Mining Management Plan

MCARTHUR RIVER MINE

McArthur River Mining Pty Ltd

A GLENCORE Company

DOCUMENT PROPERTIES

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In accordance with Condition 128 of Variation of Authorisation 0059 and NT EPA Assessment Report 86, commercially sensitive information has been removed from this version of the Mining Management Plan. This document and the attached Adaptive Management Plan give an overview of the environmental management to be implemented under the Mining Management Plan.

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1 Introduction

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) south-east of Darwin, and approximately 45 km south-west of the township of Borroloola (Figure 1).

In addition to mining activities, the operations include an on-site 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.

Since 2013, MRM has operated consistent with its Sustainable Development Mining Management Plan 2013-2015 and associated amendments (the 2013-2015 MMP). On-site mining and processing activities are conducted within Mineral Lease Northern (MLN) 1121, MLN 1122, MLN 1123 and MLN 1124 (Figure 2).

The BBLF is located within MLN 1126 (Figure 3).

1.1 Background and Scope

MRM submitted the Overburden Management Project (OMP) Environmental Impact Statement (EIS) in early 2017 and subsequently prepared and submitted a Supplementary OMP EIS in early 2018. In July 2018, the NT Environment Protection Authority (NT EPA) released *Assessment Report 86 for the McArthur River Mine Overburden Management Project* (NT EPA, 2018a) (Assessment Report 86) and recommended the OMP for approval.

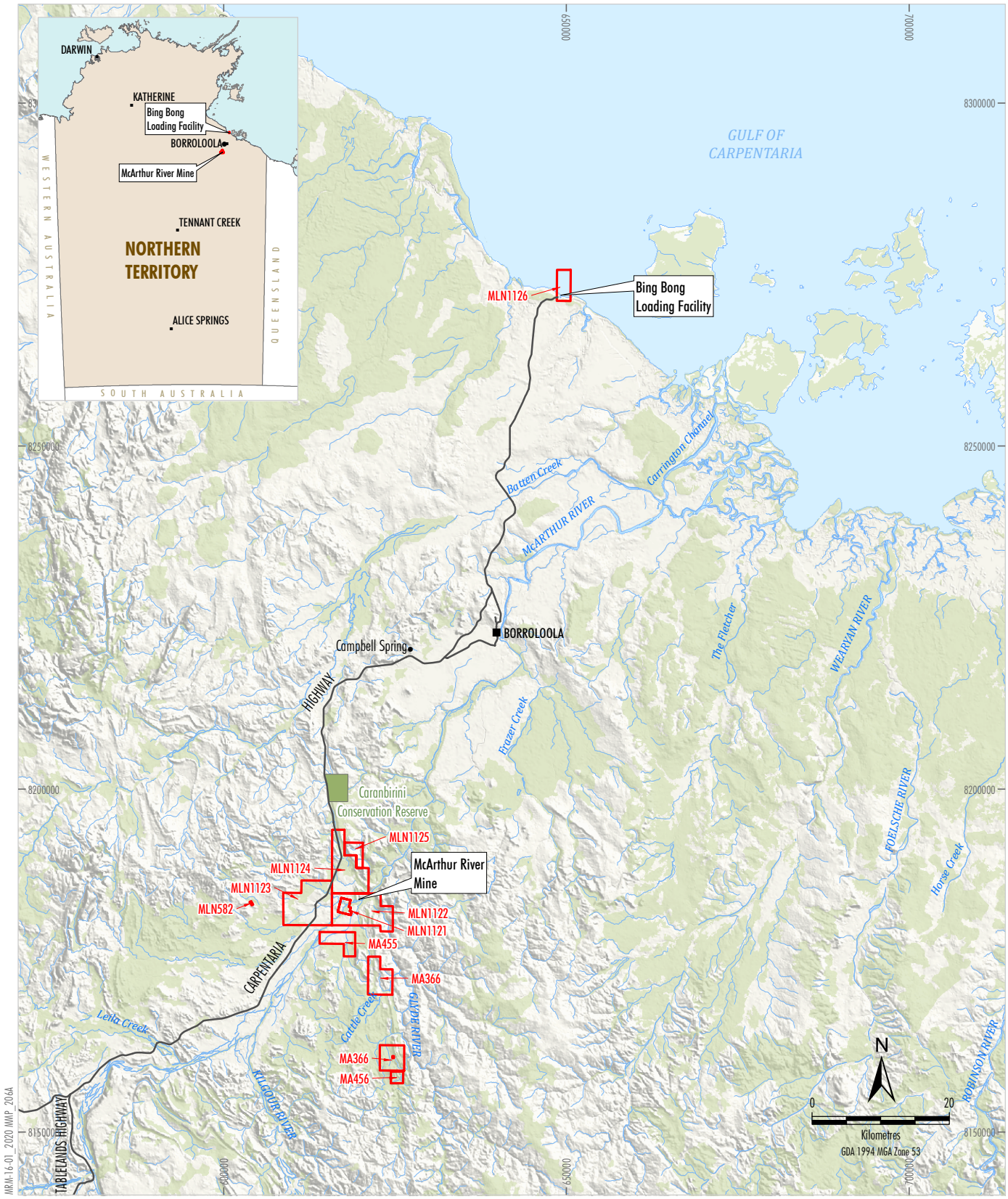
Assessment Report 86 included 30 recommendations, which have been conditioned by the NT Department of Primary Industry and Resources (DPIR) in Variation of Authorisation (VOA) 0059 (dated 15 August 2019). The Mine is also subject to Waste Discharge Licence (WDL) 174 and *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) approval conditions.

This Mining Management Plan (MMP) has been prepared in accordance with DPIR's *Mining Management Plan Structure Guide for Mining Operations* (DPIR, 2017). It formalises the activities and actions to be taken and strategies to be implemented that, when combined, will manage impacts to the environment to acceptable and sustainable limits.

An Environmental Risk Assessment (ERA) workshop has been conducted to identify and assess potential environmental risks and controls associated with the planned MMP activities. The ERA included a review of all risks posed by ongoing operations (reconciled with the OMP EIS risk assessment) as well as potential new/altered risks resulting from the planned activities. The ERA found that there was no increase in the environmental risks compared to those presented in the OMP EIS, and all risks (including new/altered risks) were determined to be Low or Medium based on the assessment matrix. The ERA is presented in Appendix A.

Further detail on the planned activities is presented in Section 4. Environmental management and water management is provided in Section 5 and 6, respectively.

The Adaptive Management Plan (AMP) is provided as Appendix B and provides the strategic framework for environmental management, monitoring, mitigation and reporting at the Mine.



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-16-01_2020 MMP_207A

LEGEND

Mineral Lease

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

McARTHUR RIVER MINE

Mine Site

Figure 2

LEGEND

Mineral Lease

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

MRM-16-01_2020 MMP_208B

McARTHUR RIVER MINE

Bing Bong Loading Facility

Figure 3

1.2 Operator Details

Glencore is one of the world's largest global diversified natural resource companies. As a leading integrated producer and marketer of commodities with a well-balanced portfolio of diverse industrial assets, Glencore is strongly positioned to capture value at every stage of the supply chain, from sourcing materials deep underground to delivering products to an international customer base.

Glencore's industrial and marketing activities are supported by a global network of more than 90 offices located in over 50 countries and its diversified operations comprise over 150 mining and metallurgical sites, offshore oil production assets, farms and agricultural facilities. Glencore employs approximately 190,000 people (including contractors).

The Mine is contained within five contiguous mineral leases (MLN 1121, MLN 1122, MLN 1123, MLN 1124 and MLN 1125), located on the McArthur River Station Pastoral Lease. The McArthur River Station is 100 percent (%) owned by Mount Isa Mines Limited and managed by Colinta Holdings Pty Ltd, a Glencore subsidiary.

Zinc concentrate is transported from the Mine to the BBLF by road. From there, it is loaded onto a barge and transported to waiting ocean going vessels at sea in the Gulf of Carpentaria. Lead concentrate is transported by road to the Mount Isa Mine for smelting in the Mount Isa Mine Lead Smelter.

MRM is dedicated to supporting local people and local businesses, and creating strong links between their operations and the Gulf Region. MRM does this through generous contributions to local health, education, cultural and capacity building initiatives, the funding of vital public services and infrastructure development projects, and local employment and procurement.

Legal Entity:	McArthur River Mining Pty Ltd
ABN:	90 008 167 815
ACN:	008 167 815
Registered Business Address:	Level 44, 1 Macquarie Place, Sydney NSW 2000
Postal Address:	PO Box 36821
	Winnellie NT, 0821

1.2.1 Organisational Structure and Responsibility

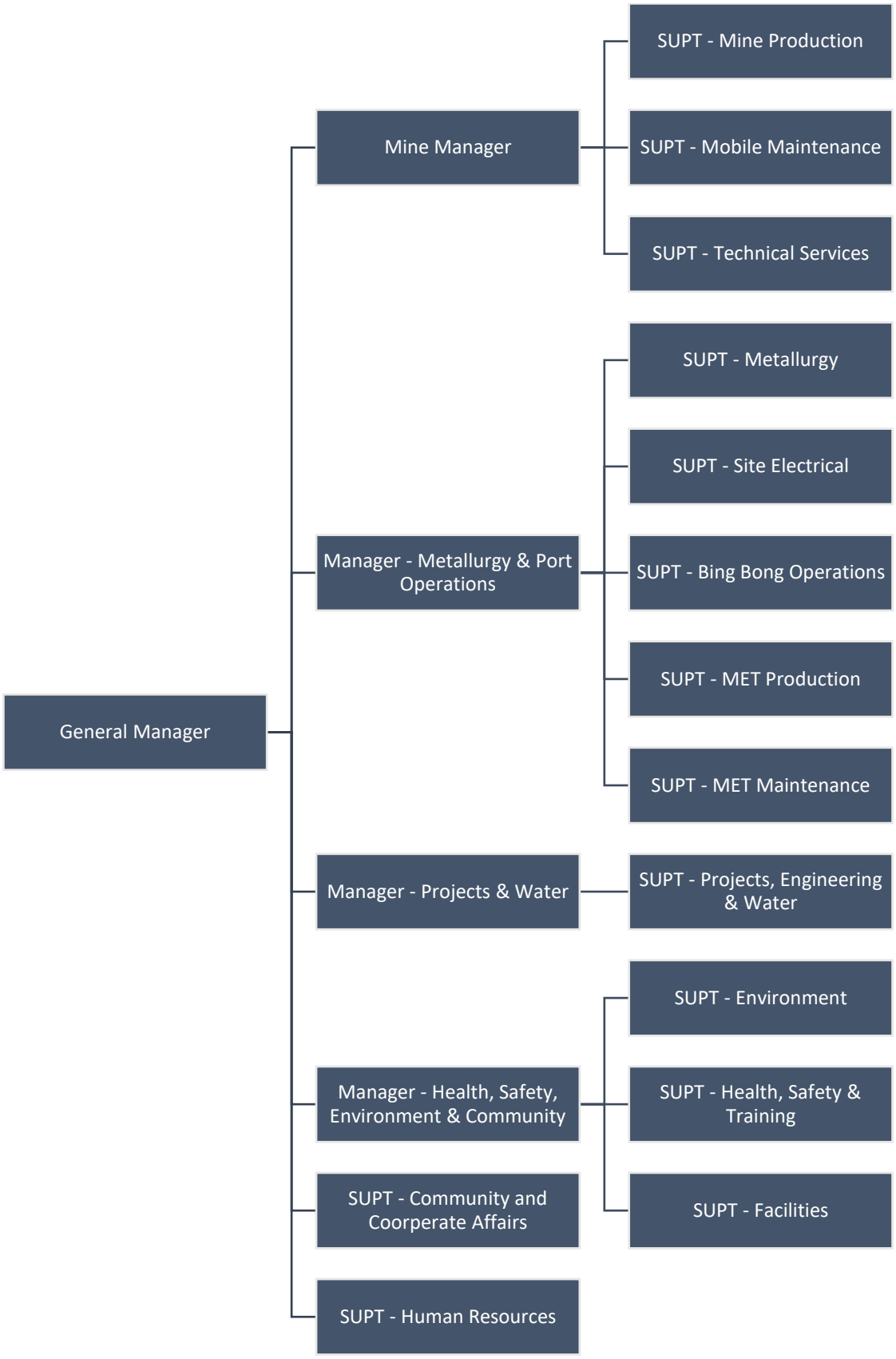
Plate 1 provides a summary of the MRM site organisational structure for the senior leadership team. The contact details for key personnel, along with the MRM information line, are provided in Table 1.

TABLE 1 - CONTACT NUMBERS FOR KEY SENIOR PERSONNEL

Position	Contact Details
MRM Email Address	mrmprojenq@glencore.com.au
MRM Information line	1800 211 573

Specific MRM responsibilities in relation to environmental management include:

- General Manager – overall responsibility for ensuring that all environmental commitments are met.
- Managers – management of their specific department's performance including ensuring that personnel under their management have the requisite competencies, skills and training to carry out their assigned tasks (including in relation to environmental management).
- Superintendent – responsible for the implementation and performance of environmental management, and (in the event of non-conformance) coordinating appropriate investigation, reporting and implementation of corrective actions.
- Environment team personnel – as outlined within the respective management plans. The team delivers a number of key components including monitoring, rehabilitation, compliance, reporting and projects.
- All employees – responsible for the environmental impact of their activities, complying with the laws of the NT and Commonwealth and the day-to-day implementation of the requirements of environmental management plans.



SUPT = Superintendent

Plate 1 – MRM Site Organisational Structure

1.3 Title Details

Locations and details of MRM tenements are shown in Table 2 and Figures 1, 2 and 3.

TABLE 2 - LIST OF MCARTHUR RIVER MINING PTY LTD TENEMENTS

Tenement	Date Granted	Date of Expiry	Area	Holder
MA 366	08 Jun 1992	07 Jun 2020	9 blocks	Mount Isa Mines Limited
MA 455	21 Aug 2006	20 Aug 2020	4 blocks	Mount Isa Mines Limited
MA 456	21 Aug 2006	20 Aug 2020	1 block	Mount Isa Mines Limited
MLN 582*	01 Sep 1958	31 Dec 2019	16.18 ha	Mount Isa Mines Limited
MLN 1121	05 Jan 1993	04 Jan 2043	372.4 ha	Mount Isa Mines Limited
MLN 1122	05 Jan 1993	04 Jan 2043	3,348 ha	Mount Isa Mines Limited
MLN 1123	05 Jan 1993	04 Jan 2043	3,884 ha	Mount Isa Mines Limited
MLN 1124	05 Jan 1993	04 Jan 2043	3,283 ha	Mount Isa Mines Limited
MLN 1125	05 Jan 1993	04 Jan 2043	656.8 ha	Mount Isa Mines Limited
MLN 1126	05 Jan 1993	04 Jan 2043	900 ha	Mount Isa Mines Limited

MA = Mineral Authority; ha = hectares.
* An application to renew MLN 582 has been submitted by Glencore. At the time of writing, the tenement renewal has not been received.

1.4 Existing McArthur River Mine

1.4.1 Overview of Operations

1.4.1.1 History of Development

The Mine is an open pit operation developing one of the largest known sedimentary stratiform zinc-lead-silver deposits. The orebodies, making up the deposit known as “Here’s Your Chance” (HYC), were discovered in 1955 by Mount Isa Mines Limited geologists. Initial development did not commence until 1975, when a small decline and pilot plant were constructed on-site.

Following the preparation of an EIS in 1992, development of MRM’s underground operation commenced in 1994, with the first shipments of concentrate commencing in mid-1995.

Until 2006, the Mine was an underground operation producing around 333,000 dry metric tonnes per annum (dmtpa) of bulk lead-zinc-silver concentrate for overseas and domestic markets. The Mine was converted to an open pit operation following the completion of the 2005 environmental impact assessment process for the Phase 2 Project. MRM were authorised by the then Minister for the Environment, Heritage and the Arts, Peter Garrett, to construct and operate an open pit lead, zinc and silver mine to replace a closed underground mine on 20 February 2009.

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 output from 360,000 dmtpa to 800,000 dmtpa and involved improvement, expansion and upgrades of existing infrastructure.

1.4.1.2 Mining and Processing Operations

The main activities associated with the operation of the Mine include:

- Mining of ore within the Open Pit using excavators, and transport by haul truck to the run-of-mine (ROM) pad for stockpiling.
- Mining of waste rock within the Open Pit using excavators, and transport by haul truck to the North Overburden Emplacement Facility (NOEF).
- Overburden emplacement facility construction activities to manage waste rock, including compaction and clay capping of waste rock.
- Processing of ore via crushing, heavy/medium 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).
- Construction of embankment lifts at the TSF.
- Transport of product materials by road train along the Carpentaria Highway to the BBLF, where the product is barged offshore for transfer to ocean going vessels in the Gulf of Carpentaria.
- Other ancillary activities, such as dam construction, flood protection works, rehabilitation and excavation of borrow material for construction activities.

1.4.1.3 Environmental Management

MRM operates consistent with its Environmental Management Framework (EMF), which is a group of integrated plans, programs, guidelines, specifications and procedures designed to facilitate the management of environmental impacts and continuously improve environmental performance. The EMF is a proactive approach to environmental management and provides the framework to help MRM achieve its environmental objectives and address various approval requirements in a systematic and sustainable manner. The EMF for the Mine and the BBLF is shown on Plate 2 below.

A central component of the EMF is the AMP, a document that facilitates management and decision making over time in response to evolving knowledge, environmental performance and changing circumstances. The AMP is the overarching document that provides the strategic framework for environmental management, monitoring, mitigation and reporting of environmental performance against the conditions of MRM's approvals.

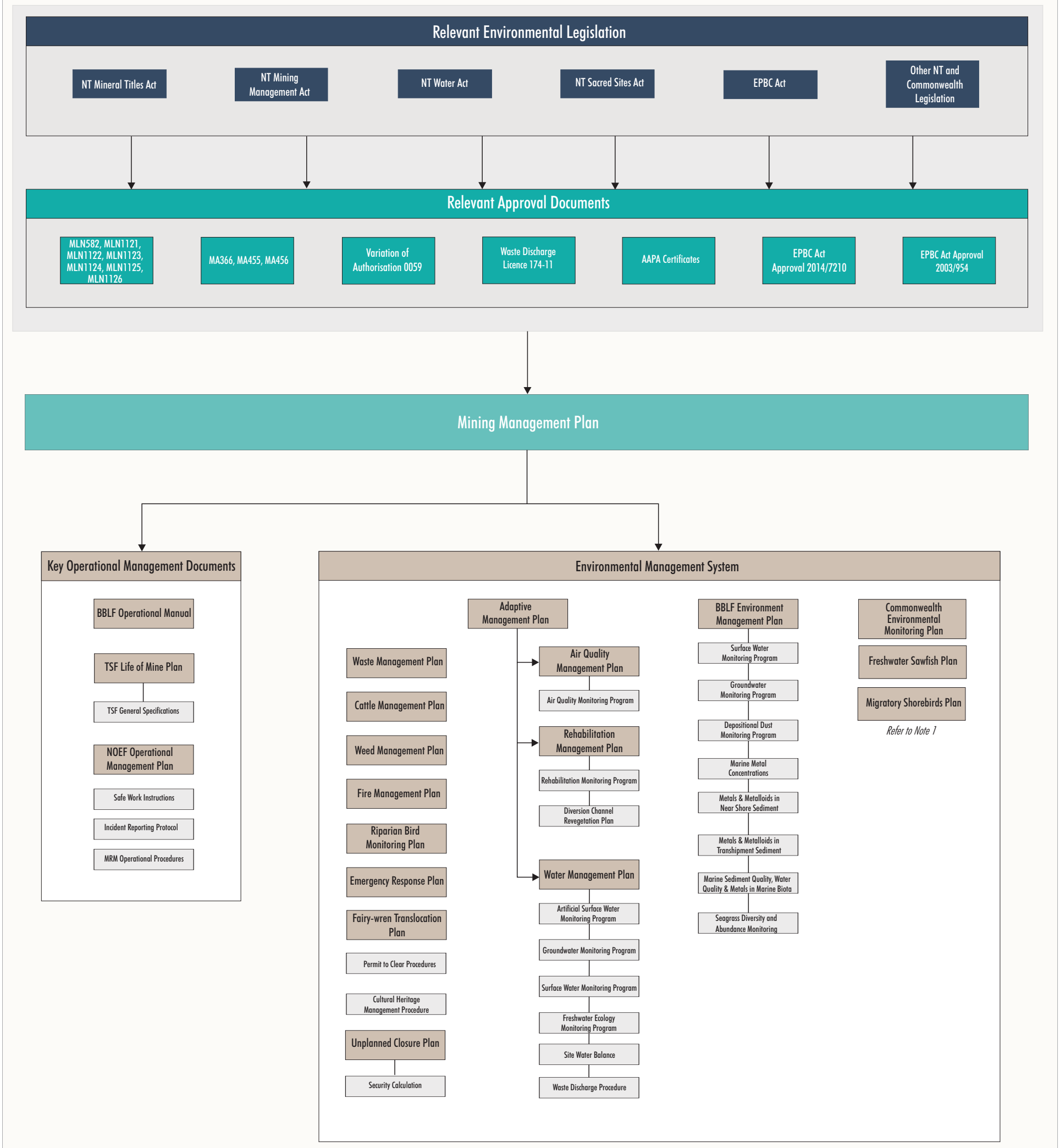
The AMP has been prepared in accordance with the NT EPA *Guidance on Adaptive Management* (NT EPA, 2018b). Management measures are outlined in the AMP to minimise environmental impacts.

The environmental objectives under the AMP have been established in consideration of key environmental risks for the Mine that were identified by the ERA and OMP EIS. MRM, with input from expert consultants, has developed Trigger Action Response Plans (TARPs) and monitoring programs for the AMP to assess performance against the environmental objectives to identify when additional management controls are required to continue to meet the objectives. MRM's performance against the environmental objectives and TARPs will be reported in annual Operational Performance Report (OPR).

The AMP and associated Environmental Management Plans are provided as Appendix B.

Any major revisions to the strategies, plans and programs will be submitted to the relevant regulatory authorities. Minor changes will be made with version control.

MRM Environmental Management Framework



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Note 1: Commonwealth Environmental Monitoring Plan, Freshwater Sawfish Plan and Migratory Shorebirds Plan are required by EPBC Act Approval 2003/954, and are therefore approved by the DOEE. As such, they are not appended to the MMP.

McARTHUR RIVER MINE

MRM Environmental Management Framework

Plate 2

1.4.2 Overburden Management Project

In late 2013, MRM lodged the 2013-2015 MMP with the NT Department of Mines and Energy (now DPIR). The 2013-2015 MMP incorporated revisions to the classification of overburden and resultant modifications to overburden emplacement design, particularly the NOEF. The revised waste classification system identified that the proportion of non-benign to benign waste rock proposed to be mined over the life of mine (LOM) was significantly higher than previous estimates provided in the Phase 3 EIS.

Following initial review, the revisions presented in the 2013-2015 MMP were referred to the 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 EIS was required.

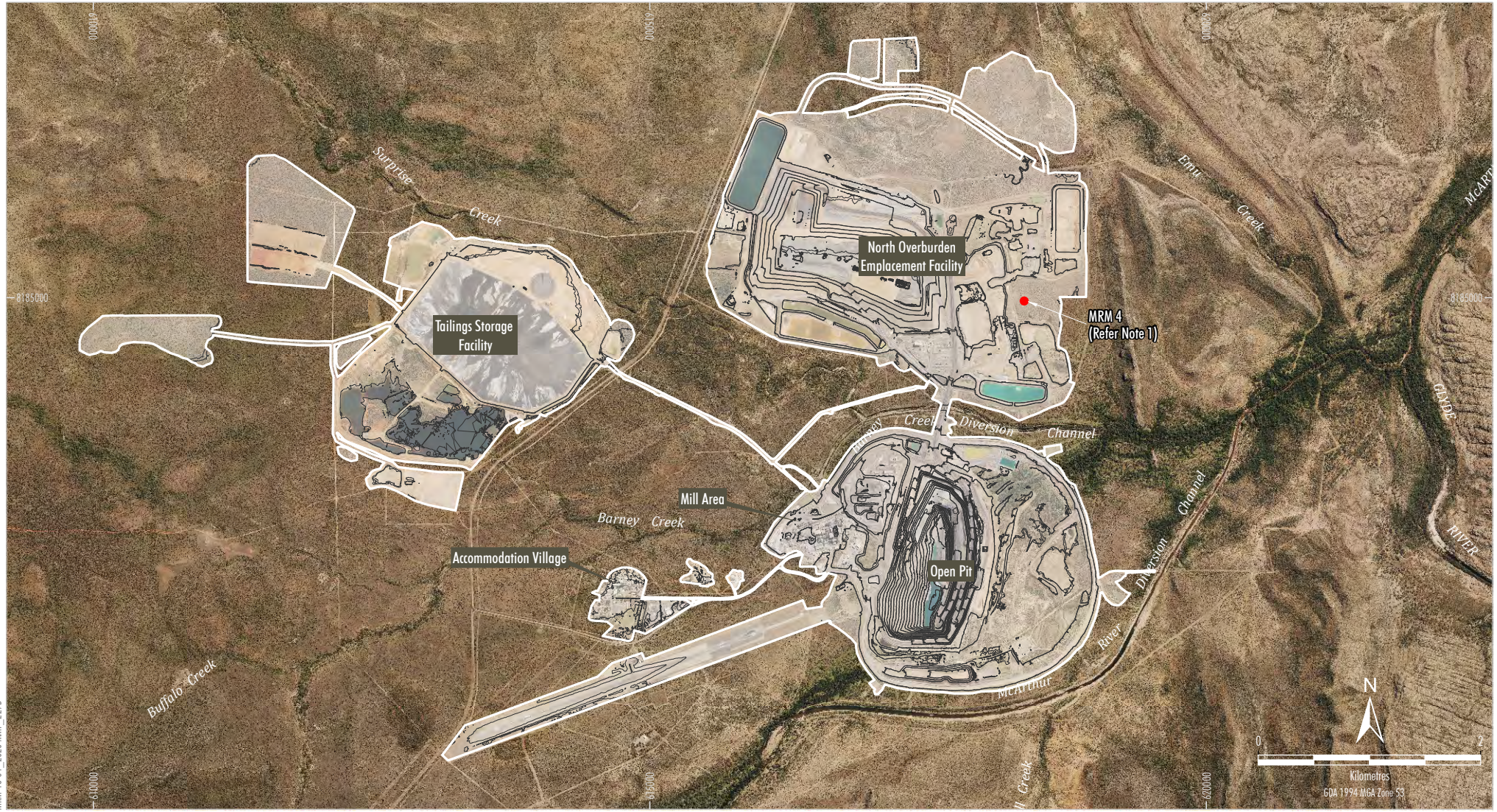
The draft OMP EIS was subsequently prepared and proposed the following for the Mine:

- Redesign of the NOEF to securely store the higher proportion of non-benign waste rock for the LOM.
- Reduction of the final footprint of the overburden emplacement facilities by increasing the height of the NOEF from 80 metres (m) to 140 m.
- Continued Open Pit and TSF development and closure.
- Suitable water management for the activities listed above.
- Revised long-term closure strategy.

MRM submitted the Draft OMP EIS in early 2017 and subsequently prepared and submitted a Supplementary OMP EIS in early 2018. The Supplementary OMP EIS maximum disturbance footprint for the LOM is shown on Figure 4.

In July 2018, the NT EPA released Assessment Report 86 and recommended the OMP for approval. A key overarching objective outlined in Assessment Report 86 was the protection of the McArthur River and the values it supports from mining related degradation. The NT EPA reviewed available monitoring data and sought advice from the Department of Health, and concluded that:

> *"At present, based on all data available to the NT EPA, McArthur River water quality is good off the mineral leases. Aquatic life in the river appears to be unaffected by the mine to date and fish in the McArthur River are safe to eat (DoH, pers. comm. 2018)."*



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LEGEND

Indicative Extent of Overburden Management Project Surface Development

Archaeological MRM4 Site

NOTE

1. Disturbance of MRM4 is subject to the relevant approval under VOA 0059 Condition 121.

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

McARTHUR RIVER MINE

Overburden Management Project
General Arrangement for the LOM

Figure 4

2 Site Conditions

2.1 Physical Environment

A summary of the physical environment at the Mine and the BBLF is provided below.

More detail on the physical environment for the Mine and the BBLF can be found in Section 2 of the Water Management Plan (WMP) (Appendix B of the AMP).

2.1.1 Climate

2.1.1.1 McArthur River Mine Weather

The McArthur River catchment experiences a monsoonal climate regime, which is strongly seasonal with distinct wet and dry seasons. The average daily minimum and maximum temperatures at the Mine range between 12 degrees Celsius (°C) (in July) and 39°C (in November).

The average monthly rainfalls at the Mine exhibit distinct wet (November to April) and dry (May to October) seasons during the year, with a dry season low of 0.4 millimetres (mm) in August to a wet season high of 192 mm in January. The wet season average monthly rainfalls (32 mm to 192 mm) are significantly higher than the equivalent dry season monthly rainfalls (0.4 mm to 15 mm). The recorded mean annual rainfall at the Mine site over the period 1889 to 2019 is approximately 723 mm (WRM Water & Environment Pty Ltd [WRM], 2019).

The average annual pan evaporation at the Mine site is estimated to be approximately 2,752 mm, which is approximately 3.8 times the average annual rainfall. The evaporation rate is high throughout the year, with highest evaporation rates occurring in the months between August and January. Mean monthly evaporation is generally much higher than mean monthly rainfall in all months of the year, except January and February.

2.1.2 Hydrology

2.1.2.1 Mine Site Hydrology

The McArthur River is the major surface water feature in the region. The McArthur River originates in the Barkly Ranges and flows in a north-east direction before discharging into the Gulf of Carpentaria near the Sir Edward Pellew Group Islands. The river falls more than 250 m over its 330 km length. The total catchment area of the McArthur River is approximately 18,000 square kilometres (km^2).

Figure 2 shows the creeks in the vicinity of the Mine. Most of the Mine site is within the McArthur River floodplain. The Glyde River joins the McArthur River to the north-east (and downstream) of the Mine. Bull Creek and Emu Creek join the McArthur River from the east and north-west respectively, upstream of the Glyde River confluence. Barney Creek and Surprise Creek join the McArthur River from the western side through the Mine site.

The McArthur River Diversion Channel was completed in 2009 and consists of a 5.5 km diversion. The works have allowed open cut mining to the ore deposits beneath the McArthur River. The McArthur 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.

The condition of the McArthur River in the vicinity of the Mine is considered as Level 2: slightly to moderately disturbed ecosystems, as defined by the Australian and New Zealand Governments' (ANZG) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018), due to the influence of pastoralism and grazing throughout the wider catchment.

2.1.2.2 Bing Bong Hydrology

The BBLF is located on the Gulf of Carpentaria coastline to the west of the Sir Edward Pellew Group Islands. Bing Bong Creek, which is located approximately 7.5 km to the west of the BBLF, has a catchment area of approximately 590 km^2. Mule Creek, which is located approximately 3.7 km to the south and southeast of the BBLF, has a catchment area of approximately 136 km^2. Both creeks drain in a northeasterly direction. The BBLF is located on the catchment divide between these two watercourses. Runoff from the BBLF is contained within surface runoff ponds. Runoff from historic dredge spoil stored adjacent to the BBLF drains directly to the ocean via a constructed channel in accordance with the WDL conditions.

2.1.3 Land Systems

Based on the land system types described by Aldrick and Wilson (1990), six land systems are present at the Mine and include:

- McArthur: Broad or narrow fluvial corridors conducting regional drainage across various land systems towards the coast.
- Bukalara: Rugged rocky plateau and steep, linear ridges on massive sandstones such as the Bukalara Sandstone.
- Unnamed: Major river depositional flood plains.
- Surprise: Level to gently undulating plains of mainly unconsolidated, transported materials.
- Emmerugga: Undulating to rolling low hills on mainly argillaceous sediments.
- Favenc: Steep hills on mainly argillaceous sediments.

2.1.3.1 Topsoil and Subsoil

Soils at the Mine vary according to terrain, ranging from lithosols on hill and ridge tops, to grey and brown cracking clays in gullies and depressions. The chemical characteristics of soils at the Mine can be summarised as follows:

- Soil pH – pH levels in general range from slightly acidic to neutral with strongly alkaline subsoils occurring.
- Salinity – Electrical Conductivity levels are generally nil to slight in all soils tested except for deeper subsoils of the brown cracking clay soils, which were highly to severely saline.
- Dispersion – Slightly dispersive soil layers are present in the majority of soil profiles.

2.1.3.2 Vegetation

The vegetation that occurs within the mineral leases has been described and mapped in a number of projects; locally by MRM and regionally, as a part of a McArthur River catchment vegetation survey and mapping project (Cuff et al., 2009).

The most recent and comprehensive vegetation mapping has identified 10 vegetation mapping units (VMUs), including 25 VMU subunits. VMUs and subunits were described with reference to catchment wide mapping by Cuff et. al. (2009) to enable an assessment of the distribution of each vegetation type within the site and the McArthur River catchment. The distribution of VMUs within the site is defined by the dominant land systems.

A comprehensive list of the VMUs within the Mine can be found in the *McArthur River Mine Rehabilitation Management Plan 2018 – 2020* (the RMP) (Appendix C of the AMP).

2.1.4 Flora and Fauna

2.1.4.1 Flora

The surveying of vegetation in the McArthur River region and surrounds have detected 445 species of vascular plant, with a further 727 species known from the broader region (within 20 km of the Mine) (Ecological Management Services [EMS], 2017). The plant species detected were not listed as threatened (endangered, vulnerable or near threatened) under the NT *Territory Parks and Wildlife Conservation Act, 1976* (TPWC Act) or the EPBC Act (EMS, 2017).

A total of 31 species of non-native (i.e. exotics/weeds) plants have been recorded at the Mine.

Detailed descriptions of the McArthur River regional and surrounding vegetation are provided in the RMP.

2.1.4.2 Fauna

Data from database searches, literature reviews, current monitoring programs and general field surveys have been used to describe the species composition and habitats of terrestrial vertebrate fauna in the wider McArthur River area. Surveys of the mineral leases have detected 26 species of amphibian, 79 species of reptile, 216 species of bird and 39 species of mammal (EMS, 2017).

Twenty terrestrial fauna species that are protected under the EPBC Act as Matters of National Environmental Significance (MNES) have been recorded within the mineral leases, although several of these have not been recorded for 20 years or more and are likely to be locally extinct. The Gouldian Finch (*Erythrura gouldiae*) which is listed as an endangered species, is a confirmed visitor (in small numbers to feeding habitats) within the mineral leases.

In addition, three aquatic species that potentially occur within freshwater stretches of the McArthur River are listed as MNES under the EPBC Act, which includes:

- Largetooth Sawfish (*Pristis pristis*) which is listed as a vulnerable and migratory species, is confirmed on-site within the mineral leases;
- Estuarine Crocodile (*Crocodylus porosus*) is confirmed nonbreeding visitor in small numbers within the mineral leases; and
- Gulf Snapping Turtle (*Elseya lavarackorum*) which has not been identified at site and has no habitat present.

Details of the MNES species and a description of their habitat is discussed in detail within Chapter 10 of the Draft OMP EIS.

2.1.5 Mine Area Geology

This section describes the geology and hydrogeology for the Mine and surrounding environment.

2.1.5.1 Regional Geology

The HYC silver-lead-zinc deposit at McArthur River is a classic shale hosted base metal deposit. It lies on the eastern margin of the McArthur Basin, part of a northwest trending belt of Middle Proterozoic sediments, which extend southwards to Mount Isa. The belt is host to similar silver-lead-zinc deposits at Century, Cannington, Lady Loretta, Dugald River, Mount Isa and Hilton. The McArthur Basin is divided into four geological formations. From the oldest to the youngest, they are the:

- Tawallah Group consisting of quartz arenites and basic volcanics;
- McArthur Group comprising carbonates and the host to the HYC deposit;
- Nathan Group consisting of carbonates and arenites; and

- Roper Group comprised of quartz arenite and micaceous lutites.

2.1.5.2 Mine Geology

The HYC mineralisation covers an area of about two km^2 and has an average thickness of about 55 m. It is 1.5 km west of the Emu Fault and separated from the fault by the Cooley Dolomite Member of the Barney Creek Formation and the Western Fault Block.

The western margin of the deposit has been folded and eroded and the eastern margin is faulted against the Cooley Dolomite Member. The northern margin interfingers with sedimentary slump breccia derived from older McArthur River Group sediments to the north of the deposit. The southern margin, which has been down faulted by 100 to 200 m by the northeast trending Woyzbun Fault, is transitional into barren pyritic shale.

The deposit is divided into seven mineralised intervals referred to as orebodies. Orebodies comprise shale with lesser amounts of sedimentary breccia and tuff. Number 1 orebody is used to refer to an interval of weak silver-lead-zinc mineralisation hosted by nodular dolomitic shale in the footwall sequence. In addition, there is a broad interval of weak silver-lead-zinc mineralisation hosted by nodular dolomitic shale in the immediate hanging wall, along the eastern margin of the deposit.

The hanging wall sequence comprises interbedded dolomitic shale, sedimentary turbidite breccia and occasional tuff beds.

The Cooley Dolomite occurs along the eastern margin of the deposit. It comprises a fault bounded block of Teena and Mara Dolomite Members (older than the host to the mineralisation), which have incurred several episodes of brecciation. The Cooley Dolomite commonly hosts coarse-grained sphalerite and galena as veins, disseminations and breccia matrix.

2.1.5.3 Regolith

Within the mineral leases, Quaternary sediments overlie the rocks of the Barney Creek Formation and consist of colluvial, alluvial, lacustrine sediments and residual soils. The sediments are dominated by unconsolidated clays, sands, silts, and gravels. These Quaternary strata are overlain by more recent alluvial silt, sand and clay deposited on the floodplains, flood terraces, levees and channel floors of the McArthur River and the Glyde River. The cover sequence is highly variable with a thickness varying between approximately 1 and 25 m.

2.1.5.4 NOEF Geology and Hydrogeology

Klohn Crippen Berger (KCB) (2017) provides a description of regional and NOEF geology and hydrogeology. Ross Logan and Associates (2017) provides information gained from drilling and geophysical surveys of the NOEF area. GHD (2018) describes a Central West (CW) Charlie-specific geotechnical investigation including 47 test pits through the footprint of the planned stage.

2.2 Socio-Economic Environment

The Mine is located in the Roper Gulf Regional Council which is defined by the Australian Bureau of Statistics (ABS) as the Roper Gulf Statistical Local Area (SLA) and is considered in this document as the boundary for describing the baseline social values of the region.

The 2016 ABS census identified 6,505 people whose place of usual residence is the Roper Gulf SLA (ABS, 2016). The census indicated that the population is divided between male (51.1%) and female (48.9%) with a median age of 26 years. Aboriginal people make up 79.7% of the population. Of that, 4,151 people reside within the Roper Gulf SLA where 51.0% (2,115) were male and 49.0% (2,029) were female. Aboriginal and Torres Strait Islander people made up 85.0% of the Roper Gulf SLA population.

A number of social organisations and businesses operate within the vicinity of the Mine. Social organisations facilitate community contributions to the decisions affecting livelihoods, whereas economic organisations act as

a source of employment and services in the area. Amongst a diverse range of employers in the region are small to medium businesses and organisations representing a variety of industry sectors including: retail; agribusiness; pastoral; health and community services; trades; education; transport; civil engineering; mining; and tourism.

MRM is predominantly a fly-in fly-out operation, so while mining is the largest private sector employer in the region, resources associations such as Mabunji and Mungoorbada are the largest employers of local indigenous and non-indigenous people. The majority of MRM employees reside permanently in Darwin or interstate, and a small proportion resides locally (Borroloola, King Ash Bay and neighbouring pastoral properties).

The closest established township to the Mine is Borroloola which has a total population of approximately 900 with the majority of the workforce employed in fishing, retail or government sectors. The rural workforce is mainly employed in the pastoral industry and in mining. Residents include people from Gurdanji, Yanyuwa, Garrwa and Marra language groups.

2.2.1 Current Land Use

Development of MRM's underground operation commenced in 1994, with conversion to an open pit operation in 2009. The Mine is contained within five contiguous mineral leases as mentioned in Section 1.3, which are located on McArthur River Station, Perpetual Pastoral Lease 1051. McArthur River Station is also held by Glencore. Other regional pastoral enterprises are owned by private persons, companies, and Aboriginal groups.

Immediately surrounding the Mine is the McArthur River Station, with approximately 10,000 head of cattle on 8,000 km^2. The station uses approximately one third of the area for grazing. Cattle are excluded from the mining and processing areas.

MRM is located in one of the more sparsely populated areas of Northern Australia. Populations of townships fluctuate with people leaving outstations in the wet season. MRM is located on lands traditionally used by the Gurdanji (the Mine) and Yanyuwa (Bing Bong) people. Although areas of land are identified as belonging to particular language and family groups, other groups may have important traditional interests in that land.

2.2.2 Identified Stakeholders and Consultation

A stakeholder engagement process was undertaken between May 2015 and December 2016 for the OMP EIS, with 566 people consulted during 263 separate consultations. The purpose of the consultation was to inform the public of the scope, impacts and mitigation measures and to gather feedback from communities and stakeholders potentially impacted or benefited by the OMP EIS project.

In general, there was a genuine interest and support for the OMP EIS project and support for the consultation process. More information on the stakeholder engagement process for the OMP EIS can be found in Appendix Y – Stakeholder Consultation Report of the draft OMP EIS.

The stakeholder categories include (but are not limited to):

- **Government:** An employee or representative of the Commonwealth or Northern Territory Governments or agencies. This includes Ministers, members of parliament, agency staff or a person representing the Government for the purposes of the consultation.
- **Business:** A person representing a business that may or may not be a supplier to MRM.
- **Interest Group:** People representing, or members of, a group or association that has an interest in the project whether that interest is positive, negative or neutral.
- **Gulf region resident:** People resident in the Gulf region.

- **Traditional Owner:** Aboriginal people who have identified themselves as Traditional Owners during the course consultations or communications with MRM. MRM does not claim the authority to decide who may identify themselves as a Traditional Owner.
- **Gurdanji, Yanyuwa, Garrwa, Mara:** Language groups or clans with which people associate.
- **Custodians:** Aboriginal people with responsibility for a sacred site and includes Aboriginal people who have identified themselves as custodians.
- **Roper Gulf:** A councillor, mayor, local authority member or employee of Roper Gulf Regional Council.
- **Local organisation:** A member or representative of a Gulf region community group, club or organisation. This includes Mabunji Aboriginal Resource Centre Indigenous Corporation, Mawurli Wirriwangkuma Aboriginal Corporation, Mungoorbada, ranger groups, Women's Group, and partners in sponsorships and donations.
- **NGO:** Non-government organisation including the Independent Environmental Monitor, Environment Centre Northern Territory, Northern Land Council, Amateur Fishermen's Association of the Northern Territory and Territory Natural Resource Management.

2.2.3 Community Affairs

MRM has a dedicated Community and Corporate Affairs team with responsibility for community engagement, cultural heritage management and community development initiatives. Activities planned for this MMP include:

- establishing a permanent office in Borroloola for day-to-day engagement with the local community;
- establishing a Borroloola School partnership agreement to provide cash and in-kind support to school activities including mentoring, coaching, flights and support for school programs;
- developing a Cultural Respect Strategy to achieve a culturally inclusive workplace and equitable environment, promoting the culture and values of Traditional Owners, Aboriginal and Torres Strait Island employees, and local community;
- developing a local procurement partnership program with the Northern Territory Industry Capability Network and Gulf Region suppliers; and
- ongoing sponsorship and donations programs for culture and art, community and social development, education, health and wellbeing and the environment.

A total of 32 sponsorship and donation programs were implemented by MRM in 2019, as shown below in Table 3.

TABLE 3 – SPONSORSHIP AND DONATION PROGRAMS SUPPORTED IN 2019

Health and Wellbeing	Community and Social Development	Education
Community sporting events	King Ash Bay Fishing Competition	MLLLC Darwin visit (Borroloola School)
Men's Health Week (Mabunji)	Borroloola Rodeo	NT Young Achiever Awards
Women's Wellness Week (Mabunji)	Borroloola Show	NT Training Awards
Mother's Day Classic	Borroloola Kids Christmas Party	Engineers Australia SySTEMic program
HPA Health and Wellness Festival	Age Care Christmas celebration	National Youth Week
CareFlight	Barra Classic	
Humpty Dumpty Foundation	Clean Up Australia Day	
Prostate Cancer Foundation	Robinson River Fishing Competition	
Environment	**Culture and Art**	**Other**
TNRM Conference and Awards	Barunga Festival	Minerals Council of Australia Gala
King Ash Bay Fish Tagging program	Waralungku Arts	Dinner
NT Flyrodders competition	NAIDOC Week Borroloola (Mabunji)	Chamber of Commerce Business at
	NAIDOC Week Darwin (Larrakia)	Sunset
		Women in Resources Awards
		Arafura Wind Ensemble

MRM will continue to record complaints and grievances made by the local community in BSafe and respond appropriately in accordance with the incident reporting protocol. There were no complaints received about the Mine or BBLF in calendar year 2019.

2.2.3.1 Community Benefits Trust

The Community Benefits Trust (CBT) is a joint partnership between the Gulf region community, the Northern Territory Government and McArthur River Mining. It is funded by an annual donation from MRM, which was approximately $1,301,483 in 2019.

The CBT has an independent Board comprising one representative of the Gurdanji, Yanyuwa, Garrwa and Marra language groups, one Borroloola representative, two directors appointed by the NT Government and two directors appointed by MRM. It meets quarterly to consider applications for funding in six categories: Culture & Art, Education, Enterprise & Job Creation, Environment, Health and Social & Community Development.

In 2018, the CBT Board established a Legacy Fund to ensure funding continues for community benefit after the end of the mine life. A $1 million fund was established, with an additional $250,000 to be contributed in each subsequent year from the annual CBT donation. It is anticipated the Legacy Fund will be in a position to become self-sustaining over time.

The CBT operates under a three-year rolling community development program which is developed following extensive engagement with the local community.

3 Statutory and Non-Statutory Requirements

3.1 Statutory Requirements

MRM currently operates in accordance with NT and Commonwealth environmental approvals and regulatory obligations, including:

- VOA 0059-01 and 0059-02 issued pursuant to the NT *Mining Management Act, 2001*;
- the Commonwealth EPBC Approval (2003/954) issued pursuant to the EPBC Act;
- the Commonwealth EPBC Approval (2014/7210) issued pursuant to the EPBC Act;
- MLN and MA conditions;
- WDL 174-11 conditions issued pursuant to the NT *Water Act, 1992*;
- Aboriginal Areas Protection Authority (AAPA) Certificates; and
- legally binding and non-legally binding commitments.

The full extent of applicable legislation framework is described in detail in Chapter 2 of the OMP EIS.

3.1.1 Compliance Management System

MRM continues to use a compliance register to track its requirements. The compliance register lists all conditions of environmental approval for the Mine, assigns a responsible MRM employee and tracks progress against statutory requirements. Compliance with approvals can be effectively managed and audited on an ongoing basis, and the information can be readily available for regulators upon request.

3.2 Non-Statutory Obligations

3.2.1 Codes of Practice, Standards and Guidelines

MRM will consider all applicable National and NT Codes of Practice, standards and guidelines, including those relevant to the environment (Table 4).

TABLE 4 - CODES OF PRACTICE, STANDARDS AND GUIDELINES

Description	Reference
Leading Practice Sustainable Development Program for the Mining Industry	July 2011
Mine Close Out Objectives: Life of Mine Planning Objectives. Northern Territory Government	October 2006
Guidelines For Preparing Mine Closure Plans—Western Australia	May 2015
NT EPA Guidelines on Conceptual Site Models	November 2013
NT EPA Environmental Assessment Guidelines for Acid and metalliferous drainage	April 2013
NT EPA Guidelines for Assessment of Impact on Terrestrial Biodiversity	November 2013
Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy	October 2012
Environment Protection and Biodiversity Conservation Act 1999 Offsets Assessment Guide	October 2012
NT EPA Guideline for the Preparation of an Environmental Management Plan	January 2015
NT EPA Guidelines on Environmental Offsets and Associated Approval Conditions	November 2013
NT EPA Guidance on Adaptive Management	December 2018
NT Land Suitability Guidelines	December 2013
NT Land Clearing Guidelines	2010
Draft Northern Territory Mine Closure Guidelines	2016
National recovery plan for the red goshawk (*Erythrotriorchis radiates*)	July 2012
National Recovery Plan for the Gouldian Finch (*Erythrura gouldiae*)	May 2005
Sawfish and River Sharks Multispecies Recovery Plan	November 2015
AS 5667.1-1998: Water Quality – Sampling – Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples	April 1998
AS 4482.1-2005: Guide to the investigation and sampling of sites with potentially contaminated soil	November 2005

3.3 Heritage Sites and AAPA Certificates

Sacred, archaeological and heritage sites at the Mine have been surveyed as part of previous environmental assessments, with the latest summary provided in Chapter 11 of the OMP EIS. Figure 5 shows the sites that have been identified in the vicinity of the Mine and the current AAPA Certificates.

MRM's ongoing cultural heritage management, training and consultation includes:

- Surveys and Investigation – MRM will continue to work with the Traditional Owners directly and the AAPA to meet obligations under the Cultural Heritage Management Procedure (Appendix C).
- MRM Cultural Awareness Training – all MRM employees and contractors are required to complete this as a mandatory compliance training.

All works described in this MMP will be undertaken in accordance with relevant AAPA authority certificates.

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LEGEND

- Archaeological and Historical Sites
- Sacred Sites
- Restricted Area
- AAPA Certificates
- Indicative Extent of Overburden Management Project Surface Development

Note: 1. Disturbance of MRM4 is subject to the relevant approval under VOA 0059 Condition 121.

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

McARTHUR RIVER MINE

AAPA Certificates and Cultural Heritage Sites

Figure 5

4 Operational Activities

4.1 MMP Overview

The MMP provides for the continuation of all activities carried out at the Mine and BBLF. The MMP also describes OMP activities, including:

- continued development of the Open Pit;
- continued development and emplacement of overburden in the NOEF;
- continued processing of ore, and stockpiling, trucking and barging of concentrate product;
- continued deposition of thickened tailings at the TSF Cells 1 and 2;
- development of stockpiles, laydown area and quarries/borrow areas;
- supporting activities required to monitor and assess MRM's performance against key environmental objectives; and
- other associated minor infrastructure, plant, equipment and activities and modifications to existing structures, plant, equipment and activities.

Excavators and trucks will continue to remove the overburden and ore from the Open Pit. Figure 6 shows the planned Open Pit stages, as well as indicative timing. Overburden will continue to be emplaced at the NOEF, using the improved OMP EIS emplacement methodologies and geometries. The MMP will involve the necessary development of areas of the NOEF to increase available overburden emplacement capacity. Benign materials will continue to be sourced from the Open Pit, borrow areas and quarries.

Ore will continue to be processed at the processing plant to produce bulk concentrate (containing zinc, lead and silver) and separate lead and zinc concentrates. The concentrates will continue to be temporarily stockpiled in the concentrate shed prior to being reclaimed and loaded into enclosed trailers or sealed containers to be transported to BBLF (bulk and zinc concentrates) and to Mount Isa Mines (lead concentrate).

Thickened tailings produced from the processing operations will continue to be pumped as a slurry to the TSF. Cell 1 of the TSF has been recommissioned to allow tailings to be deposited into this cell, in addition to the continued development of Cell 2.

Water management infrastructure will continue to be developed as operations progress to maintain separation between water of varying qualities.

Figure 7 shows the planned indicative development of the Open Pit, NOEF and TSF for the MMP. The MMP will remain consistent with the OMP and/or Phase 3 EISs.

MRM-16-01_2020 MMP_213C

LEGEND

Stages and Indicative Timing

- Stage I (Current)
- Stage J (2018 - 2024)
- Stage K (2019 - 2025)
- Stage L (2022 - 2029)
- Stage M to Final (2025 - 2037)

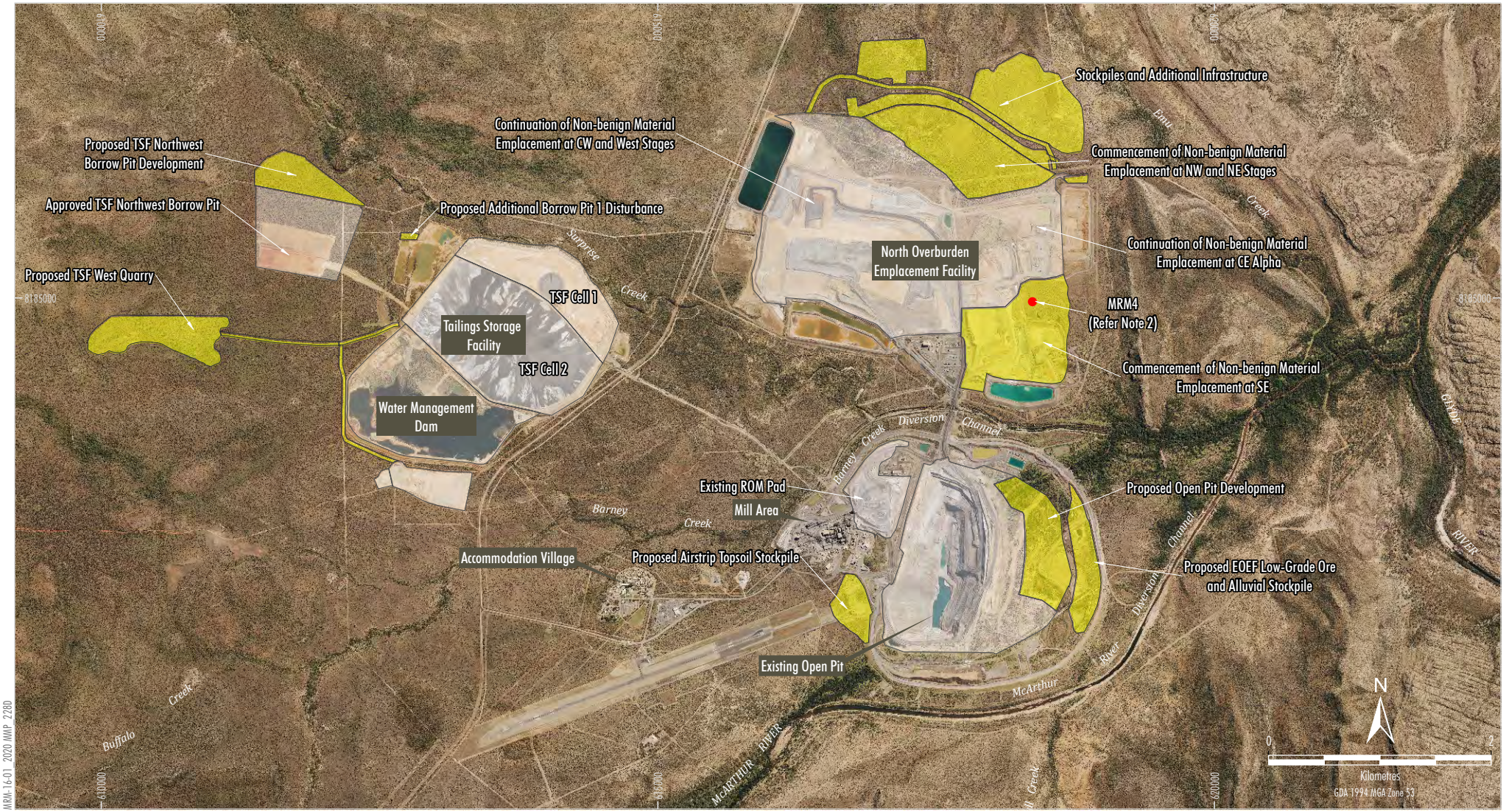
Note: Years of Operation are Indicative

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

McARTHUR RIVER MINE

Open Pit Stages and Indicative Timing

Figure 6



MRM-16-01 2020 MMP 228D

LEGEND

Continuation of Approved Activities

Proposed MMP Activities

Note: 1. Minor activities and disturbance such as flood protection and benign stockpiles not shown.

2. Disturbance of MRM4 is subject to the relevant approval under VOA 0059 Condition 121.

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

McARTHUR RIVER MINE

MMP Indicative Arrangement

Figure 7

4.2 Mining Activities

4.2.1 Geology and Exploration

4.2.1.1 Exploration and Investigation Activities

Annual updates for exploration and investigation activities are reported in the OPR. MRM will continue to report on the progress of exploration and investigation activities in the OPR.

Existing and proposed exploration and investigation activities are planned to continue, consistent with methods that have been previously approved:

- exploration drilling within MLN 582, MLN 1121, MLN 1122, MLN 1123, MLN 1124, MA 366, MA 455 and MA 456;
- drilling to identify potential mineralisation within MLN 1123; and
- drilling for ore and waste sequencing within MLN 1121.

These activities will be used to investigate aspects such as:

- ore and waste sequencing;
- waste characterisation;
- resource definition;
- alluvium characterisation; and
- potential mineralisation within and external to the existing operational areas.

Results of these investigations will be used to inform future mine planning and designs.

The planned activities over the four-year period include drilling, soil and stream sediment sampling, geological mapping, and geophysical data acquisition by airborne or land based methods.

Environmental risks associated with drilling are considered Low to Moderate (Appendix A). Access to drill sites will utilise existing access tracks, where practicable. New drill pads and access roads are developed as required in accordance with MRM's Permit to Clear Procedure (Appendix D), and approved AAPA certificates, where applicable.

Waste resulting from drilling activities will continue to be disposed of in accordance with MRM's Waste Management Plan (Appendix E). Spill kits are located on drill sites for the duration of drilling activities and maintained in accordance with MRM's General Spill Response Procedure (PRO-2600047). For all drilling activities, an environmental management plan will be in place that addresses chemical use/storage, erosion and sediment control, and dust, prior to the drilling being carried out.

Following the completion of the drilling program and prior to the wet season, drill hole collars will be surveyed, plugged and backfilled with clean fill. Compacted ground will be ripped, with stockpiled topsoil and vegetation spread over the cleared area.

4.2.1.2 Geochemical Investigations

Two principal geochemical and hydrogeochemical investigations are planned to be carried out at the West Overburden Emplacement Facility (WOEF) and the BBLF. These investigations will be limited to existing disturbed areas, and as such, no new clearing will be required.

Bing Bong Geochemical Investigations

The planned BBLF geochemical investigations include:

- Acid Sulphate Soil assessment of the dredge spoils and regolith and groundwater geochemistry; and
- Investigation of Thallium distribution in sediments, surface water and ground water.

The geochemical program involves shallow drilling through the dredge spoils and adjacent soils down to the water table for geochemical sampling and analysis. The program aims at addressing recommendations provided by MRM's former Independent Monitor for improving the understanding of environmental risks associated with the BBLF operation.

WOEF Geochemical Characterisation

The WOEF geochemical program will involve characterisation of waste by drilling through the WOEF to enable hydrogeochemical modelling of long-term seepage water quality. Long-term seepage water quality predictions are required for the long-term water management planning, in particular for the assessment of the final water quality in the pit lake after closure.

4.2.1.3 Waste Rock Characterisation

The following section presents an overview of waste rock characterisation at the Mine. Details of waste classes, classification criteria, geochemical testing, material properties and management requirements are presented in the appended MRM Waste Characterisation Report (Appendix F).

Waste Rock Classification Scheme

The Waste Rock Classification Scheme takes into consideration all forms of Acid and Metalliferous Drainage (AMD), including Acid Drainage (AD), Neutral Metalliferous Drainage (NMD) and Saline Drainage, in line with industry leading practice as outlined by both Australian and international guidelines (AMIRA International, 2002; Department of Industry, Tourism and Resources [DITR], 2007; The International Network for Acid Prevention [INAP], 2009; Department of Industry, Innovation and Science, 2016). The Waste Rock Classification Scheme also identifies the risk of self-heating for each waste rock class.

The Waste Rock Classification Scheme is consistent with the MRM/KCB 2016 classification scheme presented in Section 6 of the Draft OMP EIS, which was subsequently updated in the Supplementary OMP EIS to include an additional waste rock sub-class, Potentially Acid-Forming (PAF) Hangingwall pyrite (HW). PAF (HW) is a subset of PAF (High Acid Production Capacity [HC]), located in the Open Pit hangingwall. It has been classified differently for operational purposes rather than significant geochemical differences.

Waste Rock Classes

Waste rock materials are separated into six distinct categories based on geochemical compositions, an approach considered best practice by the *Global Acid Rock Drainage Guide* (INAP, 2009) and the *ARD Test Handbook; Prediction & Kinetic Control of Acid Mine Drainage* (AMIRA International, 2002). The classes reflect the respective potential AMD generation effects and the environmental risk profile of the various materials.

The six waste rock classes, in order of increasing potential effects on water quality, are:

- LS-NAF (HC): Low Salinity Non-Acid Forming rock (High [Acid Consumption] Capacity).
- MS-NAF (HC): Metalliferous Saline Non-Acid Forming rock (High [Acid Consumption] Capacity).

- MS-NAF (LC): Metalliferous Saline Non-Acid Forming rock (Low [Acid Consumption] Capacity).
- PAF (HC): Potentially-Acid-Forming rock (High [Acid Production] Capacity).
- PAF (RE): Potentially-Acid-Forming rock (Reactive).
- PAF (HW): Potentially-Acid-Forming rock (Hangingwall pyrite).

The geochemical characteristics of each class are discussed in detail in the appended MRM Waste Characterisation Report (Appendix F).

Waste Rock Classification Criteria

The 2016 MRM/KCB waste rock classification criteria are presented below in Table 5.

TABLE 5 - 2016 MRM/KCB WASTE ROCK CLASSIFICATION CRITERIA

Criteria	Class	Description	Management
NPR ≥ 2 and S < 1% and Zn < 0.12% and Pb < 0.04% and As < 40 ppm and Cd < 10 ppm	LS-NAF (HC)	Low Salinity High Capacity NAF. Material considered at low risk of generating AMD. Generally characterised by a high acid consumption capacity.	This material is considered environmentally benign and suitable for placement in environmentally sensitive areas such as the overburden emplacement facility (OEF) outer cover.
NPR ≥ 2 and S ≥ 1% or Zn ≥ 0.12% or Pb ≥ 0.04% or As ≥ 40 ppm or Cd ≥ 10 ppm	MS-NAF (HC)	Metalliferous Saline High Capacity NAF. Material considered at low risk of generating AD but higher risk of generating Saline Metalliferous drainage. Generally characterised by a high acid consumption capacity.	This material is not considered environmentally benign and requires some form of encapsulation and water management strategy.
1 ≤ NPR < 2	MS-NAF (LC)	Metalliferous Saline Low Capacity NAF. Material considered at low risk of generating AD but higher risk of generating Saline Metalliferous drainage. While non-acid forming, this material is likely to provide limited acid consumption capacity.	This material is not considered environmentally benign and requires some form of encapsulation and water management strategy.
NPR < 1	PAF (HC)	High Capacity PAF. Material considered at risk of generating AD, and is likely to have a significant capacity to do so. Samples classed as undefined according to the DITR 2007 classification are included in the PAF (HC) category at MRM.	This material is not considered environmentally benign and requires some form of encapsulation and water management strategy.
NPR < 1 and S ≥ 10% and BbH	PAF (RE)	Reactive PAF Material considered at high risk of generating AD, and at high risk of self-heating which may progress into spontaneous combustion.	This material is not considered environmentally benign. It requires encapsulation and is likely to require specific additional handling strategies to manage self-heating.
S ≥ 20%	PAF (HW)	Hangingwall pyrite, which is the most pyritic material at MRM. PAF Material considered at high risk of generating AD, and at high risk of self-heating which may progress into spontaneous combustion.	This material is not considered environmentally benign. It has been segregated for management as per PAF (RE) before sub-aqueous disposal at the end of mine life.

NPR = neutralisation potential ratio; S = sulfur; Zn = zinc; Pb = lead; As = arsenic; Cd = cadmium; BbH = Black Bituminous Shale; ppm = parts per million

The waste rock characterisation process is illustrated in Figure 8 and described below. This process is used to determine the amount of non-benign materials to be encapsulated and confirm availability of benign materials is adequate to meet design objectives.

Geological Block Model

The quantities of each class of material is determined using a geological block model, a 3D computer model generated by statistical interpretation of data gathered from the Mine. The model is a representation of the planned mining zone as a set of 'blocks' characterised by parameters such as grade, density, and rock type. The model is subject to ongoing review and updates to incorporate additional drilling data and other information collected each year.

Material Identification and Handling

In-pit material classification is undertaken to confirm the validity of the waste classifications of the geological block modelling. The in-field overburden class validation implemented at the Mine is based on analyses of blast hole cuttings. Thermal monitoring of higher self-heating risk areas is undertaken prior to and during drill and blast operations, enabling the early detection of potentially problematic material. 10% of the planned blast holes are selected for validation by laboratory Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) analysis as described in Section 6.7.2 of the Draft OMP EIS.

The analysis suite includes the following elements: zinc, lead, copper, magnesium, aluminium, silicon, phosphorous, chlorine, potassium, calcium, scandium, titanium, vanadium, chromium, manganese, iron, cobalt, nickel, arsenic, selenium, rubidium, strontium, zirconium, niobium, molybdenum, palladium, silver, cadmium, tin, antimony, tellurium, thallium, caesium, barium, hafnium, tantalum, tungsten, rhenium, gold, mercury, bismuth, thorium, uranium and sulfur.

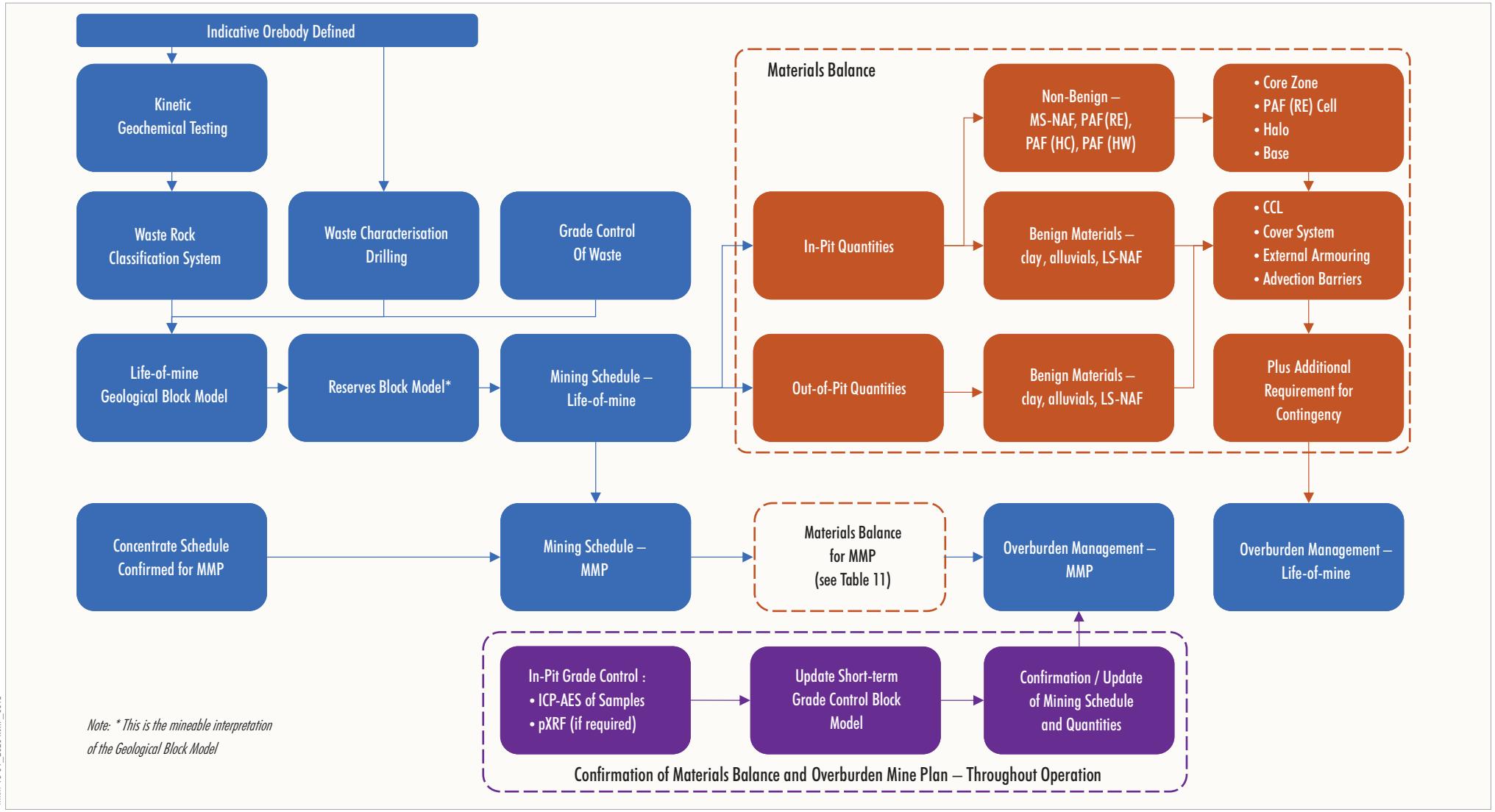
Of these, the following elements are relevant to the classification and/or management of the rock: zinc, lead, copper, aluminium, chromium, manganese, arsenic, molybdenum, silver, cadmium, thallium, antimony, bismuth, calcium, magnesium and sulfur.

The ICP-AES analysis is supported by field-based X-Ray Fluorescence (pXRF) analysis (back-up contingency only). Once analysed, the samples are classified according to the six overburden classes and a map of the blast block is produced by the mine geologist for the mining engineers and production crews to plan and execute extraction and appropriate placement in the NOEF.

The placement of material in the NOEF is tracked using the Fleet Management System (FMS) that utilises a GPS tracking system to log haul truck movements from the Open Pit to the NOEF. The FMS facilitates the following process:

- classification of excavated overburden, assigned based on the haul trucks' loading location within the Open Pit;
- overburden classification information is then transferred to the haul truck transporting the overburden;
- an emplacement destination is assigned for the haul truck based on the overburden classification;
- alerts are provided to the haul truck operator if the haul truck is in an invalid emplacement area; and
- overburden classification, emplacement information and responses to alerts are logged for further investigation, with remediation plans prepared and executed if necessary.

The FMS will continue to be upgraded as required to improve the placement and tracking of waste in the NOEF.



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McARTHUR RIVER MINE

Waste Rock Characterisation Process

Figure 8

4.2.2 Open Pit Domain

4.2.2.1 Mining

Open Pit Design

The Open Pit mining stages are shown on Figure 6, while the general arrangement of the Open Pit is presented on Figure 9. Open Pit mining will remain consistent with the methodology presented in the Draft OMP EIS, with multiple stages operating at a time to maintain a sustainable ore supply from 2020 onwards.

The indicative Open Pit wall design parameters are summarised in Table 6. The inter-ramp slope angle (IRSA) refers to the angle of wall in between haul ramp segments, excluding the batter and berm geometries. The key parameter is the IRSA, whilst the batter and berm geometries can be varied to suit local conditions. Part of the lower western wall in Stage I has been flattened off in response to geotechnical considerations identified during Cyclone Trevor in March 2019.

TABLE 6 – INDICATIVE OPEN PIT WALL DESIGN PARAMETERS

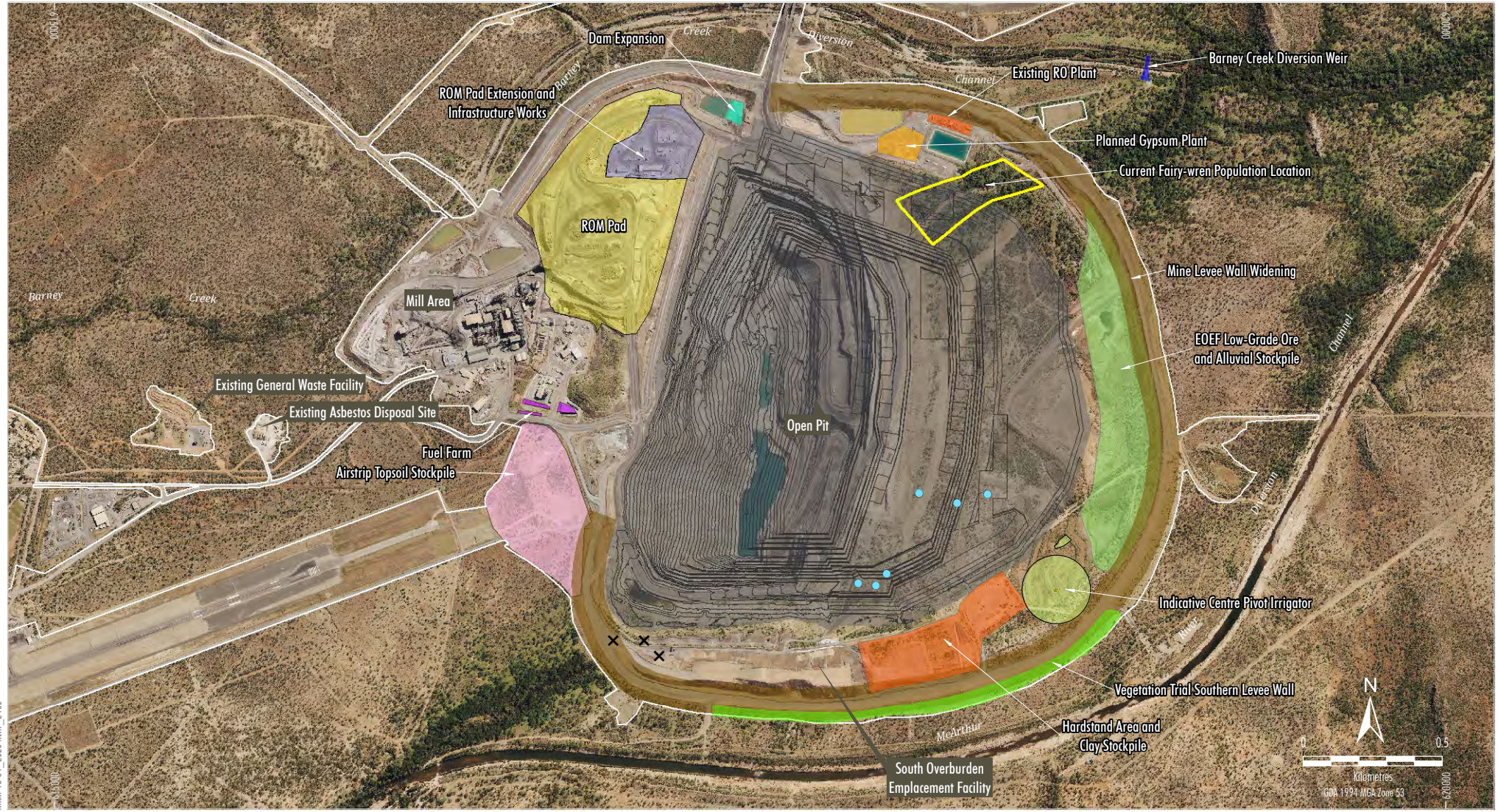
Component	Alluvial and Weathered Zones	North, South, East Walls above Ore Zone	North, South, East Walls in Ore Zone	West Wall North of 2,000 mN	West Wall North of 2,000 mN (Below 9,824 mRL)	West Wall South of 2,000 mN
IRSA	12-30°	55°	45°	51°	22°	22°
Batter angle	18-30°	65°	65°	65°	22°	22°
Berm interval (m)	24	16	16	32	-	-
Berm width (m)	10-35	6	10	11	-	-

mRL = metres reduced level; ° = degrees; mN = metres north

The Open Pit stage designs are north-south oriented, serviced largely by a single haul ramp system originating in the northern end of each stage, to reduce haul distances to the NOEF. The inter-ramp slope angles provided in Table 6 will continue to be used, with revisions made as required as new geological, hydrogeological and geotechnical information becomes available.

The west wall will continue to be the main focus of geotechnical investigations, with alternate bench-batter geometries being considered, in light of continuing local wall failures. Flattening of the wall in areas of local instability will continue where required to maintain safe operating conditions.

There is an internal process for amending Open Pit designs that requires review by competent and experienced geological, geotechnical and engineering staff before final management approval. If a change in the Open Pit design is required (such as for safety or operational requirements), internal reviews will be carried out by experienced geotechnical, geological and/or engineering staff prior to commissioning works associated with the new design.



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LEGEND

- Approved Indicative Extent of Surface Development
- Open Pit Extent
- Temporary Mine Underground Dewatering System
- Dewatering Bores

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

McARTHUR RIVER MINE

Open Pit Area General Arrangement

Figure 9

The indicative Open Pit development extents are shown on Figure 9. Significant quantities of LS-NAF (HC) are located in the southern end of each stage, and are required for the rehabilitation of the NOEF Cover.

The Open Pit is planned to be developed over Old McArthur River (NC1A). Disturbance of NC1A will be subject to translocation of the Purple-crowned Fairy-wren (*Malurus coronatus*), which will be carried out in accordance with Appendix U – Fairy Wren Translocation Plan of the Supplementary OMP EIS and in consultation with a suitably qualified ecologist. The timing of the translocation will be determined by the ecologist, based on the best outcomes for the Purple-crowned Fairy-wren population.

The approximate maximum footprint area of each stage is provided in Table 7.

TABLE 7 – OPEN PIT STAGE FOOTPRINT AREAS

Pit Stage	Footprint (ha)	Cumulative (ha)
Current	287.6	287.6
Stage K	21.2	308.8
Stage L	25.0	333.8
Stage M	34.7	368.5
Total	-	368.5

The quantities of each class of waste rock will continue to be determined using the geological block model.

4.2.2.2 Open Pit Geotechnical Work

The Open Pit walls and floors are required to be stable to allow continued operations. The wall geometries, such as slope angles, berm widths and intervals, and wall orientations, are crucial to the performance of the excavation. The stability of the walls is influenced by water, rock properties and geological structures. The geotechnical department gather and interpret data from drilling, mapping, and monitoring (such as pore pressures and displacement) to regularly assess the condition of the Open Pit. Activities associated with wall stability will continue, including:

- depressurisation drilling in the walls of the Open Pit to drain excess pore pressure;
- installing piezometers, survey prisms, and extensometers to monitor conditions;
- using radar systems to monitor wall displacements;
- using windrows to catch and retain falling rocks;
- installing shear pins to lock in rock strata; and
- probing, surveying, collapsing and backfilling voids.

These works are not expected to present any new environmental risks when compared to previous and current works.

Further geotechnical drilling campaigns are planned to investigate the eastern walls of the Open Pit, particularly at the faulted junction of the Barney Creek Formation rock sequence and the Cooley Dolomite. Further hydrogeological investigations around all sides of the Open Pit will be conducted to further inform the conceptual model for the near-pit rock mass. These investigations will be limited to areas of the Open Pit that are planned to be mined and, as such, no additional clearing beyond that which will be accounted for in the security assessment is considered to be required.

4.2.2.3 Open Pit Dewatering and Water Management Infrastructure

Dewatering Bores

The Open Pit dewatering systems are designed to limit the risk of inundation in the lower benches of the Open Pit to maintain access to the ore supply.

Water that accumulates in the Open Pit and old underground workings will continue to be dewatered via the Mine Underground Dewatering Systems (MUDS) to contained storages. Both diesel and electrically powered pumps may also be used to pump water collected in temporary sumps on the Open Pit benches for transfer into contained storages.

The construction of the South MUDS system is planned and will have up to three holes collared from the south end of the Stage K pit to remove water from the underground workings. As with the existing North MUDS, the water would be pumped and stored in accordance with the WMP.

Operation of the water supply and shallow groundwater interception bores will continue.

General Water Management Infrastructure

New drains, sumps and dewatering bores will continue to be developed as the Open Pit progresses to the east. Existing infrastructure will be decommissioned and removed ahead of the Open Pit development. Wells to intercept groundwater may need to be developed on the footwall side of the Open Pit.

As the Open Pit stages are developed through the Old McArthur River, plugs are proposed to be constructed from low-permeability compacted clay across the old channels to retain water in the Old McArthur River. New plugs east of Stage L are planned to be built, which will service Stage K and L mining. These plugs are planned to be removed when Stage M commences, and replacement plugs are planned to be built to support the final Open Pit footprint. The crest level of the plugs will be designed to contain at least the 5% annual exceedance probability (AEP) rain event.

The developing Open Pit footprint will remove the existing drains situated to the east of the current Open Pit. Replacement drains will be designed and constructed as required to maintain the diversion of clean water, where practical. The drains will be excavated in natural alluvium, and sloped towards collection points, typically the Old McArthur River (also known as NC1A).

Evaporation fans may be used as required around the upper benches of the Open Pit to remove excess water by evaporation. The spray drift will be contained within the mine levee wall, and generally within the Open Pit. The locations of the evaporation fans may vary around the Open Pit, to reduce water sprayed onto the operations below. Operators have the ability to lower the angle of the fans, relocate them, or turn them off to match ambient environmental conditions (e.g. temperature, humidity and wind direction / speed). This will reduce the risk of spray drift moving beyond the application area.

The Centre Pivot Irrigator is planned to be relocated to the south of the East Levee Storage (ELS) (Figure 9). Water from the Centre Pivot Irrigator system will largely be evaporated. The Rice Paddies Pond (RPP), a lined sump is planned to be constructed adjacent to the system to capture any runoff from the system footprint, for management in accordance with the WMP. Any groundwater infiltration associated with the irrigator is expected to predominantly migrate in a northwest direction to the Open Pit.

South Overburden Emplacement Facility

Runoff from the northern side of the South Overburden Emplacement Facility (SOEF) is planned to be redirected. The existing SOEF sump at the base of the SOEF is planned to be upgraded to store the runoff from a 20% AEP (5 year average recurrence interval [ARI]) 24-hour rainfall event. Water collected in the sump will be managed in accordance with the WMP, and any overflows of the sump would report to the Open Pit.

East Overburden Emplacement Facility

As shown on Figure 9, the East Overburden Emplacement Facility (EOEF) area is planned to be active and the southern portion will be used for stockpiling benign alluvial materials. Drainage for the benign portion is planned to be constructed to direct runoff to the existing surface, which will report to Donkey Drain, NC1A or the ELS. A large portion of the footprint is in the former ELS area, and depressions may be utilised as sumps to enable water to be managed in accordance with the WMP. The northern end of the EOEF will be used to store non-benign low-grade waste (assumed to be PAF [HC] for handling purposes). The runoff from this stockpile is expected to be Class 5 and, as such, the following water management infrastructure is planned to be constructed:

- A 0.5 m thick basal compacted clay liner (basal CCL) in the stockpile foundation to promote runoff rather than infiltration. The basal CCL will slope to the west and north to a perimeter drain, to direct runoff to the north.

- The Low-Grade sump (LGS), a lined sump (e.g. compacted clay liner [CCL] or geosynthetic liner [GSL]) to capture the runoff. Water from the sump will be pumped to the Water Management System in accordance with the WMP.

Dams

The existing Van Duncan's Dam (VDD), which collects runoff from the northern regions of the WOEF, will be reassessed for appropriate sizing and lining. It is understood that overflows and/or leakage from the water cart fill point and VDD may be causing elevated pore pressures in the sensitive west wall of the Open Pit, where repeated failures are being experienced. As such, the facility will have its design capacity and lining system reviewed. An increase in size and/or pumping capacity, as well as a lower-permeability lining system, may be required. The water cart fill point will be removed from this area and relocated adjacent to Pete's Pond.

In 2019, MRM developed a *Tailings Storage Facility and Dam Management Fatal Hazard Protocol 14* (Glencore, 2019) document to identify, understand and minimize or eliminate potential health, safety, environmental, social and business risks associated with TSFs and other water storages. In response to this document, MRM are planning to inspect existing water storages inside the mine levee wall and carry out a consequence category assessment to determine if any upgrades are required. The key design features of each water storage (e.g. spillway dimensions) will be assessed for their suitability. Detailed designs will be developed prior to any remedial works being carried out.

4.2.2.4 Heavy Vehicle Laydown Area and SOEF Temporary Stockpiles

The laydown yard developed on the eastern end of the SOEF will continue to be used to store haul truck trays and other mining fleet materials (Figure 9). The stored components are not expected to impact on runoff water quality and runoff from this area will report to the planned SOEF sump.

Stockpiling of benign alluvium materials may be undertaken on portions of the SOEF that are not occupied by heavy vehicle parts. Any residual waste remaining in the assembly area will be managed in accordance with the Waste Management Plan prior to the stockpiling of clay in this area.

Haul roads within the mine levee wall will continue to be built to connect the Open Pit and the stockpiles, and the mine levee wall will continue to be progressively widened as materials become available.

4.2.2.5 Ore Stockpiles

The ROM pad expansion, including the ramp, will be used to temporarily store low grade material that will eventually be processed through the concentrator (i.e. materials will not be permanently emplaced in this area). The ROM pad expansion will continue throughout 2020 and to the indicative footprint shown in Figure 9. This will increase the storage capacity and optimise utility of the adjacent industrial area and offices. The wash pad and communications infrastructure will be relocated as required. Three extensions are planned to achieve this:

1. Low grade mineralised material (assumed to be PAF [HC] for handling purposes) will be used to extend the ramp to the east and expand the main pad by approximately 1.7 ha.

2. The vehicle wash and a small shed will be relocated on the West Overburden Emplacement Facility (WOEF), following the expansion of the pad to the east by approximately 1.4 ha.

3. A minor expansion of the ROM stockpile to the south by approximately 0.9 ha.

An approximately 2 m thick clay layer was prepared during the construction for the base of the WOEF, which has been shaped to direct potential seepage to VDD and the Open Pit. The ROM pad will continue to drain to the north and south, with runoff reporting to VDD and Lake Archer. Seepage through the pile will report to the Open Pit via natural seeps on the west wall, where it will be removed via the underground water management system.

The change is considered to be incremental, and poses no significant change in environmental risk from the existing WOEF/ROM facility.

Dust suppression will continue to involve the use of water carts as required.

Ore will continue to be temporarily stockpiled at various locations within the Open Pit development footprint, as required. Surface water runoff from the temporary stockpiles will report to the Open Pit.

4.2.2.6 Other Stockpiles

Stockpiles of topsoil and other benign materials will continue to be developed and expanded inside the mine levee wall. Surface water runoff from these stockpile areas will report to the Open Pit or other contained water storages.

As shown on Figure 9, a number of benign and non-benign stockpiles are currently in use and are planned to be developed:

- Benign topsoil and some clay are planned to be stockpiled in the Airstrip stockpile, located to the west of the mine levee wall. A perimeter drain and sediment trap will be developed to direct the Class 2 runoff to the McArthur River catchment in accordance with the WMP.

- The eastern portion of the SOEF and the southern portion of the EOEF are planned to be used to temporarily store alluvium mined from the Open Pit, until the material is required for use in the construction of the OEFs.

- Minor topsoil stockpiles are planned to be stored on the southern portion of the SOEF.

- The area to the north of the Open Pit will continue to be used for stockpiling Heavy Media Rejects that will be used in the Open Pit for stemming, road base and voids filling.

- Any area within the final Open Pit footprint (to east of the current Open Pit) may be used for temporary storage of benign and non-benign materials as required, following the development of suitable water management infrastructure.

Non-benign temporary stockpiles would be located immediately adjacent to the Open Pit and be up to approximately 5 ha in size and up to approximately 22 m high. At this height, the stockpiles would be designed to be stable. Runoff from the stockpiles would be directed to sumps located within the Open Pit. Up-catchment water would be diverted around the stockpiles, via a clay bund, northwards to the Old McArthur River.

Haul roads connecting the southern end of the Open Pit to the mine levee wall will enable hauling of materials to the topsoil stockpiles. Sections of the crest of the mine levee wall will be widened to enable safe hauling of material. MS-NAF will be used on the internal side of the mine levee wall, and benign material on the outside. The works will not change the existing flood immunity of the mine levee wall.

4.2.2.7 Supporting Infrastructure or Services

Open Pit and ROM Pad Infrastructure

The ROM Pad and infrastructure area, as shown in Figure 9, include the mining offices, light vehicle and medium vehicle maintenance workshops, mining electrical workshop, the primary crusher and the ore stockpiles on the ROM pad. These facilities are on the main electrical and fibre optic system, and have their own potable water, fire water, and septic system. A Dyno Yard is located west of the ROM Pad.

The haul road network at the Mine connects the Open Pit to the various emplacement facilities and stockpile locations. In the Open Pit and on emplacement facilities, haul roads are typically constructed from material sourced from within that area. Across other areas, the material used to construct haul roads will depend on the water catchment type in the area and water management infrastructure.

The Mine has a network of overhead and underground power cables to provide electricity to various installations. The selection of overhead or underground power considers many factors including nearby vehicle movements, flood levels, ground stability, blasting proximity, life and cost. Voltages used in the mining area ranges from 11 kilovolts to 240 volts.

Machinery and equipment laydown yards and dewatering crew storage and repair facilities are located in the southern area inside the mine levee wall.

Other ancillary and temporary infrastructure may be developed within the mine levee wall away from the operational areas as required.

Services and Systems

A new powerline is planned to be installed from the mill area to Pete's Pond, to cater for increased power requirements for the Water Treatment Plant, MUDS, Mining Administration office and other infrastructure and equipment in the Open Pit area. The majority of the 1.8 km powerline will be buried within existing development areas. Existing powerline infrastructure will be decommissioned and removed as required.

Relocation of the existing radio tower infrastructure and washdown bay, and establishment of new electrical and communications facilities including associated services will be required to accommodate the extension of the ROM Pad Ore Stockpile. The new washdown bay will have the same environmental controls as the current facility. Surface water runoff and associated sediment will be directed into a concrete sump. The sediments are periodically cleaned out and emplaced in the Core Zone of the NOEF. Water that collects in the sump will report to the water management system. The facility will drain to the Open Pit or VDD.

To enable better communications in the Open Pit area, another communications container with aerials will be positioned on the SOEF.

Blasting will continue as required.

A new safety system is proposed to be constructed at the end of the Airstrip. A system of warning lights and possibly audible alarms are planned to be installed on each side of the no-go zone, to be used during take-off and landing times. No additional clearing will be required for this work. A Core Yard and Magazine Area are located south of the Airstrip.

A communications upgrade is planned for the WOEF. The existing main radio antenna and associated equipment will be replaced and the final location will depend on ROM and WOEF traffic management plans, communicates signal modelling and height. No additional clearing will be required for these works.

Supporting Infrastructure

New light vehicle access roads will be developed in the vicinity of the ore stockpile areas to remove light vehicle traffic from a haul road used by haul trucks. Other light and heavy vehicle access roads would be developed within the mine levee wall as required.

Additional mining related works that are planned include:

- Development of a ramp on the footwall to provide small vehicle access to the bottom of the Open Pit. This would result in benefits to ancillary tasks such as dewatering and Open Pit inspections, and provide an additional egress for vehicles.

- A pushback of the west wall may be designed and mined if pit stability requirements show an overall benefit to the operations. A review of the design will be carried out by a specialist geotechnical engineer prior to the work taking place. The pushback will be designed so that it does not interfere with the cover system of the WOEF.

These activities will be carried out within previously disturbed areas within the mine levee wall, and do not present any new environmental risks when compared to previous and current works.

Haul roads will be required in the southern and the eastern portions of the Open Pit, within the mine levee wall, to connect the successive Open Pit stages to the SOEF, EOEF, and stockpile locations. Existing drains may be filled in during the dry season to accommodate these roads and then recommissioned prior to the wet season. Roads for use in the wet season will require rock sheeting for grip, which is planned to be constructed using MS-NAF. Runoff water from these roads would report directly to the Open Pit and NC1A, where it will form part of the water management system. For wet season roads, culverts may be installed at crossings that intersect drains. The majority of these roads are within the final Open Pit footprint, and will be removed as the Open Pit is developed. Clearing for this work is planned within the Open Pit footprint area shown on Figure 9.

The mine levee wall will need to be widened to accommodate haul trucks, where it is too narrow. The top of the mine levee road will slope towards the interior, to manage runoff in accordance with the WMP. Whilst LS-NAF (HC) rock is the preferred material for constructing this road, MS-NAF (HC) may be used for the inner sections, where insufficient LS-NAF is available. Any MS-NAF materials used would be removed upon mine closure. The LS-NAF (HC) materials used on the exterior of the mine levee wall will be regularly inspected for erosion and/or slumping, especially after flood events. Evidence of excessive erosion may be resolved by application of selectively placed coarser LS-NAF (HC) rock. Clearing for this work will be carried out within the area shown on Figure 9.

The MRM geotechnical department inspects and reports on the mine levee wall each month. An external audit of the mine levee wall by an appropriately qualified consultant is also conducted periodically.

A 12-15 m wide access road may need to be constructed around the external base of the mine levee wall, to allow for hauling of materials that may be required for ongoing maintenance and repair of the levee wall (such as fixing up erosion from both rain and floodwaters, and armouring of the levee toe).

Light Vehicle roads are planned to be constructed parallel to the main haul roads to separate Light Vehicle traffic from Heavy Vehicle Traffic. As such, the effective haul road corridor width may increase from approximately 40 m up to 50-55 m.

Fuel Storage

Additional fuel storage and an alternative dispensing location are planned to be constructed to meet an increase in diesel fuel consumption. The mining fuel farm would be located inside the mine levee wall (Figure 9). Fuel tankers would be given a dedicated lane on the main road where they can stop to supply the fuel. Piping would run down to storage tanks at ground level, inside the mine levee wall and below the road crest. Any spills during refuelling would report to Lake Archer and form part of the water management system. A series of self-bunded or externally bunded tanks would be installed that could store up to 600 kilolitres (kL) of fuel. These tanks would be constructed to Australian Standard (AS) 1940:2004 – *The storage and handling of flammable and combustible liquids*, and their maintenance requirements added to the scheduled maintenance programs. The conceptual model for groundwater in the area predicts groundwater being drawn into the Open Pit dewatering system, which is a groundwater sink. Clearing will not be required for this work.

4.2.2.8 Other Dewatering and Water Supply

To maintain an uninterrupted raw water supply for potable water and operational requirements, additional water supply bores may be required. Test drilling for raw water investigations and installation of water supply bores will continue to be undertaken within the areas provided on Figure 10.

To improve the Open Pit wall stability and reduce the amount of water entering the Open Pit, interception wells are planned to be installed in the west, south and possibly the east of the current and future Open Pit perimeter. Where possible, water from the interception wells will be used to supplement raw water supply. The planned investigation areas for interception bores are shown on Figure 10.

The new interception and water supply bores will continue to be installed within existing disturbed areas, as far as practicable and in accordance with applicable requirements under the NT *Water Act 1992*. New drill pads, access tracks and sumps will result in some minor disturbances within the investigation areas. All drilling works will be undertaken in accordance with the requirements of relevant AAPA certificates and MRM Permit to Clear procedures (Appendix D) and water bores will be constructed in accordance with the *Minimum Construction Criteria for Water Bores in Australia* (National Uniform Drillers Licensing Committee [NUDLC], 2012). Following completion of the drilling programs and prior to the forthcoming wet season, all work areas that are outside of the planned footprints for the Open Pit and OEF development will be rehabilitated. Compacted ground will be ripped, with stockpiled topsoil and vegetation re-spread over the disturbed areas.

The interception and water supply bores will result in approximately 3.1 ha of new disturbance as shown in Table 8.

TABLE 8 – APPROXIMATE NEW DISTURBANCE FROM PLANNED WORKS

Area	Purpose	Approximate Area of Disturbance (ha)
Wiki Borefield	To investigate whether additional water supply bores could be installed in the Wiki Borefield.	0.8
Highway Tree Screen area	To provide a water supply bore to support the development of a highway tree screen adjacent to the Carpentaria Highway and NOEF.	0.1
MIMEX Borefield	To investigate whether additional water supply bores could be installed in the MIMEX Borefield.	0.8
Southern Extension	To intercept groundwater inflow to the Open Pit. Extracted water may be used for operational purposes.	0.5
Western Fault area	To investigate and intercept potential groundwater inflows from the Western Fault to the Open Pit. Extracted water may be used for operational purposes.	0.3
Emu Borefield	To investigate whether the existing borefield could supply additional water for general water use.	0.5

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LEGEND

Raw Water Supply Investigation Areas

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

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Raw Water Supply Investigation Areas and Areas for Possible Pit Interception Bores

Figure 10

4.2.3 NOEF Domain

4.2.3.1 Overview of the Existing NOEF

The NOEF, located to the north of the Open Pit, is the principal waste rock emplacement facility at the Mine and is accessed by bridges over the Barney Creek Diversion Channel.

The stages of the NOEF construction are West, CW, Northwest (NW), Northeast (NE), Central East (CE) and Southeast (SE), as shown on Figure 11. Details of the internal architecture, structure and composition for the historic core of the NOEF (for all stages except the active CW stage and the undeveloped NW and NE stages) can be found in the Draft OMP EIS Appendix H, NOEF Historical Construction and Drilling Report.

The structure and construction methodology of the existing NOEF varies depending on when the stage was built, with three principal internal architectures existing within the facility (Figure 11):

- **West A, B, C:** West A, B and C were built as per the original URS 2008 NOEF design. The West stage Lift 1 was built in 2-3 m lifts of various NAFs and alluvium, sloping towards the South Perimeter Runoff Dam (SPROD). A minimum 0.6 m thick CCL sits on top of the wedge and under the PAF cell above, with the aim of promoting infiltrating water to report to SPROD. The PAF cell lifts were typically 15 m high with the outer surface of the PAF cell flattened off to a 1V:4H slope before being covered by a fine grained wet season cap. Some areas have several wet season caps, when their construction covered multiple wet seasons.

- **Southeast and Central East Alpha:** The SE and CE Alpha stages were also built to the URS 2008 design. The lower Lift 1 and part of Lift 2, comprising various NAFs and alluvium, were constructed prior to 2015. A wet season cap was placed on the plateau, which is sloped towards Southeast Perimeter Runoff Dam (SEPROD) and East Perimeter Runoff Dam (EPROD). EPROD will be commissioned in 2020 and will capture runoff from the CE Alpha stage, once the wedge is completed. SE stage also includes a cover system trial.

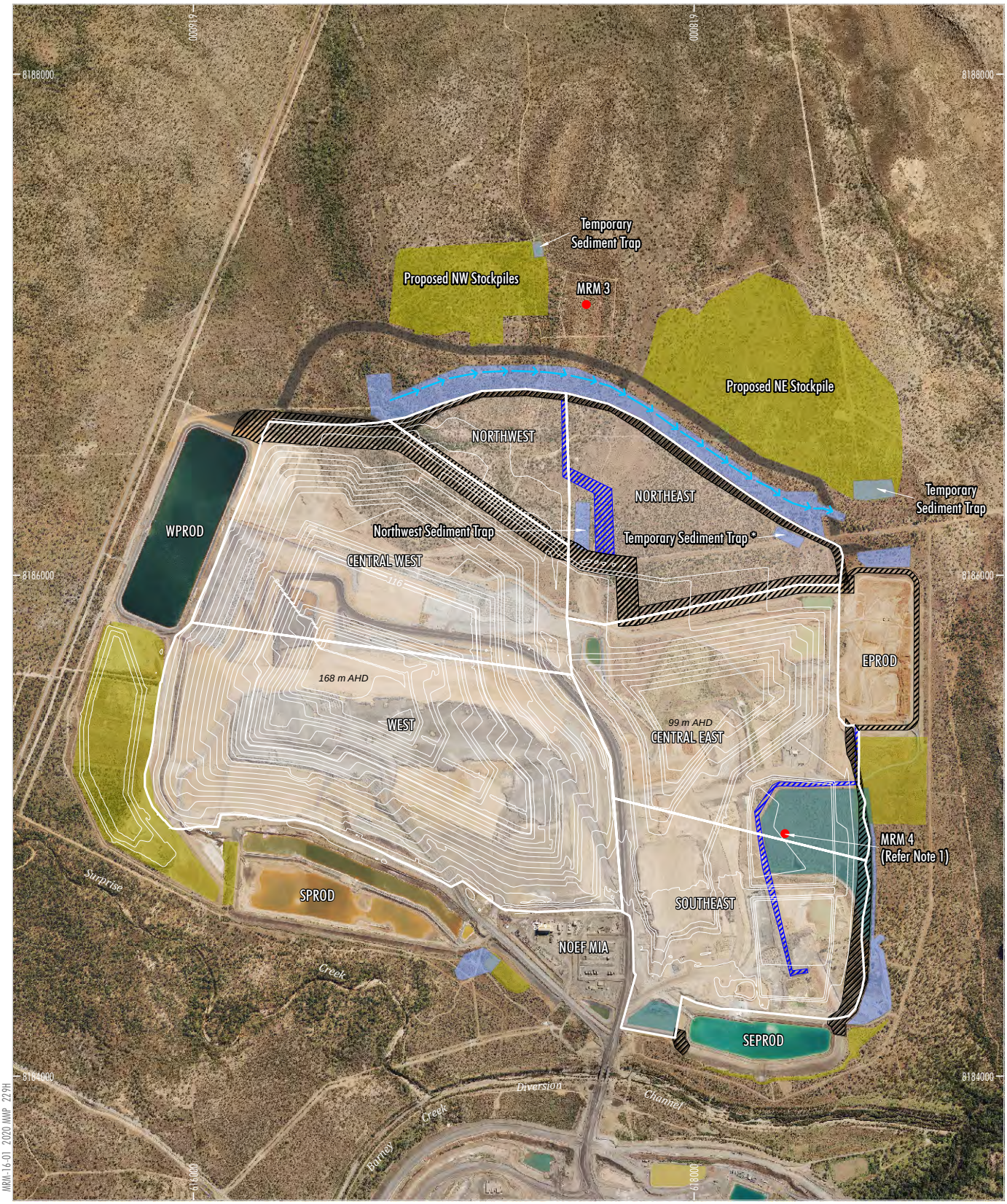
- **West D:** West D is underlain by a clay foundation with underdrains built in that report to the West D sump. The lower Lift 1 comprises various NAFs and is overlain by a Wedge CCL. The overlying PAF cell was constructed in 2 m lifts with compaction, and outer batters laid back at a 1V:4H slope as construction progressed. An approximate 40 m wide strip termed a “halo” was then built out of MS NAFs to encapsulate the PAF cell, and was tipped in 2 m lifts before receiving a wet season cap.

- **Central West Alpha and Bravo:** CW Alpha and Bravo are being constructed following the methodology detailed in the *North Overburden Emplacement Facility (Central West Phase) Design, Construction & Operations Manual* (MRM, 2016). This stage is characterised by a 0.5 m thick basal CCL overlain by a wedge of benign material (alluvium and LS-NAF [HC]) to form a slope to the West Perimeter Runoff Dam (WPROD). As per the Phase 3 concept, a 0.6 m thick Wedge CCL is built on top of the wedge prior to construction of the PAF cell. The PAF cells are constructed in 2 m lifts, with each lift overlain by a 100 mm thick fine-grained low air permeability barrier, termed an advection barrier. External batters of the core are overlain by a 0.5 m thick advection barrier. An MS-NAF Halo envelopes the core and protects it from further erosion and oxidation.

- **Central West Charlie:** The construction of the CW Charlie foundation was approved on 12 October 2018. The foundation works include preparation of the sub-grade, construction of a 0.5 m thick basal CCL layer and construction of a 1 m thick protective benign armour layer, as per CW Alpha and Bravo. Construction of the CW Charlie foundation commenced in October 2018. The placement of non-benign waste material in CW Stage commenced following approval on 15 August 2019. After this date, the 1 m rock protection layer over the basal CCL was changed to at least 2.5 m of MS-NAF.

- **Northwest stage:** This stage is undeveloped and no placement of materials has taken place.

- **Northeast stage**: This stage is undeveloped and no placement of materials has taken place.



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LEGEND

- Emplacement Area
- 20 Year ARI Flood Protection
- 100 Year ARI Flood Protection
- Benign Material Stockpile
- Laydown Area/Clearing
- Access Road
- Water Management
- Indicative Drainage Path
- Archaeological Site

NOTES

1. Disturbance of MRM4 is subject to the relevant approval under VOA 0059 Condition 121.
2. Temporary Sediment Traps are required during clearing and construction of the Basal CCL using benign material.
3. Any structure above AAPA maximum height limit of 80 m (116 m AHD) is subject to the relevant approval under VOA 0059 Condition 120.

* Sediment trap to be converted to sump prior to non-benign material emplacement

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

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Planned North Overburden Emplacement Facility Landform

Figure 11

The NOEF Mine Infrastructure Area (MIA) is located north of the Barney Creek haul road crossing. The NOEF MIA includes workshops, offices, crib huts, stores, hardstand areas, welding bays and ancillary infrastructure (Figure 11). These facilities are on the main electrical and data system, and have their own potable water, fire water, and septic system.

Temporary infrastructure may be developed within the NOEF domain away from the operational areas as required.

4.2.3.2 Planned NOEF Works

MRM plans to develop the NOEF to the full extent of the footprint described in Section 6.5.1.3 of the Supplementary OMP EIS (Figure 11). The indicative final layout of the NOEF for this MMP is shown on Figure 11. The general sequencing of the NOEF, and as such the final layout, may be subject to change, however the NOEF will be constructed in accordance with:

- the NOEF Management Plan (NOEF MP) (Appendix G) and NOEF Construction and Design Guidelines (MRM, 2020) as consistent with the construction and design objectives provided in Section 6.5.1.3 of the Supplementary OMP EIS; and
- the requirements of the VOA and NT EPA recommendations.

The construction sequencing for the NOEF is subject to a number of operational and approval constraints including:

- construction of water containment infrastructure to separate runoff from non-benign, benign and undisturbed areas;
- construction of flood protection barriers around areas to be used to store non-benign material;
- obtaining AAPA certificate approvals for proposed construction activities;
- prevailing weather and rainfall conditions (e.g. certain construction activities cannot be undertaken over the wet season); and
- haul distances and limits on stockpile capacities.

Foundation and Base work can only generally be carried out in the dry season, and NOEF construction planning ensures that new stages are prepared prior to capacity being reached in the Core Zone of the preceding stage.

The general strategy for constructing the NOEF is to develop some stages to their full extent so that the cover system can be installed and the NOEF progressively rehabilitated. Installation of a benign cover system will reduce:

- the overall amount of contaminated water reporting to the PRODs and sumps. Water that comes in contact with the completed cover system will be redirected to sediment management infrastructure and passively released in accordance with the WMP; and
- the amount of LS-NAF and alluvium materials that require stockpiling.

Commencement of the final cover system and associated rehabilitation works will be subject to relevant approvals.

The Core, Halo and advection barriers will be designed to redirect runoff towards the PRODs. The aim is to construct as much of the wedge as possible during the dry season to maximise the quantity of runoff that reports to the PRODs over the subsequent wet season.

Unless the relevant approvals are obtained, the NOEF will:

- remain below the current AAPA maximum height limit for the NOEF as per VOA 0059 Condition 120. A TARP has been established to formalise survey measurements and recording height against the limit;

- avoid disturbance to the MRM4 archaeological site as per VOA 0059 Condition 121; and
- comply with all EPBC Act Approval requirements.

MRM will provide any approvals obtained from AAPA or related to MRM4 as detailed above to DPIR prior to commencement of any related works.

An overview of the planned works for each stage of the NOEF includes (Figure 11):

- **West stage:** Completion of the MS-NAF Halo and advection barriers on the top face; continuation of cover system trials; stockpiling of materials for later use; rehabilitation of the southern and western portion; emplacement of wastes in the upper Core, Halo and Cover after the relevant approvals have been obtained;
- **Central West stage:** Completion of the Core Zone, PAF (RE) Cell and the Halo, using the OMP EIS methodology; stockpiling of materials for the construction of the cover system;
- **Central East stage:** Construction as per OMP EIS methodology and other relevant approvals to connect up to EPROD; construction of a dedicated PAF (RE) cell as per OMP EIS methodology; removal of topsoil stockpiles and clay borrow from CE Bravo footprint; stockpiling of materials construction of the Base, Core Zone, and Halo in CE Alpha and Bravo;
- **Southeast stage:** Construction as per OMP EIS methodology and other relevant approvals; continuation of a PAF (RE) cell and cover system trial; stockpiling of materials; installation of monitoring instrumentation;
- **NW Stage:** test-pits and drilling investigations for future foundation and works; construction of foundation, Base and emplacement of waste as per OMP EIS methodology and other relevant approvals;
- **NE Stage:** test-pits and drilling investigations for future foundation and works; construction of foundation, Base and emplacement of waste as per OMP EIS methodology and other relevant approvals; and
- **Flood protection:** Construction of flood protection at CW Charlie to EPROD; EPROD to SEPROD; construction of the northern permanent levee.

OMP Construction and Design Objectives

The NOEF construction and design objectives are contained in the NOEF Design and Construction Guidelines (MRM, 2020), with the exception of some design elements that have been changed via VOA 0059. A summary of how the construction and design objectives are met for the following NOEF components is provided in the NOEF Design and Construction Guidelines:

- Foundation / basal CCL (the Foundation);
- Base, including the development of an MS-NAF base (the Base);
- Core Zone – PAF (HC) and MS-NAF;
- Core Zone – PAF (RE) Cell, including maximum 2 m lifts, associated advection barriers and wet season caps (the PAF [RE] Cell);
- Internal NAF Halo to provide a buffer between the Core Zone and the cover system;
- NOEF Batters, that will form part of the post-mining landform;
- Temporary Halo Cap until relevant AAPA approvals are received; and
- An NOEF Cover System, of at least 1.5 m thick to encapsulate the entire NOEF (the Cover System).

Construction of the NOEF will remain generally consistent with the conceptual design provided in Figure 12.

The NOEF MP is provided as Appendix G and presents the overarching management document for the design, construction and operation of the NOEF. The NOEF MP is intended to provide the fundamental approach to the development and management of the NOEF to maintain relevant environmental values at the Mine. The NOEF MP:

- identifies the key risks associated with operation of the NOEF;
- presents objectives for the design, construction and operation of the NOEF based on the identified risks and the relevant controls required to meet these objectives;
- provides a concise overview of the design, construction, and operation of the NOEF consistent with the methodology provided in the OMP EIS;
- describes process flows for moving from conceptual designs and specifications to for-construction designs and specifications, including the role of the Independent Certifying Engineer (ICE) in their review and endorsement of detailed designs; and
- identifies the monitoring programs to measure the performance of the design, construction and operation controls against the objectives and the corrective actions in the event that relevant performance criteria are not being met.

The design methodology and construction of each stage of the NOEF will remain generally consistent with the NOEF MP. Detailed information about the design and construction of the NOEF and the relevant OMP EIS design criteria is provided in the NOEF Construction and Design Guidelines.

The NOEF Construction and Design Guidelines (MRM, 2020) provides:

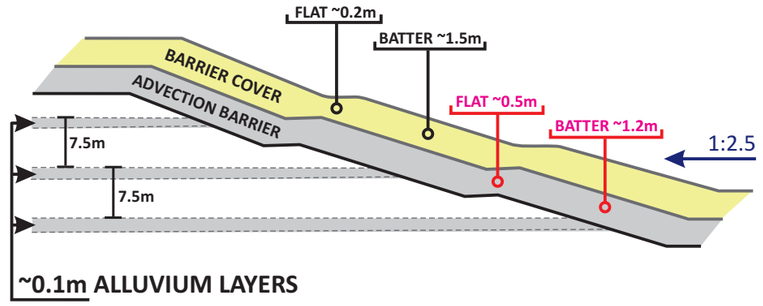
- an overview of the NOEF design standards and philosophy;
- general specifications and standards associated with the design, construction and operation of the NOEF, based on the relevant OMP EIS methodology;
- hold points and Quality Assurance/Quality Control (QA/QC) requirements; and
- general requirements for associated infrastructure including water management, roads and instrumentation.

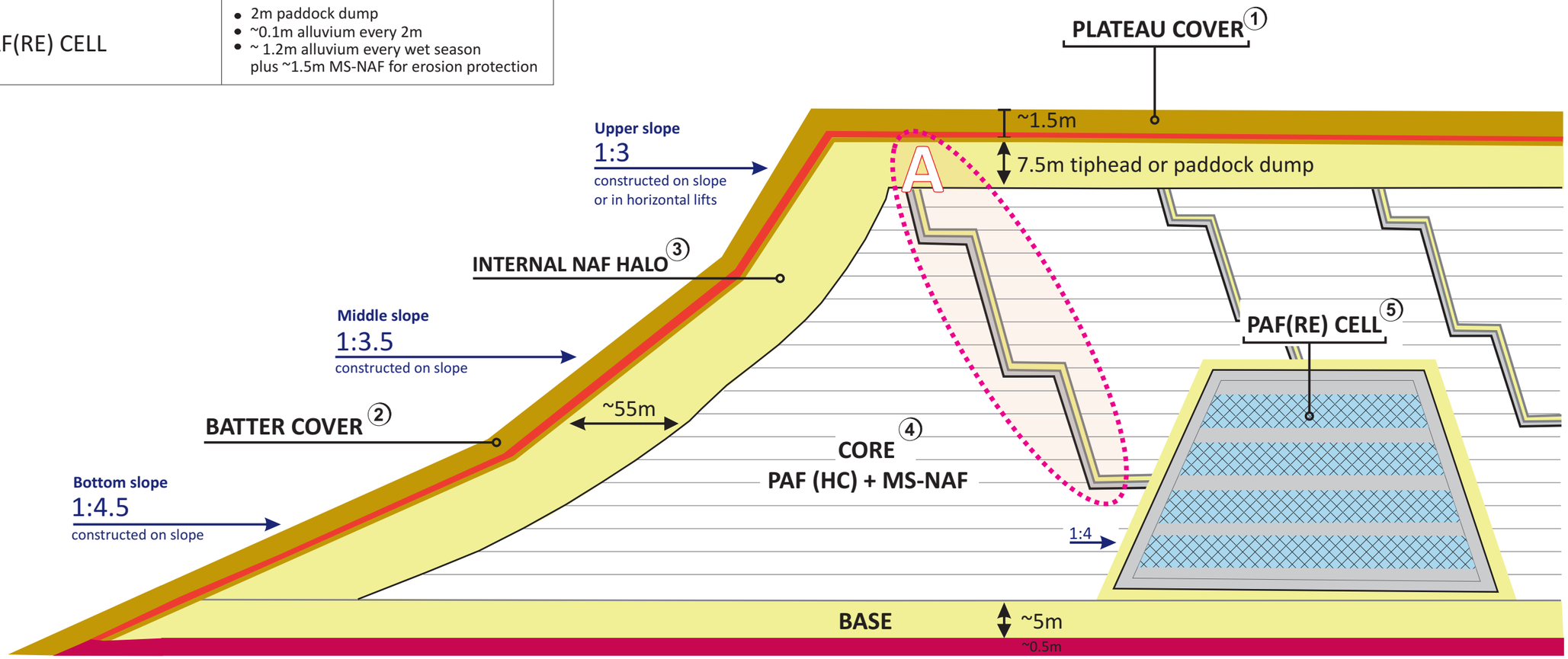
The NOEF Construction and Design Guidelines do not include detailed designs of individual stages, which will be developed and submitted to DPIR in accordance with the process defined in the conditions of VOA 0059. Detailed designs will be reviewed and endorsed by the ICE for their consistency with the NOEF Construction and Design Guidelines (and the OMP EIS methodology, by extension) prior to submission to DPIR.

The ICE has reviewed and endorsed the consistency of the NOEF MP and the NOEF Construction and Design Guidelines with the OMP EIS principles (Appendix H).

1	PLATEAU COVER	• ~0.1m Topsoil (TS) • ~0.6 - 0.9m Growth Media (GM) - alluvium • ~0.2 - 0.5m drainage layer • ~0.2 - 0.3m GSL Overliner (alluvium) • Geosynthetic liner • ~0.2m HMR or alluvium GSL Underliner
2	BATTER COVER	• ~0.1m Topsoil (TS) • ~1.1 - 1.4m Breccia GM/Erosion protection • ~0.2 - 0.3m GSL Overliner (alluvium) • Geosynthetic liner • ~0.2m HMR or alluvium GSL Underliner
3	INTERNAL NAF HALO	• MS-NAF's or better (e.g. LS-NAF) • up to 7.5m tiphead
4	CORE	• PAF(HC)/MS-NAF • 2m paddock dump and/or up to 7.5m tiphead with advective barriers (~0.1m alluvium)
5	PAF(RE) CELL	• 2m paddock dump • ~0.1m alluvium every 2m • ~ 1.2m alluvium every wet season plus ~1.5m MS-NAF for erosion protection

A INTER-STAGE INTERNAL BATTERS





METSERVE Mining & Energy Technical Services Pty Ltd

McArthur River Mining
A GLENCORE COMPANY

LEGEND

- Cover
- MS-NAF
- Cover GSL
- Basal CCL
- Alluvium
- PAF(RE)

Note: No PAF (HW) to be mined during MMP Period

Overburden Management Project

NOEF Concept Design

13/12/2017

FIGURE 12

West Stage Works

The West stage is currently at a maximum of approximately 75 mRL high (111 m AHD [metres Australian Height Datum]), with a temporary MS-NAF cap on top of the former PAF cells. The southern and western faces are largely completed to the outer Halo face, and are awaiting the installation of the Cover System.

Trials for various cover system configurations on both the plateau and batter will be completed.

Subject to relevant AAPA approvals, the West stage will be progressively raised above the AAPA height limit in accordance with the NOEF Construction and Design guidelines and VOA 0059 Condition 120. The AAPA Certificate would be provided to DPIR prior to construction the upper West stage above the AAPA height limit.

Rehabilitation of the south west face of the West Stage is planned to be undertaken as described in Section 4.2.3.5 (Figure 13).

A number of monitoring wells are proposed to be drilled through the NOEF, in the southern portion of the West Stage, to determine whether water is mounding on the clay foundation. If significant water mounding is identified, a seepage extraction system may be installed to extract the water. Extracted water would be managed in accordance with the WMP.

Central West Alpha-Bravo Stage Works

Central West Alpha Sump (CWAS) is planned to be decommissioned due to construction requirements for the CE Bravo stage. The sump will be drained, the liner and contaminants removed and disposed of in the Core Zone, and the footprint built up as per the standard NOEF foundations. The CW Alpha and the CE underdrains are planned to be connected to direct seepage to a temporary geosynthetic lined sump at the eastern edge of the NOEF, where it will be recovered and pumped into the water management system.

Subject to relevant AAPA approvals, the CW Alpha-Bravo stage will be progressively raised above the AAPA height limit in accordance with the NOEF Construction and Design guidelines and VOA 0059 Condition 120. The AAPA Certificate would be provided to DPIR prior to any construction of the CW Alpha-Bravo stage above the AAPA height limit. The CW Alpha-Bravo stage will be raised in conjunction with the West stage.

The continued construction of the proposed CW Alpha-Bravo Stage will be undertaken in accordance with detailed design reports to be endorsed by the ICE.

Rehabilitation of the west face of the Stage are planned to be undertaken as described in Section 4.2.3.5 (Figure 13).

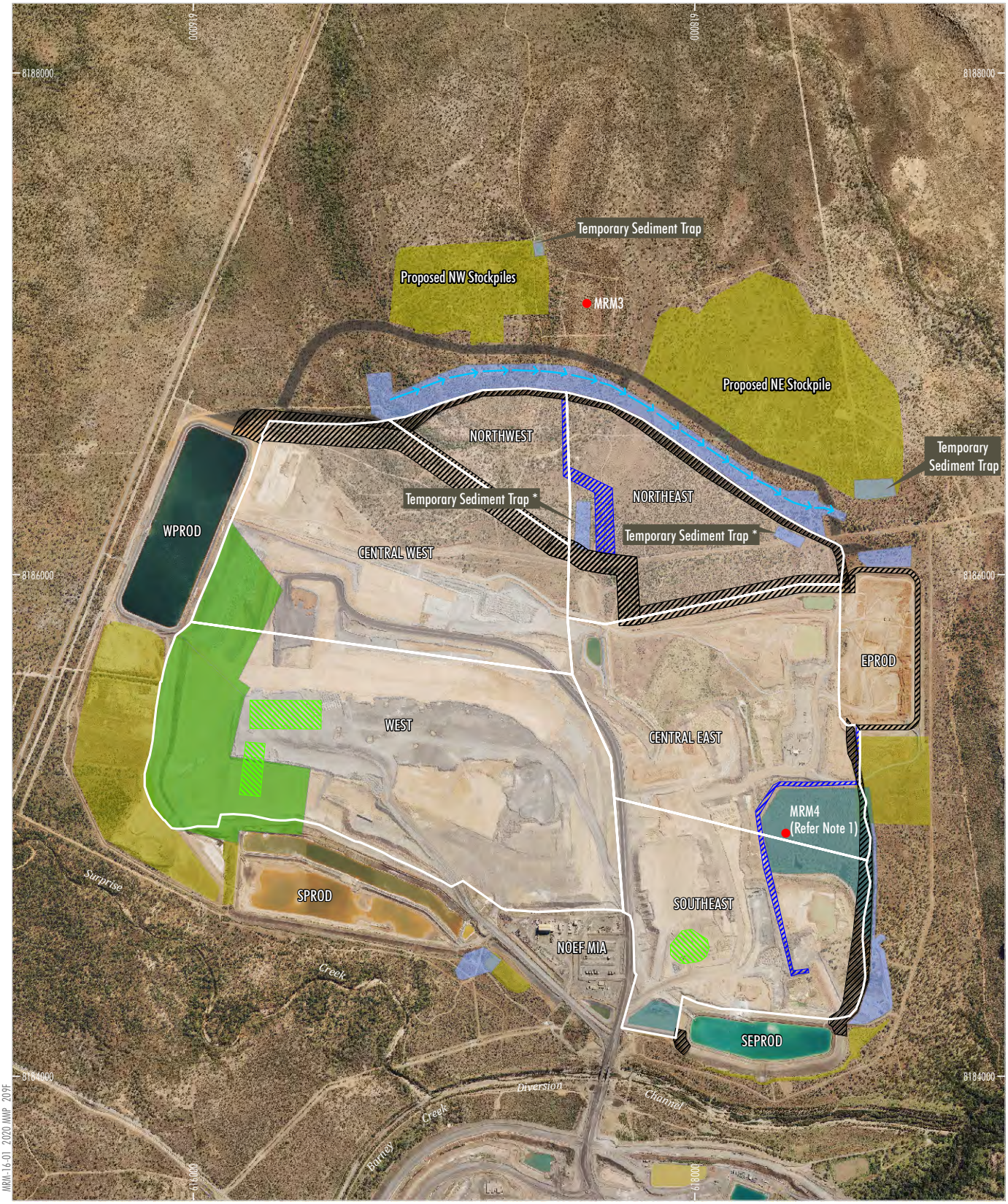
Central West Charlie Stage Works

The works at CW Charlie will continue in accordance with detailed designs (generally consistent with conceptual designs) to be endorsed by the ICE. The planned works involve the completion of the PAF (RE) Cell, Core Zone and the Halo, using the OMP EIS methodology and continued stockpiling of materials.

Subject to relevant AAPA approvals, the CW Charlie stage will be progressively raised above the AAPA height limit in accordance with the NOEF Construction and Design Guidelines and VOA 0059 Condition 120. The AAPA Certificate would be provided to DPIR prior to construction of the CW Charlie stage above the AAPA height limit.

Upon development of the NE stage, the temporary flood protection levee wall between the CW and NE stages is planned to be removed and a basal CCL underdrain system will be constructed to direct water to a toe seepage recovery well near EPROD, where it will be recovered and pumped into the water management system (Figure 13).

The Core Zone and Halo Zone will continue to be constructed above the 100 year ARI flood level.



MRM-16-01 2020 MMP 209F

LEGEND

- Emplacement Area
- 20 Year ARI Flood Protection
- 100 Year ARI Flood Protection
- Indicative Rehabilitation Trial Location
- Benign Material Stockpile
- Rehabilitation
- Laydown Area/Clearing
- Access Road
- Water Management
- Indicative Drainage Path
- Archaeological Site

NOTES

1. Disturbance of MRM4 is subject to the relevant approval under VOA 0059 Condition 121.
2. Temporary Sediment Traps are required during clearing and construction of the Basal CCL using benign material.
   * Sediment trap to be converted to sump prior to non-benign material emplacement

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

McARTHUR RIVER MINE

Planned North Overburden Emplacement Facility General Arrangement

Figure 13

Central East Stage Works

The CE stage currently consists of undisturbed land (associated with the MRM4 site), areas where NAF has been historically placed, benign stockpiles and clay borrow pits. Development of the CE stage will be in accordance with detailed designs to be endorsed by the ICE and will include PAF (RE) cells.

MRM will undertake further geotechnical investigations on undeveloped areas of the CE Alpha stage to determine if the in-situ clays are suitable to be used as a liner, or whether new materials to form a basal CCL will be required. The in-situ clays will be considered suitable if they are at least 0.5 m thick, with a maximum permeability of 1 x 10^{-9} metres per second (m/s). The detailed designs will report on the results of the investigations and identify the suitability of the existing in-situ clays. If the investigations determine that the in-situ clays are not suitable, a basal CCL will be constructed in undeveloped areas that do not currently contain PAF wastes, as appropriate. Underdrains are planned to be constructed in the foundations to direct water to the Central East Bravo Sump (CEBS) near EPROD. This sump is planned to be lined. CE Alpha stage is planned to be raised to above the wedge level (Base and Core Zone) prior to the emplacement of PAF (RE) in the CE Alpha stage. The wedge will be constructed to direct seepage to EPROD.

For developed areas of the CE stage, MRM plan to use the in-situ clay as a basal clay liner. Both historic and recent investigations have been undertaken to determine whether the in-situ clay meets the design intent of Recommendation 7 from NT EPA Assessment Report 86. The main findings of these investigations are that the in-situ clay in the developed areas of the CE stage:

- satisfies (and exceeds) the minimum 0.5 m thick and maximum permeability of 1x10^{-9} m/s specification required for the basal CCL;
- is inferred to direct potential seepage to relevant water management infrastructure, without the presence of low points; and
- satisfies the intent of Recommendation 7 of NT EPA's Assessment Report.

A report detailing the results of these investigations is planned to be provided in the detailed design for the CE stage, as well as an endorsement letter provided by the ICE, which supports MRM's approach to using the in-situ clay as a basal clay liner.

Prior to the development of the CE Bravo stage, the excavation of old topsoil, clay and in-situ clay will be required. These materials will be used to construct the advection barriers or temporarily stockpiled for use in rehabilitation. Following the removal of this material, the foundation and basal CCL is planned to be constructed, as required. Underdrains are planned to be constructed in the foundations to direct water to CEBS. These underdrains will also connect into the CW Alpha-Bravo underdrains. The Base, Core Zone, and Halo will be progressively developed to the wedge level to direct runoff to EPROD. The PAF (RE) Cells will be constructed above the 100 year ARI flood level, and within the OMP EIS PAF (RE) outer limit. Flood protection will be constructed as per the NOEF Construction and Design Guidelines.

The Central East Alpha sump (CEAS) is only planned to be developed if non-benign waste emplacement is occurring in the CE Alpha, but not the Bravo stages. The sump would be lined and used to store runoff from non-benign areas of the CE Alpha stage.

Southeast Stage Works

The development of the SE stage will be carried out in accordance with the NOEF Construction and Design Guidelines. A basal CCL is planned to be constructed on new areas, subject to the results of geotechnical investigations that will determine whether the in-situ clay is suitable to be used as a liner. The construction of a Base, Core Zone, Halo and Cover System up to the wedge level is planned. The following general development steps will be followed in the SE stage:

1. Clearing of vegetation and removal of unsuitable materials from the foundation, which will be stockpiled for later use in NOEF rehabilitation.
2. Cutting of the foundation to the designed gradients.

3. Construction of the Basal CCL in new areas that are currently undeveloped. Construct the underdrains and install pumping infrastructure.

4. Construction of the MS-NAF Base in lifts from approximately 2.5 m to 5 m thick to protect the Basal CCL. An advection barrier will be constructed on top of the MS-NAF Base.

5. Construction of the MS-NAF Halo on the eastern side to the 100 year ARI flood level or higher, and batter the outer face back to the final angle. Progressively install the cover system over the face to provide flood protection. This is expected to occur over two dry seasons.

6. Concurrently with step 5, construct the Core above the Base in lifts up to 7.5 m high, with an advection barrier over each lift.

7. Various temporary stockpiles are planned to be placed on the SE wedge for use in construction of other stages of the NOEF.

Underdrains are planned to be constructed in the foundations to direct water to new extraction points within the NOEF footprint. The NOEF East Drain Sump (EDS) will be decommissioned as the southernmost underdrain will intercept the seepage that would report to this sump. A polyvinyl chloride well will be extended up through the rock pile to the top of the wedge, enabling a submersible pump to be used to extract seepage collected in the system.

A temporary 20 year ARI flood protection levee is planned to extend from EPROD to SEPROD in the south (Figure 13). Construction will be in accordance with the NOEF Construction and Design guidelines. The temporary 20 year ARI flood protection levee will be in place for a maximum of two wet seasons.

A 100 year ARI flood protection levee is planned to be constructed on the eastern extent of the NOEF over approximately two dry seasons (Figure 13).

Following the development of the flood protection around the SE stage, the existing Southeast Levee (SEL) is planned to be used as an external toe drain to direct runoff behind the SEL embankment. The SEL will also function as a sediment basin, and water will be discharged in accordance with the WMP.

As the flood protection works are completed, the SE stage foundation and Base to the west of the final NOEF perimeter, will be constructed. The Core and Halo will then be constructed up to the wedge level to establish drainage into SEPROD. Benign materials (e.g. alluvials and LS-NAF) would be stockpiled within the footprint of this area for use in the NOEF construction.

MRM may undertake maintenance and upgrade works to the flood protection of SEPROD in the south-eastern area of the NOEF. These upgrades would be in accordance with a detailed design endorsed by the ICE.

Northwest Stage Works

The NW stage presently remains largely undeveloped with the exception of a few tracks. Planning for this stage is conceptual and a detailed design will be prepared after ground investigations have been completed. The detailed design will be prepared in accordance with the NOEF MP and the NOEF Construction and Design Guidelines and be endorsed by the ICE.

To prepare for future emplacement in this stage, test pits and shallow hydrogeological drill holes are planned to be completed to characterise the footprint of the NW stage. The NW stage is planned to be cleared to its full extent, with surface water runoff draining to the proposed sediment trap to the east of this stage.

Following the clearing of this stage in accordance with the Permit to Clear Procedure (Appendix D), the construction of the NW Stage foundations (i.e. sub-grade, basal CCL and protective Base layer) is planned to occur across the entire stage. Flood protection is planned to be developed around the northern extent of the stage to the 100 year ARI flood level. The flood protection works would also divert up-catchment clean water away from the disturbed areas.

The Base will be constructed over the foundation and will be sloped towards the planned temporary North West sump (NWS) located on the east side of the NW stage or construct suitable drainage to the existing CW Charlie sump.

The NW Stage will be developed using the OMP EIS methodology and the maximum elevation will remain consistent with AAPA approvals.

The NW Stage may be used to temporarily stockpile benign materials. Any surface water runoff from the stockpiled materials would report to a sediment trap in accordance with the WMP.

Northeast Stage Works

The NE stage presently remains largely undeveloped with the exception of a few tracks and a powerline corridor. Planning for this stage is conceptual and a detailed design will be prepared after ground investigations have been completed. The detailed design will be prepared in accordance with the NOEF MP and the NOEF Construction and Design Guidelines and be endorsed by the ICE.

Following clearing of this stage in accordance with the Permit to Clear Procedure (Appendix D), the construction of the NE Stage foundations (i.e. sub-grade, basal CCL layer and protective Base layer) is planned to occur across the entire stage. Flood protection is planned to be developed around the northern extent of the stage to the 100 year ARI flood level. The flood protection works would also divert up-catchment clean water away from the disturbed areas.

A Base, Core and Halo will be constructed over the foundation to form a wedge sloped to direct runoff to EPROD and the North East sump (NES). Surface water during the construction phase at the foundation level would report to the underdrain wells, and once the height reached the wedge elevations, drainage would largely report to EPROD.

The NE Stage is planned to be developed using the OMP EIS methodology and the maximum elevation will remain consistent with AAPA approvals.

The NE Stage may be used to temporarily stockpile benign materials. Any surface water runoff from the stockpiled materials would report to a sediment trap in accordance with the WMP.

4.2.3.3 NOEF LOM Design

The NOEF is planned to be constructed in individual stages, as shown on Figure 13, to effectively manage disturbance and surface water runoff from operational areas. A series of PRODs are located at positions on the perimeter of the NOEF to contain runoff and pumped water from the disturbed footprint. Workshop and hardstand facilities are located in the NOEF MIA.

The proposed LOM NOEF design is shown on Figure 13, along with relevant features that are planned to be constructed throughout the LOM. Various stockpile and borrow footprints are located around the NOEF for sourcing and storing benign materials over the LOM.

4.2.3.4 Consideration of Existing Authorisation Requirements and NT EPA Assessment Report 86

The current VOA 0059 for the Mine allows for development of the NOEF in accordance with NT EPA Assessment Report 86 Recommendations. A summary of the main VOA conditions and interpretations relating to the construction of the NOEF is provided in Table 9 below. The NOEF Construction and Design Guidelines have been developed in accordance with the conditions provided in Table 9.

TABLE 9 - MRM INTERPRETATION OF THE VOA CONDITIONS RELATING TO THE CONSTRUCTION OF THE NOEF

Relevant VOA Section	Current VOA Condition	Interpretation
Waste Rock Management	16a	Non-benign waste cannot be permanently placed below the 100 year ARI flood level, unless suitable flood protection measures are provided, with the exception of PAF (RE).
	17	PAF (HC) and PAF (RE) waste rock cells require an interim alluvial cover by 1 November each year.
Central West Bravo	20a	PAF (HC) lift heights will be no greater than 7.5 m, and must include advection barriers of appropriate thickness and moisture condition.
Central West Charlie	22a	The basal CCL thickness for the construction of CW Charlie Stage must be at least 500 mm.
	23a	PAF lift heights must not exceed 7.5 m and PAF (RE) cell lift heights will be no more than 2 m high. All PAF lifts require advection barriers. The CW Charlie sump must be lined.
	23b	The 100 year ARI flood protection levee on the north side of CW Charlie Stage is required prior to the start of the oncoming wet season.
Central East	25a	New areas of the NOEF foundation development will require a basal CCL at least 500 mm thick with a maximum permeability of $1x10^{-9}$ m/s.
	26a	PAF (RE) cell lifts must not exceed 2 m in height and have suitable advection barriers on each lift. Wet season caps must be constructed prior to every wet season. 20 year ARI and 100 year ARI flood protection to be constructed prior to the start of the wet season.
	27	The basal CCL thickness for the construction of CE Stage must be at least 500 mm.
Overburden Management Project	111	An independent environmental audit of the QA/QC procedures and waste rock identification and handling performance will be undertaken every three years.
	112	New areas of the NOEF with no existing PAF waste will require a basal CCL of at least 500 mm thickness with a maximum permeability of $1x10^{-9}$ m/s.
	114	Submission of a report to inform the requirements for a NOEF seepage and recovery system are due within 12 months of approval.
	115	Within two years of approval, provide a plan to DPIR including details of trials for an NOEF GSL cover system, with a GSL-CCL layer combination.
	120	Comply with AAPA conditions, including but not limited to height restrictions.
	121	Do not disturb or encroach within 5 m of archaeological site MRM4 until a design is agreed in writing by DPIR and consultation has been provided by the Minister for Resources, the Operator and the Minister for Tourism, Sport and Culture.
	123	Develop and revise an Air Quality Management Plan that monitors SO_2 emissions from the NOEF and the nearest sensitive receptor within 12 months of approval.

4.2.3.5 NOEF Rehabilitation

The rehabilitation trials will continue to assess cover system constructability and longer-term performance. The locations of the current trial areas on the NOEF are presented in Figure 13.

The rehabilitation trials are located within contained runoff catchments in the NOEF and will comply with AAPA maximum height restrictions.

MRM will also develop new rehabilitation trials to meet relevant EPBC and VOA conditions. The trial results will be reported to the relevant independent expert panels in accordance with VOA 0059 and will be informed by a GSL cover system plan.

Existing trials that are currently being carried out on the NOEF are discussed further in the below sections.

Cover System Construction Test Pads Trial

Cover system construction trials are planned for 2020 (Figure 13). These trials consist of a series of Construction Test Pads (CTP) used to:

- Identify technical and engineering difficulties associated with the construction of a GSL cover system, both on the top plateau and the batters of the NOEF.
- Perform comparative testing of two potential GSLs: a bituminous geomembrane and a rubber-based ethylene propylene diene monomer.
- Determine the impacts of construction methodology on the liner for QA/QC purposes and construction optimisation. This involves partially re-excavating the liner for inspection and testing.
- Validate engineering assumptions with regards to timing, resources and cost optimisation for cover system construction.

Surface water runoff from the CTP trial area will be captured by the NOEF water management system.

These field trials will be complemented by ongoing laboratory trials of likely GSL products to further refine MRM's understanding of friction angles with various site materials, heat tolerance, elongation and lifespan. The results of these will be used to inform the next stage of large-scale field installation.

PAF (RE) Cell and Cover System Performance Trials

The construction of a longer-term cover system performance test pile will continue on the NOEF (Figure 13). The proposed trial is outlined in Appendix AB of the Supplementary OMP EIS. The trial is expected to run for approximately seven years and aims to test the performance of the PAF (RE) Cell construction methodology (low lift heights and regular advection barriers) and the cover system with regards to controlling both oxygen ingress and percolating waters into the waste rock. The test pile will be constructed in two steps:

1. Construction of a PAF (RE) cell as per the OMP EIS design, on an impervious geosynthetic-lined base. The PAF (RE) cell will be constructed in 3 x 2 m lifts and will include fine-grained low-air-permeability barriers (advection barriers) and a wet season cover, replicating the OMP EIS design. The PAF (RE) lifts will be instrumented for temperature, moisture and gas analysis. It will be left to stand for at least one wet season (2019/20) to determine the effectiveness of both the wet season cover and the low-air-permeability barriers. PAF (RE) was selected for the cover system trial because it represents the most reactive material that will be encapsulated by the NOEF cover system.

2. In the dry season of 2020 or 2021, a MS-NAF Halo layer will be placed above the PAF (RE) cell to replicate the internal architecture of the EIS NOEF. The cover system will then be constructed and instrumented as per the detailed designs. The test pile will then be monitored for an additional five or six years. Parameters include in-situ climatic variables, internal temperatures, gas composition, oxygen penetration profile, and soil moisture content.

NOEF Full-scale Rehabilitation

Full-scale rehabilitation activities are planned on the western and southern portion of the West Stage of the NOEF, and on the western face of CW stage. The final design of the NOEF cover system will consider the results of trials, lab tests and relevant independent expert panel recommendations on the cover system trial.

The South Stilling Basin (SSB) is planned to be developed to capture runoff from the rehabilitated sections of the NOEF. This water will be managed in accordance with the WMP.

4.2.3.6 NOEF Borrow Areas and Stockpiles

Alluvium, clay and LS-NAF (HC) materials required for construction and armouring is predominantly sourced from the Open Pit, however existing stockpiles and borrow areas at the NOEF also provide a significant source of benign construction materials. Rehandling of existing LS-NAF (HC) from the SE Stage will be completed if additional material is required.

Areas on the NOEF that are not being actively used for emplacement of waste rock will continue to be used to temporarily stockpile alluvium, clay, LS-NAF (HC) and MS-NAF materials for use in NOEF construction (Figure 13). These stockpiles will continue to be progressively developed within previously disturbed areas and will be constructed up to a height of 15 m and in accordance with maximum AAPA approval height limits. Surface water runoff from these stockpiles is captured by the existing contained water management system.

The approved access road along the north of CW Charlie and CE is used to temporarily stockpile benign materials.

NW and NE Stockpiles

The NW and NE Stockpiles are planned to be developed to their maximum extent, based on concepts provided in the OMP EIS (Figure 13). These stockpile complexes will be used to store soil, clay, alluvium and LS-NAF (HC) as required. Levees, drains and sediment traps will be constructed to manage the risk of sediment transport from the stockpiles due to incident rainfall and external surface water. There would be no emplacement of non-benign material at the NW and NE Stockpiles.

A detailed design report will be prepared for ICE review as per the process and specifications contained in the NOEF Design and Construction Guidelines.

4.2.3.7 NOEF Infrastructure Works

With the expansion of the mining fleet in 2019, the following planned upgrades to the NOEF MIA will be carried out:

- realignment of existing overhead powerlines;
- conversion of existing overhead powerlines to underground;
- construction of additional workshop bays at the MIA;
- relocating the tyre bay;
- constructing improved stores and lube reticulation;
- construction of a 3-bay service workshop;
- reconfiguring existing crib hut/ablutions and hardstand parking area; and
- other minor maintenance, repairs and upgrades.

The existing lime treatment plant will continue to operate in the vicinity of the PRODs on the NOEF to improve water quality of stored waters. The civil construction crew facilities that are currently located at Central East Alpha are planned to be relocated to a benign rock pad in the NW Stockpile area.

Haul roads are planned to be built to connect the NW and NE Stockpiles to the NOEF areas and will be typically 40 m wide. The topsoil will be stripped from the footprint and any soft patches will be removed and replaced with suitable benign materials, as required. Low-level crossings with small culverts may need to be developed across minor drainage lines to maintain access.

Overhead powerlines and underground cables will be installed to power the infrastructure at the NW stockpile area and seepage extraction pumps in the NE stage. Overhead power line routes will require a firebreak and access track, which will result in less than 0.5 ha of clearing.

As the NOEF is progressively raised, radio and telephone communications will be required on the northern side of the NOEF to maintain communication at the Mine. A 20 foot shipping container or trailer with solar power will be required for this activity and therefore the disturbance is expected to be minimal. A communication relay upgrade is also required for the SEL pumping area, consisting of a small 20 m x 10 m pad built from LS-NAF (HC) to mount the instruments above the flood level.

Small sheds for repairing pumps and welding poly pipe will be relocated from the mine levee wall to the NOEF, above the flood level. The facilities will not generate significant quantities of waste.

A watercart fill point, consisting of a clay lined 'turkeys nest' pond and standpipe, will be required to the north of the NOEF for CCL construction. Water will be sourced from a new groundwater bore. The exact location of the bore will depend on the results of hydrogeological investigations to find a suitable water resource. Additional disturbance related to this activity is expected to be less than 0.5 ha.

MRM will comply with the requirements of the NT *Water Act 1992*, including obtaining and holding water licences where necessary.

4.2.3.8 Ore Stockpiles

Emplacement of low-grade waste (assumed to be PAF [HC] for handling purposes) will continue in the NOEF below the AAPA height limit. PAF (HC) will be stored in an 8 ha area on top of the NOEF West A stage, below the applicable AAPA height limit. Drainage from this area will report to SPROD. PAF (HC) will remain in place until it is either rehandled for processing or encapsulated within the NOEF in accordance with the NOEF Construction and Design Guidelines. After the NOEF West A stockpile is at capacity, further PAF (HC) will take place in the northern end of the EOEF, as per Section 3.4.4.2.2 of the OMP EIS.

4.2.3.9 Tyre Management

Used tyres are planned to be stockpiled in existing disturbed locations at the NOEF. The area that would be used for stockpiling tyres would be inside the firebreak for the power lines, and close to water supply sources should any fires require extinguishing near the tyre piles. Larger tyres will be stacked up to five tyres high and smaller tyres placed in dedicated piles.

4.2.3.10 NOEF Monitoring Programs

The monitoring programs for the NOEF assess the performance of the NOEF over time and are described further in the NOEF MP document (Appendix G). The NOEF monitoring programs include:

- geochemical quality assurance / quality control monitoring;
- gas and temperature monitoring; and
- spontaneous combustion monitoring.

These monitoring programs will continue to be carried out, and the planned changes are described below.

Gas and Temperature Monitoring

An additional monitoring bore through the PAF cell of the CW Bravo stage is planned to be constructed (Figure 14). The monitoring bore will be instrumented for temperature and gas monitoring in order to measure the in-situ performance of the newly developed Core Zone. In addition, the installation of a horizontal temperature and gas monitoring array in the CW Core Zone is planned to provide complementary information to the vertical monitoring bores, in particular with horizontal temperature and oxygen gradients closer to batters (Figure 14).

MRM-16-01_2020 MMP_220C

LEGEND

- Proposed Monitoring Location
- Decommissioned Bore
- Existing Monitoring Location

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

McARTHUR RIVER MINE

North Overburden Emplacement Facility - Existing and Proposed Monitoring Locations

Figure 14

The 2016 monitoring bore network is expected to progressively expire due to the thermocouples exceeding their operational life (approximatively 18 months). The monitoring bores in areas that have shown invariant background temperatures since 2016 will not be replaced. Attention will remain on areas where higher temperatures remain, principally the north eastern batter of the West Stage of the NOEF where monitoring will continue and bores will be replaced as required.

4.2.3.11 NOEF Interception Scheme

Detailed Design Studies

A detailed design of the proposed NOEF interception scheme will be completed in accordance with Condition 12 of EPBC Act approval 2014/7210. As part of the design process, further investigations into preferential flow paths between the NOEF and surrounding creeks will be carried out. The investigation and design works will largely be desktop based and will utilise data that was collected during field and drilling campaigns. Pending the outcomes of these desktop studies, additional field based works and drilling investigations might be necessary to better define possible preferential flow paths and ground conditions for the detailed design of the interception scheme.

Any required drilling will be carried out within existing disturbance areas as far as practicable. New drill pads, access tracks and sumps may be required in some areas resulting in minor disturbances within the investigation areas shown on Figure 15. All drilling works will be undertaken in accordance with the requirements of relevant AAPA certificates and MRM Permit to Clear procedures (Appendix D) and water monitoring bores will be constructed according to the Minimum Construction Criteria for Water Bores in Australia (NUDLC, 2012). Following completion of the drilling programs and prior to the forthcoming wet season, all work areas will be rehabilitated. Compacted ground will be ripped, with stockpiled topsoil and vegetation re-spread over the site.

The possible investigation works will result in approximately 0.5 ha of new disturbance within the areas shown in Figure 15.

Interception Scheme Implementation

In accordance with Condition 12c of EPBC Act approval 2014/7210, a plan for the implementation of the interception scheme within 2 years of EPBC Act approval will be developed. Implementation of the scheme will include the installation of a groundwater level monitoring system at the Barney Creek Diversion Channel and a detailed TARP process. The groundwater level monitoring system will be able to detect when groundwater levels rise to a level where discharge to the creek becomes physically possible. Trigger values for groundwater levels are currently being defined as part of groundwater studies in the area. If groundwater levels rise above the defined trigger values, then installation and/or construction of the relevant components of the proposed interception infrastructure will need to be carried out.

Groundwater levels along the Barney Creek Diversion Channel are currently below the base of the creek, which physically inhibits groundwater discharge to the creek. Modelling undertaken as part of the EIS predicts that these conditions will remain unchanged until mining ceases and the pit lake fully recovers. Further, modelling results and monitoring data suggest that rates of potential seepage migration are relatively slow, which will allow sufficient time to finalise the interception scheme detailed designs, seek approval, and implement the interception scheme prior to potential impacts to the Barney Creek Diversion Channel. The TARP based implementation of the interception scheme will allow MRM to test and validate these modelling predictions and construct the relevant interception infrastructure, if required.

In the unlikely event that construction of individual components of the interception infrastructure will be triggered by the TARP earlier than expected, construction works could result in up to 5 ha of new disturbance within the area shown in Figure 15, and are expected to be completed within one dry season. Construction will be undertaken in accordance with the requirements of relevant AAPA certificates and MRM Permit to Clear procedures (Appendix D).

MRM-16-01_2020 MMP_202C

LEGEND
Indicative Investigation Area

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

McARTHUR RIVER MINE

Area for Possible Drilling and Field Investigations for the NOEF Interception Scheme

Figure 15

4.2.3.12 NOEF Water Management Infrastructure

Flood Protection

The construction of flood levees around the NOEF are described in the NOEF MP (Appendix G) and NOEF Construction and Design Guidelines (MRM, 2020). Typical sections showing the layers and geometry of permanent and temporary flood barriers are also provided in Appendix G. Temporary flood protection levees (20 year ARI) are proposed to be constructed, where required, to allow for the placement of non-benign material at the NOEF. Temporary levees will remain for a maximum two year period, at which time, will be upgraded to a permanent flood protection levee (100 year ARI).

The proposed location of flood protection levees are shown in Figure 13.

Underdrains and Seepage Extraction Wells

A network of underdrains is proposed for areas that require the development of a foundation. Underdrains are proposed to be installed to reduce pore pressures in the waste rock around the perimeter of the NOEF, and to direct seepage along the basal CCL to seepage extraction points.

Once the development of underdrains are close to the final perimeter of the NOEF, seepage extraction wells are planned to be installed. While the design details haven't been confirmed yet, the current concept is to construct seepage extraction wells within the NOEF to above the 100 year ARI flood level, so that there is less risk of floodwater entering the existing drains, with access all year round. The NOEF Construction and Design Guidelines provides a conceptual design for the seepage extraction well (MRM, 2020).

PRODs

Maintenance works to SEPROD may be undertaken to the embankments to reduce the potential for excess floodwater to migrate into the NOEF (Figure 13).

Operations Sumps and Drains

The sumps CWAS, CW Charlie Sump and EDS are planned to be decommissioned, and replaced by seepage extraction wells on the final NOEF perimeter. The sumps will be drained, and any affected materials removed and disposed of in the Core Zone of the NOEF. The sumps will then be backfilled as per the subgrade specifications, and basal CCL and underdrains will be constructed to tie in the surfaces between adjacent stages.

New temporary sumps inside the NOEF footprint for the construction phase may be required in CE Alpha and Bravo stages, the NW stage, and the NE stage. These will be constructed and operated as per the NOEF MP and NOEF Construction and Design Guidelines.

The SEL will be converted to a sediment trap following the installation of flood protection between EPROD and SEPROD. Water runoff from the cover system on the east side of the NOEF will report to a toe drain and then to the SEL. As part of this, a pipe spillway has been designed to control water spilling versus retaining the waters reporting to the area. The spillway would only be opened when water is of suitable quality (e.g. Class 2 or better).

Clean Water Drains

Once the NW and NE stages have commenced, an existing natural overland ephemeral drainage channel that drains the areas to the west and northwest of the NOEF will be intercepted via the construction of the northern clean water drain. The clean water drain will be constructed to direct clean water around the NOEF areas to Emu Creek in accordance with the WMP.

4.2.4 Other Emplacement Facilities

4.2.4.1 WOEF

Overview of the Existing WOEF

The WOEF is a permanent OEF located to the west of the Open Pit, wholly inside the mine levee wall. The WOEF was the primary OEF for the start of open cut mining in 2005 to 2008. During that time, the geochemical classification system had only identified NAF and PAF for purposes of segregation and management.

The WOEF was constructed with a NAF base to the 38 m AHD level, which equated to the 100 year ARI flood event at the time. Above the NAF base, a PAF cell was constructed in the core of the facility, at least 25 m from the exterior for first lift and 10 m on the second lift, with a 3 m thick cap above. The PAF cell was fully encapsulated in at least 1 m of clay. NAF was then tipped outside and above the PAF cell. All lifts were 10 m high, generally tipped as a paddock dump layer on the bottom and then a single tip head over the top. All batters were left at the material's natural angle of repose (rill). The WOEF was constructed to 20 m high (i.e. in two 10 m lifts).

Following development of the NOEF, the WOEF was prepared for the installation of office and workshop infrastructure on the northern end through 2009 and 2010. An additional capping layer of NAF material was placed on the surface and graded to direct water to contained storages to the north and south.

With the construction of the Phase 3 project, the central portion of the WOEF was converted to a ROM pad, with the primary crusher positioned on the western wall. To match the level of the crusher, a third 10 m lift was added in the central portion using NAF, and the surface was re-graded to promote runoff. These works occurred between 2013 and 2014. The top of the WOEF is heavily trafficked and tightly compacted, however the sides are still as-tipped at the angle of repose (33° to 38°).

Currently approved waste placement works on the WOEF relate to the optimisation of the ROM pad and infrastructure, with no bulk tipping.

Planned Work

All planned works on the WOEF will be completed within previously disturbed areas. The ore stockpiles on the ROM pad will continue to be developed as per Section 4.2.2.5 (Figure 9).

With the changes to the ROM areas, infrastructure changes will also be required including relocation and upgrades to the vehicle wash, laydown yards, sheds and minor offices. Connecting roads and services will also be modified to suit the new layout.

VDD will be modified to increase the storage capacity, enable lining, and construct culverts and drains. The modifications would possibly involve reshaping to increase the storage capacity, developing an access ramp and lining of the dam.

4.2.4.2 SOEF

Overview of the Existing SOEF

The SOEF is a temporary OEF located wholly inside the mine levee wall on the southern side of the Open Pit. This facility contains overburden that will be relocated into the WOEF or Open Pit for permanent subaqueous storage upon cessation of mining. Its footprint is located to the southeast of the original McArthur River, on the alluvial floodplains that previously drained into the river (Figure 9).

The SOEF was initially constructed in 2010 and 2011 using approximately 2.8 Mt of alluvial materials mined from the Open Pit (including clays, silts, and sands), to a height of between 6 and 15 m. The crest of the SOEF was kept below that of the mine levee wall to ensure runoff remained inside the mining operations area, with contouring of the top surface to direct runoff water into drains around the Open Pit.

During 2013, approximately 725 kt of NAF material was stockpiled in a 15 m lift on the western end of the SOEF for use in long-term infrastructure projects.

During 2015, overburden emplacement recommenced on the SOEF under the revised waste classification scheme. MS-NAFs was mined from the Open Pit and placed in the SOEF in 10 m to 15 m lifts to a total height of 30 m above the initial lift.

Waste placement activities currently approved for the SOEF relate to the stockpiling of benign materials.

Planned Work

The eastern portion of the SOEF will continue to be used to assemble, disassemble and store mining equipment (Figure 9). This area will also be used to stockpile benign alluvium and soils mined from the Open Pit.

The shape, finish materials and drainage around the SOEF will be reviewed for its effectiveness at directing water to the appropriate water management system. Works to be considered will include reshaping, capping, constructing drains, sumps and chutes and would occur within the mine levee wall.

4.2.4.3 EOEF

The EOEF is planned to be developed to the extents shown on Figure 9.

The footprint of the EOEF is between the mine levee wall and final limit of the Open Pit, and is bound by NC1A in the north and the Woyzbun Quarry in the south. The temporary expansion of the EOEF aims to provide a storage area for both benign and non-benign materials.

The southern half of the footprint is planned to be used to store benign alluvium materials until they are required for use in the OEF construction. Water from the EOEF will be contained in the existing water management system within the mine levee wall. Haul roads will be constructed between the active pit stages and the EOEF.

Low-grade material (assumed to be PAF [HC] for handling purposes) is planned to be stored in the northern portion of the EOEF. The following controls are planned to manage environmental risks associated with non-benign material storage:

- A sloping base will be constructed, directing runoff towards a planned drainage system and the Open Pit. The base layer will be capped with a low permeability CCL (nominally a 0.5 m thick CCL).
- A perimeter surface drainage system that will consist of bunds, geomembrane-lined drains and culverts will be constructed around the footprint, draining to the LGS in the north. This will be lined with a geomembrane to reduce the risk of seepage.
- Any seepage through the water management system base will report to the Open Pit due to the steep hydraulic gradient in this area. The collected water will be managed in the water management system in accordance with the WMP.
- Following the completion of these works, storage of non-benign materials will commence on top of the CCL. The stockpiles are planned to be extended above the height of the mine levee wall and will be sloped and offset to direct runoff to the EOEF water management system.
- Truck compaction will control oxidation of the Low-Grade material, and as such, limited lift heights, advection barriers, and wet season caps are not planned for the EOEF stockpile.

Haul roads within the mine levee wall will continue to be built to connect the Open Pit and the stockpiles, and the mine levee wall will continue to be progressively widened as materials become available.

Dust will be managed in accordance with the Air Quality Management Plan and will likely involve the use of water carts.

Advection barriers are not proposed, however, as outlined in Section 3.4.4.2.2 of the OMP EIS, air and groundwater monitoring will continue and will indicate whether additional environmental controls (such as capping) are required.

The ICE will review the detailed designs and specifications of the foundations, water management and critical controls of the planned facility.

4.3 Processing Activities

4.3.1 Treatment and Ore Processing

4.3.1.1 Ongoing Treatment and Ore Processing

Ore extracted from the Open Pit is hauled to the ROM Ore Stockpile, where it is stockpiled for processing. Processing initially involves three stages of crushing, heavy media separation (for lower grade ore), and grinding through a three-stage primary grinding circuit. Material is then treated through the rougher flotation circuit to produce a rougher concentrate. The rougher concentrate is pumped to precyclones, with the coarse underflow progressing to regrinding and the fine overflow reporting straight to the cleaner circuit.

Fine materials and the finely ground materials from the re-grinding circuit are directed through a cleaner flotation circuit incorporating six cleaning stages to produce bulk zinc-lead concentrate. Some of this concentrate is pumped to the lead oxidative leach (PBOX) circuit for the separation into zinc and lead concentrates. All concentrates are thickened in the dewatering stage prior to pressure filtration. Tailings are also thickened prior to pumping to the TSF.

4.3.1.2 Planned Work

Planned improvements for the PBOX process include the construction of a fourth gas scrubbing unit. This will provide all of the existing leaching tanks with a dedicated gas scrubbing unit, which will allow for a higher production rate of zinc and lead concentrates, while maintaining low gas emissions. Alternate mediums will continue to be tested to identify the most efficient and safe means of gas scrubbing within the PBOX circuit.

A dedicated lead concentrate filter and storage/bagging facility is planned to be constructed, which will be located adjacent to the planned Reagent Mixing Facility. The facility will receive product directly from the existing lead concentrate thickener for dewatering and bagging and the facility will be compliant with the relevant NT Work Health and Safety regulations and acts for Class 6.1 – Dangerous Goods. This project will decouple the dewatering operations of bulk and zinc concentrates from the lead concentrates, preventing product cross contamination, and allow for better control of lead management through improved handling facilities. This will significantly improve lead hygiene to the limited number of workforce personnel that are dedicated to the handling of lead concentrate.

A detailed design is to be prepared for the lead concentrate storage and Reagent Mixing Facility. The facility will include:

- Separate catchments and drainage to divert water away from the reagent and lead filter footprint (minimise volume) where water will either bypass the reagent farm footprint or be pumped back into the Concentrator Runoff Pond (CRP) for general process water use.
- Silt and water catchment capability for the lead filter footprint.
- Individual bund containment areas for the respective reagents.
- Suitably sized, high-density polyethylene (HDPE) lined catchment dam(s) for the reagent footprint outside of the bund areas.
- Overflow from all of the above containments is planned to report to Lake Archer through the existing drainage system. Lake Archer is a HDPE lined dam.

There are no other planned changes to the processing operations.

4.3.2 Concentrate Handling and Storage

4.3.2.1 Ongoing Concentrate Handling and Storage

The concentrate filter cake is transported from the filter building to the mine site concentrate storage shed via a covered conveying system. This shed comprises of five compartments, with a total capacity of 12,000 wet metric tonne with a load-out area. The shed is a completely enclosed facility with roller doors at each end. These doors will only be open when concentrate is being loaded into haul trucks.

Bulk and zinc concentrate is loaded into the trailers using a front-end loader, before it is transported from the Mine to BBLF by road-trains with covered, side-tipping trailers. The road-trains usually have a payload of approximately 120 tonnes. Transportation of concentrate occurs up to 24 hours per day, 7 days per week.

The distance from the Mine to BBLF is approximately 120 km. The road is a two-lane highway, including a section that bypasses the town of Borroloola. Road haulage is undertaken by a contractor.

Lead concentrate is loaded into double lined bulka bags using specially designed bagging equipment and excavator. The bags are then loaded into sealed containers for road transport to Mt Isa or Darwin for export.

Bulk and zinc concentrate may be stored external to the concentrate storage shed in a specific area adjacent to the storage facilities if there are delays in shipping and marketing of the material.

The external concentrate storage area is concrete bunded to allow better control and management of stocks should external storage be required. Dust mitigation measures (e.g. containing the storage with the use of a tarpaulin) are used to manage potential dust issues.

4.3.2.2 Planned Work

The concentrate handling and storage facilities will undergo several improvements in addition to the dedicated lead filter and bagging facility mentioned above.

Upgrades to the existing storage facility at the Mine will be required. This will involve either increasing the size of the shed or improving the storage area outside the concentrate shed storage facility. Dust mitigation and water management measures (e.g. containing the storage with the use of a tarpaulin) will be used to manage potential dust from concentrate stored externally and any runoff from this area would report to the water management system.

A detailed design of the shed expansion will be completed for the proposed expansion, prior to the developments taking place. Spills in the expanded concentrate storage shed will continue to be managed consistent with existing methods. Water from the areas outside of the shed and proposed expansion are contained with the Mill water management system and will continue to report to the CRP.

The expanded concentrate shed storage facility will remain within the catchment for the Mill, and any runoff would be managed consistent with the current water management system.

4.3.3 Reagent, Chemical and Water Requirements

A number of reagents that are specific to the flotation process will continue to be used, including:

- Frother – methyl isobutyl carbinol (MIBC) – to maintain stable flotation froths;
- Activator – copper sulphate pentahydrate – enables flotation of the sphalerite (zinc sulphide) relative to the unwanted gangue minerals;
- Activator – copper mud – copper bearing by-product from refining used as a substitute for copper sulphate pentahydrate;

- Collector – sodium isopropyl xanthate and sodium ethyl xanthate – to make the wanted minerals hydrophobic so that they attach to the air bubbles in the flotation pulps and float to the surface for collection;
- Depressant – naphthalene sulphonate and dextrin – to depress the flotation of pyrite and carbonaceous material;
- Flocculent – to aid the solids settling rates in the concentrate and tailings thickeners;
- Ferrosilicon – used in the Heavy Medium Plant, adjusts the density of the separating medium allowing a density separation at 2.5 – 2.8;
- Sulfuric acid – used in the selective oxidation of lead sulphide in the PBOX process;
- Na_2CO_3/NaOH – used to scrub H_2S gas from the PBOX process; and
- Antiscale – to slow/inhibit formation of gypsum scale in the plant.

Most of the reagents are received on-site in a bulk solid form and are then mixed with water to the required concentrations for use in the process, with the exception of MIBC and sulfuric acid, which are received and used in neat form. The reagents are stored and mixed in dedicated areas. Occasionally, other reagents may be used as a part of technical trials to enhance the performance of the process.

4.3.3.1 Planned Work

MRM plan to introduce NaOH (caustic) as a scrubbing medium for the PBOX process to replace Na_2CO_3) (soda ash). This will include a dedicated storage tank for high concentration NaOH (50%) and dedicated storage for low concentration NaOH (~2%), which is fed directly into the gas scrubbers. Trials in 2019 concluded that sodium hydroxide is significantly more efficient at removing H_2S gas from the system by converting H_2S to sodium hydrosulfide (NaSH). Research shows that H_2S is more soluble in NaOH form rather than in Na_2CO_3, by a factor of about 2 in the pressure ranges in the scrubber, and the reaction between NaOH and H_2S in solution to form NaSH is a much faster and favourable reaction than with Na_2CO_3. The spent liquid from the caustic scrubbers containing dissolved NaHS and spent NaOH is blended with the final tail slurry and transferred to the TSF.

Copper mud will also be introduced as a substitute for copper sulphate pentahydrate. Copper mud is a by-product of the refining processes. The material will be leached to extract copper into solution where it will be used in the same way as the existing copper sulphate pentahydrate. A dedicated copper mud leaching facility is proposed to be constructed. There would be negligible change in risk to the environment as a result of this substitution.

Reagent Mixing Facility

The construction of a reagent mixing facility is planned and will provide a dedicated, centralised location for the storage, mixing and distribution of various reagents and chemicals currently in use at the Mine. A key driver for establishing this facility is to reduce pedestrian-heavy vehicle interaction that occurs when unloading reagent road trains at the current the concentrator workspace. The facility will also provide a location for the construction of a reagent mixing plant in the future.

The proposed reagent mixing facility and the lead filter infrastructure will be located in an existing disturbed footprint, immediately east of the Concentrator, adjacent to the power stations. Existing infrastructure will be removed to allow for the facility to be constructed. The facility location will cover a nominal area of 3 ha and is to be positioned on two levels.

The facility will be profiled to manage surface water and clay and HDPE lined containment will be established to capture surface runoff that will be exposed to chemicals and reagents. Individual reagent mixing plants will be contained with separate concrete bunds. Water captured within the reagent mixing facility footprint will either be reused within the respective mixing facility or directed to the Concentrator for integration with the main plant process water system.

Electrical infrastructure will be constructed to supply electricity from the existing power station. The infrastructure will consist of new transformers, switch rooms and cable tray routes to provide electrical and utility services for the new installations.

The storage facility will consist of dome structures or purpose-built steel sheds. The positioning of the storage sheds to the east will reduce safety risks associated with unloading of road trains using heavy forklift equipment as there is a low level of pedestrian-heavy vehicle interaction at the proposed location.

The existing reagents that are proposed to be transitioned to the new facility include xanthate, copper sulphate/copper oxide, caustic and soda ash. The xanthate mixing facility will be designed and constructed in accordance with relevant Major Hazard Facility requirements under the:

- *Work Health and Safety (National Uniform Legislation) Act 2011;* and
- *Work Health and Safety (National Uniform Legislation) Regulations 2011.*

The facility design will incorporate electrical redundancy and physical space for reagent mixing capacity.

Annual summaries of the actual versus estimated processing throughputs will continue to be provided in MRM's annual OPR.

4.4 Tailings Storage Facility

4.4.1 Tailings Storage Facility Description

The TSF is divided into three cells - Cell 1, (52 ha), Cell 2 (138 ha) and the Water Management Dam (WMD) (122 ha), previously referred to as Cell 3 (Figure 16). The total combined area of the TSF is 312 ha. The Cell 2 area is currently being utilised for tailings deposition. Tailings deposition into Cell 1 recommenced in late 2019 following completion of the Cell 1 Stage 4 lift construction.

Tailings are transferred from the tailings thickener circuit to the TSF via a pipeline that runs along the main access road between the two facilities.

Tailings are deposited using a spigot discharge system around the cell perimeter. The tailings are deposited sub-aerially in thin layers to maximise the density of the tailings beach against the embankment. The perimeter spigot discharge system also maintains an appropriate level of saturation/moisture within the tailings beach during the cycling between spigots. This limits the potential for oxidation of tailings that could generate sulphates/acidic water.

The sub-aerial beach achieves relatively high strength tailings adjacent to the perimeter embankment that allows for the further increase in the TSF capacity using upstream lifting with each embankment raise supported directly on the tailings. This approach allows for continued tailings deposition without the need to significantly increase the footprint of the facility.

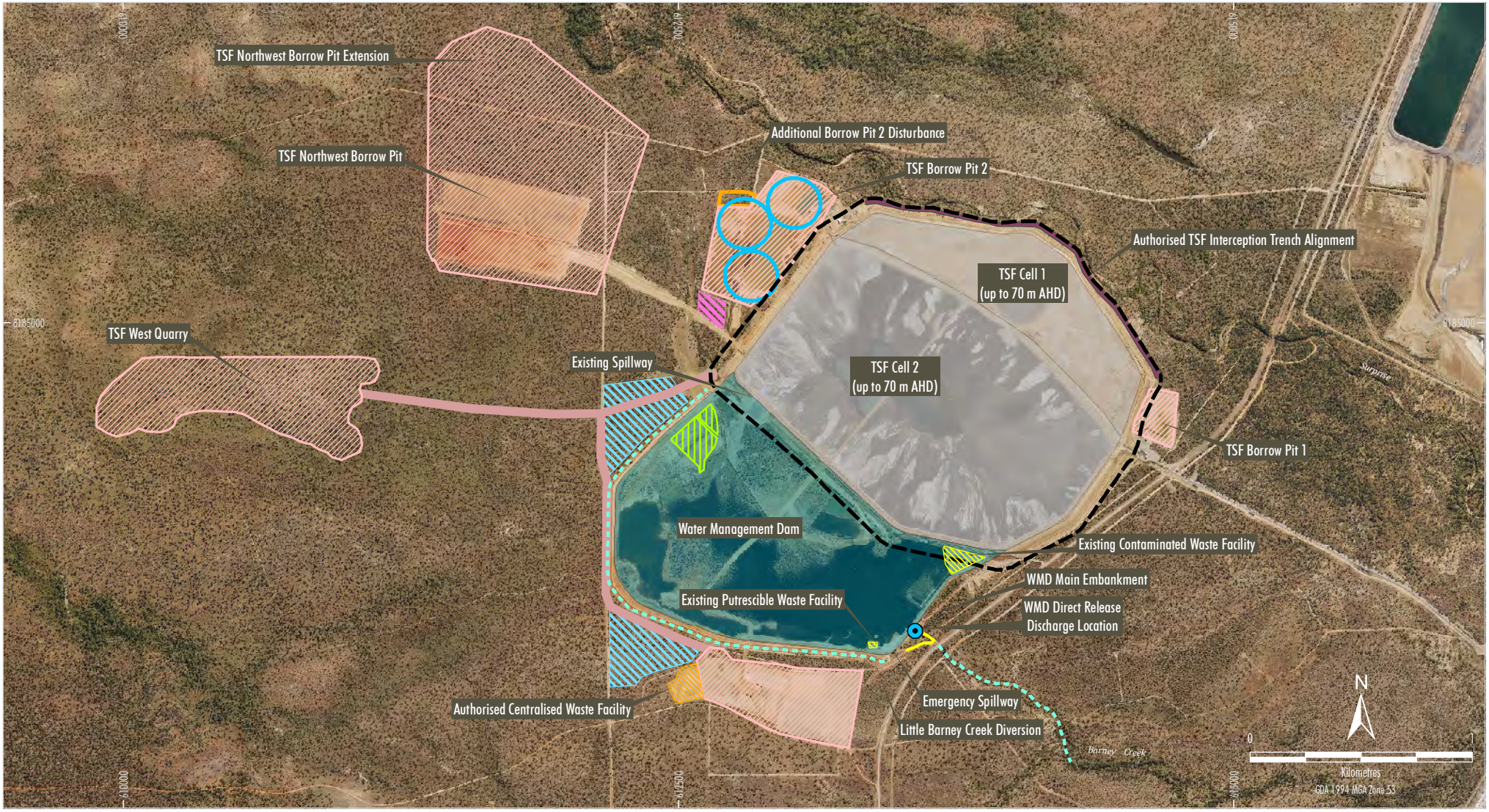
Both TSF cells are designed to contain a 1:100, 72 hour AEP flood event. Emergency spillways have been designed to discharge flows above the 1:100 event, up to 1:100,000 AEP events.

The WMD contains treated mine water for discharge via the WMD Release Point in accordance with MRM's VOA 0059 or via the Mine Levee Discharge Point in accordance with the WDL. In an extreme rainfall event above the design capacity of the TSF, release to the environment from the WMD will be via the emergency spillway, which is excavated into the southern abutment of the WMD and founded within surface soils/extremely weathered bedrock. This WMD spillway discharges into the Little Barney Creek Diversion.

4.4.2 Life of Mine Plan

A LOM Plan for the TSF (TSF LOM Plan) (GHD, 2017) is provided in Appendix I of the Supplementary OMP EIS and presents the preferred design of the TSF over the life of the facility, which includes the following:

- removal of TSF Cells 3 and 4 approved under the Phase 3 EIS;
- recommissioning of the partially capped TSF Cell 1;
- adoption of a combined Cell 1/2 over time; and
- rehandling and reprocessing of tailings prior to disposal in the Open Pit upon cessation of Open Pit mining.



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LEGEND

- TSF Cells 1 and 2
- Water Management Dam
- Woodland Irrigation
- Evaporators
- Additional Borrow Pit 1 Disturbance
- Bioreactors
- Phytoremediation Trial
- Little Barney Creek Diversion
- Little Barney Erosion Works
- Indicative Extent of Borrow Pit/Quarry Development
- Proposed Haul Road
- TSF Buttress Extent
- TSF Interception Trench Alignment
- Authorised Centralised Waste Facility

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

McARTHUR RIVER MINE

Tailings Storage Facility General Arrangement

Figure 16

The TSF LOM Plan outlines the Observational Approach and ongoing Dam Safety Program, for monitoring and measuring the safe and environmentally responsible management of the TSF throughout its full life cycle. It presents the proposed TSF design in terms of:

- design standards and criteria;
- TSF Consequence Category Assessment (under ANCOLD, 2012);
- Observational Approach philosophy, identification of TSF Critical Operating Parameters and ongoing dam safety management;
- tailings geochemistry and management of AMD and NMD;
- detailed consideration of the TSF embankment geotechnical stability at various stages, tailings beach and decant water management, spillway, construction materials and groundwater seepage interception;
- planning for the transition to a combined Cell 1/2 operation;
- TSF closure and rehabilitation;
- risk assessment and dam failure planning; and
- ongoing works program.

The TSF LOM Plan does not include detailed designs of individual TSF cell raises, which will be carried out according to the conditions of VOA 0059 and the proposed observational approach in accordance with ANCOLD (2012), overseen by the ICE and reviewed by the Independent Tailings Review Board (ITRB) (or equivalent body).

More detailed information about the design and proposed Observational Approach and ongoing Dam Safety Program is presented in the TSF LOM Plan (GHD, 2017). The indicative staged plans for the TSF showing proposed lifts for the LOM are provided in Appendix A of the TSF LOM Plan (GHD, 2017).

The ITRB has endorsed the TSF LOM Plan (ITRB, 2018).

4.4.3 TSF Raising Design and Construction Document

A General Specification for Design and Construction Document (herein referred to as the Design and Construction Document) is included as Appendix I and provides:

- an overview of the TSF design standards and philosophy;
- concept embankment design;
- general specifications for civil earthworks, foundation preparation, spillway modification and associated works;
- hold points and QA/QC requirements; and
- monitoring and reporting requirements.

The design methodology and construction of each TSF raise will continue to remain generally consistent with the Design and Construction Document.

4.4.4 Planned TSF Cell Lifts

4.4.4.1 TSF Design Philosophy

The TSF is progressively raised to provide sufficient capacity to accommodate the forecasted tailings production, plus an allowance for minimum beach freeboard.

The following points define the general design philosophy for the ongoing management of the TSF (Appendix H):

- Reduce seepage from the TSF by maintaining a small decant pond, and through optimised tailings management to remove surface water (by evaporation). This also assists in controlling pore water pressures in the tailings adjacent to the perimeter embankments.
- Achieving and maintaining consistent target tailings density by managing tailings deposition, ponded water and tailings drainage.
- Maintain a uniform beach profile around the TSF to consistently provide the design stormwater storage capacity.
- Maintain beach freeboard (and therefore reduce piping risk). This will be achieved by progressively raising the emergency spillway to match the tailings rate of rise. Therefore, at all times, the spillway level will remain below the minimum tailings beach level.

4.4.4.2 Planned Cell Lifts

The TSF final planned height is 10,078 mRL, as described in the TSF LOM Plan. An indicative raise schedule for the TSF is provided in Table 10 below (Figure 16).

The planned lifts are generally consistent with the TSF LOM Plan. The design methodology and protocols will remain consistent with the TSF LOM Plan and the Design and Construction Document.

The nominal raise heights provided in Table 10 may be subject to change, as future production schedules may change; in addition, any future changes in the tailings slurry density may affect the storage capacity and/or the achieved tailings beaching angles. The final raise heights will be determined during the process of detailed design.

A 50 m wide spillway with filter and buttress embankment protection was constructed at the western end of the Cell 2 southern embankment as part of the 2017 Stage 4 raise (Figure 16). This will be the location of the spillway for the LOM, with the spillway crest being progressively raised as the tailings level increases.

Any seepage flows observed at the TSF will continue to be managed through visual inspection, collection, daily monitoring of flow rates and pumped back to the storage area.

The final design and construction of each TSF raise will be in accordance with a detailed design, to be endorsed by the ITRB, and submitted to DPIR prior to the commencement of the raise. The detailed designs will include finalised raise heights, embankment geometry and earth fill zones, and the extent of buttressing requirements. Detailed designs will be prepared with reference to the TSF LOM Plan, using the Observational Approach for monitoring and measuring the safe and environmentally responsible management of the TSF. The detailed designs would also be supported by further detailed risk assessment.

The Operations, Maintenance and Surveillance Manual for the TSF will be updated annually, and following completion of construction programs.

All scheduled raises will be constructed in accordance with detailed designs, which will be subject to ITRB endorsement.

TABLE 10 – PLANNED TSF CELL LIFTS

Activity	Indicative Raise Height (nominal RL in metres)	Description
TSF Cell 2 Raise 6 (approved / endorsed by ITRB)	10,061.0	Construction continuation in accordance with the previously approved detailed design.
TSF Cell 1 Raise 5	10,059.0	3.0 m upstream raise of Cell 1. The raise may include expansion of the TSF footprint due to buttressing. Cell 1 will be the primary TSF until Cell 1 and Cell 2 are joined in 2021.
TSF Cell 1 Raise 6	10,061.5	1.5 m upstream raise of Cell 1, may include buttressing.
TSF Cell 2 Raise 7	10,061.5	0.5 raise to Cell 2. Required for maintaining the beach saturation and reducing the rate of rise in Cell 1 during transition from two cells to one.
Combined TSF Raise 1	10,062.6	1.1 m raise to the combined TSF. The decant ponds will have transitioned to a single, centrally located pond.
Combined TSF Raise 2	10,063.8	1.2 m raise to the combined TSF.
Combined TSF Raise 3	10,065.0	
Combined TSF Raise 4	10,066.2	
Combined TSF Raise 5	10,067.4	
Combined TSF Raise 6	10,068.6	
Combined TSF Raise 7	10,069.8	
Combined TSF Raise 8	10,071.0	
Combined TSF Raise 9	10,072.2	
Combined TSF Raise 10	10,073.4	
Combined TSF Raise 11	10,074.6	
Combined TSF Raise 12	10,075.8	
Combined TSF Raise 13	10,077.0	
Combined TSF Raise 14	10,078.0	1.0 m raise to the combined TSF.

4.4.4.3 Extents of TSF Footprint

At the time of writing, the proposed footprint for the TSF is anticipated to be slightly larger than the footprint proposed in the OMP EIS, due to additional buttressing requirements (Figure 16). The footprint will only be expanded to allow for buttressing required for stability, and will consist of benign material. A full assessment of the environmental risk associated with the footprint, including assessment against MRM's Fatal Hazard Protocol 14 (Glencore, 2019), will be provided in the detailed designs. Footprints provided in the OMP EIS and the MMP are conceptual, and may be revised subject to the detailed design and subsequent ITRB endorsement.

4.4.5 TSF Interception Trench

The TSF Interception Trench is currently being constructed between the TSF Cell 1 and the adjacent Surprise Creek, to capture seepage from the TSF, and to minimise this seepage from reporting to Surprise Creek via the groundwater system (Figure 16).

Construction of the TSF Interception Trench will involve the excavation of a deep trench to below the invert level of Surprise Creek. At the base of the excavation, a gravel-filled trench with slotted pipes will be installed and connected to a series of sumps, with penstock valves to allow control of the water level in the various drain sections. Pressure relief wells drilled at nominal 10 m intervals have been specified along the full length of the trench.

All works will be overseen and certified by the ICE in accordance with the requirements of the current VOA 0059.

4.4.6 Tailings Line Management

The tailings line comprises two main sections being HDPE and rubber lined steel sections from the processing plant to the TSF, a distance of 2.7 km, which then connects to the ring mains that runs around the TSF, a distance of 4.5 km on Cell 2 and 2.2 km on Cell 1. An all-weather access road follows the full extent of the pipeline route to allow for monitoring, inspection and maintenance.

The tailings system is inspected on a daily basis with two persons dedicated to the operation of the line and associated facilities. Flowmeters at the start and end of the rubber lined steel section provides early warning of any pipe rupture as well as pressure indicators. A rupture disc has been installed at the start of the HDPE section to protect the main system in the event of blockage.

Non-destructive thickness testing of the pipeline and the steel shroud around the pipeline at the Surprise Creek crossing occurs each year to monitor pipe wear. The expansion joints are also checked and reset as required. It is anticipated that parts of the tailings line and/or pumps may require maintenance or replacement. The HDPE section is planned to be replaced with rubber steel lined sections. Any associated works will either reinstate or upgrade the system from its current specification for continued protection of the surrounding environment. Any replacement tailings lines will be appropriately sized for the pumping capacity.

An existing plastic lined collection pond is located at the low point of the pipe line system to allow for drainage and collection of any material held in the pipe during periods of maintenance, repair or upgrade. Any water and materials collected will be transferred to the TSF for disposal.

Tailings line management will continue as per the existing operational management approach. No changes to the footprint of the existing tailings line will be required.

4.4.7 TSF Borrow Pits, Quarries and Stockpile Areas

The following existing borrow areas are currently utilised in TSF construction activities (Figure 16):

- Northwest Borrow Area, used to source low permeability clay; and
- South Rock Quarry, used to source weathered general earthfill, along with rockfill.

Borrow areas are progressively developed as required, with topsoil separated and stockpiled for future rehabilitation. Up-catchment diversion drains are constructed around the perimeter of the borrow areas as required, to divert clean water around disturbed areas.

Existing activities and features at the TSF, including but not limited to borrow pits, quarries and stockpile areas are shown on Figure 16.

MRM will continue to use the existing borrow pit / rock quarry areas, and further develop the northwest Borrow Pit as required.

A new borrow area, the TSF West Rock Quarry, will be developed along with an access road. This will be used for general earthfill and rockfill, for future embankment and buttress construction.

The following is planned to be developed, with indicative extents of borrow pits, and haul roads provided in Figure 16:

- The TSF Northwest Borrow Pit will be expanded further to the north and east of the current borrow location.
- The TSF West Rock Quarry is planned to be commissioned to support ongoing raises of the TSF.
- Associated haul roads for the TSF Northwest Borrow Pit and the TSF South Rock Quarry will be maintained and a new haul road will be constructed to the TSF West Rock Quarry.

Up-catchment diversion drains would continue to be constructed around the perimeter of the borrow areas as required, to divert clean water around disturbed areas. Sediment control infrastructure, such as drains, retention ponds and fences, will be constructed as required in construction areas prior to passive discharge.

4.4.8 Geotechnical and Geochemical Investigations

MRM plan to undertake geotechnical investigations in 2020 to review and confirm the sources of benign material within the planned borrow pit areas. The investigations will characterise, classify and quantify sources of material within each borrow pit and involve a combination of test pitting and shallow borehole drilling, taking bulk samples for geotechnical and geochemical classification.

All test pits will be reinstated under the supervision of an appropriately qualified geotechnical engineer. Boreholes will be grouted upon completion. Investigations will be completed in accordance with AS 1726: 2017-*Geotechnical site investigations*, and soil testing in accordance with AS 1289: 1991-*Methods of testing soils for engineering purposes*.

As the investigations will be carried out within the proposed borrow pit footprints, the environmental disturbance beyond that which has been accounted for in the Security Bond Assessment calculations is considered to be negligible.

4.5 Water Management System

The water management system at the Mine and the BBLF are continuously reviewed and updated to incorporate the development of mining related areas. These systems have to manage water generated on-site during the pronounced wet and dry seasons, in addition to significant rainfall variations from year-to-year. This means that the water management system should be capable of accommodating distinct seasonal fluctuations and severe shortages and surpluses of water over the LOM.

A summary of the Water Management System at the Mine is provided in Section 3 of the WMP (Appendix B of the AMP) and includes the following:

- The current water classification system for the Mine, including six water classes that have been adopted at the Mine.
- A summary of the water management infrastructure at the Mine, including a tabulated summary of the dimensions, type of lining, maximum storage capacity and expected water class for each dam.
- A summary of the Open Pit, MUDS and groundwater bore fields, including approximate dewatering rates.
- A summary of the water management tools at the Mine, including the water balance and water storage TARPs.

Plate 8 of the WMP provides the existing approved Water Management System for the Mine.

A summary of the Water Management System at BBLF is provided in Appendix J – the BBLF Environment Management Plan.

Any amendments to the Water Management System, including the current water classification system will be provided to DPIR via a revised copy of the WMP.

4.5.1 Water Treatment

4.5.1.1 Water Treatment Plant

Construction of the Open Pit reverse osmosis (RO) water treatment plant was completed in August 2018 (Figure 9). The first stage of commissioning was completed in September 2018 with the successful production of permeate. However, the commissioning process highlighted process control issues with the chemical pre-treatment step such as flow rates, sludge removal and dosing, in particular at high throughput when the plant approached production capacity of 6 megalitres per day (ML/d). A partial modification and redesign of the pre-treatment infrastructure was required to fix the process control issues and was undertaken in 2019. Reliability testing will be carried out in January to February 2020, prior to the plant becoming fully operational.

The Open Pit RO water treatment process consists of pH adjustment, oxidation, precipitation, coagulation and clarification for removal of coarse and fine solids, as well as the bulk of the dissolved metals including zinc, lead, iron and manganese. This pre-treatment step is followed by ultra-filtration prior to passing through the RO membranes for removal of major ions and residual dissolved metals.

The plant is expected to operate at a nominal capacity of up to approximately 6 ML/d, producing approximately 4.4 ML/d of RO permeate and approximately 1.6 ML/d of waste. The waste is output in two streams:

1. 0.12 ML/d of clarifier sludge, which is produced by the chemical pre-treatment stage that removes the bulk of the metals by pH adjustment, oxidation, precipitation, coagulation and clarification. The contaminants are present as solids (1.5% weight per weight).
2. 1.5 ML/d of brine, which is produced by the RO membrane and is hypersaline but contains low concentrations of metals.

The management strategies for the water treatment plant output streams include:

- RO permeate:
  - storage in the WMD prior to managed release in accordance with WDL conditions;
  - storage in Open Pit Pond 2 prior to managed release in accordance with WDL conditions; and
  - utilisation in other areas within the lease to offset new water requirements.
- Clarifier sludge:
  - filtration and disposal of the metalliferous solids into the TSF, and transfer of the filtered water into the process water circuit.
- RO Brine:
  - treatment by gypsum precipitation and transfer to the WMD.

Refer to Plate 12 of the WMP for the various output streams associated with Open Pit RO Plant (Appendix B of the AMP).

Operation of the Open Pit RO plant will be as required, and will depend on the amount and type of water in the stored water inventory. The Open Pit RO plant is not expected to be operational until final commissioning and reliability testing can be completed. Once testing has been completed, the plant may operate during the wet season months and the first months of the dry season (December to May), depending upon business demands for water and the amount of rainfall experienced over the wet season.

4.5.1.2 In-Dam Lime Treatment

Mine and process water is treated with hydrated lime (calcium hydroxide) to raise the pH and precipitate metal hydroxides as part of existing on-site water management practices. Lime treatment has occurred in SEPROD to date.

A hydrated lime slurry is produced in a mixing plant, which is circulated (dosed) through a dam to raise the pH to a level sufficient to precipitate metals. The treatment method uses the high residency time of the water within the treatment dam to enable the solid waste (primarily gypsum and precipitated metals) to settle within the dam. Comprehensive testing of the supernatant water is carried out, after which it is transferred to the Class 4 managed release circuit for storage and discharged in accordance with the WDL or used to meet other potential end uses. The in-dam lime treatment method has been operating in SEPROD since 2017 and has resulted in significant metal load reductions, in particular for zinc, in the managed water release inventory. The performance of the lime treatment over the period 1 April 2018 to 30 April 2019 is provided in Section 4.2.2.1 of the *McArthur River Mine 2018 – 2019 Operational Performance Report* (the 2018 – 2019 OPR).

MRM will continue to implement lime treatment as part of its water treatment processes. Lime treatment will be undertaken in SEPROD and/or other lined dams as required.

The waste sludge generated by the treatment process will be managed in SEPROD or other lined dams where treatment may be undertaken, and the low volume generated (approximately 500 tonnes per annum) will ultimately be dewatered by filtration and disposed of in the NOEF.

Treated water will continue to be transferred to the WMD.

4.5.1.3 Gypsum Plant

A Gypsum Plant is planned to be constructed and commissioned for water treatment, in addition to the in-dam lime treatment undertaken at SEPROD (Figure 9).

The Gypsum Plant will be designed to treat high sulfate return water from the concentrator leach circuit as well as brine from the Open Pit RO water treatment plant. It is based on a conventional lime treatment plant with pH adjustment, precipitation, coagulation, clarification and filtration stages to produce a treated effluent and a solid waste. It will use calcium hydroxide to remove dissolved metals and reduce sulfate from approximately 20,000 milligrams per litre (mg/L) to potentially 2,500 mg/L. The use of additional reagents, such as barium and aluminium, to further optimise the treatment process will also be investigated.

The Gypsum Plant is expected to operate at a nominal capacity of up to 4.8 ML/d. The Gypsum Plant will consist of the following:

- A lime slacking circuit to generate calcium hydroxide from quicklime. All insoluble residues from the quicklime, such as unreacted Calcium Oxide, silicates, will be added to the solid gypsum stream for co-disposal in the TSF or NOEF.
- A precipitation circuit containing 4 agitated tanks, a thickener or clarifier.
- A dewatering stage containing either a filter or some other mechanical process to dewater the solid waste stream.
- Lime silos to store the quicklime.
- Several small reagent mixing tanks to allow trial reagents and flocculant to be mixed for immediate use in the gypsum circuit.
- Water storage header tanks to allow mixing and slaking.

The circuit will be bunded and have multiple spill pumps to allow all waters to be directed to the mill process water circuit in the event of rain or when tanks are offline due to maintenance. The location of the gypsum plant is inside the mine levee wall, with the wider footprint having run-off reporting to the Open Pit, forming part of the water management system.

A conceptual engineering study is currently being carried out for the Gypsum Plant. A detailed design will then be completed prior to the plant being constructed and becoming operational.

The treated water is expected to have a residual pH of 10.0 to 10.5, and will be transferred to SEPROD where it will be blended with mine waters to reduce the pH to 8.5. This water will either be transferred to the WMD or will be used as water supply for the Mill.

The waste gypsum and precipitated metal sludge will be dewatered and geochemical investigations will be undertaken to determine the best location for long-term disposal. It is anticipated that the solid waste will be disposed of as a solid in either the TSF or a dedicated NOEF PAF cell.

The proposed footprint for the plant is 1.5 ha and will be limited to existing disturbed areas.

4.5.1.4 Sulfate Treatment System

MRM will continue to investigate the use of sulfate reduction bioreactors for the treatment of metals, sulphate and nitrate in mine waters (Figure 16). The investigations will determine whether the bioreactors could be used as a secondary polishing stage for lime treated water, prior to disposal either through evaporation, irrigation or managed release in accordance with WDL and VOA 0059 requirements.

Two principal methods are planned to be investigated by MRM:

1. **Passive engineered wetland treatment:** Investigate the existing pilot scale bioreactor located within the footprint of the WMD. High sulfate (>2,500 mg/L) pH neutral waters are circulated in a series of artificial ponds where the growth of sulfate reducing bacteria is promoted through the addition of organic carbon. A metal oxide is added to the water to promote the conversion of metal oxides to sulphides by reaction with the H_2S produced by the bacteria, removing both dissolved metals and sulfate from the water. The aim of the pilot study is to investigate the feasibility of converting part of the existing WMD footprint into a polishing wetland prior to storing managed release waters for disposal or evaporation.

2. **Active Bioreactor:** Evaluate the design and construction of a small scale pilot bioreactor plant. The plant will use bioreactor vessels (tanks) containing sulfate reducing bacteria (as opposed to passive artificial open ponds) and will enable full control of the treatment process, by regulating the flow of water and the amount of artificial growth media in the system. The aim of the pilot plant is to determine the cost effectiveness and efficiency of a bioreactor plant compared to an engineered wetland.

These systems are pilot scale only, and as such, the risks associated with these activities are expected to be negligible. Implementation of large-scale systems will be subject to detailed designs, and will include a robust environmental risk assessment, which will provide suitable environmental controls. The detailed design will be submitted to DPIR prior to the implementation of these large-scale systems.

No additional disturbances or clearing activities will be required for either projects as they will be conducted within the footprint of existing disturbed areas. The proposed sulfate reduction bioreactors are planned to be located within the WMD catchment.

4.5.1.5 Additional Centre Pivot Irrigators

Additional centre pivot irrigators (up to three) are planned to be constructed adjacent to the TSF and within existing disturbed borrow pits, where possible (Figure 16). The irrigators will cover an approximate area of 11.4 ha. Approximately 1 ha is proposed to be cleared to support the development of the irrigators.

The footprints for the irrigators will be designed to manage and control all surface runoff from the evaporators in accordance with the MRM water classification system, including conveyance to the WMD. The footprints will be constructed to minimise the risk of infiltration, noting that under normal operating conditions, pooling and infiltration of water within the footprint should not occur. The perimeter of the irrigator footprint will be bunded to keep external water out.

Operators will have the ability to adjust the pivot speed and application rates to match ambient environmental conditions and operation will be suspended if significant pooling/surface runoff is observed and during periods of heavy rainfall. In addition, the system will be designed with a number of operating rules to reduce the occurrence of surface runoff, including:

- operators have the ability to adjust the pivot speed and application rates to match ambient environmental conditions;
- operation during daylight hours only;
- match daily application rates with daily evaporation rates;
- routine inspection by operators;
- operation suspended if significant pooling/surface runoff is observed; and
- operation suspended during periods of heavy rainfall.

Any pooled water will be pumped to a nearby suitable water storage and any surface water runoff would report to the WMD.

The system is designed to dispose of up to 960 kL per day of Class 2 or Class 4a, or better water per evaporator, with final disposal volumes dependent on ambient evapotranspiration rates. The application rate is adjusted based on delivery system pressure and evaporation rates so that it does not generate seepage under normal operating conditions.

The purpose of the centre pivot irrigators is to reduce the volume of water stored on-site.

4.5.2 Future Water Storage Infrastructure

The OMP EIS proposed the construction of a new 4 gigalitre (GL) Process Water Dam and a 2 GL WMD within the existing WMD footprint. This MMP does not propose the construction of these new dams.

Planned works will focus on environmental, engineering and geotechnical investigations as well as conceptual designs for new storage dam requirements, including an additional storage dam to store process water in the dry season.

In addition to the storages listed in Condition 37a of the VOA 0059 dated 15 August 2019, the following storages will be used to store potential AMD-water:

- NES (North East sump) – sump planned to be constructed in the eastern portion of the NE stage.
- NWS (North West sump) – sump planned to be constructed in the western portion of the NE stage.
- NESB (North East stilling basin) – stilling basin planned to be constructed immediately north of EPROD.
- CEAS (Central East Alpha sump) – planned to be constructed in the central SE stage.
- CEBS – planned to be lined in future to store AMD-water.
- SOEF Sump – planned to be upgraded to store runoff from the northern side of the SOEF up to a 20% AEP.
- LGS (Low-grade sump) – planned to be constructed to service the EOEF.

- RPP (Rice paddies pond) – planned to be constructed to capture potential runoff generated by the Centre Pivot Irrigator.

For NOEF storages, the final location and specific design criteria for each water storage will be subject to the detailed designs and ICE review prepared for each stage of the NOEF.

4.5.3 Irrigation of Treated Water

MRM proposes to investigate the use of alternative methods of irrigation to dispose of treated water. The aim of the investigations is to decrease the long-term reliance on waste discharge in accordance with the WDL and VOA by developing alternative strategies to dispose of excess water. The following two methods will be investigated:

- **Open woodland irrigation:** This will involve the irrigation of a designated section of on-lease natural woodland with treated water. The aim is to sustainably dispose of stored water of sufficient quality to reduce the amount of stored water in MRM's site water inventory. Water applied to these areas will be of high quality (Class 2) to reduce the risk of increasing salinity and metal concentrations in soils at the application site.

- **Phytoremediation:** MRM proposes to investigate the use of high metal uptake crops to effectively dispose of treated water (Class 2) by irrigation. The biomass produced would be harvested and used as a source material to supply to the passive and active bioreactors.

The irrigation application rate will be monitored and controlled to minimise surface water runoff from the irrigation. The application rate will be adjusted to suit ambient environmental conditions and operation will be suspended if significant pooling/surface water runoff is observed and during periods of heavy rainfall. Routine inspections will be carried out during operations to determine whether the application rate needs to be adjusted.

Approximately 1.3 ha of clearing will be required for the phytoremediation investigation, which is located to the west of the TSF Cell 2. The footprint for the phytoremediation trial will be designed to manage and control all surface water runoff in accordance with the MRM water classification system, including conveyance to the WMD.

Routine monitoring will be undertaken in the application area to determine whether the activity results in any environmental impacts to the immediate area.

Water quality monitoring will consist of weekly water sampling and analysis of both irrigated water and any surface runoff/pooling (should it occur) including pH, electrical conductivity, total dissolved solids, alkalinity, total acidity (calculated) and elemental content on both filtered and total fractions, as per MRM's artificial water monitoring protocol.

Daily visual inspections will be conducted by MRM personnel when irrigating to prevent pooling of irrigated water. In the case that irrigation rates exceed evaporation, the supply of irrigated water will be adjusted so as to prevent surface water runoff from the facility.

These projects are currently in their conceptual phase. Initial feasibility studies and environmental risk assessments will be undertaken in 2020 to determine surface area requirements, efficiency of this method, any additional environmental risks, suitable controls and cost implications. Should the initial studies identify that these projects are feasible, small pilot scale trial areas are proposed to be carried out. If the pilot trials are successful, full implementation would be expected to be developed shortly thereafter. Figure 16 shows the areas proposed for the pilot scale trials, which are located to the north and west of the TSF.

4.5.4 Widening / Stabilisation of the Little Barney Creek

4.5.4.1 Little Barney Creek Diversion

MRM plans to undertake remedial works on the Little Barney Creek Diversion. The works will consist of reshaping and widening the diversion to accommodate additional storm water flow and more effectively channel surface waters away from the western WMD wall. The works are necessary to improve the geotechnical stability of the wall and minimise the inflow of external water into the WMD. The remedial works will also remove the build-up of silt run-off that has accumulated in the channel over consecutive wet seasons. Silt will be disposed of in the TSF material stockpiles and active borrow pits for reuse in the construction of the TSF.

The area that will be targeted for remediation is shown on Figure 16. A nominal 10 m wide area may need to be cleared to support the remedial works, which could result in clearing of up to 2.4 ha.

4.5.4.2 Little Barney Creek

MRM will investigate erosion prevention and management options for sections of the Little Barney Creek, located downstream of the WMD release siphons, and undertake earthworks if required. A geomorphological and hydrological assessment will be undertaken prior to carrying out any earthworks. The aim of the project is to enable safe rapid discharge of water from the WMD siphons without compromising the stability of the Little Barney Creek channel. The proposed project area is shown on Figure 16.

4.5.5 Phytoremediation

MRM plans to investigate the use of vegetation for reducing the local water table elevation in the vicinity of the NOEF. The project consists of planting suitable species of trees in the vicinity of the NOEF to lower the water table to below the base of nearby creeks. This may reduce the groundwater/surface water interactions over the long-term.

The area for the project is shown in Figure 17 and is located between the NOEF and the Barney Creek Diversion Channel and Surprise Creek.

The irrigation application rate will be monitored and controlled to minimise surface water runoff from irrigation and minimise percolation to the water table. Routine inspections will be carried out during operation.

A desktop study including potential species selection, required density and surface area, distance from the creek and an environmental risk assessment will be conducted in 2020-2021. Pending the results of the study, implementation is expected for 2022 onwards.

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LEGEND
Indicative Extent of Overburden Management Project Surface Development
Potential Phytoremediation Areas

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

McARTHUR RIVER MINE

Proposed Potential Phytoremediation of Groundwater Areas

Figure 17

4.6 Bing Bong Loading Facility

The BBLF is located within MLN 1126 (Figure 3). The operations at the BBLF consists of the following:

- The receipt and unloading of product from road transport into the concentrate storage shed.
- A concentrate storage shed for storing bulk and zinc concentrate delivered from the Mine.
- The stockpile is controlled and maintained using front-end loaders to move the concentrate away from the truck discharging area to the rear of the shed bays.
- An enclosed conveyor system, which carries the bulk and zinc concentrate from the storage shed to the wharf and the ship-loading conveyor. The concentrate is loaded onto the bulk carrier (the Aburri) via a single shore-mounted loading chute.
- The Swing Basin and Dredge Channel, which provides access for the Aburri and other vessels for operational purposes. Maintenance (dredging) of the swing basin is carried out approximately every four years.
- Disengaging of the Aburri from its moorings, and shuttling of the Aburri through a dredged channel to an ocean-going vessel waiting in the designated offshore transfer zone.
- Securing of the Aburri to the ocean-going vessel and positioning of the loading boom discharge point in the centre of the nominated hatch with the chute below the hatch coaming. Unloading to an off-shore, ocean-going vessel.
- The purpose built accommodation camp and associated site infrastructure.
- Water management infrastructure, including:
    - Surface Runoff Pond (SRP) 1 that collects runoff from the industrial area around the BBLF and return water from the truck wash;
    - two overflow ponds (SRP2) and (SRP3) that collects water pumped from SRP1;
    - two water collection sumps, one of which is located at the entrance on the western side of the site and the other on the dock on the northern side of the site, that collect surface runoff that is pumped back to SRP1;
    - two 1,137 litre tanks located on the Aburri that are pumped into the SRP1 via the dock sump; and
    - rainwater tanks that collect runoff from the concentrator shed.

Replacement of the existing water supply bores may be required to ensure continuous raw water supply at the BBLF. Investigations to determine a suitable location for the replacement bore will focus on the area around the current water supply bore, which is located approximately 20 km south (inland and up gradient) from BBLF.

In addition, it is proposed to install 2-3 monitoring bore locations up gradient from the BBLF. These additional monitoring bores are required to improve the resolution for characterising background groundwater quality at the BBLF.

New drill pads, access tracks and sumps will be required if the proposed drilling is undertaken, resulting in minor disturbances in the area south of BBLF. All drilling works will be undertaken in accordance with the requirements of relevant approvals and MRM Permit to Clear procedures (Appendix D). Water supply and water monitoring bores will be constructed according to the *Minimum Construction Criteria for Water Bores in Australia* (NUDLC, 2012). Following completion of the drilling programs and prior to the forthcoming wet season, all work areas will be rehabilitated. Compacted ground will be ripped, with stockpiled topsoil and vegetation re-spread over the site.

The proposed works will result in approximately 0.75 ha of new disturbance south of BBLF.

Dredging may be required within the next 5 years to sustain the transhipment of concentrates. The timing will be informed by further surveys. Prior to commencing any dredging works, MRM will prepare and submit a Dredging and Dredge Spoil Management Plan, in accordance with its regulatory requirements under its Waste Discharge Licence. The Dredging and Dredge Spoil Management Plan will be provided to DPIR prior to commencing any dredging works.

The management plan will identify key environmental risks associated with the activity and provide appropriate environmental controls to mitigate the risks.

4.7 Mine Camp Accommodation

MRM accommodates all of its employees in a purpose built accommodation village at the Mine. The accommodation village has a capacity of approximately 564 beds, ranging from multi-room houses to demountable buildings with multiple adjacent rooms.

The Mine peak workforce is estimated at approximately 1,020 people. The current camp will be upgraded to accommodate a further 104 rooms. The camp upgrades will occur within existing disturbance and contained catchment areas.

The existing gas-fired power plant has a total generating capacity of 54 megawatts per annum, which will provide sufficient power for the life of mine. Power is supplied to the accommodation village via overhead powerlines to the village substation. The existing overhead powerlines will be upgraded to underground high voltage lines as part of the site wide electrical infrastructure project. No disturbance will be required as part of these upgrades.

The sewage plant at the accommodation village is a four stage system involving treatment with bacteria, aeration, chemical treatment and the removal of solids. A replacement treatment plant will be installed to improve performance of the quality and quantity of by-products from this process (i.e. minimised sludge creation and grey water output). There will be no increase in capacity of the sewerage plant and no clearing would be required.

Other minor maintenance and upgrades will continue to be carried out to the Mine camp accommodation infrastructure and services as required.

4.8 Development of Detailed Designs

This MMP generally presents conceptual designs for the proposed works. Conceptual designs for the NOEF have been used to identify and assess environmental risks and mitigation measures, as described in Section 5.

Detailed designs will be prepared, and where applicable endorsed by the ICE and ITRB, for the various activities described in Section 4.

The detailed design reports will, at a minimum:

- provide design criteria and specifications (e.g. geochemical, geotechnical) to adequately meet relevant engineering and regulatory standards;
- provide detailed design engineering drawings;
- outline the proposed construction methodology;
- identify relevant responsibilities, accountabilities, consultation and information requirements for the design, construction and ongoing operation;
- outline sampling, testing and surveying requirements;
- outline construction hold points and witness/inspection requirements; and
- outline QA/QC requirements for the construction and ongoing operation.

An example Responsible, Accountable, Consulted and Informed (RACI) table that would be included in the detailed design reports is included in Appendix K. Detailed designs, and where applicable, associated endorsement, will be provided to DPIR prior to construction.

5 Environmental Management

MRM operates consistent with its EMF, which is a group of integrated plans, programs, guidelines, specifications and procedures designed to facilitate the management of environmental impacts and continuously improve environmental performance. The EMF is a proactive approach to environmental management and provides the framework to help MRM achieve its environmental objectives and address various approval requirements in a systematic and sustainable manner. The EMF for the Mine and the BBLF is shown on Plate 2.

5.1 Adaptive Management Plan

The AMP is the overarching document that provides the strategic framework for environmental management, monitoring, mitigation and reporting. The AMP has been prepared in accordance with the NT EPA *Guidance on Adaptive Management* (NT EPA, 2018b) to address the requirements of DPIR's *Mining Management Plan Structure Guide for Mining Operations* (Appendix B).

The AMP facilitates management and decision making over time in response to evolving knowledge, environmental performance, and changing circumstances. The AMP is the overarching document that provides the strategic framework for environmental management, monitoring, mitigation and reporting of environmental performance against the conditions of MRM's approvals. The AMP involves implementing evidence-based management actions; monitoring and evaluating 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).

Management plans and associated monitoring programs provided in the AMP include the:

- WMP, including:
  - Artificial Surface Water Monitoring;
  - Surface Water Monitoring Program;
  - Groundwater Monitoring Program;
  - Fluvial Sediment Monitoring Program; and
  - Freshwater Ecology Monitoring;
- Rehabilitation Management Plan, including the Rehabilitation Monitoring Program; and
- Air Quality Management Plan, including the Air Quality Monitoring Program.

The AMP, and associated sub-plans are provided in Appendix B. Further information on the WMP can be found in Section 6.2 below.

5.2 Environmental Policy

The purpose of Glencore's environmental policy is to provide a consistent and structured approach to the management of environmental matters throughout the Glencore group, to achieve compliance with applicable regulatory requirements and improve environmental performance.

The environmental policy applies to all Glencore commodity departments, assets, operations and projects, as well as to all sites where Glencore has the responsibility to set Health, Safety, Environmental and Community policies and standards.

The intents and verifiable outcomes of Glencore's environmental policy are listed below:

- Senior and line management are accountable for environmental performance.
- Operations, assets and projects comply with applicable environmental regulations and monitor relevant regulations for changes.
- Compliance, risk based management approaches, and resource efficiency determine Glencore's priorities, capability requirements, capital expenditure and controls.
- Improvement plans and target setting at each level of our organisation take the group's focus areas into account, namely:
    1. integrity of Glencore facilities for minimising pollution (e.g. spills, emissions, effluents);
    2. efficient use of resources (e.g. energy, water, land, raw materials, waste);
    3. protected areas and biodiversity; and
    4. closure planning and rehabilitation.
- All environmental incidents are reported and investigated to prevent repeat incidents.

5.3 Environmental Commitments

5.3.1 Key Commitments Contained in this MMP

A summary of the key commitments contained in this MMP, and which environmental issues each commitment relates to, is presented in Appendix L.

5.3.2 Recommendations and Conditions Resulting from Formal Environmental Assessment

Northern Territory Environmental Assessment Act 1982

MRM submitted the Draft OMP EIS in early 2017 and subsequently prepared and submitted a Supplementary OMP EIS in early 2018. The NT EPA released its Assessment Report 86, McArthur River Mine Overburden Management in July 2018 recommending the OMP for approval subject to 30 recommendations. The relevant OMP EIS commitments and NT EPA recommendations have been addressed in this MMP.

A summary of how the OMP EIS commitments, 30 NT EPA recommendations and the key conditions of VOA 0059 have or will be addressed is provided in Appendices M and N.

Environment Protection and Biodiversity Conservation Act 1999

Approval of the Mine was granted under the EPBC Act in 2009 (EPBC Approval 2003/954).

MRM submitted OMP Referral 2014/7210 under the EPBC Act in 2014. The then Department of the Environment determined the proposed action requires EPBC Act approval and would be assessed under a bi-lateral assessment.

In June 2019, Approval 2014/7210 was granted under the EPBC Act by the Department of the Environment and Energy. MRM will operate the Mine consistent with the conditions of all approvals obtained under the EPBC Act, including any requirement to update its Commonwealth Environmental Monitoring Plan.

5.4 Environmental Training and Education

MRM has implemented the following environmental training and education related initiatives:

- Development of specific environmental responsibilities for relevant Managers within Job Descriptions and Environmental Management Plans.
- Provision of environmental information through the site induction process.
- Provision of specific environmental training as required to various departments.
- Cultural Awareness training for all MRM employees and contractors.
- Environmental Emergency Response training for select scenarios provided in MRM's Emergency Response Plan (Appendix O).

The induction process provides an overview of the environmental requirements at the Mine and BBLF. This is supplemented by job-specific training for each new employee or contractor.

The general induction process also covers cultural and heritage management at the Mine and BBLF.

5.5 Environmental Emergency Preparedness Plan

MRM currently operates under an Emergency Response Plan (ERP), which provides all responsible MRM departments with a response plan in the event of occupational and environmental emergencies. Environmental emergencies that have the potential to cause material environmental harm have been identified in the ERP, with an action plan in place to respond to the emergency.

The environment department is primarily responsible for responding to environmental emergency events. This includes the initial step of undertaking an investigation to assess whether environmental harm has or could occur and if applicable, determine the appropriate methods to mitigate any further impacts. Once the initial investigation is undertaken, the environment department will notify the relevant statutory authorities as required under the *Mining Management Act 2001* and *Waste Management and Pollution Control Act 1998*.

The ERP is provided in Appendix O.

5.6 Implementation, Monitoring and Review

This MMP proposes the continuation of existing operations including continuation of OMP EIS activities commenced in 2019. The continuation of existing activities is not expected to increase the environmental risk when compared to the existing operations. The potential environmental impacts associated with the OMP activities were assessed under the Draft and Supplementary OMP EIS.

5.6.1 Environmental Risk Assessment

An ERA was conducted for the OMP and is presented in Section 7 of the Draft OMP EIS. This ERA identified risks and control measures for OMP activities over the life-of-mine.

An ERA workshop was carried out for the MMP to identify and assess potential environmental risks and controls for further consideration in this document. The ERA workshop considered existing and potentially new/altered risks resulting from the specific MMP activities.

The key potential environmental issues identified during the ERA workshop were associated with:

- surface water and groundwater;
- air quality;
- vegetation and terrestrial fauna;
- aquatic fauna; and
- heritage.

The risk matrix and environmental descriptors used are based on the Glencore corporate risk matrix which is documented in PRO-2600060 Risk Management Procedure. In general terms, risk management processes are consistent with International Standards Organisation (ISO) 31000 *Risk Management – Principles and Guidelines* and any further guidance material provided by Glencore corporate functional departments or Divisions.

The risks associated with the potential environmental issues identified were ranked in accordance with the frameworks detailed in Australian Standard/New Zealand Standard ISO 31000:2009 *Risk Management – Principles and Guidelines, Handbook 203:2012 Managing Environment-Related Risk.*

A summary of the potential environmental risks and proposed control measures is provided in the sections that follow.

5.6.2 Surface Water

Potential impacts on surface water could include a reduction in surface water quality due to uncontrolled runoff from disturbed areas, uncontrolled release of contaminants from contained storages/areas to the downstream environment or groundwater drawdown affecting baseflow in nearby surface water resources.

Potential surface water impacts associated with the implementation of the OMP were assessed in the Surface Water Assessment Report (Appendix U of the Draft OMP EIS).

MRM conducts (with the assistance of external experts) extensive water management and monitoring at the Mine and BBLF. Water management at the Mine and BBLF is conducted in accordance with the WMP. The existing water management structures and controls will be retained with additions made, as described previously in Sections 4 and 5, and below.

5.6.2.1 Surface Water Runoff and Contaminants

Water management at the Mine can be divided into four main systems:

1. Clean and Sediment Water Systems aim to divert clean water around mining areas and manage sediment levels in runoff reporting from areas of benign material.

2. Mine and Process Water Systems aim to contain poorer quality water in engineered storages to minimise the risk of uncontrolled release off-site. Water in this system is preferentially used in the Mill, transferred to the Water Treatment System to improve the water quality for beneficial reuse or transferred to the Managed Release Water System.

3. Water Treatment System aims to treat water from the Mine and Process Water System in a water treatment plant or via other treatment processes, such as hydrated lime treatment, to allow for discharge off-site and other potential end uses.

4. Managed Release Water System aims to maximise the discharge of good quality water in accordance with the WDL during periods of water balance surplus. Water contained in this system may at times require treatment to allow for discharge.

Water structures will continue to be progressively constructed to manage runoff from new mining areas and changed mine landforms in accordance with the principles of the existing water management systems described above. The augmentation of the existing water management systems is detailed below.

Clean Water Drains

The MMP will involve new disturbance areas and changes to existing mine landforms at the NOEF, TSF and Open Pit. Consistent with current operations, permanent and temporary clean water runoff drains will be constructed to divert water reporting from non-cleared land and fully rehabilitated areas around mining operational areas. This will minimise water captured on-site and avoid exposing clean water to materials that may elevate contaminant and sediment levels.

The design objectives of runoff drains will be consistent with the Draft OMP EIS Surface Water Impact Assessment. MRM will continue to undertake regular visual inspections of drains to identify potential erosion of drains, and allow for the implementation of corrective measures.

Flood Protection

To limit the interaction between flood water and active overburden emplacement areas, permanent and temporary flood protection will continue to be progressively constructed around the NOEF as discussed in Section 4.2.3.12. The design objectives of the flood protection will be consistent with the Draft OMP EIS Surface Water Impact Assessment and be subject to detailed design.

Sediment Control Structures

Surface water runoff from benign areas may have elevated sediment levels and is currently diverted to sediment control structures for passive treatment. Consistent with current operations, sediment control structures will continue to be constructed to capture runoff from benign areas to minimise soil and sediment entering the receiving environment.

Water runoff from benign areas, including but not limited to cleared areas, partially rehabilitated areas and benign stockpiles, will be captured by sediment drains and directed through sediment control structures around the site. The design of sediment control structures will be consistent with the Draft OMP EIS Surface Water Impact Assessment.

Mine Water

Runoff from active Open Pit mining areas, overburden emplacements and infrastructure areas can be exposed to non-benign materials and is typically of poorer quality. Consistent with current operations, runoff reporting from these areas is contained within the water management systems and directed to Mine Water storages, such as the PRODs (Figure 13).

The MMP will continue to use existing Mine Water storages (e.g. PRODs) to contain water reporting from new mine areas.

The continued development of the Open Pit and associated activities will occur within mine levee wall contained catchment area. MRM will continue to develop suitable water management infrastructure to manage water as required.

Any future Mine Water storages will comply with the design objectives for water storages outlined in the Draft OMP EIS Surface Water Impact Assessment.

Process Water

Process Water is both used and generated by the Mill. Process Water may also include water from the TSF and runoff in the Mill area. There will be no change to the existing management of Process Water as a result of the MMP.

PAF Material Management

The potential geochemical effects on surface and groundwater quality resulting from mining activities have been labelled as AMD (Appendix F). Possible impacts include saline drainage, NMD and AD. The overburden classes take into consideration the effects of saline drainage, NMD and AD, as well as the potential for spontaneous combustion. The waste rock classes and potential impacts are further detailed in Section 4.2.1.3 and the Waste Characterisation Report (Appendix F).

As described in the NOEF Design Guidelines document (MRM, 2020), PAF material will be stored using specific management measures to limit potential geochemical effects including:

- building a core zone for non-benign materials including PAF (HC);
- segregating reactive PAF (RE) from all other materials in dedicated cells;
- constructing a 500 mm basal CCL layer as per NT EPA recommendation 7;
- encapsulating the ultimate NOEF in a cover system that would limit water and oxygen ingress;
- use of advection barriers to restrict the formation of advection currents within the NOEF;
- building PAF (RE) cells in maximum 2 m lifts;
- primarily mining PAF (RE) material in the dry season; and
- adding a 1 m compacted advection barrier cover to PAF (RE) cells prior to every wet season.

More detail on management strategies of PAF material is provided in the NOEF Design Guidelines document (MRM, 2020).MRM will continue to undertake sampling and monitoring of the NOEF as described in the NOEF MP (Appendix G). Surface water and groundwater monitoring in the vicinity of the NOEF will continue to be undertaken in accordance with the AMP to identify any adverse trends in quality that may be a result of mining activities.

5.6.3 Groundwater

MRM conducts (with the assistance of external experts) extensive groundwater management and monitoring at the Mine and BBLF. Water management at the Mine and BBLF is conducted in accordance with the WMP.

5.6.3.1 Groundwater Drawdown and Contaminants

The Djirrinmini Waterhole is a permanent pool on the McArthur River of cultural significance located approximately 1 km upstream of the Mine. The Djirrinmini Waterhole is supported by stream flow during the wet season, however, during the dry season groundwater baseflows maintains water levels, with recharge from the weathered bedrock and alluvial aquifers. The OMP EIS groundwater impact assessment predicts up to 0.4 m of drawdown in the overburden and weathered bedrock and up to 0.65 m of drawdown in the fresh bedrock adjacent to the waterhole. The 2018-2019 monitoring data reviewed in the OPR indicates that groundwater levels decreased during the reporting period due to below average rainfall conditions (EMM, 2019). The bores surrounding the Djirrinmini waterhole experienced the same average drawdown rate as bores located away from potential sources of drawdown and mounding. This indicates that groundwater levels at the Djirrinmini waterhole have not been affected by Open Pit dewatering (EMM, 2019).

MRM will continue to develop the NOEF using the OMP design and construction methodology including the implementation of additional control measures (compared to the existing approvals) to manage oxygen and water ingress into stored PAF materials. The most reactive materials, PAF (RE), will be isolated in dedicated cells to limit potential interaction with oxygen and water. MRM will continue to conduct its groundwater monitoring in the vicinity of the NOEF.

Modelling of the proposed TSF interception trench has indicated that it will reduce the loads to Surprise Creek (KCB, 2017). MRM will continue to conduct its groundwater monitoring in the vicinity of the TSF.

The continued mining and development of the Open Pit, NOEF and TSF, as proposed under the MMP, has been modelled in the OMP EIS groundwater assessment (KCB, 2017). The proposed MMP activities do not result in new or increased risks relating to groundwater drawdown or quality impacts

5.6.3.2 Monitoring along Local Creeks

To improve estimates of base flow, seepage and groundwater loads into creeks (VOA Condition 110) on-site and loads leaving site, approved low flow measurement structures are planned to be installed in various locations in the site water ways. The likely locations will be along the Barney Creek Diversion Channel and Surprise Creek south of the NOEF. The installation of the flow measurement structures will be undertaken in consultation with an aquatic ecological expert. These structures will complement the existing manual flow gauging undertaken at the Mine.

To increase monitoring of groundwater and surface water interactions, a network of monitoring bores have been installed in the Barney Creek Diversion Channel.

Clearing impacts associated with these installations are expected to be minor and will be associated with the removal of riparian vegetation for access. The expected disturbance area will be approximately 0.5 ha.

5.6.4 Air Quality

The Mine is located approximately 44 km and 28 km from the nearest identified sensitive receptor locations of Borroloola and Devils Springs respectively and therefore the influence of air emissions from the Mine on the townships are low (identified in Draft OMP EIS Air Quality Impact Assessment).

MRM currently implements its Air Quality Management Plan to monitor, assess and manage potential air quality impacts at the Mine and BBLF. Todoroski Air Sciences (TAS) concluded in the 2018-2019 OPR that pollutant concentrations at Borroloola and Devils Springs due to the mining activities would be significantly lower than those recorded by any Mine monitor, and would likely not be discernible from background concentrations.

A review of the SO_2 monitoring by TAS in 2019 concluded:

> *"Ongoing modelling / data interpolation studies conducted by Todoroski Air Sciences using the validated NOEF monitoring data indicate that the SO_2 levels from the Mine site continue to remain well below the NEPM standard level at Borroloola, Devils Spring and the MRM Village."*

The continued mining and development of the Open Pit, NOEF and TSF, as proposed under the MMP, has been modelled in the Draft OMP EIS Air Quality Impact Assessment. Predicted air quality impacts are within the acceptable criteria for sensitive receptor locations. The MMP will involve the continued development of the NOEF and Open Pit, however, the expansions will be minor compared to the distance to the nearest sensitive receivers (i.e. 28 km away).

MRM will continue to implement its Air Quality Management Plan to monitor, assess and manage potential air quality impacts.

5.6.4.1 Spontaneous Combustion

Spontaneous combustion of overburden material can result in the release of SO_2 and other products into the air. The proposed OMP design and construction methodology will result in the isolation of more reactive PAF (RE) in dedicated cells with increased controls, to reduce the risk of spontaneous combustion. MRM will continue to undertake spontaneous combustion monitoring as described in the NOEF MP (Appendix G).

5.6.5 Vegetation and Terrestrial Fauna

Disturbance of new areas will be carried out in accordance with MRM's Permit to Clear Procedures and Forms (Appendix D). The Permit to Clear Procedure includes a pre-clearance survey for identification of Vegetation Management Units to determine potential for Gouldian Finch, Buff Sided Robin (*Poecilodryas cerviniventris*) or Purple-crowned Fairy-wren (eastern) habitat. The procedure also outlines the requirement for all proposed

clearing areas to be inspected for flora/fauna protected under the EPBC Act and TPWC Act, 1976 and for the proposed clearing areas to be marked by survey to allow for a comprehensive clearing database to be maintained.

Works would be conducted in accordance with the conditions of relevant AAPA certificates covering the development area.

5.6.6 Heritage Sites

Figure 5 shows the sacred, archaeological and heritage sites that have been identified in the vicinity of the Mine and the current AAPA certificates.

MRM will continue to seek and obtain necessary AAPA certificates prior to disturbing any sacred sites within the proposed MMP development area (Figure 5). Surface disturbance will be undertaken in accordance with all AAPA certificate requirements and MRM's Permit to Clear Procedures and Forms (Appendix D).

Disturbance or encroachment within 5 m of site MRM4 will not occur until a design is agreed in writing by DPIR and consultation has been undertaken with the Minister for Resources and the Minister for Tourism, Sport and Culture, in accordance with VOA 0059 Condition 121.

5.6.7 Aquatic Fauna

Potential impacts to aquatic fauna could result from deterioration of surface water quality in rivers and creeks, as discussed in Section 5.6.2.

The aquatic fauna monitoring, as presented in the WMP, is considered to be suitable to monitor, assess and manage potential impacts associated with the MMP activities.

5.6.8 Environmental Monitoring Programs

MRM has reviewed the existing monitoring programs in consideration of the proposed MMP works and potential risks identified in the OMP EIS and MMP ERA (Appendix A). MRM will continue to implement the existing strategies, plans and programs and where necessary, review and revise them (in consultation with the relevant regulatory authorities) for the MMP. The environmental monitoring schedule that will be implemented is provided in the AMP. Any future revisions of the monitoring schedule will be provided to DPIR annually.

5.7 Key Environmental Activities

5.7.1 Hydrology Projects

5.7.1.1 Mine Levee Discharge Point

Background

The Mine Levee Discharge Point (MLDP) is located on the downstream side of the northeast embankment of the mine levee wall and is one of the Authorised Discharge Points in accordance with WDL 174-11 (Figure 18). The MLDP allows for the discharge of water from the mine site to the receiving environment, including water sourced from locations such as the Water Treatment Plant, NC1A, Pond 2 and the WMD.

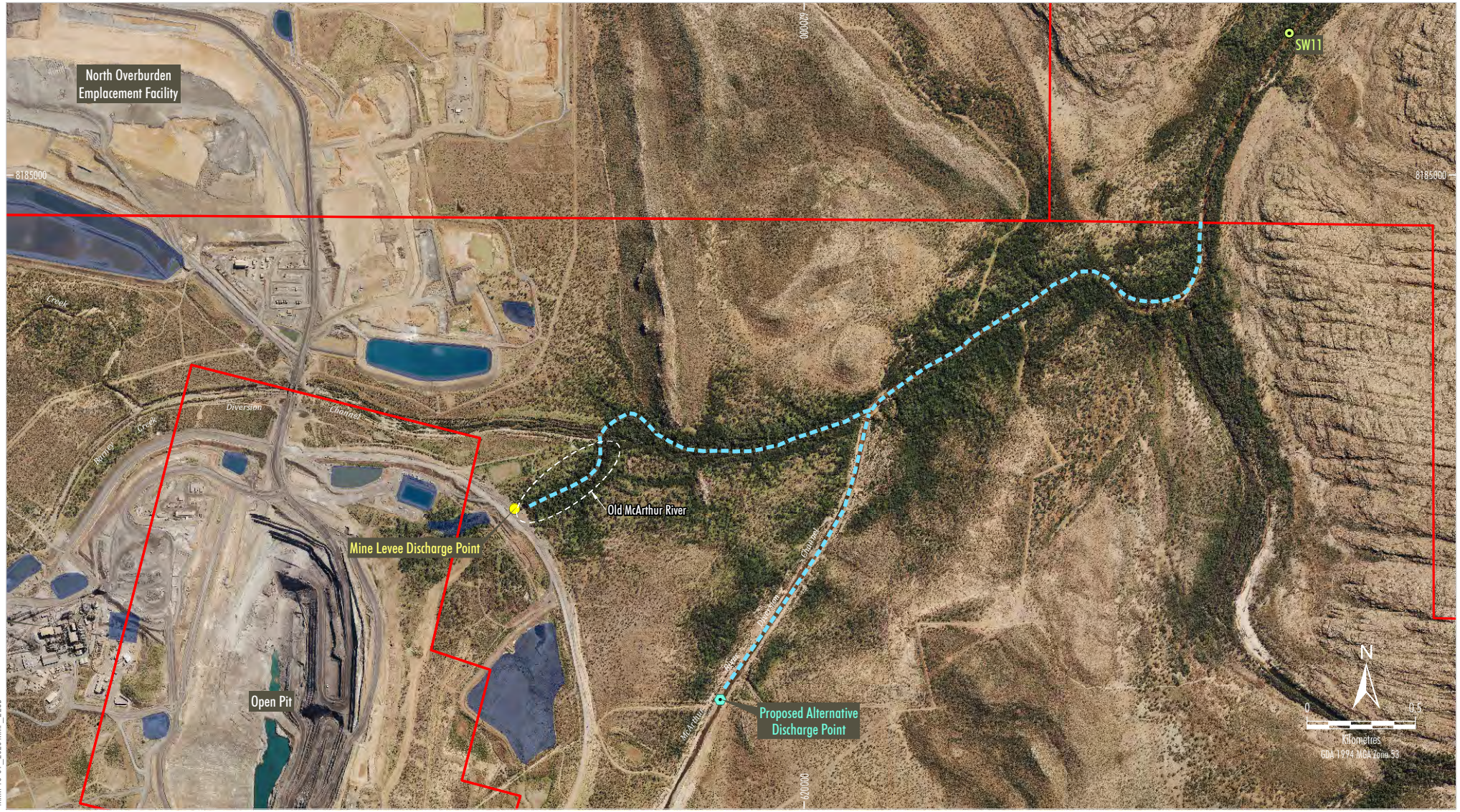
Waters discharged at the MLDP are pumped over the mine levee wall and flow into the Old McArthur River channel upstream of the McArthur River and Glyde River confluence. The mixing zone for the MLDP extends from the discharge point outlet to the northern boundary of MLN 1122 (Figure 18). However, natural surface water flow along the Old McArthur River can be limited during times of active discharge, reducing dilution, impeding flow and promoting sediment deposition.

Monitoring data has indicated an opportunity to improve the environmental outcomes of the MLDP, by relocating the MLDP to the southeast to allow for direct discharge into the McArthur River Diversion Channel rather than via the Old McArthur River flow path.

Proposed Works

The pipelines associated with the MLDP would be extended southeast of their current location and positioned along or adjacent the mine levee wall, utilising existing cleared areas and pipeline routes, where possible. The pipelines would traverse the flood plain (potentially trenched) between the mine levee wall and the McArthur River Diversion Channel. The new discharge point would release directly into the McArthur River Diversion Channel, likely in the vicinity of the SW16 monitoring location (Figure 18).

A suitable system for diffusing discharge waters at the discharge point would be engineered and installed in accordance with the *Northern Territory Guidelines on Mixing Zones* (NT EPA, 2013). The point source diffuser would maintain environmental values in the McArthur River Diversion Channel and reduce the breadth, depth and length of the mixing zone in this section of waterway. This would include subaerial and/or submerged discharge using fixed, trenched and/or floating diffusers. An example of a discharge point diffuser is provided in Figure 19. These type of diffusers are commonly used for discharge of effluent from sewage treatment plants to rivers and oceans. Hydraulic modelling would be completed to inform the design of the diffuser.



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LEGEND

- Mineral Lease
- Authorised Waste Discharge Location
- Compliance Monitoring Site
- Proposed McArthur River Diversion Channel Discharge Point
- Water Storage
- Mixing Zone

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

McARTHUR RIVER MINE

Proposed Alternative McArthur River Diversion Channel Discharge Point Location

Figure 18

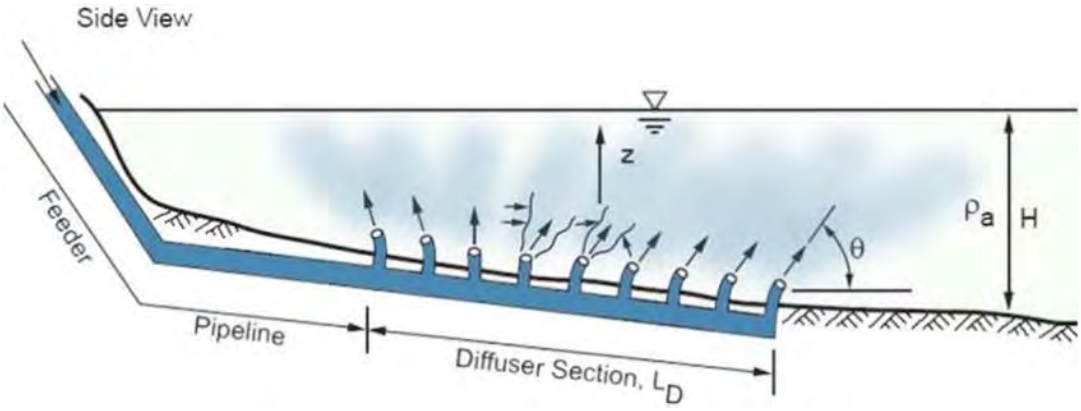


Figure 19 - Example of a Fixed Submerged Diffuser Used in Ocean and River Effluent Discharge.

The relocation of the MLDP would also include installation of ancillary infrastructure such as flow meters, communication equipment, valves and concrete footings and pads. Clearing associated with the proposal is expected to be approximately 1 ha. Where possible, existing cleared areas will be used for the infrastructure to minimise any additional clearing required.

Approval for relocating the MLDP will also be sought from the NT Department of Environment and Natural Resources via an application to update the WDL.

Environmental Benefits and Controls

The proposal to relocate the MLDP aims to provide the following environmental benefits:

- Rapid dilution of discharge waters with receiving waters to minimise any effects on aquatic organisms within the mixing zone; and
- Direct discharge to higher velocity receiving waters to promote downstream transport and minimise the risk of sediment deposition.

The proposed discharge point would be located downstream of the two main refuge pools within the McArthur River Diversion Channel. This would help minimise the interactions between aquatic fauna and discharge waters during recessional flow periods.

Any water discharged from the relocated MLDP would continue to be managed to comply with the relevant Site Specific Trigger Values (SSTVs) at the SW11 monitoring point. As the SSTVs have been developed to protect the downstream environmental values and beneficial uses, ongoing compliance with the SSTVs at SW11 means the release of water via the relocated MLDP would not result in material change to environmental risk.

Monitoring

It is anticipated that the relocation of the MLDP would not require any change to the current surface water monitoring schedule. Surface water monitoring would continue to be carried out in accordance with the WMP and the WDL.

Routine inspections of pipelines to check for potential leaks and pipeline integrity would be expanded to cover the additional pipeline installed to the relocated MLDP.

Flowmeters would be installed as part of the relocation project to ensure that flow rate and volumes could be monitored in accordance with the WDL conditions.

5.7.1.2 Gauging Stations on Emu Creek and the Glyde River

To meet requirements of WDL 174-11 Condition 60, MRM will install gauging stations that will measure flow and water quality on Emu Creek and the Glyde River.

Possible locations for the gauging stations are provided in Figure 20. Locations will be confirmed in 2020, following an assessment of the McArthur River backflow during flood events along these waterways. The options listed in Figure 20 are indicative and may be relocated to more suitable locations (expected to be within 1 km).

Minor excavations will be required to install the equipment, and no clearing is expected. The proposed locations presented in Figure 20 are outside of the current AAPA certification areas. Accordingly, MRM will obtain AAPA certification for any disturbance associated with the new stations prior to installing.

5.7.1.3 Barney Creek Diversion Sediment Bunds

Flow measurement structures are proposed to be installed along the Barney Creek Diversion Channel and Surprise Creek to improve estimates of mine lease contributions to loads. Structures would potentially be located at natural surface water monitoring locations SW18, SW19 and SW20 in the Barney Creek Diversion Channel and SW02 and SW24 in Surprise Creek (pending suitable AAPA clearance certificates) as well as upstream sites on Barney and Surprise Creeks to determine background contributions. Installation would be staggered, with one or two structures constructed initially as a trial to assess performance and viability.

The flow measurement structures would be constructed in the form of a bund or weir to provide a control for flow measurement. The installation would be undertaken in consultation with an aquatic ecology expert so that the proposed heights do not adversely affect aquatic fauna upstream of the structures. Construction materials would be determined during the detailed design process.

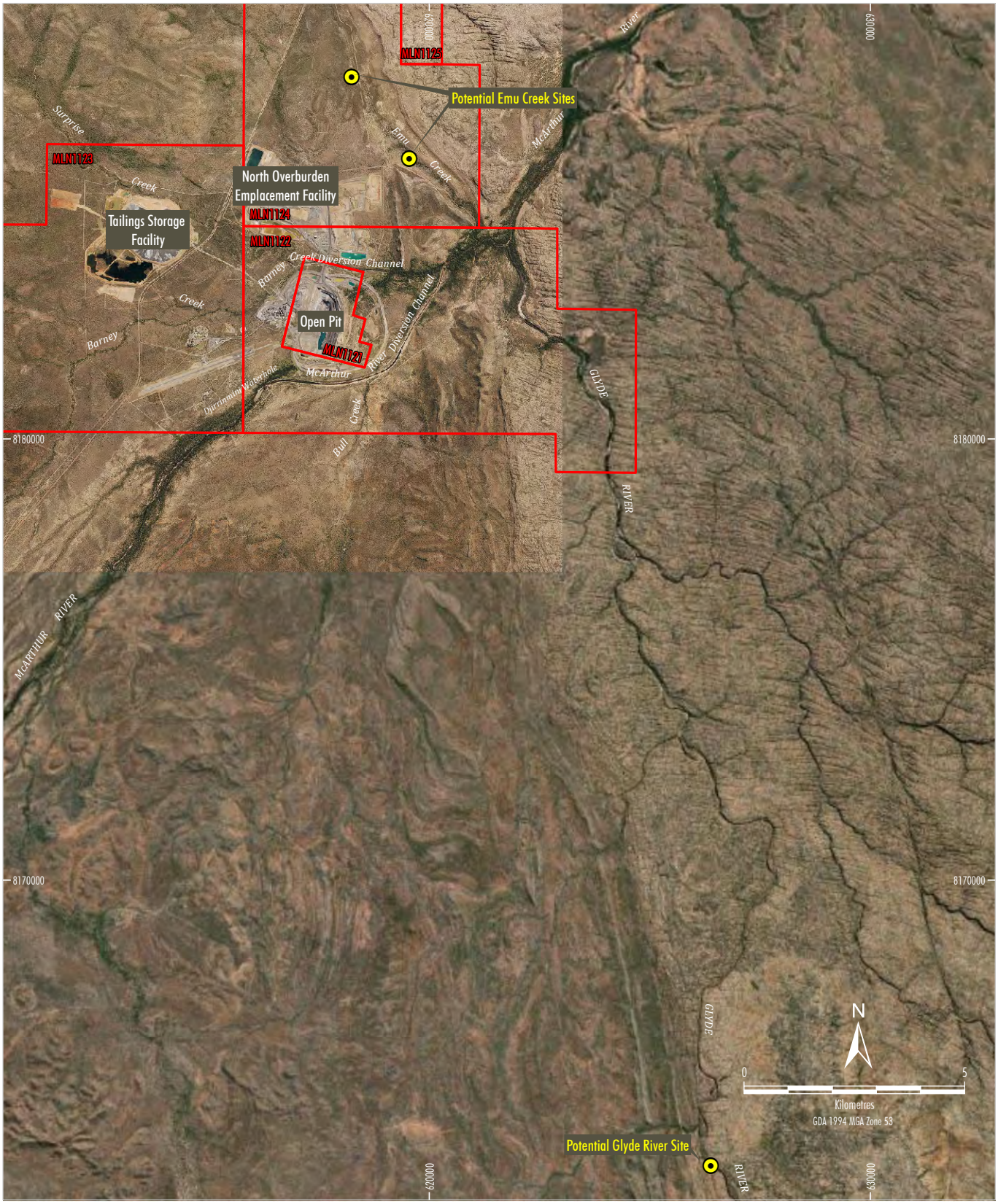
The flow measurement structures would also be designed to provide sumps to capture baseflow and fluvial sediments, and would be utilised when required in accordance with the AMP. The installation of the flow measurement structures would also include installation of ancillary infrastructure such as ramps, pumps, pipelines, concrete footings/pads, gauging and monitoring equipment.

Clearing associated with these installations are expected to be minor and would be associated with the removal of riparian revegetation for access and construction. The disturbance area is proposed to be approximately 0.5 ha.

Environmental Benefits and Controls

The primary aim of the structures is to provide monitoring to measure and model mine-derived loads entering the McArthur River and associated tributaries. The data will also help inform requirements for contaminant source control and provide additional ongoing assessments of risk to downstream Beneficial Uses and Community Values from potential load based impacts.

The secondary aim of the project is to provide options for further capture and recovery of potentially mine affected baseflow and fluvial sediments. Mitigation measures outlined in the OMP EIS included multiple baseflow interception sumps in the Barney Creek Diversion Channel. The use of these structures to recover baseflow and sediment would be determined by monitoring results and MRM's AMP. The structures would also be designed with a drainage mechanism to limit the creation of artificial habitat during dry season periods. This would minimise the risk of metal uptake to aquatic fauna residing within the sediment capture sumps.



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LEGEND

Mineral Lease

Continuous Flow and Water Quality Gauging

Source: Department of Environment and Natural Resources (2016); Orthophoto MRM (2018); Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

McARTHUR RIVER MINE

Potential Locations for Continuous Flow and Water Quality Gauging on Emu Creek and the Glyde River

Figure 20

The final height of the structures above the creek invert will be considered as part of the detailed designs. The bunds/weirs would extend across the full width of the creek to provide a control for flow monitoring and to aid in sediment and base flow capture. MRM engaged an aquatic ecology expert (Indo-Pacific Environmental) to provide advice with respect to impediments of aquatic fauna passage/migration from the proposed installation of the flow measurement structures. This advice included bund height recommendations, which if implemented are considered unlikely to have any significant impact on aquatic biota recruitment or the ecology within Barney/Surprise Creek system. These height recommendations will be adhered to during the design and construction of the flow measurement structures.

Monitoring

The structures would be complemented with an array of monitoring equipment to assist in flow measurement. This would include water level and water velocity sensors. The flow measurement structures are planned to be designed with a drainage mechanism to help minimise the formation of artificial habitat (particularly in the early dry season) upstream of the structures. This will help reduce the potential for metal uptake by minimising fauna residence times. Sediment accumulating upstream of the structures will also be removed periodically. This process will be guided by maintenance requirements, as well as MRM's environmental monitoring program and the AMP.

Aquatic fauna abundance and diversity monitoring would continue to be undertaken both downstream and upstream of the flow measurement structures to validate the suitability of the bund/weir heights.

The sumps located on the upstream side of the bunds/weirs would be routinely monitored for sedimentation and vegetation encroachment. Sediment and vegetation would be routinely removed as part of annual maintenance during operation of the structures.

5.7.2 Hydrogeological Investigations

MRM will continue to undertake hydrogeological characterisation investigations within the vicinity of the Open Pit, TSF, NOEF and at the BBLF.

The proposed investigations will be undertaken within existing disturbance areas as far as practicable. New drill pads, test pits, access tracks and sumps will result in some minor disturbances within the investigation areas shown on Figure 21 to Figure 23. All drilling works will be undertaken in accordance with the requirements of relevant approvals and MRM Permit to Clear procedures (Appendix D). Water monitoring bores will be constructed according to the *Minimum Construction Requirements for Water Bores in Australia* (NUDLC, 2012).

Following completion of the drilling programs and prior to the forthcoming wet season, all work areas will be rehabilitated. Compacted ground will be ripped, with stockpiled topsoil and vegetation re-spread over the site.

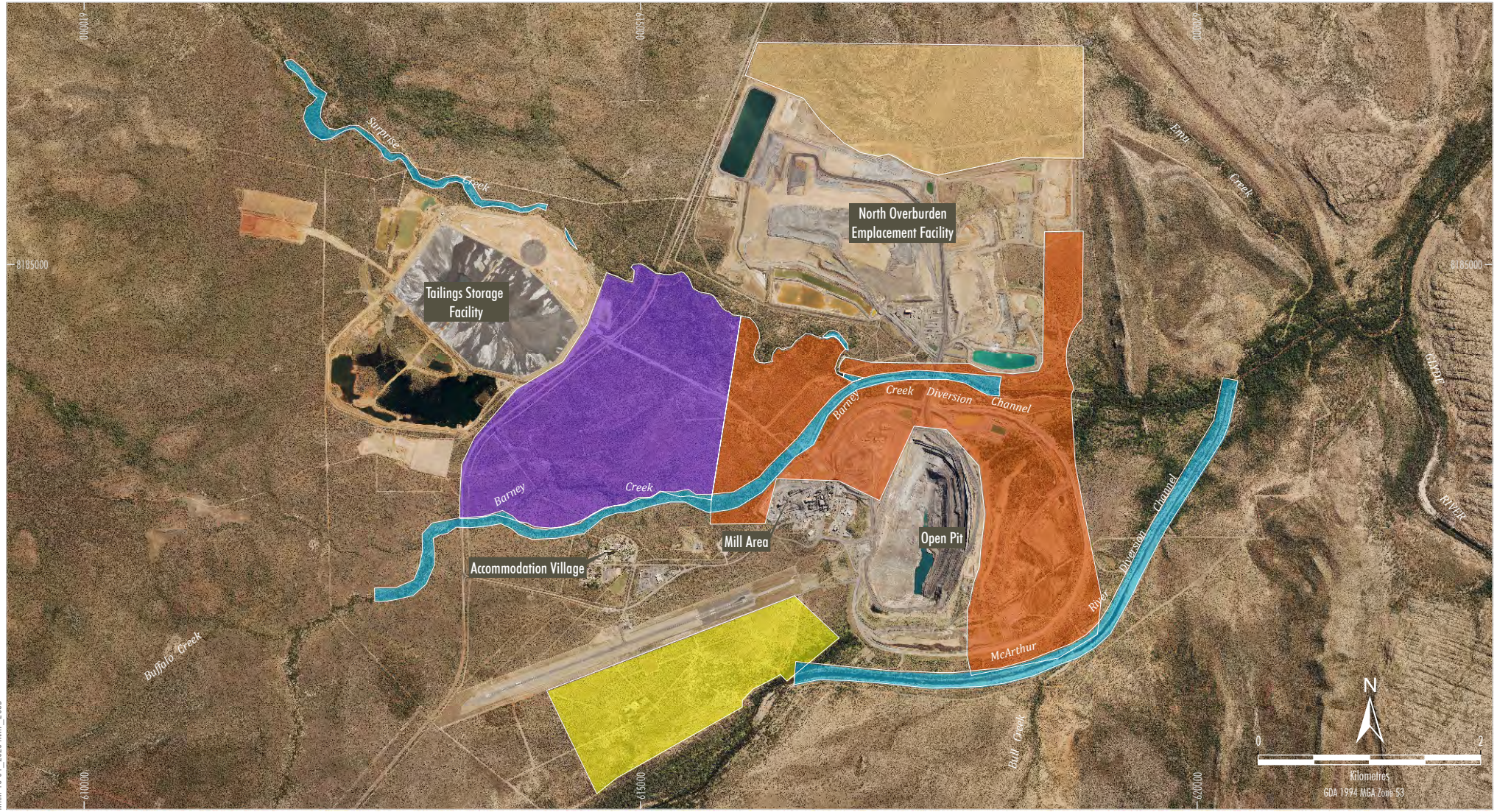
The proposed hydrogeological investigations can broadly be divided into three groups:

1. Investigations that support the refinement of the conceptual and numerical groundwater models for the Mine, which will be used to support the development of the AMP (see Figure 21 for the indicative investigation areas);

2. Installation of additional groundwater monitoring infrastructure to satisfy operational and regulatory monitoring requirements (see Figure 22 for the indicative installation areas at the Mine); and

3. Additional hydrogeological investigations to support operational and regulatory requirements (see Figure 23 for the indicative investigation areas).

The investigations are expected to result in approximately 10 ha of new disturbance as detailed in Table 11.



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LEGEND

Indicative Investigation Areas

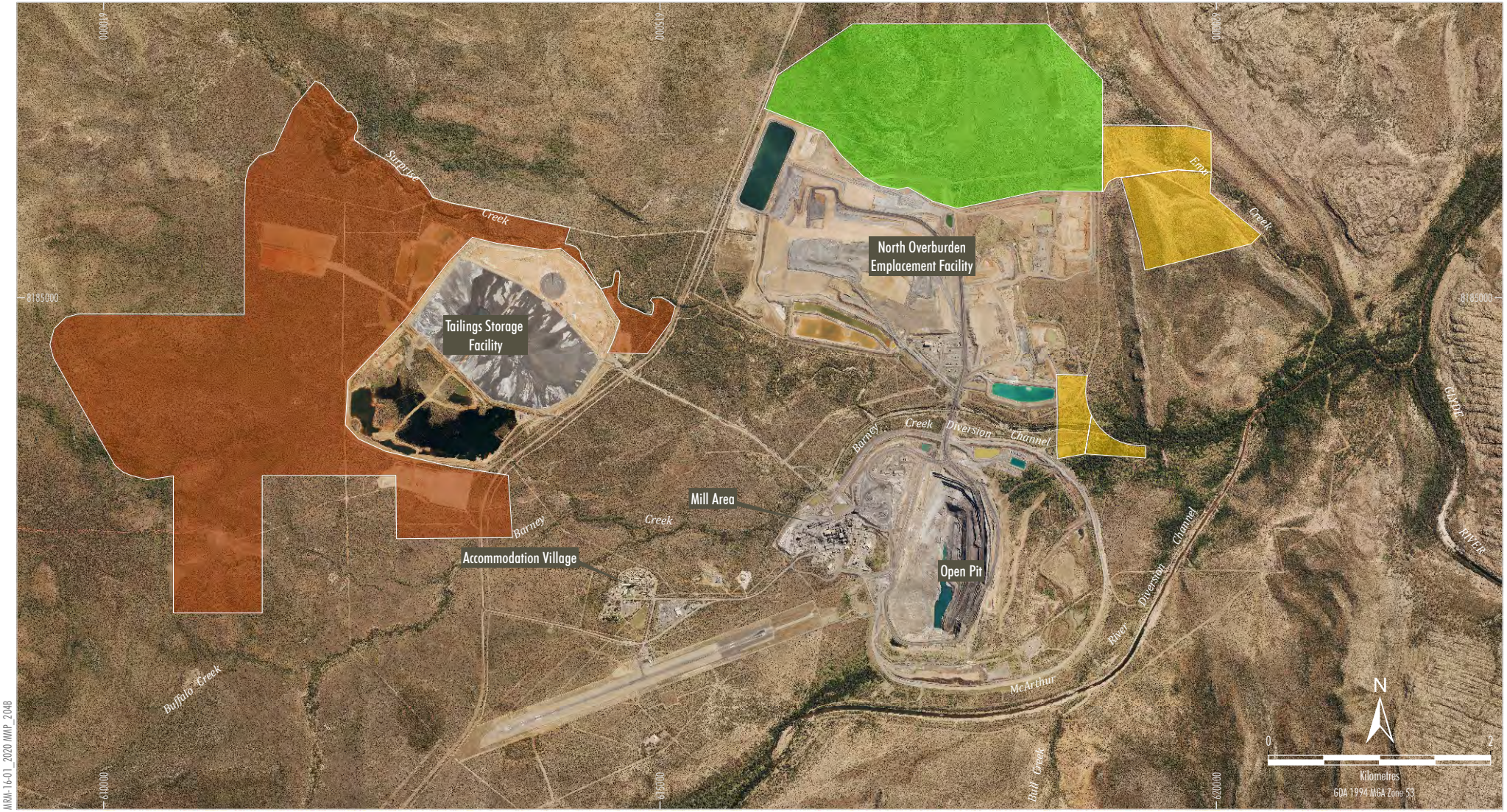
- Open Pit Preferential Flow Paths
- NOEF Emu Plains Flow Paths
- MIMEX Borefield
- Surface Water and Groundwater Connectivity
- Mineralised Zones

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

McARTHUR RIVER MINE

Areas for Possible Drilling and Field Investigations to Refine the Conceptual and Numerical Groundwater Models

Figure 21



LEGEND

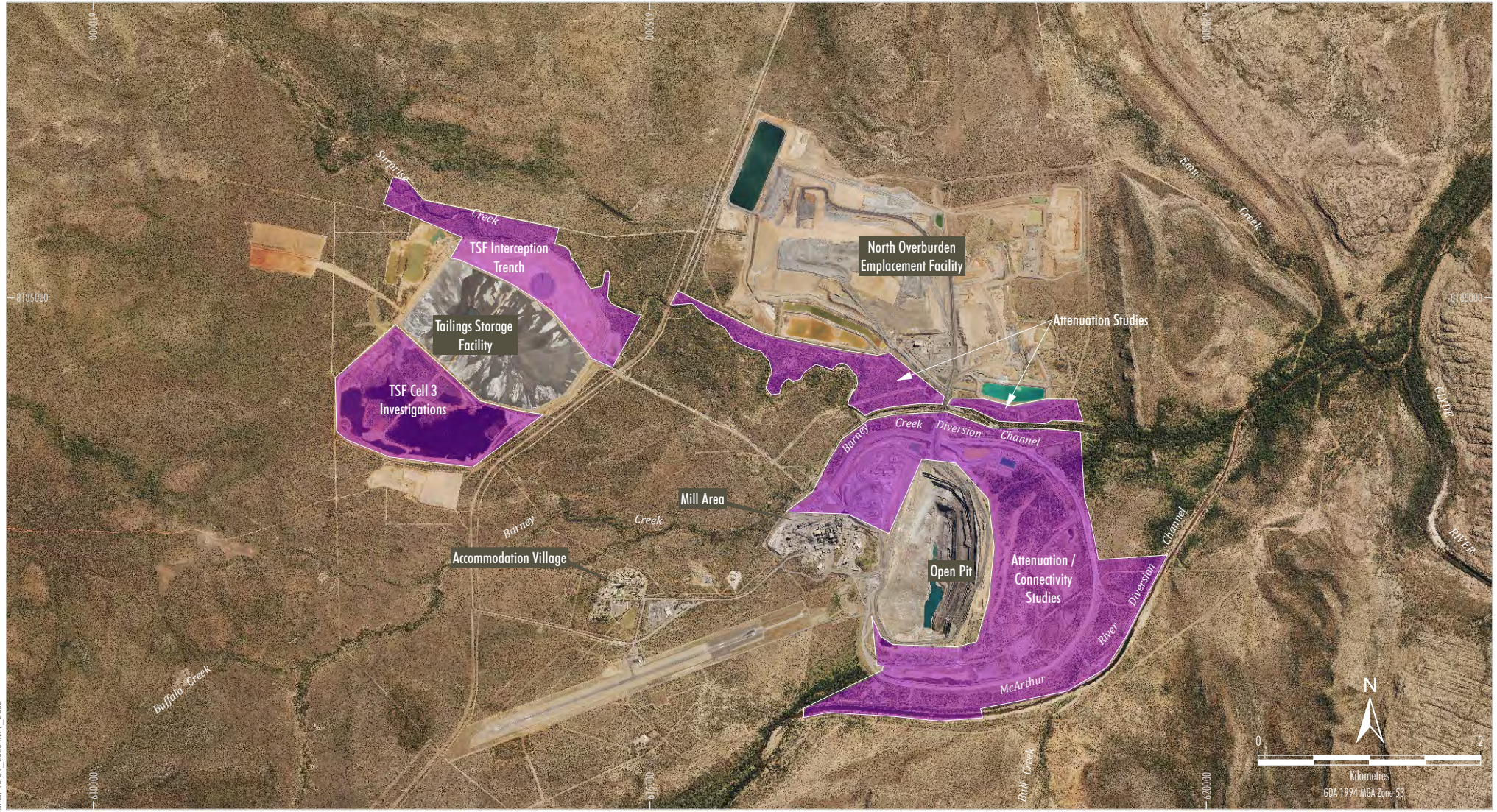
- Emu Creek and Barramundi Dreaming Investigations
- NOEF Investigations
- Tailings Storage Facility Investigations

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

McARTHUR RIVER MINE

Indicative Areas for Possible Drilling to Install Additional Groundwater Monitoring Bores

Figure 22



LEGEND

Potential Areas for Additional Investigations

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

McARTHUR RIVER MINE

Areas for Possible Additional Drilling and Field Investigations

Figure 23

TABLE 11 - APPROXIMATE NEW DISTURBANCE FROM PROPOSED HYDROGEOLOGICAL INVESTIGATION WORKS

Investigation Project	Purpose	Commitment	Approximate Area of new Disturbance (ha)
Refinement of conceptual and numerical groundwater model			
Open Pit preferential flow paths	Refine the structural model and further characterise the preferential flow paths for groundwater.	VOA Condition 110.a, EPBC Approval 2014/7210, Condition 5.b, 6.A.a, 6.A.c and 12.b	1.25
NOEF Emu Plains flow paths	Investigations of groundwater flow in the Emu Plains area to support the model at the northern boundary of the NOEF.	EPBC Approval 2014/7210, Condition 6.A.a and 6.A.c	0.8
MIMEX Borefield	Characterise the potential impact of the MIMEX bore field extension on Djirrinmini.	VOA Condition 119. a., EPBC Approval 2014/7210, Condition 6.A.a, 6.A.c and 14.b	0.6
Surface water and groundwater connectivity	Characterise connectivity of surface water and groundwater to support assessment of groundwater loads to surface water.	VOA Condition 109.b, 110.a., EPBC Approval 2014/7210 Condition 6.a.h	0.75
Mineralised zones	Characterise naturally mineralised zones including the area between the TSF and the Open pit.	EPBC Approval 2014/7210, Condition 6.C.h	0.8
Additional groundwater monitoring			
NOEF additional monitoring	Baseline monitoring north of the NOEF prior the development of the NOEF to the maximum footprint.	EPBC Approval 2014/7210, Condition 6.C.h	0.5
TSF additional monitoring	Groundwater monitoring at borrow pits and Centralised Waste Facility.	VOA Condition 12.a.ii	1.0
Emu Creek and Barramundi Dreaming additional monitoring	Additional monitoring bores south west of Barramundi Dreaming and at Emu Creek.	EPBC Approval 2014/7210, Condition 6.C.g	0.6
Additional groundwater investigations			
TSF Cell 3 Investigations	Groundwater investigations to support the lining of the WMD and the construction of the Process Water Dam.	-	1.2
TSF Interception Trench performance	Possible further investigations to assess performance of TSF interception trench.	ITRB recommendation	0.8
Attenuation studies	Site wide groundwater attenuation studies.	VOA Condition 110.b., EPBC Approval 2014/7210, Condition 5.a	0.8
Connectivity studies	Open Pit to McArthur River connectivity studies.	EPBC Approval 2014/7210, Condition 5.b	0.5

5.7.3 Rehabilitation Related Activities

5.7.3.1 Mine Levee Wall Revegetation Trial

The Draft OMP EIS outlines the post-closure objectives relating to landform design and revegetation of the Mine and the BBLF. To meet these objectives vegetation must be established on the final cover system of landforms to provide resistance to erosion, habitat and visual amenity.

The mine levee wall is constructed with a clay core, with a NAF material halo layer. The halo is over 12 m thick in areas and protects the clay core from desiccation. MRM plan to undertake civil work to repair the existing erosion without impacting on the clay core, followed by covering the area with approximately 0.1 m of topsoil.

To ensure that the integrity of the mine levee wall is not compromised, a risk assessment will be completed and the work will be supervised by the Environment Team and Civils Team. In addition, MRM has a Permit to Dig procedure which prohibits the excavation of material below 300 mm which will restrict the material which can be moved. MRM considers that the above controls are suitable to minimise the risk of the activity impacting the clay core of the mine levee wall.

A 10 ha revegetation trial will be conducted on the outer edge of the southern levee wall batters as this has a similar slope to many final landforms and requires minimal civil work to prepare the land (Figure 9).

One of the objectives of the vegetation trial is to determine the irrigation requirements. The irrigation must facilitate vegetation growth whilst preventing drenching of soil, which may promote water infiltration to the trial cover system or erosion on the topsoil and growth medium layers. Visual inspections would be conducted daily when the sprinklers are in use. In the event that irrigation system generates runoff that leads to significant erosion, which may impact on the integrity of the mine levee wall, the trial will immediately cease and, if necessary, repairs will be undertaken.

The trial aims to replicate revegetation of the final landforms and will be carried out to a similar standard as outlined in the Rehabilitation Management Plan for routine revegetation activities.

5.7.3.2 Cattle Management

MRM currently manages a cattle exclusion area surrounding active operations. This cattle exclusion area has been in effect since 2006, with the location and size of the exclusion area having been refined as mining operations changed from underground to open pit and active operations expanded.

The objectives of the cattle exclusion area are:

- To exclude cattle from operational areas, reducing the risk of injury to cattle.
- To exclude cattle from operational areas, improving the safety of vehicle operations.
- Remove cattle access to the McArthur River and Barney Creek Diversion Channels to prevent impacts to bank stability and improve the success of the rehabilitation program.
- Reduce the likelihood of cattle transporting weeds into the cattle exclusion area, allowing MRM to focus on the eradication of current weed populations.
- To exclude cattle from both upstream and downstream McArthur River to minimise cattle impacts to riparian vegetation, temporarily offsetting terrestrial fauna habitat while the Diversion Channels are rehabilitated.
- To establish a cattle free, long term biodiversity offset area upstream of the Mine. This offset area will provide habitat for the Purple-crowned Fairy-wren (*Malurus coronatus coronatus*), listed as Vulnerable under the *Territory Parks and Wildlife Conservation Act* 1976.

MRM regularly consults with stakeholders in regards to the management of cattle in the cattle exclusion area. Furthermore, MRM reviews and ensures compliance with the following legislation and guidelines:

- *Territory Parks and Wildlife Conservation Act 1976* (NT);
- *Biosecurity Act 2015* (Cth);
- *Weed Management Act 2001* (NT);
- *Territory Parks and Wildlife Conservation Act 1976* (NT); and
- *Northern Territory Biosecurity Strategy 2016-2026* (NT).

MRM plan to complete the upgrade to the Cattle Exclusion Area fence, which commenced in 2017.

Figure 24 below shows the Cattle Exclusion area, with the location of the fences to be replaced in 2020. No additional land disturbance will occur through this process as all replacement fences will be installed at existing fence locations.

MRM will work with McArthur River Station and DPIR Biosecurity to undertake a review of floodgate designs where the cattle exclusion fence crosses rivers and creeks. Where possible (based on accessibility and AAPA conditions), MRM will upgrade the floodgates to improve the strength of the cattle exclusion fence at these locations.

MRM plan to construct new cattle yards within the TSF Cattle Exclusion Area to improve the capacity of the McArthur River Station to relocate cattle mustered from within the TSF.

The location of the cattle yards will be consulted with both McArthur River Station and DPIR prior to construction. The estimated clearing area is 0.15 ha which is consistent with the existing cattle yard located north of the NOEF.

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LEGEND

Cattle Exclusion Fencing

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

McARTHUR RIVER MINE

McArthur River Mine
Cattle Management Fence

Figure 24

5.7.3.3 Tree Screens

TSF and NOEF Tree Screens

Two tree screen projects are planned to be carried out to provide a visual screen between the Carpentaria Highway and operational areas to improve visual amenity for road users.

The tree screens will be established using native woodland species, which will increase the density of vegetation along sections of the Carpentaria Highway as shown in Figure 25.

Individual tubestock will be irrigated through the use of plant cocoons, which supply water directly to the plant without the need for irrigation to be installed. These plant cocoons are expected to supply water for 12 months, after this time permanent irrigation may be required to ensure the success of this project. A groundwater bore will be required at a suitable location to supply water for irrigation purposes.

For the groundwater bore, MRM will comply with the requirements of the NT *Water Act 1992*, including obtaining and holding water licences where necessary.

No clearing will be required for the development of the tree screens. All infrastructure will be removed when the vegetation becomes self-sufficient.

Metallurgy Tree Screens

In 2018, tree screens were established along the haul road to the north of the processing facility to trial the use of vegetation in reducing dust emissions from the processing plant being transported into Barney Creek.

As a result of the success of this trial, additional tree screens are planned to be established within existing disturbed areas of the Mill Area.

5.7.3.4 Erosion Mitigation Works

MRM would continue to undertake erosion mitigation works to prevent long-term stability issues at key locations around the Mine and BBLF.

Confluence of Surprise Creek and Barney Creek Diversion

In 2016, MRM commissioned a Geomorphological Assessment of the McArthur River and Barney Creek Diversion Channels. A recommendation of this report was to undertake an assessment of the potential avulsion of the confluence of Surprise Creek and Barney Creek Diversion Channel.

In 2019, this area was reassessed and whilst the potential area of avulsion had not progressed it was recommended that an options assessment be undertaken to determine the potential likelihood of avulsion occurring, the potential impacts and options to prevent this occurrence.

MRM plan to engage a consultant to undertake an options assessment of this location and the preferred option is proposed to be carried out.

McArthur River Plug

In 2019, a recommendation was included in the *McArthur River Mine Geomorphology – Geomorphic Monitoring and Rehabilitation Design* report (Hydrobiology, 2019) that further assessment of the stability of the Old McArthur River plug, located at the upstream confluence of the McArthur River and McArthur River Diversion Channel, was required.

MRM will engage a consultant to undertake an options assessment of this location to determine the cost benefit of the project based on the likely impact. Any remedial actions required will be completed, with a potential disturbance area shown on Figure 25. The work will likely involve minor disturbance, which will be carried out in accordance with MRM's Permit to Clear procedures and AAPA certificates (Appendix D).

LEGEND

Erosion Mitigation Works

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

McARTHUR RIVER MINE

Proposed Erosion Mitigation Works

Figure 25

Water Culvert Installation

MRM plan to install culverts at four key locations where water courses or surface water drainage points interact with access tracks within the MRM lease areas.

The culverts are being installed to address existing erosion and surface water drainage at key locations. Whilst it is expected that erosion at these key locations will be significantly reduced, the following additional controls are planned to be implemented to minimise erosion following installation:

- ground compaction of material at both sides of the culverts;
- installation of rock armouring on batters and road surface of culverts; and
- the short term use of jute fabric.

Land disturbance for this work will be as described below:

- A culvert will be constructed at Bull Creek as shown below in Figure 25. The culvert will prevent ongoing erosion issues at this location, which is causing sediment being transported into the McArthur River Diversion Channel.
- A replacement culvert will be installed at Surprise Creek as shown below in Figure 25. The culvert will replace existing culverts that were damaged in the 2017/2018 wet season. These culverts provide water flow under the APP access track onto the tails pipeline for maintenance of this infrastructure.
- A culvert will be constructed at Surprise Creek as shown below in Figure 25. The culvert will allow all weather access to environmental monitoring sites through this location and provide a secure location to install a flood gate to increase the security of the Cattle Exclusion Area.
- A culvert will be constructed at the unnamed creek on the McArthur River Diversion Channel as shown below in Figure 25. The culvert will prevent ongoing erosion issues at this location, which is causing sediment being transported into the McArthur River Diversion Channel.

BBLF Dredge Spoil Ponds

MRM plan to develop a dredge spoil management plan for the ongoing monitoring and maintenance of the infrastructure.

5.7.3.5 McArthur River and Barney Creek Diversion Channels Revegetation

McArthur River and Barney Creek Diversion Channels Revegetation

MRM will continue to undertake revegetation and rehabilitation works along the McArthur River and Barney Creek Diversion Channels in accordance with its RMP.

It is anticipated that active revegetation work on the McArthur River Diversion Channel will be completed and reactive management will commence. Reactive Management activities include:

- Infill planting at areas where vegetation density or species composition does not meet the performance criteria specified in the RMP;
- Weed management as described in the Weed Management Plan, but with a focus on *parkinsonia* and *noogoora burr*;
- Pest management, specifically targeted at the control of feral pigs; and
- Erosion control at locations where erosion does not become stable through the establishment of vegetation.

Revegetation monitoring will continue until the completion criteria described in the RMP has been achieved at all sites.

5.7.4 Waste Management

MRM currently operates a General Waste Facility (Figure 9), as well as a Contaminated Waste Facility and a Putrescible Waste Facility (Figure 16), to manage waste materials generated from mining operations and domestic activities. MRM has previously identified risks associated with these facilities relating to seepage and water runoff, and safety risks of the close proximity to the Mine village residence. In order to mitigate these risks, MRM has obtained approval to construct a new Centralised Waste Facility located in an existing disturbed area within the footprint of the South Borrow Pit (Figure 16). Existing waste facilities will be decommissioned and rehabilitated as part of the proposed works. It is expected that the Centralised Waste Facility will be constructed in 2020.

6 Water Management

6.1 Existing Water Monitoring Programs

Water management at the Mine is supported by the following monitoring programs, that form part of the WMP:

- Artificial surface water quality monitoring program.
- Groundwater monitoring program.
- Surface water monitoring program.
- Freshwater ecology monitoring program, including:
    - macroinvertebrate monitoring;
    - aquatic fauna abundance and diversity;
    - Freshwater Sawfish and Barramundi acoustic monitoring; and
    - metals in aquatic fauna monitoring.

6.1.1 Current Conditions and Reporting

The annual OPR provides a comprehensive review of the Mine and BBLF surface water and groundwater conditions, including the following:

- updated site water balance based on recorded data;
- surface water quality performance along rivers and creeks;
- artificial surface water quality in contained water storages;
- fluvial sediment quality performance along rivers and creeks; and
- groundwater quality performance in the vicinity of all Mine and BBLF facilities.

MRM will continue to report environmental and operational performance in the annual OPR, which will include review of environmental monitoring data by MRM and external experts.

6.2 Water Management Plan

MRM's WMP for the Mine is provided as *Appendix B – MRM Water Management Plan 2019/20* of the AMP (Appendix B).

The purpose of the MRM WMP is to provide transparency for operational water management at the Mine and in the wider catchment area, outline the adaptive management approach for control of water-related risks to the environment and fulfil the requirements of key approval and licence conditions.

The water management strategy focusses on six principal objectives:

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. Management of water resources to ensure continuous water supply for mining operations and the Concentrator whilst minimising water abstraction and maximising water recycling;

5. Management of the operational risk of Open Pit inundation to ensure continuous mining operations and protection of assets; and

6. Ensure water management is conducted in accordance with all of MRM's regulatory obligations including the Mining Management Plan, WDL 174, and EPBC Approvals 2003/954 and 2014/7210.

For detail on the BBLF water management system, refer to Appendix J - *Bing Bong Loading Facility Environment Management Plan 2019/20*.

6.2.1 Site Water Balance

The site water balance for the Mine is undertaken annually to assess the historical performance of the water management system as well as forecast performance over a four year period to determine:

- the ability to meet water supply requirements for mine water demands such as Mill makeup water, dust suppression, clay conditioning, etc.;
- the risk of overflows from on-site water storages;
- the risk of Open Pit inundation and the ability to dewater the Open Pit within an acceptable time frame;
- the likely behaviour of the various on-site storages during the coming two years;
- the frequency and volume of managed releases to the McArthur River;
- information for storage and pumping infrastructure requirements and TARP trigger levels for each year; and
- recommendations for additional monitoring and investigations to improve the accuracy of future mine water balances.

The *2019/20 Site W*ater *Balance for the McArthur River Mine* is appended to the WMP.

6.2.2 Water Licensing

MRM will consult with the DENR to confirm the water licensing requirements for the activities proposed under the 2020 MMP. MRM will comply with the requirements of the NT *Water Act 1992*, including obtaining and holding water licences where necessary.

7 Reporting

7.1 Environmental Performance Reporting

A review of environmental performance relating to the above plans and programs is reported annually as part of the OPR. MRM will continue to report on environmental performance in the annual OPR.

7.2 Incident Reporting

Incident reporting is recorded and tracked in MRM's on-site safety system (BSafe) and is reviewed daily. Information recorded when an incident is identified includes the following:

- incident number (used for tracking purposes);
- the date of the incident;
- the person who 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; and
- actions completed.

Reporting of environmental incidents or serious environmental incidents will occur in accordance with MRM's incident reporting protocol (Appendix Q).

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

8 Closure Planning

8.1 Unplanned Closure Plan

The *Mining Management Plan Structure Guide for Mining Operations* (DPIR, 2017) requires an unplanned closure plan to address the possibility and impacts of unscheduled and unplanned termination of operations during the life of the MMP.

A conceptual Mine Closure Plan was developed as part of the Draft OMP EIS, which describes the LOM closure plan. The objectives of the unplanned closure plan remain consistent with the conceptual Mine Closure Plan, which have generally been defined as:

- The Post-mining landscape will be left in a condition safe and secure for humans and animals.
- The Post-mining landscape will be a stable landform, non-polluting and able to sustain an agreed post-mining land use.

The Unplanned Closure Plan that has been prepared for this MMP has adopted suitable rehabilitation methods to the specific risks and characteristics of each mine component. Accordingly, mine components have been divided into rehabilitation domains, which have similar geophysical characteristics, risks, and rehabilitation objectives and approaches. The domains are as follows:

- Domain 1 – Infrastructure
- Domain 2 – Borrows Pits and Quarries
- Domain 3 – Open Pit
- Domain 4 – Underground Workings
- Domain 5 – Tailings Storage Facility and Water Storages
- Domain 6 – Stockpiles & Overburden Emplacement Facilities
- Domain 7 – Exploration
- Domain 8 – Access and Haul Roads
- Domain 9 – River Diversions

The Unplanned Closure Plan for this MMP, including the full list of objectives and the proposed unplanned closure methods are provided in Appendix P.

9 Abbreviations

°	Degrees
°C	Degrees Celsius
%	Percent
2013-2015 MMP	Sustainable Development Mining Management Plan 2013-2015
2018-2019 OPR	2018-2019 Operational Management Plan
AAPA	Aboriginal Areas Protection Authority
ABS	Australian Bureau of Statistics
AD	Acid Drainage
AEP	Annual Exceedance Probability
AMD	Acid Metalliferous Drainage
AMP	Adaptive Management Plan
ARI	Average Recurrence Interval
As	Arsenic
AS	Australian Standard
BbH	Black Bituminous Shale
BBLF	Bing Bong Loading Facility
CBT	Community Benefits Trust
CCL	Compacted Clay Liner
Cd	Cadmium
CE	Central East
CEAS	Central East Alpha Sump
CEBS	Central East Bravo Sump
CRP	Concentrator Runoff Pond
CTP	Construction Test Pads
CW	Central West
CWAS	Central West Alpha Sump
DENR	Northern Territory Department of Environment and Natural Resources
Design and Construction Plan	General Specification for Design and Construction Document

DITR	Northern Territory Department of Industry, Tourism and Resources
dmtpa	Dry metric tonnes per annum
DPIR	Department of Primary Industry and Resources
EDS	East Drain Sump
EIS	Environmental Impact Statement
ELS	East Levee Storage
EMF	Environmental Management Framework
EMS	Ecological Management Services
Environmental Assessment Act	Northern Territory *Environmental Assessment Act, 2013*
EOEF	East Overburden Emplacement Facility
EPBC Act	*Environment Protection and Biodiversity Conservation Act, 1999*
EPROD	East Perimeter Runoff Dam
ERA	Environmental Risk Assessment
ERP	Emergency Response Plan
FMS	Fleet Management System
GL	Gigalitre
GSL	Geosynthetic liner
H_2S	Hydrogen Sulphide
ha	Hectares
HDPE	High-density Polyethylene
HSEC	Health, Safety, Environment and Community
HW	Hangingwall Pyrite
HYC	Here's Your Chance
ICE	Independent Certifying Engineer
ICP-AES	Inductively Coupled Plasma Atomic Emission Spectroscopy
IRSA	Inter-ramp Slope Angle
ISO	International Standards Organisation
ITRB	Independent Tailings Review Board
KCB	Klohn Crippen Berger
kL	Kilolitres
km	Kilometres

km^2	Square Kilometres
kt	Kilo tonnes
LG	Low-grade
LGS	Low-grade Sump
LOM	Life of Mine
LS-NAF	Low Salinity Non-Acid Forming rock
LS-NAF (HC)	Low Salinity Non-Acid Forming rock (High [Acid Consumption] Capacity)
m	Metres
m/s	Metres per second
MA	Mineral Authority
m AHD	Meters Australian Height Datum
mg/L	Milligrams per litre
MIA	Mine Infrastructure Area
MIBC	Methyl Isobutyl Carbinol
ML/day	Megalitres Per Day
MLDP	Mine Levee Discharge Point
MLN	Mineral Lease Northern
mm	Millimetres
MMP	Mining Management Plan
mN	Metres north
MNES	Matters of National Environmental Significance
mRL	Metres Reduced Level
MRM	McArthur River Mining Pty Ltd
MS-NAF	Metalliferous Saline Non-Acid-Forming rock
MS-NAF (HC)	Metalliferous Saline Non-Acid-Forming rock (High [Acid Consumption] Capacity)
MS-NAF (LC)	Metalliferous Saline Non-Acid-Forming rock (Low [Acid Consumption] Capacity)
Mt	Million tonnes
Mtpa	Million tonnes per annum
MUDS	Mine Underground Dewatering Systems
Na_2CO_3	Sodium Carbonate
NaOH	Sodium Hydroxide

NaSH	Sodium Hydrosulfide
NC1A	Northern Crossing 1A
NE	Northeast
NES	North East sump
NESB	North East stilling basin
NMD	Neutral Metalliferous Drainage
NOEF	North Overburden Emplacement Facility
NOEF MP	North Overburden Emplacement Facility Management Plan
NPR	Neutralisation Potential Ratio
NT	Northern Territory
NT EPA	Northern Territory Environmental Protection Authority
NUDLC	National Uniform Drillers Licensing Committee
NW	Northwest
NWS	North West sump
OEF	Overburden Emplacement Facility
OMP	Overburden Management Project
OPR	Operational Performance Report
PAF	Potentially Acid-Forming rock
PAF (HC)	Potentially Acid-Forming rock (High [Acid Production] Capacity)
PAF (RE)	Potentially Acid-Forming rock (Reactive)
PAF (HW)	Potentially Acid-Forming rock (Hangingwall pyrite)
Pb	Lead
PBOX	Lead Oxidative Leach
Phase 3	MRM Phase 3 Development Project
ppm	Parts per million
PROD	Perimeter Runoff Dam
QA/QC	Quality Assurance/Quality Control
RACI	Responsible, Accountable, Consulted and Informed
RO	Reverse Osmosis
ROM	Run-of-mine
S	Sulfur

SE	Southeast
SEPROD	Southeast Perimeter Runoff Dam
SLA	Statistical Local Area
SOEF	South Overburden Emplacement Facility
SO_2	Sulfur dioxide
SPROD	South Perimeter Runoff Dam
SRP	Surface Runoff Pond
SSB	South Stilling Basin
SSTV	Site Specific Trigger Value
SUPT	Superintendent
TARP	Trigger Action Response Plan
TAS	Todoroski Air Sciences
the Mine	McArthur River Mine
the RMP	The Rehabilitation Management Plan
TPWC Act	Northern Territory *Territory Parks and Wildlife Conservation Act, 1976*
TSF	Tailings Storage Facility
TSF LOM Plan	Tailings Storage Facility Life of Mine Plan
VDD	Van Duncan's Dam
VMU	Vegetation Mapping Unit
VOA	Variation of Authorisation
WDL	Waste Discharge License
WMD	Water Management Dam
WMP	Water Management Plan
WOEF	West Overburden Emplacement Facility
WRM	WRM Water & Environment Pty Ltd
Zn	Zinc

10 References

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11 Appendices

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