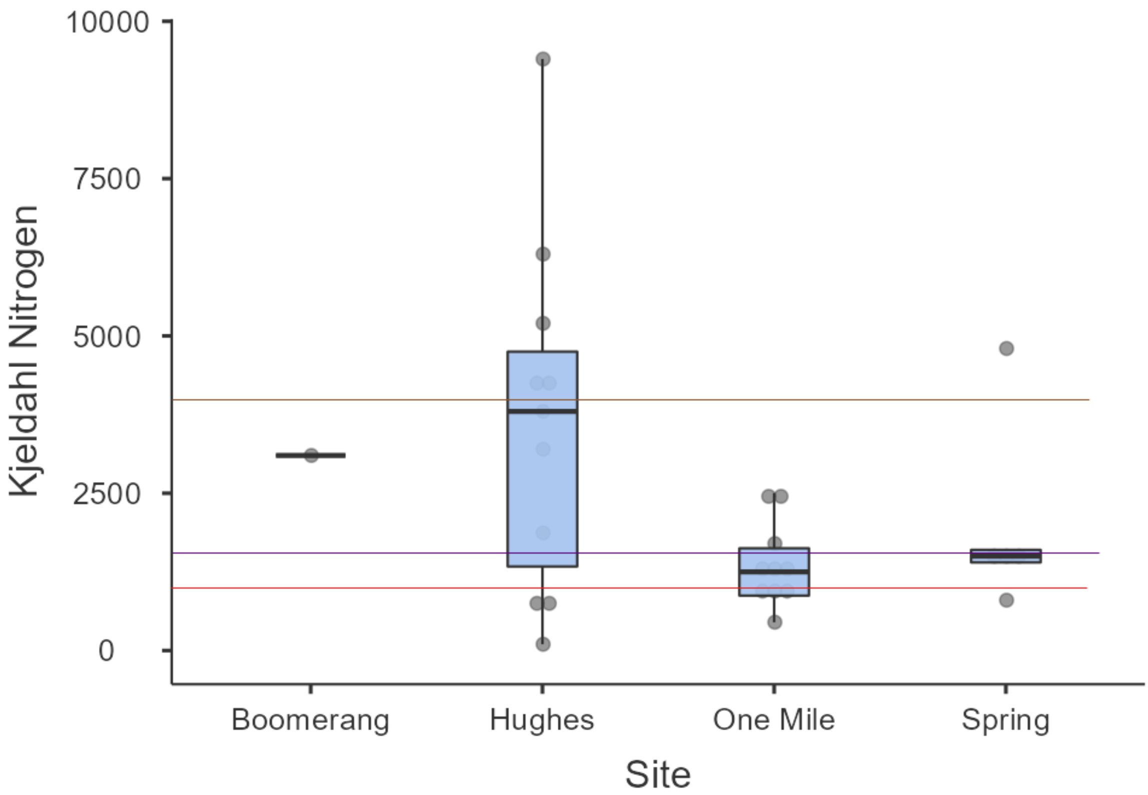


**Figure 19 Statistical summary of Kjeldahl Nitrogen**

Red line represents the developed WQO for low flow (916 µg/L), the purple line displays the developed WQO for high flow (1440 µg/L) and the brown line represents the 80th percentile of the combined stream data.

### Total Nitrogen

Total Nitrogen concentrations from best available reference sites is provided in Figure 20 below. The adapted WQOs for Total Nitrogen are 1174µg/L for low flow conditions (red line) and 2420µg/L for high flow conditions (purple line). For comparison the default guideline value for Total Nitrogen is 500µg/L (not shown), which is more than one SE away from both WQOs. There is no statistically significant difference for Total Nitrogen between different streams (Kruskal-Wallis: $\chi^2 = 4.42$, df = 3, $p = 0.219$), but there is a high variability between flow regimes (section 4.6.1). Similar to Kjeldahl Nitrogen, Hughes Creek exhibits large variability in the parameter and Boomerang Creek only has one data point. Samples from these two creeks lies mostly above low flow and high flow WQOs. The 80$^{th}$ percentile (brown line) would be a more reasonable benchmark to allow for this variation. A more detailed separation displaying the 80$^{th}$ percentile for low flow data and 70$^{th}$ percentile for high flow data is described in section 4.6.1.

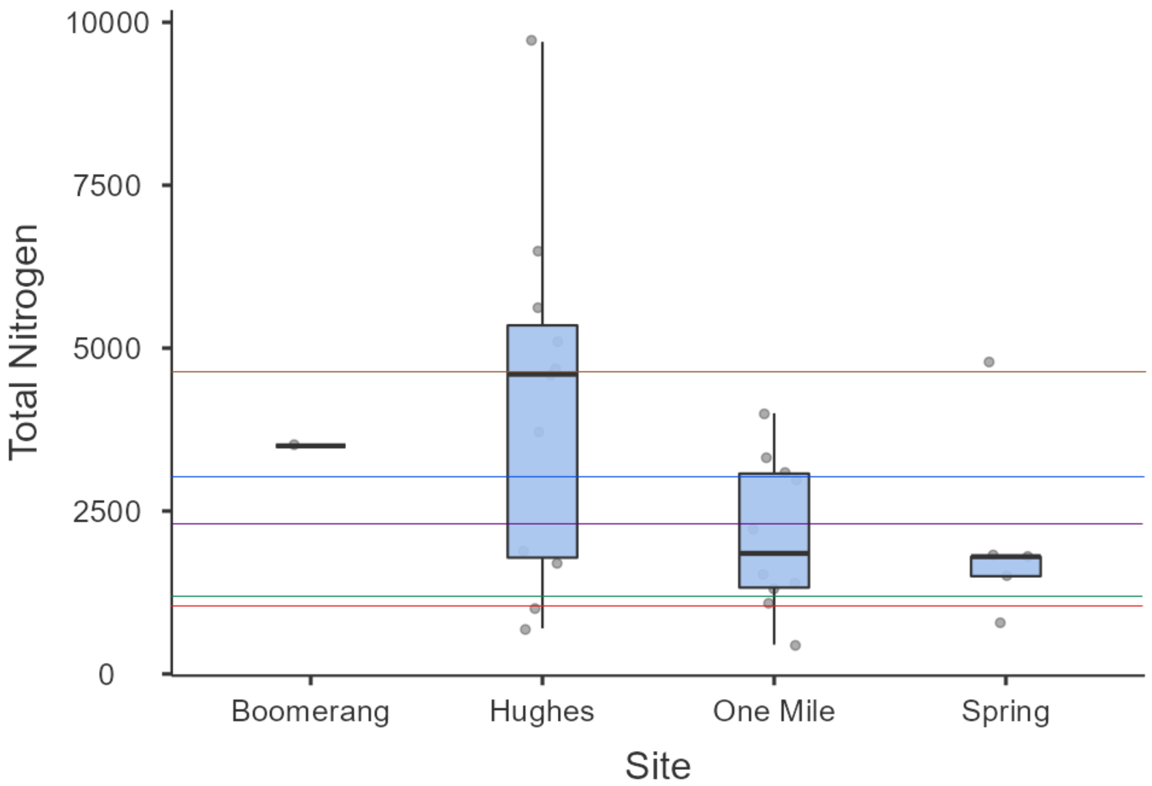


**Figure 20 Statistical summary of Total Nitrogen**

Red line represents the developed WQO for low flow (1174 µg/L), green line represents WQO low flow + 1SE low flow, the purple line displays the developed WQO for high flow (2420 µg/L) and the blue line symbolises WQO high flow + 1SE high flow. The brown line depicts the 80th percentile of the combined stream data.

### Reactive Phosphorous

Reactive phosphorus concentrations were below the detection level of the laboratory assays used to analyse the samples and could therefore not be calculated. The default regional guideline value of 20µg/L has been adopted.

### Total Phosphorous

Total Phosphorus concentrations at best available reference sites is provided in Figure 21 below. The default regional guideline value for Total Phosphorous (50µg/L) has been used as new WQO (red line) as the 40th percentile value was within one SE (green line). There is no statistically significant difference for Total Phosphorus between different streams (Kruskal-Wallis: $\chi^2 = 1.68$, df = 3, p = 0.641), and no statistically significant variability between flow regimes. The majority of data for all streams sits above this default guideline value. It is therefore recommended to apply the 80th percentile (brown line) as a more pragmatic criterion for determining mining impact on WQ in the adjacent streams.

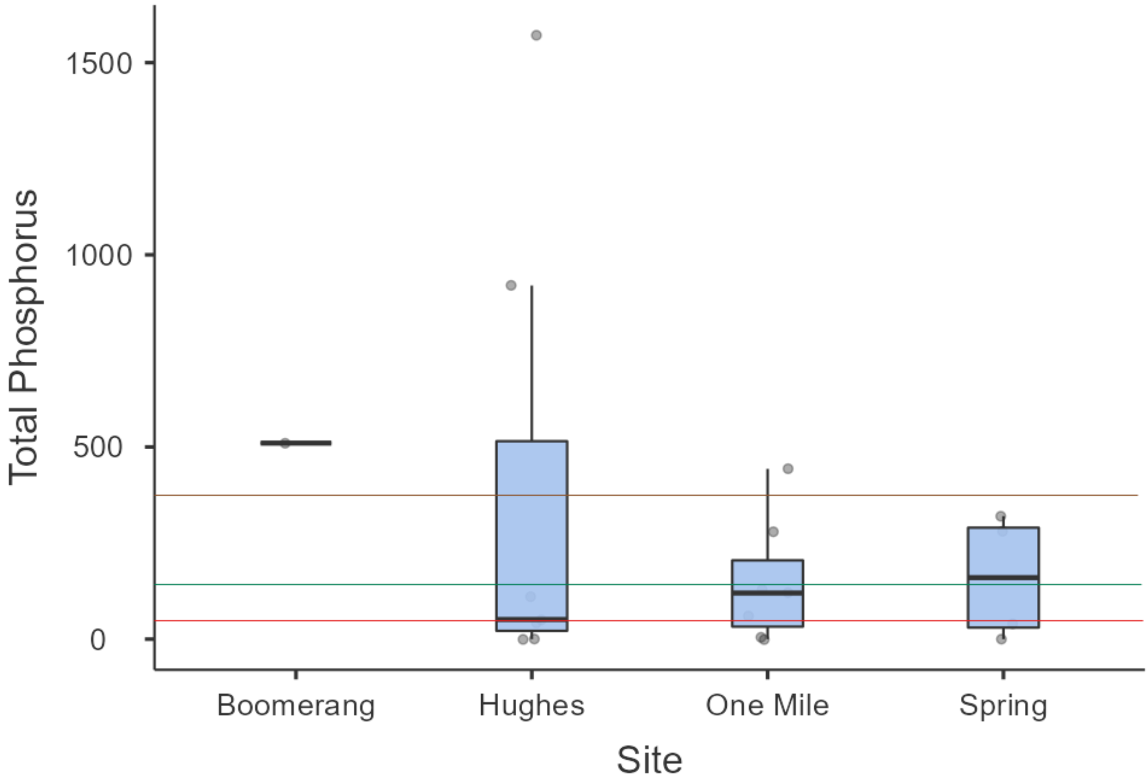


**Figure 21 Statistical summary of Total Phosphorous**

Red line represents the WQO (50µg/L), green line exhibits WQO + 1SE. The Brown line displays the 80th percentile of the combined stream data.

### Metals

The following section provides a summary of existing dissolved metal data at the best available reference sites upstream, and compares the data to applicable guidelines (*ANZG 2018*) and between streams. For each water quality parameter, box and whisker plots showing the minimum, 20th percentile, median, 80th percentile and maximum values are presented (Figure 10 for an example).

The toxins Arsenic (< 1µg/L), Chromium (< 1µg/L), Molybdenum (< 1µg/L), Selenium (< 10µg/L), Uranium (< 1µg/L) and Zinc (< 5µg/L) were below the detection threshold for the majority of the data. For these values the *ANZG* (2018) default guideline values have been applied. The LOR values for Selenium and Uranium were above their *ANZG* (2018) default guidelines of 5µg/L (Selenium) and 0.5µg/L (Uranium).

### Aluminium

Data for Aluminium at best available reference sites is provided in Figure 22. The developed WQO for Aluminium is the *ANZG 2018* default guideline value (55µg/L, red line) as the 40$^{th}$ percentile value, 144µg/L, was within 1SE of the default guideline value. Data exhibits no statistical significant variation between water courses (Kruskal-Wallis: $\chi^2 = 5.553$, df = 3, p = 0.136) or between flow regimes. The default guideline value however lies below the majority of data values for all creeks and it is proposed that the 80$^{th}$ percentile would be a more reasonable objective to assess impact from the project.

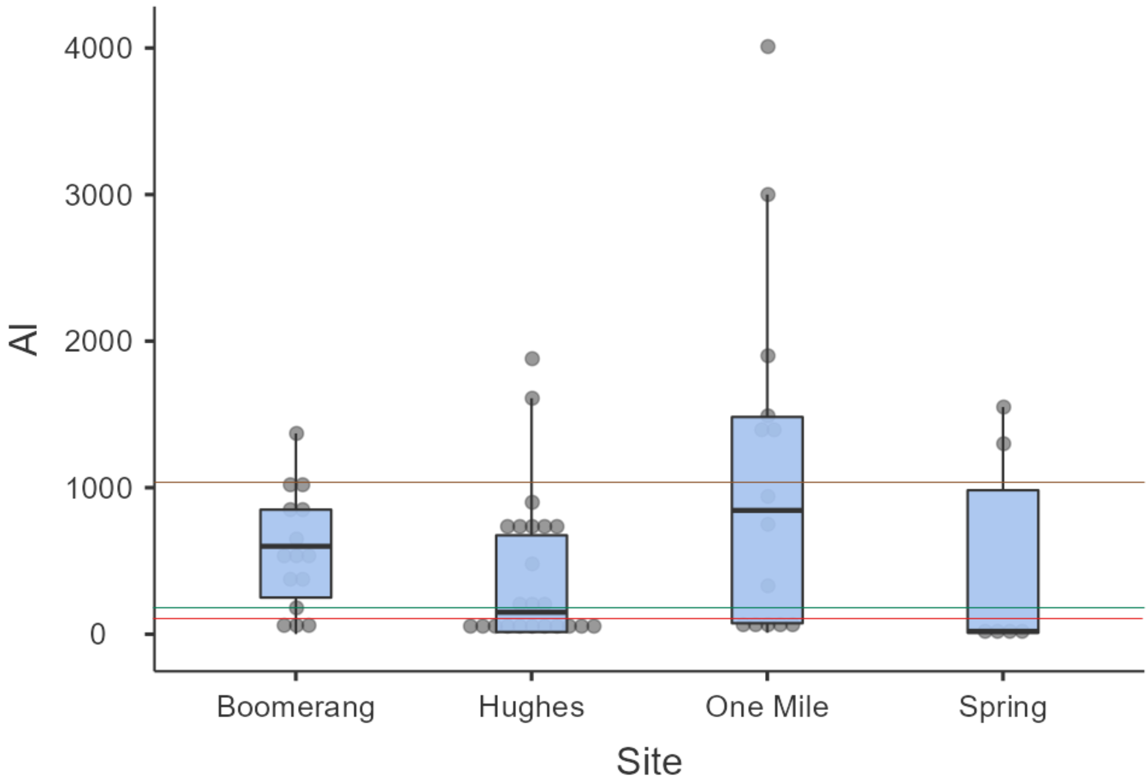


**Figure 22 Statistical summary of Aluminium**

Red line represents the WQO (55µg/L), green line exhibits 1SE + GLV. The brown line depicts the 80th percentile of the combined stream data.

### Copper

Data for Copper at best available reference sites is provided in Figure 23 below. The adapted WQO for Cu is the 40th percentile value 1µg/L (red line) of the combined data and is lower than the concentration of the default guideline value of 1.4µg/L for this parameter. The data exhibits no statistical significant variation between water courses (Kruskal-Wallis: $\chi^2 = 0.78$, df = 3, p = 0.855) or between flow regimes. As displayed in *Figure 18* below, the developed WQO is exceeded by the majority of the environmental background data. Utilising the 80th percentile (brown line) would allow for the determination of project impacts on WQ in the catchment.

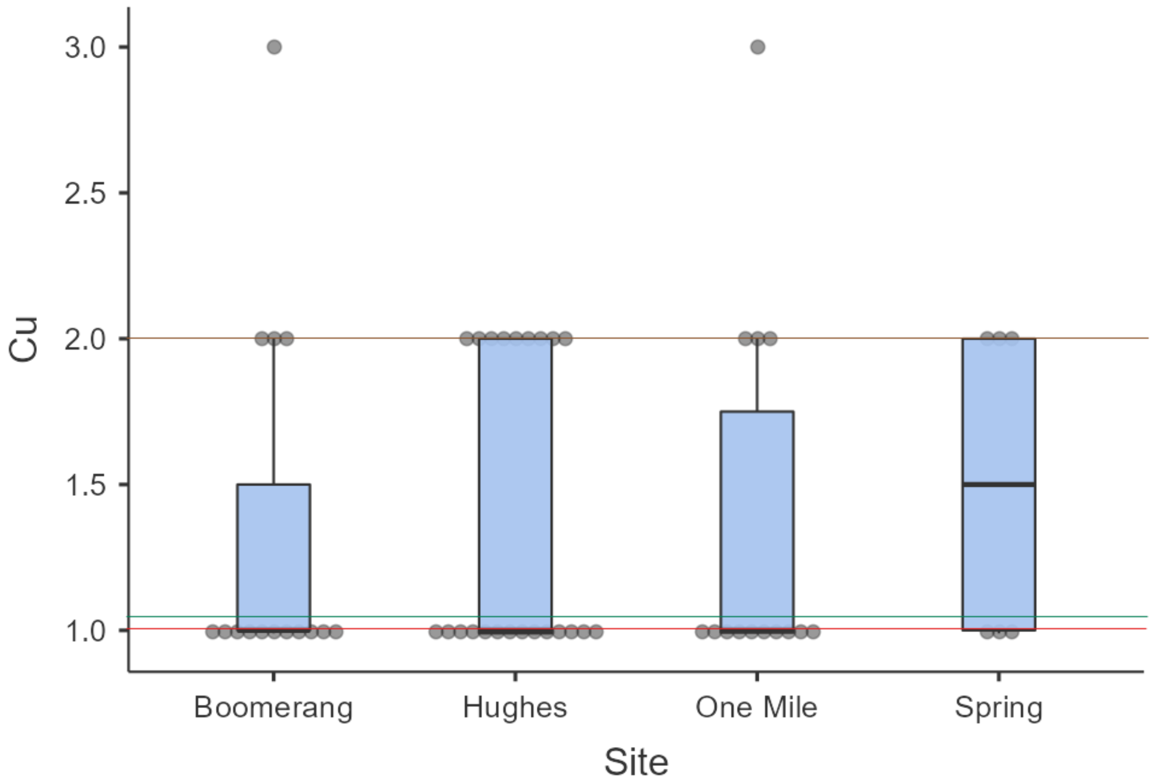


**Figure 23 Statistical summary of Copper**

Red line represents the WQO (1µg/L), green line exhibits 1SE + GLV. The brown line depicts the 80th percentile of the combined stream data.

### Iron

Data for Iron at best available reference sites is provided in Figure 24 below. The adapted WQO for Fe is the 40th percentile of the 40th percentile values of the individual streams (214µg/L) (red line). No default guideline value exists in ANZG (2018) for this parameter. The data exhibits statistical significant variation between water courses (Kruskal-Wallis: $\chi^2 = 8.544$, df = 3, p = 0.036) but none between flow regimes. One Mile Creek shows the highest median concentration of Iron and some extreme outliers. It is recommended to apply the 80th percentile (brown line) as it is a more reasonable measure considering the natural variability of dissolved iron within the catchment and allows for more realistic determination of mining impact.

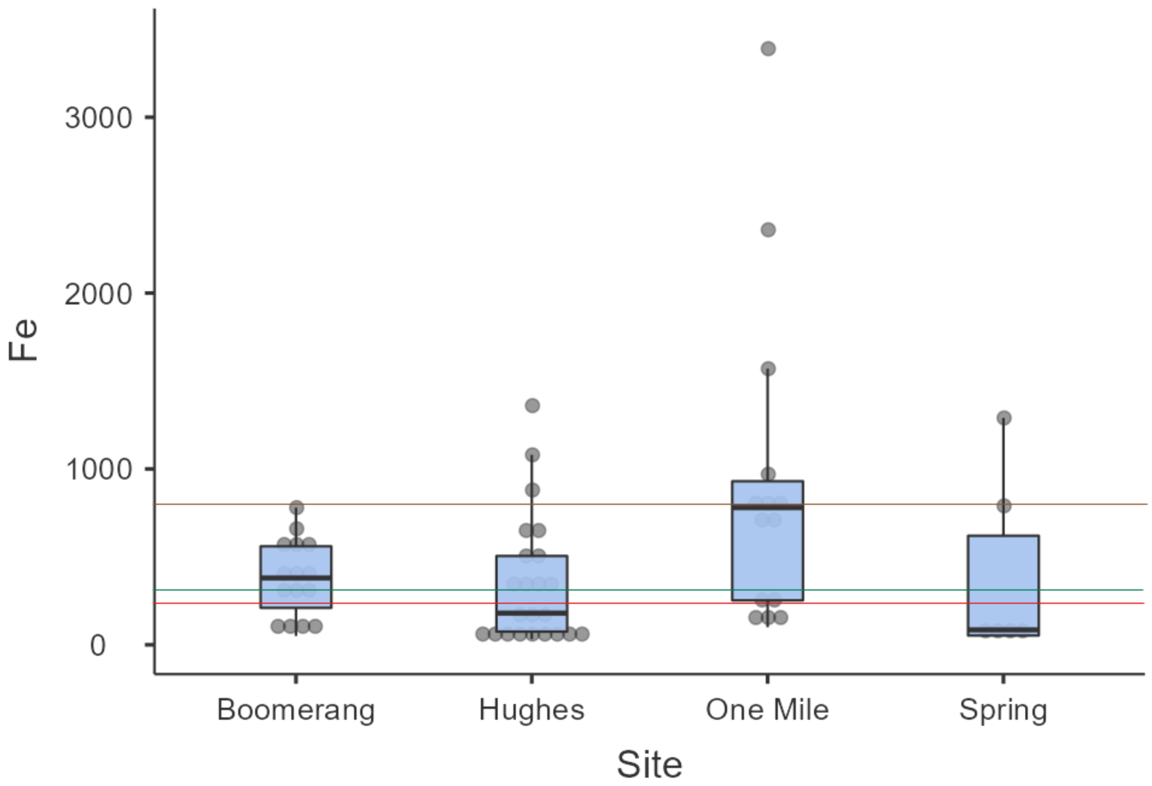


**Figure 24 Statistical summary of Iron**

Red line represents the WQO (214µg/L), green line exhibits WQO + 1SE. The brown line depicts the 80th percentile of the combined stream data.

### Nickel

Data for Nickel at best available reference sites is provided in Figure 25 below. The adopted WQO for Nickel is the 40th percentile of the 40th percentile values of the individual streams (1.2µg/L) (red line), which is lower than the ANZG (2018) default guideline value of 11µg/L The data exhibits statistical significant variation between water courses (Kruskal-Wallis: $\chi^2 = 8.36$, df = 3, p = 0.039) but none between flow regimes. Median values differ between1µg/L and 3µg/L between creeks, with the largest outliers detected at 5µg/L. Although the adapted WQO would allow for showing mining impact on Boomerang Creek, the majority of data from the other streams sits above this objective. It is recommended to apply the 80th percentile (brown line) as it would be a more realistic criterion for mining impact on the WQ of streams.

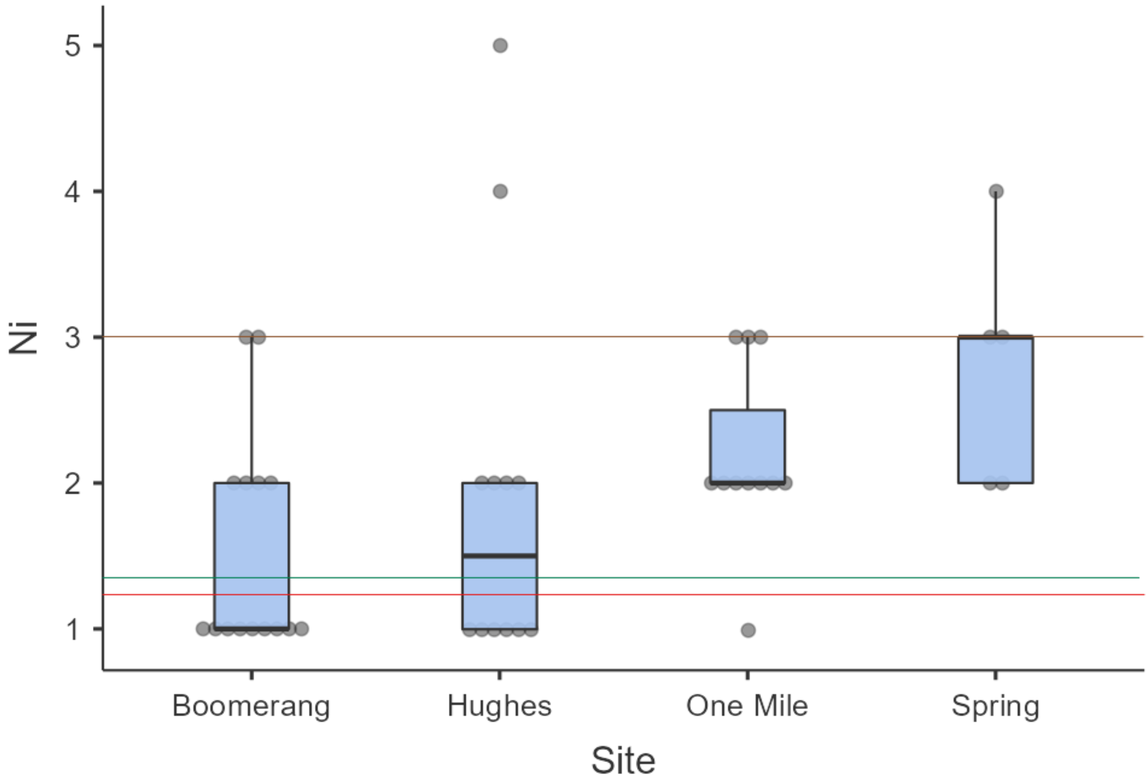


**Figure 25 Statistical summary of Nickel**

Red line represents the WQO (1.2µg/L), green line exhibits 1SE + GLV. The brown line depicts the 80th percentile of the combined stream data.

## Streamflow and seasonality

Influence of streamflow fluctuations and seasonal rainfall variation on physico-chemical parameters and dissolved metals have been assessed and included in the derivation of sub-regional WQOs.

### Streamflow

Comparing no flow data with flow data, only Turbidity ($p = 0.021$) and Nickel ($p = 0.032$) showed a statistically significant difference between flow regimes. Although statistically significant ($p > 0.05$), the p values were still relatively high, suggesting a reasonably small difference between sites. Additionally, no flow data are limited to three 3 sampling events, which is insufficient for replication to be confident of a significant difference. Therefore, no flow and low flow data were combined into one data set.

The separation between low flow and high flow was performed by using the standard approach outlined in QWQG 2022 Appendix 1. The 90th percentile (upper 10th percentile) of average daily flow rate at the nearest discharge station (Isaac River Deverill discharge station approx. 21km upstream of the Isaac River – Boomerang creek confluence) was used to differentiate between low flow and high flow data (Figure 26). This value was calculated at 1.46 $m^3/s$ (cumecs). There were some statistically significant differences in the data between high flow and low flow conditions. For these variables (Turbidity, TSS, Nitrate, Kjeldahl Nitrogen and Total Nitrogen), the 30$^{th}$ percentile of the high flow data was used as new WQO for high flow conditions. Statistical analysis using scatterplots and regression equations (Pearson's / Spearman's) resulted in weak to very weak correlations between discharge data and parameter values. The only parameter that showed a slight correlation was turbidity (Rho = 0.536, $p = 0.003$). The separation into low flow and high flow data reduces significantly the amount of samples available for comparison. Therefore, it has to be taken into consideration that when differentiating between flow regimes, determined results are based on a smaller data set and should therefore be interpreted with some caution.

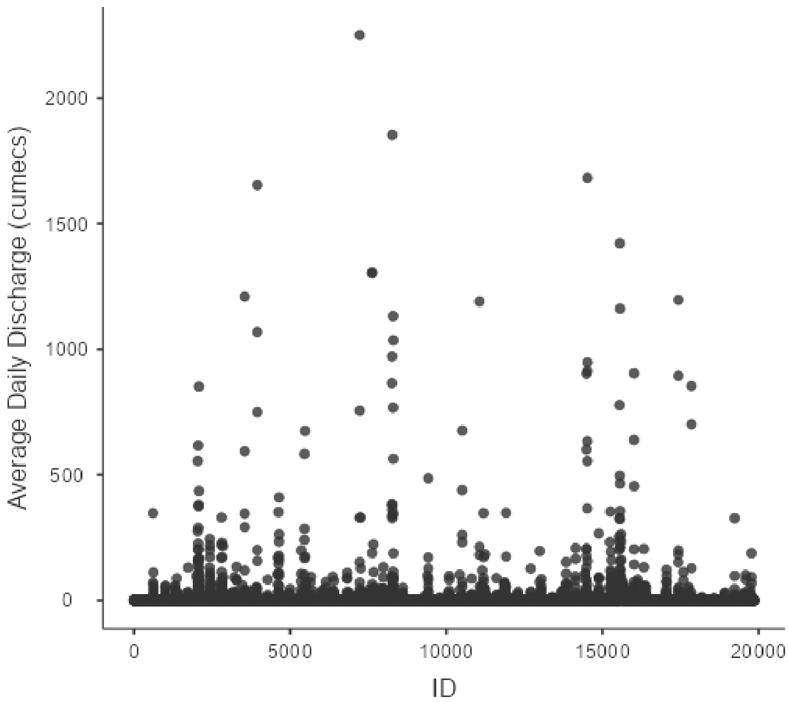


**Figure 26 Statistical summary of average daily streamflow ($m^3/s$ or cumecs) at Isaac River Deverill discharge station on a temporal gradient (x-axis is number of days)**

### Turbidity

Turbidity was compared during high and low flow conditions. Figure 27 below presents the distribution of Turbidity data between streams. There was a large variation between sites as well as between flow conditions (U = 35, df = 26, p = 0.005). The developed sub-regional guideline (50 NTU, red line) is below most of the low flow and high flow data and not recommended to apply to the Saraji East Project. The 70$^{th}$percentile of the high flow data set (2056 NTU) and the 80$^{th}$ percentile of the low flow data set (brown lines) would be more realistic values for the assessment of impacts, considering the large variation between streams, within streams, and between flow regimes.

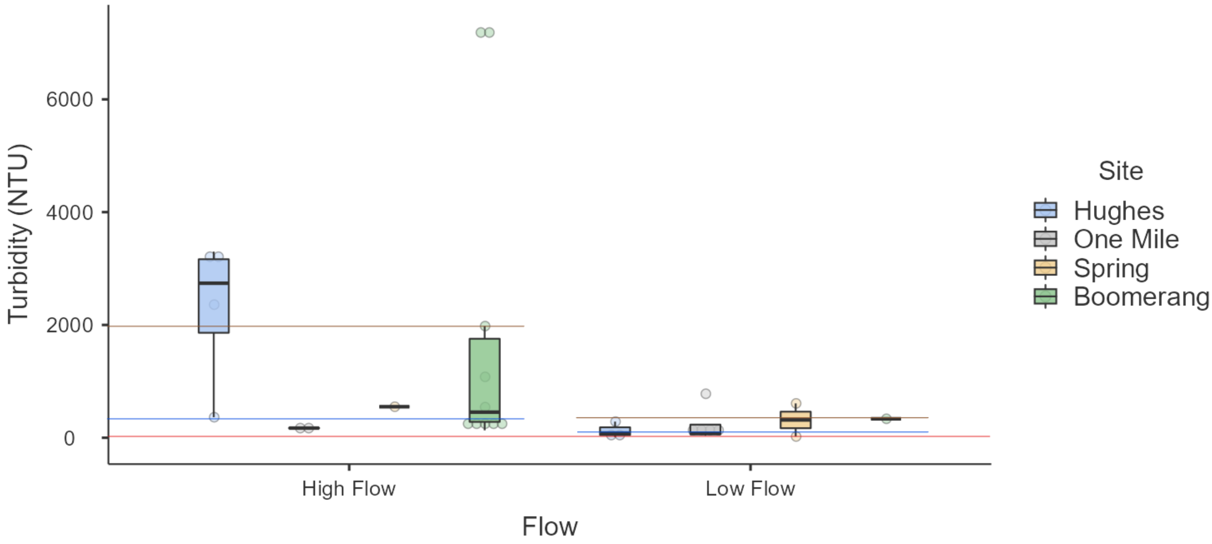


**Figure 27 Statistical summary of Turbidity between watercourses and during different flow conditions.**

The red-line represents the developed WQO (50NTU), blue lines exhibit 40th percentile low flow (79.6NTU) and 30th percentile high flow (311NTU). The brown line depicts the 80th percentile low flow (336NTU) and 70th percentile high flow (2056NTU) of the combined stream data.

### Total Suspended Solids

Total suspended solids was compared between streams and flow regimes (Figure 28). TSS concentrations were highly variable between sites, within sites and between flow regimes (U = 108.5, df = 41, p = 0.001). The majority of collected data in both flow scenarios is higher than the developed WQO (55 mg/L, red line)). To account for the high variability within the catchment and the streams, it is recommended to apply the 80$^{th}$ percentile of the low flow data (94.8mg/L) and the 70$^{th}$ percentile of the high flow data set (1405mg/L) (brown lines) for future assessments of potential impact.

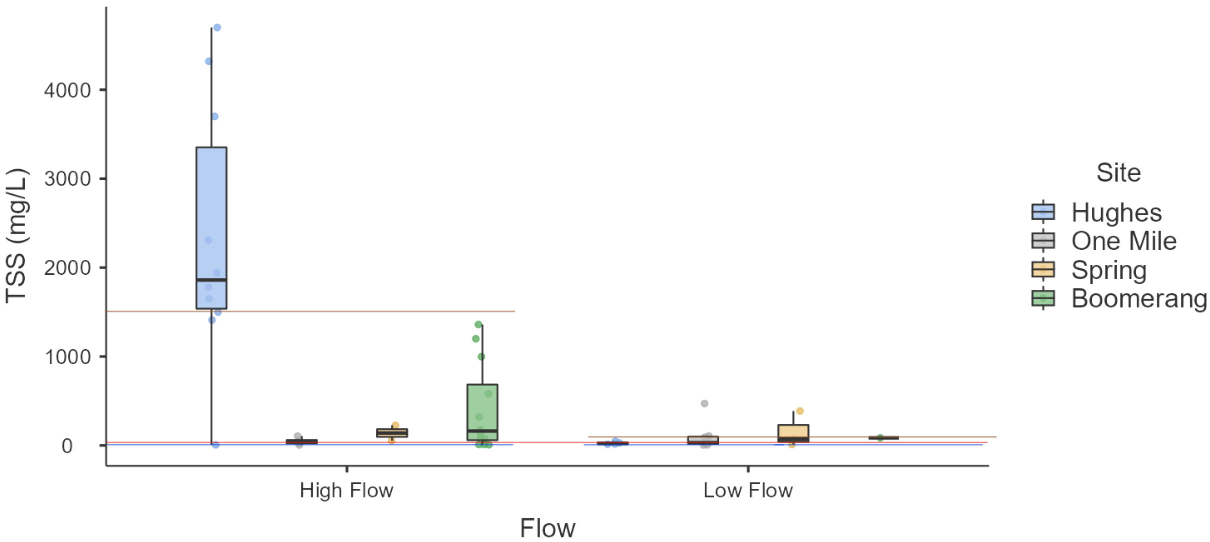


**Figure 28 Statistical summary of TSS in mm/L between watercourses and during different flow conditions.**

The red-line represents the developed WQO (55mg/L), blue lines exhibit 40th percentile low flow (43.39mg/L) and 30th percentile high flow (44.68mg/L). The brown line depicts the 80th percentile low flow (94.8mg/L) and 70thpercentile high flow (1405mg/L) of the combined stream data.

### Nitrate

Nitrate concentrations were compared (Figure 29) and these exhibit a statistically significant difference between flow regimes ($U = 81.5$, $df = 39$, $p = 0.003$). Additionally, there is a high variability in concentrations within the watercourses and between them. Therefore, it is suggested to apply the 70th percentile for high flow data (800µg/L) and the 80th percentile for the low flow data (458µg/L) (brown lines) instead of the adopted WQOs (red lines).

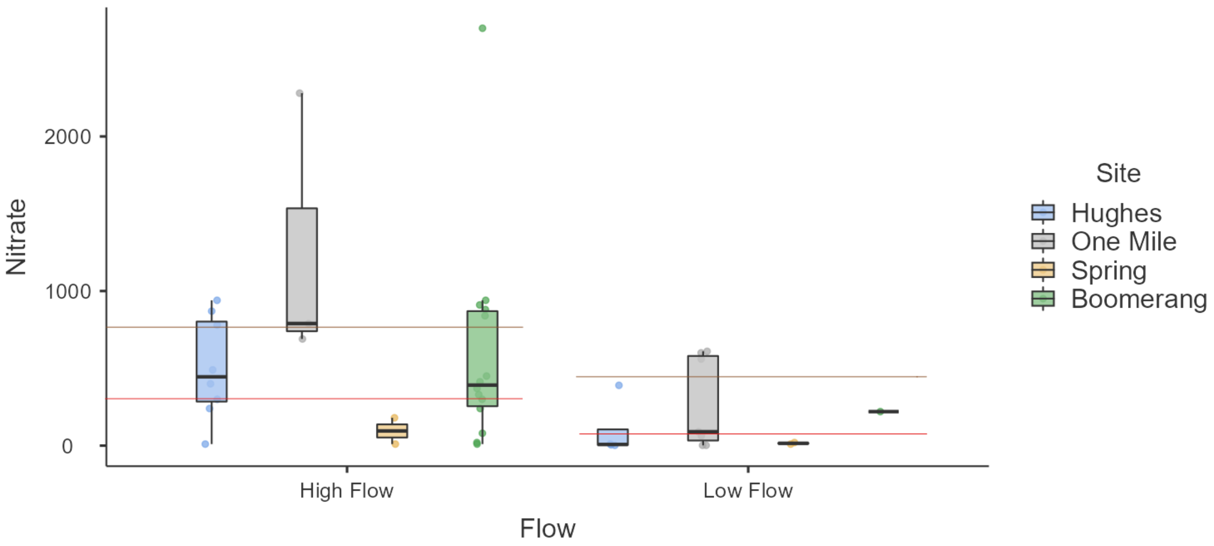


**Figure 29 Statistical summary of Nitrate in µg/L between watercourses and during different flow conditions.**

The red-line represents the developed WQOs at the 40th percentile low flow (60µg/L) and 30th percentile high flow (288µg/L). The brown line depicts the 80th percentile Lf (458 µg/L) and 70th percentile Hf (800µg/L) of the combined stream data.

### Organic (Kjeldahl) Nitrogen

Organic nitrogen was assessed to compare differences between low flow and high flow data (Figure 30). This exhibited a statistically significant difference between flow regimes ($U = 44$, $df = 25$, $p = 0.026$). No low flow data was available for Boomerang creek. The other streams show substantial variation between each other. To account for this variation, it is recommend to apply the 80$^{th}$ percentile for low flow conditions (2294µg/L) and the 70$^{th}$ percentile of high flow conditions (4120µg/L) (brown lines instead of the 40$^{th}$ percentile (916µg/L) and the 30$^{th}$ percentile (1440µg/L) (red lines) respectively.

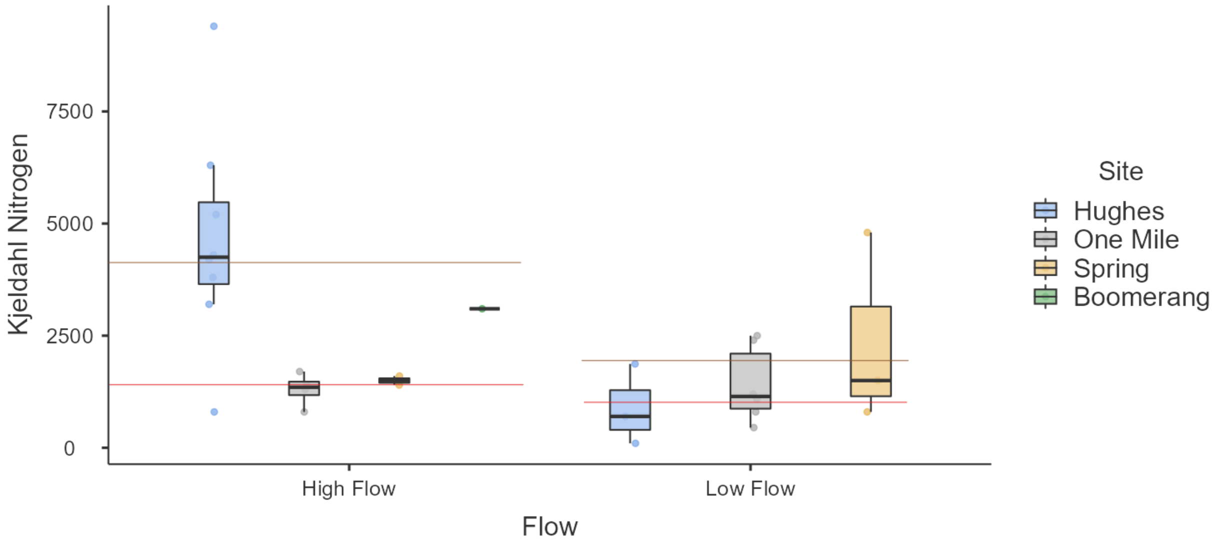


**Figure 30 Statistical summary of Kjeldahl Nitrogen in µg/L between watercourses and during different flow conditions.**

The red-line represents the developed WQOs at the 40th percentile Lf (916µg/L) and 30th percentile Hf (1440µg/L). The brown line depicts the 80th percentile low flow (2294 µg/L) and 70th percentile high flow (4120µg/L) of the combined stream data.

### Total Nitrogen

Total nitrogen data was analysed to compare high flow and low flow data. The data showed a statistically significance for total nitrogen (U = 25.5, df = 25, p = 0.002). Additionally, there is substantial variation between creeks. No low flow data was recorded for Boomerang Creek. The majority of data in the streams shows higher concentrations than the developed sub-regional WQOs (red lines) for low flow (40th percentile 1174µg/L) and high flow data (30th percentile 2420µg/L) (brown lines). It is proposed that the application of the 80th percentile for low flow data (2774µg/L) and the 70thile for high flow data (4680µg/L) (brown lines) would be a more reasonable measure for mine impact.

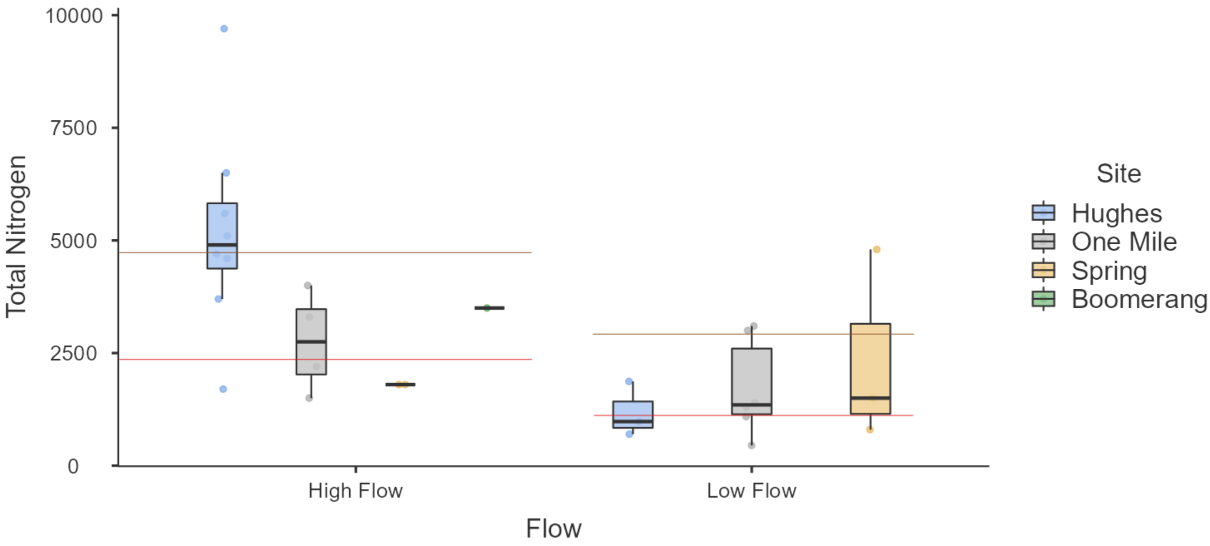


**Figure 31 Statistical summary of Total Nitrogen in µg/L between watercourses and during different flow conditions.**

The red-line represents the developed WQOs at the 40th percentile low flow (1174µg/L) and 30th percentile high flow (2420µg/L). The brown line depicts the 80th percentile low flow (2774µg/L) and 70th percentile high flow (4680µg/L) of the combined stream data.

## Seasonality and rainfall

Monthly rain data from BOM nearest weather stations was compared to water quality parameters. The rainfall graph below (Figure 32) displays a pattern seasonal rainfall, wet (Oct-March) and dry (April-September).

There was a statistically significant difference between wet and dry season for the parameters TSS ($p$ = 0.12), Kjeldahl N ($p$ = 0.021), Total N ($p$ = 0.009), Aluminium ($p$ = 0.018) and Iron ($p$ = 0.042). However, due to the likely association between season and rainfall, it is proposed to separate data into flow regimes (section 4.6.1) instead of seasonality.

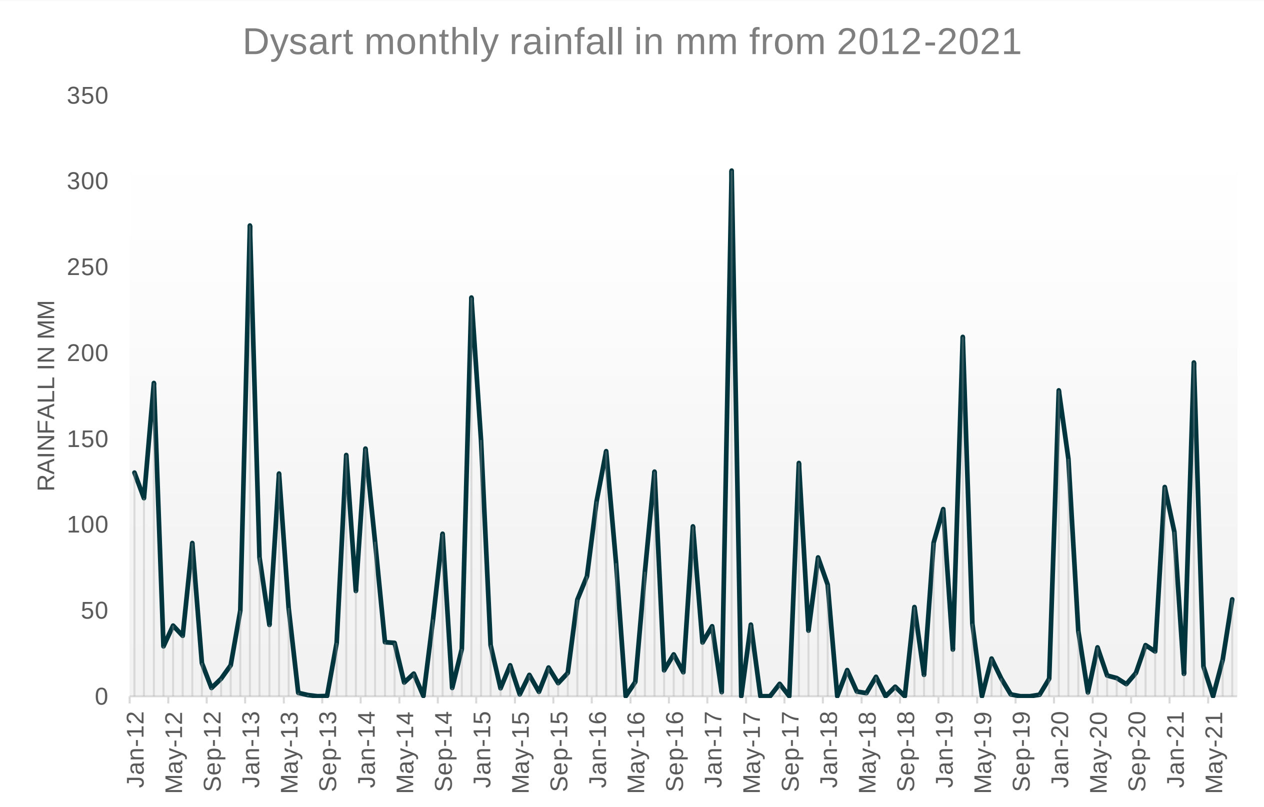


**Figure 32 Monthly rainfall data (mm) from 2012 - 2021 at the nearest Dysart weather stations.**