Adaptive Management Plan

OCTOBER 2021

MCARTHUR RIVER MINE

McArthur River Mining Pty Ltd

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1. Introduction

1.1 Background

The McArthur River Mine (the Mine) is an open pit zinc, lead and silver mining operation in the Northern Territory (NT) located approximately 700 kilometres (km) southeast of Darwin, and approximately 45 km southwest of the township of Borroloola (Figure 1).

In addition to mining activities, the operations include an on-site concentrator and processing plant, and the Bing Bong Loading Facility (BBLF) located on the Gulf of Carpentaria approximately 95 km north-northeast of the Mine (Figure 1). McArthur River Mining Pty Ltd (MRM) is the operator of the Mine, and is a wholly owned subsidiary of Glencore. MRM is the world's largest producer of zinc in bulk concentrate form.

A summary of key MRM operations at the Mine is as follows:

- Mining of ore within the Open Pit using conventional load and haul method to the run of mine pad for stockpiling.
- Mining of waste rock within the Open Pit using excavators, and transport by haul truck to the Overburden Emplacement Facilities (OEFs).
- Processing of ore via crushing, heavy media separation, grinding, flotation, lead oxidation, dewatering and concentrate handling and storage.
- Thickening of tailings generated by ore processing and piping of tailings for disposal at the Tailings Storage Facility (TSF).
- Transport of product materials by road train along the Carpentaria Highway to the BBLF, where the product is barged offshore for transfer to ships in the Gulf of Carpentaria.
- Other ancillary activities, such as dam construction, flood protection works, rehabilitation and excavation of borrow material for construction activities.

MRM has been operating since 1995 and during that time has developed a comprehensive understanding of the local environment and community values, and the potential impacts of the operation on those values.

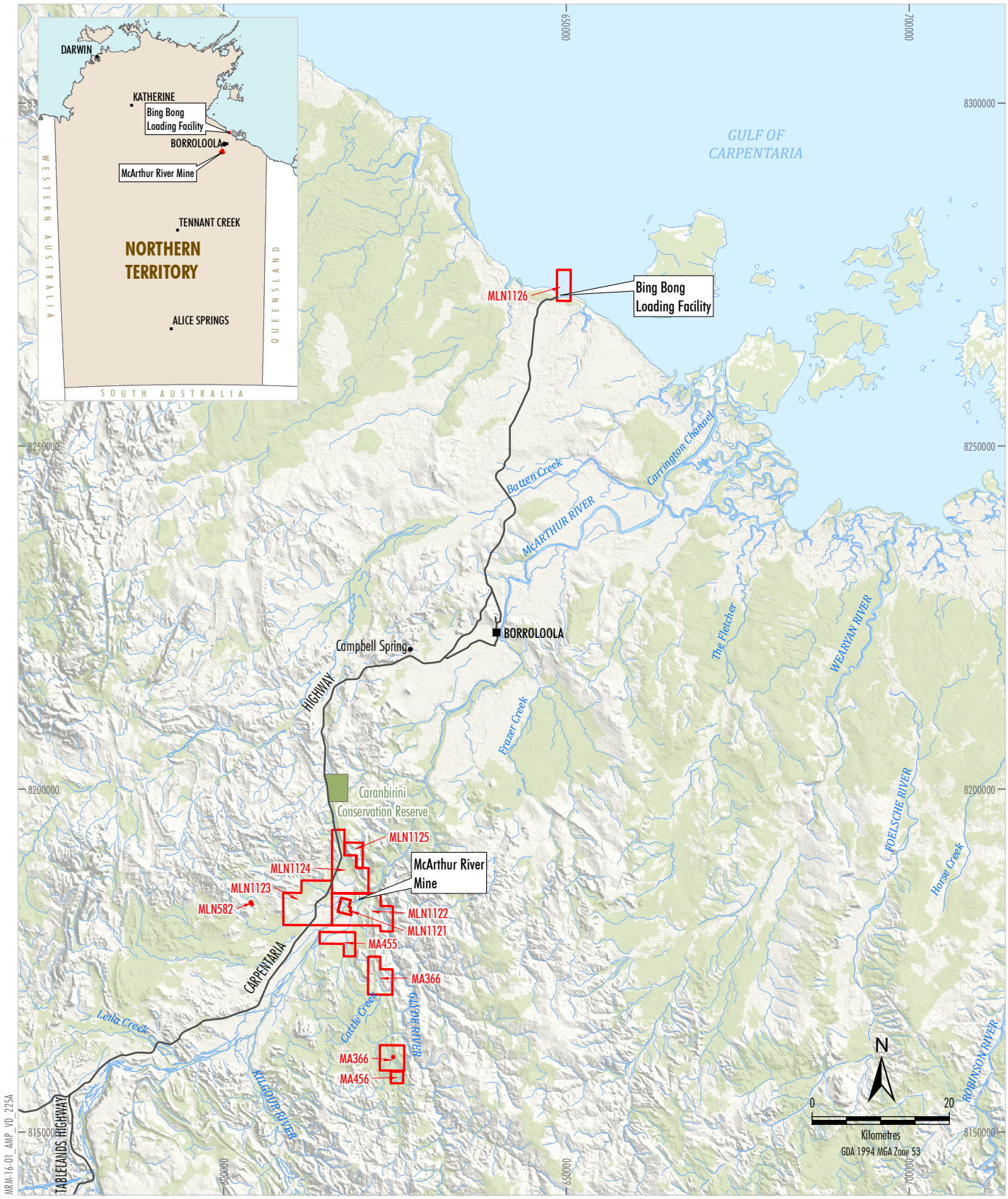
Up until 2006, the Mine was an underground operation producing approximately 333,000 dry metric tonnes per annum (dmtpa) of bulk lead-zinc-silver concentrate for overseas and domestic markets. The environmental impact assessment process for the Phase 2 Project (Phase 2) resulted in Territory and Commonwealth approval for the construction and operation of an open pit lead, zinc and silver mine to replace the underground mine.

In 2013, the NT Government approved the MRM Phase 3 Development Project (Phase 3). Phase 3 extended the life of the Mine by nine years to 2036, increased ore production from 2.5 million tonnes per annum (Mtpa) to 5.5 Mtpa, improved the ore processing facilities to increase concentrate production from 360,000 dmtpa to 800,000 dmpta and involved improvement, expansion and upgrades of existing infrastructure.

Overburden Management Project

Early in 2014, MRM lodged the 2013-2015 Mining Management Plan (2013-2015 MMP) with the NT Department of Mines and Energy (DME) (now the NT Department of Industry, Tourism and Trade [DITT]). The 2013-2015 MMP incorporated amendments to the classification of overburden and resultant modifications to overburden emplacement design, particularly the North Overburden Emplacement Facility (NOEF).

Following initial review, the amendments presented in the 2013-2015 MMP were referred to the NT Environment Protection Authority (NT EPA) in March 2014, for consideration under the NT *Environmental Assessment Act 2013* (Environmental Assessment Act). The NT EPA determined that the amendments to overburden management were significantly different from those presented and approved as part of Phase 3, and assessment under the Environmental Assessment Act was, therefore, necessary. Furthermore, the NT EPA determined that assessment via an Environmental Impact Statement (EIS) was required.



LEGEND

- Mineral Lease/Exploration
- Major Road
- River/Creek

Source: Geoscience Australia - Topography (2006); Department of Environment and Natural Resources (2016)

McARTHUR RIVER MINE

Regional Locality

Figure 1

MRM submitted the Overburden Management Project (OMP) EIS in early 2017 and the Supplementary OMP EIS in early 2018.

In July 2018, the NT EPA completed its assessment of the OMP EIS and issued *Assessment Report 86 for the McArthur River Mine Overburden Management Project* (Assessment Report 86) (NT EPA, 2018a). Assessment Report 86 determined the project could be implemented, subject to 30 recommendations to be considered by the relevant Ministers responsible for authorising the proposal.

Approval of the OMP was received from the then Department of Environment and Energy (now the Department of Agriculture, Water and the Environment) on 12 June 2019, with the approval document *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Approval 2014/7210 issued. The OMP was approved under the *Mining Management Act 2001* via Variation of Authorisation (VOA) 0059 (dated 13 November 2020).

1.2 Site Layout

The layout of the Mine is shown in Figure 2. The site can be broadly subdivided into five main operational areas:

- **Open Pit**: encompasses the Open Pit itself and associated infrastructure. It is surrounded by the Mine Levee Wall.
- **Administration** and **Concentrator area**: adjacent to the Open Pit and includes administration buildings and the mill and processing facility.
- **NOEF**: the principal waste rock emplacement facility at the Mine. It includes the OEF itself and supporting infrastructure as well as mechanical workshops and mining operations offices.
- **TSF**: includes the tailings depositional infrastructure and the Water Management Dam.
- **Accommodation Village**: includes the accommodation facilities and the McArthur River airport.

1.3 Scope and Purpose

This Adaptive Management Plan (AMP) has been prepared in accordance with the NT EPA *Guidance on Adaptive Management* (NT EPA, 2018b), as well as to address the requirements of the *Mining Management Plan Structure Guide for Mining Operations* (Department of Primary Industry and Resources [DPIR], 2017). The current version of the AMP focuses on adaptive management at the Mine during the mining operations phase. The AMP is intended to be a dynamic document and MRM will review and, where necessary, resubmit updated versions of the AMP for approval which incorporate adaptive management during the post-mining operations phase, in preparation for eventual site closure. This would include consideration of adaptive management for all relevant rehabilitation aspects in all domains.

Current regulatory conditions related to adaptive management include:

- Conditions 8, 17 and 48 of Waste Discharge Licence (WDL) 174-12 (dated 25 May 2021);
- Conditions 45, 46, 93 and 94 of VOA 0059 (dated 18 June 2021); and
- Condition 6 of the Commonwealth EPBC Act Approval 2014/7210 (dated 18 December 2020).

Previous iterations of the AMP were developed and submitted to address VOA Conditions 45, 46, 93 and 94 as listed above. The current version continues to be consistent with the requirements of these Conditions.

EPBC Act Approval 2014/7210 Condition 6 (noted above) has been considered and addressed where relevant in the preparation of this AMP, however, the submission date has not yet been triggered. Future revisions of the AMP will address all requirements of the EPBC condition.

The AMP has also been developed to ensure the OMP is implemented in a manner that protects the health of the McArthur River from mine-related impacts, consistent with the NT EPA overarching environmental outcome outlined in Assessment Report 86 (NT EPA, 2018a).

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LEGEND

Mineral Lease

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016)

McARTHUR RIVER MINE

Mine Site

Figure 2

1.3.1 Adaptive Management Process Overview

Adaptive management aims to provide a framework for sound management and decision-making in the face of uncertainty. It is a carefully planned and structured, iterative approach that facilitates improved management and decision making over time in response to evolving knowledge and changing circumstances. Fundamentally, it involves implementing evidence-based management actions, monitoring and evaluating the outcomes of these actions, and systematically adapting those actions according to what is learned.

Adaptive management has been recognised as an application of the precautionary principle. The precautionary principle provides for the application of precautionary measures or, where such measures cannot reduce the threat of serious or irreversible environmental harm, other appropriate actions, including prohibiting the activity from being carried out (NT EPA, 2018b).

Table 1 summarises the steps outlined in the NT EPA *Guidance on Adaptive Management* and where these steps are addressed in the AMP.

TABLE 1: ADAPTIVE MANAGEMENT PROCESS OVERVIEW

Step	Summary	AMP Section
Step 1: Define the management problem	Defines the management problem by analysing the ecosystem and establishing baseline conditions and an understanding of how these may be impacted by the development.	3.1, 3.3
Step 2: Establish clear environmental objectives	Defines clear environmental objectives to guide decisions that are specific, measurable, achievable, results-orientated and time-fixed (SMART).	3.2
Step 3: Identify uncertainties and hypotheses	Identifies uncertainties in any actions and modelling that have taken place to develop an understanding of the management problem.	3.3, 3.4
Step 4: Establish Performance Triggers	Establishes performance that can be used to identify the potential of environmental harm due to mining activities. Identify when performance deviates from objectives and thus trigger a change in management actions.	4, 5
Step 5: Identify and Implement Management Actions	Outlines management actions that can be implemented should trigger levels be exceeded. Actions should take into account industry best practice and relevant guidelines. Outlines the process for determining the most appropriate management.	5
Step 6: Monitor Ecosystem Response	Provides an overview of the monitoring programs that will be used to assess performance against the environmental objectives; records progress of management objectives, evaluates response to management of trigger value exceedances and develops an improved understanding of ecosystem function, status and dynamics.	4, 5
Step 7: Evaluate effectiveness	Provides an overview of the analysis and reporting procedures.	5, 8
Step 8: Adjust management actions	Process feedback from evaluations and adjust management for improved achievement of overarching management objectives.	5, 6, 7

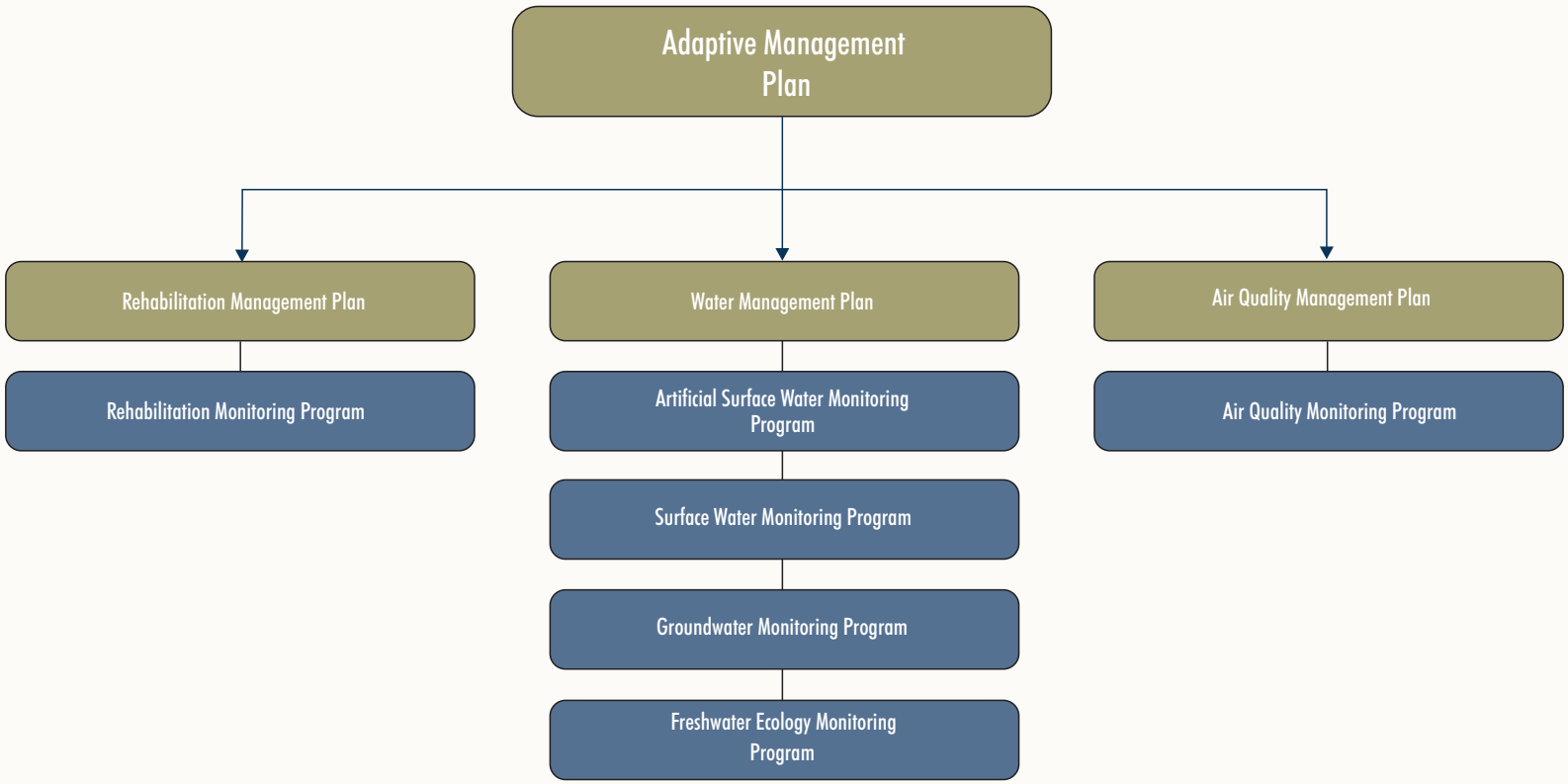
1.3.2 Adaptive Management Plan Structure

This management plan is the overarching document that provides the strategic framework for environmental management, monitoring, mitigation and reporting. Figure 3 shows the structure of the AMP, sub-management plans and monitoring programs.

Table 2 below provides a summary of the management plans of the AMP.

TABLE 2: SUB-MANAGEMENT PLAN SUMMARY

Management Plan	Description	Appendix
Water Management Plan (WMP) (MRM, 2021c)	The WMP describes: • the management of on-site water and the water management system, principles, wastewater discharge, monitoring, and site water balance; • the surface water setting, monitoring, and the management strategies implemented to protect surrounding river and tributaries from mining impacts; • the groundwater setting (groundwater and surface water interaction, hydraulic gradients), groundwater hydrogeological site model, monitoring and groundwater management; • the freshwater ecology setting surrounding the Mine, monitoring of aquatic fauna and the management protocols in place; and • the contaminants of potential concern within fluvial sediments, the fluvial sediment monitoring program and management strategy.	A
Air Quality Management Plan (AQMP) (MRM, 2020a)	The AQMP describes: • the regional and local air quality setting at the Mine, including climate, potential air emissions and potential receptors; • the sources of air emissions and associated management controls; and • the air quality monitoring programs.	B
Rehabilitation Management Plan (RMP) (MRM, 2021b)	The RMP describes: • the existing environment (landforms and land use, flora, terrestrial fauna, aquatic fauna, etc.); • rehabilitation planning (objectives, final landform concepts, progressive rehabilitation, etc.); and • rehabilitation implementation.	C



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McARTHUR RIVER MINE

Adaptive Management Plan
Structure

Figure 3

2. Legislation

2.1 Statutory Requirements

The Mine operates in accordance with Territory and Commonwealth approvals and regulatory obligations, including:

- VOA 0059 issued pursuant to the NT *Mining Management Act 2001*;
- Commonwealth EPBC Act Approvals 2003/954 and 2014/7210 issued pursuant to the EPBC Act;
- Mineral Lease Northern (MLN) conditions; and
- WDL 174 issued pursuant to section 74 of the NT *Water Act 1992*.

3. Problem Definition and Objectives

3.1 Environmental Assessments and Understanding of the Natural Environment

Over 25 years of environmental studies and assessments have been undertaken to understand the natural environment and assess the potential impacts of the Mine. These investigations were conducted in liaison with specialist consultants, NT EPA, DPIR (now DITT), Department of Environment and Natural Resources (now the Department of Environment, Parks and Water Security [DEPWS]) and other relevant stakeholders.

Five environmental impact assessments have been previously completed throughout the Mine life as follows:

- MRM Lead Zinc Silver Project, 1992;
- MRM Phase 2 Open Cut Project, 2006;
- MRM Open Cut Amendment Project, 2006;
- MRM Phase 3 Development Project, 2012; and
- MRM Overburden Management Project, 2018.

This AMP has been developed with a primary objective of protecting the McArthur River. The importance of the McArthur River and its environmental setting in the context of the Mine is summarised below and described in Appendix A.

Environmental objectives of the AMP are discussed in Section 3.2.

3.1.1 Surface Water Setting

The McArthur River is the regional surface water resource of relevance to the Mine (Figure 1), it drains some 20,000 square kilometres (km^2), and flows through MLN 1122 and 1124. The McArthur River was diverted around the Open Pit through the McArthur River Diversion Channel in the 2008/09 wet season. The McArthur River ultimately drains to the Gulf of Carpentaria east of BBLF.

The key watercourses proximal to the Mine site that form part of the McArthur River catchment are summarised as follows:

- McArthur River Diversion Channel consists of a 5.5 km diversion. The works have allowed open cut mining of the ore deposits beneath the McArthur River. The river was diverted to the east around the proposed footprint of the Open Pit. To protect the Open Pit from floodwater, a Mine Levee Wall has been constructed between the Open Pit and the McArthur River Diversion Channel.
- Barney Creek is an ephemeral (fleeting) waterway, only flowing during the wet season following large episodic rainfall. Barney Creek flows west to east and is crossed by the Carpentaria Highway to the south of the TSF.
- Barney Creek Diversion Channel is a 2.5 km diversion of the lower Barney Creek to divert the creek around the northern section of the Mine Levee Wall. The diversion begins to the north of the Concentrator area and cuts between the Open Pit and the NOEF. The junction of the Barney Creek Diversion Channel and the Old McArthur River is seasonally inundated. During peak flow events, backwater from the McArthur River can extend upstream along the Barney Creek Diversion Channel.
- Little Barney Creek Diversion Channel is a 2.9 km diversion of Little Barney Creek around the southern side of the TSF complex (including the Water Management Dam). The diversion re-joins Little Barney Creek and flows easterly to join Barney Creek. A culvert has been constructed to allow Little Barney Creek to flow under the Carpentaria Highway.

- Surprise Creek is also an ephemeral (fleeting) waterway, only flowing during the wet season following large episodic rainfall. The waterway originates to the northwest of the site and meanders to the north of the TSF before being crossed by the Carpentaria Highway. Downstream of the highway, Surprise Creek continues to flow south of the NOEF, converging with the Barney Creek Diversion Channel between the Open Pit and the NOEF.

- Bull Creek was intersected by the McArthur River Diversion Channel and flows into the diversion channel from the south. The Bull Creek catchment is not impacted by the Mine.

- Emu Creek flows southward along the western edge of the Bukalara Plateau. The creek flows past the northern extent of the NOEF and joins the McArthur River upstream of the Glyde River confluence.

- Glyde River originates in the sandstone ranges to the east of the Mine and converges with the McArthur River downstream and to the northeast of the Mine. The Glyde River catchment is not impacted by the Mine.

Wet Season

Background surface water quality in the McArthur River catchment during the wet season is typified by low total dissolved solids, low hardness and alkalinity and low electrical conductivity (EC) associated with surface water dilution from catchment runoff and frequent rainfall events. The pH typically ranges from 6.5 – 8.0 during the wet season.

Wet season flood pulses have high erosive forces, transporting sediments downstream, particularly from upstream catchments degraded by pastoral land use. The sediment-laden water contains high concentrations of total suspended sediments, including fine colloidal material, which results in turbid waters. The fine colloids also cause elevated concentrations of particulate metals associated with catchment regolith, including aluminium and iron.

Background water quality during flood pulses can also be influenced by the erosion of mineralised zones which occur at surface in the McArthur River catchment. These mineralised zones can result in naturally elevated particulate concentrations of metals such as copper, lead and zinc.

First flush and flood pulse events in the McArthur River catchment often result in the rapid mobilisation of catchment organic matter. The bacterial decomposition of this material often causes low dissolved oxygen concentrations during these times. Similarly, the mobilisation of partially decomposed organic matter can also cause naturally elevated concentrations of nutrients such as nitrate.

Dry Season

Background surface water quality in the McArthur River catchment during the dry season is typified by higher concentrations of total dissolved solids, moderate hardness, high alkalinity and moderate conductivity. These features are associated with the influence of mineral rich groundwater derived baseflow on the surface water quality. As a result, the pH typically ranges higher during the dry season from 7.5 to 8.5.

Flow in the McArthur River adjacent the Mine and the local tributaries occurs predictably every wet season, with cease to flow conditions common during the dry season. Recessional flow during the dry season is dictated by the catchment size and the magnitude of the previous wet season, which recharges the shallow groundwater systems responsible for sustaining baseflow. The local tributaries, including Barney, Surprise and Emu Creeks contain fleeting waters that typically cease to flow early in the dry season. Flow in the McArthur River is sustained for longer periods.

The cease to flow conditions and eventual drying of sections of the waterways influence water quality through the evapo-concentration of major solutes. The EC in background waters can range up to 2.2 millisiemens per centimetre during these conditions. The background dry season water is bicarbonate-dominant. Suspended sediments and total metal concentrations in background water during the dry season are typically low, with the exception of iron associated with expression of reduced groundwater in some background catchments. The low flow and cease to flow conditions are susceptible to influence from non-mine activities, including cattle waste from pastoral land use.

There are a number of zones of natural mineralisation present across the catchment and on the mineral leases that influence water quality during the dry season. These occur in the areas to the east of the Open Pit, which is intersected by and outcrops in the McArthur River Diversion Channel, and in the area around Barney Creek between the Concentrator and the TSF. Elevated concentrations of sulphate, lead, zinc, and copper in surface water have been recorded in these areas.

3.1.2 Geology and Mineralisation

The Mine is situated within the McArthur River floodplain, so the weathered and fresh bedrock of the Proterozoic McArthur Group are overlain by a variable thickness of Quaternary alluvial sediments which can reach up to 18 m in thickness in some parts. The McArthur Group is a sequence of Proterozoic formations that are extensive and predominantly dolomitic. These sequences are generally thicker than 4 km and consist of interbedded dolostones, siltstones, shales and sandstones.

The McArthur Group comprises two sub-groups; the Batten sub-group and the underlying Umbolooga sub-group. The Umbolooga subgroup of the McArthur River Group is comprised of interbedded cycle dolostones, dolomitic siltstone, sandstone and shale. The Batten subgroup overlies the Umbolooga and is comprised of a succession of shallow marine deposits, chiefly dolomitic siltstone, cherty dolostone, pyritic shale, quartz sandstone and evaporites.

The Bukalara Plateau, the main local geographic feature is composed of the Early Cambrian Bukalara Sandstone overlying folded Proterozoic material. The Plateau lays unconformably over dolomitic sediments in the McArthur Group. Bukalara Sandstone is jointed, slightly feldspathic and has distinctive cross-bedding.

Mineralisation occurs within several known and two inferred zones across the Mine. These zones have an influence on groundwater quality and have been defined by Logan and Associates (2018) based on consideration of pre-mining soil and sediment geochemistry as well as historic and recent drilling results.

The immediate Mine area geology includes the Barney Creek Formation and various identified dolomites (Teena, Mitchell Yard and Mara Dolomite).

Directly east of the Mine site is the Bukalara Plateau, which rises 20 metres (m) to 100 m above the surrounding land surface and is comprised mainly of lower Cambrian Bukalara Sandstone (Klohn Crippen Berger Ltd, 2017).

3.1.3 Groundwater Setting

Alluvium, weathered bedrock and bedrock (both fractured and intact) are the three main hydrostratigraphic units across the area. Groundwater gradient contours are from the west towards the east, and locally towards the ephemeral creeks, where discharge occurs. Groundwater levels exhibit a moderate to strong response to seasonal changes, with large fluctuations in groundwater levels between the wet and dry seasons (particularly near surface water systems).

There is significant variability in the groundwater quality across the Mine. Groundwater is neutral to slightly alkaline in pH. Groundwater quality is generally dolomitic (i.e. calcium/magnesium bicarbonate water type), influenced by the variability in geology. Natural mineralisation in the area results in elevated sulphate, metals and EC in certain locations.

3.1.4 Groundwater and Surface Water Interaction

Groundwater and surface water are connected directly through the following processes:

- **Recharge/Infiltration**: When a portion of rainfall runoff from rainfall events enters the groundwater system through infiltration/recharge processes. These processes can also occur through natural and artificial water bodies (i.e. OEF, TSF or other water management dams).
- **Toe and Basal Seepage**: When surface water enters the groundwater system through an OEF vertically via gravity (basal seepage) and horizontally via pressure gradients in the groundwater table (toe seepage). Seepage water can migrate to surface water systems.
- **Baseflow**: Baseflow describes the discharge of groundwater into streams, rivers or creeks. This occurs when the groundwater levels are higher than the natural surface water levels resulting in hydraulic flow from the groundwater system into the surface water system.

3.1.5 Modelling of Groundwater and Surface Water System

A groundwater numerical model was developed as part of the OMP EIS using MODFLOW SURFACT version 4.0 modelling software and Groundwater Vistas (Version 6.83) visualisation software. This model undergoes review on a three-yearly basis to ensure predictions are calibrated to recent groundwater observations. Further information on the groundwater numerical model is available in the WMP (Appendix A).

A site water balance is undertaken annually, prior to the wet season, to assess the historical performance of the water management systems as well as forecast performance over the following years. The forecast model considers 120 years of historical climate data (using the Queensland Climate Change Centre of Excellence SILO Patched Point Data Service for rainfall and evaporation data). Goldsim software is the modelling software used to simulate the Mine's water management system. The model has been validated against monitoring data dating to 2010. Further information on the site water balance is provided in the WMP (Appendix A).

Conceptual site models have also been developed to understand the potential risks posed by a source to a receptor. These conceptual site models integrate the understanding of surface water, groundwater, mining infrastructure and activities and the surrounding environment to demonstrate the interactions between each system, and are used to develop potential mitigation strategies on a source to receptor basis.

Through the EIS process and continuous improvement of environmental management, an in-depth understanding of site-wide environmental processes and the associated interaction with the Mine has been developed.

3.1.6 Freshwater Ecology Setting

The McArthur River reach above the Mine is characterised by a low-sinuosity channel with many anabranches within a broad level floodplain. Outcropping rock supports riffle habitats at several locations. Long, deep pools separated by glides/runs and riffles are common. Edge habitats are present as near-vertical banks, with root masses formed by fringing riparian vegetation. A single uniform channel with low sinuosity characterised the original McArthur River overlying the main orebody. Broad depositional levees, tributary gullies and discontinuous flood channels were present. Instream habitat commonly included pools separated by shallow glides/runs with near-vertical banks.

Following construction of the Diversion Channel, the Mine reach is characterised by the remnants of the original McArthur River, and substrates are dominated by fine silt and mud. Sandstone ridges of the Bukalara Range contain the downstream section of the McArthur River. The river then emerges onto a broad alluvial plain approximately 20 km downstream of the mineral leases. Instream habitats in this area include long shallow runs and occasional pools, with riffle habitats occurring intermittently below the Bukalara Range.

During the dry season, lengths of the main McArthur River channel can cease to flow and become dry. Groundwater-fed pools become important for the survival of aquatic fauna during the dry season, particularly larger species such as Freshwater Sawfish (*Pristis pristis*) that require a larger area and diverse food source. Within the Mineral Lease, the only body of water considered a true dry season refuge pool is Wurrini Waterhole. During dry season conditions, the approximate dimensions of Wurrini Waterhole are 800 m in length, 30 m average width, 2.37 m average depth, maximum depth of 4.77 m, and a total storage volume of 32,600 cubic metres (WRM Water & Environment Pty Ltd, 2021). Other regionally-significant true dry season refuge pools include Eight Mile Waterhole located 6 km upstream of the Mineral Lease boundary, and Waranguri Lagoon located 12 km downstream of the Mineral Lease boundary.

Three listed species of conservation significance as defined by the EPBC Act have been identified in the McArthur River. These species include the Freshwater Sawfish (vulnerable migratory species), Freshwater Crocodile (*Crocodylus johnstoni*) (marine) and Estuarine Crocodile (*Crocodylus porosus*) (marine migratory species). In addition, the Gulf Snapping Turtle (*Elseya lavarackorum*) (listed as endangered) has been recorded in neighbouring river systems, though not the McArthur River.

Commonly consumed aquatic fauna species such as crustacea (cherabin), molluscs (freshwater mussel) and fish (Barramundi [*Lates calcarifer*], Sooty Grunter [*Hephaestus fuliginosus*], and more) also exist within the McArthur River.

In contrast to the conservation significance of the McArthur River, the creeks occurring on the Mineral Lease, including Barney and Surprise Creeks, are highly ephemeral and are not considered important refugia for the persistence of any aquatic species. In addition, these creeks do not provide a major ecological role within the wider McArthur River catchment.

3.2 Environmental Objectives

The NT EPA Assessment Report 86 (NT EPA, 2018a) overarching environmental outcome is reproduced below as follows:

Ensure the health of the McArthur River is protected along its whole length at all times from mine related impacts.

Key environmental objectives have been developed as a result of environmental assessment processes (including EISs), environmental risk assessments, stakeholder engagement and feedback, development of management and monitoring plans, specialist investigations, independent monitoring reviews and regulatory approvals.

The key environmental management objectives for the Mine are described as follows:

1. Protect the McArthur River beneficial uses and community values from mining impacts.
2. Facilitate development of the ecosystems and their functions along the McArthur River Diversion Channel for terrestrial and aquatic flora and fauna.
3. Achieve a recovering trend in the water quality and ecosystem function in creeks on the Mine site within 20 years of cessation of mining.
4. Minimise air quality related impacts from the Mine's operations with respect to community health and the environment.

The overarching objectives are supplemented by performance indicators and associated SMART environmental triggers detailed in sub-management plans and Section 5. The environmental objectives and the connections to sub-management plans are detailed in Figure 4.

Future revisions of the AMP will provide further details on monitoring and assessment of performance relevant to environmental objective 3, and post-closure aspects will be addressed in further updates towards the end of operations, including relevant adaptive management criteria.

The terms 'community values' and 'beneficial uses', as referred to in Objective 1, have been defined below.

Community Values

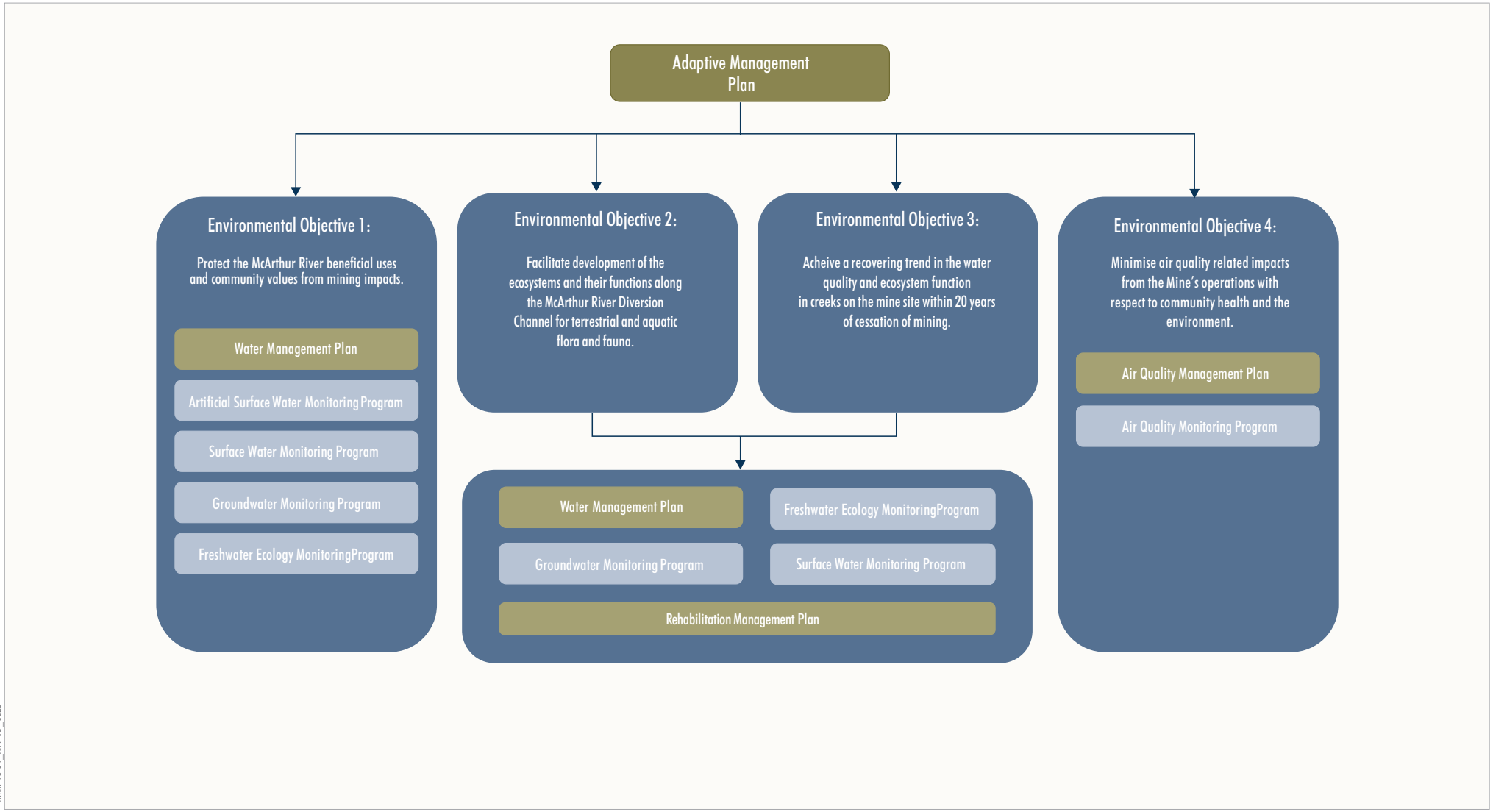
Community values are particular values or uses of the environment that are important for a healthy ecosystem or for public benefit, health, safety or welfare, and require protection from the effects of stressors.

The term 'environmental value', used extensively in the NT EPA Assessment Report 86 (NT EPA, 2018a), has been superseded by the term 'community value' in the updated ANZG (2018). MRM has adopted the updated term 'community value' in the AMP, however, both terms have the same meaning.

In accordance with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018), MRM has identified the following community values for the receiving waters downstream of the Mine:

1. aquatic ecosystem protection (slightly to moderately disturbed);
2. primary industries including stock drinking water, irrigation and general water uses;
3. recreation and aesthetics; and
4. cultural and spiritual values.

Typically, the most stringent water quality objectives are associated with the protection of aquatic ecosystems. Where more stringent water quality guidelines have been identified for other McArthur River community values (e.g. primary industries, recreation and aesthetics or cultural and spiritual), these have been incorporated into MRM's environmental monitoring program as performance indicators in addition to the aquatic ecosystem values.



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McARTHUR RIVER MINE

Overview of the Adaptive Management Plan and Environmental Objectives, and Associated Management Plans

Figure 4

Beneficial Uses

WDL 174 lists the following beneficial uses as declared under the *Water Act 1992* (NT) and the sensitivity of the surrounding land use and environment in the vicinity of the Mine. These include:

- Declared beneficial uses and/or water quality objectives:
  - McArthur River Area: aquatic ecosystem protection, recreational water quality and aesthetics (Gazette references G9 11 March 1998 and G20 27 May 1988); and
  - McArthur River Catchment Area: environment, cultural and riparian (Gazette reference G10 14 March 2001).
- Sites of conservation significance (SOCS):
  - Sir Edward Pellow Island group (SOCS No. 33);
  - McArthur River coastal floodplain (SOCS No. 34); and
  - Borroloola area (SOCS No. 35).

3.3 Source – Pathway – Receptor Model

The source-pathway-receptor (SPR) conceptual site model is used by MRM to determine environmental risks from potential contaminant sources (e.g. areas of the Mine associated with high environmental risk) to a receptor (e.g. McArthur River). This is summarised in Figure 5.

The SPR model is robust and allows undesirable conditions to be identified at all stages through monitoring of the source, pathway and the receptor. A comprehensive understanding of the SPR model allows for effective and targeted mitigation strategies. Key elements of the model include:

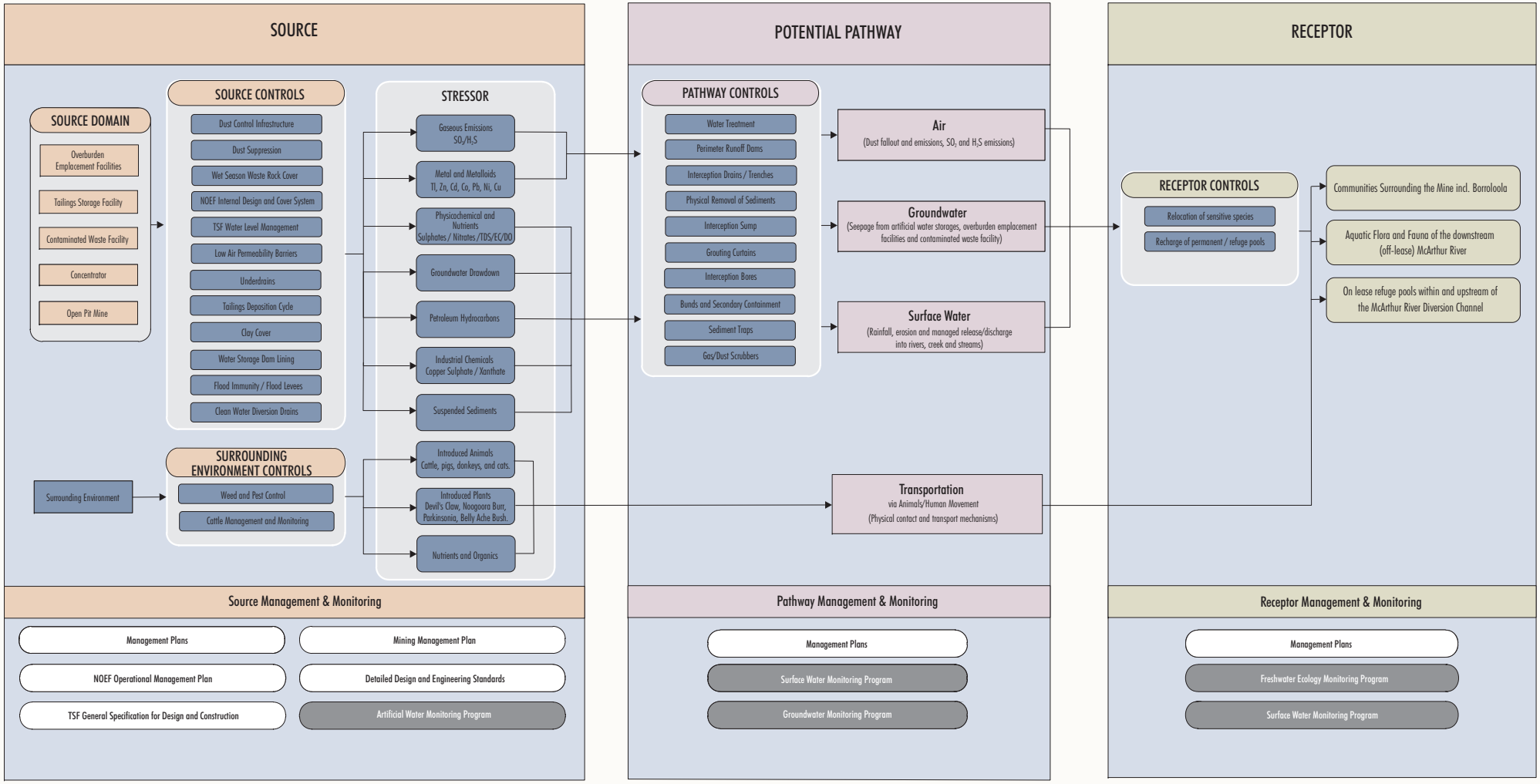
- prioritising the management of potential contamination at sources (preventing and minimising contamination at the source is the most effective strategy in SPR risk management);
- utilising pathway controls to limit the transmission of contaminants of potential concern (COPCs) from the source to the receiving environment;
- monitoring of on-lease surface water, groundwater, fluvial sediment and aquatic fauna for early identification of adverse or unexpected trends prior to potential off-lease impacts; and
- monitoring of off-lease and sensitive receptors including surface water, fluvial sediments and aquatic fauna to confirm environmental objectives are being met.

Section 3.3.1 describes the basis of identification of COPCs for the Mine, as well as potential sources for each. While the COPCs described have been specifically chosen due to their relevance to the Mine site and potential to impact the environment, MRM will continue to monitor for all analytes listed in Appendix 3 of the WDL.

3.3.1 Contaminants of Potential Concern

The open cut mining process involves the removal of large quantities of overburden to access the orebody located deeper beneath the surface. The characteristics of the overburden varies with depth and location within the Open Pit. Some overburden may have potential impacts on the environment if it is not managed correctly, whereas others are environmentally benign and provide useful resources for construction and rehabilitation.

MRM's target ore is a base metal sulphide deposit that has a relatively high proportion of sulphide minerals (including pyrite) in the rocks. Consequently, overburden may also contain a high proportion of sulphide minerals and base metals.



MRM-16-01_AMP VD_001B

McARTHUR RIVER MINE

Source - Pathway - Receptor
Conceptual Site Model

Figure 5

Sulphide minerals can oxidise when exposed to oxygen and water, generating sulphuric acid and secondary oxidation products in the process. The generation of acid liberates metallic oxides, sulphates and other major ions, which may be soluble to varying degrees, depending on the pH of the water. Certain types of overburden are also at risk of spontaneous combustion. Spontaneous combustion is the propensity of some sulphide and carbon-rich rocks to self-heat due to rapid oxidation. It is characterised by high temperatures and the emission of gases, in particular sulphur dioxide.

At the Mine, the term Acid and Metalliferous Drainage (AMD), is used to refer to all possible impacts from sulphide oxidation including saline drainage (SD), neutral metalliferous drainage (NMD) and acid drainage (AD). These broad sub-categories reflect differing behaviours, differing environmental risks/impacts, and differing remediation strategies:

- **Saline Drainage (SD)**: refers to drainage characterised by elevated salinity, with circumneutral pH, and metal concentrations similar to background levels.
- **Neutral Metalliferous Drainage (NMD)**: refers to drainage characterised by circumneutral pH waters with elevated metal concentrations and potentially elevated salinity.
- **Acid Drainage (AD)**: specifically refers to drainage characterised by acidic pH, and potentially elevated salinity and elevated metal concentrations.

The COPCs at the Mine include sulphur dioxide and sulphate as the primary indicators of sulphide oxidation/mine waste reactivity/spontaneous combustion. The COPCs also include lead and zinc as reaction products from the sulphide oxidation and as pH-sensitive metals (i.e. significantly more soluble and mobile as acidification occurs).

Cadmium, cobalt, nickel and thallium are indicators of potential NMD and AD. Copper sulphate reagent is used extensively during the processing of ore and is highly toxic in freshwater environments.

COPCs for water quality were assessed through a risk assessment undertaken by Klohn Crippen Berger Ltd (2020). Contaminants with the highest-ranking risk to the surrounding environment were recommended for site-specific guideline value (SSGV) development. Specifically, these were: thallium, zinc, cadmium, cobalt, sulphate, lead, nickel and copper. EC was also recommended for SSGV development so that its utility as an indicator of water quality could be employed.

Sulphate

Waste rock at the Mine is enriched in sulphide minerals (sphalerite, galena and pyrite). Sulphide oxidation has a significant influence on water quality at the site. The sulphur species generated from sulphide oxidation is sulphate and as such, sulphate is an important indicator to assess the potential impacts on water quality from the Mine.

Sulphur Dioxide

Spontaneous combustion is the propensity of some sulphide and carbon rich rocks to self-heat due to rapid oxidation. It is characterised by high temperatures and the emission of gases, in particular sulphur dioxide. Sulphur dioxide emissions can affect air quality and potentially impact community health. Sulphur dioxide monitoring remains an important indicator for air contamination.

Lead

Lead is principally released through the oxidation and weathering of sulphide minerals, especially galena. Since common lead minerals such as sulphides, sulphates, oxides, carbonates, and hydroxides are near insoluble in natural waters, levels of dissolved lead in aquatic ecosystems are generally low; however, decreasing pH increases solubility and the bioavailability of divalent lead.

Zinc

Zinc is principally released through the oxidation and weathering of sulphide minerals, especially sphalerite. In aqueous solutions, zinc is amphoteric, that is, it dissolves in acids to form the hydrated cations Zn^{2+} and in strong bases it forms zincate anions. Chemical speciation of zinc is affected primarily by pH and alkalinity. The greatest dissolved zinc concentrations occur in water with low pH, low alkalinity, and high ionic strength.

Cadmium, Cobalt, Nickel and Thallium

These occur as enriched trace to minor metals/metalloids at the Mine. They are indicative of potential water quality impact from mining waste including NMD and AD.

Copper

Copper is used extensively onsite as copper sulphate and copper mud reagent during ore processing. Levels of copper in aquatic ecosystems are generally low; however, copper sulphate is soluble in natural waters. The presence of copper in natural waters could indicate impact from ore processing. Additionally, the McArthur River Diversion Channel intercepts a minor zone of natural copper mineralisation (named Cooley II copper prospect).

3.3.2 Potential Site Contaminant Sources

As discussed in Section 3.3.1, principal sources of environmental risks at the Mine include the development of AMD and the transport of potential contaminants associated with mining and processing activities. Practices that prevent or limit the oxidation of sulphide materials are therefore the most effective controls for minimising potential risk to the receiving environment.

Significant research and investment have been made into the design of the key facilities and associated preventative controls as part of the OMP development. In addition, a number of additional controls were recommended by NT EPA Assessment Report 86 (NT EPA, 2018a), such as the increase of the basal Compacted Clay Liner (CCL) from 0.25 m to 0.5 m.

Table 3 describes the potential site contaminant sources of COPCs, including the relevant domain, stressor and preventative controls.

TABLE 3: POTENTIAL SITE SOURCES OF COPCS

Domain	Source	Stressor	Preventative Controls
NOEF	Waste rock	Metals and metalloids Physicochemical and nutrients Gaseous emissions Suspended sediments	OMP emplacement methodology: Low permeability base Internal architecture Low air permeability barriers Wet season covers NOEF internal design and cover system Flood immunity / levees Dust suppression Waste rock classification Wet season waste rock caps
	Perimeter Run-off Dams (PRODs) Sumps Water Drains	Metals and metalloids Physicochemical and nutrients Suspended sediment	Low permeability liners Underdrains Flood immunity / levees Clean water diversion drains
Open Pit	OEFs waste rock	Metals and metalloids Physicochemical and nutrients Gaseous emissions Industrial chemicals	Clay cap (Western Overburden Emplacement Facility [WOEF]) Flood immunity (Mine Levee Wall) Waste rock classification Wet season waste rock caps
	Dams and sumps	Metals and metalloids Physicochemical and nutrients Suspended sediment	Low permeability liners Operational controls (TARPs) Water storage dam lining

Domain	Source	Stressor	Preventative Controls
	Open Pit	Metals and metalloids Physicochemical and nutrients Petroleum hydrocarbons Gaseous emissions Groundwater drawdown	Dust suppression Flood immunity (Mine Levee Wall)
	Run-of-mine (ROM) Pad	Metals and metalloids Physicochemical and nutrients Petroleum hydrocarbons	Dust suppression Flood immunity (Mine Levee Wall)
TSF	Tailings Active Cell process water	Metals and metalloids Physicochemical and nutrients Industrial chemicals	Slurry dewatering Deposition cycle Active Cell water management Operational controls (TARPs)
	Water Management Dam	Metals and metalloids Physicochemical and nutrients	Water quality and level management Operational controls (TARPs)
	Contaminated Waste Facility	Metals and metalloids Physicochemical and nutrients Petroleum hydrocarbons Industrial chemicals	Low permeability liners Operational controls (TARP)
Concentrator	Mill and processing plant	Metals and metalloids Petroleum hydrocarbons Industrial chemicals (e.g. copper sulphate) Gaseous emissions	Dust control infrastructure Tanks / primary containment Operational controls (TARPs) Flood Immunity

TARP = trigger action response plan (refer Section 5).

In addition to the controls listed in Table 3, the design and management of the facilities at the Mine are governed by the following:

- Conceptual designs and environmental controls outlined in the Mining Management Plan.
- Detailed designs, technical specifications, construction methodologies endorsed by the Independent Certifying Engineer (ICE) and/or Independent Tailings Storage Facility Review Board.
- Quality Assurance and Quality Control requirements. This includes sampling, testing and surveying requirements outlined in the above documents that are subject to approved construction hold points and witness/inspection requirements.
- Relevant Australia Standards and other construction standards.

3.3.3 Potential Site Contaminant Pathways

Airborne and waterborne (via surface water or groundwater) transport are the two dominant mechanisms for the transport of contaminants from sources to receptors in natural systems at the Mine.

Of these mechanisms, waterborne transport has the greatest potential to provide pathways from source to receptor, and unlike airborne contamination, waterborne pathways can remain active for significant periods. The principal waterborne pathways are associated with the infiltration and runoff of rainwater.

Infiltrated rainwater can express at the toe of stockpiles and travel overland or cause basal seepage and enter groundwater. Overland flow and groundwater can discharge to surface water features, such as local creeks, that then act as downstream transport mechanisms for contaminants.

The principal potential site pathways are presented in Table 4.

TABLE 4: POTENTIAL SITE PATHWAYS OF COPCS

Domain	Potential COPC Pathway	Pathway Controls
NOEF	Rainfall run-off Rainfall infiltration and seepage Surface Waters: • Barney Creek Diversion Channel • Surprise Creek • Emu Creek	Perimeter Runoff Dams Interception sumps Interception drains Interception bores Operational controls (TARPs) Water treatment (lime treatment) Fluvial sediment removal
	Groundwater (basal seepage)	NOEF Groundwater interception scheme Interception sumps
Open Pit	Rainfall run-off Rainfall infiltration and seepage Surface Waters: • Barney Creek Diversion Channel • McArthur River Diversion Channel	Mine Levee Wall Open Pit draw down Operational controls (TARPs) Interception sumps Water treatment (lime treatment)
	Groundwater (basal seepage)	Open Pit draw down Void dewatering Water treatment (lime treatment)
TSF	Rainfall run-off Rainfall infiltration and seepage Surface Waters: • Surprise Creek • Little Barney Creek	Interception sumps Interception drains Interception bores Water Management Dam Operational controls (TARPs) Water treatment (lime treatment)
	Groundwater (basal seepage)	Engineered construction Grouting curtain Interception bores TSF Surprise Creek interception scheme
Concentrator	Rainfall run-off Rainfall infiltration and seepage Surface Waters: • Barney Creek • Barney Creek Diversion Channel	Anti-pollution / runoff ponds Bunds and secondary containment Fluvial sediment removal
	Groundwater (basal seepage)	Interception bores
	Air (dust and gas)	Dust extractors Gaseous scrubbers
All	Transportation via Animals or Human Movement	Cattle Management (exclusion zones and mustering) Weed Management Pest Control

3.3.4 Potential Receptors

The potential receptors of the COPCs discussed in Section 3.3.2 are:

- aquatic flora and fauna of the downstream (off lease) McArthur River;
- on-lease refuge pools within and upstream of the McArthur River Diversion Channel; and
- communities surrounding the Mine.

The controls for the potential receptors are the same as those listed for the Source (Section 3.3.2) and Pathways (Section 3.3.3), with the addition of "artificial recharge of on-lease refuge pools".

3.4 Environmental Risk Assessment

MRM has undertaken an environmental risk assessment to identify the likelihood, severity and consequence of potential scenarios due to mining activities, see Appendix 1 of the *January 2020 Mining Management Plan* (MRM, 2020b).

The risk management processes are consistent with International Organization for Standardization (ISO) 31000:2018 *Risk Management –Guidelines.* The risks associated with the potential environmental issues identified were ranked in accordance with the frameworks detailed in ISO 31000:2018 *Risk Management –Guidelines,* and *Handbook 203:2012 Managing Environment-related Risk.* The risk ranking is consistent with the risk assessment completed for the Draft OMP EIS (Operational Risk Mentoring, 2017).

The following environmental scenarios were determined to represent the highest environmental risk:

- Seepage from the NOEF including potentially acid-forming material giving rise to AMD and potentially significant impacts on surface water quality and aquatic habitat.
- Inappropriate storage of waste rock leads to significant contamination of surface water and groundwater systems.
- TSF embankment failure with subsequent release of tailings and sediment causing significant environmental damage.

After the implementation of scenario-specific and effective controls, the residual environmental risk of all assessed scenarios was reduced to moderate and low.

The environmental risks associated with the Mine was a key consideration in the development of the AMP environmental objectives. Control measures identified in the environmental risk assessment process have been incorporated into this AMP.

4. Environmental Management & Monitoring

4.1 Environmental Management Strategy

MRM operates an extensive Environmental Management Strategy (EMS), prepared with the assistance of external experts.

The purpose of the EMS is to provide structured and formal guidance to the operation to achieve the four key environmental objectives, based on the Plan, Do, Check, Act (PDCA) Model. The objectives have been developed through the outcomes of environmental assessment processes (including EISs), stakeholder engagement and feedback, development of management and monitoring plans, independent monitoring reviews and regulatory approvals.

A summary of the PDCA model and how it aligns to the MRM EMS is provided below and in Plate 1:

1. **Plan** - Includes formal management plans that describe overarching objectives and targets (including key performance indicators), potential environmental risks, appropriate controls and relevant TARPs (e.g. AMP).

2. **Do** - Implementation of the controls as described in the relevant management plans (e.g. the MMP) to manage potential environmental risk from operational activities to an acceptable level.

3. **Check** - Implementation of MRM's comprehensive environmental monitoring program to monitor environmental performance and verify that controls are working to achieve the four key objectives.

   Monitoring includes on-site monitoring (an early indicator of control performance and potential environmental risk) and off-site monitoring (to verify that operations are having no material impact on the environment). External experts are engaged to assist with the check phase including collection, review and analysis of environmental monitoring data.

   This phase also includes external independent checks such as the Independent Monitor and various other independent bodies (i.e. Independent Tailings Review Board and the ICE).

4. **Act** - Implementation of the AMP and relevant TARPs (including additional controls over and above those proposed in the EIS and MMP) in response to monitoring data analysis.

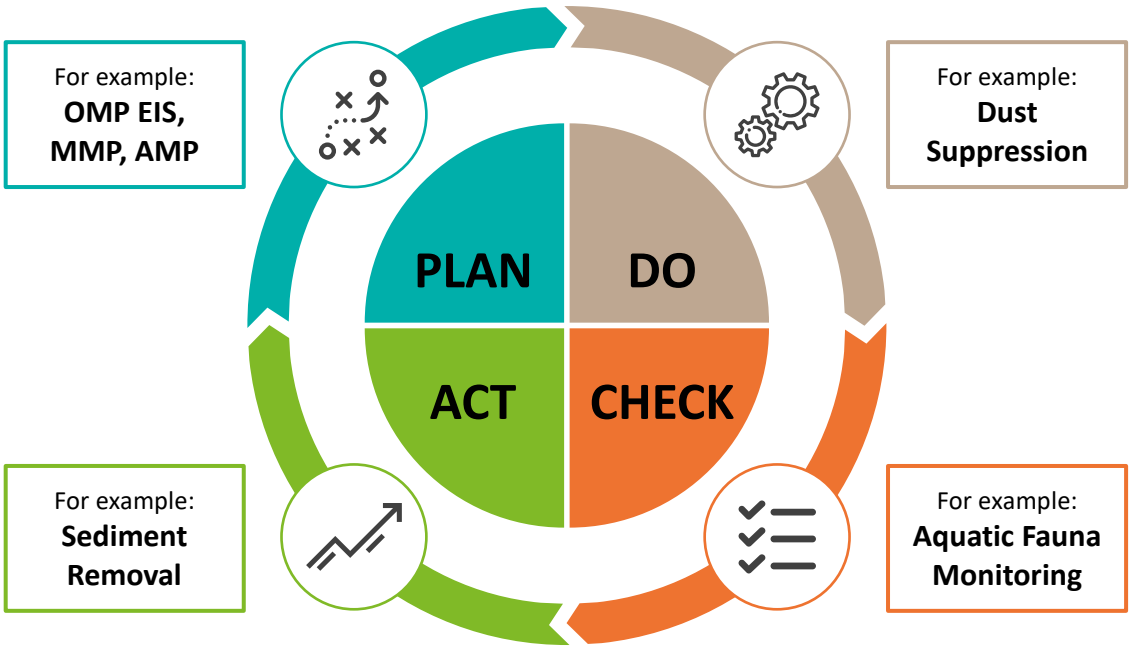


Plate 1: Plan, Do, Check, Act Model

4.2 Standards and Guidelines

International and Australian standards and guidelines were incorporated into this AMP to assist in the development of performance indicators, monitoring programs and trigger action response plans (TARPs). A summary of the guidelines that were used to assist in the development of performance criteria is detailed in Table 5.

TABLE 5: MANAGEMENT PLAN STANDARDS AND GUIDELINES

Management Plan	Performance Indicator Guidelines
WMP (Appendix A)	• *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018) • *Sediment quality assessment: A practical guide* (Simpson and Batley, 2016) • *Guidelines on the Environmental Management of Dams* (Australian National Committee of Large Dams [ANCOLD], 2019) • *Preventing Acid and Metalliferous Drainage Guidelines* (Department of Industry, Innovation and Science, 2016) • *Australian Drinking Water Guidelines* (National Health and Medical Research Council, 2011) • *Practical Guide to Catchment Based Water Management* (International Council of Mining and Metals, 2017) • Site-specific Trigger Values (SSTVs) (WDL 174) • *Guidelines for groundwater quality protection in Australia* (Department of Agriculture and Water Resources, 2013) • *Environmental Assessment Guidelines Acid and Metalliferous Drainage* (NT EPA, 2013a) • *Guidelines on Mixing Zones* (NT EPA, 2013b) • *Guidelines for the Preparation of an Environmental Management Plan* (NT EPA, 2015) • *Global Acid Rock Drainage Guide* (International Network for Acid Prevention, 2009) • Glencore Water Management Guidelines
AQMP (Appendix B)	• *National Environment Protection (Ambient Air Quality) Measure* (as amended May 2021) • *Approved Methods for the Modelling and Assessment of Air Pollutants* (New South Wales Environment Protection Authority, 2016)
RMP (Appendix C)	• *Northern Territory Draft Guidelines for Mine Closure Plan* (NT DME, 2016) • *Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure* (ANCOLD, 2012)

4.3 Environmental Monitoring Programs

Weight-of-evidence describes the process to collect, analyse and evaluate a combination of different qualitative, semi-quantitative or quantitative lines of evidence to make an overall assessment of environmental management. It is the central platform for water quality assessments in ANZG (2018). Applying a weight-of-evidence process incorporates judgements about the quality, quantity, relevance and congruence of the data contained in the different lines of evidence.

The weight-of-evidence approach employed by MRM includes extensive water quality, biological and sediment monitoring downstream of the Mine. The numerous environmental monitoring programs are used to assess performance against the environmental objectives, record progress of management objectives, evaluate response to management of trigger value exceedances and develop an improved understanding of ecosystem function, status and dynamics. Monitoring requirements for the Mine are conditioned in WDL 174-12, VOA 0059, EPBC Act Approval 2003/954 and EPBC Act Approval 2014/7210. The monitoring programs, as multiple lines of evidence (MLE), are used holistically to inform the ongoing health of the McArthur River.

The environmental monitoring programs for the Mine are subject to routine reviews and updates as required under the conditions of these approvals, and to ensure monitoring data collected continues to allow for an assessment of performance against the environmental objectives to be made.

MRM will conduct monitoring in accordance with the MRM Environmental Monitoring Schedule (as may be updated from time to time) (MRM, 2021a). The monitoring programs undertaken at the Mine are summarised in Table 6.

The locations of the environmental monitoring sites are shown on Figures 6 to 16[1].

[1] Figures 6 to 16 include some historical sites. The MRM Environmental Monitoring Schedule provides the current monitoring site list required to satisfy the requirements of WDL 174.

TABLE 6: ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Management Plan	Monitoring Program	Sites	Monitoring Parameter/Analysis	Monitoring Frequency
WMP (Appendix A)	Surface Water Quality, Flow and Discharge (Figures 6 and 7)	• McArthur River and McArthur River Diversion Channel. • Barney Creek and Barney Creek Diversion Channel. • Emu and Surprise Creeks. • Glyde River. • McArthur River Catchment gauging stations. • Water levels and quality in refuge pools/waterholes, upstream and downstream of the Mine and within the McArthur River Diversion Channel.	• Physicochemical parameters. • Metals and metalloids (total and filtered). • Hydrocarbons (at select sites). • Streamflow. • Abstracted volumes. • Water levels.	• Weekly, monthly and during discharge depending on site.
WMP (Appendix A)	Artificial Surface Water Quality (Figure 8)	• Artificial waterbodies surrounding the TSF, NOEF, Open Pit and Concentrator area.	• Physicochemical parameters. • Metals and metalloids (total and filtered). • Hydrocarbons (at select sites). • Waste discharge volumes (at select sites).	• Weekly, monthly or event based depending on the site.
WMP (Appendix A)	Fluvial Sediment (Figure 6)	• McArthur River and McArthur River Diversion Channel. • Barney Creek and Barney Creek Diversion Channel. • Emu and Surprise Creeks. • Glyde River.	• Metals and metalloids. • Lead isotope ratios. • Physicochemical parameters.	• Annually.
WMP (Appendix A)	Groundwater Quality (Figure 9)	Groundwater monitoring bores are situated surrounding potential contaminant sources, natural mineralised zones and adjacent downstream receptors including the TSF, the Concentrator Area, the Open Pit, the NOEF, and Wurrini Waterhole.	• Physicochemical parameters. • Metals and metalloids (filtered). • Hydrocarbons at select sites.	• Quarterly, Bi-Annually and annually depending on the site.
WMP (Appendix A)	Groundwater Level (Figure 10)	• Groundwater monitoring bores surrounding Wurrini Waterhole. • TSF. • Concentrator Area. • Open Pit. • NOEF. • Underground workings.	• Groundwater Level, measured as manual dip levels at all monitoring bores and high frequency pressure transducers in approximately 125 bores.	• Wurrini Waterhole is assessed quarterly. • The Underground workings water level is recorded daily. • Manual dip levels collected bi-annually. • High frequency level measurements taken at least every four hours.

Management Plan	Monitoring Program	Sites	Monitoring Parameter/Analysis	Monitoring Frequency
WMP (Appendix A)	Aquatic Abundance and Diversity (Figures 11 and 13)	• McArthur River and McArthur River Diversion Channel. • Barney Creek and Barney Creek Diversion Channel. • Surprise Creek. • Glyde River. • Kilgour River.	• Aquatic Fauna Abundance, including the use of non-lethal sampling methods. • Aquatic Fauna Diversity, including the use of non-lethal sampling methods.	• Bi-Annually (early and late dry season).
WMP (Appendix A)	Macroinvertebrate (Figure 12)	Performance Indicator Sites: • McArthur River and McArthur River Diversion Channel, Barney Creek Diversion Channel and Surprise Creek. Reference Sites: • Barney Creek, Upstream McArthur River, Caranbirini Creek, Leila Creek, Amelia Creek and Glyde River.	• Macroinvertebrate species abundance and diversity.	• Annually.
WMP (Appendix A)	Metals in Aquatic Fauna (Figure 14)	Performance Indicator Sites: • McArthur River and McArthur River Diversion Channel, Barney Creek Diversion Channel and Surprise Creek. Reference Sites: • Limmen River, Robinson River, Upstream McArthur River, Upstream Barney Creek.	• Metals in Aquatic Fauna, including the use of non-lethal sampling methods where practicable.	• Annually.
AQMP (Appendix B)	Air Quality (Figure 15)	• Depositional dust sites are located between significant potential sources (such as the Concentrator) and pathway/receptor sites.	• Sulphur dioxide monitoring. • High Volume Air Sampler – TSP and metals. • Depositional dust.	• Continuous (Sulphur dioxide). • 24 hours every 6th day (High Volume Air Sampler). • 30 days (dust deposition).
RMP (Appendix C)	Revegetation Monitoring Program (Figure 16)	• Barney Creek Diversion Channel. • McArthur River Diversion Channel.	• Vegetation Surveys. • Erosion Assessment. • Weed Assessment. • Photo monitoring. • Fauna Disturbance.	• Annually.

MRM-16-01_AMP_VD_210A

LEGEND

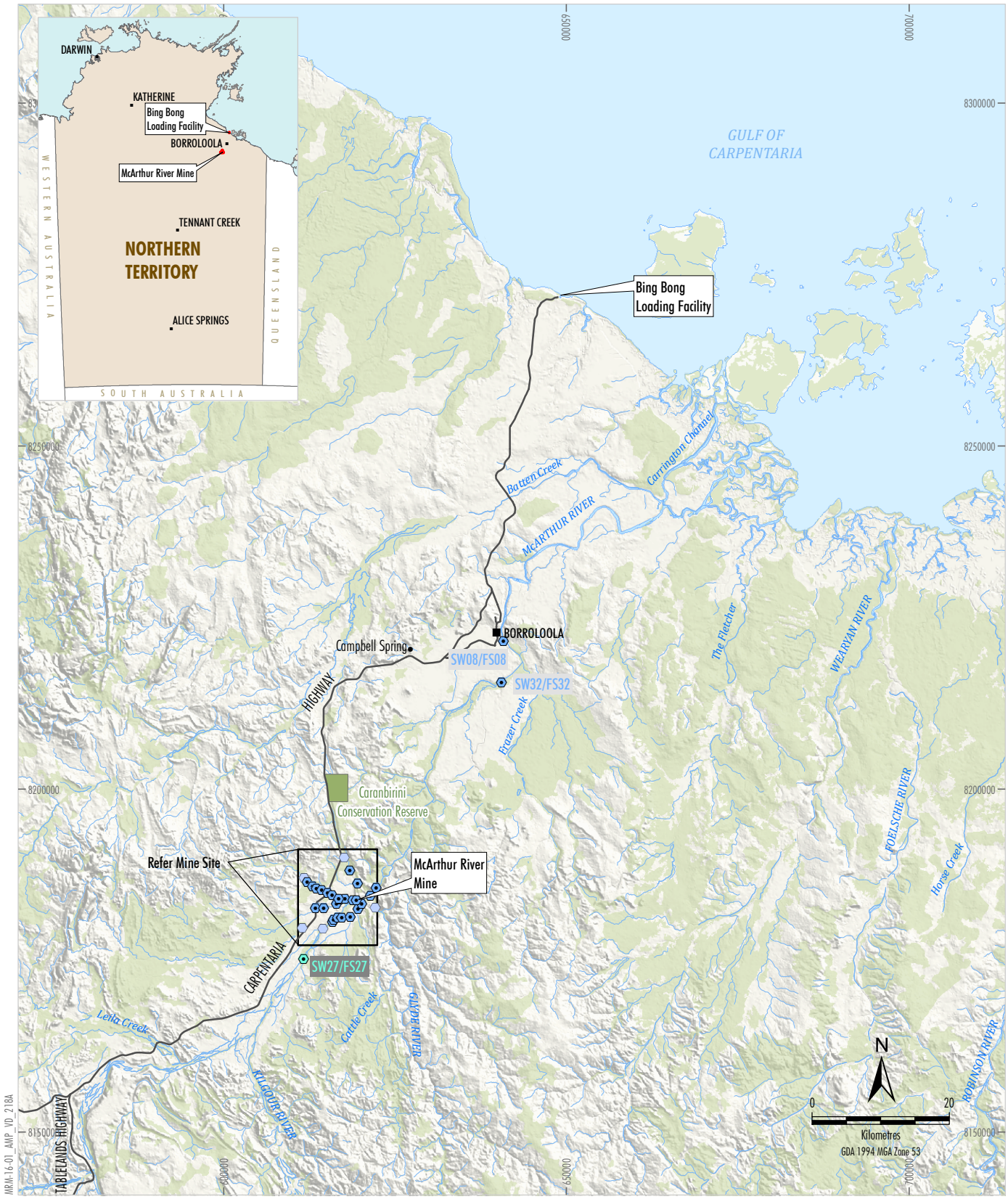
- Natural Surface Water Reference Site
- Natural Surface Water Monitoring Site

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2018)

McARTHUR RIVER MINE

Local Surface Water and Fluvial Sediment Monitoring Sites

Figure 6a



MRM-16-01_AMP_VD_218A

LEGEND

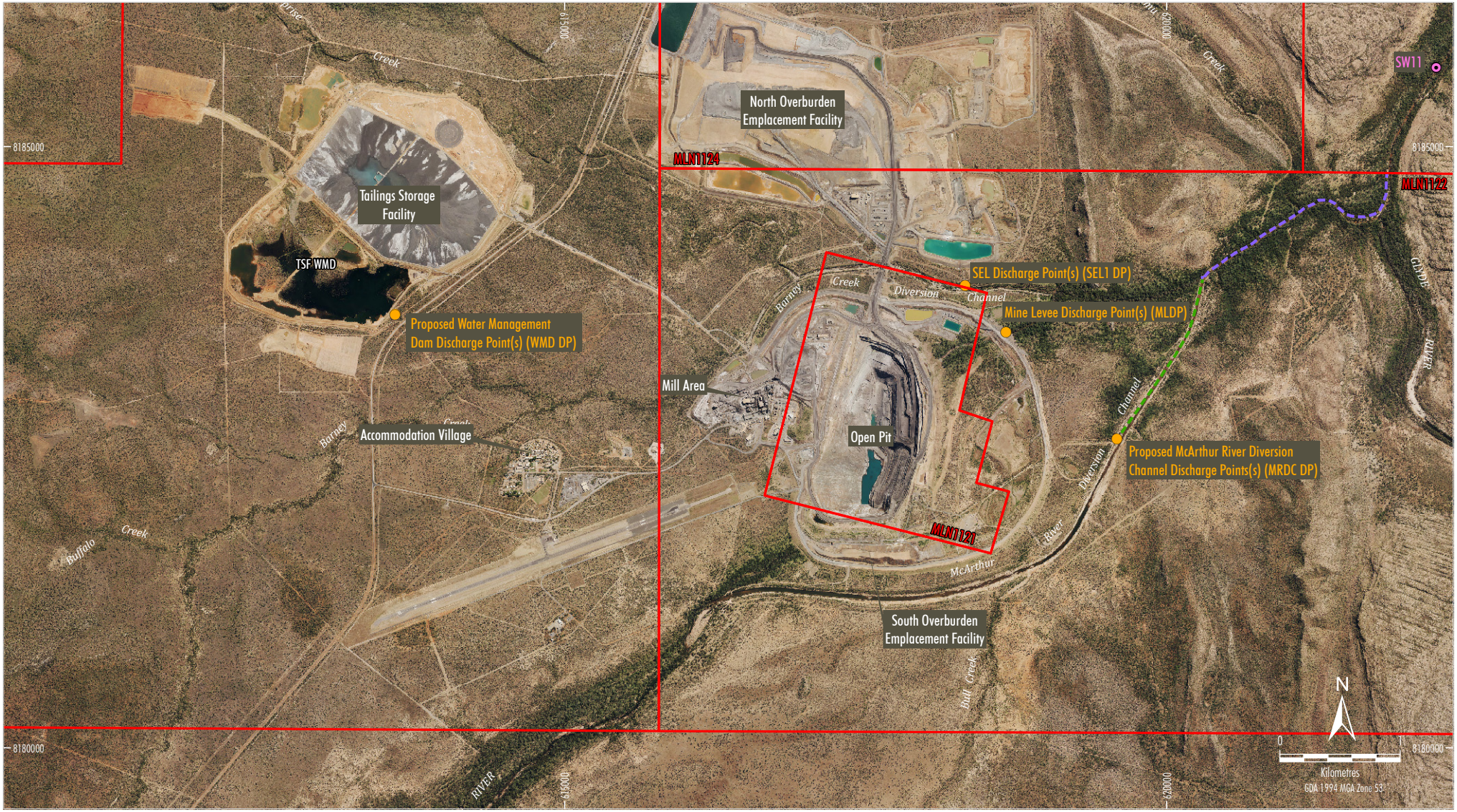
- Major Road
- River/Creek
- Natural Surface Water Monitoring
- Natural Surface Water Reference
- Upstream

Source: Geoscience Australia - Topography (2006); Department of Environment and Natural Resources (2016)

McARTHUR RIVER MINE

Regional Surface Water and Fluvial Sediment Monitoring Sites

Figure 6b



MRM-16-01_AMP_VD_223A

LEGEND

- Mineral Lease
- Authorised Discharge Point
- Compliance Monitoring Location

Mixing Zone

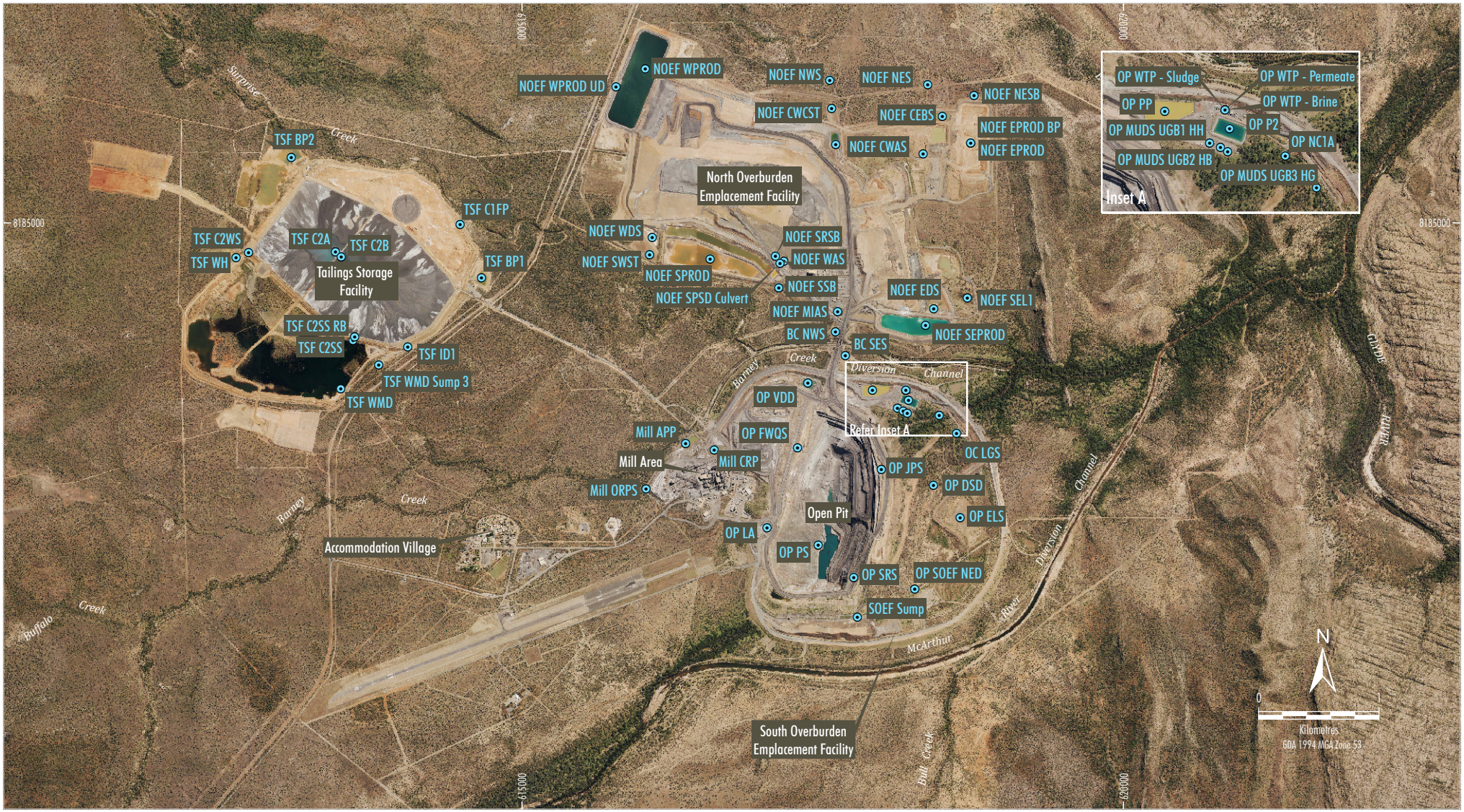
- McArthur River
- McArthur River Diversion Channel

McARTHUR RIVER MINE

Authorised and Proposed Discharge Points and Mixing Zones

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2019)

Figure 7



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LEGEND

- Artificial Surface Water Site

Source: *Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2018)*

McARTHUR RIVER MINE

Artificial Surface Water Monitoring Sites

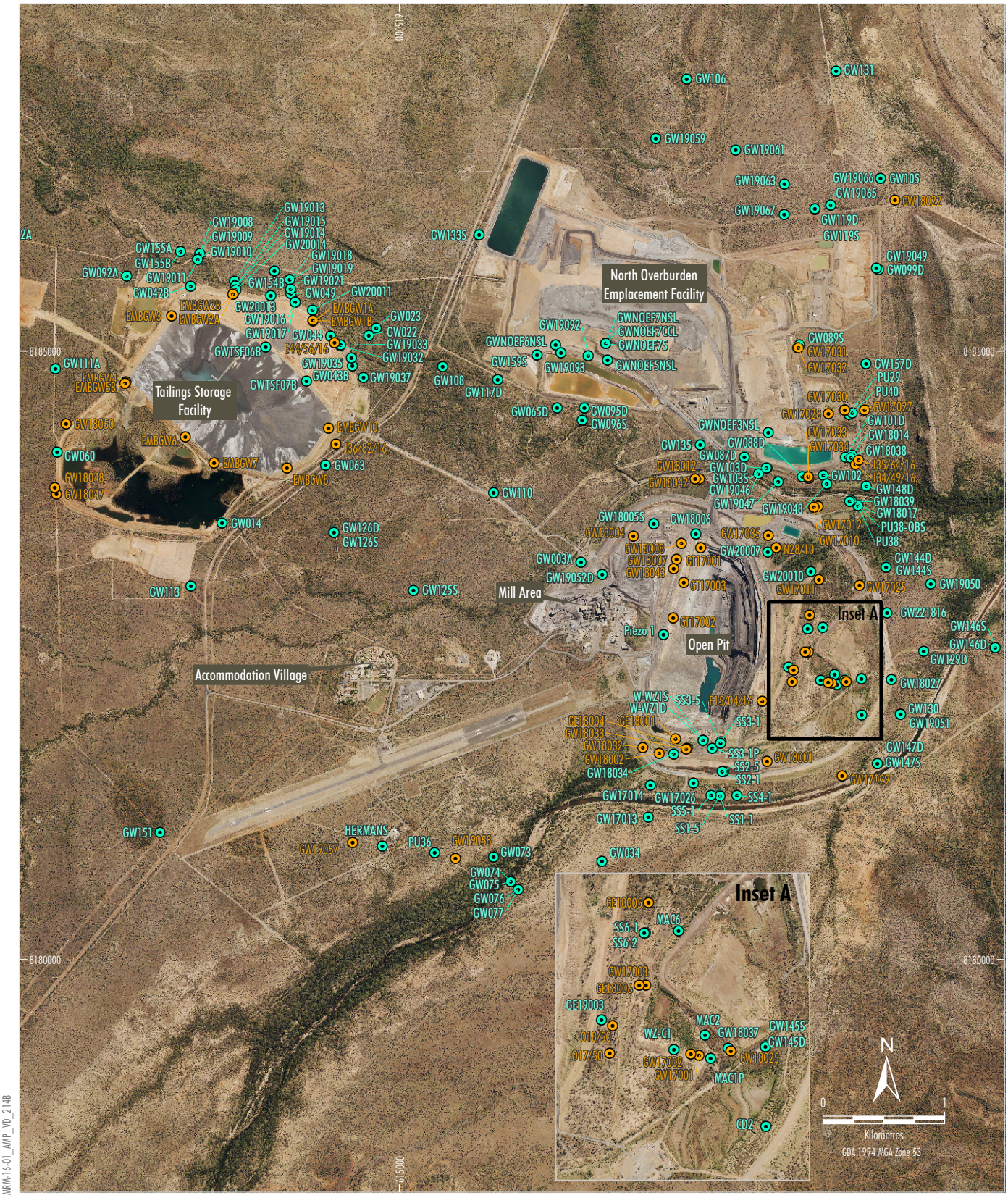
Figure 8

Source: *Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2019)*

McARTHUR RIVER MINE

Groundwater Monitoring Network

Figure 9



LEGEND

- Groundwater Level Monitoring
- Vibrating Wire Piezometer

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2018)

McARTHUR RIVER MINE

Continuous Groundwater Level Monitoring (March 2021)

Figure 10

LEGEND

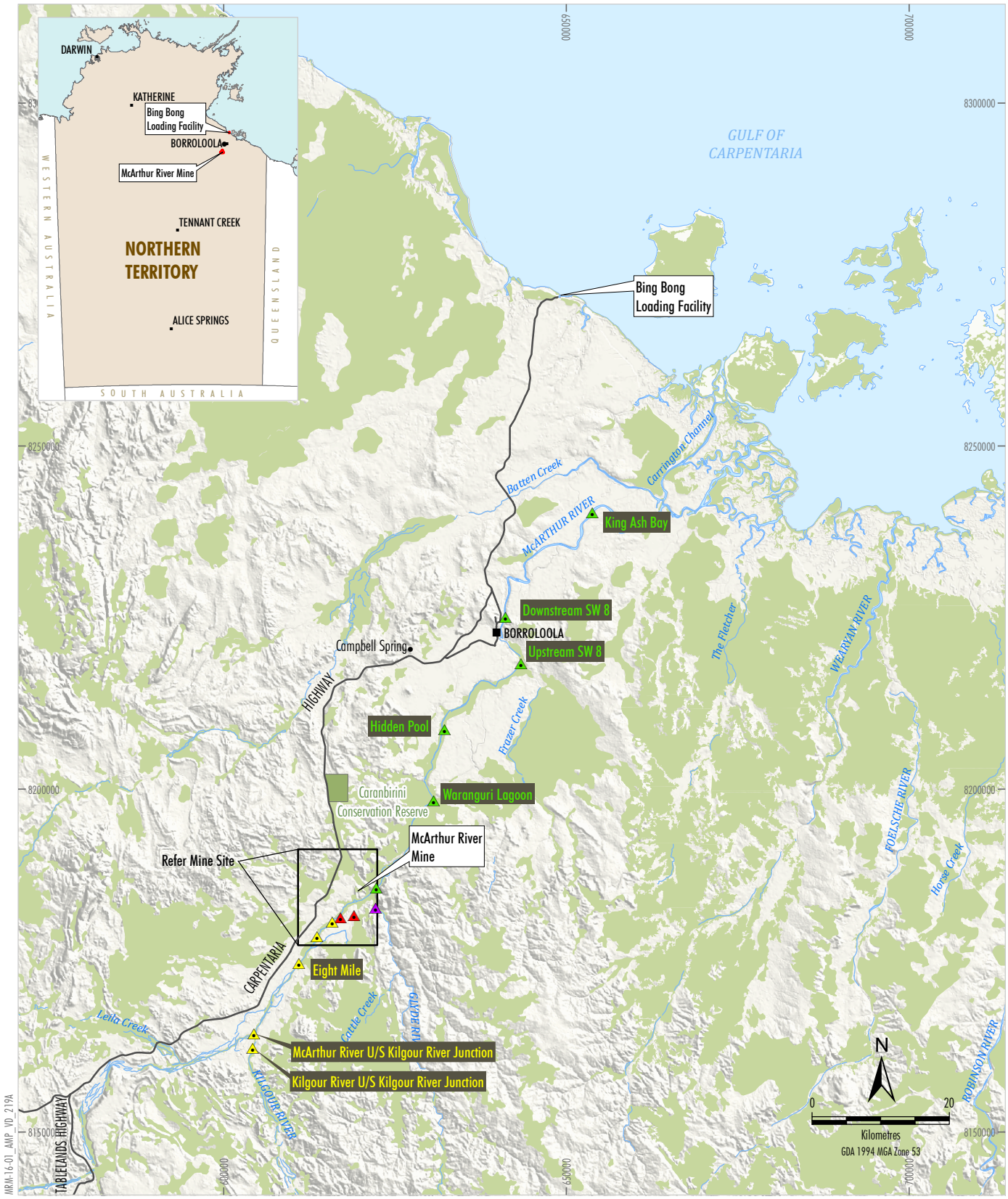
- Downstream of Diversion Channel
- Upstream of Diversion Channel
- Within Diversion Channel
- Glyde River

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); EMS (2019); MRM (2019)

McARTHUR RIVER MINE

Local Acoustic Receiver Monitoring Sites

Figure 11a



LEGEND

- Major Road
- River/Creek
- Downstream of Diversion Channel
- Upstream of Diversion Channel
- Within Diversion Channel
- Glyde River

McARTHUR RIVER MINE

Regional Acoustic Receiver Monitoring Sites

Source: Geoscience Australia - Topography (2006); Department of Environment and Natural Resources (2016) EMS (2019); MRM (2019)

Figure 11b

LEGEND

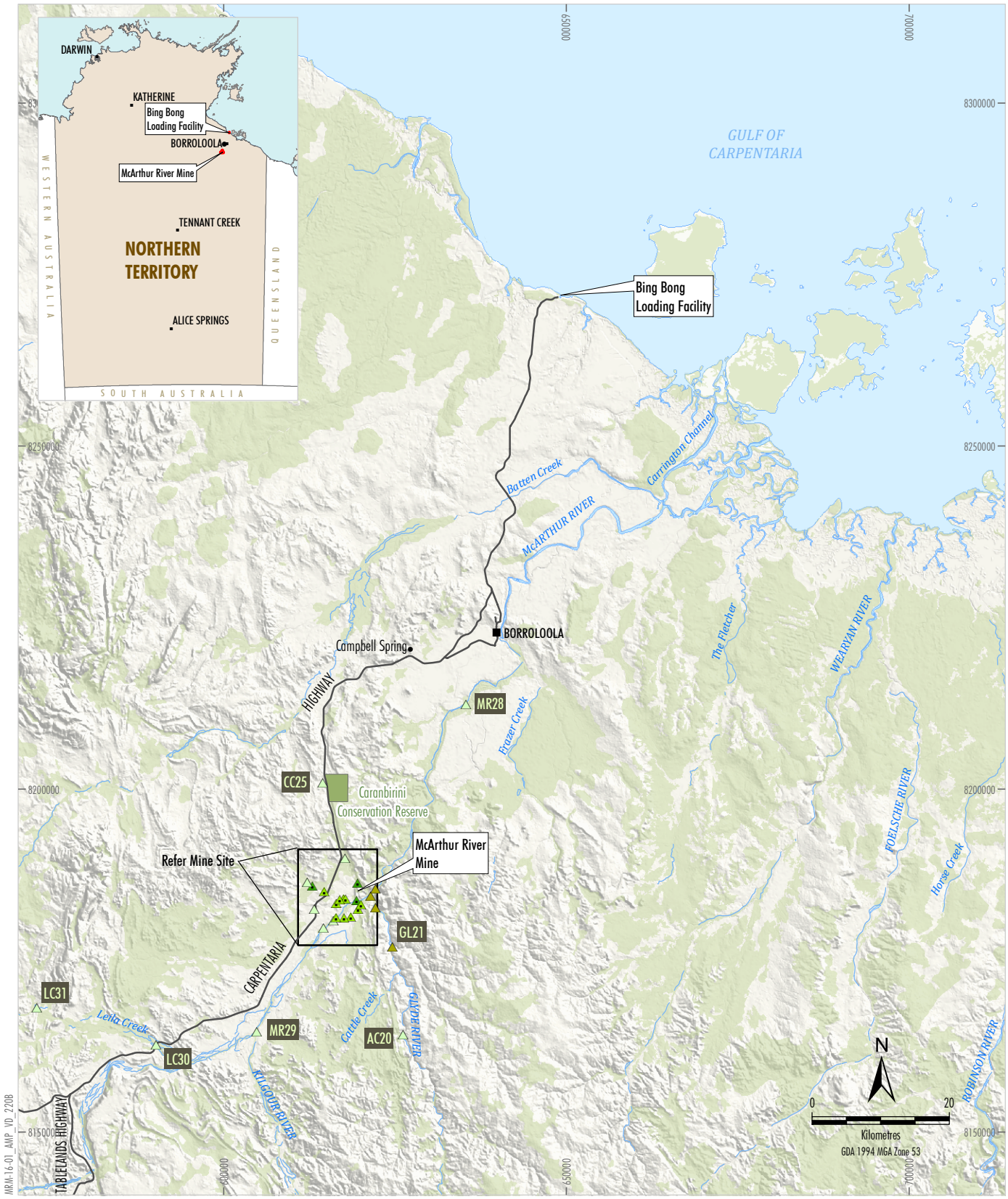
- Monitoring Site (Edge & Riffle)
- Monitoring Site (Edge)
- Reference Site (Edge & Riffle)
- Reference Site (Edge)

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); EMS (2016)

McARTHUR RIVER MINE

Local Macroinvertebrate Monitoring Sites

Figure 12a



LEGEND

- Major Road
- Performance Identification Site (Edge & Riffle)
- Performance Identification Site (Edge)
- Reference Site (Edge & Riffle)
- Reference Site (Edge)

McARTHUR RIVER MINE

Regional Macroinvertebrate Monitoring Sites

Source: Geoscience Australia - Topography (2006); Department of Environment and Natural Resources (2016) EMS (2019); MRM (2019)

Figure 12b

MRM-16-01_AMP_VD_211A

LEGEND

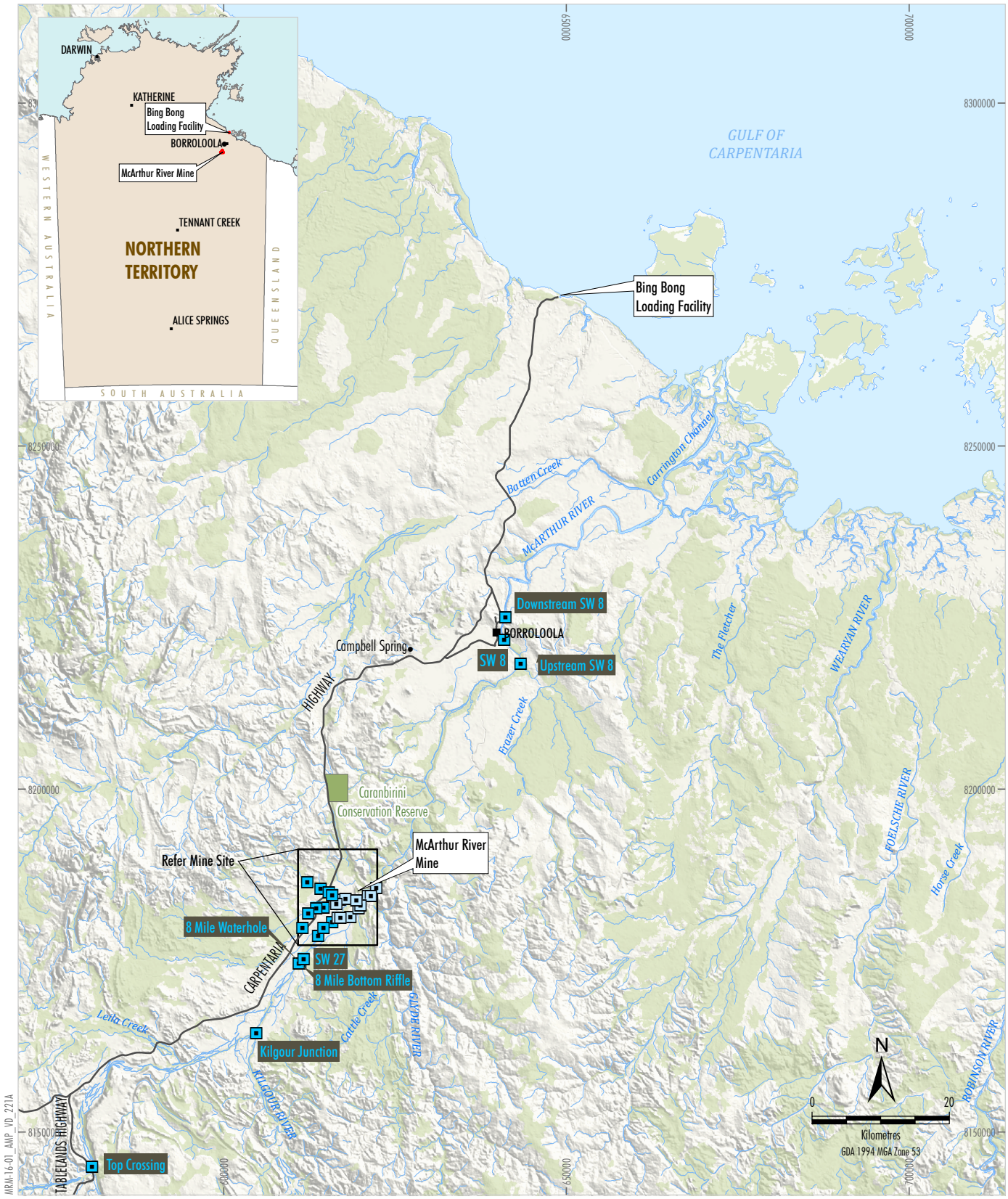
- Performance Identification Site
- Reference Site

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); EMS (2019); MRM (2019)

McARTHUR RIVER MINE

Local Aquatic Fauna Monitoring Sites

Figure 13a



LEGEND

- Major Road
- River/Creek
- Performance Identification Site
- Reference Site

McARTHUR RIVER MINE

Regional Aquatic Fauna Monitoring Sites

Source: Geoscience Australia - Topography (2006); Department of Environment and Natural Resources (2016) EMS (2019); MRM (2019)

Figure 13b

MRM-16-01_AMP_VD_2138

LEGEND

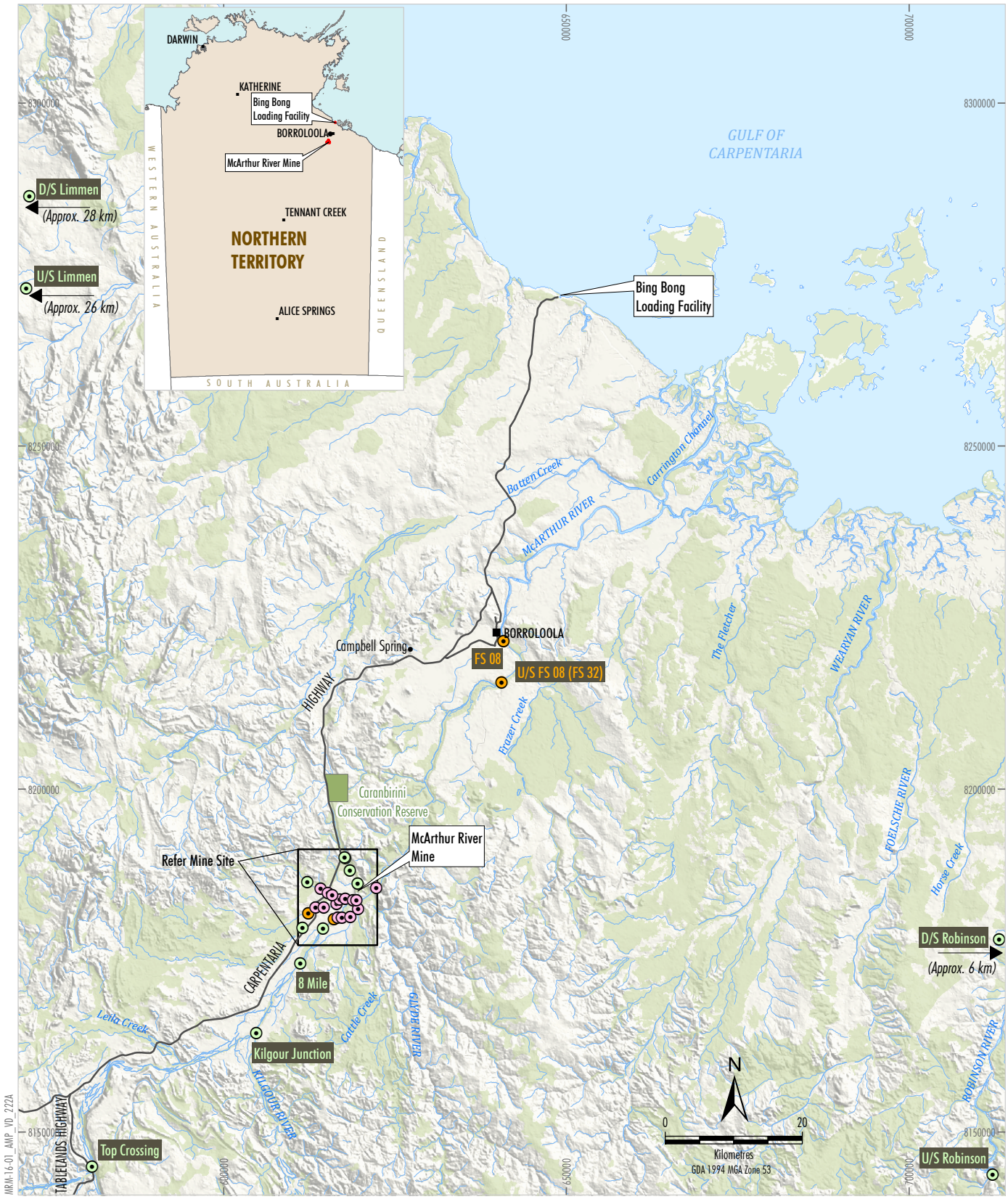
- Performance Identification Site
- Reference Site
- Reference Site / Performance Identification Site

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); EMS (2019); MRM (2019)

McARTHUR RIVER MINE

Local Metals in Aquatic Fauna
Monitoring Sites

Figure 14a



LEGEND

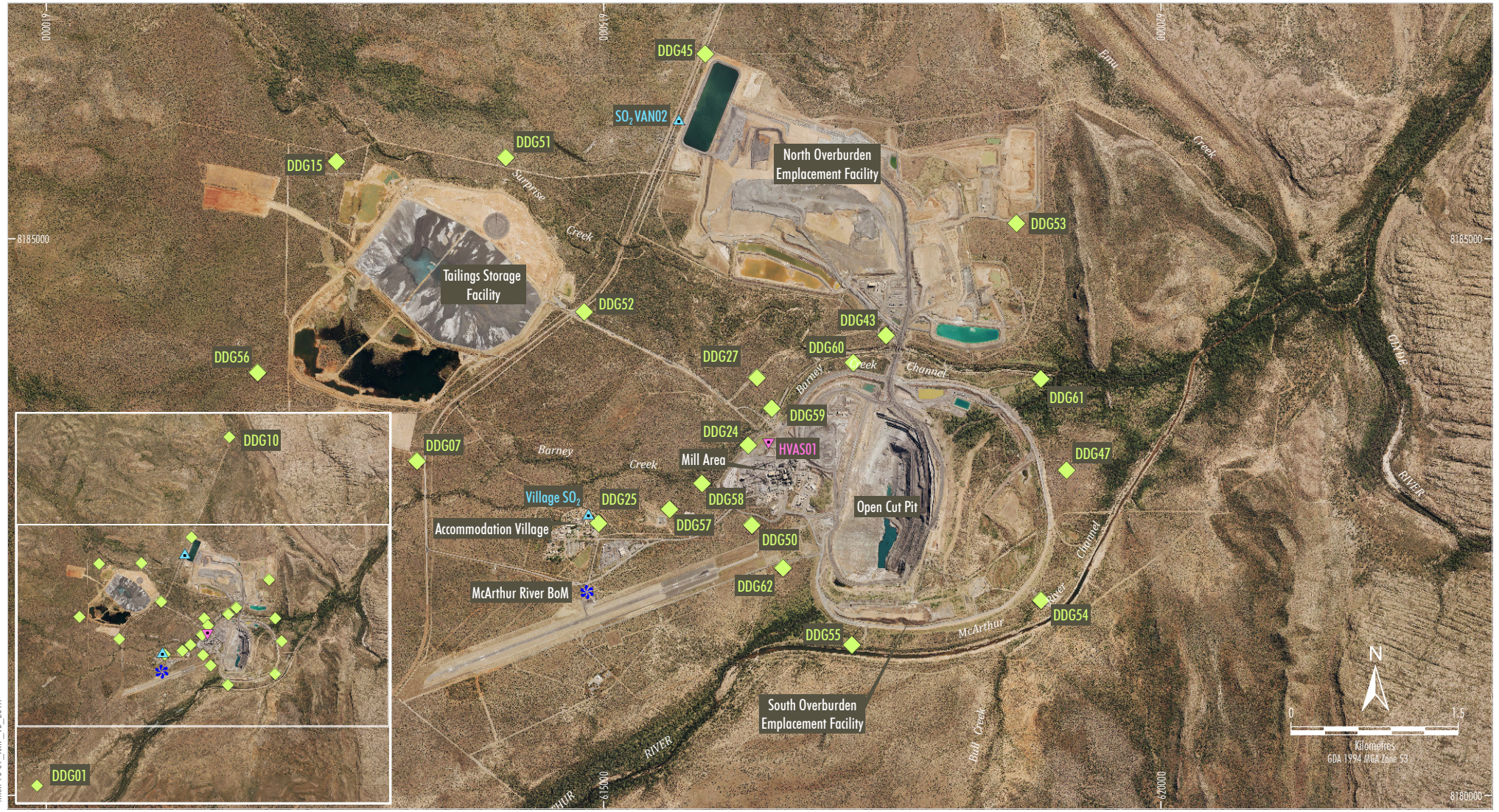
- Major Road
- River/Creek
- Performance Identification Site
- Reference Site
- Reference Site / Performance Identification Site

McARTHUR RIVER MINE

Regional Metals in Aquatic Fauna Monitoring Sites

Source: Geoscience Australia - Topography (2006); Department of Environment and Natural Resources (2016) EMS (2019); MRM (2019)

Figure 14b



MRM-16-01_MAP_VD_209A

LEGEND

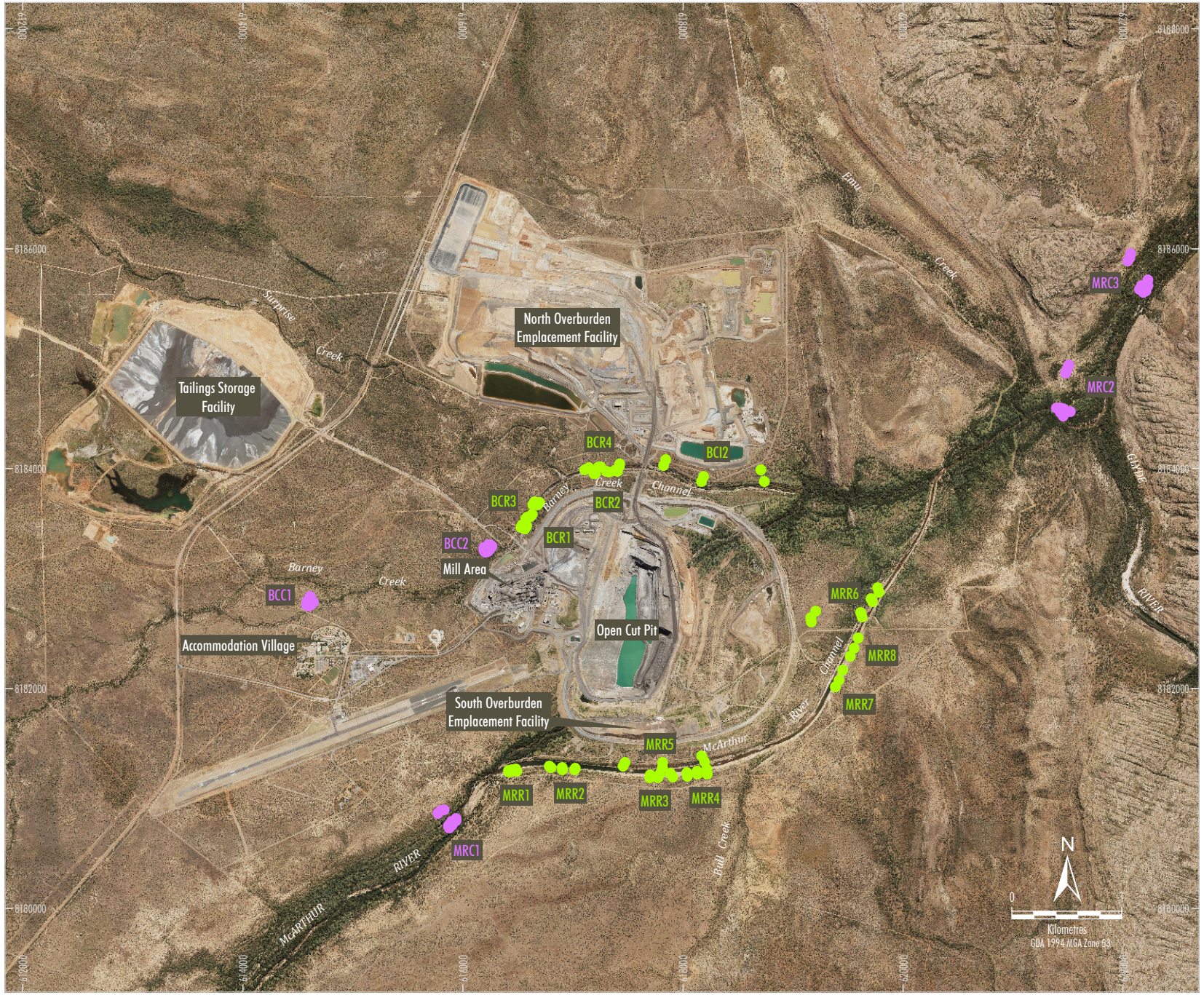
- Dust Deposition Gauge
- High Volume Air Sampler
- SO_2 Monitor
- Meteorological Station

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); Todoroski Air Sciences (2018)

McARTHUR RIVER MINE

MRM Mine Site Air Quality Monitoring Network

Figure 15



LEGEND

- Control
- Revegetation

Source: Orthophoto MRM (2017); Department of Environment and Natural Resources (2016); EcOz (2016)

MRM-16-01_AMP_VD_208A

M c A R T H U R R I V E R M I N E

Existing Mine Revegetation Monitoring and Control Sites

Figure 16

5. Trigger Action Response Plan

TARPs are implemented by MRM to manage potential adverse environmental conditions, mitigate environmental impacts, inform mitigation options where required and to assess performance against overarching environmental objectives.

5.1 TARP Overview

The interactions between the mining operations and natural environment have been studied extensively and are well understood. Significant research and investment have been made into the design of the major Mine facilities and associated preventative controls as part of the OMP development. In addition, a number of additional controls were recommended by NT EPA Assessment Report 86 (NT EPA, 2018a), such as the increase of the basal CCL from 0.25 m to 0.5 m (i.e. Assessment Report 86 Recommendation 7). The source controls are described in more detail in Section 3.3.2.

Nevertheless, the interactions between the mining operations and the natural environment are complex, with many potential sources and pathways contributing to the potential impacts at a receptor. Therefore, TARPs have been developed to assess progress towards meeting the environmental objectives, and to allow for management actions to be implemented to reduce any risks to meeting the objectives in the future.

Consistent with the principles of the adaptive management approach, the TARP approach focuses on creating certainty of achieving the environmental outcome, while maintaining a high degree of flexibility and optionality in the management actions that may be required. This is described by Justice Preston, Chief Judge of the NSW Land and Environment Court (NSWLEC) in *Newcastle & Hunter Valley Speleological Society Inc v Upper Hunter Shire Council and Stoneco Pty Limited* [2010] NSWLEC 48 at [184]:

> *In adaptive management the goal to be achieved is set, so there is no uncertainty as to the outcome and conditions requiring adaptive management do not lack certainty, but rather they establish a regime which would permit changes, within defined parameters, to the way the outcome is achieved.*

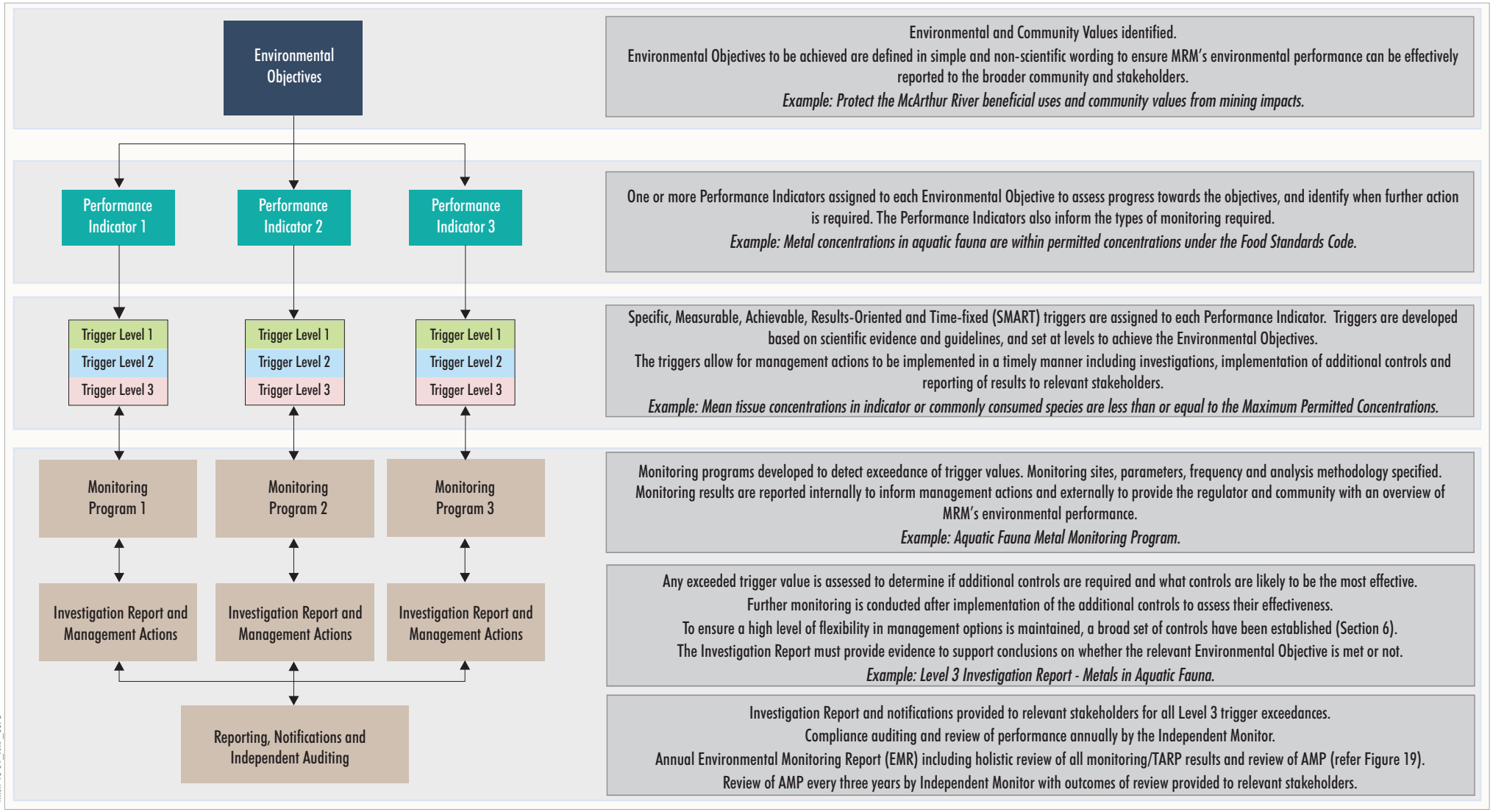
While the preventative controls described in Section 3 are fundamental to achieving the overarching environmental objectives for the Mine, there may be circumstances where additional controls are required to ensure the environmental objectives are met. The TARPS will be used to identify these circumstances, and provide a suitable framework for MRM to respond appropriately.

The TARP process is supported by robust data analysis and reporting. Annual environmental reports will include analysis of results from multiple monitoring programs, and use the source-pathway-receptor model to identify and describe sources of contaminants that are contributing to the overall performance. This allows for key performance outcomes, including performance against the environmental objectives, potential environmental risks and proposed management actions/improvements to be reported to the regulators and community. An advantage of the source-pathway-receptor model is that monitoring results of sources and pathways can be analysed, and an appropriate response implemented pre-emptively, to minimise any potential impacts to the receptor.

5.2 TARP Development Process and Structure

The key components of the TARPs and their interactions are explained on Figure 17. All AMP environmental objectives are included in the TARP and are linked to performance indicators and SMART triggers as detailed in Table 7.

Each TARP consists of three distinct Trigger Levels (Levels 1 to 3). Each level of the TARP sets out specific actions that are proportional to the environmental risk. No individual Trigger Level is directly indicative of an environmental impact, or an environmental objective not being met. Trigger Levels as used in the TARP process are a tool to indicate when performance is as expected (Level 1), or when additional monitoring or management may be required (Level 2 and 3). Prior to the Level 3 Investigation being required, a Level 2 Trigger will prompt a pre-emptive response including an investigation, and implementation of additional monitoring and management, if appropriate, to minimise the risk of any potential impact. A process flow diagram of the TARP process is shown in Figure 18.



McARTHUR RIVER MINE

TARP Key Components and Interactions

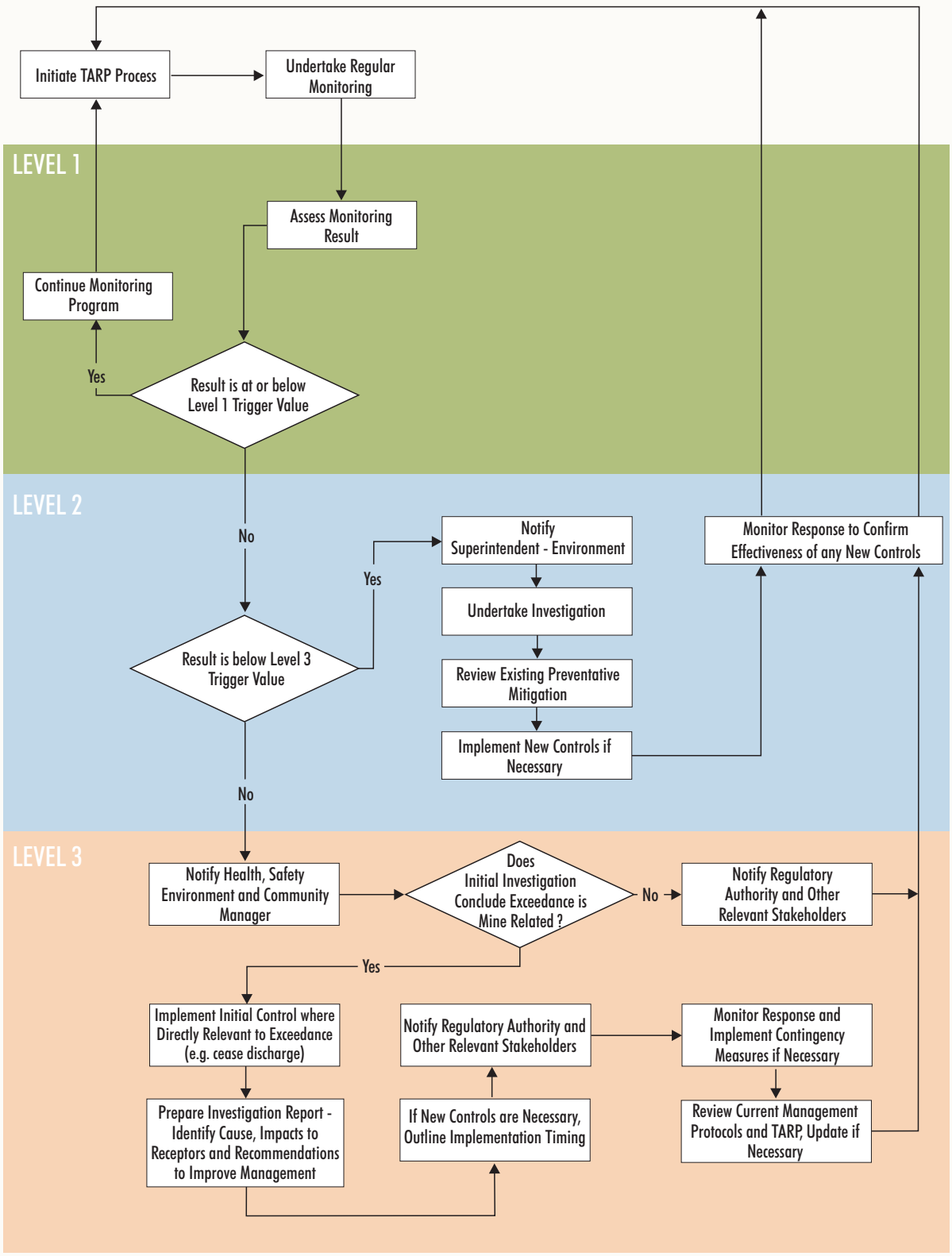
Figure 17

TABLE 7: ENVIRONMENTAL OBJECTIVES AND ASSOCIATED ENVIRONMENTAL SMART PERFORMANCE CRITERIA TRIGGERS

Environmental Objective	Performance Indicator	SMART Trigger				
		Specific	**Measurable**	**Achievable**	**Results-oriented**	**Time-fixed**
Protect the McArthur River beneficial uses and community values from mining impacts	*Water quality downstream of the McArthur River Mine mineral leases does not exceed site specific trigger values*	SSTV analyte concentrations, range and levels as defined in WDL 174 at monitoring site SW11.	Measured by field measurements and/or lab analysis.	SSTVs defined in WDL 174.	SSTVs developed based on guidelines relevant to the protection of aquatic ecosystems.	Monitoring weekly basis and during discharge to McArthur River.
	Fluvial Sediment quality at or downstream of the Mine does not exceed guideline values	Defined sediment quality guideline values for arsenic, cadmium, copper, lead and zinc at fluvial sediment monitoring sites.	Measured according to AS5667.12:1999 *Guidance on Sampling of Bottom Sediments* and *CSIRO Sediment Quality Assessment: A Practical Guide* (Simpson and Batley, 2016).	Based on national sediment quality guideline values as described in *A Sediment Quality Assessment: A Practical Guide* (Simpson and Batley, 2017).	Guidelines are relevant to the protection of aquatic ecosystems.	Monitoring annually in accordance with WMP.
	Sediment trap water quality is of acceptable standard	The quality of water within sediment traps.	Measured by field measurements and/or lab analysis.	Sediment water quality triggers developed in consideration of historical data. Water classes are defined in MRM's WMP (Appendix A).	Passive release of water of acceptable quality aims to protect downstream aquatic ecosystems.	Monitoring and assessment against the TARP is undertaken weekly.
	Managed release loads in accordance with VOA total load conditions	Quantified loads (kg) of lead and zinc discharged each year.	Measured concentration multiplied by the discharge rate is used to determine the load.	Limit set in accordance with NT EPA Assessment Report 86 Recommendation 3.	MLE are ultimately the relevant measure of impact to aquatic fauna.	Measurements are taken when discharge takes place.
	Groundwater level of the Wurrini Waterhole is above acceptable levels	The groundwater level of the Wurrini Waterhole.	Groundwater elevation is recorded via continuous loggers and quarterly manual dip measurements in bores near the Wurrini Waterhole.	Based on combination of OMP EIS prediction and historical observations.	Protects known site values and potential aquatic fauna habitat.	Measurements are recorded periodically (at least every six months).
	Groundwater levels in the vicinity of the lower reaches of the Barney Creek Diversion Channel behave as modelled in the OMP EIS	Groundwater levels at monitoring bores between the NOEF and Barney Creek Diversion Channel.	Groundwater elevation is recorded via continuous logger and quarterly manual dip measurements at bores south of the NOEF.	Triggers developed in consideration of EIS groundwater model predictions and historical observations.	Triggers relevant to water quality in the Barney Creek Diversion Channel which reports to the McArthur River.	Measurements are recorded periodically (at least every quarter).

Environmental Objective	Performance Indicator	SMART Trigger				
		Specific	**Measurable**	**Achievable**	**Results-oriented**	**Time-fixed**
	Freshwater Sawfish is observed navigating or recorded via acoustic receiver station within the McArthur River Diversion Channel or in waters upstream of the Channel	The number of visual observations of sawfish that are undertaken during survey periods at survey monitoring sites via acoustic receiver monitoring station and acoustic monitoring.	Measured via gill netting, line fishing, fish tagging and acoustic monitoring.	Based on historical observations.	Consistent with the OMP EIS (to ensure protection of Freshwater Sawfish).	Surveys are undertaken on an annual basis.
	No statistically significant difference in macroinvertebrate species richness / assemblage at McArthur River performance identification sites	The diversity and richness of macroinvertebrate species at McArthur River performance identification sites.	In accordance with established NT protocols (Lamche, 2007) with reference to Lloyd and Cook (2002) and Queensland Department of Natural Resources and Mines (2001) for sampling riffle habitats.	Samples are taken and compared to nearby reference sites that are of the same stream order.	Consistent with the requirement of NT EPA Assessment Report Recommendation 3 (i.e. protection of the McArthur River health and ecosystem habitat).	Surveys are undertaken annually.
	No statistically significant difference in aquatic fauna species diversity and relative abundance at McArthur River performance identification sites during the early dry season survey	Aquatic fauna species diversity and relative abundance at on-site and downstream monitoring locations.	Measured via fyke netting, seine netting and electrofishing.	Comparative statistical analysis to reference sites of similar characteristics to the McArthur River ecosystem.	Consistent with the requirement of NT EPA Assessment Report Recommendation 3.	Surveys are undertaken annually during the early dry season.
	Metal concentrations in aquatic fauna	Tissue sample analysis of metals within aquatic fauna.	Measured annually from commonly consumed species at performance identification sites.	Based on maximum permitted contaminants in aquatic species in accordance with the *Australian and New Zealand Food Standards Code* (2016).	Guidelines developed to ensure food in Australia is safe and suitable for consumption.	Surveys are undertaken annually.
Minimise air quality related impacts from the Mines operations with respect to community health and the environment	*Negligible air quality impacts to community health*	The concentration of SO_2 within the air at the nearby communities of Borroloola and Goolminyini.	Monitoring sites undertake Fluorescence analysis in accordance with AS 3580.4.1-2008 and Method 4.1 *Determination of sulfur dioxide – Direct reading instrumental method*.	SO_2 concentration with triggers derived from the *National Environment Protection (Ambient Air Quality) Measure* (as amended May 2021).	Guidelines developed with the desired outcome of protection of human health.	Monitoring is undertaken continuously.

Environmental Objective	Performance Indicator	SMART Trigger				
		Specific	**Measurable**	**Achievable**	**Results-oriented**	**Time-fixed**
Facilitate development of the ecosystems and their functions along the McArthur River Diversion Channel for terrestrial and aquatic biota	*Revegetation monitoring indicates progressive remediation according to schedule*	Revegetation success at McArthur River Diversion Channel and Barney Creek Diversion Channel monitoring locations.	Field assessment of monitoring sites against adaptive completion criteria.	Adaptive completion criteria developed annually from representative control sites.	Adaptive completion criteria developed to achieve functioning riverine ecosystems comparable to the original water courses prior to diversion.	Assessment of monitoring site criteria is completed annually.



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McARTHUR RIVER MINE

Trigger Action Response Plan
Process Flow Chart

Figure 18

Three Trigger Levels are assigned to each performance indicator to identify where there is potential for increased risk to the environment and off-site human health, which may require further investigation and/or additional controls to be implemented. An overview of each trigger level and the TARP process is provided below.

Level 1

When a performance indicator is at or below the Level 1 trigger value, this suggests performance is achieving the overarching environmental objectives. Monitoring continues to be undertaken in accordance with the relevant monitoring program.

Level 2

Level 2 is triggered when a performance indicator is above the Level 1 trigger value and below the Level 3 trigger value. This indicates that performance is within expected, predicted and/or conditioned levels, however, further investigation of the trend is warranted. This means that performance is still within the range of relevant guidelines, predictions and/or conditioned limitations (i.e. no "exceedance" has yet been observed), however, analysis of monitoring data and trends indicates an increased potential for environmental risk, leading to further, pre-emptive actions, where required. Existing preventative controls as discussed in Section 5.3 are typically undertaken as follows:

- Implement investigation to determine potential cause of elevated trigger value.
- Identify the potential Source (refer Section 3.3.2) and/or Pathways (Section 3.3.3) associated with the trigger exceedance.
- Implement mitigation controls (refer Sections 3.3.2 and 3.3.3), if necessary.
- Consider additional monitoring and/or reporting.

Level 3

In the event a performance indicator is greater than the Level 3 trigger value, performance is above expected, predicted and/or conditioned levels, and further investigation is needed to determine if additional controls are required. The following actions are typically undertaken:

- Validate relevant data to confirm exceedance of trigger.
- Undertake MRM and/or specialist investigation to identify the potential Source (refer Section 3.3.2) and/or Pathways (Section 3.3.3) associated with the trigger exceedance, and if the exceedance is Mine-related.
- Implement mitigative controls (refer Sections 3.3.2 and 3.3.3), if necessary.
- Undertake an assessment against the environmental objective to determine if it is still being met.
- Submit investigation report to relevant regulators.
- Review current management plans and update if necessary.
- Undertake further monitoring to re-assess the Mine performance.
- Implement a planned contingency response action, if required.

An investigation report will be prepared following a Level 3 trigger as described in Section 5.2.1.

5.2.1 Level 3 Investigation Report and Assessment Against Environmental Objective

Exceedance of a Level 3 trigger may occur due to natural influences that are outside of MRM's control (e.g. due to elevated surface water quality upstream of the Mine). Accordingly, a Level 3 trigger value does not necessarily indicate that an environmental objective is not being met (i.e. an environmental objective would still be considered met if a Level 3 trigger exceedance is a result of natural causes). Therefore, a Level 3 trigger will prompt an investigation to understand the source of the exceedance and assess the mining operation's contribution to an exceedance, if any. The scope of a Level 3 investigation report will typically include:

- review and analysis of data from all relevant monitoring programs, including data at sites outside of the Mine's influence (e.g. upstream of the Mine);
- consideration of historical data at relevant sites;
- assessment against the relevant environmental objective;
- outlining of recommended management actions and timing, if required;
- review of any new learnings and opportunities to improve/adapt management actions;
- review of adequacy of current TARP and monitoring program; and
- input from specialists in the analysis and identification of suitable management actions, where required.

The investigation report would be prepared using a weight-of-evidence approach that considers all available monitoring data to inform the assessment of MRM's performance against the environmental objective. The investigation report will conclude whether MRM's environmental objectives are being met.

Investigation reports will be submitted to DEPWS and DITT within 10 days of the assessment completion. Where contingency measures (as described in Section 6) are to be implemented, MRM would consult with the relevant regulators with regards to the details of the measures including how and when they would be implemented.

MRM will provide written notice to DITT and DEPWS where trends indicate performance indicators and environmental objectives will not or are unlikely to be met by implementing the AMP.

5.3 TARP Table

The TARPs associated with achieving the environmental objectives are provided in Table 8.

TABLE 8: TRIGGER ACTION RESPONSE PLAN SUMMARY – MCARTHUR RIVER MINE

Environmental Objective	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis/Sampling Methodology	Level	Triggers	Action/Response
Protect the McArthur River beneficial uses and community values from mining impacts	*Water quality downstream of the McArthur River Mine mineral leases does not exceed site-specific trigger values (SSTVs) from managed release*	SW11 detailed in Figure 6.	In accordance with WDL 174.	In accordance with WDL 174.	In accordance with WDL 174.	Level 1	SW11 analyte predicted^ or measured less than 90% of SSTV due to the managed release. ^ Predictive tools, including a dilution calculator, are used to inform discharge rates prior to authorising managed release and during managed release as environmental conditions change (e.g. flow and water quality in the McArthur River). These pre-emptive operational controls ensure that wastewater leaving the mine site will meet the SSTVs at SW11 prior to managed release commencing.	Continue monitoring of the release in accordance with WDL 174 and MRM's discharge procedure (e.g. daily updated of dilution calculations and adjusted of discharge if required, regular monitoring of on-site water). Continue annual reporting.
						Level 2	SW11 analyte predicted^ or measured greater than or equal to 90% of SSTV due to the managed release. ^ Predictive tools used as per Level 1.	Notify the Environment – Superintendent. Cease further managed release. Continue monitoring and annual reporting. *
						Level 3	Monitoring indicates: 1. SW11 analyte greater than SSTV on three consecutive sampling occasions; 2. SW11 analyte equal to or greater than 3 x SSTV; or 3. subsequent consecutive exceedances of SSTVs described in 1 and 2 above.	Notify WDL administrating authority of potential non-compliance as conditioned within the WDL, including any required preliminary investigation report. Notify the Environment Manager – Health, Safety, Environment and Community. Implement Level 3 investigation and response process as detailed in Section 5.1. Consider potential sources and pathways, which may have contributed to the trigger exceedance. If the exceedance is not due to the Mine, report MRM's performance against this Performance Indicator as Level 2. If the investigation confirms the exceedance is due to the Mine, undertake an assessment against the environmental objective considering results from other monitoring programs and historical (Pre-Overburden Management Project) performance. Issue the investigation report to DEPWS and DITT within 10 days of assessment completion. Consider implementation of management and contingency measures outlined in Sections 6 and 7.
Protect the McArthur River beneficial uses and community values from mining impacts	*Water quality downstream of the McArthur River Mine mineral leases does not exceed site-specific trigger values (SSTVs) from all mine lease contributions*	SW11 detailed in Figure 6.	In accordance with WDL 174.	In accordance with WDL 174.	In accordance with WDL 174.	Level 1	SW11 analyte measured less than 90% of SSTV.	Continue monitoring and annual reporting.
						Level 2	SW11 analyte measured greater than or equal to 90% of SSTV.	Notify the Environment – Superintendent. Implement investigation to determine if the cause of the elevated measurement is due to the Mine, and if so, implement additional controls or management actions (e.g. removal of on-lease mine-affected baseflow to return trigger value to Level 1). Continue monitoring and annual reporting.
						Level 3	Monitoring indicates: 1. SW11 analyte greater than SSTV on three consecutive sampling occasions; 2. SW11 analyte equal to or greater than 3 x SSTV; or 3. subsequent consecutive exceedances of SSTVs described in 1 and 2 above.	Notify WDL administrating authority of potential non-compliance as conditioned within the WDL, including any required preliminary investigation report. Notify the Environment Manager – Health, Safety, Environment and Community. Implement Level 3 investigation and response process as detailed in Section 5.1. Consider potential sources and pathways, which may have contributed to the trigger exceedance. If the exceedance is not due to the Mine, report MRM's performance against this Performance Indicator as Level 2. If the investigation confirms the exceedance is due to the Mine, undertake an assessment against the environmental objective considering results from other monitoring programs and historical (Pre-Overburden Management Project) performance. Issue the investigation report to DEPWS and DITT within 10 days of assessment completion. Consider implementation of management and contingency measures outlined in Sections 6 and 7.

Environmental Objective	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis/Sampling Methodology	Level	Triggers	Action/Response
Protect the McArthur River beneficial uses and community values from mining impacts	*Fluvial Sediment quality at or downstream of the Mine does not exceed guideline values*	The performance triggers are applied to all potential impact sites located on lease or downstream of the Mine. Monitoring Sites detailed in Figure 6.	• Arsenic • Cadmium • Copper • Lead • Zinc	Annually following the wet season (typically April/May/June).	Dilute acid extraction on the <63 micrometre fraction. In accordance with: • AS5667.12:1999 *Guidance on sampling of bottom sediments*. • *CSIRO Sediment Quality Assessment: A Practical Guide* (Simpson and Batley, 2016).	Level 1	Fluvial sediment analyte less than or equal to the Sediment Quality Guideline Value (SQGV). For further information on SQGV and SQG-High, refer to the WMP (Appendix A).	Continue monitoring and annual reporting.
						Level 2a	Fluvial sediment analyte greater than SQGV and less than or equal to SQG-High.	Notify the Environment – Superintendent. Implement investigation to determine if additional controls or management actions (e.g. sediment removal from Barney Creek Diversion Channel and/or review of dust and sediment controls in this area) are necessary to return trigger value to Level 1. Continue monitoring and annual reporting.
						Level 2b	Fluvial sediment analyte greater than SQG-High.	Implement any relevant action(s) as determined by investigation under Level 2a. Increase monitoring frequency to quarterly until the fluvial sediment analyte is below SQG-High. Annual Reporting.
						Level 3	Fluvial sediment analyte greater than SQG-High for 4 consecutive quarterly results.	Notify the Environment Manager – Health, Safety, Environment and Community. Implement Level 3 investigation and response process as detailed in Section 5.1. Consider potential sources and pathways, which may have contributed to the trigger exceedance. If the exceedance is not due to the Mine, report MRM's performance against this Performance Indicator as Level 2. Undertake investigation to determine the performance of the environmental objective considering results from other monitoring programs and historical (Pre-Overburden Management Project) performance. Issue the investigation report to DEPWS and DITT within 10 days of assessment completion. Consider implementation of management and contingency measures outlined in Sections 6 and 7.
Protect the McArthur River beneficial uses and community values from mining impacts	*Sediment trap water quality is of acceptable standard*	Sediment traps	Physical and chemical parameters detailed in WDL 174. Water classes are defined in MRM's WMP (Appendix A).	Weekly.	Samples are collected in accordance with MRM's Artificial Surface Water Monitoring procedure PRO-2200025 (MRM, 2019a).	Level 1	Sediment trap water quality = Class 2 or better (lower) based on median concentrations over the reporting period (as detailed in the WMP).	Continue monitoring and annual reporting.
						Level 2	Sediment trap water quality = Class 4 based on median concentrations over the reporting period (as detailed in the WMP)[1].	Notify the Environment – Superintendent. Implement investigation to determine if additional controls or management actions (e.g. sediment removal from sediment trap and/or review adequacy of catchment drainage controls) are necessary to return trigger value to Level 1. Continue monitoring and annual reporting.
						Level 3	Sediment trap water quality ≥ Class 5 based on median concentrations over the reporting period (as detailed in the WMP).	Notify the Environment Manager – Health, Safety, Environment and Community. Implement Level 3 investigation and response process as detailed in Section 5.1. Consider potential sources and pathways which may have contributed to the trigger exceedance. Undertake investigation to determine the performance of the environmental objective considering results from other monitoring programs and historical (Pre-Overburden Management Project) performance. Issue the investigation report to DEPWS and DITT within 10 days of assessment completion. Consider implementation of management and contingency measures outlined in Sections 6 and 7.

Environmental Objective	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis/Sampling Methodology	Level	Triggers	Action/Response
Protect the McArthur River beneficial uses and community values from mining impacts	*Managed release loads in accordance with VOA total load conditions*	Approved Release Points and Authorised Discharge Points in Figure 7.	• Total Lead; and • Total Zinc.	During discharge (annual period between 1 May to 30 April).	Samples are collected in accordance with MRMs Waste Discharge Procedure PRO – 2200035 (MRM, 2019b) and WDL 174.	Level 1	Discharge/release loads are 90 % or less of the following limits: • Lead: Annual Defined Limit = 15.8 kilograms (kg). • Zinc: Annual Defined Limit = 3,429 kg.	Continue monitoring and annual reporting.
						Level 2	Discharge/release loads are greater than 90% but less than 100% of defined limit.	Notify the Environment – Superintendent. Cease further managed release. Continue monitoring and annual reporting.
						Level 3	Discharge/release loads are greater than 100% of defined limit.	Notify the Environment Manager – Health, Safety, Environment and Community. Implement Level 3 investigation and response process as detailed in Section 5.1. Consider potential sources and pathways or process failures, which may have contributed to the trigger exceedance. Undertake investigation to determine the performance of the environmental objective considering results from other monitoring programs and historical (Pre-Overburden Management Project) performance. Issue the investigation report to DEPWS and DITT within 10 days of assessment completion. Consider implementation of management and contingency measures outlined in Sections 6 and 7.
Protect the McArthur River beneficial uses and community values from mining impacts	*Groundwater level of the Wurrini waterhole is above acceptable levels*	Bores surrounding the Wurrini waterhole (GW073, GW074, GW075, GW076, GW077) detailed in Figure 9.	Water elevation. **Normal limit:** lowest recorded groundwater elevation; **Control limit:** lowest recorded groundwater elevation minus 0.5 m; and **Critical limit:** lowest recorded groundwater elevation minus 0.7 m.	Manual groundwater elevation measurements are recorded periodically (at least six-monthly).	Samples are collected in accordance with MRM's Groundwater Monitoring Procedure PRO-2200024 (MRM, 2018).	Level 1	Water elevation equal to or above the control limit.	Continue monitoring and annual reporting.
						Level 2	Water elevation below the control limit but above or equal to the critical limit for two consecutive months.	Notify the Environment – Superintendent. Implement investigation to determine if additional controls or management actions (e.g. update of groundwater model predictions based on recent data) are necessary to return trigger value to Level 1. Continue monitoring and annual reporting.
						Level 3	Water elevation below the critical limit for one consecutive month following a downward trend.	Notify the Environment Manager – Health, Safety, Environment and Community. Implement planned mitigation strategy. Identify suitable water source for the recharge of Wurrini. Commence recharge. Issue the investigation report to DEPWS and DITT within 10 days of assessment completion. Consider implementation of management and contingency measures outlined in Sections 6 and 7.
Protect the McArthur River beneficial uses and community values from mining impacts	*Groundwater levels in the vicinity of the lower reaches of the Barney Creek Diversion Channel behave as modelled in the OMP EIS*	Bores GW102 and GW103S in between the NOEF and Barney Creek Diversion Channel, shown in Figure 9.	Water elevation. **Normal limit**: less than 1.0 m above the invert level of Barney Creek Diversion Channel; **Control limit:** 1.0 m above the invert level of Barney Creek Diversion Channel; and **Critical limit**: 2.5 m above the invert level of Barney Creek Diversion Channel.	Continuous logger data is reviewed at least every two months following the end of the wet season until groundwater levels are within the normal limit.	Samples are collected in accordance with MRM's Groundwater Monitoring Procedure PRO-2200024 (MRM, 2018).	Level 1	During no flow in the Barney Creek Diversion Channel (at SW19), groundwater elevation below the control limit.	Continue Monitoring Program. Annual Reporting.
						Level 2	During no flow in the Barney Creek Diversion Channel (at SW19), groundwater elevation above the control limit but below the critical limit for more than three consecutive months.	Implement investigation to determine if additional controls or management actions are necessary to return trigger value to Level 1. Continue Monitoring Program. Annual Reporting.
						Level 3	During no flow in the Barney Creek Diversion Channel (at SW19), groundwater elevation above the critical limit for more than two consecutive months.	Notify the Environment Manager – Health, Safety, Environment and Community. Implement Level 3 investigation and response process as detailed in Section 5.1. Undertake investigation to determine the performance of the environmental objective considering results from other monitoring programs and historical (Pre-Overburden Management Project) performance. Issue the assessment report to DEPWS and DITT within 10 days of assessment completion. Consider implementation of management and contingency measures outlined in Sections 6 and 7 (e.g. temporary pumping of poorer quality water to contained water storages, increased pumping from surrounding bore fields).

Environmental Objective	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis/Sampling Methodology	Level	Triggers	Action/Response
Protect the McArthur River beneficial uses and community values from mining impacts *and* *Facilitate development of the ecosystems and their functions along the McArthur River Diversion Channel for terrestrial and aquatic flora and fauna*	*Freshwater Sawfish is observed navigating or recorded via acoustic receiver station within the McArthur River Diversion Channel or in waters upstream of the Channel*	McArthur River Diversion Channel, Upstream McArthur River: Kilgour Junction, Eight Mile, Cattle Yard, Djirrinmini / Wurrini waterholes.	Presence of Freshwater Sawfish.	Annually.	• Gill netting. • Line Fishing. • Acoustic Monitoring.	Level 1	Freshwater Sawfish observed navigating or recorded via acoustic receiver station within the McArthur River Diversion Channel or in waters upstream of the Channel annually.	Continue monitoring and annual reporting.
						Level 2	Freshwater Sawfish not observed navigating or recorded via acoustic receiver station within the McArthur River Diversion Channel or in waters upstream of the Channel in a consecutive three-year period.	Notify the Environment – Superintendent. Implement investigation to determine if additional controls or management actions (e.g. installation of large woody debris in the McArthur River Diversion Channel and/or additional revegetation works) are necessary to return trigger value to Level 1. Review applicable data such as magnitude of wet season, monitoring effort, captures downstream of the mineral lease, historical water quality variation and captures outside of the McArthur River catchment to supplement the investigation. Continue monitoring and annual reporting.
						Level 3	Freshwater Sawfish not observed navigating or recorded via acoustic receiver station within the McArthur River Diversion Channel or in waters upstream of the Channel in a consecutive five-year period.	Notify the Environment Manager – Health, Safety, Environment and Community. Implement Level 3 investigation and response process as detailed in Section 5.1. Consider potential sources and pathways, which may have contributed to the trigger exceedance. If the exceedance is not due to the Mine, report MRM's performance against this Performance Indicator as Level 2. If the investigation confirms the exceedance is due to the Mine, undertake an assessment against the environmental objective considering results from other monitoring programs and historical (Pre-Overburden Management Project) performance. Issue the investigation report to DEPWS and DITT within 10 days of assessment completion. Consider implementation of management and contingency measures outlined in Sections 6 and 7.
Protect the McArthur River beneficial uses and community values from mining impacts	*No statistically significant difference in macroinvertebrate species richness / assemblage at McArthur River performance identification sites*	Site M17 and M18 detailed in Figure 12.	Macroinvertebrate species richness / assemblage.	Annually.	Sampling and processing closely follows established NT protocols (Lamche, 2007) with reference to Lloyd and Cook (2002) and Queensland Department of Natural Resources and Mines (2001) for sampling riffle habitats.	Level 1	No statistically significant difference[2] in macroinvertebrate species richness/assemblage at McArthur River impact sites (M17 and M18) compared to reference sites of the same stream order.	Continue monitoring and annual reporting.
						Level 2	Statistically significant difference[2] in macroinvertebrate species richness/assemblage at McArthur River impact sites (M17 and M18) when compared to reference sites of the same stream order during annual sampling.	Notify the Environment – Superintendent. Implement investigation to determine if additional controls or management actions (e.g. seek specialist input to identify potential causes of diversity changes and mitigation options) are necessary to return trigger value to Level 1. Continue monitoring and annual reporting.
						Level 3	Statistically significant difference[2] in macroinvertebrate species richness/assemblage at McArthur River impact sites (M17 and M18) when compared to reference sites of the same stream order over two or more consecutive sampling years.	Notify the Environment Manager – Health, Safety, Environment and Community. Implement Level 3 investigation and response process as detailed in Section 5.1. Consider potential sources and pathways, which may have contributed to the trigger exceedance. If the statistical difference is not due to the Mine, report MRM's performance against this Performance Indicator as Level 2. If the investigation confirms the statistical difference is due to the Mine, undertake an assessment against the environmental objective considering results from other monitoring programs and historical (Pre-Overburden Management Project) performance. Issue the investigation report to DEPWS and DITT within 10 days of assessment completion. Consider implementation of management and contingency measures outlined in Sections 6 and 7.

Environmental Objective	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis/Sampling Methodology	Level	Triggers	Action/Response
Protect the McArthur River beneficial uses and community values from mining impacts *and* *Facilitate development of the ecosystems and their functions along the McArthur River Diversion Channel for terrestrial and aquatic flora and fauna*	*No statistically significant difference in aquatic fauna species diversity and relative abundance at McArthur River performance identification sites during the early dry season survey*	SW11, SW12 and Emu Creek Convergence as detailed in Figure 13.	Aquatic fauna species diversity and relative abundance.	Annual early dry season survey.	• Fyke netting. • Seine netting. • Electrofishing.	Level 1	Statistical analysis[3] indicates that species diversity and relative abundance at downstream performance identification sites are comparable to habitat at reference sites located away from the influence of mining operations.	Continue monitoring and annual reporting.
						Level 2	During annual monitoring, statistical analysis[3] indicates that species diversity and relative abundance at downstream performance identification sites are significantly different to habitat at reference sites located away from the influence of mining operations.	Notify the Environment – Superintendent. Implement investigation to determine if additional controls or management actions (e.g. seek specialist input to identify potential causes of diversity changes and mitigation options) are necessary to return trigger value to Level 1. Continue monitoring and annual reporting.
						Level 3	Over two or more consecutive sampling years, statistical analysis[3] indicates that species diversity and relative abundance at downstream performance identification sites are significantly different to habitat at reference sites located away from the influence of mining operations.	Notify the Environment Manager – Health, Safety, Environment and Community. Implement Level 3 investigation and response process as detailed in Section 5.1. Consider potential sources and pathways, which may have contributed to the trigger exceedance. If the statistical difference is not due to the Mine, report MRM's performance against this Performance Indicator as Level 2. If the investigation confirms the statistical difference is due to the Mine, undertake an assessment against the environmental objective considering results from other monitoring programs and historical (Pre-Overburden Management Project) performance. Issue the investigation report to DEPWS and DITT within 10 days of assessment completion. Consider implementation of management and contingency measures outlined in Sections 6 and 7.
Protect the McArthur River beneficial uses and community values from mining impacts	*Metal concentrations in aquatic fauna are within permitted concentrations under the Food Standards Code*	Performance identification sites as detailed in Figure 13	Maximum permitted concentrations (MPC) of metal contaminants in aquatic species in accordance with the *Australian and New Zealand Food Standards Code* (2016). The MPC for cadmium is: • Molluscs = 2 milligrams per kilogram (mg/kg). The MPC for lead is: • Fish = 0.5 mg/kg. • Molluscs = 2 mg/kg.	Annually.	Tissue sampling.	Level 1	Mean tissue concentrations in indicator or commonly consumed species ≤ MPC.	Continue monitoring and annual reporting.
						Level 2	Mean tissue concentrations in indicator or commonly consumed species > MPC at performance identification sites on-lease and resultant of mine operations.	Notify the Environment – Superintendent. Implement investigation to determine if additional controls or management actions (e.g. sediment removal from Barney Creek Diversion Channel and/or review of dust and sediment controls in this area) are necessary to return trigger value to Level 1. Continue monitoring and annual reporting.
						Level 3	Mean tissue concentrations in indicator or commonly consumed species > MPC at performance identification sites off-lease and resultant of mine operations.	Notify the Environment Manager – Health, Safety, Environment and Community. Implement Level 3 investigation and response process as detailed in Section 5.1. Consider potential sources and pathways, which may have contributed to the trigger exceedance. Undertake investigation to determine the performance of the environmental objective considering results from other monitoring programs and historical (Pre-Overburden Management Project) performance. Issue the investigation report to DEPWS and DITT within 10 days of assessment completion. Consider implementation of management and contingency measures outlined in Sections 6 and 7.

Environmental Objective	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis/Sampling Methodology	Level	Triggers	Action/Response
Minimising air quality related impacts with respect to community health and the Environment	*Negligible air quality impacts to community health*	Sites shown on Figure 14: **Level 2** MRM workers camp (SO2Village) and NOEF (SO2VAN02) **Level 3** Borroloola and Goolminyini (Devils Spring)	SO_2 concentration with triggers derived from the *National Environment Protection (Ambient Air Quality) Measure* (as amended May 2021): • 1hr average = 0.10 parts per million (ppm). • 24hr average = 0.02 ppm.	Continuous.	Fluorescence analysis in accordance with AS 3580.4.1-2008. Method 4.1 *Determination of sulfur dioxide – Direct reading instrumental method*. Dispersion modelling.	Level 1	Concentrations of SO_2 at MRM workers camp (SO2Village) and NOEF (SO2VAN02) below or equal to NEPM guideline values.	Continue monitoring and annual reporting.
						Level 2	Exceedance of NEPM guideline values at MRM workers camp (SO2Village) or NOEF (SO2VAN02).	Notify the Environment – Superintendent. Implement investigation to determine if additional controls or management actions (e.g. temporary relocation or cessation of relevant fleet) are necessary to return trigger value to Level 1. Consider implementation of management and contingency measures outlined in Sections 6 and 7. Dispersion modelling for community receptors to be undertaken based on maximum monthly values. Continue monitoring and annual reporting.
						Level 3	Exceedance of NEPM guideline values at Borroloola and Goolminyini (Devils Spring) based on dispersion modelling results.	Notify the Environment Manager – Health, Safety, Environment and Community. Implement Level 3 investigation and response process as detailed in Section 5.1. Consider potential sources and pathways, which may have contributed to the trigger exceedance. Undertake investigation to determine the performance of the environmental objective considering results from other monitoring programs and historical (Pre-Overburden Management Project) performance. Issue the investigation report to DITT within 10 days of assessment completion. Consider implementation of management and contingency measures outlined in Sections 6 and 7.
Facilitate development of the ecosystems and their functions along the McArthur River Diversion Channel for terrestrial and aquatic flora and fauna	*Revegetation monitoring indicates progressive remediation according to schedule*	Monitoring sites along the McArthur River Diversion Channel detailed in Figure 15.	Adaptive completion criteria developed from control sites, See Appendix C – Rehabilitation Management Plan.	Annually.	Field assessments of monitoring sites against completion criteria.	Level 1	The monitoring site characteristics indicate that all of the following completion criteria have been met: • Bare/Rock Cover (%); • Grass and Herb cover; • Number of Key Species; • Number of Trees; • Declared Weed Cover (%); • Fauna Disturbance Score; • Erosion and Stability; and • Flood Damage.	All completion criteria met. or Tracking towards completion, no intervention is required. Continue routine rehabilitation works, monitoring and annual reporting.
						Level 2	Sites are considered to be "Level 2" if the Level 1 criteria have not been met, but the landform is stable (i.e. the following completion criteria have been met): • Erosion and Stability; and • Flood Damage.	Notify the Environment – Superintendent. Additional routine revegetation works required to increase vegetation diversity and cover or implement measures to encourage sedimentation. or Additional routine rehabilitation maintenance works may be required including weed control, fencing repairs and mustering. Continue monitoring and annual reporting.
						Level 3	Sites are considered to be "Level 3" if monitoring indicates the landform is unstable in comparison to control sites (i.e. any of the following completion criteria have not been met): • Erosion and Stability; or • Flood Damage.	Notify Environment Manager – Health, Safety and Community. Extensive earthworks required that would not typically form part of a rehabilitation maintenance to repair erosion or reduce water velocities. Where erosion is severe, this may include the installation of riprap, gabion walls or groynes to reduce water velocities and encourage sedimentation. Following repairs and mitigation measures, or where erosion is moderate, continue revegetation program with a successional approach focusing on the initial planting of grasses to establish stability of the ground prior to the planting of tree and shrub tube stock in numbers. Issue the investigation report to DITT within 10 days of assessment completion. Consider implementation of management and contingency measures outlined in Sections 6 and 7.

[1] Note that Class 3 water is not included in this TARP criteria, as this water is treated via the reverse osmosis system when WTP is operational.

[2] Results are statistically significant (rejecting the null hypothesis of no differences between groups of sites/treatments) if the generated p-value is less than 0.05 ($p<0.05$).

[3] Aquatic fauna abundance and diversity statistical analysis is as per the Aquatic Fauna Abundance and Diversity Monitoring Program (Indo-Pacific Environmental, 2020).

* Note that no investigation is required for this Level 2 trigger due to the overlap in performance indicator with the following TARP.

6. Contingency Measures

This section describes contingency measures that would occur in response to the TARP process outlined in Section 5. Contingency measures will be implemented, as appropriate, to comply with the relevant statutory requirements (Section 2.1) and the environmental objectives of this AMP (Section 3.2).

Potential contingency measures have been identified based on the comprehensive knowledge acquired through EIS assessments, environmental monitoring and reporting and environmental risk assessments.

The potential contingency measures that may be implemented in response to a Level 2 or Level 3 trigger are listed in Table 9.

TABLE 9: POTENTIAL CONTINGENCY MEASURES

Contingency Measure	Realistic and Achievable Justification	Implementation	Potential Risks Managed by Implementation of Measure
Waste rock material excavation and re-compaction.	Works previously undertaken on-site.	Can be implemented following consideration by mine planners.	AMD (surface water)/groundwater seepage, spontaneous combustion.
Adjustments and/or maintenance to cover systems and waste rock landforms.	Consideration of rehabilitation trial outcomes required under VOA 0059.	May be subject to Mine Closure Panel input (once established).	Erosion, poor quality runoff, stability.
Repair to dam and dam liners.	Works previously undertaken on-site.	Subject to design sign-off by ICE.	Uncontrolled spill (surface water), groundwater seepage.
Removal of mine affected sediments or baseflow.	Works previously undertaken on-site.	Subject to weather and access constraints.	Poor quality runoff/sediment.
Increased water treatment capacity.	Water Treatment Plant constructed.	Subject to by-product storage availability.	Reduce poor quality water inventory (allowing for increased discharge, if required).
Alternative water treatment technology.	Ongoing review of available technologies.	Review of feasible options would be undertaken as required.	Reduce poor quality water inventory (allowing for increased discharge, if required).
Increased water storage.	Multiple storages already constructed at site.	Upgraded Process Water Dam/WMD proposed in OMP EIS. Subject to detailed designs.	Uncontrolled spill (surface water).
Engineered dust suppression controls.	Ongoing trial/improvement works occurring.	Subject to trial outcomes.	Air quality impacts to humans and environment (e.g. surface water/sediment).
Expanded water cart fleet/dust suppression capacity.	Augmentation of current operations.	Additional fleet/equipment required.	Air quality impacts to humans, environment (e.g. surface water).
Construction of interception sumps, drains or bores.	Works previously undertaken on-site.	Can be implemented following consideration by hydrogeologist and mine planners.	Groundwater seepage to surface water system.
Accelerated rehabilitation.	Additional resourcing required.	Subject to mine planning and existing rehabilitation outcomes.	Erosion, poor quality runoff, stability.
Construction of additional sediment control structures (e.g. sediment traps).	Consistent with current operations.	Can be implemented following consideration by mine planners.	Erosion, poor quality runoff (elevated sediment).

Contingency Measure	Realistic and Achievable Justification	Implementation	Potential Risks Managed by Implementation of Measure
In-stream sediment traps.	Conceptual design completed.	Detailed design would be required.	Poor quality runoff (elevated sediment).
Construction of additional sumps to capture and manage toe seepage.	Works previously undertaken on-site.	Can be implemented following consideration by mine planners.	Groundwater seepage to surface water system.
Construction of an NOEF groundwater interception scheme.	Interception trench constructed at TSF. Conceptual designs complete.	Detailed design would be required.	Groundwater seepage to surface water system.
Installation of additional large woody debris within the McArthur River Diversion Channel.	Works are currently completed annually.	Routinely undertaken. Limited by the amount of Large Woody Debris available from clearing activities.	Lack of suitable aquatic fauna habitat in the McArthur River Diversion Channel, erosion.
Modified rehabilitation techniques/rehabilitation trials.	To be informed by rehabilitation trials.	Rehabilitation trials are currently underway and will inform future rehabilitation techniques.	Erosion, poor quality runoff, stability.
Adjustment of mining and processing production rates.	Production rates previously reduced.	Can be implemented following consideration by mine planners.	Dust, various.
Relocation of operations and/or temporary cessation of operations.	Previously undertaken on-site.	Can be implemented following consideration by mine planners.	Dust, various.
Alternative water disposal techniques to reduce discharge.	Alternative techniques currently being investigated.	Consideration of potential environmental impacts required.	Uncontrolled spill (surface water).
Adjustment of water management and discharge volumes.	Site water balance updates inform optimal storage/discharge volumes.	Routinely undertaken (e.g. following site water balance updates).	Uncontrolled spill (surface water).
Identity a suitable water source and artificially recharge the Wurrini waterhole and other refuge pools.	Consistent with OMP EIS commitment.	Water transfer infrastructure would be required between source and pools.	Risks to site values and aquatic fauna.

The most appropriate management measures would be determined based on available information collected and analysed following the investigation resulting from a Level 2 or Level 3 trigger exceedance.

Follow-up inspections will be conducted to assess the effectiveness of implemented management measures and the requirement for any additional management measures. Management measures will be reported in the Environmental Monitoring Report (EMR).

7. Contingency Plan

In the event an environmental objective detailed in Section 3.2 is considered as not being met, MRM will implement the following Contingency Plan:

- MRM's performance against the environmental objective will be reported to the Superintendent – Environment and/or Manager – Health, Safety, Environment & Community within 24 hours of assessment completion.
- The Superintendent – Environment and/or Manager – Health, Safety, Environment & Community will report MRM's performance against the environmental objective to the General Manager as soon as practicable after being made aware.
- MRM will report the performance against the environmental objective to DITT and DEPWS as soon as practicable after MRM becomes aware of its performance.
- MRM will identify an appropriate course of action with respect to the identified impact(s), in consultation with specialists and relevant agencies, as necessary. For example, this may include proposed contingency measures and a program to review the effectiveness of the contingency measures.
- Contingency measures will be updated or developed in consideration of the specific circumstances relevant to MRM's performance against the environmental objective and the assessment of environmental consequences.
- MRM will submit the proposed course of action and a program to review the effectiveness of the contingency measures to the relevant regulator for approval.
- MRM will implement the approved course of action to the satisfaction of DITT.

8. Review and Update

This AMP will be subject to ongoing reviews and revisions as part of MRM's environmental performance reporting. Revisions will incorporate emerging knowledge, technology and management techniques to inform mitigation, contingency and the TARP process.

This AMP will be reviewed, and if necessary revised, on an annual basis as part of the preparation of the annual EMR. Recent advances in best practices will be taken into account in the review in accordance with the conditions of the EPBC Act Approval (2014/7210).

Additionally, the AMP will also be reviewed, and if necessary, revised:

- when a MMP (or amendment) is submitted;
- following any modification to the conditions of VOA 0059; and
- following the issue of any WDL 174 renewal.

The ongoing AMP review and revision process is shown in Figure 19. The AMP would be updated in consultation with the appropriate regulatory authorities and stakeholders (if necessary) for any major amendments. Minor changes will be made with version control.

The AMP will be reviewed by the Independent Monitor or an appropriately qualified independent third party in accordance with the requirements of VOA 0059.

The AMP will also be reviewed in consideration of any learnings made and evolving knowledge as part of the adaptive management process.

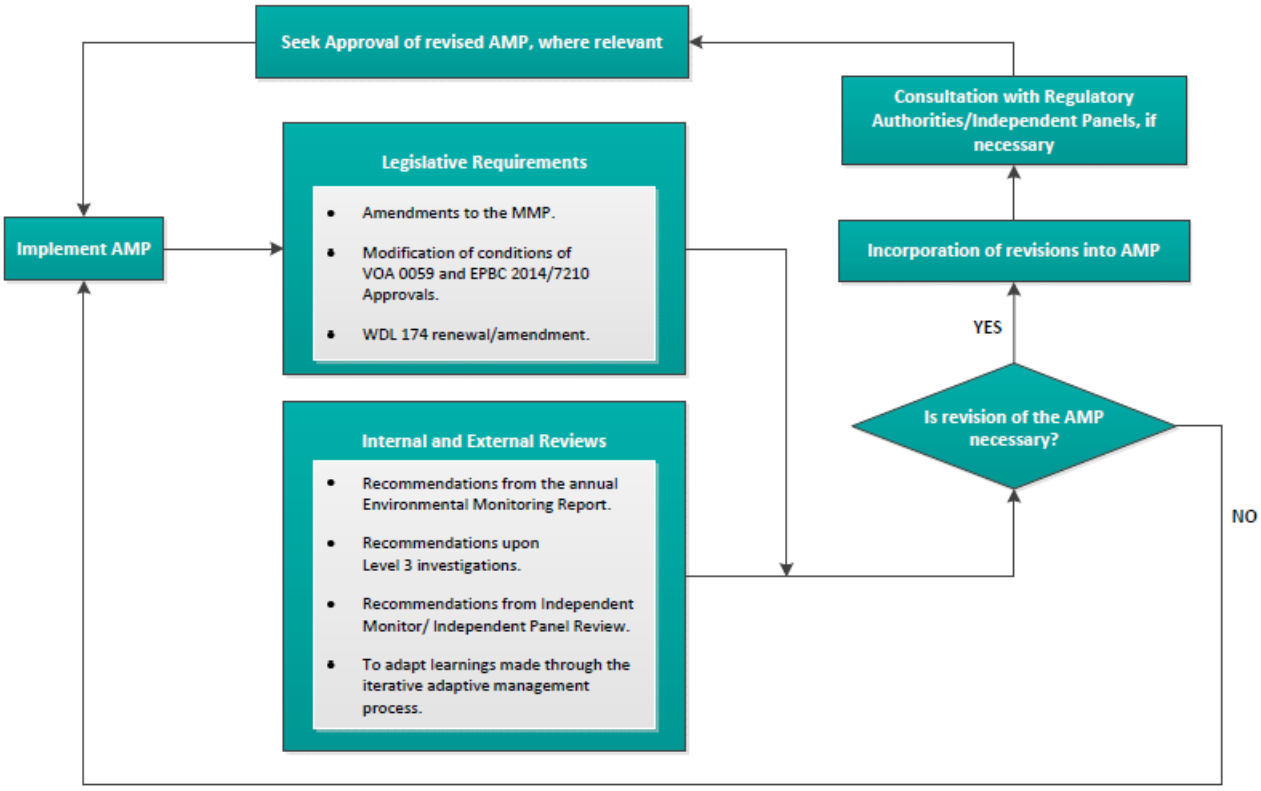

Figure 19: AMP Review and Revision Process

8.1 Independent Monitor Review

The Independent Monitor is required to review the AMP every three years in accordance with NT EPA Assessment Report (NT EPA, 2018a) Recommendation 29. The outcomes of the review will be made available to the relevant regulators, the NT EPA, the Community Reference Group (once established) and the public.

8.2 Ongoing Compliance and Reporting

MRM currently reports environmental monitoring and performance data via the following:

- Annual WDL Monitoring Report to DEPWS.
- Annual WDL Return to DEPWS.
- Annual reporting via the EMR to DITT which includes annual results from:
    - Fluvial Sediment monitoring;
    - McArthur River Riparian Bird Monitoring;
    - Freshwater Aquatic Macroinvertebrate Monitoring;
    - Aquatic Fauna Diversity and Abundance Monitoring;
    - Acoustic Monitoring Program;
    - Aquatic Fauna Metal Monitoring Program;
    - Air Quality Monitoring Program;
    - Water Quality and Metals in Biota Monitoring;
    - Groundwater Monitoring;
    - Surface Water Monitoring; and
    - Rehabilitation Monitoring.
- Quarterly reporting of raw monitoring data to DITT.
- Reporting of environmental incidents to DITT and DEPWS, as required by legislation and licences.
- Reporting elevated results at SW11 to DEPWS as required by the WDL.
- EPBC Annual Compliance Report (2003/954) to Department of Agriculture, Water and the Environment.
- EPBC Annual Compliance Report (2014/7210) to Department of Agriculture, Water and the Environment.

8.3 Environmental Incidents

Environmental incidents are reported as soon as practicable to the DITT, and the NT EPA where relevant, following investigation of validity. All incidents are recorded by MRM in an internal incident database with improvement actions assigned to prevent incident reoccurrence. Information recorded when an incident is identified includes the following:

- Incident number (used for tracking purposes).
- The date of the incident.
- The party that detected the incident.
- A brief description of the findings of the investigation following incident identification.
- Assessment of the risk of environmental harm.
- Actions considered to mitigate environmental harm that may have occurred.
- Corrective actions to prevent re-occurrence of the incident.
- Actions completed.

Reporting of environmental incidents or serious environmental incidents occurs in accordance with the regulatory requirements of MRM's licence and authorisation conditions, the *Mining Management Act 2001*, the *Waste Management and Pollution Control Act 1998*, and MRM's Incident Investigation Procedure PRO-260063 (MRM, 2019c) and Incident Reporting Protocol (MRM, 2020c).

A summary of incidents is reported annually as part of the EMR. Corrective actions are reviewed on a monthly basis to track progress and completion.

8.4 AMP Planned Future Revisions

This AMP has been prepared in accordance with the NT EPA *Guidance on Adaptive Management* (NT EPA, 2018b) and Conditions of WDL 174 and VOA 0059. The AMP has also been prepared to address the requirements of the *Mining Management Plan Structure Guide for Mining Operations* (DPIR, 2017).

MRM will be required to resubmit updated versions of the AMP for approval to address the full requirements of EPBC Act Approval (2014/7210).

8.5 Mine Closure

The AMP will be reviewed as the Mine approaches closure to adapt to changes to environmental objectives, mitigation measures, TARP processes and contingency measures due to the Mine closure.

9. References

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McArthur River Mine (2019c) *McArthur River Mine Incident Investigation Procedure (PRO-2600063).*

McArthur River Mine (2020a) *McArthur River Mine Air Quality Management Plan.*

McArthur River Mine (2020b) *McArthur River Mine January 2020 Mining Management Plan.*

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WRM Water & Environment Pty Ltd (2021) *Waterways modelling of drawdown impacts on refuge pools – Extent and duration of drawdown on Wurrini and Djirrinmini waterholes.*

Appendix A: Water Management Plan

Appendix B: Air Quality Management Plan

Appendix C: Rehabilitation Management Plan

PO Box 36821 · Winnellie · Northern Territory 0821 · Australia
34a Bishop Street · Stuart Park · Northern Territory 0820 · Australia
Tel +61 8 8975 8179 · Fax +61 8 8975 8170 · Web ww.mcarthurrivermine.com.au

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McArthur River Mining Pty Ltd ABN 90 008 167 815