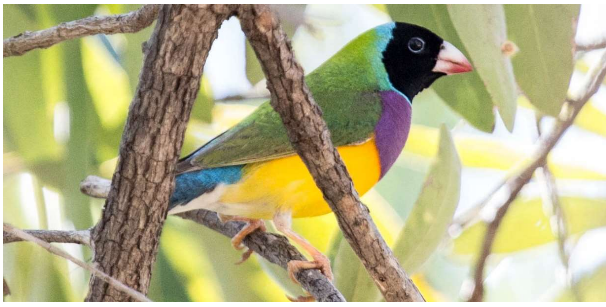
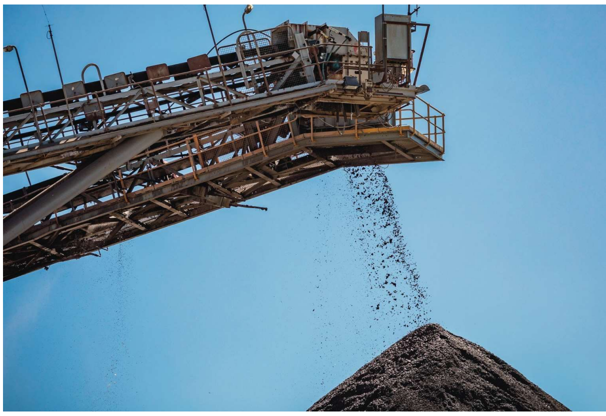
Environmental Monitoring Report

MCARTHUR RIVER MINE

McArthur River Mining Pty Ltd



August 2020

A GLENCORE Company

Environmental Monitoring Report 2019-2020

1 May 2019 to 30 April 2020

MCARTHUR RIVER MINE

McArthur River Mining Pty Ltd
August 2020

DOCUMENT PROPERTIES

Date	31 August 2020
Department, Area	Environment
Prepared by	McArthur River Mining Pty Ltd

A GLENCORE Company

McArthur River Mine

Authorisation Number: Variation of Authorisation 0059 (10 August 2020)

I, <u>Adam Hatfield, Manager – Health, Safety, Environment & Community</u>, declare that to the best of my knowledge the information contained in this mining management plan is true and correct and commit to undertake the works detailed in this plan in accordance with all the relevant Local, Northern Territory and Commonwealth Government legislation.

Signature:

Date:

31 August 2020

Executive Summary

This Environmental Monitoring Report has been prepared by McArthur River Mining Pty Ltd (MRM) for the McArthur River Mine (the Mine) and the Bing Bong Loading Facility (BBLF) (Figures ES1, ES2 and ES3).

The Environmental Monitoring Report describes the environmental and operational performance of the Mine and BBLF between 1 May 2019 and 30 April 2020 (the reporting period). In addition, long-term environmental and operational monitoring data is reviewed as part of the Environmental Monitoring Report to identify adverse or unexpected trends that require management.

Overall, based on external experts' and MRM's review of environmental monitoring data, it is concluded key environmental objectives are being met. The key environmental objectives are summarised as follows:

1. Protect the McArthur River beneficial uses and community values from mining impacts.
2. Facilitate development of the ecosystems and their functions along the McArthur River Diversion Channel for terrestrial and aquatic flora and fauna.
3. Minimise air quality related impacts from the Mine's operations with respect to community health and the environment.
4. Protect the environment (terrestrial and marine) near the BBLF and transhipment corridor.

Operational Activities

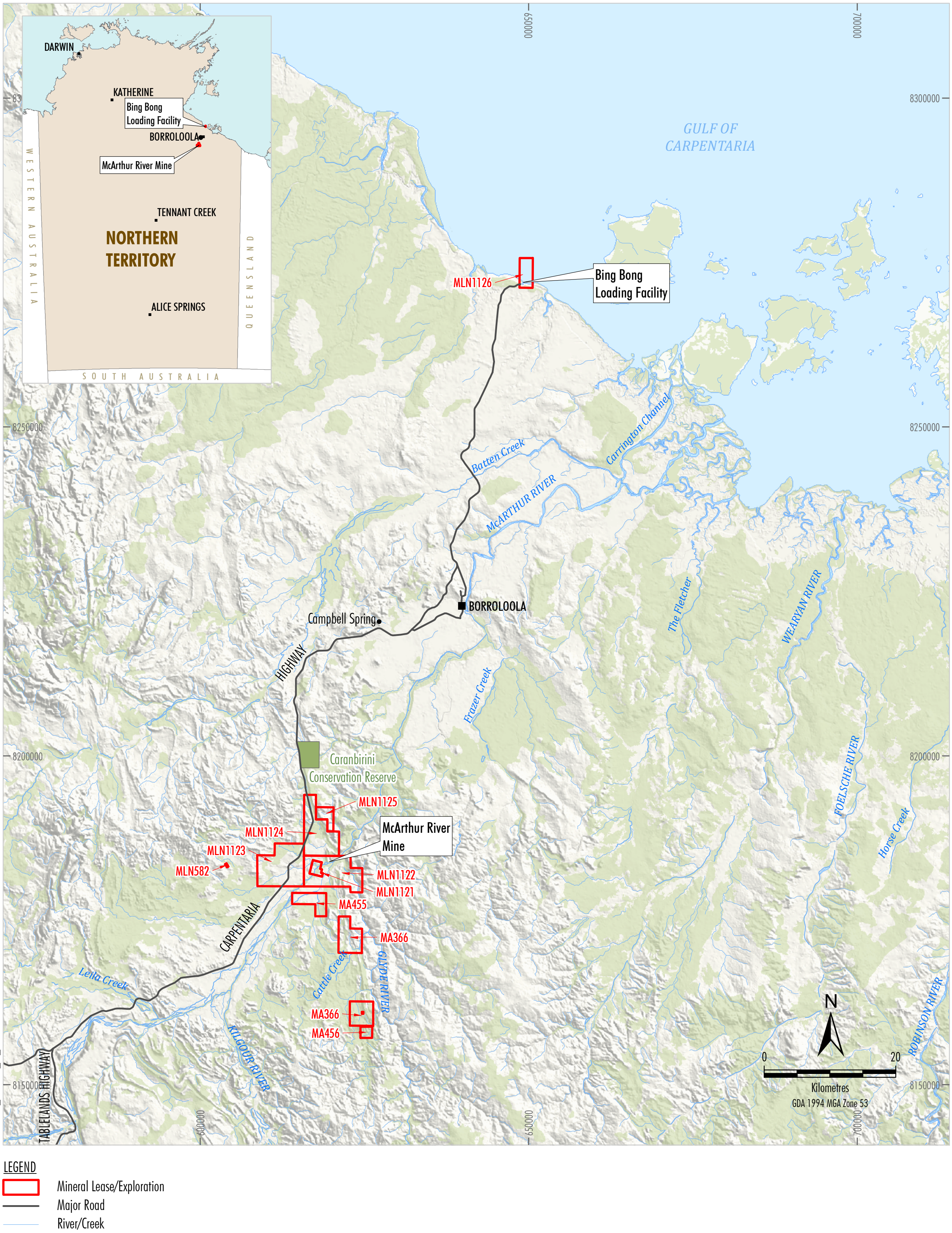
The Mine and BBLF operate in accordance with Variation of Authorisation 0059 and the 2013-2015 Mining Management Plan and its approved amendments. Key operational activities conducted during the reporting period included:

- Mining of waste rock and ore in the Open Pit.
- Emplacement of waste rock at the North Overburden Emplacement Facility (NOEF) consistent with management procedures for handling non-benign and benign material.
- Construction and upgrade of water management infrastructure (Plate ES1).
- Processing of ore (including low grade ore rehandled from stockpiles) at the mill area.
- Deposition of tailings in Cells 1 and 2 of the Tailings Storage Facility, following the recommencement of Cell 1 operation.
- Transport of product material to the BBLF and then via barge to ships in the Gulf of Carpentaria.
- Exploration activities and a regional drilling program for hydrogeological testing, characterisation of waste materials and the installation of geotechnical and environmental monitoring sites.

Environmental Activities

Key environmental activities conducted during the reporting period included:

- Development of the TSF Interception Trench to manage seepage from the Cell 1 of the TSF.
- Ongoing drilling at key areas of the site to refine the hydrogeological model.
- Rehabilitation trials to inform long term performance and design of the NOEF cover system.
- Ongoing rehabilitation and revegetation activities.



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

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Regional Locality

Figure ES-1

LEGEND

Mineral Lease

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

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Mine Site

Figure ES-2

LEGEND

Mineral Lease

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

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Bing Bong Loading Facility

Figure ES-3

MRM-16-01_EMR2020_ES_203A

Plate ES1: Lining of Central West Charlie Sump at the North Overburden Emplacement Facility

Environmental Management Strategy Overview

MRM (with the assistance of external experts) operates an extensive environmental management strategy.

Key objectives for the environmental management strategy have been developed through the outcomes of environmental assessment processes (including Environmental Impact Statements), stakeholder engagement and feedback, development of management and monitoring plans, independent monitoring reviews and regulatory approvals (Plate ES2).

The key environmental objectives for the Mine and BBLF are:

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. Minimise air quality related impacts from the Mine's operations with respect to community health and the environment.
4. Protect the environment (terrestrial and marine) near the BBLF and transhipment corridor.

MRM achieves these objectives through the implementation of the environmental management strategy (Plate ES2), which uses a tiered management approach comprising preventative management, environmental performance indicators (with associated contingencies) and performance verification. This tiered approach is illustrated in Plate ES3.

External experts are engaged to assist with the collection, review and analysis of environmental monitoring data collected during the reporting period. These experts have provided conclusions regarding environmental performance (as reported in the technical appendices to this Environmental Monitoring Report).

Climatic Conditions over the Reporting Period

Climatic conditions are known to significantly influence the natural environment in the vicinity of the Mine, in particular the McArthur River and its tributaries. Whilst total rainfall over the reporting period was recorded as being above average, the majority of this rain (more than 97 percent) fell during the delayed 2019-2020 wet season, with the first significant rainfall occurring on 7 January 2020.

As a result, periods of stream connectivity in the main tributaries surrounding the Mine were greatly reduced during the reporting period, compounded by the effects of the 2018-2019 wet season recording the lowest flows and rainfall of any year since 2008 (approximately 200 millimetres below average). For example, Aquatic Fauna Abundance and Diversity Monitoring was attempted at nine sites along the Barney Creek and Diversion Channel during the late dry season, each of which typically contain aquatic fauna during the early dry season, but all were found to be dry.

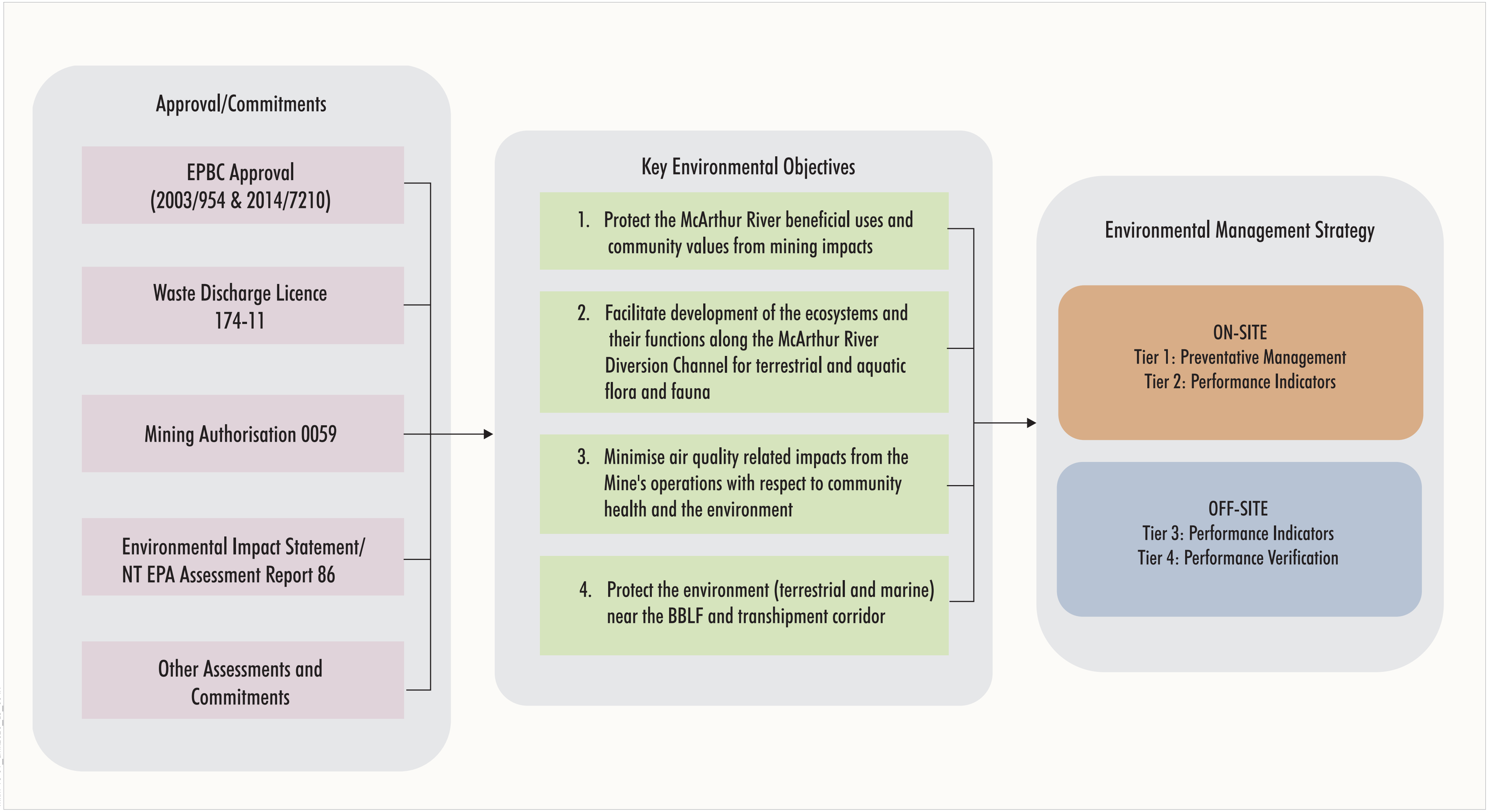
Environmental Performance Review

Overall, based on external experts' and MRM's review of environmental monitoring data, it is concluded key environmental objectives are being met.

Figure ES4 provides an overview of the environmental performance of each monitoring program based on the conclusions of the external experts.

For the monitoring programs shaded green on Figure ES4, the data demonstrates the performance indicators required to meet key environmental objectives are being achieved, and on this basis, the existing monitoring and management measures should be continued.

For three monitoring programs, the external experts recommended additional monitoring and/or management be undertaken to confirm performance indicators will continue to be achieved (Figure ES4). These recommendations, and how they will be implemented, are outlined in Table ES1.



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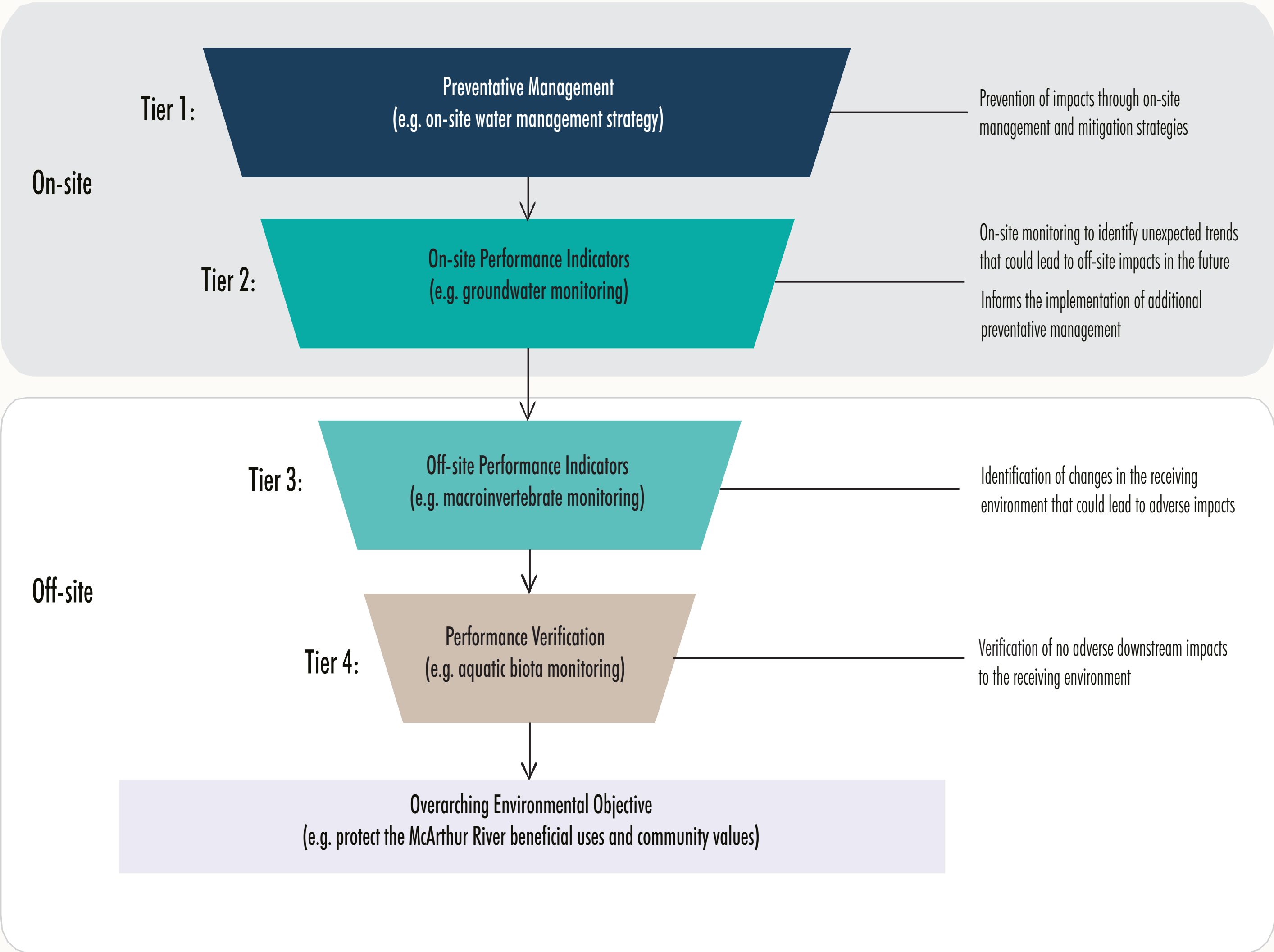
Development of Key Environmental Objectives for the Environmental Management Strategy

Plate ES2



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Environmental Management and Monitoring Tiers

Plate ES3

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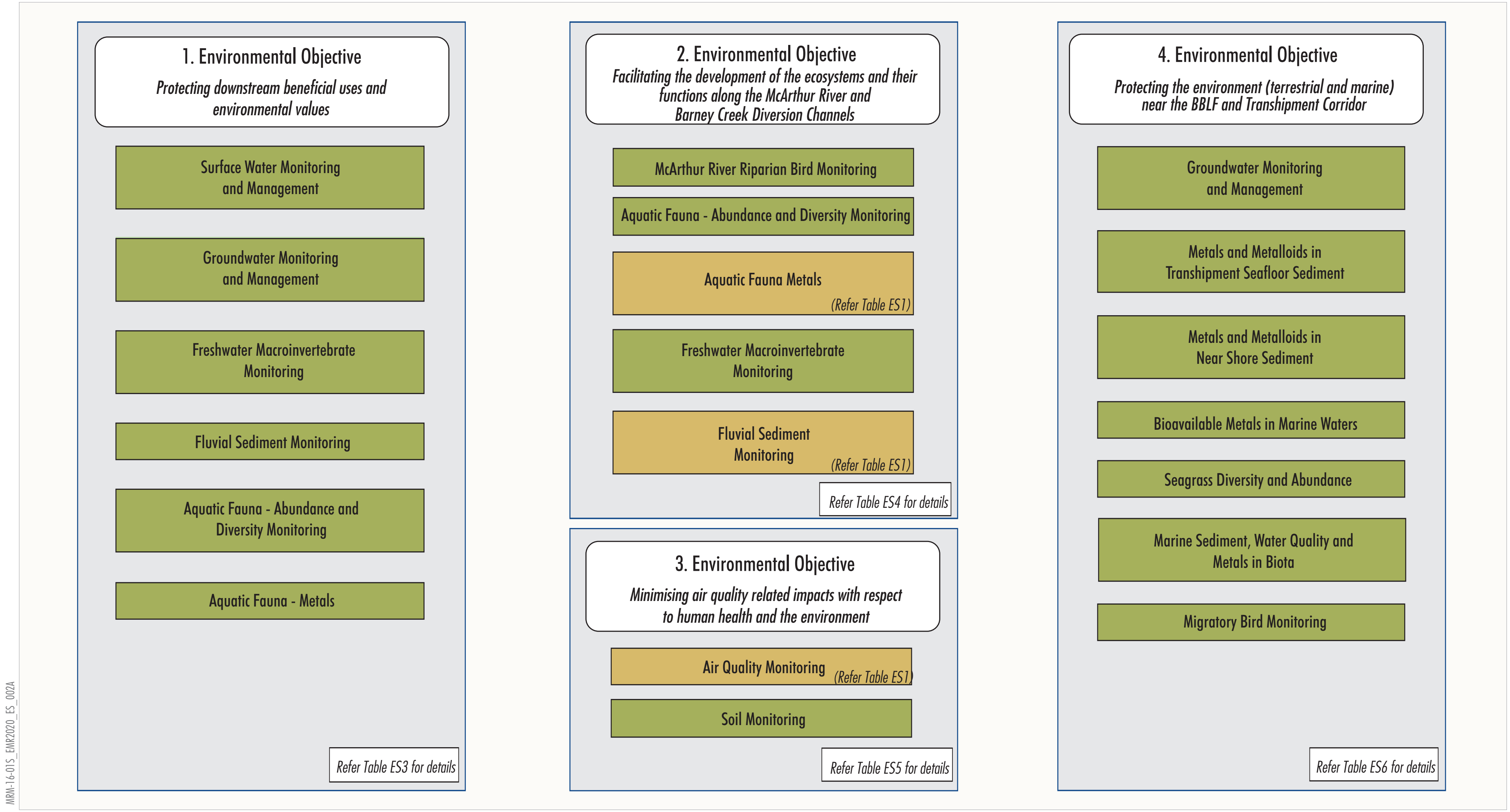

LEGEND

- Additional monitoring or management measures recommended to confirm performance (Refer Table ES1)
- Required performance achieved - continue existing monitoring and management measures

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MRM Environmental Objectives and Relevant Monitoring Programs

Figure ES4

TABLE ES1: ADDITIONAL MONITORING AND/OR MANAGEMENT MEASURES RECOMMENDED

Program	Additional Monitoring and/or Management	Implementation
Fluvial Sediment Monitoring	Dr Dean Thorburn of Indo-Pacific Environmental (IPE) recommended that MRM investigate the viability of extending the sediment remediation program to include the lower reach of Barney Creek in the vicinity of FS20 and FS06 to reduce the likelihood of this sediment reaching the McArthur River.	MRM continues to undertake remediation along Barney Creek near FS19, including physical removal of sediment from the Barney Creek batters, sump and creek bed near the Barney Creek Bridge (refer Plate ES4). MRM will continue to undertake remediation works as required. MRM is investigating the viability for extending the program into the area suggested by IPE, with safe access being required.
Aquatic Fauna – Metals in Fish Program	Due to the close correlation between biota tissue concentrations and fluvial sediment concentrations, improvements in fluvial sediment quality (as per the recommendation above) will likely result in reduced concentrations in biota over time. Dr Dean Thorburn of IPE noted that there is scope to increase the tracking area of the current acoustic monitoring program to include *L. calcarifer* and *H. fuliginosus* within Barney and Surprise Creeks. This would provide insight into the residential times of these species within sites showing influence from MRM operations and also indicate if these individuals return to the McArthur River main channel where they could be potentially caught and consumed by the public.	MRM will undertake an expansion of the acoustic monitoring program within the next reporting period. Three new receivers and twenty new acoustic tags have been acquired for implementation.
Air Quality Program	TAS and MRM have identified further opportunities to reduce dust associated with the Mill and haulage of waste rock over Barney Creek Bridge.	Refer Table ES2.

Holistic Environmental Performance Review

In addition to the findings and recommendations of the individual monitoring programs, a review of the environmental performance at the Mine site and BBLF over the reporting period has been undertaken using a weight of evidence assessment. Data from multiple monitoring programs have been considered holistically to improve the understanding of how contaminant sources influence the environmental performance indicators at receptors. Results of key monitoring programs have been reviewed to determine whether there are potential areas of significant environmental risk that require further management.

It has been identified that major sources of elevated contaminants of potential concern in the fluvial sediment and biota monitoring are dust from the Mill and the associated material handling and processing, and dust associated with haulage of waste rock over the Barney Creek Bridge.

Further measures and investigations will be carried out during the next reporting period to improve the management of dust from these sources and reduce the potential risk to fluvial sediment and biota as outlined in Table ES2.

TABLE ES2: DUST MITIGATION MEASURES TO BE UNDERTAKEN DURING THE NEXT REPORTING PERIOD

Identified Contaminant Source	Measures to be Undertaken in next Reporting Period	Timing
Dust impacts associated with haulage across Barney Creek Bridge	• Trial of dust suppression binders / additives for watering of haul roads. • Investigate the viability of extending the sediment removal program to include the lower reach of Barney Creek in the vicinity of FS20 and FS06. This will be dependent on safe machinery access, AAPA and water licensing approvals. • Annual assessment and management of sediments along the Barney Creek batters, sump and creek bed near the Barney Creel Bridge. • Further planned use of the newly commissioned water trucks to reduce wheel-sourced dust from vehicle movements.	2020-21 reporting period.
Dust impacts associated with the Mill operations	• Trial of dust suppression binders / additives in the Mill area. • Investigate options for providing a clean water source to the Primary Crusher/ ROM hopper, to allow for improved operation of the recently installed dust suppression system. • Further planned use of the newly commissioned water trucks to reduce wheel-sourced dust from vehicle movements.	2020-21 reporting period.

Plate ES4: Sediment Removal from Barney Creek

Environmental Management During the Next Reporting Period

MRM submitted its Adaptive Management Plan to the Department of Primary Industry and Resources in January 2020 in accordance with the conditions of Variation of Authorisation 0059. The Adaptive Management Plan will be revised and submitted to the Department of Environment and Natural Resources in accordance with the conditions of Waste Discharge Licence 174-11.

The Adaptive Management Plan will continue to undergo updates in light of any relevant new information from technical investigations, and to meet various other regulatory requirements. This will include further formalisation of the triggers for each monitoring program, which are linked to the environmental objectives for the Mine. The Adaptive Management Plan will also outline the actions and processes to be implemented in response to any exceedance of performance indicators, which will include investigations to identify sources for targeted management measures to be implemented.

1. *Environmental Objective: Protect the McArthur River Beneficial Uses and Community Values from Mining Impacts*

The following management measures and monitoring programs are implemented to reduce potential downstream impacts to the McArthur River and to verify the protection of McArthur River beneficial uses and community values from mining impacts:

- **Tier 1: Preventative management measures and monitoring:**
    - On-site water management strategy, including management and treatment of water storage/inventory to reduce the potential for uncontrolled release of contaminants off-site.
    - Ongoing review of site water balance and water management system.
    - Dust suppression measures outlined in the air quality management plan.
- **Tier 2: On-site performance indicators:**
    - Monitoring of on-site artificial surface water quality (i.e. on-site water storages), groundwater quality, surface water quality, and fluvial sediment (i.e. on-site watercourses) (Table ES3) to identify adverse or unexpected trends.
    - Implementation of additional proactive management controls as necessary (Plate ES5).
- **Tier 3: Off-site performance indicators:**
    - Monitoring of downstream surface water and comparison to Site Specific Trigger Values (Table ES3).
    - Monitoring of downstream macroinvertebrate abundance and diversity (Table ES3).
- **Tier 4: Off-site performance verification:**
    - Monitoring of the abundance and diversity of aquatic fauna (Table ES3).
    - Monitoring of metal concentrations in aquatic fauna (Table ES3).

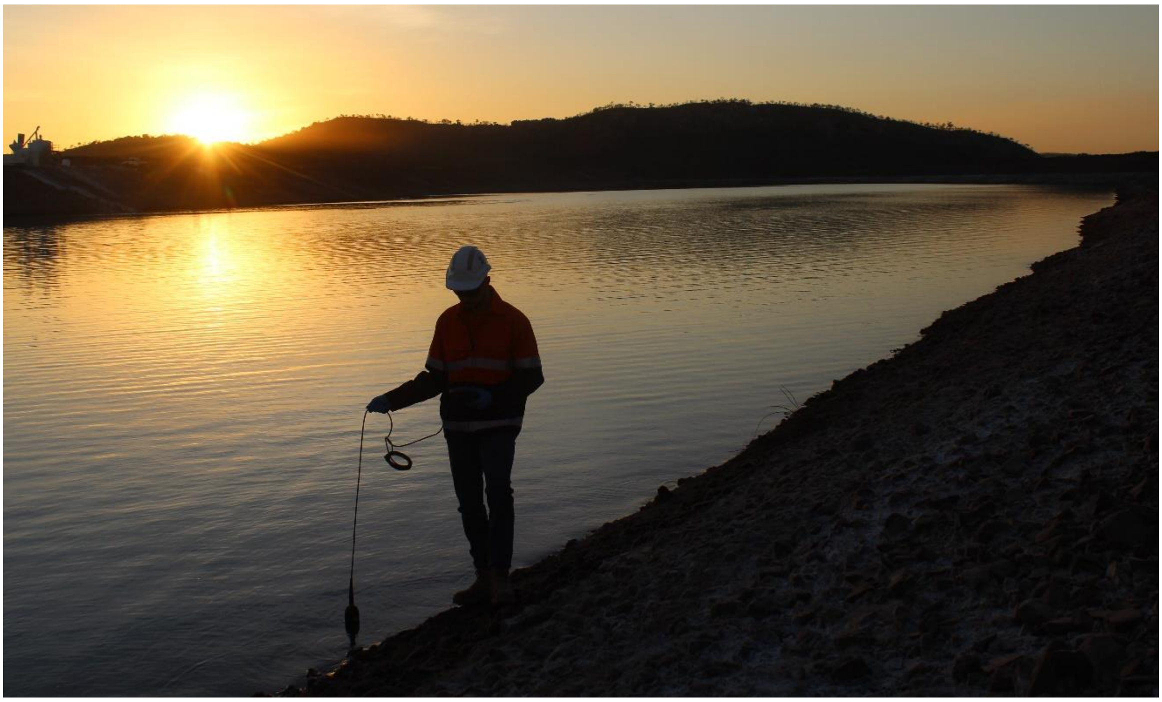

Plate ES5: Surface Water Quality Sampling

A review of environmental monitoring data for Tiers 2 to 4 has been undertaken by the following external experts:

- Dr Dean Thorburn of IPE.
- Dr Brent Usher of Klohn Crippen Berger (KCB).
- Mr Todd Hodgkin and Ms Elizabeth Stanmore of Pando Australia (Pando).

The key conclusions of the external experts in regard to Objective 1, protection of McArthur River beneficial uses and community values from mining impacts, are provided in Table ES3.

TABLE ES3: KEY OUTCOMES OF SPECIALIST REVIEWS RELATING TO THE PROTECTION OF MCARTHUR RIVER BENEFICIAL USES AND COMMUNITY VALUES FROM MINING IMPACTS

Environmental Monitoring Program	Key Outcomes of Expert Specialist Review
Groundwater	Pando concluded: - *Sulphate and zinc concentration trends are behaving as modelled in the OMP EIS and EIS-S (KCB 2017a, KCB2017b) where sulphate plumes are predicted downgradient of the NOEF, TSF and any unlined water management facilities.*
Surface Water	KCB concluded: - *Based on the review of surface water quality monitoring data between 1 May 2019 and 30 April 2020, MRM continue to implement effective controls to minimise the contamination of receiving waters downstream of the Mine.* - *The review concluded that the beneficial uses and community values of the McArthur River continue to be protected from potential mining impacts.* - *No mine derived SSTV exceedances or non-compliances were recorded at the SW11 compliance point in the McArthur River during the reporting period.* - *The SSTV exceedances recorded at SW11 during the reporting period, are not considered to be related to mine activities, and are considered to be as a result of natural river processes and contributions from areas upstream of the Mine.*
Freshwater Aquatic Macroinvertebrates	IPE concluded: - *Additionally, analysis of assemblages at reference sites located on the McArthur River upstream and downstream of MRM operations indicated that there were no significant differences in the 2019 sampling period. As such, and consistent with years prior, there continues to be no detectible decline or change in freshwater macroinvertebrate populations resulting from MRM mining and processing operations at downstream reference sites.*
Aquatic Fauna – Diversity and Abundance	IPE concluded: - *The current survey found decreased abundance of all species… This decreased abundance is considered a reflection of the very limited connectivity period throughout the survey area during the previous wet season rather than any particular anthropogenic influence, including mining related impacts. In fact, regional reference sampling for MRM's metal concentrations in freshwater biota program conducted in June 2019 found a general low abundance of all aquatic biota within both the Limmen and Robinson Rivers, strengthening the hypothesis that current abundance levels are related to naturogenic region wide conditions rather than anthropogenic influence.* - *Regardless of current total abundances, the relative abundance and distribution of species within current survey was consistent with those recorded between 2014 to 2018 indicating overall populations and distributions remain relatively balanced.* - *The current data continues to support past conclusions that there has been no observable decline in species diversity in waters upstream and downstream of the mineral lease, outside of that which would be considered natural variation or as a result of variable seasonal flows or changes in river bed morphology*

Environmental Monitoring Program	Key Outcomes of Expert Specialist Review
Aquatic Fauna – Metals	IPE concluded: - *Overall the analysis of environmental indicator species showed that MRM operations continue to have little measurable effect on the McArthur River main channel, and that elevated tissue metal concentrations are limited to Barney and Surprise Creek sites within operational areas.* - *The concentrations of lead in commonly consumed finfish was well below the applicable MPC of 0.5 mg/kg with safe consumption amounts being vastly greater than the current Food Standards Australia New Zealand (FSANZ) recommendation of 2-3 servings of fish per week.* - *Data collected during 2019 demonstrated that all L. calcarifer and H. fuliginosus caught throughout the McArthur River catchment, including mine lease areas, were considered safe to consume.* - *If geographical location is taken into consideration, the lead concentrations recorded for 2019 were relatively consistent with those reported in previous years.*
Fluvial Sediment	IPE concluded: - *The combined analysis of fluvial sediment and environmental indicator species sampled during 2019 showed MRM operations continue to have little measurable effect on the McArthur River main channel.*

Todd Hodgkin (Pando) Dr Brent Usher (KCB) Dr Dean Thorburn (IPE)

Note: Green shading indicates performance required to meet the environmental objectives is being achieved and the existing monitoring and management measures should be continued (refer Figure ES4).

2. Environmental Objective: Facilitate Development of the Ecosystems and their Functions along the McArthur River Diversion Channel

The following management measures and monitoring programs are implemented to progress the development of the ecological function of the McArthur River and Barney Creek Diversion Channels:

- **Tier 1: Preventative management measures and monitoring:**
  - Revegetation activities as outlined in the Rehabilitation Management Plan.
  - Active management of the revegetation areas, including management of weeds and pests.
  - Installation of large woody debris within the Diversion Channel to create aquatic habit.
  - Management of cattle in accordance with the Cattle Management Plan.
- **Tier 2: On-site performance indicators:**
  - Diversion Channel revegetation monitoring.
  - Monitoring of riparian bird abundance, diversity and movement along the Diversion Channel vegetation (Table ES4).
  - Monitoring of macroinvertebrate abundance and diversity within the Diversion Channels (Table ES4).
  - Monitoring of surface water quality within the Diversion Channels.
  - Monitoring of fluvial sediments within the Diversion Channels.
  - Monitoring of aquatic fauna abundance and diversity within the Diversion Channels.
  - Monitoring of metals in aquatic fauna within the Diversion Channels.

- **Tier 3: Off-site performance indicators:**
  - Monitoring of upstream and downstream macroinvertebrate abundance and diversity (Table ES4).
  - Monitoring of metals in aquatic fauna upstream and downstream of the Diversion Channels.
- **Tier 4: Off-site performance verification:**
  - Monitoring of the abundance and diversity of aquatic fauna upstream and downstream of the Diversion Channels to confirm fish passage (Table ES4).

Review of environmental monitoring data for Tiers 2 to 4 has been undertaken by the following external experts:

- Paul Bardon of Environmental Management Services (EMS).
- Dr Dean Thorburn of IPE.

The key conclusions of the external experts in regard to Objective 2, development of the ecological function of the McArthur River and Barney Creek Diversion Channels, are provided in Table ES4.

Photos of the revegetation activities in the McArthur River Diversion Channel are provided in Plate ES6.

Plate ES6: Revegetation Activities

TABLE ES4: KEY OUTCOMES OF SPECIALIST REVIEWS RELATING TO THE FUNCTION OF THE ECOSYSTEMS ALONG THE MCARTHUR RIVER DIVERSION CHANNEL

Environmental Monitoring Program	Key Outcomes of Expert Specialist Review
Fluvial Sediment	IPE concluded: - *Concentrations of arsenic, cadmium and copper in fluvial sediments from all sample sites were found to be below the relative SQGV.* - *In relation to lead, no site within the main channel of the McArthur River was found to have a concentration exceeding the SQGV of 50 mg/kg. However the bioavailable concentration of lead in fluvial sediments collected at a number of sites within Barney and Surprise Creeks was found to exceed the SQGV.* - *No fluvial sediment sample collected from any site was found to contain bioavailable lead exceeding the SQGV-High value of 220 mg/kg.* - *All sites that exceeded the SQGV for lead were within or directly adjacent operational areas. This finding is consistent with years prior, however, concentrations of lead recorded during 2019 at Barney and Surprise Creek potentially impacted sites were lower than those reported for 2018. Furthermore, sites which have historically recorded the highest lead concentrations, such as FS03, FS18 and FS19, were found to have lead concentrations lower than any year since 2012. ... Mitigation measures employed by MRM, including the physical removal of sediment and the construction of silt traps to capture runoff, have been shown to reduce analyte concentrations. Indeed, these practices should be regularly undertaken to maintain low fluvial sediment lead concentrations.* IPE recommended: - *However, noting the current results, benefit may also exist in investigating the viability of extending this remediation program to include the lower reach of Barney Creek in the vicinity of FS20 and FS06 to further reduce the likelihood of this sediment reaching the McArthur River.*
McArthur River Riparian Birds	EMS concluded: - *There has been progression at sites on the McArthur River Diversion Channel, particularly at the upper and lower ends of the Diversion Channel, where the riparian bird assemblage has increased in similarity to reference riparian forest over time.* - *Bird communities at sites on the mid-section of the Diversion Channel support lower numbers of species, particularly forest and woodland passerine birds. These sites have yet to be revegetated and this is reflected in riparian condition assessment scores and bird assemblage data.* - *Impediments to revegetation at these sites include the narrow gauge of the Diversion Channel, steep banks, areas of erosion and exposed bedrock.* - *Analysis of habitat data indicates that bird species diversity is positively correlated with indicators based on improving vegetation structure and condition and negatively correlated with disturbance related variables.* - *MRM are undertaking extensive revegetation works to improve this situation, and these efforts are improving the condition of the available riparian bird habitat.* - *Ongoing development of regenerating vegetation on Barney Creek has resulted in all revegetation sites in this area supporting a bird assemblage that is increasingly similar to open woodland and riparian (minor drainage line) reference sites.* - *Between 2014 and 2019, all sites on the Barney Creek Diversion Channel showed improvement in terms of the bird assemblage present.* - *The movement of riparian specialist birds (buff-sided robin) into the lower Barney Creek Diversion Channel in 2018 is a sign that conditions are improving as regenerating vegetation develops.*

Environmental Monitoring Program	Key Outcomes of Expert Specialist Review
Freshwater Aquatic Macroinvertebrates	IPE concluded: - *Macroinvertebrate assemblages from edge habitats at impact minor drainage line sites were generally lower in abundance, however, were not found to be significantly different when compared to those at reference sites. Furthermore, taxa diversity was found to be somewhat similar.* - *With respect to McArthur River Diversion Channel sites, analysis indicated that both riffle and edge habitat macroinvertebrate assemblages were not significantly different to those at McArthur River reference sites.* - *For edge habitat* [within the McArthur River Diversion Channel]*, these results generally conform to historic results whereby edge macroinvertebrate assemblages appear to be improving and increasing in resemblance to those at McArthur River reference sites. This is likely being driven by the regeneration of bankside riparian vegetation and the placement of large woody debris within the Diversion Channel.* - *These results conform to those obtained between 2008 and 2018 which indicated that within two years of operation macroinvertebrate assemblages at riffle sites within the McArthur River Channel resembled, and continue to resemble, those at McArthur River reference sites.* - *Additionally, analysis of assemblages at reference sites located on the McArthur River upstream and downstream of MRM operations indicated that there were no significant differences in the 2019 sampling period. As such, and consistent with years prior, there continues to be no detectible decline or change in freshwater macroinvertebrate populations resulting from MRM mining and processing operations at downstream reference sites.* - *As such, some benefit may exist in discontinuing reference sites on other rivers and increasing the number of reference sample sites on the McArthur River to would allow for a more relevant comparison.*

Environmental Monitoring Program	Key Outcomes of Expert Specialist Review
Aquatic Fauna – Diversity and Abundance	IPE concluded: - *This decreased abundance is considered a reflection of the very limited connectivity period throughout the survey area during the previous wet season rather than any particular anthropogenic influence, including mining related impacts. In fact, regional reference sampling for MRM's metal concentrations in freshwater biota program conducted in June 2019 found a general low abundance of all aquatic biota within both the Limmen and Robinson Rivers, strengthening the hypothesis that current abundance levels are related to naturogenic region wide conditions rather than anthropogenic influence.* - *The aquatic fauna assemblages and abundance data during the current survey reflect the low connectivity of permanent water holes within the McArthur River during 2019. Low rainfall and limited periods of sustained connectivity during the first half of 2019 resulted in a reduction in the amount of habitat available to sustain aquatic fauna, resulting in lower captures. This aligns with results from previous aquatic surveys which show that the abundance and distribution of aquatic fauna is positively correlated to rainfall, which in turn determines river flow and connectivity.* - *Species diversity was comparable to the 2018 late dry survey, however overall abundance was 34.3% lower than the 2018 survey. This was likely due to the low rainfall experienced in 2019 which led to a lower quantity of available habitat conducive to sustaining large populations of aquatic fauna.* - *In relation to rehabilitation works within the McArthur River Diversion Channel, appropriate placement of LWD and planting of vegetation at strategic locations within the McArthur River Diversion Channel has proven to increase fish densities and diversity.* - *Low water levels within the McArthur River Diversion Channel restricted the amount of habitat available to sample in comparison to recent late dry season surveys. However, the lower diversity recorded in CHB habitats is more likely due to increased areas of large woody debris (LWD) and successful tree planting creating larger sections of CHC and thereby reducing the amount of area classified as CHB. With increased opportunity to reside within CHC habitat the aquatic fauna is not "forced' to reside in open CHB habitat.* - *In comparison to the 2018 late dry season survey, these results indicate a decrease in fish abundance* [at McArthur River Diversion Channel sites] *for the habitat classifications of USC, CHC and CHB with the exception of DSC which increased from 1.6 ± 0.59 to 2.85 ± 0.03 fish per metre during the current survey. Lower abundance within USC, CHC and CHB habitats this season is very likely is due to a reduction in the area of habitable water.*
Acoustic Monitoring	IPE concluded: - *Based on the magnitude of previous wet seasons the relative abundance of P. pristis within the reach upstream of the McArthur River Diversion Channel in 2019 was within the expected range. Overall McArthur River catchment relative abundance was higher than anticipated despite the 2019 wet season recording the lowest flows and rainfall between 2008 and 2019. As such, the McArthur River Diversion Channel or activities associated with the Mine are not considered to be restricting the movement of P. pristis throughout the McArthur River catchment or having measurable impact on the P. pristis population.*

Environmental Monitoring Program	Key Outcomes of Expert Specialist Review
Aquatic Fauna – Metals	IPE concluded: - *Overall the analysis of environmental indicator species showed that MRM operations continue to have little measurable effect on the McArthur River main channel, and that elevated tissue metal concentrations are limited to Barney and Surprise Creek sites within operational areas.* - *Analysis of samples collected in 2019 found the mean lead concentration of M. splendida at FS03 to be 0.575 mg/kg which marginally exceeded the current MPC for lead in fish of 0.5 mg/kg. However, this was less than half the concentration recorded at this site in 2018 of 1.26 mg/kg.* - *No other exceedances of any relevant MPC were recorded amongst the three environmental indicator species at any site, including sites within the Barney Creek Diversion Channel.* - *The concentrations of lead in commonly consumed finfish was well below the applicable MPC of 0.5 mg/kg with safe consumption amounts being vastly greater than the current Food Standards Australia New Zealand (FSANZ) recommendation of 2-3 servings of fish per week.* - *It is extremely unlikely that a sufficient number of V. angasi could be collected and consumed from this site on a regular basis to cause measurable harm. At sites that facilitate legal public access, and which often support larger populations of this species, it is also considered unlikely that sufficient numbers could be collected and consumed to exceed an intake of lead or zinc (or any other analyte associated with MRM operations) that is considered to have a detrimental health effect. However, the fact that very high concentrations of other analytes including aluminium, manganese, iron and total arsenic have been consistently recorded in V. angasi throughout the region over a number of years, including catchments removed from the mining lease, suggests that intake should be limited irrespective of their site of collection.*

Dr Dean Thorburn (IPE)

Paul Barden (EMS)

Note: Green shading indicates performance required to meet the environmental objectives is being achieved and the existing monitoring and management measures should be continued (refer Figure ES4).

Amber shading indicates that additional monitoring and/or management measures are recommended to be implemented to confirm environmental performance (refer Figure ES4).

3. Environmental Objective: Minimise Air Quality Impacts from the Mine's Operations with Respect to Community Health and the Environment

The following management measures and monitoring programs are implemented to protect off-site community health (with regards to airborne particles):

- **Tier 1: Preventative management measures and monitoring:**
  - Mitigation measures outlined in the Air Quality Management Plan, such as haul road watering and appropriate waste rock emplacement strategies.
- **Tier 2: On-site performance indicators:**
  - On-site air quality monitoring and comparison to historic trends and performance indicators.
  - On-site soil monitoring and comparison to historic trends and performance indicators (Table ES5).
- **Tier 3: Off-site performance indicators:**
  - Off-site air quality monitoring at reference and diagnostic monitoring locations and comparison to historic trends and performance indicators.

- Off-site metals in bush food monitoring at reference and diagnostic locations and comparison to historic trends and performance indicators.

- **Tier 4: Off-site performance verification:**
  - Air quality monitoring at compliance monitoring points representative of sensitive receivers and comparison to national health standards (Table ES5).

Review of soil monitoring data (Tier 2) and air quality monitoring data (Tiers 2 to 4) has been undertaken by Aleks Todoroski of TAS. Review of metals in bush food monitoring data (Tiers 3 to 4) has been undertaken by Dr Dean Thorburn of IPE. The key conclusions of the external expert relating to Objective 3, protection of off-site community health (with regards to airborne particles), are provided in Table ES5.

TABLE ES5: KEY OUTCOMES OF SPECIALIST REVIEWS RELATING TO AIR QUALITY

Environmental Monitoring Program	Key Outcomes of Expert Specialist Review
Air Quality	TAS concluded: - *Generally the monitoring data indicate that elevated levels of various substances were recorded at many of the monitoring locations, but mainly near to processing activities. This would be expected given that the monitoring sites are positioned in close proximity to the processing area and mining activities.* - *The interpolation of the particulate monitoring data (including lead and zinc) shows that the elevated results were confined to areas near to the Mine's processing and mining areas. The Mine's monitoring locations further from these areas generally recorded low pollutant levels, considered to be at or near to the likely background pollutant concentrations for the area. This indicates that these pollutants only travel a short distance before they are dispersed and/ or deposited.* - *It can therefore be inferred from the monitoring data that concentrations due to the mining activities at the nearest identified air quality sensitive receptor locations, such as Borroloola and Devils Spring (44km and 28km away respectively), would be significantly lower than those recorded by any Mine monitor, and would likely not be discernible from background concentrations.* - *The data indicate there were no exceedances of National Environmental Protection Measure (NEPM) guidelines for SO_2 concentrations during the reporting period, and that recorded levels at both monitoring sites were acceptable at these locations.*
Soils	TAS concluded: - *No exceedances of the NEPC (2013) commercial / industrial Health Investigation Levels (HIL) were recorded at both the Mine and the BBLF during the reporting period.* - *The October 2019 sample results were similar to historical measurements with the exception of the S22 and S24 locations, which are located near the processing facility and recorded elevated levels of most contaminants. For some sample locations, levels of lead, zinc, cadmium and copper generally increased from the mid 2000's, however the majority of the sample location levels were stable.* - *The data show that the most recent series of samples from October 2019 were similar to historical measurements.* - *From the commencement of sampling, the majority of metal and metalloid concentrations and monitoring locations at the S22 and S24 monitoring locations have increased over time, however the October 2019 levels are considerably lower than the 2018 results.* - *Another notable trend is a considerable increase in the manganese levels at S07 in the 2018 and 2019 results, which is likely due to the relocations of the monitoring location by approximately 600m south-west.* - *The levels of contaminants* [at BBLF] *were generally low.* - *At the BBLF, BBS02 recorded levels above the adopted EILs for copper and zinc.*

Aleks Todoroski (TAS)

Note: Green shading indicates performance required to meet the environmental objectives is being achieved and the existing monitoring and management measures should be continued (refer Figure ES4).

Amber shading indicates that additional monitoring and/or management measures are recommended to be implemented to confirm environmental performance (refer Figure ES4).

4. ***<u>Environmental Objective: Protect the Environment (Marine and Terrestrial) Near the BBLF and Transhipment Corridor</u>***

The following management measures and monitoring programs are implemented to monitor and protect the environment (both terrestrial and marine) near the BBLF and transhipment corridor:

- **Tier 1: Preventative management measures and monitoring:**
  - Management of water storage/inventory on-site to prevent the uncontrolled release of contaminants off-site.
  - Dust suppression measures outlined in the Air Quality Management Plan.
- **Tier 2: On-site performance indicators:**
  - Monitoring of groundwater and artificial surface water to identify adverse or unexpected trends.
  - On-site air quality monitoring and comparison to historic trends and performance indicators.
- **Tier 3: Off-site performance indicators:**
  - Monitoring of marine sediment and water quality (Table ES6).
  - Monitoring of metals and metalloids in near shore sediments (Table ES6).
  - Monitoring of metals and metalloids in transhipment area seafloor sediment (Table ES6).
  - Monitoring metals in marine waters by Diffusive Gradients in Thin Films (Table ES6).
- **Tier 4: Off-site performance verification:**
  - Monitoring of the diversity and abundance of seagrass (Table ES6).
  - Monitoring of metals in marine biota (Table ES6).
  - Migratory bird monitoring (Table ES6).

Review of environmental monitoring data for Tiers 3 and 4 has been undertaken by the following external experts:

- Dr Dean Thorburn of IPE.
- Paul Barden of EMS.

The key conclusions of the external experts in regard to Objective 4, protection of the terrestrial and marine environment near the BBLF and transhipment corridor, are provided in Table ES6.

TABLE ES6: KEY OUTCOMES RELATING TO THE PROTECTION OF THE MARINE ENVIRONMENT NEAR THE BBLF AND TRANSHIPMENT CORRIDOR

Environmental Monitoring Program	Key Outcomes of Expert Specialist Review
Metals and Metalloids in Transhipment Area Seafloor Sediments	IPE concluded: - *The overall analysis of the <63 µm fraction of seafloor sediment samples collected in 2019 showed analyte concentrations to be comparable to those concentrations reported previously by Indo-Pacific Environmental and maximum analyte concentrations continue to be well below applicable SQGVs.* - *Samples with slightly higher concentrations of lead and zinc remained localised to the main concentrate transfer location in the vicinity of the BB1 anchorage.* - *Therefore, it is considered unlikely that the transfer of shipping concentrate has resulted in measurable detrimental impacts within the benthic community and surrounding environment. The dataset to date, combined with known ship loading positions, shows that the program methods are sensitive enough to reflect known shipping movements even when analyte concentrations are below that likely to cause harm to biota and as such the current method is considered appropriate to achieve the aim of the program.*
Metals and Metalloids in Near Shore Sediments	IPE concluded: - *Comparison of mean zone arsenic, cadmium, copper, lead and zinc concentrations to relevant SQGVs (and thallium to the calculated IV) found no exceedances during the current study. The mean concentrations of arsenic, cadmium and copper were generally comparable between zones and well below the applicable SQGV.* - *In light of the analyte concentrations recorded during the current study and following the tiered framework outlined in ANZG (2018) and Batley and Simpson (2016), whilst considering the amount of <63 µm fraction within the whole sediment fraction, sediments present within the immediate vicinity of the BBLF (Zone 2, Zone 3 and Zone 4) are still considered to be of low environmental risk.*
Seagrass – Diversity and Abundance	IPE concluded: - *Overall mean seagrass percentage cover in 2019 calculated though CPCe were 40.9%, 55.1%, 56.4% and 74.1% for the BBLF, Sector 3, Sector 5 and Sector 6, respectively. In comparison to 2018, these results represent an overall decrease in mean percentage seagrass cover of 21%, 7% and 10% for the BBLF, Sector 3 and Sector 5 respectively. These decreases are considered to reflect the moderate disturbance experienced due to TC Trevor between the 2018 and the current survey and not be anthropogenic in cause. Sector 6 was found to have increased in mean percentage cover by 14% in comparison to 2018.* - *Overall changes observed within BBLF Sector were consistent with the other sectors surveyed. This indicated that over the reporting period BBLF activities had no observable impact on seagrass communities in the adjacent waters.* - *Consistent with the conclusions of previous surveys, increases in macroalgae density are still considered naturogenic, representing natural succession from epiphytic macroalgae as seagrass assemblages mature and stabilise the surrounding benthic environment thus creating greater habitable benthic environment for aquatic flora.*
Bioavailable Metals in Marine Waters	IPE concluded: - *operations at the BBLF during the current reporting period did not appear to increase the bioavailable concentrations of lead, zinc, cadmium, copper, nickel, cobalt, manganese or iron within marine waters to a level which would adversely affect the surrounding marine environment*

Environmental Monitoring Program	Key Outcomes of Expert Specialist Review
Monitoring of Marine Sediment, Water Quality and Metals in Biota	IPE concluded: - *No analytes investigated within the <63 µm sediment fraction of marine sediments collected from sites outside of the BBLF swing basin were found to exceed any applicable sediment quality guideline value (SQGV). In relation to lead and zinc, the predominant analytes of interest within the shipping product, concentrations were well below the applicable SQGVs of 50 mg/kg and 200 mg/kg. In general, sites in close proximity to the BBLF swing basin recorded higher concentrations of analytes associated with the shipping product with concentrations decreasing as distance increased from the BBLF.* - *Consistent with previous years, the concentrations of manganese, cobalt, nickel, mercury and antimony within the swing basin and maintained shipping channel sediment sample sites were relatively consistent. The concentrations of those analytes at the swing basin and maintained shipping channel sites was also comparable to results obtained from the wider AMMP survey area during the current survey and with concentrations recorded in previous years.* - *The current survey found no exceedances of any relevant Maximum Permitted Concentration (MPC) for lead specified by Food Standards Australia and New Zealand (FSANZ) in any of the of the 348 tissue samples analysed from the eight species of collected fauna.* - *The concentration of cadmium within a Saccostrea spp. sample collected at SW Island was 3.3 mg/kg which exceeded the 2 mg/kg MPC for this element. However, the mean concentration of this analyte at this site was 1.55 (± 0.45) mg/kg which was below the MPC. Cadmium concentrations were also high within Saccostrea spp. at Manta Point and Black Island, those being 1.3 (± 0.07) mg/kg and 1.225 (± 0.10) mg/kg respectively. Consistent with the findings of previous AMMPs cadmium concentration was highest within Saccostrea spp. collected at sites furthest from, and to the northeast, of the BBLF (i.e. Rosie Creek, Black Island, SW Island and Manta Point).* - *Evidence compiled through analysis of water, sediment and fauna samples collected during the 2019 AMMP indicated that influence from operations at the BBLF on the marine environment continued to be confined to the swing basin, and a small section of tidal flat on the western side of the facility. Environmental impacts coincide with mobilisation of sediments within the swing basin known to contain shipping concentrate. The impact on fauna within this relatively small area is essentially restricted to sessile species, species of low mobility and individuals of species which have extended residency times in the swing basin itself.* - *Whilst concentrations of lead, zinc and arsenic within biota collected at the BBLF were, on occasion, higher in comparison to biota collected from reference sites, the risk to human health through consumption was considered to be low.*
Migratory Bird	EMS concluded: - *Monitoring conducted in 2020 and review of data collected during counts conducted between 2010 and 2020 indicates there has been no identifiable impact on shorebirds or wetland birds within the Port McArthur Key Biodiversity Area due to MRM's operations.* - *There is a general trend indicating a decrease in numbers of migratory shorebirds within the Port McArthur study area over the past 10 years (Barden 2018c). The declining trend detected in migratory shorebirds at Port McArthur reflects declines in populations of migratory shorebirds that have occurred across Australia and the East Asian-Australasian flyway.*

Dr Dean Thorburn (IPE)

Paul Barden (EMS)

Note: Green shading indicates performance required to meet the environmental objectives is being achieved and the existing monitoring and management measures should be continued (refer Figure ES4).

Incidents

MRM maintains a comprehensive incident database for all health, safety and environmental related incidents. For each incident, investigation reports are undertaken to identify the severity of the incident, potential environmental impacts, likely causes and proposed mitigation or management measures to prevent future incidents.

During the reporting period, 27 incidents occurred which were reported to the Northern Territory Department of Primary Industry and Resources. Two of these incidents were also reported to the Northern Territory Environment Protection Authority. No incidents with the potential to cause material environmental harm occurred during the reporting period.

MRM Community Engagement

MRM has a comprehensive community engagement program that extends to Borroloola, other communities in the Gulf region and the wider Territory community. Underpinned by open, honest and transparent engagement, we work hard to form genuine and meaningful relationships with all our stakeholders and give back to the communities where we operate.

TABLE ES7: KEY MRM COMMUNITY STATISTICS

Community Interactions	1,152
Events Attended	44
Site Tours	26
App Downloads	811
App Visits	30,102

A summary of the community engagement highlights during the reporting period is given below.

Local Resident Community Workforce

Activation of a local resident community workforce who were sent home at the beginning of March 2020 to protect the Borroloola and Gulf communities from the potential transmission of COVID-19. The workforce have been working on a number of community projects, such as installing fencing, irrigation, firebreaks, working with Parks and Wildlife and the local Borroloola School, fixing potholes and cleaning. The initiative means local employees remain employed and fit and ready to return to work on site while contributing to the community they live in.

Plate ES7: Local Workforce Installing Fencing (left), and Filling Potholes (right)

Cultural Respect Strategy

Development and implementation of our Cultural Respect Strategy which demonstrates our commitment to engage with our Aboriginal and Torres Strait Islander employees, our local community stakeholders and the Traditional Owners and Custodians of the country on which we operate in a culturally appropriate manner. The initiatives within the strategy aim to ensure a culturally safe and equitable workplace at McArthur River Mine. The Cultural Respect Strategy includes a dedicated support hotline for supervisors to call for advice on cultural challenges in the workplace.

Cultural Workshops

Cultural Workshops were developed as part of the Cultural Respect Strategy, to provide MRM employees and contractors with face-to-face cultural learning experience about the local people, environment and traditional land the mine operates on. Workshops are held after hours in a voluntary capacity with attendance on average 25-30 participants. The sessions are facilitated twice per month, by Gudanji Elders and leaders, with engagement and conversation being as important as the activity being conducted. To facilitate this initiative, a culturally safe space was created in the mine village with native bush medicine plants, campfire and facilities. The outcomes have been:

- Broadened cultural competency and understanding across MRM workforce of Gudanji land and culture.
- Greater respect and willingness to learn about local culture.
- Large participation from local Indigenous employees who voluntarily attend and assist with informal learning conversations.
- Sense of reconnection with family for local Indigenous employees who are currently on site working roster away from community.

Borroloola Bush Plants – Traditional Botanical Knowledge Resource

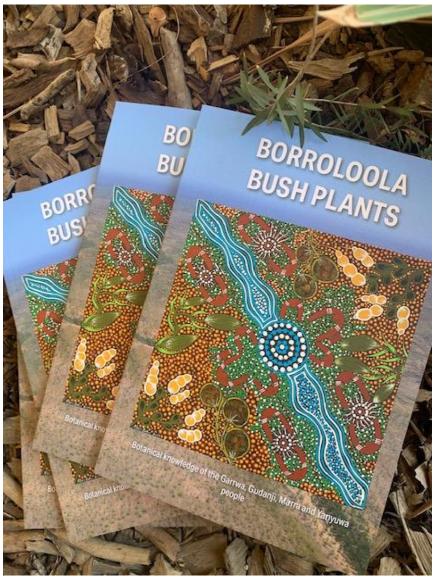

Plate ES8: Borroloola Bush Plants Book

Gudanji Elders, with the support of MRM, documented and published a botanical resource book to preserve the traditional knowledge and language relating to the diverse edible and medicinal plants within the mineral lease. Over 2019 the Gudanji Elders spent many hours with our consultant IPE and our own community relations team walking through the bush and documenting local flora, which they called "Bush Walks & Talks". These sessions were open to all community members, and as a result enthusiasm for the project soon meant plant names and uses were also collected from Garrwa, Marra and Yanyuwa people. Due to the success of the initial works, the community project was expanded to ultimately create this book as a resource for the people of Borroloola and surrounding communities.

The book presents Garrwa, Gudanji, Marra and Yanyuwa botanical knowledge recorded during the course of the project. Knowledge recorded included language names, traditional uses, habitats of occurrence, fruiting period and distinguishing features of 100 plant species. Plant species were broadly grouped into grass, herb, shrub, tree, tuber, vine and aquatic plant forms and ordered alphabetically by scientific names.

SySTEMic Collaboration

MRM is involved with the SySTEMic program, a collaboration model that involves the establishment of long-term partnerships between industry, schools and tertiary education providers that enables our business to play an active role in the learning and career development of their future workforce. It aims to increase the number of students undertaking STEM studies in senior secondary school, and then in post-secondary education and training with STEM related qualifications. The partnership between Engineers Australia, and Northern Territory high schools ensures future generations of young Territorians will have the skills to equip them for the workforce of the 21st century. The innovating curriculum and approaches to learning involves an intensive mine site visit to see firsthand the stages of mining, processing plant operations and environmental rehabilitation projects. Students meet and discuss processes with MRM's engineers, process operators, environmental technicians and employees who have achieved career pathways through the Glencore Graduate program.

Borroloola School

Signing of a Partnership Agreement with Borroloola School. The three-year partnership delivers $260,000 in benefits to the school including financial sponsorships, flights to Darwin, support for school activities, school site visits, trade training support and mentoring.

MRM Borroloola Community Office

Commissioning of a permanent community-based office in Borroloola to further strengthen relationships in the local community and provide an open and transparent information centre. The office is scheduled to open when face-to-face community contact restrictions are lifted by MRM, planned towards the end of September 2020.

Plate ES9: Helping Out at Borroloola School

Youth Mentoring Network

Plate ES10: Youth Mentoring with Students from Borroloola School

MRM has a dedicated program to attract local employees from the Gulf Region, and our partnership with Borroloola School aims to generate interest among school students to participate in the mining industry and develop career pathway plans. The MRM Youth Mentoring Network (YMN) involves a series of four workplace mentoring sessions held over the school year, covering the mining lifestyle and workplace environment, workplace health and safety, and career pathway planning. A number of culturally-appropriate educational resources and interactive materials have been developed in partnership with Borroloola School to deliver the program. The success of the term one sessions saw the highest school attendance rates on the days the YMN session were held.

Local Procurement

Development of a partnership with the Industry Capability Network of the NT to increase local industry participation in mine supply and service provision. The partnership was signed in June 2020.

The MRM Community Benefits Trust

The Community Benefits Trust (CBT) has operated since 2007, and in that time has provided $19 million in grants to more than 100 programs and initiatives in the areas of culture and art, job creation and enterprise development, education, environment, social and community development and health. MRM contributes around $1.3 million per year to the CBT and pays for project management and secretariat services valued at $340,000 per year.

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1 Introduction

1.1 Operator Details

Glencore PLC (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 158,000 people (including contractors).

McArthur River Mining Pty Ltd (MRM) is a subsidiary of Glencore, and is the operator of the McArthur River Mine (the Mine). MRM operations consist of the open pit mine, a concentrator and processing plant, and the Bing Bong Loading Facility (BBLF) in the Gulf of Carpentaria. MRM is the world's largest producer of zinc in bulk concentrate form, which is used by Imperial Smelting Process smelters in Europe and Asia, and zinc concentrate, which is supplied to electrolytic smelters. Concentrate is transported from the Mine to the BBLF by road. From there, it is loaded onto a barge and transported to waiting ships at sea in the Gulf of Carpentaria.

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

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 Project Description

1.2.1 Location and Tenements

The Mine is located approximately 45 kilometres (km) south-west of the township of Borroloola (approximately 65 km by road) and 715 km south-east of Darwin (approximately 900 km by road), in the Gulf Region of the Northern Territory (NT) (Figure 1).

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 per cent (%) owned by Mount Isa Mines Limited and managed by Colinta Holdings Pty Ltd, a Glencore subsidiary.

The BBLF is situated on MLN 1126, located on the Bing Bong Pastoral Lease. Locations and details of MRM tenements are shown in Table 1 and Figures 1, 2 and 3.

TABLE 1: 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	04 Feb 2020	31 Dec 2040	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	3348 ha	Mount Isa Mines Limited
MLN 1123	05 Jan 1993	04 Jan 2043	3884 ha	Mount Isa Mines Limited
MLN 1124	05 Jan 1993	04 Jan 2043	3283 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.

* Applications to renew MA 366, MA 455 and MA 456 have been submitted by Glencore. At the time of writing, the tenement renewals have not been received.

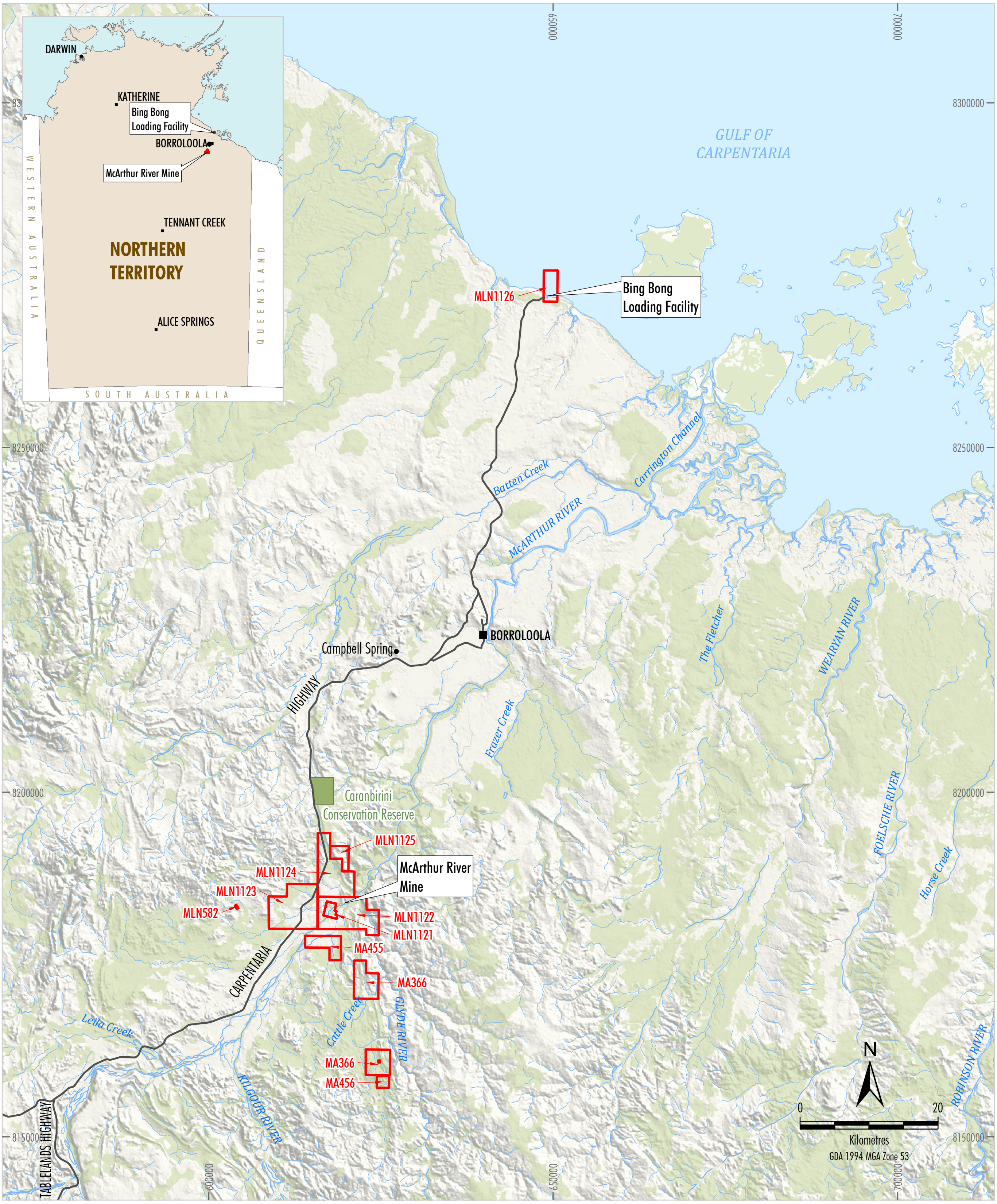
1.2.2 Project Summary

History of Development

The Mine is a major 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 Environmental Impact Statement (EIS) in 1992, development of MRM's underground operation commenced in 1994, with the first shipment 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 (Phase 2). 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.



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

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)

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McARTHUR RIVER MINE

Bing Bong Loading Facility

Figure 3

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

Overburden Management Project

In late 2013, MRM lodged the 2013-2015 Mining Management Plan (2013-2015 MMP) with the then NT Department of Mines and Energy (DME) (now the NT Department of Primary Industry and Resources [DPIR]). The 2013-2015 MMP incorporated amendments to the classification of overburden and resultant modifications to overburden emplacement design, particularly the North Overburden Emplacement Facility (NOEF).

Following initial review, the amendments presented in the 2013-2015 MMP were referred to the NT Environment Protection Authority (NT EPA) in March 2014, for consideration under the NT *Environmental Assessment Act 1982* (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.

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

In July 2018, the NT EPA completed its assessment of the OMP EIS and issued *Assessment Report 86 for the McArthur River Mine Overburden Management Project* (Assessment Report 86), recommending the OMP for approval. Assessment Report 86 is not an environmental approval although it guides the decision for a mining authorisation and the decision for approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Report also informs approvals under the *Northern Territory Aboriginal Sacred Sites Act 1989*, *Heritage Act 2011* and *Water Act 1992*. Assessment Report 86 makes 30 recommendations to be adopted in future authorisations where relevant.

Federal approval of the OMP was received from the then Department of the Environment and Energy on 12 June 2019, with the approval document EPBC 2014/7210 issued.

1.3 Scope and Purpose

The purpose of this Environmental Monitoring Report (EMR) is to fulfil the reporting requirements for an 'Environmental Mining Report' under sections 37 (3)(e), (4), and (5) of the *Mining Management Act 2001*.

This report has been prepared in accordance with DPIR's *Mining Management Plan Structure Guide for Mining Operations*, and should be read with reference to the mine management documentation defined in MRM's approved Variation of Authorisation (VOA).

Reporting in this EMR covers the period of 1 May 2019 to 30 April 2020 (herein referred to as the reporting period). The Mine operated in accordance with VOA 0059 dated 20 December 2018, 7 June 2019, and 15 August 2019 over the reporting period.

MRM submitted the *McArthur River Mining Pty Ltd, Mining Management Plan 2020* (January 2020 MMP) on 31 January 2020 to DPIR. Determination on the January 2020 MMP did not occur during the reporting period.

In addition, MRM operated in accordance with the following approval documents over the reporting period:

- EPBC Act Approval 2014/7210 (dated 12 June 2019).
- EPBC Act Approval 2003/954 (dated 20 February 2009).
- Waste Discharge Licence (WDL) 174-11 (dated 28 April 2019).

2 Operational Activities

2.1 Exploration

Exploration works undertaken within MA366, MA455 and MA456 during the reporting period consisted of:

- reconnaissance and familiarisation of tenements;
- historical exploration data reviewed by Ross Logan and Associates to identify future targets;
- a total of 52 m of diamond drilling on MA455 targeting the HYC sequence (refer Figure 1 for location of MA455; refer Appendix A for details); and
- grading main access roads to tenements.

2.1.1 Ongoing or Future Exploration Activities

The following exploration activities are planned for the next reporting period:

- submission of AAPA applications for designated areas of MA366 and MA455;
- prospecting anomalous soils on MA456;
- mapping sections of MA366 and MA456; and
- grading of access roads to tenements post wet season.

2.2 Regional Drilling and Investigation Program

MRM undertook a series of regional drilling programs during the reporting period within MLN 1121, MLN 1122, MLN 1123, and MLN 1124, which included 237 drill holes for waste characterisation, alluvium cover definition, and resource development. MRM completed a total of 4,160 metres (m) of drilling, comprising 235 air core, and 2 diamond core holes. MRM also collected 668 soil samples for waste characterisation (Appendix A).

The drilling program was designed to:

- develop mineral resources and waste characterisation within the Life of Mine Open Pit;
- determine the extents of Teena mineralisation within the mining lease; and
- identify the geometry and spatial location of suitable clay material that could be used for NOEF construction, and identify coarse gravels and cobbles acting as preferential pathways for groundwater inflows to the mine operations.

The main findings from the drilling program were that the:

- ore zone intersected within the Lower Fold Zone was consistent with the current geological model;
- Teena mineralisation was identified within the mining lease; and
- alluvium definition drilling showed suitable clays could be used for NOEF construction can be sourced from within the first 2-3 m of the cover sequence.

All drilling and soil sampling during the reporting period was undertaken in accordance with the 2013-2015 MMP and associated amendments.

2.3 Resource Definition and Waste Characterisation

2.3.1 Ore Identification and Mark-up

The 2013-2015 MMP describes the process for ore identification and mark-up, which includes:

- geological observation to identify lithostratigraphic boundaries of low-grade ore (LGO) and high-grade ore on the pit floor;
- use of fluorescent paint and tape to mark up the lithostratigraphic boundaries;
- excavation of material;
- hauling of excavated material to the appropriate area;
- qualified personnel to direct and supervise operations from the excavator when physically marking the lithostratigraphic boundaries was not possible; and
- physical inspection of the run-of-mine (ROM) ore.

Ore identification and mark-up during the reporting period was undertaken consistent with the process described in the 2013-2015 MMP.

2.3.2 Waste Characterisation and Identification

Waste Classification Criteria

MRM operated in accordance with the January 2019 MMP Amendment (MRM, 2019a) following its authorisation on 15 August 2019. The January 2019 MMP Amendment describes the MRM waste rock classification criteria.

Waste Characterisation and Identification

The 2013-2015 MMP describes the procedure for in-pit waste characterisation, which includes:

- material classification for each blast block;
- sampling of a representative slice of blast hole cuttings from each drill hole mound;
- analysis of subsamples via on site laboratory ICP-MS analyses, supported by a portable X-Ray Fluorescence (pXRF) analysis (back-up contingency only);
- data processing concentrating on elements known to be rich in the hanging wall sequence: antimony (Sb), arsenic (As), bismuth (Bi), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), molybdenum (Mo), selenium (Se), sulphur (S) and zinc (Zn);
- verifying on site laboratory performance by use of an external laboratory for elemental analysis of samples; and
- use of block model estimations and geochemical results to determine final material classification and boundaries, and prepare a geology dig guide.

Waste characterisation quality assurance and quality control (QA/QC) activities were undertaken for the reporting period in line with site grade control practices. Blasthole and reverse circulation samples taken during the period were analysed using pXRF and inductively coupled plasma mass spectrometry (ICP-MS) analysis methods.

The frequency of blasthole sampling verification checks taken as part of grade control practices is summarised in Table 3, and waste dump grab sampling frequencies are summarised in Table 4.

TABLE 3: BLASTHOLE SAMPLING VERIFICATION CHECKS

Total Number of Samples:	**2,983**			
QA/QC	**Standard (ratio)**	**Standard (quantity)**	**Actual (ratio)**	**Actual (quantity)**
Laboratory checks (umpire)	1:20	149	1:19	158
Duplicates	1:20	149	1:19	158

TABLE 4: OVERBURDEN EMPLACEMENT FACILITY WASTE SAMPLING FREQUENCIES

Waste Rock Class	Tonnes	Standard (ratio)	Standard (quantity)	Actual (quantity)
LS-NAF (HC)	207,087	1:50000	4	16
MS-NAF (HC)	6,397,228	1:50000	128	406
MS-NAF (LC)	11,636,776	1:50000	233	
PAF (HC)	8,536,915	1:50000	171	582
PAF (RE)	7,551,834	1:25000	302	
Total	34,329,839	-	838	1,004

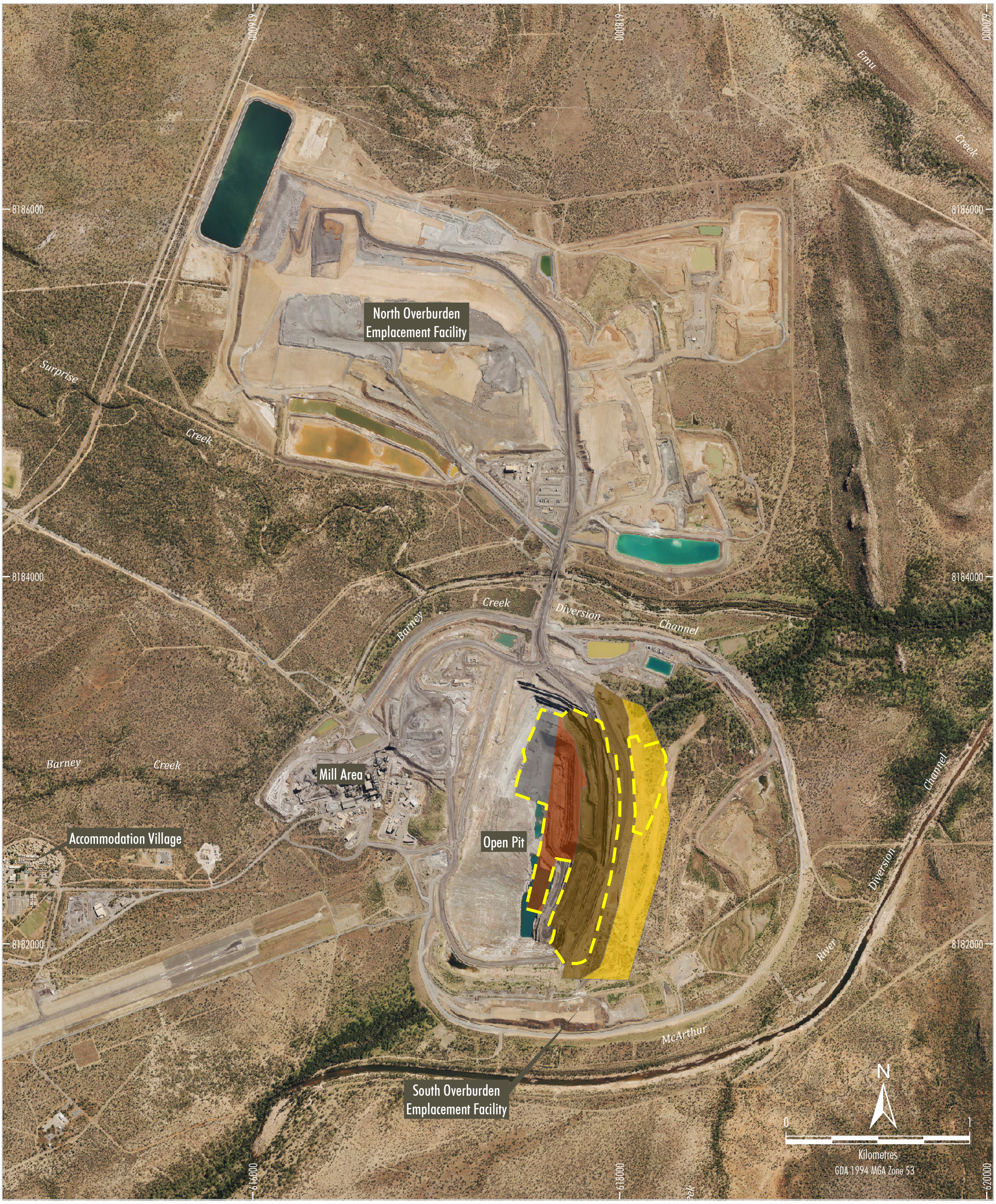
2.4 Open Pit Mining

2.4.1 Mine Schedule

Open Pit regions active during the reporting period are shown on Figure 4.

Stage I, FWQ, J and K progressed as planned during the reporting period. The FWQ and Stage I reached their extents, while waste pre-strip in Stage J progressed down to the 9,904 reference line (RL). During the reporting period, a small portion of the upper bench of Stage K (10,016 RL) was mined to provide alluvium for use in development of the NOEF. The northern portion of Stage K around the old McArthur River and Fairy Wren habitat was not disturbed during the reporting period.

As planned, the mining fleet was updated and increased during the reporting period to accommodate the increase in annual waste tonnes mined.



LEGEND

- Active Mining Area (2019-2020 Reporting Period)
- Footwall Quarry
- Stage I
- Stage J
- Stage K

McARTHUR RIVER MINE

Mining Activities during the Reporting Period

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

Figure 4

Table 5 provides the mining quantities for the period of 1 May 2019 to 30 April 2020, along with a breakdown of waste material according to the MRM waste rock classification criteria.

TABLE 5: 1 MAY 2019 TO 30 APRIL 2020 MINING QUANTITIES

Material	Mined Quantity (Mt)
Alluvium	1.11
LS-NAF (HC)	0.21
MS-NAF (HC)	6.40
MS-NAF (LC)	11.64
PAF (HC)	8.54
PAF (RE)	7.55
Total Waste	**35.44**
Low Grade Ore	0.06
Ore	5.27
Grand Total	**40.77**

Note: Mt = million tonnes

2.4.2 Clearing and Soil Stripping

The clearing and soil stripping activities undertaken during the reporting period are provided in Table 6 and Figure 5.

TABLE 6: CLEARING AND SOIL STRIPPING ACTIVITIES

Location	Destination of Stripped Material
1. Parts of Stage K	Inside the Stage K perimeter
2. Parts of NOEF CW Charlie Stage	Stockpiled in dedicated topsoil stockpile to the south of the Western Perimeter Runoff Dam (WPROD)
3. Parts of NOEF CE and SE Levees	Stockpiled in dedicated topsoil stockpile to the south of the Eastern Perimeter Runoff Dam (EPROD)
4. Access Tracks for the Alluvium Drilling Program	Material left to the side of the tracks

2.4.3 Ongoing Operational Activities

Planned activities are outlined in the January 2020 MMP.

LEGEND

Clearing and Soil Stripping

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

McARTHUR RIVER MINE

Clearing and Soil Stripping Activities during the Reporting Peroid

Figure 5

2.5 Overburden Emplacement

2.5.1 Emplacement Areas

The following activities were undertaken during the reporting period:

- **NOEF West stage**: Continued construction of the MS-NAF Halo and advection barriers on the top face.
- **NOEF Central West stage**: Completion of the CW Bravo PAF cell (Core Zone) and Halo; completion of the Charlie Stage foundation and construction of a Core Zone and Halo, transitioning from CW Bravo methods to the OMP EIS methodology; stockpiling of materials.
- **NOEF Central East stage**: Construction of CE Alpha stage as per OMP EIS methodology to connect up to EPROD; construction of a dedicated CE PAF(RE) cell as per OMP EIS methodology; removal of topsoil stockpiles and clay borrow from CE Bravo footprint; stockpiling of materials.
- **NOEF Southeast stage**: Construction of a PAF(RE) cell and cover system trial and complete 20-year ARI flood levee in southeast of NOEF.
- **NOEF infrastructure**: NOEF Mine Infrastructure Area (NOEF MIA) workshop and crib facility expansions; powerline and pipeline installations; high density polyethylene (HDPE) lining of water management facilities (Southern Perimeter Runoff Dam [SPROD], EPROD and Central West Charlie Sump [CWCS]); test pits for future drains; lime plant operation; monitoring installations.
- **Flood protection**: Construction of flood protection prior to the wet season at CW Charlie north face (100-year ARI); CW Charlie to EPROD (100-year ARI); EPROD to SEPROD (20-year ARI).

A breakdown of the quantities of waste emplaced in each of these areas is provided in Table 7, along with classification of the waste as per the MRM waste rock classification criteria (note this breakdown does not include waste required to be rehandled as part of LGO rehandling activities [Section 2.3 of the February 2016 Amendment]).

During the reporting period, the majority of the overburden was placed in the CW Stage of the NOEF (Alpha/Bravo and Charlie) as planned. Smaller amounts of MS-NAF waste were emplaced on West A, B, C and D (as planned) as a cover to protect the top of the West PAF cell from erosion and set up drainage towards to the main southern haul ramp. No overburden was placed on the SOEF, and a small quantity of waste was used on the WOEF to reshape the surface beneath the ore stockpiles.

TABLE 7: WASTE DUMPING DURING THE REPORTING PERIOD

Emplacement Area		Alluvium	LS-NAF (HC)	MS-NAF (HC/LC)	PAF (HC)	PAF (RE)	Total
SOEF (Mt)		0	0	0	0	0	0
WOEF (Mt)		0	0	0	0	0	0
NOEF (Mt)	West	0.01	0	5.97	0	0	5.98
	Central West	0.91	0.05	11.53	8.54	7.53	28.56
	Central East	0	0	0.47	0	0	0.47
	PAF(RE) Trial Pad	0	0	0	0	0.02	0.02
	Stockpiles	0.19	0.15	0.07	0	0	0.41
Total (Mt)		**1.11**	**0.21**	**18.03**	**8.54**	**7.55**	**35.44**

2.5.2 North Overburden Emplacement Facility

West A, B, C and D

During the reporting period, the top of the West A, B, C and D Stage was built up using MS-NAF to provide protection for the advection barrier layer and to shape the drainage down the main southern haul ramp.

Central West Stage and Central East

Prior to the approval of the January 2019 MMP Amendment, construction in CW stage was undertaken as described in the *2013-2015 MMP Amendment – Mining Activities and NOEF Central West (CW) Alpha and Bravo Stages*, dated 5 February 2016 (the February 2016 Amendment).

The following was completed for CW Bravo Stage over the reporting period:

- Construction of CW Bravo Stage continued to near completion during the reporting period, with all types of non-benign overburden used in the Core Zone with advection barriers around and on each layer.
- A wet season cap, inter-stage advection barriers and armour was placed on the east side of CW Bravo.
- The stage is currently undergoing placement of the final lift of MS-NAF Halo on the top.

Foundation and Basal CCL development continued in CW Charlie as per the *McArthur River Mining, 2013-2015 Mining Management Plan Amendment* dated September 2018 (September 2018 Amendment) during this time, with benign materials only in the 'wedge'.

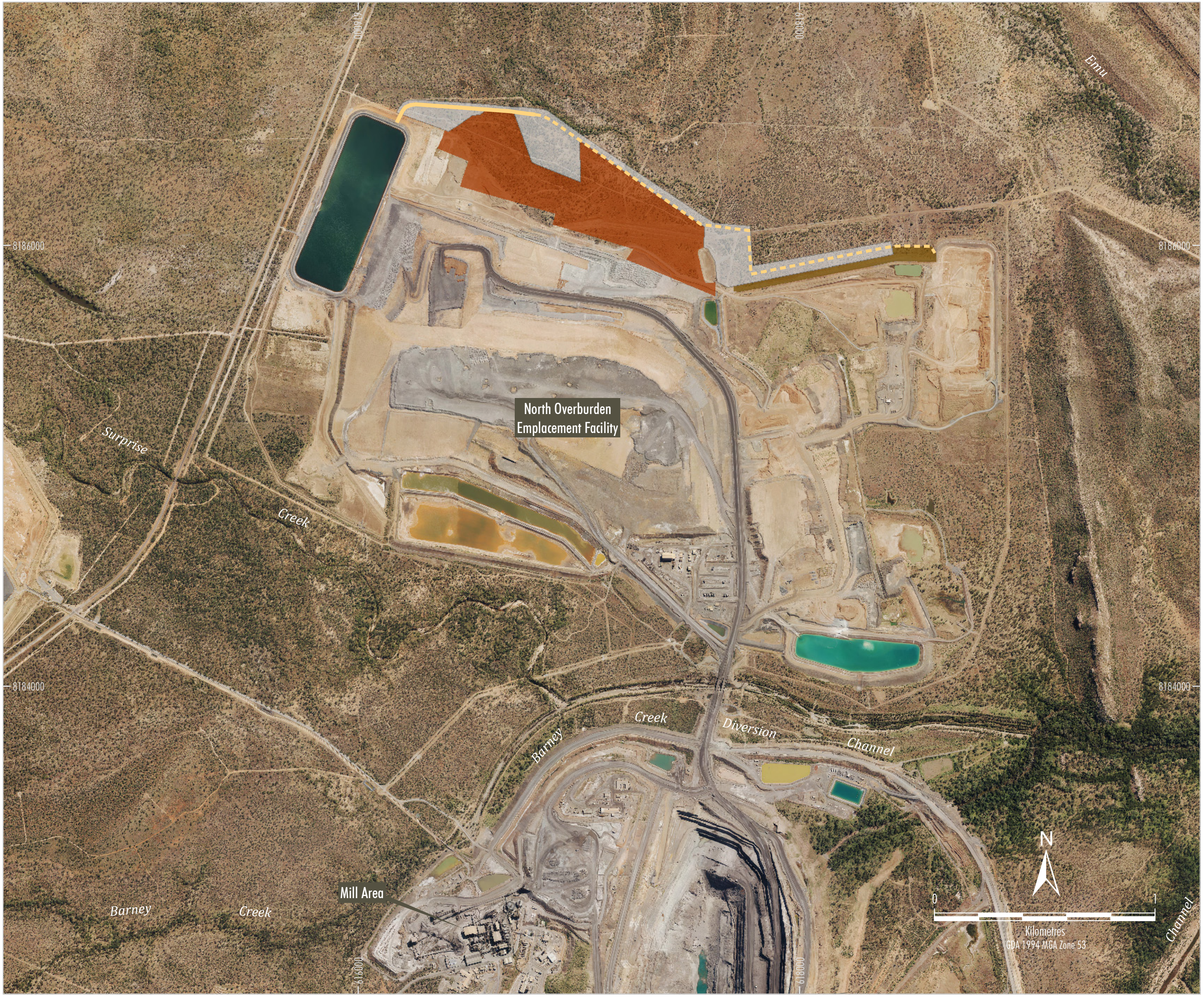
Following the approval of the January 2019 Amendment in August 2019, the CW Charlie Stage was developed as per the OMP EIS methodology, including the development of:

- a 5 m MS-NAF Base on top of the Basal CCL, sloped to direct surface runoff to the CW Charlie Sump;
- 'Wedge' geometry on top of the Base zone, constructed from non-benign material in up to 7.5 m lifts, with alluvium advection barriers between each lift, and sloped to assist surface water runoff to WPROD;
- the Core zone constructed from non-benign waste in up to 7.5 m lifts, with alluvium advection barriers between each lift to limit oxidation of the PAF material; and
- the PAF(RE) Cell, constructed in up to 2 m lifts, with alluvium advection barriers between each lift to limit oxidation of the PAF(RE) waste.

Construction of the Central East levee and installation of the temporary section of the 100-year ARI flood protection barrier between WPROD and EPROD was also undertaken as described in the January 2019 Amendment. Construction of the 20-year flood protection to the south of EPROD is described in the SE stage works.

MRM cleared an area of 22.2 ha within the Central West Charlie and Central East levee areas during the reporting period, and constructed approximately 52.7 ha of Basal CCL (Plate 1).

Plate 1 shows the cleared area and completed CCL in the CW Charlie and Central East Levee areas. The Plate also indicates the extent of the flood protection levee between WPROD and EPROD, with the solid line on the western end towards WPROD forming the permanent outer extent of the NOEF, and the dashed line representing the temporary internal section of flood barrier, to be covered by subsequent NOEF stages in the future. The temporary section of the levee had a flood protection CCL constructed during the reporting period, while the permanent section had a temporary clay barrier applied to a portion of it prior to the 2019/20 wet season, with the full geosynthetic liner based cover system which will form the permanent flood protection barrier to be installed in the next reporting period.



LEGEND

- Central East Levee Permanent
- Central East Levee Temporary
- Central East Levee - CCL Completed
- Central West Charlie - CCL Completed
- Cleared Areas

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2020)

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Central West Charlie Progress 2019/2020

Plate 1

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The testing frequencies for the CCL works completed during the reporting period for the Central West and Central East Levee Basal CCL and flood protection barrier are summarised in Table 8.

TABLE 8: CENTRAL WEST AND CENTRAL EAST LEVEE COMPACTED CLAY LINER TESTING

Works Area:		Basal CCL		Flood Protection CCL	
Volume of CCL Completed (m^3):		343,777		25,601	
Test	**Minimum Test Frequency Ratio**	**Minimum Number of Tests Specified**	**Actual Number**	**Minimum Number of Tests Specified**	**Actual Number**
Compaction	1 Test per 500 m^3	688	725	52	58
Moisture Content	1 Test per 500 m^3	688	725	52	58
Particle Size Distribution	1 Test per 20,000 m^3	18	71	2	17
Atterberg Limit	1 Test per 20,000 m^3	18	71	2	17
Emerson Class Dispersion	1 Test per 20,000 m^3	18	55	2	17
Pinhole Dispersion	1 Test per 20,000 m^3	18	42	2	2
Cation Exchange (SAR, ESP)	1 Test per 20,000 m^3	18	60	2	2
Permeability (Constant Head @25 kPa)	1 Test per 10,000 m^3	35	40	3	3

m^3 = cubic metres; SAR = sodium absorption ratio; ESP = exchangeable sodium percentage.

Central West Charlie Sump was lined with HDPE during the reporting period, as indicated on Plate 2.

Plate 2: Central West Charlie Sump (Looking South)

No construction work was carried out for the CE Alpha stage during the reporting period. The existing stockpiles and borrows in the footprint were used as sources of clay and alluvium for other NOEF construction works.

South East Stage

Construction of the South East 20-year ARI flood protection levee and Phase 1 of the PAF(RE) Trial Pad were undertaken as described in the January 2019 Amendment. Approximately 0.9 ha of clearing was required for the northern portion of the flood protection levee (Plate 3).

LEGEND
PAF (RE) Trial Cell
South East Levee - Clay Composite
South East Levee - Cleared Area

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2020)

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Southeast Stage Works 2019/2020

Plate 3

Testing details on the clay used in construction of the flood protection levee is provided in Table 9.

TABLE 9: SOUTH EAST FLOOD PROTECTION LEVEE COMPACTED CLAY LINER TESTING

Works Area:		Flood Protection CCL	
Volume of CCL Completed (m^3):		26,562	
Test	**Minimum Test Frequency Ratio**	**Minimum Number of Tests Specified**	**Actual Number**
Compaction	1 Test per 500 m^3	54	70
Moisture Content	1 Test per 500 m^3	54	70
Particle Size Distribution	1 Test per 20,000 m^3	2	9
Atterberg Limit	1 Test per 20,000 m^3	2	9
Emerson Class Dispersion	1 Test per 20,000 m^3	2	9
Pinhole Dispersion	1 Test per 20,000 m^3	2	2
Cation Exchange (SAR, ESP)	1 Test per 20,000 m^3	2	2
Permeability (Constant Head @25 kPa)	1 Test per 10,000 m^3	3	3

Perimeter Run-off Dams

During the reporting period, the following was completed in relation to the perimeter run-off dams:

- Installation of the HDPE liner in EPROD (Plate 4). The commissioning process is underway and is expected to be complete during the next reporting period.
- HDPE lining of the previously clay lined South Perimeter Runoff Dam (SPROD) (Plate 5).

Plate 4 HDPE-Lined EPROD

Plate 5: HDPE-Lined SPROD (Looking West)

Stockpiles

Topsoil, clay, alluvial and LS-NAF (HC) materials were stockpiled in areas within the NOEF footprint during the reporting period.

Other

The geochemical investigation into the planned northern clean water drain was completed during the reporting period.

Ongoing Operational Activities

Planned activities are outlined in the January 2020 MMP.

2.5.3 West Overburden Emplacement Facility

The WOEF forms the base of the ROM pad and is, therefore, in constant use. Minor amounts of waste may be used to adjust ramps and drainage as stockpile sizes and shapes evolve over time. The WOEF will continue to be used as the ROM stockpile for crusher feed materials.

Geochemical Assessment Drilling

The planned geochemical assessment of the WOEF was not completed due to access constraints associated with the high volume of ore on the ROM over the 2019 dry season.

2.6 Processing Activities

The 2013–2015 MMP describes the ore processing method at the Mine which includes the following:

- crushing;
- Heavy Media Plant (HMP);
- grinding;
- PBOX-Lead Oxidation Process;
- dewatering;
- tailings disposal; and
- concentrate handling.

A summary of the processing throughputs for the 2019 to 2020 reporting period are presented in Table 10 and compared to the estimated total for 2020. The actual ore processing activities that occurred during the reporting period are described in detail below.

TABLE 10: ACTUAL AND ESTIMATED PROCESSING FOR THE REPORTING PERIOD

Process	Actual 2019	Actual 1 Jan to 30 Apr 20	Estimated 2020
Crushed Product (t)	4,610,039	1,513,387	4,800,498
HMP Feed (t)	1,590,305	511,003	2,129,188
HMP Rejects Produced (t)	310,969	105,774	498,357
Milled Feed (t)	4,203,587	1,362,779	4,235,070
Total Tailings Produced (t)	3,589,966	1,153,392	3,574,251
Total Concentrate Produced (t)	613,621	209,387	660,819

t = tonnes.

2.6.1 Crushing Activities

A total of 4,610,039 dry metric tonnes (dmt) of ROM ore was crushed in 2019, with an average grade of 8.83 % zinc and 3.89 % lead. During the first four months of 2020, a total of 1,513,387 dmt of ROM ore was crushed. For the full year 2020, the total ore to be crushed is estimated at 4,800,498 dmt, with a grade of 8.79 % zinc and 3.82 % lead.

2.6.2 Heavy Medium Plant

The HMP processed 1,590,305 dmt of material in 2019 rejecting 310,969 dmt of material. A total of 2,129,188 dmt is estimated for 2020, with a total of 511,003 dmt having been processed during 4 months generating 105,774 dmt of rejects.

2.6.3 Grinding and Flotation

A total of 4,203,587 dmt of ore and HMP product was processed through the grinding and flotation plants during 2019, with an average grade of 9.38 % zinc and 4.15 % lead. For 2020, it is estimated that a total of 4,235,070 dmt of ore and HMP product will be processed, with an average grade of 9.65 % zinc and 4.19 % lead.

2.6.4 PBOX-Lead Oxidation Process

The PBOX-Lead Oxidation Process produced 170,952 dmt of zinc concentrate and 23,793 dmt of lead concentrate from the treatment of bulk concentrates during 2019. During the first four months of 2020, 51,082 dmt of zinc concentrate and 8,180 dmt of lead concentrate were produced. For 2020, a total of 227,895 dmt of zinc concentrate and 32,924 dmt of lead concentrate are estimated to be produced from the PBOX-Lead Oxidation Process.

2.6.5 Dewatering

The dewatering plant has four thickeners for dewatering concentrates; two 25 m diameter thickeners for bulk concentrate, one 20 m diameter thickener for lead concentrate and one 30 m diameter thickener for zinc concentrate.

The dewatering circuits operated as planned during the reporting period, with total recycled process water estimated at 80,161,000 m^3.

2.6.6 Tailings Deposition

A total of 3,589,966 t of tailings were pumped to the TSF during 2019. An additional 1,153,392 t were pumped to the TSF during the first 4 months of 2020.

2.6.7 Concentrate Handling

Total production for 2019 amounted to 418.9 kilotonnes (kt) of bulk concentrate, 171.0 kt of zinc concentrate and 23.8 kt of lead concentrate.

Total production recorded for the first 4 months of 2020 was 150.1 kt of bulk concentrate, 51.1 kt of zinc concentrate and 8.2 kt of lead concentrate.

2.7 Tailings Storage Facility

2.7.1 Tailings Operation

Tailings were placed using the installed spigot discharge system around the Cell 1 and Cell 2 perimeters as per the designs and TSF operational guidelines. A total of 3,663,972 t of tailings were deposited into the TSF during the reporting period.

The TSF Cell 1 storage area was re-commissioned on 1 December 2019, following construction activities as outlined in Section 2.7.2.

The 2019 annual TSF safety inspection was completed prior to the onset of the wet season by GHD Pty Ltd (GHD). The audit/review was undertaken in accordance with the Australian National Committee on Large Dams Incorporated (ANCOLD) *Guidelines on Dam Safety Management* (2003) and the *Guidelines on Tailings Dams* (ANCOLD, 2019).

Quarterly TSF operations reports continued to be submitted to the DPIR during the reporting period. The reports cover a range of monitoring data including water inflows and outflows, seepage collection records, pond and beach levels, deposition schedule, survey monument measurements, piezometer levels, climate conditions, photographic records, water quality assays and relevant construction and earthworks recorded during the quarter.

Water reclaim from the TSF continued with water primarily returned to the Concentrator Runoff Pond (CRP) for use in the processing plant.

The design philosophy of the TSF, as outlined in the January 2019 Amendment, is as follows:

- Reduce seepage from the TSF by maintaining a small decant pond, and through optimised tailings management, remove pore water at the surface by evaporation. This also controls pore 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 storm water storage capacity.
- Maintain beach freeboard (and, therefore, low piping risk). This is achieved by progressively raising the spillway to match the tailings rate of rise; therefore, keeping the spillway level below the minimum tailings beach level at all times.

The design philosophy was achieved through operational controls throughout the reporting period.

2.7.2 Construction Works

In line with the January 2019 MMP Amendment, the following construction activities occurred over the reporting period:

- Cell 1 Stage 4 lift of varying height (up to 6 m), to RL 10,056 m (complete).
- Cell 2 Stage 6 lift of 2 m to RL 10,061 m (ongoing).
- TSF Interception Trench (ongoing).

Construction works were completed consistent with the approved designs, and the overall Life of Mine philosophy.

2.7.3 Management of Tailings Pipeline

During the reporting period, management of the tailings line was undertaken as described in Section 4.3.7 of the 2013-2015 MMP, which includes:

- inspection of the tailings system on a daily basis by two persons dedicated to the operation of the line and associated flowmeters;
- non-destructive testing of the pipeline annually to monitor pipe wear; and
- checking and resetting of expansion joints as required.

2.8 Product Handling and Transport

Section 4.2.3 of the 2013-2015 MMP describes the procedure for bulk and zinc concentrate handling and transport, which includes:

- Transporting of the filtered concentrate from the filter building to the Mine concentrate storage shed via a covered conveying system.
- Loading of concentrate into covered, side-tipping road train trailers with a front-end loader.
- Transporting of bulk and zinc concentrate from the Mine to the BBLF by road trains with a payload of approximately 120 t.

Section 4.2.3 of the 2013-2015 MMP also describes the procedure for lead concentrate handling and transport, which includes:

- Loading lead concentrate into double-lined bulka bags using specially designed equipment and excavator. Subsequent loading of these bags into sealed containers for road transport to Mt Isa or Darwin for export.

Product handling and transport activities during the reporting period were conducted in accordance with the 2013-2015 MMP.

2.9 Bing Bong Loading Facility

The loading procedure at the BBLF includes:

- The receipt and unloading of product from road transport into the concentrate storage shed.
- Holding of product in a concentrate storage shed.
- Controlling and maintaining the stockpile using front-end loaders to move the concentrate away from the truck discharging area to the rear of the shed compartments.
- Self-loading of the load-out and bulk carrier (Aburri) via a single shore-mounted loading chute.
- Disengaging of Aburri from its moorings, and shuttling of Aburri through a dredged channel to an ocean-going vessel waiting in the designated offshore transfer zone.
- Securing of 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.
- Maintenance (dredging) of the swing basin as required.

During the reporting period, the Aburri underwent routine servicing and was temporarily replaced by an alternative bulk carrier named the Wunma.

Dredging of the swing basin or navigation channel did not occur during the reporting period.

2.10 Reconciliation of Operational Commitments and Actions

A reconciliation of the operational management commitments and actions is provided in Appendix B.

3 Environmental Management

MRM uses a suite of environmental management plans to manage the performance of the Mine and the BBLF against objectives and targets, such as:

- Waste Management Plan.
- Air Quality Management Plan (AQMP).
- Rehabilitation Management Plan (RMP).
- Freshwater Sawfish Management Plan.
- Cattle Management Plan.

Further detail regarding MRM's environmental performance through implementation of its management plans is provided in Table 11.

Environmental monitoring programs that have been undertaken during the reporting period include:

- NOEF Temperatures.
- Soil Quality.
- Ambient Air Quality.
- Rechannel Vegetation Health.
- Riparian Birds.
- Migratory and Wetland Birds.
- Diversity and Abundance of Macroinvertebrates.
- Metal Concentrations in Aquatic Fauna.
- Diversity and Abundance of Aquatic Fauna.
- Seagrass Diversity and Abundance.
- Marine Sediment Quality, Water Quality and Metals in Marine Biota.
- Diesel Spill Remediation.

An environmental monitoring schedule was prepared by MRM and submitted to DPIR for the reporting period, and has subsequently been updated (Appendix C).

As described in Section 1.3, MRM submitted the January 2020 MMP to DPIR on 31 January 2020; however, determination on the January 2020 MMP did not occur during the reporting period. The January 2020 MMP includes key updates to MRM's environmental management system, including MRM's Adaptive Management Plan as well as a number of new and revised environmental management plans and programs to be implemented upon authorisation of the January 2020 MMP.

TABLE 11: ENVIRONMENTAL PERFORMANCE BY ENVIRONMENTAL MANAGEMENT PLAN

Management Plan	Performance during the Reporting Period	Actions Planned for the Next Reporting Period
Air Quality Management Plan	Operations during the reporting period were undertaken in accordance with the current AQMP. Sections 3.1 and 3.2 provide further detail in relation to soil and ambient air quality in the vicinity of the Mine and BBLF during the reporting period.	Operations during the next reporting period will continue to be undertaken in accordance with the AQMP. Upon approval of the January 2020 MMP, the revised AQMP will be implemented. The AQMP will be reviewed during the next reporting period.
Freshwater Sawfish Management Plan	Management of Freshwater Sawfish in the McArthur River Channel continued during the reporting period. Section 3.8 provides further detail on Freshwater Sawfish in the vicinity of the Mine.	The Freshwater Management Plan will be reviewed during the next reporting period. Operations during the next reporting period will be undertaken in accordance with the Freshwater Sawfish Management Plan.
Rehabilitation Management Plan	Revegetation of the McArthur River Diversion Channel was implemented in accordance with the RMP during the reporting period. Section 3.11 provides further detail on rehabilitation activities undertaken during the reporting period.	Revegetation during the next reporting period will be undertaken in accordance with the RMP.
Weed Management Plan	Operations during the reporting period were undertaken in accordance with the Weed Management Plan. Section 3.11.3 provides further detail on weed management activities undertaken during the reporting period.	The Weed Management Plan will be reviewed during the next reporting period. Operations will continue to be undertaken in accordance with the Weed Management Plan.
Cattle Management Plan	Maintenance of the cattle exclusion fence was undertaken during the reporting period in accordance with the Cattle Management Plan. Section 3.11.5 provides further detail on cattle management during the reporting period.	The Cattle Management Plan will be reviewed during the next reporting period. Operations during the next reporting period will continue to be undertaken in accordance with the Cattle Management Plan.
Waste Management Plan	Management of waste on site during the reporting period was undertaken in accordance with the Waste Management Plan. Section 3.13.1 provides details of waste generated during the reporting period.	Management of waste during the next reporting period will continue to be undertaken in accordance with the Waste Management Plan.

Management plans and monitoring programs related to water are discussed further in Section 4.

The subsections below provide a discussion of the level of compliance to the stated objectives, progress towards meeting targets and updated targets for the oncoming reporting period for each of the monitoring programs. Where interpretation of the monitoring data or other observations have detected the potential for, or actual, adverse trends in performance or impacts, details are provided of remedial/corrective strategies and actions that will be, or have been, implemented.

3.1 Soil Quality

Monitoring of soil in the vicinity of the Mine and the BBLF is undertaken on an annual basis during the dry season. Todoroski Air Sciences Pty Ltd (TAS) was engaged by MRM to review and analyse the data (TAS, 2020a).

The *Soil Monitoring Report McArthur River Mine and Bing Bong Loading Facility October 2019* (TAS, 2020a) is provided in Appendix D.

3.1.1 Monitoring Program Overview

The objective of the soil monitoring program is to measure analyte concentrations in the soil surrounding the operational areas of the Mine and the BBLF. The results are compared to previous monitoring results and soil investigation levels and concentration limits.

Monitoring Sites

Monitoring in October 2019 was undertaken at 24 sampling locations (18 at the Mine and six at the BBLF, Figures 6a and 6b). This includes two control sites at the Mine and one at the BBLF.

Sampling Methodology

Samples of the surface soil (depth of 0-10 centimetres [cm]) were taken and analysed in a National Association of Testing Authorities (NATA) accredited laboratory for the following parameters:

- the <2-millimetre (mm) fraction of Ag, Al, As, Cd, Co, Cu, Fe, Hg, Mn, Ni, Pb, Sb and Zn;
- the soluble fraction of Ca, Cl, Mg, K, Na and SO_4;
- cation exchange capacity (total Ca, Mg, K and Na);
- moisture;
- electrical conductivity (EC) (paste with 1:5 deionised [DI] water);
- pH (paste with 1:5 DI water); and
- particle size distribution.

Data Analysis

The results were compared to previous data to identify any trends. Results were also compared against the commercial/industrial health-based investigation levels (HIL) and the commercial/industrial ecological investigation levels (EIL) or added contaminant limits (ACL) for fresh contaminants in the soil from the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (National Environment Protection Council [NEPC], 2013).

LEGEND

Control Site

Monitoring Site

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

Mine Soil Monitoring Sites

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

Figure 6a

LEGEND

- Control Site
- Monitoring Site

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

McARTHUR RIVER MINE

Bing Bong Loading Facility
Soil Monitoring Sites

Figure 6b

MRM-16-01_EMR2020_207A

3.1.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

No changes were made to the monitoring program or techniques during the reporting period.

3.1.3 Performance during the Reporting Period

The Mine

The results of the soil monitoring program show that the maximum levels of lead, nickel and zinc and the average level of zinc exceeded the relevant EILs. No exceedances of the HIL were recorded during the reporting period. Table 12 provides a summary of contaminant levels measured in the mine surface soil samples.

TABLE 12: SUMMARY OF CONTAMINANT LEVELS OF THE <2 MM FRACTION OF THE MINE SURFACE SOIL SAMPLES

Levels (mg/kg)	Arsenic	Cadmium	Cobalt	Copper	Lead	Manganese	Nickel	Zinc
HIL	3,000	900	4,000	240,000	1,500	60,000	-	400,000
EIL	80	-	-	45	440	-	20	45
October 2019								
Minimum	5	1	2	5	9	115	2	13
Maximum	31	3	22	42	736	5,850	25	1,880
Average	9.6	1.3	9.2	14.7	144.8	994	8.5	295.2

Note: Light orange shading – level above relevant EIL
mg/kg = milligrams per kilograms

The EILs used for comparison are the lowest of the range of levels provided in NEPC (2013) for commercial/industrial sites. Also, all the contaminants except for arsenic were compared with the ACL. The ACL is to be added to the ambient background concentration for comparison against EILs. In the absence of the ambient background concentration, the ACLs were used as EILs and, thus, the comparison of these with the measured contaminant levels is likely to be conservative (i.e. to overestimate potential effects) (TAS, 2020a).

For the concentrations of lead and zinc, the measured levels were generally highest close to the processing plant and decreased with distance from the Mill in October 2019 sampling periods (Chart 1). This trend was evident to a lesser extent for arsenic, cadmium, cobalt and copper. A similar trend is also evident to some extent with distance from the Open Pit.

This trend was not so apparent for the NOEF and TSF, indicating that these facilities do not appear to be the source of elevated zinc and lead concentrations in the surrounding soil. Both the TSF and NOEF area show generally similar patterns between the two data sets.

The trends above are not apparent for manganese and nickel levels, which fluctuate around a similar level irrespective of distance from any of the identified major sources. This indicates that there would not appear to be any significant efflux of these contaminants from the facilities to the environment (TAS, 2020a).

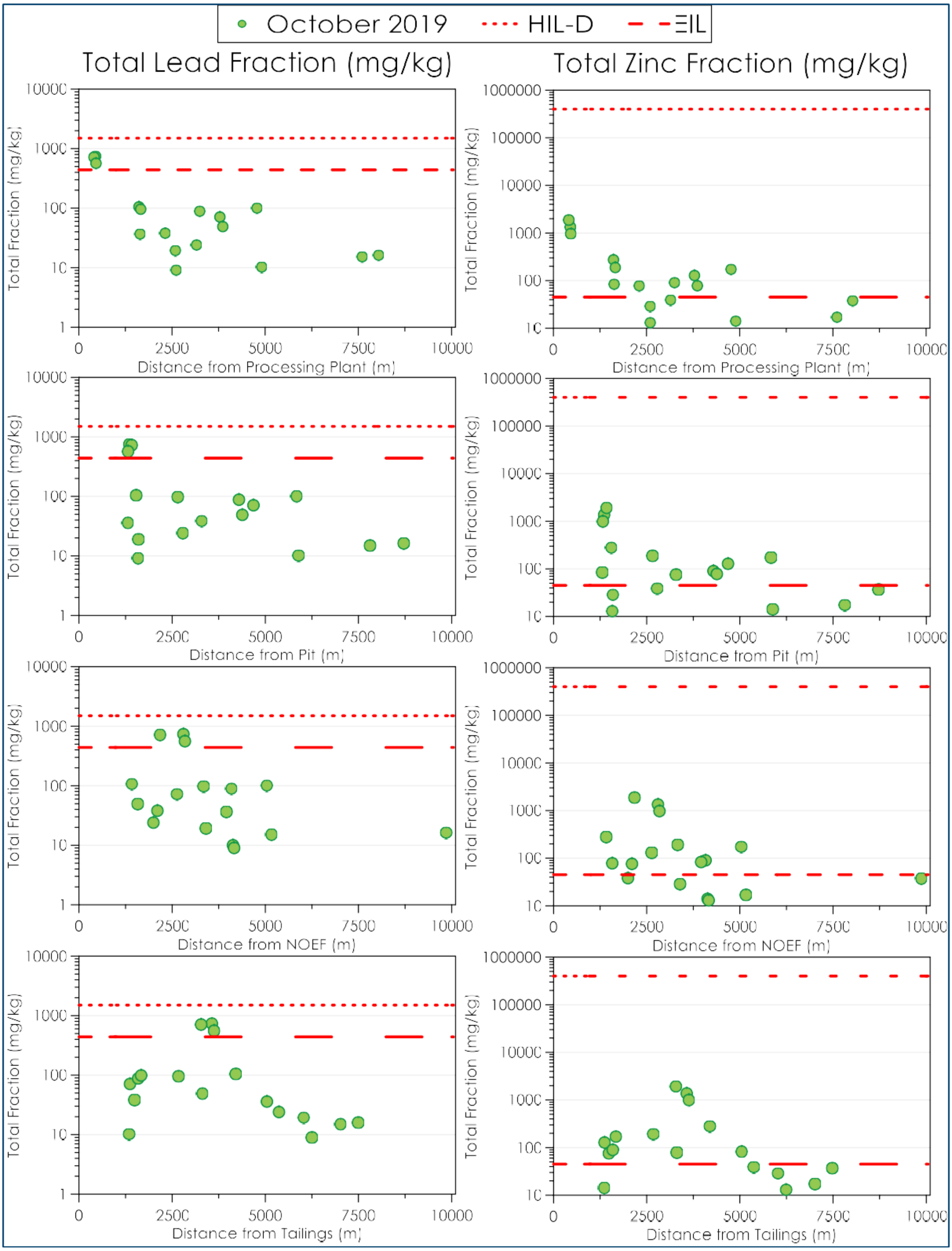


Chart 1: Measured Lead and Zinc Levels from the Surface Soil Samples with Respect to Distance from the Major Dust Sources

Bing Bong Loading Facility

Table 13 presents a summary of the contaminant levels for the BBLF surface soil samples. The maximum and average measured zinc levels of the surface soil samples exceeded the relevant EILs and the maximum copper level was above the relevant EIL level. All other contaminant levels were below the relevant HILs and EILs.

TABLE 13: SUMMARY OF CONTAMINANT LEVELS OF THE TOTAL FRACTION OF THE BING BONG SURFACE SOIL SAMPLES

Levels (mg/kg)	Arsenic	Cadmium	Cobalt	Copper	Lead	Manganese	Nickel	Zinc
HIL	3,000	900	4,000	240,000	1,500	60,000	-	400,000
EIL	80	-	-	45	440	-	20	45
October 2019								
Minimum	5.0	1	2	5	6	56	2	13
Maximum	10	4	6	47	349	280	3	1830
Average	6.8	1.5	3.2	13.3	86.3	142.3	2.3	413.8

Note: Light orange shading – level above relevant EIL

It should be noted that the concentrations of soil contaminants were compared against the most stringent values of the commercial/industrial ecological investigation levels (TAS, 2020a).

3.1.4 Non-conformances, Corrective Actions and Improvements

During the reporting period there were no exceedances of the HIL guidelines. The October 2019 sample results were similar to historical measurements with the exception of the S22 and S24 locations, which are located near the processing facility and recorded elevated levels of most contaminants. For some sample locations, levels of lead, zinc, cadmium and copper generally increased from the mid-2000s, however the majority of the sample location levels were stable. At the BBLF, BBS02 recorded levels above the adopted EILs for copper and zinc. The more elevated levels near the processing plant would likely be due to the combination of the existing mineralisation in this area and the effects of the ore processing activities occurring within close proximity (TAS, 2020a).

In the October 2019 dataset, several blind duplicate samples returned relative percentage differences greater than the acceptable 30 % variation listed in the NEPC. This indicates that there may be a level of uncertainty/ margin of error in some of the sampled results.

3.1.5 Changes for the Next Reporting Period

MRM plans to discontinue this Soil Monitoring Program for the following reasons:

- Consistent with Recommendation 27 of NT EPA Assessment Report 86, MRM have reviewed the soil monitoring program and determined that the fluvial sediment monitoring program is more appropriate for measuring potential impacts and risks associated with depositional dust on MRM's declared environmental values and beneficial uses, which are predominantly related to the protection of waterways.
- The NEPC guidelines are not applicable to mine sites. Areas of natural surface mineralisation at the Mine, such as Barney Hill, result in naturally-occurring exceedances of these values. While MRM note that soil in some areas has been impacted by operations, the comparison to these guideline values is not considered appropriate.
- The depositional dust monitoring program is the most suitable monitoring program for measuring levels of dust emissions from operational activities.

Soil sampling will be undertaken on a case-by-case basis, such as for environmental incident or other specific investigations.

3.2 Ambient Air Quality

The *Ambient Air Monitoring Report McArthur River Mine and Bing Bong Loading Facility, May 2019 – April 2020* (TAS, 2020b) is provided in Appendix E.

3.2.1 Monitoring Program Overview

The objective of the monitoring program is to measure the levels of dust and concentration of COPCs in the ambient air near the operational areas of the Mine and the BBLF and to determine the effectiveness of the air quality controls.

Monitoring Methodology

Monitoring of air quality at the Mine and the BBLF was undertaken during the reporting period using multiple methods (locations presented in Figures 7a and 7b), including:

- Thirteen Airmetric MiniVol Tactical Air Samplers (MiniVols, or Low Volume Air Samplers), ten near the Mine (including two control sites more than 3 km from the Mine) and three near the BBLF. MiniVols are deployed for 24-hour periods, typically once per 12 days. Samples from MiniVols were analysed for the PM_{10} fraction of metal concentrations including lead, zinc, arsenic, cadmium, copper, iron and manganese.

- One High Volume Air Sampler (HVAS), used to measure total suspended particulate (TSP) concentrations for a 24-hour period, on a one day in six cycle (i.e. measures concentrations every six days). Samples from the HVAS were analysed for metal concentrations.

- Three Tapered Element Oscillating Microbalances (TEOMs), used to continuously measure concentrations of particulates, at approximately 5-minute intervals.

- Two Ecotech Serinus 50 sulphur dioxide (SO_2) analysers, used to continuously monitor SO_2 concentrations.

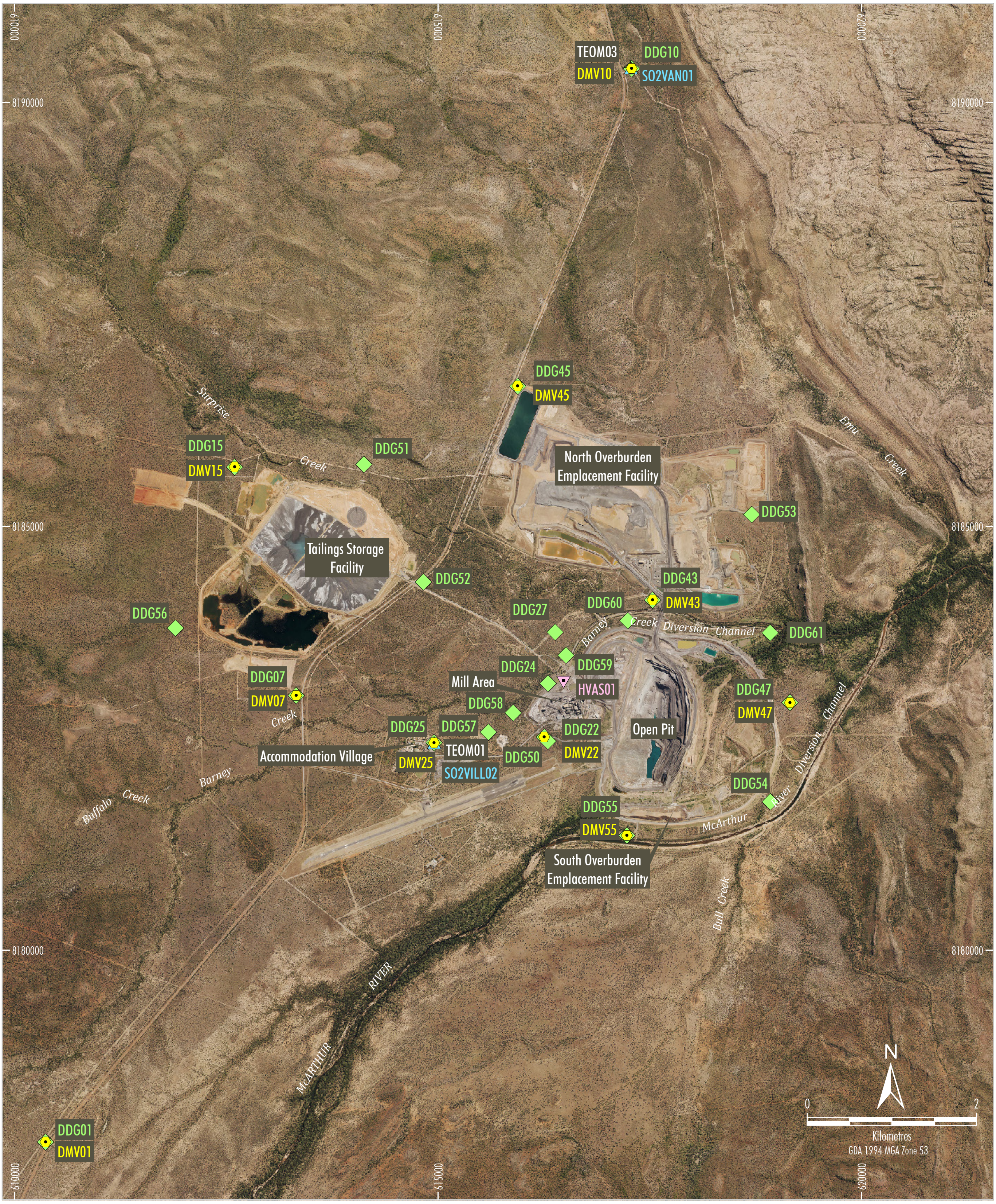
- Twenty-nine dust deposition gauges (23 near the Mine [including two control sites] and six near the BBLF [including one control site]). Note that analysis of the long-term historical monitoring data set (prior to 2018) was considered non-feasible due to previous inclusions of erroneous data (TAS, 2020b).

Performance Assessment Methodology

The *National Environmental Protection (Ambient Air Quality) Measure* (Air Quality NEPM) (NEPC, 2016) specifies national ambient air quality standards for air pollutants including PM_{10} and lead (MiniVol, HVAS, and TEOM sampling). However, the Air Quality NEPM applies at air quality sensitive receptors (such as Borroloola and Devils Springs, 44 km and 28 km away from the Mine, respectively), and so are not applicable at the Mine or BBLF monitoring locations. Historical and trend analysis will be used to assess environmental performance and identify potential areas of risk to the receiving environment.

Similarly, the Air Quality NEPM provides standards for concentrations of SO_2 are not appropriate for assessing compliance and are shown for indicative purposes only. For this reason, MRM developed a Trigger Action Response Plan (TARP) for SO_2 concentrations which includes site-specific trigger levels based on a range of occupational and health criteria including the Air Quality NEPM.

The New South Wales Environment Protection Authority (2017) and Ontario Ministry of the Environment (2012) also provide standards for air quality when sampled as depositional dust, however these standards are only applicable at air quality sensitive receptors or for assessment of general ambient air quality independent of a source. For these reasons, the standards are not appropriate for addressing compliance at the Mine or BBLF monitoring locations. However, trend and spatial analysis of depositional dust monitoring results can be used to identify key sources of risk to the environment, and allow MRM to appropriately implement management and mitigation measures.



LEGEND

- Depositional Dust Gauge
- High Volume Air Sampler
- Low Volume Air Sampler
- SO_2 Monitor
- TEOM

Source: *Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2020)*

McARTHUR RIVER MINE

Mine Ambient Air Quality Monitoring Sites

Figure 7a

MRM-16-01_EMR2020_209A

LEGEND

- Depositional Dust Gauge
- Low Volume Air Sampler
- TEOM

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); Todoroski Air Sciences (2018); MRM (2020)

McARTHUR RIVER MINE

Bing Bong Loading Facility
Ambient Air Quality Monitoring Sites

Figure 7b

3.2.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

Seven new monitoring locations were added during the reporting period (DDG27, DDG57, DDG58, DDG59, DDG60, DDG61 and BBDMV09) as recommended in the previous reporting period, in order to improve spatial resolution to assist in evaluating dust deposition (Figure 8).

Due to equipment malfunctions, equipment communications issues and NT border restrictions due to the COVID-19 pandemic, the real-time dust (also referred to as 'e-sampler') monitoring data was not available for majority of the year, and thus has been excluded from this EMR.

3.2.3 Performance during the Reporting Period

The Mine

Elevated levels of various substances were recorded at many of the monitoring locations, however, interpolation of the particulate monitoring data (including lead and zinc) shows that the elevated results were confined to areas near to the Mine processing and mining areas. Monitoring further away from these areas generally recorded pollutant levels at or near to the likely background concentrations, indicating that these pollutants only travel a short distance before they are dispersed and/or deposited. It can therefore be inferred that concentrations due to the mining activities at the nearest air quality sensitive receptor locations, such as Borroloola and Devils Spring (located 44 km and 28 km away, respectively), would be significantly lower than those recorded by any Mine monitor, and would likely not be discernible from background concentrations.

Deposited Dust Gauge Monitoring

The annual average total insoluble matter at all monitoring locations were approximately within the range of historical values, with the exception of sites DDG22, DDG43, and DDG50. When compared to the previous reporting period, the loads at monitoring sites DDG22 and DDG50 adjacent to the mill processing area both fell compared to the 2018-2019 reporting period, while the loads at DDG43, located between the NOEF and the Open Pit, increased.

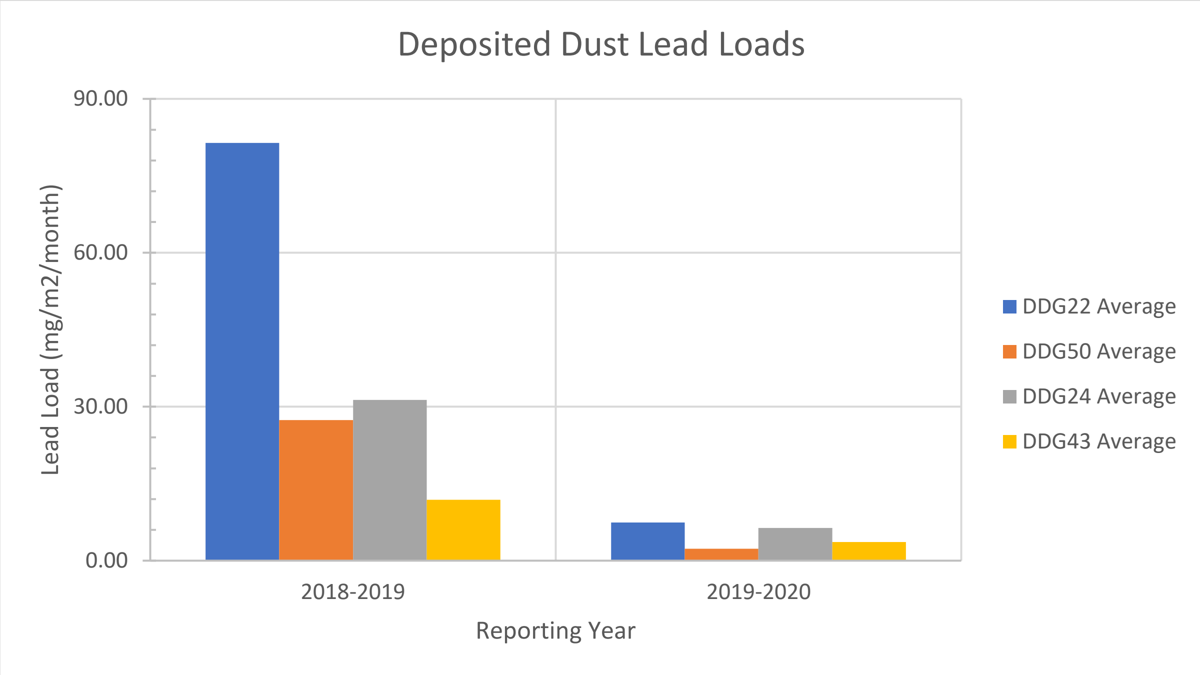
Note that the levels presented are not strictly annual averages. For the purpose of populating the plot the average at each monitor of all data is presented (i.e. a value is presented for sites with less than 75% data completeness for the annual average calculation), however monitors missing more than 3 months of consecutive deposited dust gauge measurements (i.e. DDG27, DDG57, DDG58, DDG59, DDG60 and DDG61) were excluded from the plots.

Table 14 presents a summary of total insoluble matter data for key sites in the May 2018 to April 2019 and May 2019 to April 2020 reporting periods. Note that DDG22 will be removed from the monitoring network as of next reporting period as the monitor impacted additionally by the dust generated by frequent traffic, and therefore does not meet the requirements of AS/NZS 3580.1.1-2016 (refer to Section 3.2.5 for additional details).

TABLE 14: SUMMARY OF ANNUAL AVERAGE TOTAL INSOLUBLE MATTER IN MINE DUST GAUGES

Site	Location (also refer Figure 8)	Annual Average (g/m^2/month)		
		May 18 – April 19	May 19 – April 20	Difference
DDG22	Adjacent to Mill, 10 m from Road to Camp	7.3	4.3	-3.0
DDG24	Adjacent to Mill, on Barney Creek	3.5	3.3	-0.2
DDG43	Between NOEF and Open Pit, Adjacent to Bridge	8.7	11.1	2.4
DDG50	Adjacent to Mill, 100 m from Road to Camp	4.5	2.7	-1.8

The average loads of lead across the site have decreased when compared to historical values. The maximum loads (per site) of lead detected in samples ranged from 0.00018 to 0.0274 g/m^2/month (at DDG01 and DDG24, respectively), with an average value across all sites of 0.00453 g/m^2/month. Chart 2 gives a summary of the historical loads of lead measured at depositional dust gauges for key sites.



Note: DDG22 is impacted by frequent nearby traffic, and is planned to be removed for the following reporting period (see Section 3.2.5 for further details).

Chart 2: Average Deposited Lead Loads at Key Depositional Dust Monitoring Sites

Figure 8 presents interpolated grids of the average deposited dust results for lead at the Mine for the May 2019 to April 2020 monitoring period.

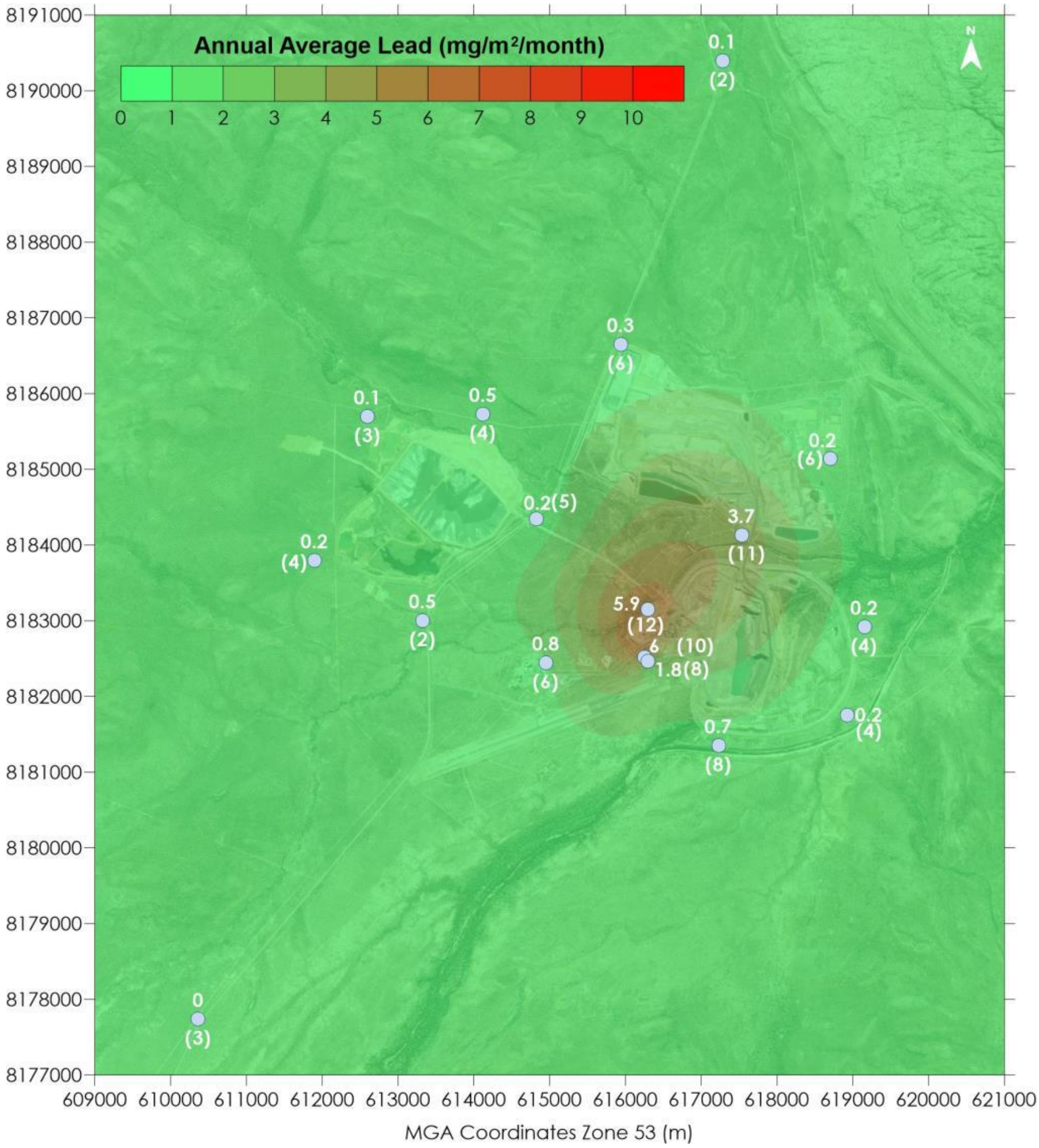


Figure 8: Interpolation of May 2019 to April 2020 Annual Average Lead Load Results

All monitoring sites were approximately within the range of historical values for annual average zinc loads, with the highest value of 0.114 g/m^2/month recorded at DDG22, resulting in a decrease when compared to the 2018-2019 reporting period annual average of 0.286 g/m^2/month.

All monitoring sites were approximately within the range of historical values for maximum zinc loads, with the exception of DDG24, DDG43 and DDG51 which each recorded an increase when compared to the 2018-2019 reporting period. Table 15 gives a summary of the maximum zinc loads data for key monitoring sites.

TABLE 15: SUMMARY OF ZINC LOADS IN MINE DUST GAUGES

Site	Location	Maximum Monthly (mg/m^2/month)		
		May 18 – April 19	May 19 – April 20	Difference
DDG22	Adjacent to Mill, 10 m from Road to Camp	950.73	232.00	-718.73
DDG24	Adjacent to Mill, on Barney Creek	185.40	237.77	52.37
DDG43	Between NOEF and Open Pit, Adjacent to Bridge	64.09	95.20	31.11
DDG50	Adjacent to Mill, 100 m from Road to Camp	407.00	174.00	-233.00
DDG51	North of TSF, Adjacent to TSF Trench Works	65.01	104.00	38.99

SO_2 Monitoring

MRM has developed a TARP, which includes site-specific triggers for SO_2 concentrations based on a range of occupational and health criteria, including the Air Quality NEPM (NEPC, 2016). The TARP has been developed in such a way that the triggers take effect at the relevant monitoring site well before elevated levels may arise at the nearest site receptors, and also at levels that will minimise worker exposure. The TARP is used to trigger escalating actions, as appropriate per the levels recorded, to reduce emissions or mitigate risks for workers, people off-site and inhabited locations in the surrounding area. The actions range from making closer observations (Action 1), to remediation, and up to work site evacuation.

Monitoring data for SO_2 recorded at the SO2VAN01 and SO2Village monitoring sites between 1 May 2019 and 30 April 2020 indicates that levels recorded at both monitoring sites were low and there were no instances of actions being triggered at these locations. The maximum 24-hour average value recorded throughout the monitoring period was 0.01 ppm.

Ongoing modelling/data interpolation studies conducted by TAS 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 (TAS, 2020b).

The SO2VAN01 monitor was damaged during Tropical Cyclone Trevor on 24 March 2019. From 2 April 2019 the SO2Village monitor was relocated to the SO2VAN01 monitoring location. Monitoring at the SO2Village monitor location resumed on 9 October 2019.

MiniVol Particulate (PM_{10})

All monitoring sites were approximately within historical range for annual average, with the exception of DMV43. The maximum value of 156.9 µg/m^3 was recorded at site DMV43, located next to the bridge between the NOEF and Open Pit. A summary of PM_{10} data from key MiniVol monitoring sites collected during the May 2019 to April 2020 monitoring period compared to the data for the April 2018 to April 2019 period (May 2018 to April 2019 for annual averages) is presented in Table 16.

TABLE 16: SUMMARY OF KEY MINIVOL PM_{10} LEVELS FROM THE MINE MONITORING

Site	Annual Average (µg/m³)			Maximum 24-hour Average (µg/m³)		
	May 18 - April 19	May 19 - April 20	Difference	April 18 - April 19	May 19 - April 20	Difference
DMV15	35.9	25.3	-10.6	209.9	41.9	-168.0
DMV22	59.4	60.5	1.1	200.1	123.2	-76.9
DMV25	32.7	30.6	-2.1	176.2	52.3	-123.9
DMV43	95.2	156.9	61.7	260.0	276.3	16.3
DMV55	37.8	42.7	4.9	195.4	97.3	-98.1

MiniVol Particulate Lead (PM_{10})

All monitoring sites measured annual average lead concentrations at or below the level of detection (0.08 µg/m³), with the exception of DMV22, DMV43, and DMV55.

Monitoring sites DMV22 and DMV55 were approximately within the historical range of concentrations (measuring 0.92 µg/m³ and 0.14 µg/m³, respectively), while DMV43 recorded an increase in annual average when compared to the 2018-2019 reporting period (0.21 µg/m³ to 0.39 µg/m³). This is expected as monitoring site DMV43 is located next to the bridge between the Open Pit and the NOEF, and the annual average total insoluble matter was measured to be higher when compared to the previous reporting period.

MiniVol Particulate Zinc (PM_{10})

All monitoring sites recorded maximum 24-hour average results for zinc that were approximately within the range of historical values.

Other MiniVol Particulate Levels

All monitoring sites recorded maximum 24-hour average results for manganese that were approximately within the range of historical values, with the exception of DMV43, which recorded an increase when compared to the 2018-2019 reporting period (0.20 µg/m³ to 0.43 µg/m³).

All monitoring sites recorded maximum 24-hour average results for manganese that were approximately within the range of historical values, with the exception of DMV22, which recorded an increase when compared to the 2018-2019 reporting period (0.16 µg/m³ to 0.24 µg/m³).

There were no recorded arsenic or cadmium results above the limit of detection during the reporting period.

HVAS Monitoring

All monitoring sites recorded annual average and maximum 24-hour average results for HVAS that were approximately within the range of historical values, with the majority of records falling when compared to the 2018-2019 reporting period.

TEOM Monitoring

Both TEOM monitoring sites TEOM01 and TEOM03 measured maximum 24-hour average concentrations lower than those recorded in the 2018-2019 reporting period. Monitoring site TEOM03 measured annual average concentration approximately within the range of historical values, where insufficient data were available for TEOM01 to accurately calculate an annual average.

Bing Bong Loading Facility

Deposited Dust Gauge Monitoring

All BBLF depositional dust monitoring sites recorded annual average loads of total insoluble matter within the range of historical values (Figure 9). All samples collected contained insufficient mass for laboratory analysis of metals concentrations.

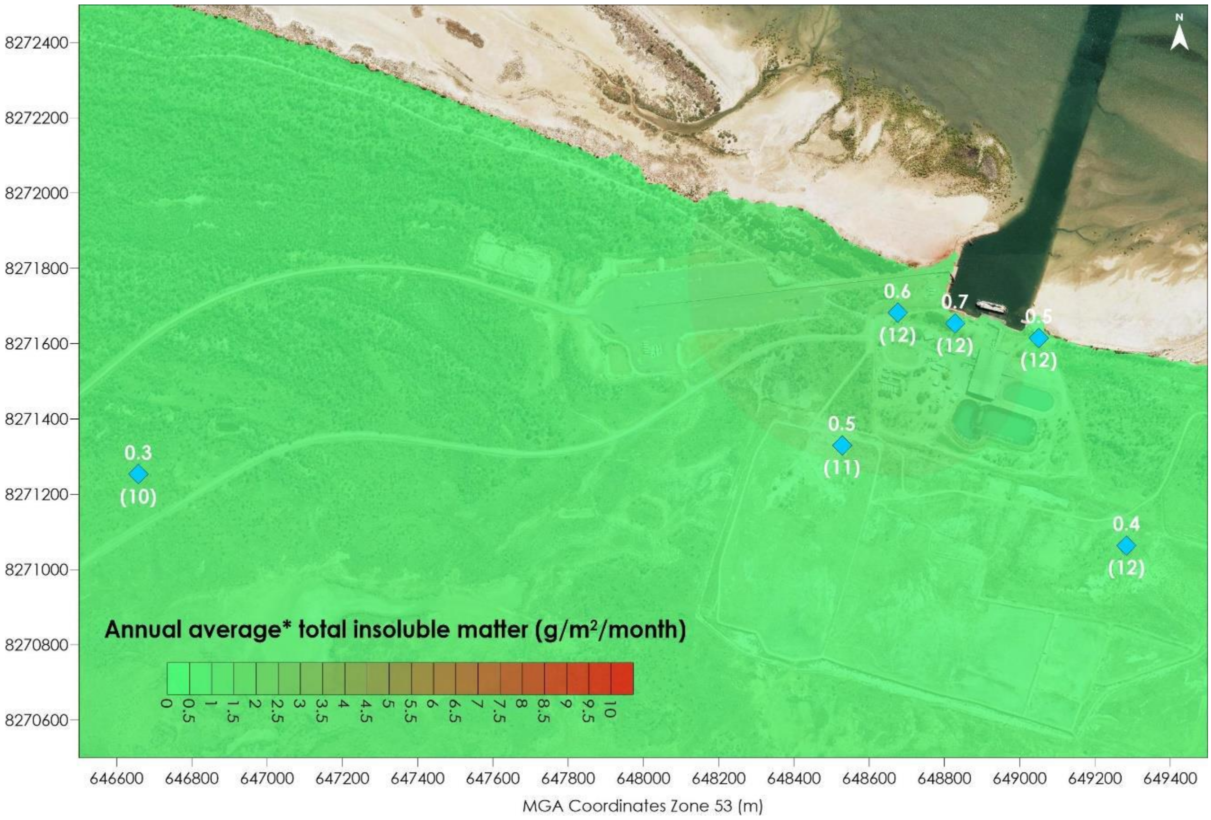


Figure 9: Interpolation of May 2019 to April 2020 BBLF Annual Average Total Insoluble Matter Results

MiniVol Particulates (PM_{10})

All monitoring sites at BBLF recorded annual average and maximum 24-hour average MiniVol results that were approximately within the range of historical values, including for total insoluble matter, lead, zinc, copper, arsenic, cadmium and manganese. The newly added monitoring site BBDMV09 recorded annual and maximum 24-hour average values equal to or below the range of historical values measured at nearby sites BBDMV01 and BBDMV02.

There were no recorded arsenic, cadmium or manganese data above the limit of detection during the reporting period.

TEOM Monitoring

The BBLF TEOM monitoring site TEOM02 recorded a maximum 24-hour average value within the range of historical values, and significantly decreased when compared to the 2018-2019 reporting period (from 281.1 µg/m^3 to 163.8 µg/m^3). There were insufficient data to accurately calculate an annual average.

3.2.4 Non-conformances, Corrective Actions and Improvements

Generally, the monitoring data indicate that elevated levels of various substances were recorded mainly near to processing activities. This would be expected given that the monitoring sites are positioned in close proximity to the processing area and mining activities.

The interpolation of the particulate monitoring data (including lead and zinc) shows that the elevated results were confined to areas near to the Mine processing and mining areas (TAS, 2020b). The Mine monitors located further from these areas (i.e. greater than approximately 1 km away) generally recorded low pollutant levels which would be considered at or near to the likely background pollutant concentrations for the area. This indicates that these pollutants only travel a short distance before they are dispersed and/or deposited. It can therefore be inferred that concentrations due to the mining activities at the nearest air quality sensitive receptor locations, such as Borroloola and Devils Spring (44 km and 28 km away, respectively), would be significantly lower than those recorded by any Mine monitor, and would likely not be discernible from background concentrations.

Notably, elevated lead concentrations around key operational areas observed in the previous reporting period were lower under the 2019-2020 reporting period.

A dust suppression system was installed on the ROM Bin/Primary Crusher in 2018 following an investigation for improving dust emissions from the Mill. During the reporting period, operation of the dust suppression system was significantly constrained due to maintenance issues due to limited clean water available during the 2019/20 reporting period.

Additionally, two new water trucks were commissioned in March 2020, uniquely designed with a spray control system that can consistently spray a controlled rate of water onto the ground, regardless of speed, to effectively control airborne dust. Road friction measurements and on-board data logging can be used to determine the maximum safe water coverage rate which in turn reduces wastage of water and decreases the risk of an unplanned movement. This allows for the maximum application of water to reduce wheel generated dust emissions, a major source of dust at the Mine.

3.2.5 Changes for the Next Reporting Period

An updated AQMP, which is a component of the overarching Adaptive Management Plan (AMP), and the BBLF Environment Management Plan (MRM, 2020a), were submitted to the DPIR in January 2020. These management plans outline air quality management and monitoring for at the Mine and the BBLF.

The key changes to the air quality monitoring program include:

- The depositional dust monitoring at the Mine has increased from 17 monitoring sites to 23 to allow for improved spatial resolution of depositional dust levels. Most additional monitors have been selected to measure depositional dust levels near the Barney Creek Diversion Channel, which has been identified as a pathway for dust-derived COPCs to enter the main McArthur River channel:

    - DDG22 will be removed from the monitoring network as the monitor is located approximately 19 m from the only road leading to the Mine, and is impacted additionally by the dust generated by frequent traffic. The monitoring location does not meet the requirements of *AS/NZS 3580.1.1-2016 Methods for sampling and analysis of ambient air Part 1.1: Guide to siting air monitoring equipment,* which recommends that air quality monitoring locations measuring particulate matter and lead should be distanced 50m or greater from roads which have an average of ≤10,000 vehicles per day.

    - Additional monitoring locations may be installed to monitor depositional dust levels in areas of Gouldian Finch foraging and nesting habitat in accordance with EPBC 2014-7210 Condition 6Df.

- Thallium has been added to the depositional dust analyte suite. Note that samples will require a minimum of 40 mg of dust to be collected for this analysis to be undertaken given sampling requirements by the selected laboratory.

- The current SO_2 monitor SO2VAN01 will be discontinued. The equipment will be relocated closer to the NOEF at the new location, SO2VAN02. This change is to meet requirements of VOA Condition 123 and Assessment Report 86 (NT EPA, 2018) Recommendation 19.

- The SO_2 TARP detailed above will be replaced by the TARP listed in the AMP.

- PM_{10} monitoring, including MiniVol, TEOM and real-time dust will be discontinued at the Mine and the BBLF for the following reasons:
  - PM_{10} monitoring was not considered a useful monitoring program in regards to the protection of MRM's declared environmental values and beneficial uses listed in the AMP (MRM, 2020b) as it focuses primarily on respirable dust (i.e. impacts on human health). DDG data was considered more appropriate as total COPC loads at each monitor could be measured as opposed to the ambient concentrations per volume of air.
  - Considerable time and expense is incurred on fieldwork, consultant fees and equipment repairs for the PM_{10} monitoring programs, to only have the data compared to guideline values which are not applicable to mine sites.
  - The distance between the Mine and nearby community receptors is significant, and as mentioned in previous reports by Todoroski Air Sciences , "*It can be inferred from the monitoring results that concentrations due to mining activities at the nearest sensitive receptor locations (e.g. Devils Spring and Borroloola, located 28 km and 44km away from the Mine, respectively) would be significantly lower than those recorded by any monitor, and would likely not be discernible from background concentrations*" (TAS, 2018; TAS, 2019; TAS 2020b).
  - The PM_{10} monitoring program is not suitable (or used) for occupational health and safety for MRM workers. An appropriate program exists in the *McArthur River Mine Health and Hygiene Management Plan 2019-2024* (MRM, 2019b).
  - The depositional dust monitoring program is capable of detecting impacts from dust emissions towards the nearby community receptors.

Management measures to be implemented during the next reporting period include the following:

- Investigation of options for providing a clean water source to the Primary Crusher/ ROM hopper, to allow for improved operation of the recently installed dust suppression system.
- Further planned use of the newly commissioned water trucks to reduce wheel-sourced dust from vehicle movements.

3.3 Rechannel Vegetation Health

A rechannel vegetation monitoring program was developed as a component of the 2006 Public Environmental Report (PER) for Phase 2. Revegetation work began at Barney Creek during the 2007-2008 wet season and at McArthur River in the 2010 dry season.

During the reporting period, the monitoring program was undertaken by Indo-Pacific Environmental Pty Ltd (IPE) in May, 2019. The *McArthur River and Barney Creek Revegetation Monitoring Report, 2019* (IPE, 2020a) is provided in Appendix F.

3.3.1 Monitoring Program Overview

The objective for the revegetation program, as stated in the *Revegetation Monitoring Procedure* 2017 (Revegetation MP), is that *"stream channels shall be stable with minimal impact on the surrounding environment and clean disturbed areas will be returned to native bushland"*.

The 2019 study aimed to:

- assess the success of the rehabilitation of the riparian habitat along the McArthur River and Barney Creek Diversion Channels in comparison to undisturbed sites on the McArthur River and Barney Creek;
- evaluate the effectiveness of revegetation works in establishing a riparian vegetation community;

- provide regular feedback to inform adaptive management of the rehabilitation program;
- measure the extent of natural regeneration and the establishment of a self-sustaining ecosystem along the diversion channels;
- determine if revegetation is on a positive trajectory; and
- determine when completion criteria have been met.

Revegetation Monitoring Procedure

In 2017, MRM engaged a specialist consultant to prepare the *Revegetation Monitoring Procedure* for monitoring the success of rehabilitation works on the McArthur River and Barney Creek Diversion Channels. The purpose of this procedure was to refine the methodology for collecting and analysing data on the ongoing revegetation works. The revegetation procedure outlined performance indicators and associated completion criteria to objectively assess ecosystem conditions.

In 2019, IPE undertook a review of performance indicators and completion criteria of the 2017 Revegetation MP and subsequently made a number of refinements. The review aimed to improve the practicality and efficiency of onsite data collection without compromising its quality or the assessment process. A major refinement involved reverting the focus to an assessment of key species only as opposed to conducting full floristic plot assessments, which were included in the 2017 Revegetation MP and the 2019 revegetation survey.

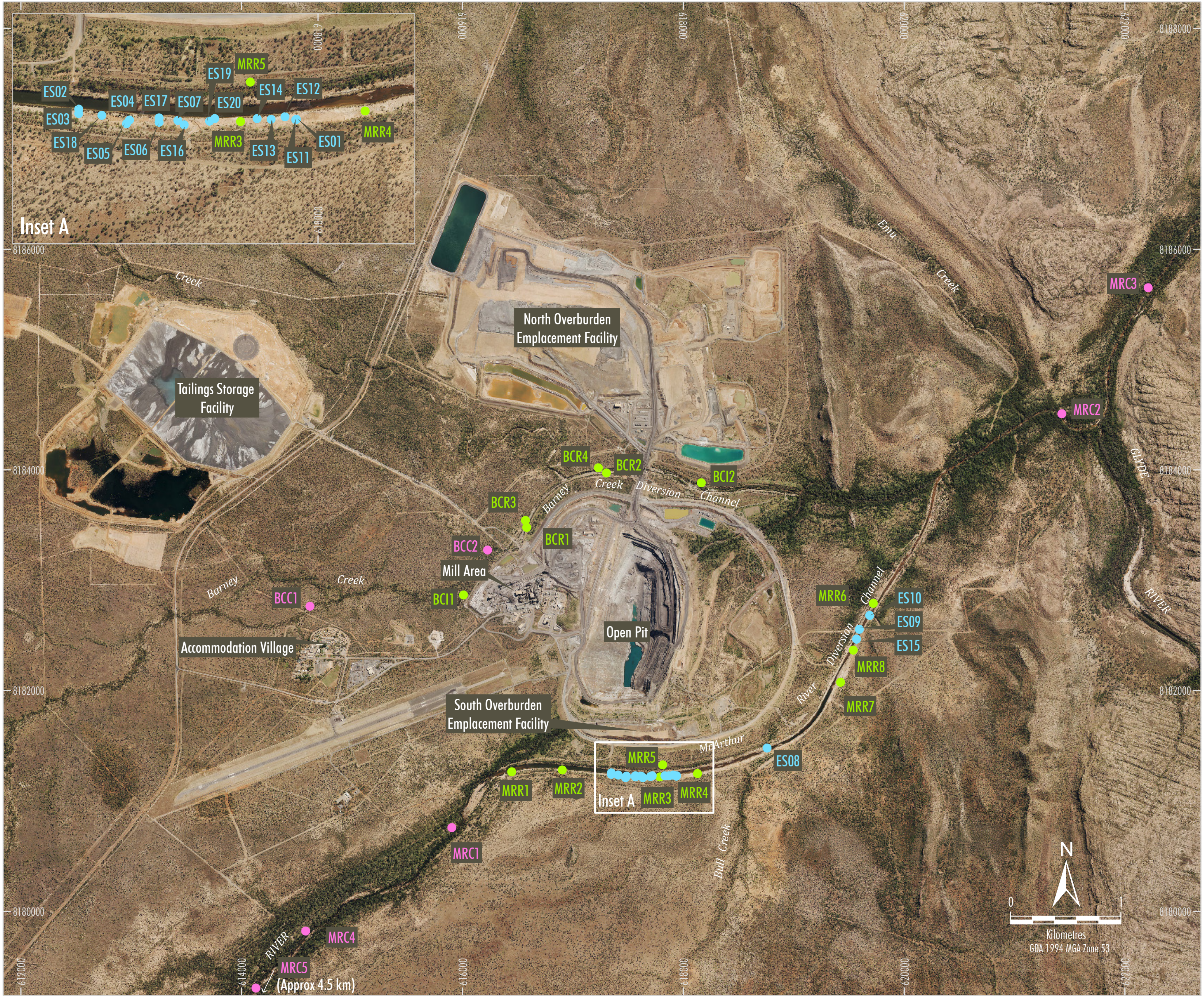
Monitoring Sites and Methodology

A total of 21 mid-stage revegetation monitoring sites were assessed within the Barney Creek Diversion Channel and the McArthur River Diversion Channel domains during the 2019 survey (Figure 10). The monitoring sites include a combination of control and revegetation sites within both watercourse ‘slope’ and ‘batter’ habitats. Each site consisted of three replicate plots, with each plot measuring either 5 m x 20 m or 10 m x 10 m with ‘slope’ and ‘batter’ plots running perpendicular and parallel to the watercourse, respectively.

In addition to Mid Stage monitoring sites, 20 Early Stage rapid assessment plots had been established in 2018 within areas of generally similar revegetation effort. All sites were 5 m x 20 m and ran parallel east-west along the McArthur River at various locations between the waterline and top of the batter (Figure 10).

The monitoring methodology was mostly consistent with the 2017 Revegetation MP, with the exception of a number of refinements made by IPE in 2019, as summarised in Appendix F. At each monitoring site the following performance indicator data was collected:

- Key species.
- Vegetation structure and fauna habitat.
- Stand Structure.
- Regeneration – seedlings and saplings.
- Erosion.
- Weeds.
- Fauna Disturbance.
- Flood Damage.
- Planting success (early stage plots only).



LEGEND

- Control Site
- Revegetation Monitoring Site
- Early Stage Monitoring Site

Source: *Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2020)*

McARTHUR RIVER MINE

Mine Revegetation Monitoring and Control Sites

Figure 10

MRM-16-01_EMR2020_210A

Aerial Imagery Monitoring

During the current reporting period, aerial imagery on a broader scale than previously monitored (i.e. the entire rehabilitation area) was obtained to record the progress of the revegetation program. An analysis of high-resolution aerial imagery collected annually by MRM was undertaken and aerial imagery from 2007 was subsequently obtained to define the areas within each domain that would be analysed. This was based on the area that had been cleared during the construction of each Diversion Channel. In addition, aerial imagery from 2017 and 2018 was obtained and the red, blue and green spectral bands of each image was used to produce a vegetation index.

3.3.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

As previously mentioned in Section 3.3.1, during the current reporting period, IPE reviewed the Revegetation MP and made a number of refinements. A summary of the changes to the monitoring of performance indicators is provided below:

- A number of species were removed from the key species list. The focus of the assessment was changed from a full floristic assessment to key indicator species only. This was consistent with recommendations made by Eco Logical Australia (2018) and the changes were made due to the absence of a number of listed key species in the broader survey area.
- The recording of reproductive structures was removed as it is not considered a particularly useful performance indicator. Many of the key tree species on the current list only presented reproductive structures for a short period, and that the timing of this can vary from year to year, or typically occurs at the onset of the wet season.
- The vegetation structure and fauna habitat performance indicators were combined as they shared the same habitat components, and were assessed by the same criteria, with the exception of foliage and stratum (mid and upper) cover. With respect to those that differed, the criteria values of foliage cover (vegetation structure) were adopted for the assessment as they were higher than those of mid and upper stratum cover (fauna habitat).
- Whilst the updated Revegetation MP indicated that the completion criteria for the weeds performance indicator was that the cover of weed species is <5 %, during the 2018 assessment this criterion was changed to the cover of declared weed species is <5 %. This was consistent with studies conducted prior to 2018 and as such was reverted back for the current survey.
- Although not included in the updated Revegetation MP, an assessment of flood impacts on vegetation had previously been undertaken by ranking plant mortality and/or damage from flooding within each plot. This performance indicator was considered useful as it may provide information on localised or catchment wide effects. As such, this component was included in the current program.
- The current survey trialled the use of high-resolution aerial imagery collected during the construction of the diversion channels and in recent years to provide an insight into the broadscale progress of the revegetation program since being implemented.

No other changes to the monitoring program or techniques were made during the reporting period.

3.3.3 Performance during the Reporting Period

Results from the 2019 reporting period indicated that revegetation along the Diversion Channels were progressing with revegetation efforts being particularly successful at upstream sites on both the Barney Creek and McArthur River Diversion Channels where a canopy and diverse shrub and ground layer has established. However, vegetation appeared to be comparatively sparse at monitoring sites on the lower and mid reaches of the diversion channels. This difference was considered largely due to issues associated with erosion, shallow soils, low retention and storage of soil moisture and that steep rocky banks made the establishment of vegetation difficult.

Based on performance indicators and completion criteria utilised from the updated Revegetation MP, each mid stage monitoring site was assessed and assigned a revegetation status. Results indicated that all sites were assigned a status of either maintenance (requiring minimal work) or monitoring (no work required). No sites were assigned a status of rework (extensive work required) or acceptable (ready for sign off by stakeholders). However, when control sites were also assessed in the same manner no sites were found to have reached an acceptable status (although the percentage of criteria satisfied was generally higher). On a number of occasions, the topography, soil profile and the vegetation surrounding control sites was not analogous with that found at revegetation sites in the Diversion Channels.

Early stage monitoring sites were established in 2018. Works conducted in 2019 therefore provided the first opportunity to conduct a quantitative comparison between years. The survival rates of tree tube stock at a number of sites appeared to be close to or exceeding the trigger value outlined in the Revegetation MP and an average of 93 trees were found to be present in early stage monitoring plots. However, it was unclear whether all trees within some of the plots were present during the 2018 survey, as some supplementary planting had occurred between the 2018 and 2019 sampling events. As such an accurate mortality estimate could not be established. Despite this, consideration must be given to the planting effort undertaken by MRM and the current number of live individuals. As previously mentioned, an average of 93 trees was present in each plot. This is vastly higher than the average of 12 trees present within a mid-stage McArthur River control slope plots. While a low survival rate in the long term should be expected, the sheer number of individuals in the assessment plots combined with increases in height and shrub cover, provides an indication that early stage revegetation sites appear to be on a positive trajectory.

The current survey trialled the use of high-resolution aerial imagery collected during the construction of the diversion channels and in recent years to provide an insight into the broadscale progress of the revegetation program since being implemented. Noting the limitations of the imagery collected and the analysis method, results indicated that at least 33 % and 27 % of the previously cleared area within the Barney Creek and McArthur River domain, respectively, had vegetation cover.

3.3.4 Non-conformances, Corrective Actions and Improvements

Despite the fact no revegetation site, including control sites, was seen to attain an acceptable status during 2019, the current results indicated that revegetation along both Barney Creek and McArthur River Diversion Channels has improved. Revegetation within the upper sections of the Diversion Channels has resulted in the establishment of a diverse riparian habitat with successful growth of canopy, shrub and ground layer species.

However, considering that the purpose of the revegetation program is to revegetate the Barney Creek and McArthur River Diversion Channels back to a natural state and that the purpose of the Revegetation MP is to indicate when this has been achieved, the fact that no control site was assigned an acceptable status strongly suggests that the current completion criteria may require review.

The limitations of the assessment and ranking status criteria have highlighted the ongoing need for an adaptive management approach to monitoring and management of revegetation in the Barney Creek and McArthur River Diversion Channels. These are in part due to the vastly different topography and geology encountered on the modified steep rocky banks of both the Barney Creek and McArthur River Diversion Channels, in comparison to that encountered on the original naturally vegetated reaches and at current control sites.

3.3.5 Changes for the Next Reporting Period

For the following reporting period IPE (2020a) recommended that MRM:

- Complete a review of completion criteria values and alter them to reflect those obtained from control sites over the course of the monitoring program and to make them more achievable at revegetation sites.
- Complete a review of the control sites used prior to the next survey in order to improve revegetation outcomes and create a sustainable vegetated system in the long term.
- Alter the way in which revegetation status criteria are presented. At present, revegetation status criteria are based on the percentage of completion criteria that have been met which can lead to a misleading status being applied at a number of sites.
- Continue with a successional revegetation approach with supplementary irrigation to improve revegetation survival rates and erosion controls, such as rock armouring, to reduce erosion and increase sedimentation rates. Successional revegetation should include a focus on the initial planting of tufted and tussock grasses to establish the stability of the ground prior to the planting of tree and shrub tube stock.
- Avoid the planting of additional tube stock within early stage revegetation sites between surveys. If additional planting is required, the number and types of plants added to assessment plots should be documented at the time of planting.
- Continue to conduct aerial imagery analysis as the results may be of benefit to provide an overall indication of revegetation progress and identifying changes in vegetation cover or areas where rehabilitation efforts should be focused.
- Reallocate reference sites, and include additional rapid assessment sites.
- Alter key species, including:
    - removal of lower stratum key species;
    - change from key species to keystone species;
    - include *Flueggea virosa* and *Antidesma ghesaembilla* as keystone species;
    - discontinue grass and herbs key species and focus on larger trees and shrubs;
    - consider addition of *Acacia genu*; and
- characterise stratum based on actual height and cover of individual trees and shrubs rather than predefined category.
- Consider splitting slope plots into zones to capture bare areas, and splitting into grass and herb cover of whole plot, for vegetation structure, fauna habitat, and stand structure.
- Implement new erosion metrics based on Landscape Function Analysis for stability.
- Record only declared weed species and their cover and abundance.
- Include additional scores calculated for whole plot for fauna disturbance, flood damage, and planting success.

3.4 Riparian Birds

A riparian bird monitoring program was developed by Ecological Management Services (EMS) for the 2006 PER for Phase 2. The monitoring program was developed in consultation with the NT Department of Natural Resources, Environment, the Arts and Sport.

Monitoring over the reporting period was carried out by EMS in June and July, (early dry season 2019), as well as in November (late dry season 2019).

Copies of the *McArthur River Riparian Bird Monitoring, Early Dry Season, June-July 2019* (EMS, 2019a) and *McArthur River Riparian Bird Monitoring, Late Dry Season, November 2019* (EMS, 2020a) are provided in Appendices G and H, respectively.

3.4.1 Monitoring Program Overview

The objective of the riparian bird monitoring program is to monitor riparian birds in the vicinity of the Mine and determine the success of rehabilitation works along the Barney Creek and McArthur River Diversion Channels as habitat for vertebrate fauna. Additionally, the monitoring is used to confirm if the McArthur River Diversion Channel is functioning as a riparian corridor that can provide for the dispersal and movement of riparian birds between habitats upstream and downstream of the Diversion Channel.

The monitoring program focuses on riparian birds and two resident riparian indicator species, the Buff-sided Robin (*Poecilodryas cerviniventris*) and the Purple-crowned Fairy-wren (*Malurus coronatus macgillivrayi*) (EMS, 2006a; EMS, 2006b).

The early and late dry season 2019 monitoring program included:

- Seasonal monitoring of riparian bird communities at the sample sites established during the late dry season 2006 (Barden, 2007) (with minor amendments).
- Assessment of seasonal changes in the abundance and distribution of the riparian bird assemblage and riparian habitat specialist species.

Monitoring Sites

Twenty-six riparian bird monitoring sites were established in November 2006 along the McArthur River and the McArthur River and Barney Creek Diversion Channels. During the course of the monitoring program, a number of sites have been added or relocated due to refinement of the monitoring methodology and to accommodate revised clearing and development requirements within the study area.

The monitoring sites (Figure 11) include sites within the McArthur River and Barney Creek Diversion Channel, and additional sites upstream and downstream of the Mine.

Data Collection

Survey Methods

At each site, two 2-ha (100 m x 200 m) quadrats were positioned in parallel, with the lower quadrat sampling the inner riparian zone and the second quadrat within the adjacent outer riparian zone.

A standard fixed area timed bird census method (2 ha x 20 minutes) was selected for the study (EMS, 2019a; 2020a). Each inner riparian zone quadrat (lower bank) was sampled four times and each outer riparian zone (higher bank) quadrat was sampled twice during the survey period (total sampling effort of 162 x 2 ha x 20-minute timed area searches), data was summed for each quadrat and site. Sampling was undertaken in the morning (between 6 am and 11 am) and in the afternoon (between 2 pm and 6 pm).

Each quadrat was traversed in a single direction, recording all birds seen or heard. Each survey was designed to limit the possibility of double-counting birds moving within the quadrat.

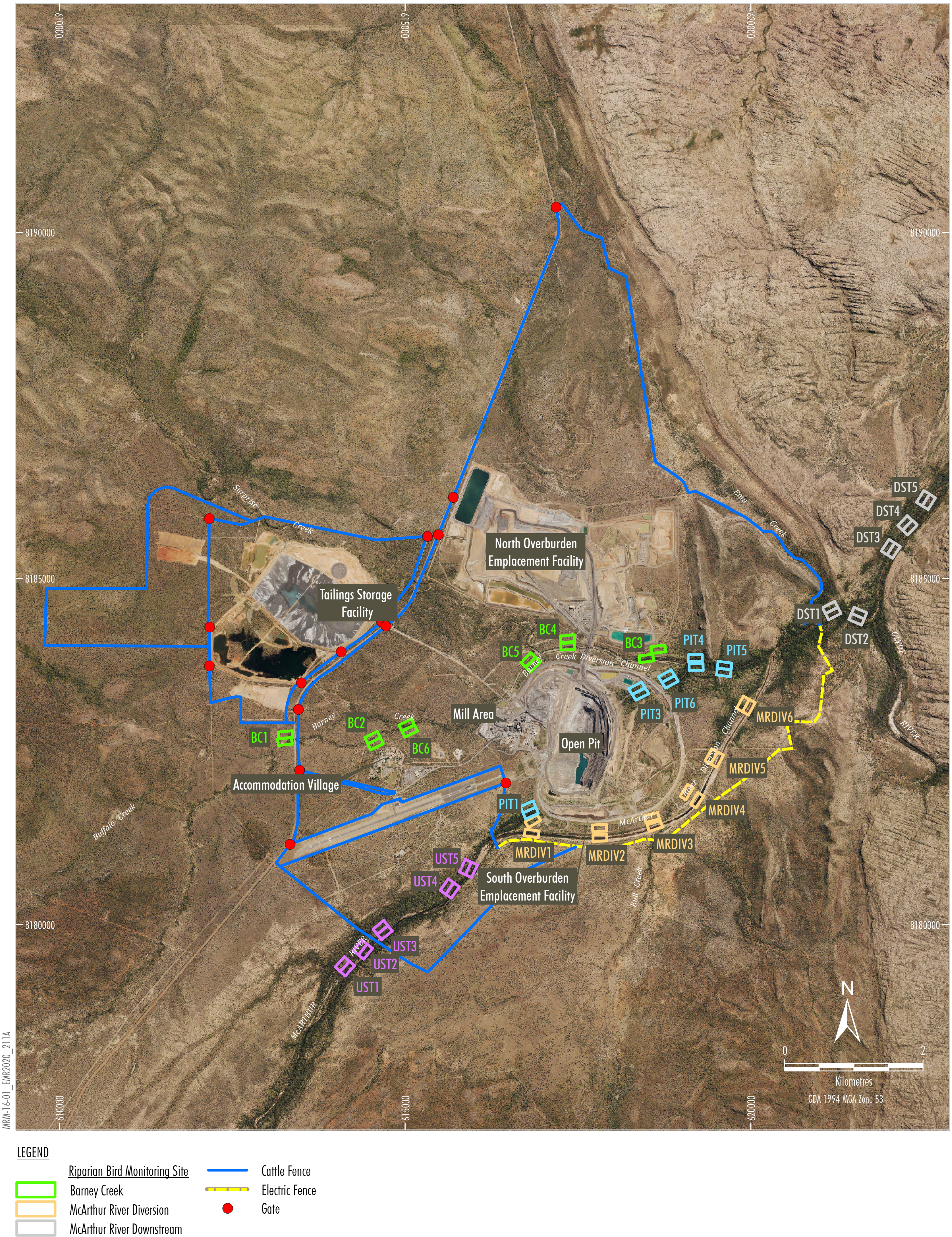
The location of a bird sighting in relation to the quadrat boundaries was determined using a GPS and laser range finder, and birds determined to be outside this area were not counted. Birds seen overflying a quadrat and not actively involved in aerial foraging or hunting were also excluded.

Habitat Data

A range of habitat variables were collected for each quadrat, including:

- riparian plant cover;
- regeneration;
- erosion;
- weeds;
- disturbance pressure; and
- condition.

This sampling was based on a 150 m transect on a central line within the quadrat and three nested 5 square metre (m^2) quadrats spaced at 50 m intervals.



McARTHUR RIVER MINE

Mine Riparian Bird Monitoring Sites

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

Figure 11

3.4.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

No changes to the monitoring program or techniques were made during the reporting period.

3.4.3 Performance during the Reporting Period

Monitoring for the 2018 Early Dry and Late Dry seasons included 162 two-ha/20-minute bird counts at established monitoring sites:

- During the 2019 early dry season survey, a total of 97 bird species were recorded and 4,014 bird observations were collated.
- During the 2019 late dry season survey period, a total of 106 bird species were recorded and 6,467 bird observations were collated.

McArthur River Diversion Channel

Riparian bird assemblage at sites on the upper and lower sections of the McArthur River Diversion Channel has increased in similarity to reference riparian forest (EMS, 2019a; 2020a). However, bird communities at sites on the mid-section of the Diversion Channel support lower numbers of species, particularly forest and woodland passerine birds. The vegetation within forest and woodland zones is dominated by slow growing species and therefore the riparian condition assessment scores for riparian bird species indicates a lower level of success than data collected during revegetation monitoring.

Analysis of habitat data indicates that bird species diversity is positively correlated with indicators based on improving vegetation structure and condition, and negatively correlated with disturbance related variables. MRM are undertaking progressive rehabilitation works to improve revegetation success and these efforts are improving the condition of the McArthur River Diversion Channel.

Barney Creek Diversion Channel

Ongoing development of regenerating vegetation on Barney Creek Diversion Channel has resulted in all sites in this area supporting a bird assemblage that is increasingly similar to open woodland and riparian (minor drainage line) reference sites.

Between 2014 and 2019, all sites on the Barney Creek Diversion Channel showed improvement in terms of the bird assemblage present. The movement of riparian specialist birds (buff-sided robin, crimson finch) into the lower Barney Creek Diversion Channel in 2018 is a sign that conditions are improving as regenerating vegetation develops.

Riparian Indicator Species

Monitoring of riparian indicator species (i.e. the Buff-sided Robin and Purple-crowned Fairy-wren) continued during the reporting period. During both the early and late dry season surveys, neither the Purple-crowned Fairy-wren or the Buff-sided Robin were detected in core revegetation areas on the McArthur River and Barney Creek Diversion Channels.

3.4.4 Non-conformances, Corrective Actions and Improvements

No non-conformances were identified during the reporting period.

EMS (2019a, 2020a) made the following recommendations for the next reporting period:

- Continue weed control measures, particularly within Diversion Channel revegetation areas.
- Continue efforts to remove cattle and feral animals (cats, donkey and feral pig) from fenced areas on the channels and revegetation areas.

- Continue to implement findings of investigations of alternative measures for establishing cane grass (*Chionachne cyathopoda*) at riparian revegetation sites.

3.4.5 Changes for the Next Reporting Period

No changes to the riparian bird monitoring program are proposed for the next reporting period.

3.5 Migratory and Wetland Birds

Monitoring and surveys of listed migratory shorebirds and other wetland birds have been conducted in the austral summer and northern migration staging periods in the vicinity of the BBLF since 2010. This monitoring program is completed as required under condition 3 of EPBC 2003/954.

Monitoring for the reporting period was conducted by EMS between 4 and 10 April 2019 (i.e. Northern Staging), and 3 and 9 February 2020 (i.e. Austral Summer).

The *Survey of Listed Migratory Shorebirds and Other Wetland Birds, Limmen Bight River to Robinson River, Gulf of Carpentaria, Northern Staging 2019* (EMS, 2019b) and *Survey of Listed Migratory Shorebirds and Other Wetland Birds, Limmen Bight River to Robinson River, Gulf of Carpentaria, Summer 2020* (EMS, 2020b) is provided in Appendix I and Appendix J, respectively.

3.5.1 Monitoring Program Overview

The objective of the migratory bird monitoring program is to observe any significant changes in the numbers and species mix of migratory shorebirds and other wetland birds as a result of operations at the BBLF.

Many of these species migrate to the northern hemisphere on the East Asian – Australasian migratory bird flyway. The EPBC 2003/954 approval condition states that if any significant changes are detected, remedial action is to be undertaken if any causal agent relating to mining activities can be determined.

Monitoring Sites

The study area covers approximately 200 km of coastline between Limmen Bight River (west of the BBLF) and Robinson River (east of the BBLF). This area was selected as it includes the segment of coast and floodplain where Garnett (2008) conducted ground and aerial counts for shorebirds during previous surveys, and incorporates the Port McArthur Tidal Wetlands System (Dutson et al., 2009) and Key Biodiversity Area (KBA). The study area covers a complex coastline supporting extensive areas of tidal channels, chenopod low shrubland (samphire), *Melaleuca acacioides* low open-woodland, open saline flats, mangroves, sand spits and intertidal flats. Rocky shore habitats are also present on the coastline of South West Island, Sharker Point (Jarrka), coastal areas between Rosie and Pine Creeks and the foreshore of Beatrice Island.

Monitoring undertaken along the coastline included (Figure 12):

- Aerial shorebird counts across 18 designated aerial count areas.
- Fifteen ground shorebird counts were conducted during the 2019 Northern Staging, and 20 during the 2020 Austral summer surveys.
- Collection of marine sediment samples from nine locations between Rosie Creek and Horse Creek.

Aerial Shorebird Survey Methodology

The survey methodology is based on the aerial survey count methods and aerial survey sections described in EMS (2010) and EMS (2018a). The coastline and adjacent tidal/saline habitats were divided into sections, allowing sampling to be restricted to a specific area during each count period.

Aerial counts were conducted by flying slow (50-70 nautical miles/hour) transects within each aerial count section at 150 feet altitude, with an attempt made to survey representative sections of the coastal tidal flats and inland saline wetlands in each section.

Migratory shorebirds and other wetland birds encountered during the aerial surveys were identified and counted from the air using binoculars. Birds that could not be positively identified (generally small shorebirds) were assigned to classes based on size and general appearance. In some cases, identifications were confirmed by enlarging digital photographic images of birds taken in flight during the aerial counts.

Ground Shorebird Survey Methodology

As the objective of the ground counts was to provide interpretation of aerial count data, ground counts were conducted at representative sites across the study area and a range of habitats were surveyed. Ground count sites were selected by flying over representative habitat/aerial count sections to identify where bird density was the highest. The helicopter was landed at a nearby location and the birds approached on foot. A count of all birds observed at the site was undertaken using spotting scopes. Migratory shorebirds were scanned and photographed to locate leg flags and bands.

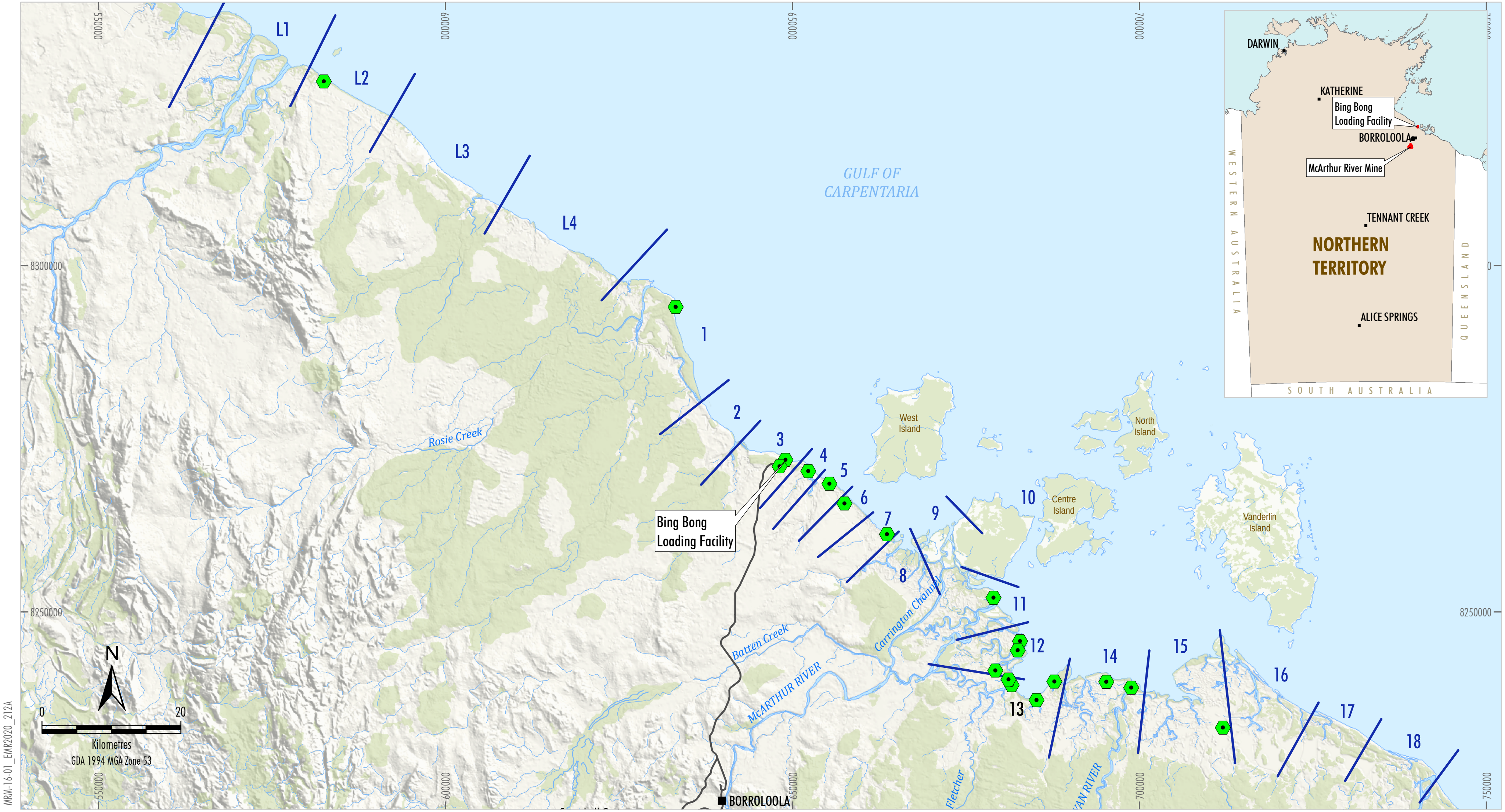
Marine Sediment Samples

Marine sediment samples were collected at nine locations between Rosie Creek and Horse Creek to determine upper sediment layer metallic element levels.

Samples were taken from the upper 10 cm of the sediment profile, where most benthic invertebrates occur and where shorebirds frequently collect invertebrates on mud flats, tidal shores or salt pans. Each sample was collected in the field using gloves and a plastic trowel, with care taken to prevent sample contamination. Three samples were collected at each location and then combined to form a single sample for analysis. Samples were stored in dual sealed plastic bags, refrigerated and then frozen for transport to the laboratory.

The content of the <63 micrometre (µm) fraction of a sediment sample is generally considered to represent material that is available for uptake by biota. Field collected sediment samples were wet-sieved to obtain the <63 µm fraction and then analysed for concentrations of silver, aluminium, arsenic, cadmium, cobalt, copper, iron, manganese, nickel, lead and zinc (mg/kg).

Metal concentrations were subsequently compared to the sediment quality guideline values (SQGVs) outlined in Table 3.5.1 of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council [ANZECC] and the Agriculture and Resource Management Council of Australia and New Zealand [ARMCANZ], 2000). Samples were analysed by the Marine and Freshwater Research Laboratories.



LEGEND

- Major Road
- River/Creek
- Aerial Count Section
- Ground Count Site

McARTHUR RIVER MINE

Migratory Shorebird Monitoring Sites

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

Figure 12

3.5.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

No changes to the monitoring program or techniques were made during the reporting period.

3.5.3 Performance during the Reporting Period

The 2019 Northern Staging survey identified (EMS, 2019b):

- 11,745 shorebirds, raptors and other wetland birds (53 species) were recorded at 15 ground count sites.
- A total of 27,756 migratory shorebirds, resident shorebirds, raptors and wetland birds (69 species) were recorded during aerial surveys.
- 15,532 migratory shorebirds and 5,523 resident wetland birds and raptors in the Port McArthur KBA (Rosie Creek to Robinson River).
- 3,830 terns and gulls of nine species were recorded within the study area during aerial counts.

Analysis of the results of the 2019 Northern Staging survey concluded that (EMS, 2019b):

- A number of species detected during the April 2019 surveys are listed as threatened under Northern Territory and Commonwealth legislation.
- During Northern Staging 2019, the red-necked stint and broad-billed sandpiper were detected at numbers that exceeded global significance thresholds.
- Four species, including the sharp-tailed sandpiper and curlew sandpiper, were present within the Port McArthur count area at numbers exceeding the flyway 1 % threshold based on Hansen et al. (2016).
- Two resident wetland/marine species, the pied stilt and eastern reef egret, exceeded WPE5 1 % population thresholds (Mundkur and Nagy, 2012).
- 13 species were present at numbers exceeding national EPBC thresholds indicating significant shorebird habitat within Australia (sites supporting more than 0.1 % of the flyway population estimate) (Hansen et al., 2016; DOE, 2015; DEWHA, 2009).
- 11 migratory species exceeded the 0.25 % staging threshold for significant shorebird staging sites.

The 2019 Austral Summer survey identified (EMS, 2020b):

- A total of 12,871 shorebirds, raptors and other wetland birds (49 species) were recorded at 20 ground count sites in February 2020.
- A total of 17,850 migratory shorebirds, resident shorebirds, raptors and wetland birds (55 species, excluding terns and gulls) were recorded during aerial surveys.
- A total of 21,916 migratory shorebirds, resident shorebirds, raptors and wetland birds (56 species) were recorded during aerial surveys.
- 10,600 migratory shorebirds and 3,984 resident wetland birds and raptors in the Port McArthur KBA (Rosie Creek to Robinson River).
- 4,668 of the shorebird and wetland birds were recorded in the area between Rosie Creek and the eastern component of the Limmen Bight KBA (lower delta of the Limmen Bight/Cox Rivers).
- 2,664 terns and gulls of nine species were recorded within the study area during aerial counts.

Analysis of the results of the 2019 Austral Summer survey concluded that (EMS, 2020b):

- Several shorebird species detected during the February 2020 surveys are listed as threatened under Northern Territory and Commonwealth legislation. The curlew sandpiper (critically endangered), eastern curlew (critically endangered), bar-tailed godwit (critically endangered), great knot (critically endangered), red knot (endangered), lesser sand plover (endangered), greater sand plover (vulnerable) are listed as threatened under the EPBC Act. The Asian dowitcher is listed as vulnerable under Northern Territory legislation.

- During Summer 2020, the red-necked stint was detected at numbers that exceeded global significance thresholds, exceeding the 1 % flyway and global threshold levels.

- 15 species were present at numbers exceeding national EPBC thresholds indicating significant shorebird habitat within Australia (sites supporting more than 0.1 % of the flyway population estimate).

In addition to the above, the marine sediment sampling indicated that sediment metal levels were low at all sites tested and did not exceed trigger values in the interim sediment quality guideline (ISQG) provided by ANZECC and ARMCANZ (2000). There were no obvious trends in marine sediment metal levels related to proximity to the lower McArthur River delta.

3.5.4 Non-conformances, Corrective Actions and Improvements

No corrective actions or improvements were recommended by EMS (2019b and 2020b).

3.5.5 Changes for the Next Reporting Period

Condition 3 of MRM's EPBC Act Approval (EPBC 2003/954) requires monitoring and survey of migratory bird species surrounding Port McArthur (the Bing Bong Loading Facility). This condition states the "purpose of the monitoring program shall be to observe if any significant changes in the numbers and species mix of listed migratory waders and other birds occurs following the opening of the McArthur River diversion".

Condition 3 also states the survey program be implemented for a minimum of 5 years. The survey program has been undertaken for 10 years (2010 – 2020) and the review of all data by EMS (2020b) concluded that the trends detected in the Port McArthur area do not show any consistent pattern of decline across all co-occurring species that would indicate a local causative factor such as pollution or disturbance associated with mining operations.

On 8 May 2020, MRM notified the Department of Agriculture, Water and the Environment of its intent to discontinue the monitoring program.

3.6 Diversity and Abundance of Freshwater Macroinvertebrates

Since 2008, MRM has engaged specialist consultants to conduct macroinvertebrate monitoring, consistent with the commitments made in the 2006 PER for the MRM Open Cut Project. The monitoring program was developed in consultation with the then NT Department of Resources – Primary Industries, Fisheries and Resources section (now the Department of Primary Industries and Resources – Fisheries section).

Macroinvertebrate monitoring is timed to coincide with the recessional flow period, approximately four to six weeks after the last wet season storm flush. The 2018/2019 wet season total rainfall was 200 mm below average between November and April. Consequently, flows within the McArthur River were later than usual and of a shorter duration. Flows within minor drainage lines, such as Surprise Creek and Barney Creek, were also sporadic and short lived. Monitoring of minor drainage lines was conducted by IPE in April with larger order streams, including the McArthur River, being sampled in May.

The *McArthur River Freshwater Aquatic Macroinvertebrate Assessment, 2019* (IPE, 2020b) is provided in Appendix K.

3.6.1 Monitoring Program Overview

The objective of the monitoring program is to identify significant changes in macroinvertebrate communities in the vicinity of MRM operations and at downstream locations, as well as to monitor the development of instream habitats within the McArthur River Diversion Channel and Barney Creek Diversion Channel.

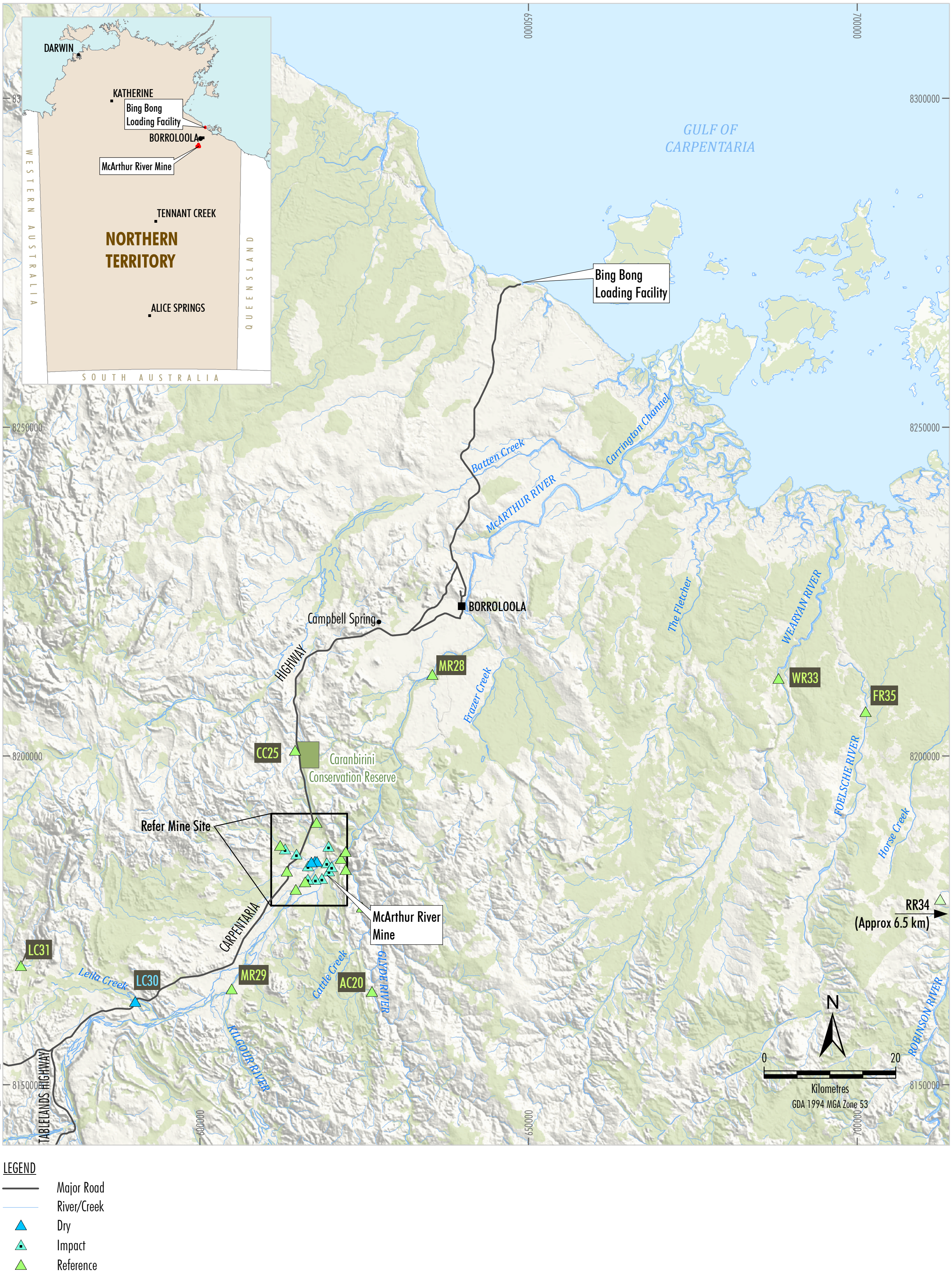
Monitoring Sites

Macroinvertebrate monitoring is conducted at edge habitats and, where present, riffle habitats at reference sites and sites that may be potentially impacted by MRM operations (Figures 13 and 14).

Data Analysis

As per the NT Australian River Assessment System (AusRivAS) macroinvertebrate sampling protocol, sampling is conducted annually during the recessional flow period (late wet season/early dry season). No AusRivAS model has been developed for the MRM region, however the NT Government recommended that sampling and laboratory processing should be conducted following AusRivAS protocols. Data analysis is based on traditional statistical methods for the assessment of site conditions and comparison of sites.

Further details on the data collection and analysis (including all monitoring sites) is provided in Appendix K.



McARTHUR RIVER MINE

Regional Macroinvertebrate Monitoring Sites

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

Figure 13

LEGEND

- Dry
- Impact
- Reference

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

McARTHUR RIVER MINE

Mine Macroinvertebrate Monitoring Sites

Figure 14

3.6.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

No changes to the monitoring program or techniques were made during the reporting period.

3.6.3 Performance during the Reporting Period

IPE (2020b) noted decreases in macroinvertebrate abundances at edge and riffle habitats at both the Barney Creek and McArthur River Diversion Channel impact sites. However, similar decreases were observed at reference sites within these systems and the wider region, suggesting that the below average 2018/2019 wet season was the likely driver of the decrease in abundance at both impact and channel sites rather than mining activities.

McArthur River

The 2019 survey noted that when analysed separately, both riffle and edge habitats macroinvertebrate assemblages at McArthur River Diversion Channel sites were not found to be significantly different when compared to those at McArthur River reference sites. However, when macroinvertebrate assemblages at off-stream reference sites on larger high order streams were compared to McArthur River Diversion Channel and McArthur River reference sites, they were found to be significantly different and somewhat separate from the main cluster within the MDS ordination.

Surface water analysis indicated that there were no significant differences between McArthur River Diversion Channel and McArthur River reference site water quality. Off-stream reference sites were, however, significantly different to both McArthur River Diversion Channel and reference sites.

Analysis of fluvial sediments indicated that McArthur River Diversion Channel sites were not significantly different from off-stream reference sites or upstream McArthur River reference sites, however were significantly different from downstream McArthur River reference sites. Downstream McArthur River reference sites were also significantly different from upstream McArthur River reference sites, which may suggest the downstream receiving waters of the McArthur River is potentially being impacted. IPE (2020b) noted that this appeared to be largely driven by higher analyte concentrations at MR28. There was no evidence of a concentration gradient from the Mine to this site or the analytes that occurred in notably higher concentrations were not associated with the mining process. As such, the cause of downstream McArthur River reference sites being significantly different from the remainder of the McArthur River is considered to be the result of naturogenic processes rather than mining activities.

No exceedances of fluvial sediment SQGVs (ANZG, 2018) occurred within the McArthur River in 2019.

IPE (2020b) concluded that whilst variability in surface water and fluvial sediment parameters between catchments may have contributed to the dissimilarity between macroinvertebrate assemblages, reference sites in other catchments are subjected to variable seasonal conditions and flows that may not be consistent with those encountered within the McArthur River.

Surprise Creek and Barney Creek

Despite attempts by IPE to sample during recessional flows in 2019, riffle habitat was not present within the Surprise and Barney Creeks and a number of edge habitat sites were also found to be dry. As such, only edge habitats within these creeks were available for sampling and analysis during the survey.

Macroinvertebrate communities at edge habitat sites on the lower Surprise Creek and Barney Creek Channel generally had lower abundances, however taxa diversity was somewhat similar in comparison to other sites. Comparable decreases in abundance were observed at reference sites within minor drainage systems and throughout the wider region.

Statistical analysis indicated that macroinvertebrate assemblages at impact minor drainage line sites were not significantly different when compared to those at reference sites. However, sites BC4 and MR16 were found to be somewhat dissimilar to other minor drainage sites.

Habitat structure variables were identified as important attributes in explaining macroinvertebrate assemblages across all sites, however IPE (2020b) suggested that other factors not identified that may have influenced macroinvertebrate communities at these locations, including elevated (compared to reference sites) concentrations of fluvial sediment lead and zinc as well as surface water soluble salts.

In previous years these variables were found to be important factors in explaining differences in macroinvertebrate assemblages. However, as a result of sites around the Barney Creek Bridge not containing water and minimal groundwater inflow into the system (as a result of the poor wet season and recharge) these variables, particularly soluble salts, were not found to be important in explaining macroinvertebrate assemblages despite being important in explaining differences between surface water and fluvial sediment chemistry at sites.

Despite sites around the Barney Creek Bridge not being sampled, the previously observed gradient of elevated (compared to reference sites) fluvial sediment metals and surface water variables related to soluble salts within the Surprise and Barney Creek system was still evident and exceedances of fluvial sediment lead and zinc SQGVs (ANZECC & ARMCANZ, 2000) were detected. However, as a result of MRM's remediation efforts in the Barney Creek Diversion Channel (i.e. removal of contaminated sediment), lead and zinc concentrations were lower than those recorded in 2018. Cadmium and arsenic were also no longer in exceedance of the SQGVs. This in turn may have also contributed to these variables no longer being considered significant drivers by the analysis. Exceedances of SQGVs and notably elevated analyte concentrations continue to be largely contained to the Surprise and Barney Creek system.

3.6.4 Non-conformances, Corrective Actions and Improvements

IPE (2020b) stated that riffle habitat results obtained in 2019 conform to those obtained between 2008 and 2018 which indicated that within two years of operation macroinvertebrate assemblages at riffle sites within the McArthur River Diversion Channel resembled those at McArthur River reference sites.

Additionally, edge habitat results generally conform to historic results in that edge macroinvertebrate assemblages appear to be improving and increasing in resemblance to those at McArthur River reference sites. This improvement is likely being driven in part by the current regeneration of bankside riparian vegetation and the placement of large woody debris creating variation in flow and micro-habitat within the Diversion Channel, which is beneficial for invertebrate and vertebrate fauna.

IPE (2020b) also noted that historically, long term data has indicated that macroinvertebrate assemblages within the McArthur River Diversion Channel have reduced resilience to impacts from extreme flood events and dry periods (EMS 2016, 2017 and 2018b). Current results, however, suggest that the resilience of macroinvertebrate assemblages within the McArthur Diversion River Channel to dry periods or a poor wet season is somewhat comparable to that at McArthur River reference sites as they were not found to be significantly different after the poor 2018/2019 wet season.

Fluvial sediment lead and zinc concentrations were slightly above the SQGV (ANZECC & ARMCANZ, 2000) values at a number of sites along the Barney Creek Diversion Channel however, these exceedances were less than those recorded in the 2018 survey, owing partly to the remediation works completed by MRM within the Barney Creek Diversion Channel. There were also no exceedances of cadmium and arsenic SQGVs, both of which recorded exceedances in 2018.

3.6.5 Changes for the Next Reporting Period

MRM will continue to refine the macroinvertebrate study design for the 2020 monitoring period. IPE (2020b) recommended that:

- the number of reference sites on the McArthur River should be increased and off-stream reference sites on larger high order streams which are subject to variable seasonal and flow conditions should be discontinued;

- MRM continue the investigation into the suitability of taxa identification to family level to improve sampling practicality without compromising the sensitivity of analysis; and
- the placement of LWD within the McArthur River Diversion Channel is continued and expanded where feasible.

3.7 Metals in Aquatic Fauna and Fluvial Sediment

MRM undertakes monitoring of metals and lead isotope ratios in fish, crustaceans and molluscs of the Limmen, McArthur and Robinson River catchments on a regular basis. Monitoring of metals in aquatic fauna has been conducted since 2005, consistent with the commitments of the 2006 PER for the MRM Open Cut Project.

In 2019, the Fluvial Sediment monitoring program was combined with the Metals in Aquatic Fauna program as the previous 10 years of data have shown a strong correlation between concentrations of analytes in sediment and biota. The combination of these monitoring programs was a result of recommendations provided during the previous reporting period.

The *Monitoring of Metals and Lead Isotope Ratios in Fluvial Sediments, Fish, Crustaceans and Molluscs of the Limmen, McArthur, and Robinson Rivers, 2019* report (IPE, 2020c) is provided in Appendix L.

3.7.1 Monitoring Program Overview

The primary objective of the monitoring program is to detect whether metals associated with MRM mining activities are entering the aquatic food chain.

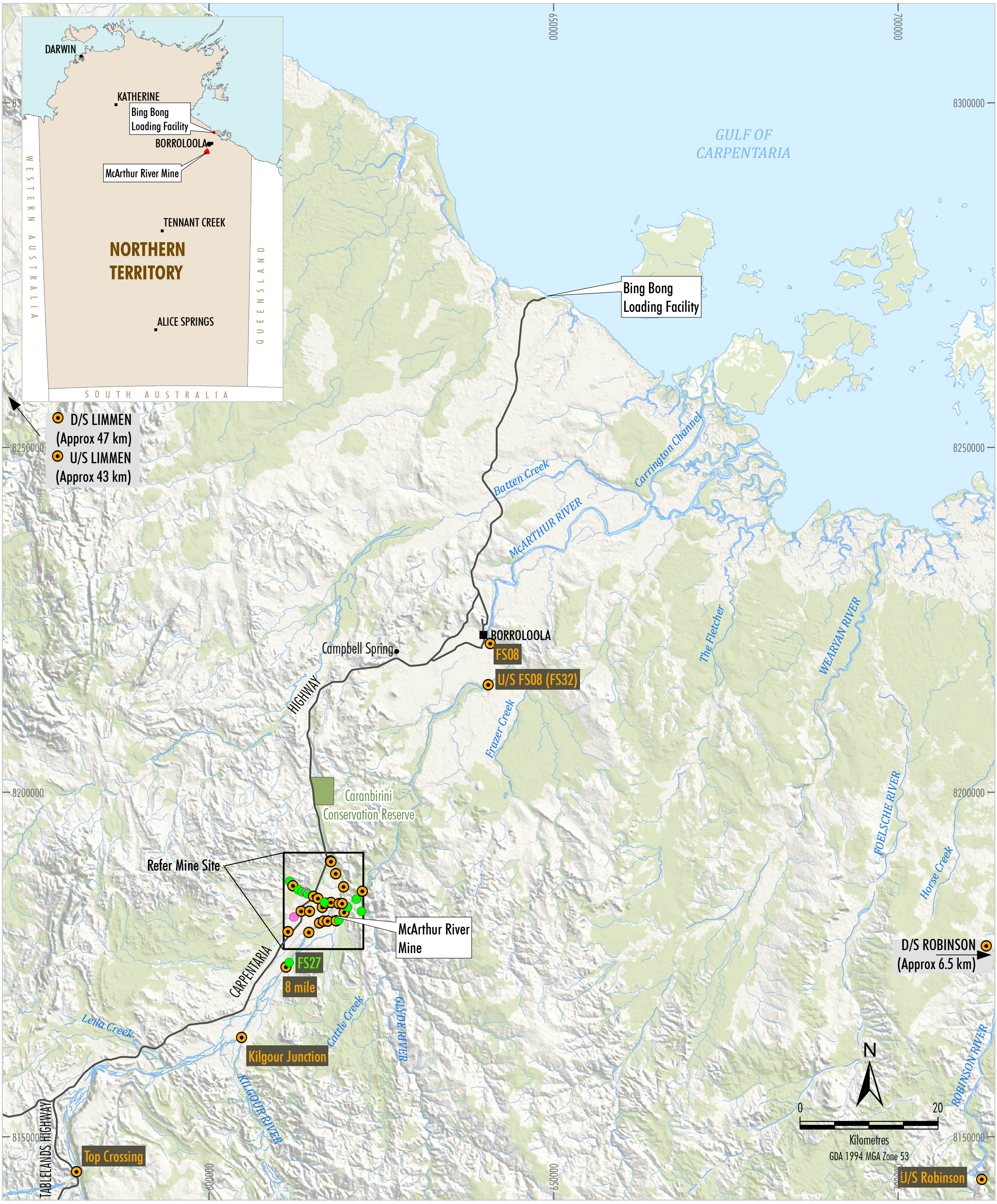
In response to comments from the Independent Monitor (IM), DPIR and Department of Health (DoH), a secondary objective investigating metal concentrations in aquatic fauna from a human consumption perspective is also incorporated into the analysis.

Monitoring Sites

Aquatic fauna samples were collected from the McArthur, Limmen and Robinson River catchments in April and May 2019. In excess of 300 aquatic fauna tissue samples were taken during the survey.

Sites where biota samples were collected remained consistent with those of 2018 (Figure 15 and 16). However, during the current survey several sites within smaller tributaries were found to be dry or contain no fish species. There was decreased rainfall during the wet season compared to previous years throughout the sampling area, resulting in a shorter period of stream connectivity (or in several cases no connectivity). The details of which species were able to be sampled at each site is provided in Appendix L.

Fluvial sediment samples were collected from natural surface water sites which are routinely monitored by MRM. In addition, fluvial sediment samples were also collected at sites at which biota were collected for tissue metal analysis. In total, 39 fluvial sediment samples were collected along Barney Creek, Surprise Creek, Emu Creek, the Glyde River and the McArthur River (Figure 15 and 16).



LEGEND

- Major Road
- River/Creek
- Monitoring Site (Aquatic Fauna Metals)
- Monitoring Site (Fluvial Sediment)
- Monitoring Site (Aquatic Fauna and Fluvial Sediment)

McARTHUR RIVER MINE

Regional Aquatic Fauna Metals and Fluvial Sediment Monitoring Sites

Source: Geoscience Australia - Topography (2006); Department of Environment and Natural Resources (2016); IPE (2019); MRM (2020)

Figure 15

LEGEND

- Monitoring Site (Aquatic Fauna Metals)
- Monitoring Site (Fluvial Sediment)
- Monitoring Site (Aquatic Fauna and Fluvial Sediment)

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); IPE (2019); MRM (2020)

McARTHUR RIVER MINE

Mine Aquatic Fauna Metals and Fluvial Sediment Monitoring Sites

Figure 16

Data Collection and Analysis

Sediment

Fluvial sediment samples were collected from natural surface water sites which are routinely monitored by MRM. The sampling and analysis were undertaken in accordance with relevant guidelines and established practices.

Biota

Environmental indicator species *Leiopotherapon unicolor* (Spangled Perch), *Melanotaenia splendida* (Chequered Rainbowfish) and *Nematalosa erebi* (Bony Bream) were collected to provide an indication of overall site environmental condition. The commonly consumed species *Lates calcarifer* (Barramundi), *Hephaestus fuliginosus* (Sooty Grunter), and *Velesunio angasi* (Freshwater Mussel) were collected to allow comment from a human health perspective, although *V. angasi* is also considered a useful environmental indicator.

In relation to *L. calcarifer*, the current survey was the first to utilise non-lethal muscle biopsy for all captured specimens.

All biota samples were collected and analysed in accordance with MRM's sampling procedure. A detailed description of the sampling and analysis is provided in Appendix L.

Guideline Values

Sediment

Filtered metal and metalloid concentrations were compared to the Sediment Quality Guideline Values (SQGVs) outlined in Appendix A of Simpson and Batley (2016). Lead isotope ratios obtained from fluvial sediment samples were compared to those of the MRM shipping concentrate to determine how similar lead detected in sediment samples was to the Mine product. The geographical location of a sample site (i.e. proximity to mining operations) and the likelihood of exposure to mining-derived dust or run-off were taken into consideration before commenting on the likelihood of lead at a sample site being the result of mining operations.

Biota

Mean analyte concentrations of respective fauna tissues were compared between survey sites within the McArthur River catchment, with reference catchment sites and with historical data. Consistent with previous years, the comparisons of tissue concentrations with the Maximum Permitted Concentrations (MPC) of metal contaminants outlined in Schedule 19 of *Standard 1.4.1 (Contaminants and natural toxicants)* (Food Standards Australia and New Zealand [FSANZ], 2017) has been retained for both environmental indicator and commonly consumed species.

3.7.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

The 2019 monitoring program incorporated the following changes:

1. Sampling was undertaken during the early dry season only.
2. The non-lethal sampling technique of sterile muscle biopsy and caudal blood sample was used for large commonly consumed species, primarily *L. calcarifer*.
3. *Toxotes chatareus* (Archer Fish) were removed from the suite of 'commonly consumed' species sampled.
4. Mercury was removed from the analytical suite.
5. Sample sites within Emu Creek were added to the list of sites investigated.
6. The fluvial sediment monitoring program was combined into this monitoring program.

Justification for the changes made to the monitoring program is provided in Appendix L.

3.7.3 Performance during the Reporting Period

Sediment

The current survey found the zinc and lead fluvial sediment concentration to be lower at sites known to receive mining influence in comparison to concentrations recorded in 2018. With respect to McArthur River fluvial sediment monitoring sites, zinc and lead concentrations were lower than those encountered within Barney and Surprise Creeks and general comparable or lower than concentrations recorded in recent years.

As with previous years, the current results indicate that the majority of lead and cadmium within fluvial sediments was readily bioavailable, whilst the portion of arsenic, copper and zinc that was bioavailable was much lower. In relation to zinc, at the majority of sites the concentration extracted using the total digest technique was more than double the concentration extracted with the weak acid digest, indicating that more than half of the overall zinc in the fluvial sediments sampled was not readily bioavailable. However, at sites where fluvial sediment is known to be affected by legacy dust accumulation, particularly within the lower section of Barney Creek Diversion Channel, the differential between total and weak digest concentrations is much less, and in several cases the biologically available concentration was 75 % or more of the total concentrations.

In general, and consistent with previous years, sites with higher lead concentrations (FS03, FS19, FS18, FS20, FS33, and FS36) within Barney and Surprise Creeks, had lead isotope ratios most similar to that of the Mine's final product for both weak and total digests. Dust from the haulage of ore is considered to be the source of most elevated analyte concentrations within the middle reach of Barney Creek, whilst TSF operations are suspected as being the source of elevated concentrations within the mid-reach of Surprise Creek.

In relation to FS19, the reduction in bioavailable lead from 340 mg/kg to 98 mg/kg and zinc from 770 mg/kg to 230 mg/kg between 2018 and 2019 is likely related to the removal of sediment between sampling events. Mitigation measures employed by MRM, including the physical removal of sediment and the construction of silt traps to capture runoff, have been shown to significantly reduce analyte concentrations at FS19. Noting the current results, benefit may exist in investigating the viability of extending this remediation program to include the lower reach of Barney Creek in the vicinity of FS20 and FS06 to further reduce the likelihood of this sediment reaching the McArthur River.

A summary of the bioavailable fractions of arsenic, cadmium, copper, lead and zinc from 2014 to 2019 is provided below in Charts 3 and 4.

In recognition that it is possible thallium may be naturally present within the study area, and therefore biota are adapted, this document does not adopt the Canadian guideline as a proxy but rather uses the method of calculating a regional specific interim value (IV) as described within ANZG (2018) and Simpson and Batley (2016). Using this method, sites directly adjacent the TSF within Surprise Creek, Barney Creek sites within the Mineral Lease, sites within the lower part of the McArthur River Diversion Channel and downstream to MR28 exceed their respective interim value. In terms of direct comparison, the lower section of Barney Creek had notably greater concentrations of bioavailable thallium within sediment than any other reach of river or creek sampled. This was consistent with reported findings in previous reports. However, concentrations recorded during the current survey had generally decreased in comparison to 2018.

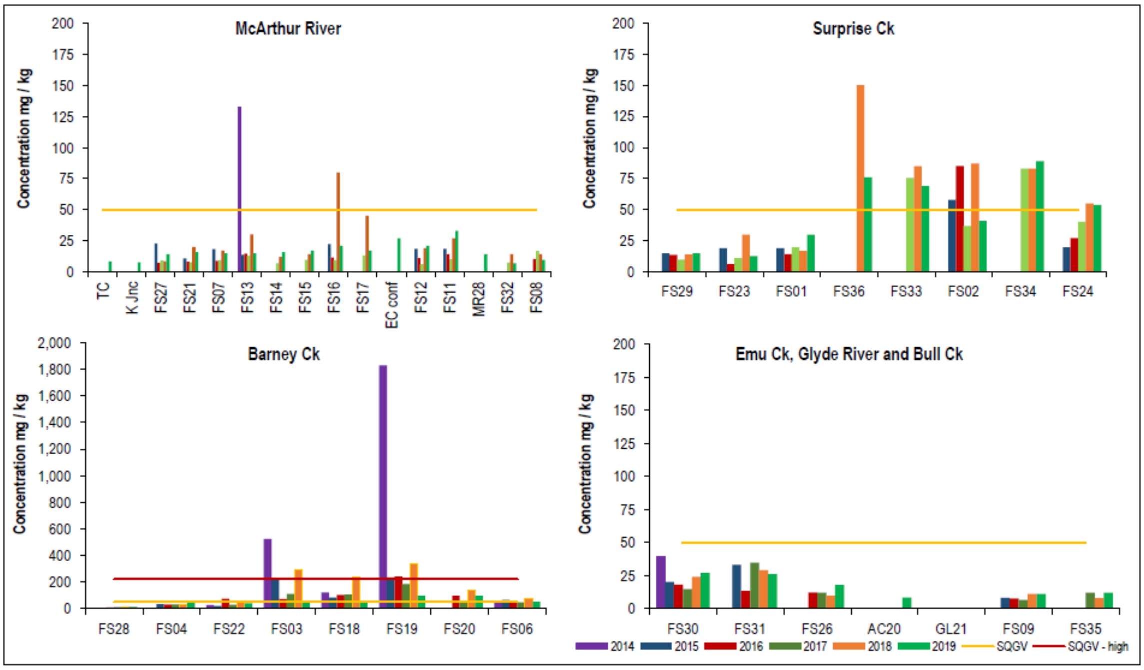


Chart 3 Comparison of Bioavailable Lead Concentrations within the <63 µm Fraction of Fluvial Sediments Collected between 2014 and 2019

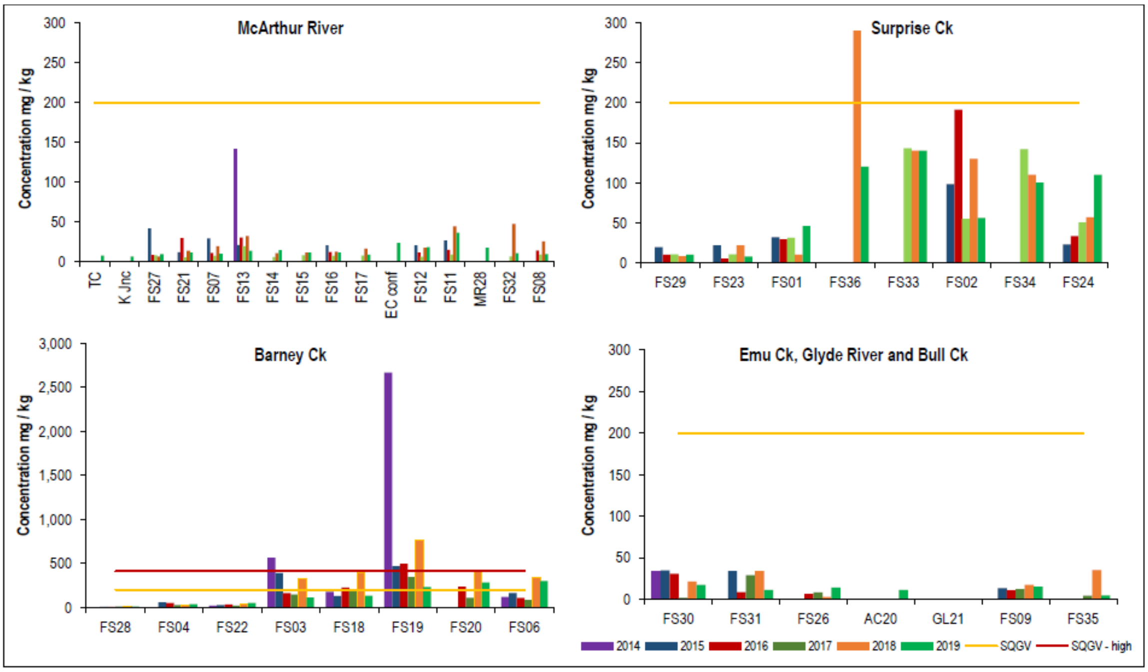


Chart 4 Comparison of Bioavailable Zinc Concentrations within the <63 µm Fraction of Fluvial Sediments Collected between 2014 and 2019

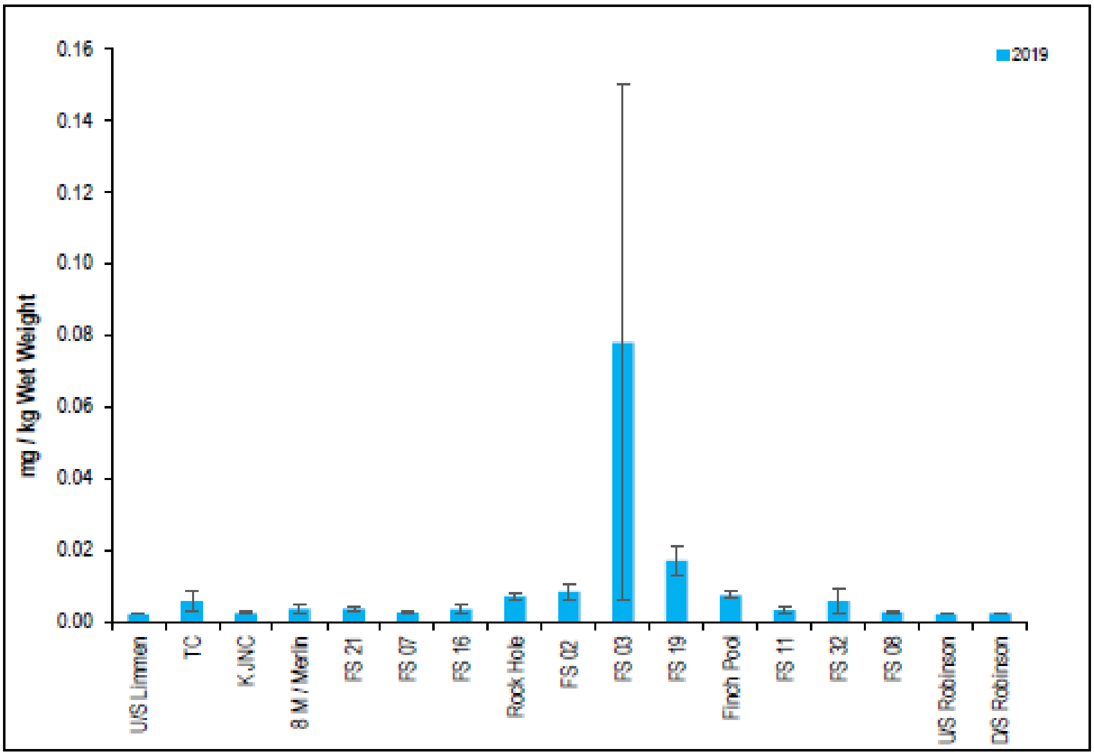
Biota

Environmental Indicator Species

Consistent with previous monitoring, *Leiopotherapon unicolor* (Spangled Perch), *Melanotaenia splendida* (Rainbowfish) and *Nematalosa erebi* (Bony Bream) were collected during sampling to provide an indication of overall site environmental condition. The mean lead concentrations in environmental indicator species' tissue samples collected during the 2019 reporting period is presented alongside a comparison of tissue mean lead concentration from 2014 to present in Charts 5, 6 and 7.

Analysis of samples collected in 2019 found the mean lead concentration of *M. splendida* at FS03 to be 0.575 mg/kg which marginally exceeded the current MPC for lead in fish of 0.5 mg/kg. However, this was less than half the concentration recorded at this site in 2018 of 1.26 mg/kg. The current mean lead concentration of *M. splendida* at other collection sites within Barney and Surprise creeks (FS02 and Rock Hole) were less than half the current concentration recorded at FS03, a pattern that is consistent with previous years. Also consistent with previous years was the finding that *M. splendida* collected from sites directly adjacent operational areas within Barney and Surprise Creeks exhibit lead concentrations five to ten times higher than other sites. However, current concentrations are considered to be consistent with recent years. No other exceedances of any relevant MPC were recorded amongst the three environmental indicator species at any site, including sites within the Barney Creek Diversion Channel.

Overall, the analysis of various analytes in environmental indicator species showed that MRM operations continue to have little measurable effect on the McArthur River main channel, and that elevated tissue metal concentrations are limited to Barney and Surprise Creek sites, within operational areas. The concentrations of MRM associated analytes within environmental indicator species at these sites during 2019 was notably lower than those reported in 2018, and closer to those recorded in 2017.



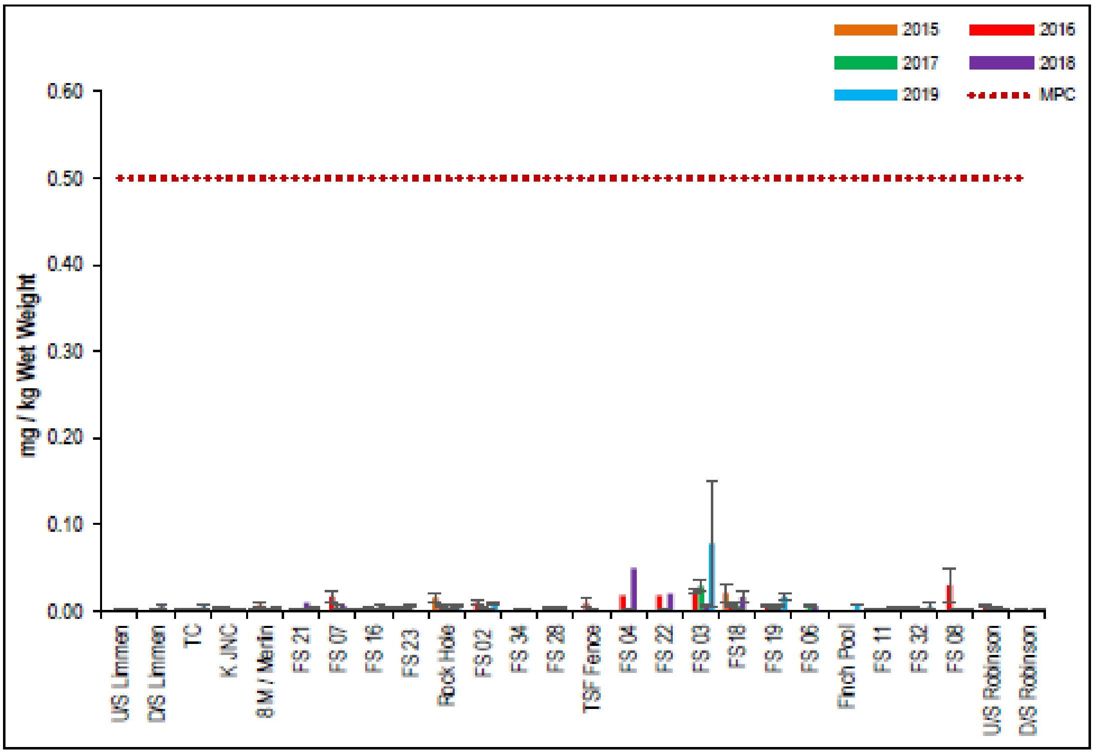
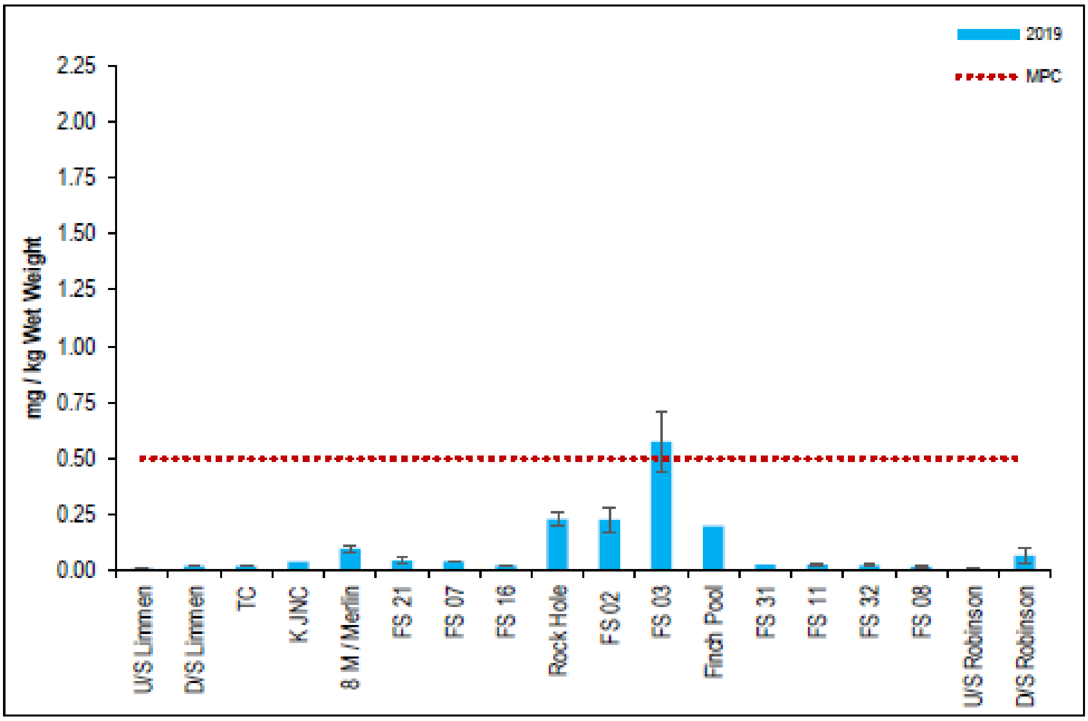


Chart 5 Mean Lead Concentration in Muscle Tissue of *Leiopotherapon unicolor* Collected during 2019 and Comparison of Mean Lead Concentration in Muscle Tissue between 2015 and 2019



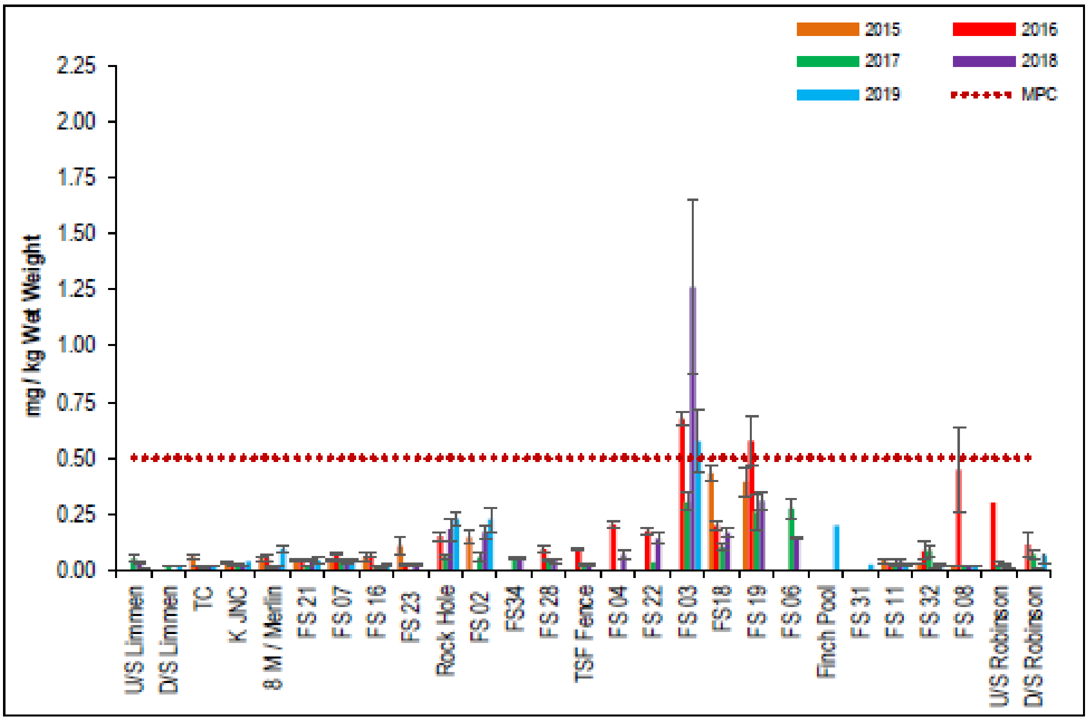


Chart 6 Mean Lead Concentration in Trunk of *Melanotaenia splendida* Collected during 2019 and Comparison of Mean Lead Concentration in Muscle Tissue between 2015 and 2019

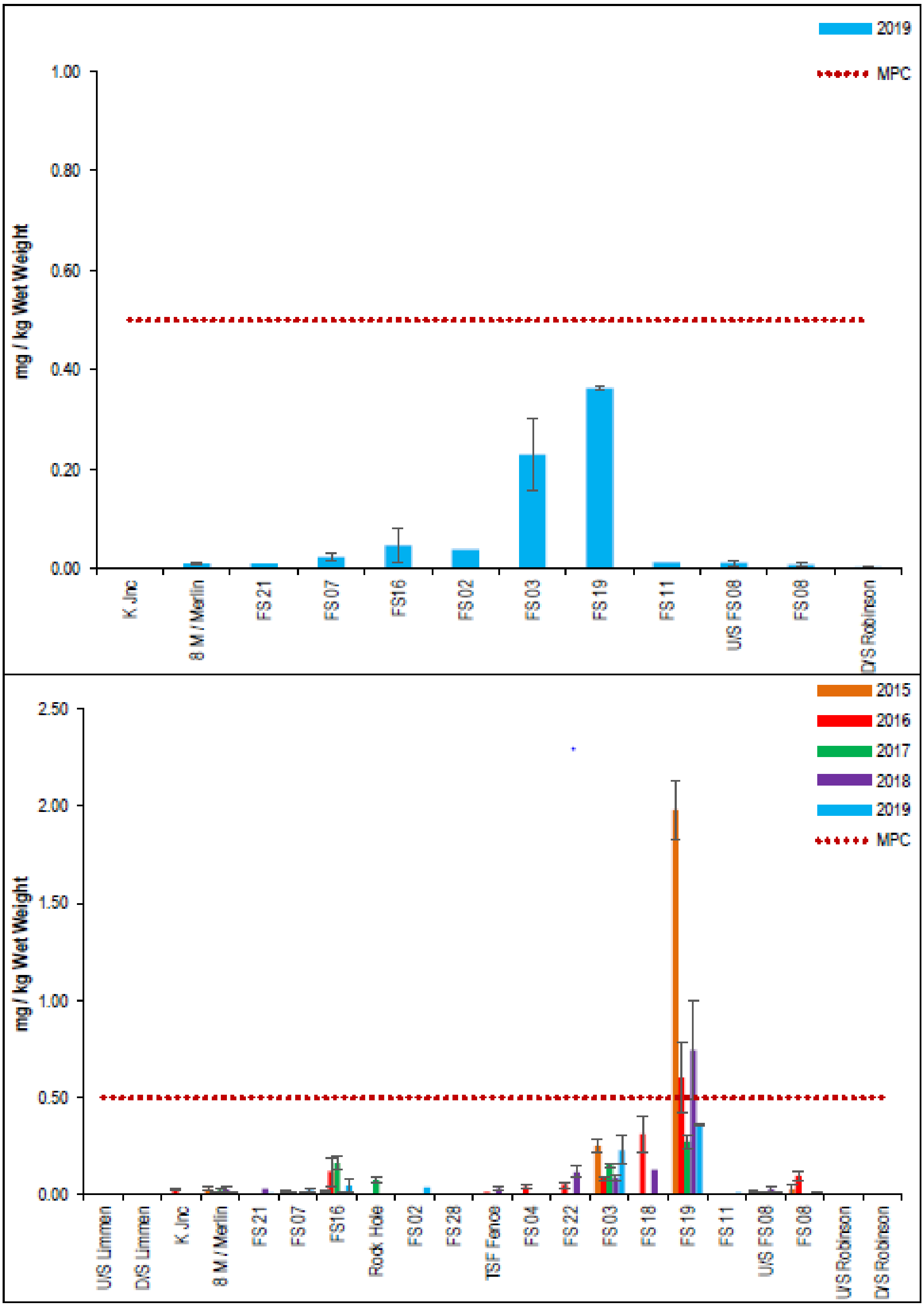


Chart 7 Mean Lead Concentration in Muscle Tissue of *Nematalosa erebi* Collected during 2019 and Comparison of Mean Lead Concentration in Muscle Tissue between 2015 and 2019

Commonly Consumed Species

All *L. calcarifer* muscle biopsy samples investigated during 2019 recorded lead concentrations ≤0.010 mg/kg. The mean zinc concentrations of *L. calcarifer* muscle biopsy samples recorded during the current survey were considered to be low and within the expected range for *L. calcarifer*, ranging from 3.3 (±0.19) to 7.3 (±4.33) mg/kg.

All *H. fuliginosus* were found to have mean lead muscle concentrations ≤0.004 mg/kg, with approximately 87 % of the individuals analysed having muscle lead concentrations which were less than the detection limit of analysis (i.e. <0.002 mg/kg). Mean zinc concentrations within the muscle of *H. fuliginosus* were found to be low and relatively consistent, ranging from 3.6 to 6.6 mg/kg.

The freshwater mussel *V. angasi* was collected from a total of nine sites during the 2019 survey period. For the first time in the history of this sampling program the species was located at FS04, with three individuals being collected. Individual lead concentrations of these specimens were 1.1, 1.7 and 5.3 mg/kg. This resulted in a mean lead concentration of 2.7 (±1.3) mg/kg which slightly exceeds the MPC for molluscs of 2 mg/kg. The species was also collected for the first time at Finch Pool, which is located in the upper reaches of Emu Creek in close proximity to FS30 (Figure 16). Specimens of *V. angasi* collected at this site recorded the second highest mean lead concentration during the current survey being 0.986 (±0.30) mg/kg and ranged from 0.36 to 1.8 mg/kg. In relation to remaining collection sites, mean lead concentrations were all below 2 mg/kg. The lead concentrations recorded for 2019 were relatively consistent with those reported in previous years at the same sites.

Consistent with previous data reported as part of this monitoring program, data collected over the 2019 monitoring program clearly demonstrated that all *L. calcarifer* and *H. fuliginosus* caught throughout the McArthur River catchment, including mine lease areas, were considered safe to consume. The concentrations of lead in commonly consumed finfish were well below the applicable MPC of 0.5 mg/kg with safe consumption amounts being vastly greater than the current FSANZ Australia-wide recommendation of 2-3 servings of fish per week. Furthermore, the vast majority of consumption amounts calculated using the FSANZ methodology and presented throughout this report was considered an unrealistic amount to regularly catch and physically consume. The current data did, however, indicate that the intake of *V. angasi* should be limited irrespective of the collection site, including sites located outside of the mineral leases, which is consistent with the findings of previous surveys.

Charts 8, 9, and 10 give a comparison of the historical mean lead concentrations in muscle tissue samples of *L. calcarifer*, *H. fuliginosus*, and *V. angasi*, respectively.

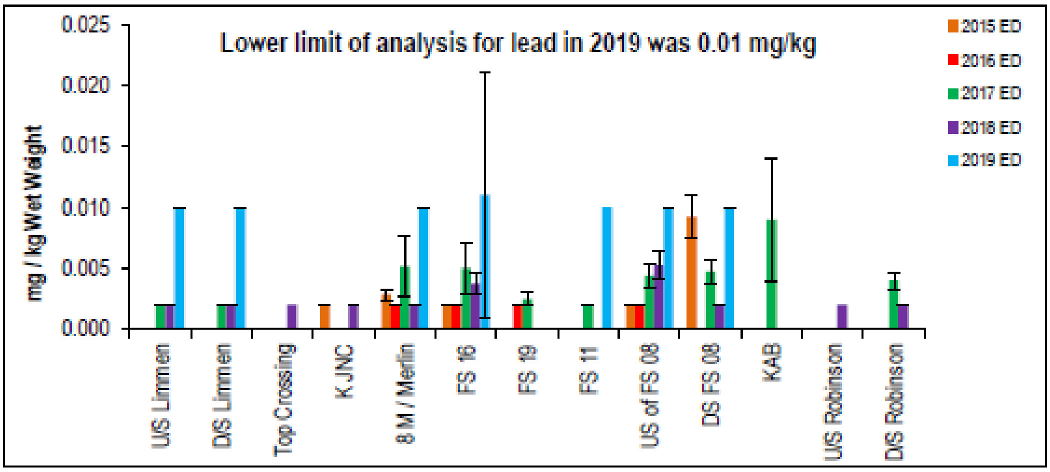


Chart 8 Mean Lead Concentrations in Muscle Tissue of *Lates calcarifer* Collected Throughout the Survey Area between 2015 and 2019

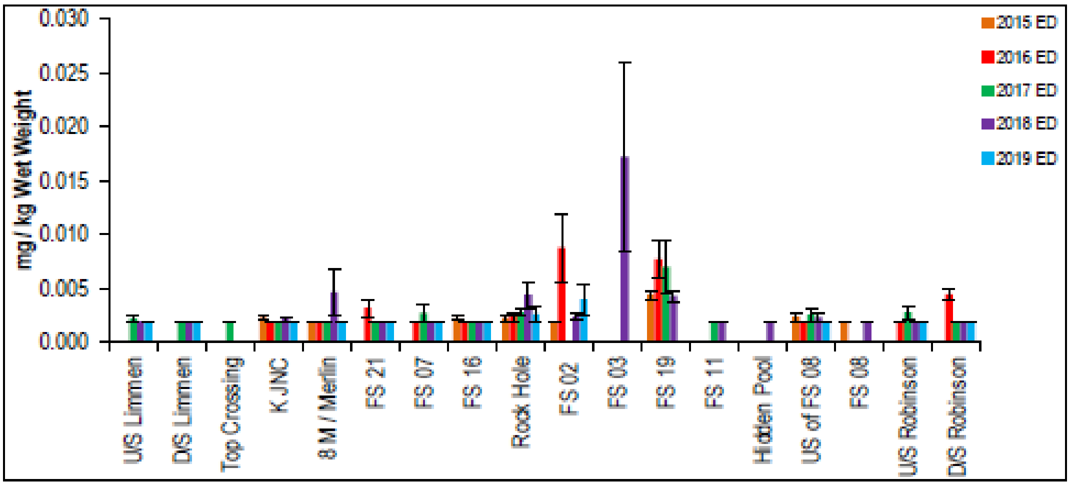


Chart 9 Mean Lead Concentrations in Muscle Tissue of *Hephaestus fuliginosus* Collected Throughout the Survey Area between 2015 and 2019

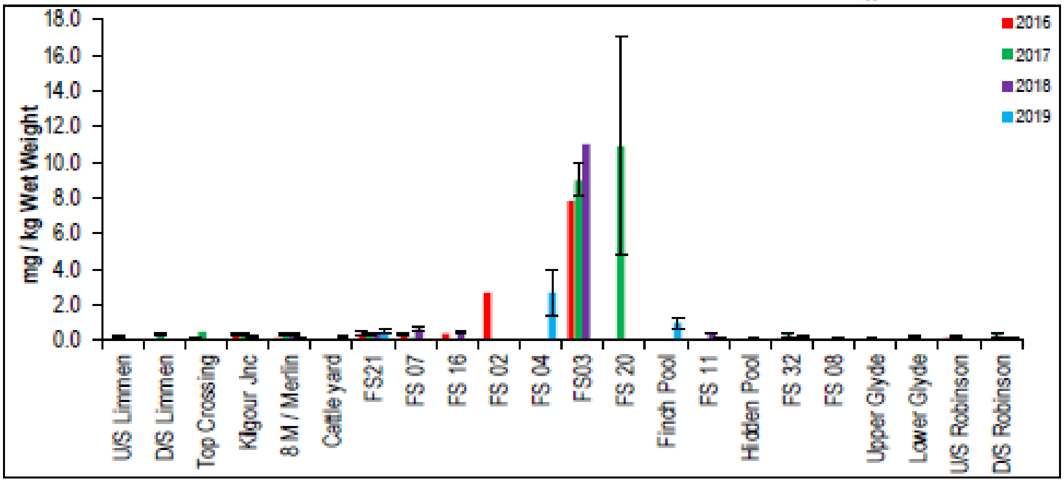


Chart 10 Mean Lead Concentrations in Muscle Tissue of *Velesunio angasi* Collected Throughout the Survey Area between 2016 and 2019

3.7.4 Non-conformances, Corrective Actions and Improvements

An exceedance of mean lead MPC in *V. angasi* and *M. splendida* were recorded during the monitoring period.

The utilization of 0.2 g sterile, non-lethal, muscle biopsy for the sampling of *L. calcarifer* proved to be a viable field technique in a range of capture scenarios enabling the released fish to provide ongoing data on residential times and possibly investigation into bioaccumulation rates. The results attained from the muscle biopsies, although less sensitive than traditional destructive sampling, were suitably accurate to allow confident conclusions to be drawn from a risk to public health viewpoint. It should be noted that current technology associated with regulatory-accepted analysis methods does not allow non-lethal sampling techniques to extend to environmental indicator species. Furthermore, non-lethal sampling through muscle biopsy is not considered appropriate for smaller commonly consumed species from an animal welfare perspective.

3.7.5 Changes for the Next Reporting Period

The current results for fluvial sediment and environmental indicator species, combined with historical trends continue to support previous conclusions that lead concentrations (and other MRM process associated elements) within environmental indicator species can be successfully controlled through maintaining low fluvial sediment concentrations. In the case of the lower reach of the Barney Creek Diversion Channel (FS19, FS20, FS06) this requires annual targeted sediment removal in addition to capture of haul road run off water. Upstream of this reach, bed rock is likely to make sediment removal problematic at some sites for which biota show increased analyte concentrations. and MRM is currently investigating potential options to remove sediment in this reach of Barney Creek.

IPE's 2019 metals in aquatic fauna monitoring report (IPE 2020c) recommended investigating the source of thallium within Barney and Surprise Creeks. This was due to the fact that there are currently no environmental guidelines for thallium within Australia. MRM have conducted an investigation into the source of thallium and are taking action to reduce concentrations, including:

- undertaking geochemical assessments to determine the source and fate of thallium in waste rock and mine waters;
- monitoring and adjusting mine water treatment to account for thallium concentrations in Class 4 (managed release) waters; and
- seeking approval from DENR to construct a managed release point for direct discharge to the McArthur River Diversion Channel.

In general, this program has consistently indicated sites with the highest analyte concentrations are small pools which hold limited numbers of aquatic fauna and which often dry completely. As such the potential for ongoing accumulation and consumption is very limited. However, there is scope for the next reporting period to increase the tracking area of the current acoustic monitoring program to include *L. calcarifer* and *H. fuliginosus* within Barney and Surprise Creeks. This would provide insight into the residential times of these species within sites showing influence from MRM operations and also indicate if these individuals return to the McArthur River main channel where they could be potentially caught and consumed by the public.

3.8 Diversity and Abundance of Aquatic Fauna

Since 2006, an aquatic fauna monitoring program has been implemented by IPE, consistent with the commitments of the 2006 PER for the Phase 2 expansion. Monitoring is undertaken in the early dry season, generally between April and May, when access permits following the wet season, and in the late dry season, generally between September and October.

The relevant monitoring reports are provided in the appendices as listed below:

- *Aquatic Fauna of the McArthur River, Northern Territory, Early Dry Season, 2019* (IPE, 2019) (Appendix M);
- *Aquatic Fauna of the McArthur River, Northern Territory, Late Dry Season 2019* (IPE, 2020d) (Appendix N); and
- *Acoustic Monitoring of Freshwater Sawfish (Pristis pristis) and L. calcarifer of the McArthur River* (IPE, 2020e) (Appendix O).

3.8.1 Monitoring Program Overview

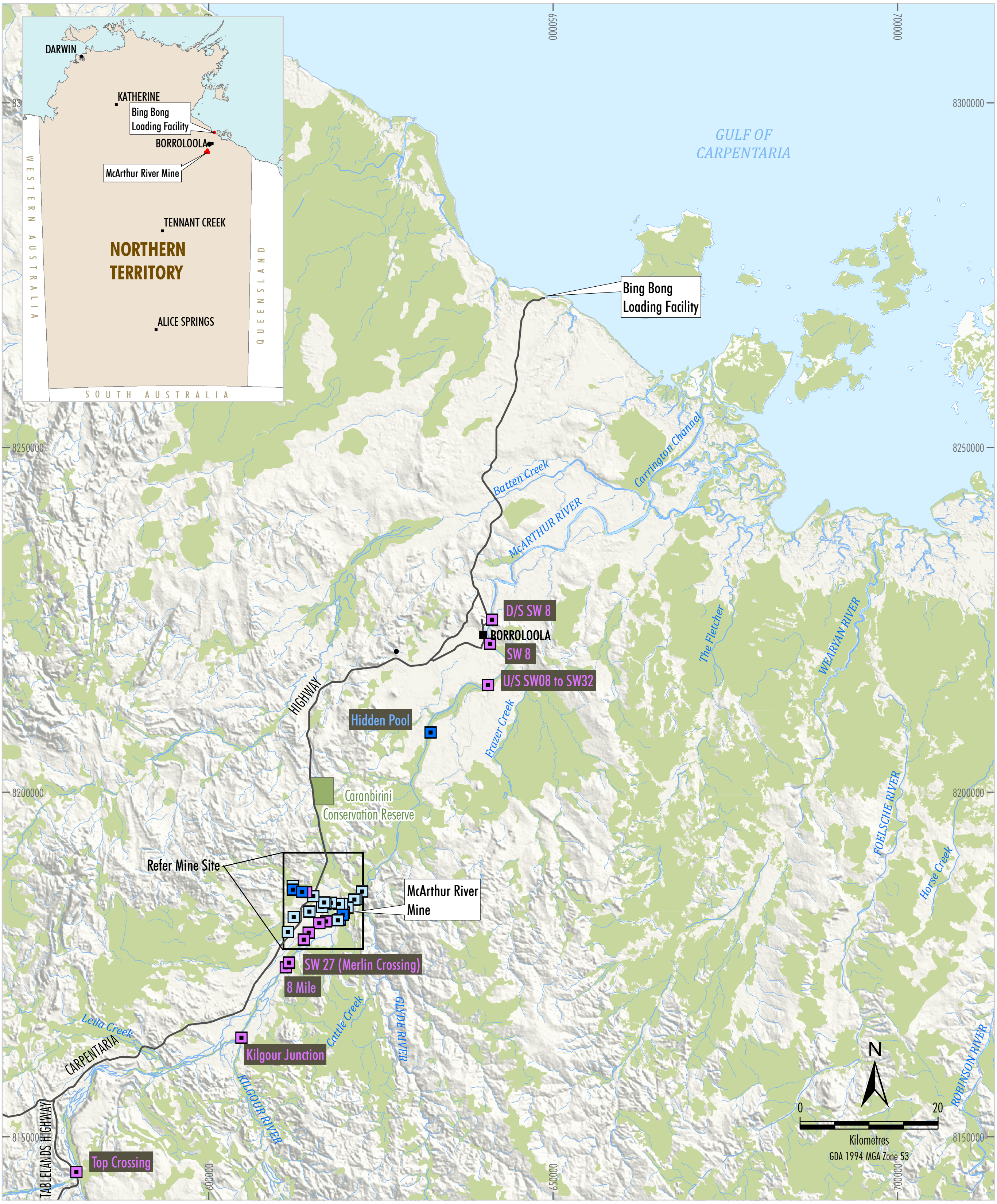
The objective of the aquatic fauna monitoring program is to establish whether the Mine is impacting aquatic fauna within the wider McArthur River catchment area and whether the Diversion Channels are providing suitable habitat for aquatic fauna.

Monitoring Sites

The following monitoring sites were sampled over the reporting period:

- *Early Dry Season* – Between April and May 2019, 49 sites (Figures 17 and 18) were sampled within the main channel of the McArthur River and its tributaries (including nine sites in Barney Creek and five sites in Surprise Creek) for the early dry season survey.
- *Late Dry Season* – In October 2019, 46 sites (Figures 17 and 18) were sampled within the McArthur River and its tributaries (including one site in Barney Creek and three sites in Surprise Creek).Data Collection

Due to the dynamic and highly variable nature of the habitat present within the study area, a broad range of methods are used to survey aquatic fauna, including gill nets, Fyke nets, seine nets, electrofishing equipment and line fishing. Visual observations were also noted for individuals that were captured. Water quality sampling is also undertaken at each site.



LEGEND

- Major Road
- River/Creek
- Early Dry Season
- Late Dry Season
- Early and Late Dry Season

McARTHUR RIVER MINE

Regional Aquatic Fauna Monitoring Sites

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

Figure 17

MRM-16-01_EMR2020_218A

LEGEND

- Early Dry Season
- Late Dry Season
- Early and Late Dry Season

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

McARTHUR RIVER MINE

Mine Aquatic Fauna Monitoring Sites

Figure 18

3.8.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

There were no changes made to the monitoring program or techniques during the reporting period.

3.8.3 Performance during the Reporting Period

Diversity and Abundance of Fish, Crustaceans and Aquatic Reptiles

Habitats have been classified as downstream complex habitat, diversion bare bank habitat, diversion complex habitat and upstream complex habitat. Abundance and diversity data for fish collected was analysed using ANOSIM to determine statistical differences in the suite of fish occurring within and between each habitat classification.

Early Dry Season

A total of 33 native aquatic species were recorded during the 2019 early dry season survey, including 27 species of bony fish, two elasmobranch species, two species of crustacean and two species of aquatic reptile. Species diversity was similar to the early dry season surveys carried out in 2017 and 2018, whilst diversity was comparable to previous surveys.

Overall, the current survey noted a general decrease in abundance and specimen total length which is attributed to prior seasonal conditions and the lateness of the brief recruitment window.

Late Dry Season

A total of 35 native aquatic species were recorded during the 2019 late dry season survey, including 28 species of bony fish, three elasmobranch species, two species of crustacean and two species of aquatic reptile. IPE (2019) concluded that in comparison to the 2018 late dry season survey, these results indicate a decrease in fish abundance is very likely is due to a reduction in the area of habitable water.

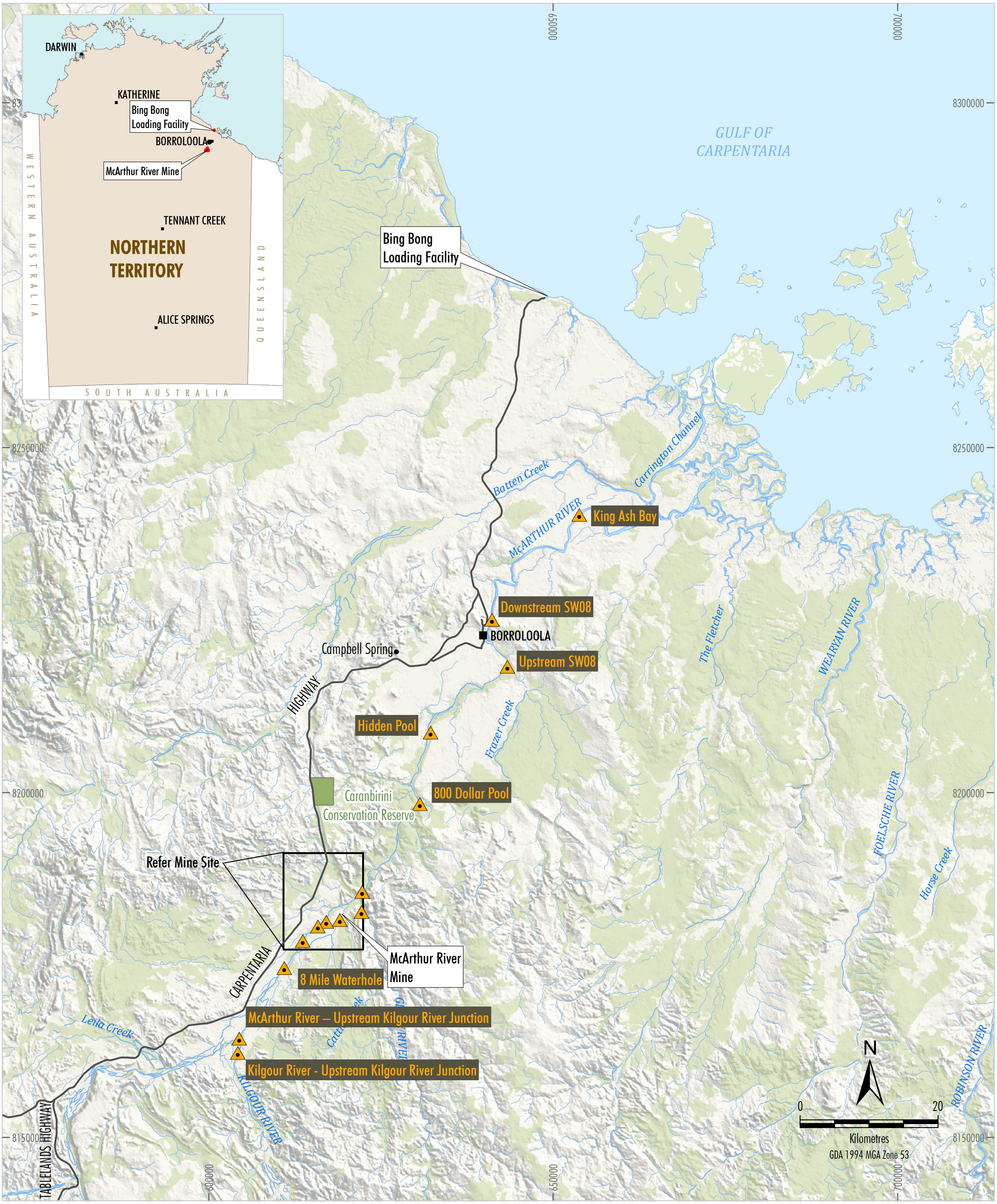
The results of the early dry and late dry season surveys are consistent with previous surveys, as are the conclusions that fish abundance and distribution within the McArthur River are strongly influenced by wet season rainfall and the duration of river inundation.

Freshwater Sawfish (*P. pristis*)

In November 2016, an acoustic monitoring program was introduced to more definitively assess the longevity and movements of individuals within the McArthur River. This involved installing ten acoustic receivers upstream, downstream and within the McArthur River Diversion Channel (Figures 19 and 20).

A total of five *P. pristis* were captured and fitted with acoustic tags over the reporting period. Of the five *P. pristis*, three were tagged during the early dry season Aquatic Fauna Survey, and two during the late dry season Survey 2019.

The total length of the two *P. pristis* captured indicated that both individuals had been born within the last year and were in the process of migration upstream to prey-rich and relatively predator-free environments. The presence of this species upstream of the old Woologorang road crossing at SW08 indicates at least some juvenile Sawfish 'young of the year' were able to migrate over this significant instream barrier during the below average flows and rainfall of the 2018/19 wet season.



LEGEND
Major Road
River/Creek
Acoustic Receiver

Source: Geoscience Australia - Topography (2006); Department of Environment and Natural Resources (2016); Australian Institute of Marine Science (2019); MRM (2020)

McARTHUR RIVER MINE

Regional Acoustic Receiver Monitoring Sites

Figure 19

MRM-16-01_EMR2020_220A

LEGEND

Acoustic Receiver

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2020)

McARTHUR RIVER MINE

Mine Acoustic Receiver Monitoring Sites

Figure 20

No *P. pristis* movements were recorded in the McArthur River Diversion Channel over the 2018/2019 wet season. However, during the previous 2017/2018 wet season two individuals acoustically tagged within the McArthur River Diversion Channel were recorded moving upstream of the McArthur River Diversion Channel thereby demonstrating successful passage of *P. pristis* at least once in the last three years. This met the OMP EIS commitment of successful passage of *P. pristis* upstream and/or downstream through the MRM leases at least once every five years. By the end of the 2019/20 reporting period, 18 *P. pristis* had been fitted with acoustic tags.

Of the 27 *L. calcarifer* captured during the current survey, three were fitted with Vemco V13 acoustic transmitting tags. In addition, 16 *L. calcarifer* were tagged with conventional dart tags. An individual *L. calcarifer* that was previously acoustically tagged was recaptured during the current survey at Eight Mile waterhole.

A number of *L. calcarifer* that were tagged within SW07 and the Eight Mile Waterhole have been detected moving downstream into the McArthur River Diversion Channel before returning to their original tagging sites. This shows that the McArthur River Diversion Channel continues to allow fish passage as well as provide an environment conducive to the growth and survival of fish species.

The acoustic data collected to date has shown that information can be attained from a far higher proportion of the tagged population in a relatively short time frame in comparison to the conventional cattle style tags that relied on the recapture of tagged individuals. IPE (2020e) concluded that the data obtained from the acoustic monitoring program has demonstrated the effectiveness of the acoustic tagging program over conventional tagging.

Surprise Creek and Barney Creek

Early Dry Season

The current survey recorded nine teleost and one crustacean species within Barney Creek 'modified' sites, two teleost species within natural sites of Barney Creek and nine species of teleost within Surprise Creek sites. This diversity is substantially less than that recorded in recent surveys.

There was very limited connectivity between these two ephemeral creeks and the main McArthur River during the previous wet season meaning there was also very limited opportunity for biota to migrate into Barney and Surprise Creek sites. This however is consistent with previous reports and is unsurprising that that relatively few fish were captured from within Barney and Surprise Creek sites during the current survey.

Late Dry Season

Consistent with previous reporting periods, the water-holding potential of Barney Creek and Surprise Creek is minimal after the cessation of rainfall; therefore, only three sites were found to contain water sufficient to sustain target species.

Species diversity within these areas were slightly lower than previous late dry season surveys, with seven species being identified in comparison to nine species in 2018 and thirteen species in 2017. IPE (2020d) conclude that this is likely to be related to a decreased wet season flow in comparison to the 2017-2018 wet season.

Effectiveness of Rehabilitating the Diversion Channels

Rehabilitation works in the McArthur River Diversion Channel and, in particular, the installation of LWD since 2014, has proven highly successful in providing fish habitat with higher numbers and an increased aquatic fauna species diversity being recorded compared to sites without rehabilitation works (IPE, 2019).

IPE (2019) concluded that no significant difference in species diversity was found between habitat classifications, including within the McArthur River Diversion Channel and downstream habitats. While no significant differences existed between habitat classifications, the singular diversion bare bank habitat site surveyed during the late dry season appeared to be the most different from complex habitats elsewhere.

This result, and the fact that no significant difference was found between sites, indicates that Diversion Channel complex habitat is reflective of complex habitats located up and downstream (IPE, 2019).

3.8.4 Non-conformances, Corrective Actions and Improvements

IPE (2019) did not identify any adverse impacts to aquatic fauna in the McArthur River catchment as a result of operations at the Mine, and monitoring confirmed the Diversion Channels are providing aquatic fauna habitat and passage. As such, no non-conformances were identified.

IPE recommended that MRM install additional information signage at key locations along the river to promote awareness of the Acoustic Monitoring Program within the wider community, and to reduce the likelihood of tampering or removal of tagged animals and associated equipment.

3.8.5 Changes for the Next Reporting Period

No changes to the aquatic fauna monitoring program are proposed for the next reporting period.

3.9 Seagrass Diversity and Abundance

MRM conducts seagrass monitoring annually in the marine waters of the Gulf of Carpentaria proximal to the BBLF. Monitoring aims to determine if any changes in seagrass distribution or composition have occurred in waters adjacent to the BBLF, and if any change identified was likely to be naturally occurring (and widespread throughout the wider area) or potentially influenced by the BBLF operations. During the reporting period, seagrass was surveyed in September 2019 (IPE, 2020f).

The *Annual Seagrass Survey of the Bing Bong Loading Facility, 2019* report (IPE, 2020f) is provided in Appendix P.

3.9.1 Monitoring Program Overview

Monitoring Sites

Consistent with surveys conducted from 2013 to 2018, an annual seagrass survey was conducted within waters adjacent to the BBLF and at reference sectors (Sectors 3, 5 and 6) during September 2019 (see Figure 21). In total 203 individual sites were surveyed for seagrass, including 95 sites in waters adjacent the BBLF, and 36 sites within each of the three reference sectors.

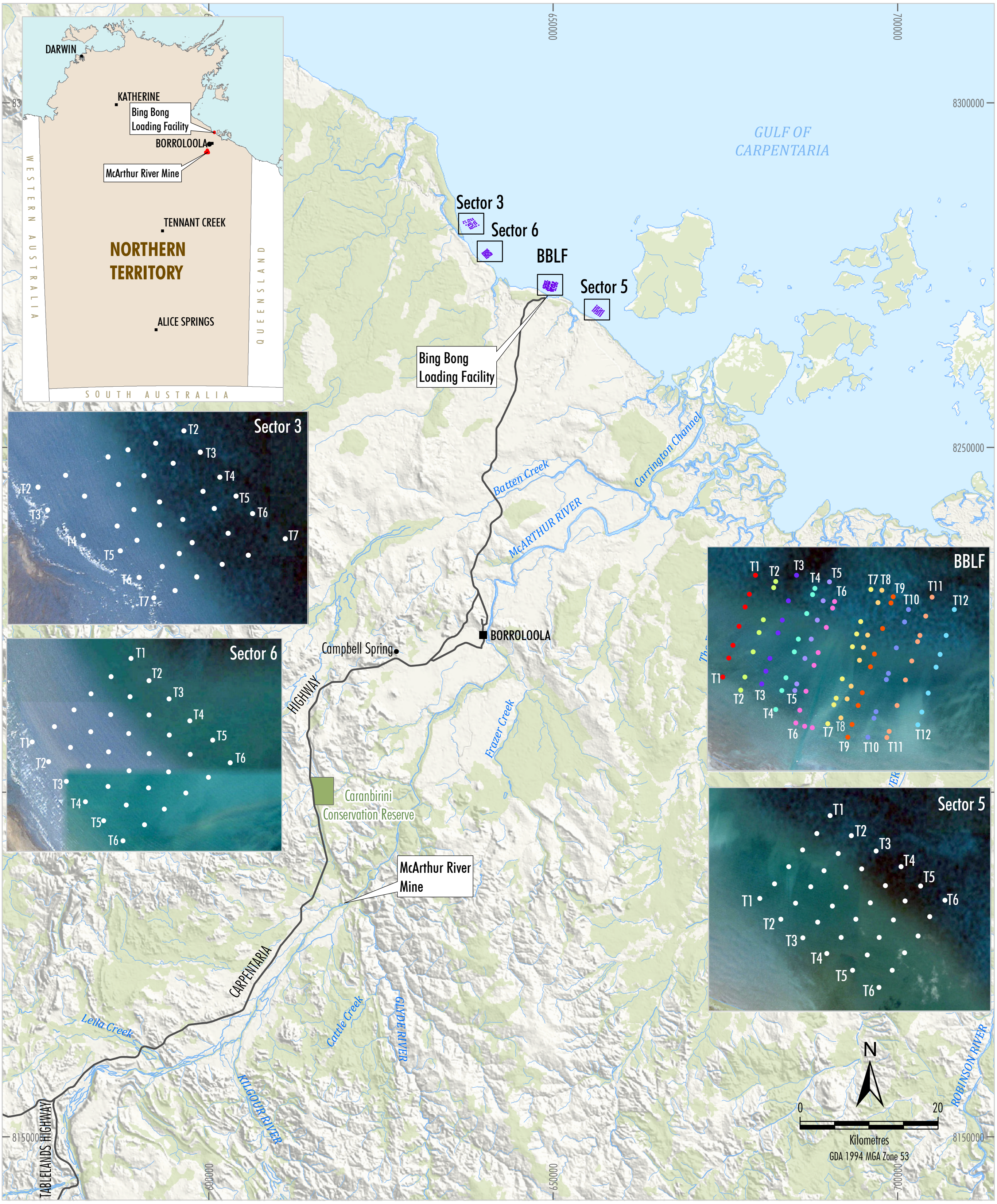
Data Collection

Qualitative data was collected through the use of an underwater drift camera and analysed to determine seagrass species diversity, estimated density and dominance within each sector. Quantitative data was collected via an underwater camera mounted atop a 50 cm x 50 cm quadrat. Photoquadrat images from each site were analysed through Coral Point Count with Excel extension (CPCe) to determine seagrass and macroalgae percentage cover.

For additional information on collection methods and results, refer to Appendix P.

3.9.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

There were no significant changes to the seagrass monitoring program during the reporting period.



LEGEND

- Major Road
- River/Creek
- Seagrass Survey Site

Source: Geoscience Australia - Topography (2006); Department of Environment and Natural Resources (2016); IPE (2019); MRM (2020)

McARTHUR RIVER MINE

Seagrass Surveys

Figure 21

3.9.3 Performance during the Reporting Period

A total of four seagrass species were identified during the current survey, those species being *Syringodium isoetifolium*, *Cymodocea serrulata*, *Halophila ovalis* and *Halodule uninervis*. *S. isoetifolium* and *C. serrulata* were found to occur within all sectors. Both *H. ovalis* and *H. uninervis* were recorded from all sectors with the exception of Sector 5.

Overall mean seagrass percentage cover in 2019 calculated through CPCe were 40.9 %, 55.1 %, 56.4 % and 74.1 % for the BBLF, Sector 3, Sector 5 and Sector 6, respectively. In comparison to 2018, these results represent an overall decrease in mean percentage seagrass cover of 21 %, 7 % and 10 % for the BBLF (see Chart 11), Sector 3 and Sector 5, respectively. These decreases are considered to reflect the moderate disturbance experienced due to tropical cyclone Trevor between the 2018 and the current survey and to not be anthropogenic in cause. Sector 6 was found to have increased in mean percentage cover by 14 % in comparison to 2018.

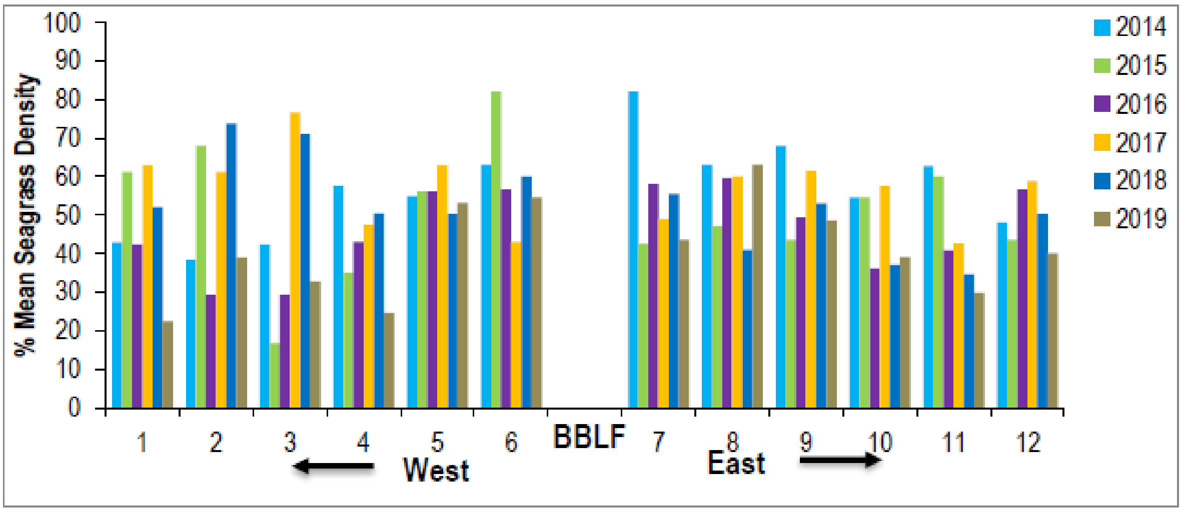


Chart 11: Comparison of Mean Percentage Seagrass for Transects in the Vicinity of the BBLF between 2013 and 2019

Current mean macroalgae percentage cover was recorded as 35.7 %, 17.1 %, 33.2 % and 13.8 % for BBLF (see Chart 12), Sector 3, Sector 5 and Sector 6, respectively. These results indicate increased macroalgae percentage cover within every sector in comparison to 2018, although the current percentage cover is not dissimilar to percentage cover recorded in 2016 and 2017 in most instances. As discussed by IPE (2020f), macroalgae from the genus Caulerpa appears to be of greater prevalence within the broader study area in recent years. It is possible that the increase in macroalgae percentage cover is a reflection of Caulerpa's ability to rapidly colonise areas of benthos from which seagrass was removed following tropical cyclone Trevor faster than the colonising rate of seagrass species.

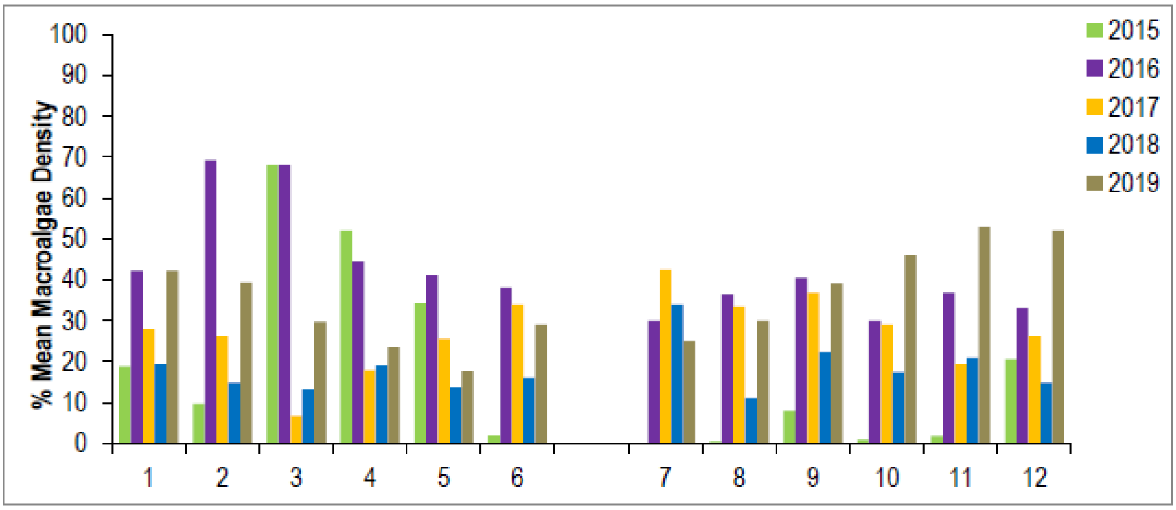


Chart 12: Comparison of Mean Percentage Cover of Macroalgae for Transects in the Vicinity of the BBLF between 2015 and 2019

Analysis of data collected during the 2019 survey indicated a small, but measurable, reduction in seagrass density and percentage cover, particularly at sites previously classified as very dense or that recorded greater than 70 % percentage cover. These reductions were relatively consistent throughout the broader survey area and likely the result of tropical cyclone Trevor. However, in consideration of the documented effects of previous cyclonic events, the current reductions are considered minor and overall seagrass density and species distribution is considered consistent with that expected for mature seagrass meadows. Localised fluctuations in density and/or percentage cover illustrate that a degree of fluctuation in overall seagrass cover is to be expected between annual surveys and highlights the importance of considering consecutive long-term data before commenting on the possible cause of yearly fluctuations.

Overall changes observed within the BBLF Sector were consistent with the other sectors surveyed. This indicated that over the reporting period BBLF activities had no observable impact on seagrass communities in the adjacent waters. Reference sector locations and transect alignments are considered suitable for the purpose of this monitoring program, with benthic habitat type and environmental conditions similar to that of the BBLF Sector. Consistent with the conclusions of previous surveys, increases in macroalgae density are still considered naturogenic, representing natural succession from epiphytic macroalgae as seagrass assemblages mature and stabilise the surrounding benthic environment thus creating greater habitable benthic environment for aquatic flora.

3.9.4 Non-conformances, Corrective Actions and Improvements

No non-conformances, corrective actions or improvements were noted.

3.9.5 Changes for the Next Reporting Period

No significant changes to the seagrass monitoring program are planned for the next reporting period.

3.10 Marine Sediment Quality, Water Quality and Metals in Marine Biota

MRM undertakes an Annual Marine Monitoring Program (AMMP), which involves the sampling of marine water, sediments and biota in the Gulf of Carpentaria to monitor operations at the BBLF. The program specifically aims to detect if operations at the BBLF are introducing mine-derived contamination into the marine ecosystem and subsequently impacting the immediate surrounds and broader marine environment.

The *Annual Marine Monitoring Program, Bing Bong Loading Facility, December 2019* report (IPE, 2020g) is provided in Appendix Q.

3.10.1 Monitoring Program Overview

Monitoring Sites

During the reporting period, sampling was undertaken from 15 November 2019 to 27 November 2019, over a 55 km stretch of coastline centred on the BBLF. Marine sediment was also collected from an additional 10 sites within the BBLF swing basin and dredged shipping channel. When available, tissue samples were collected from a range of biota occurring at the sampling sites (see Figures 22 and 23).

Guideline Values

Marine Water

Metal concentrations within filtered water samples were compared to the guideline values for toxicants for marine water outlined in Table 3.4.1 by ANZECC and ARMCANZ (2000) (where applicable). Comparison of marine water quality to guideline values focused on the filtered metal results, as this fraction is generally considered more bioavailable than total metal results and provides a better indication of ecological risk.

Marine Sediment

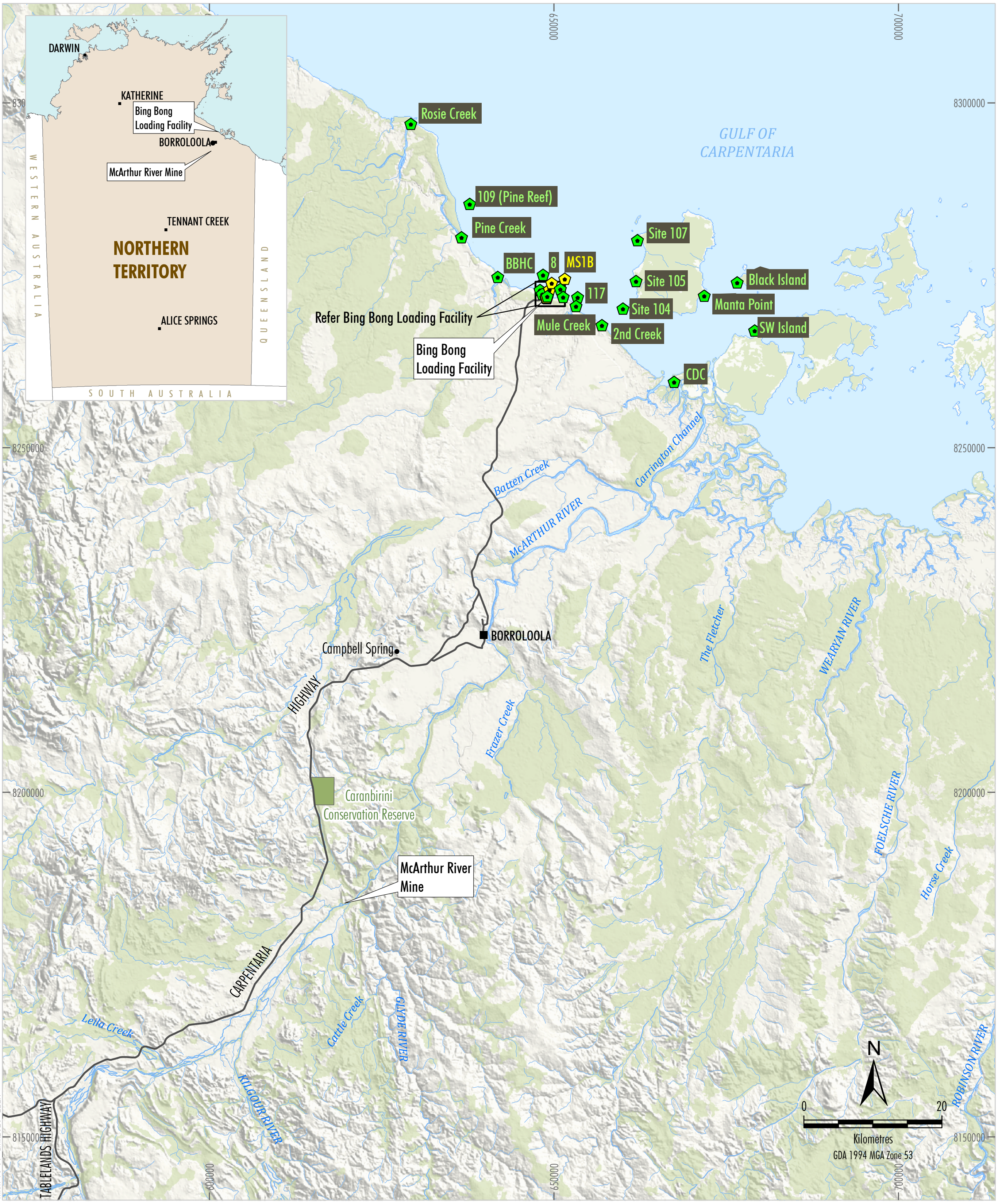
Metal concentrations in marine sediment were compared to the SQGVs outlined in Simpson and Batley (2016).

Marine Biota

Mean concentrations of Cd and Pb in biota tissue samples were compared to the applicable MPC outlined in Schedule 19 of Standard 1.4.1 *Contaminants and Natural Toxicants* (FSANZ, 2017). This includes an MPC for Cd and Pb in molluscs, and for Pb in fish. See Plate 6 for examples of biota collected.

Lead Isotope Ratios

Lead isotope ratios determined for water, sediment and biota samples were compared graphically to average background ratio values ($^{207}Pb/^{206}Pb \approx 0.83$ and $^{208}Pb/^{206}Pb \approx 2.06$) derived from the Present-Day Average Crustal (PDAC) Pb and in relation to MRM final concentrate values ($^{207}Pb/^{206}Pb = 0.9582$ and $^{208}Pb/^{206}Pb = 2.2222$).



LEGEND

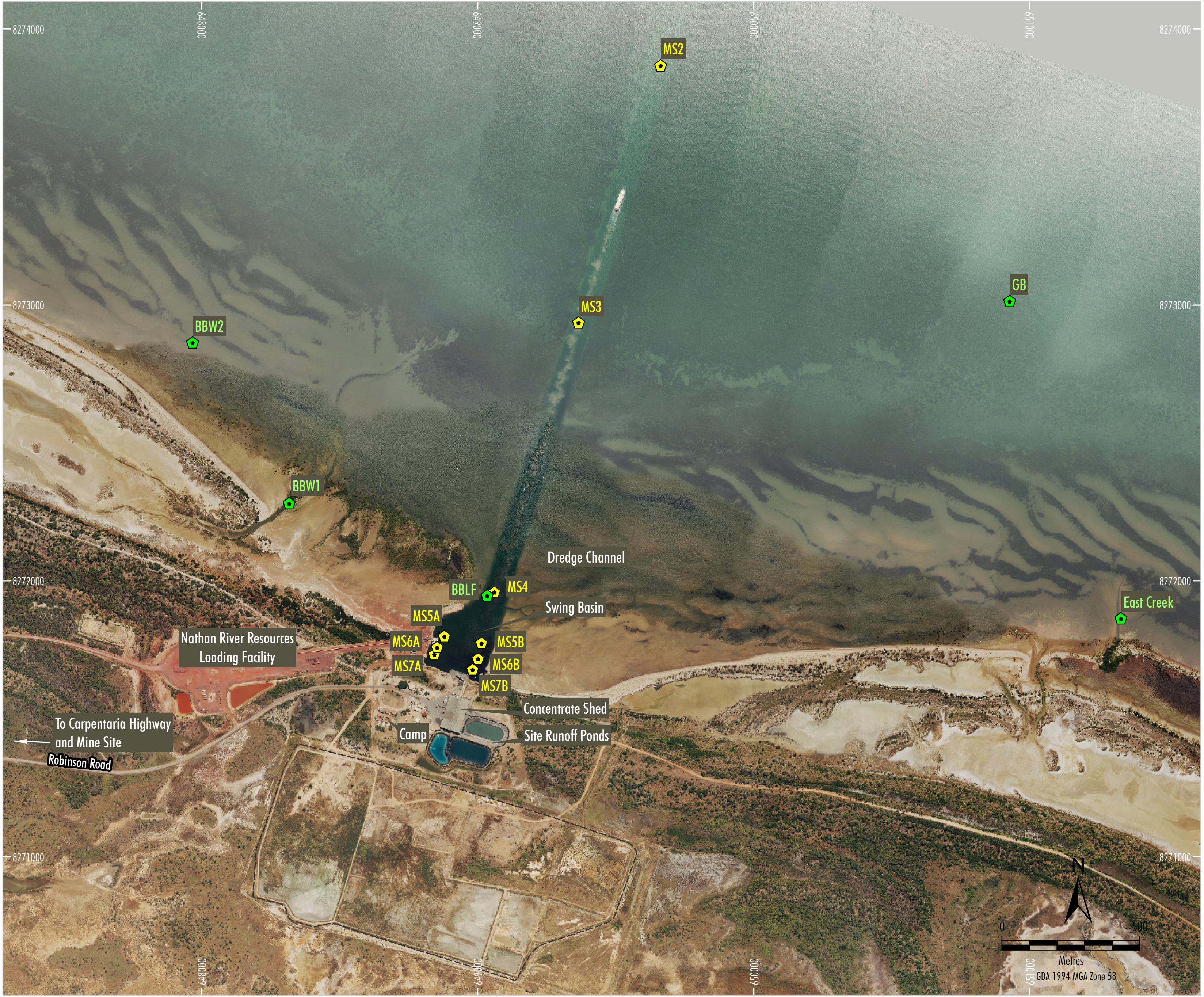
- Major Road
- River/Creek
- Marine Monitoring Site
- Sediment Sampling Site

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

McARTHUR RIVER MINE

Regional Marine Monitoring Sites

Figure 22



LEGEND

Marine Monitoring Site

Sediment Sampling Site

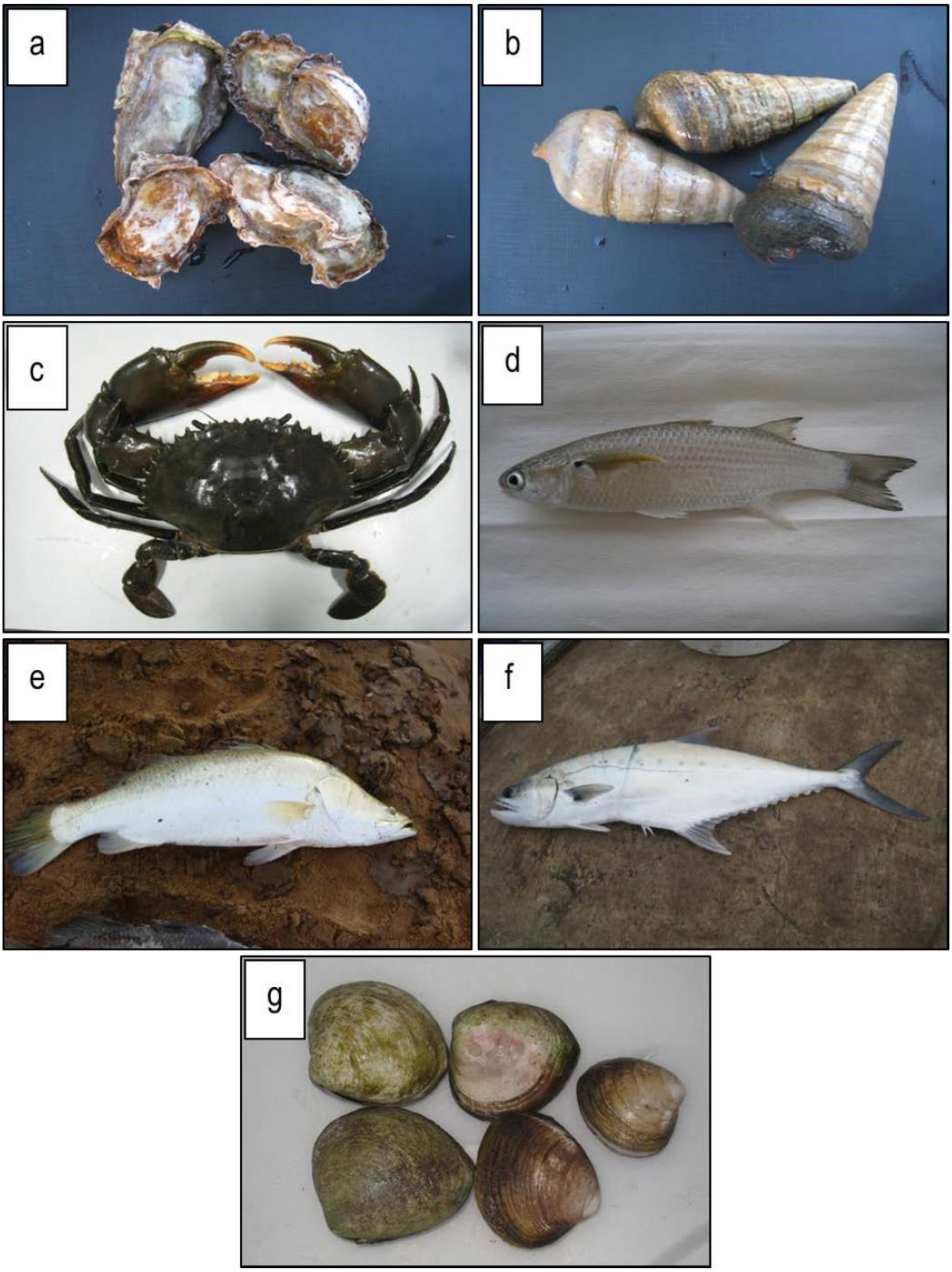
Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); IPE (2019); MRM (2019)

McARTHUR RIVER MINE

Bing Bong Loading Facility
Marine Monitoring Sites

Figure 23

MRM-16-01_EMR2020_223A



a) *Saccostrea* spp., b) *Telescopium telescopium* and *Terebralia semistriata*, c) *Scylla serrata*, d) *Valamugil buchanani*, e) *Lates calcarifer*, f) *Scomberoides commersonnianus* and g) *Polymesoda* spp.

Plate 6: Biota Collected during the 2019 AMMP

3.10.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

There were no significant changes made to the AMMP during the reporting period.

3.10.3 Performance during the Reporting Period

Marine Water

See Chart 13 for a comparison of concentrations of Pb, Zn and Cu in filtered water collected from sites sampled between 2015 and 2019.

All filtered and unfiltered water samples collected during 2019 recorded lead concentrations well below the 99 % protection trigger value of 2.2 µg/L. The highest lead concentration within filtered water samples was 0.9 µg/L, recorded at SW island. However, the lead isotope ratio of both filtered and unfiltered SW island samples was dissimilar to that of the shipping concentrate, indicating the source of lead at that site was not related to BBLF operations.

The current lead concentrations within filtered and unfiltered water samples were considered comparable to results recorded between 2015 and 2017. As discussed by IPE (2020g), the 2018 survey recorded lead concentrations of 2.9 µg/L within filtered water samples collected at BBW1 and SW Island. Results from additional water samples collected during May 2019 indicated lead concentrations were well below ANZG guidelines and comparable with historic AMMP survey results (for full discussion see IPE [2020g]).

The zinc concentration of all filtered water samples was well below the 99 % protection trigger value of 7 µg/L, and no discernible geographical pattern was evident. The highest zinc concentration within an unfiltered water sample (4 µg/L) was recorded at Site 104. Zinc concentrations for both filtered and unfiltered water samples collected during 2019 were comparable with results from 2015 to 2017, and lower than unusual results recorded at a small number of sites in 2018. The current zinc concentrations within water indicated that BBLF activities were not having a measurable impact at locations where water was collected.

Consistent with previous AMMPs, all filtered water samples collected during the current survey were found to have copper concentrations which were equal to or exceeded the ANZG marine 99 % protection trigger value of 0.3 µg/L, however none were considered close to the ANZG marine 95 % protection trigger value of 1.3 µg/L.

In relation to the remaining elements analysed, the current filtered and unfiltered water concentrations were considered consistent with results from the previous surveys.

Marine Sediment

See Chart 14 for a comparison of Pb and Zn concentrations in the <63 µm fraction of marine sediment collected from the greater AMMP survey area between 2015 and 2019. A comparison of Pb and Zn concentrations in <63 µm fraction of marine sediment collected from the BBLF swing basin and maintained shipping channel between 2015 and 2019 is also provided in Chart 15.

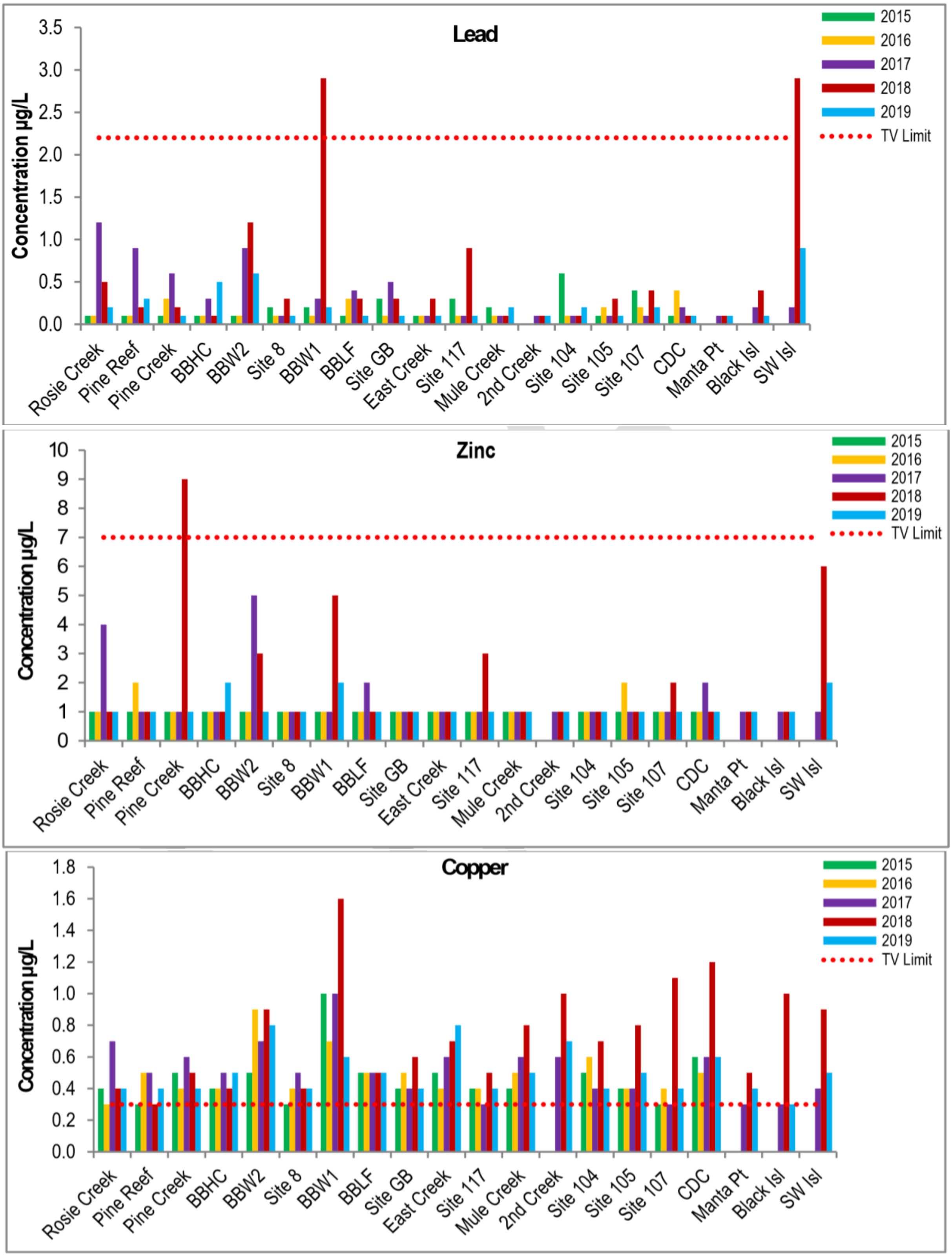


Chart 13: Comparison of Mean Concentrations of Lead, Zinc, and Copper in Filtered Water Collected from Sites Surveyed between 2015 and 2019

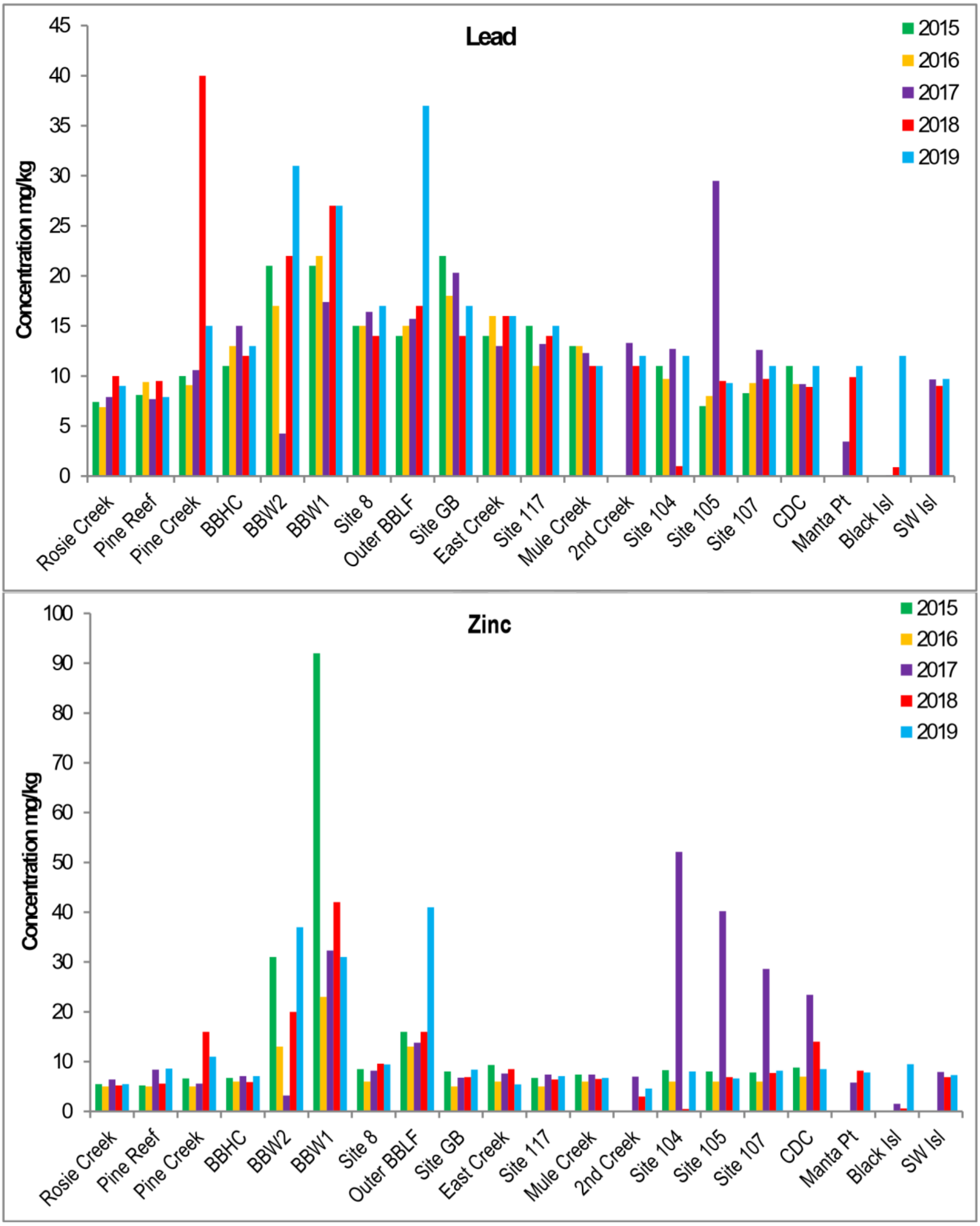


Chart 14: Comparison of Lead and Zinc Concentrations in the <63 µm Fraction of Marine Sediment Collected from the Greater AMMP Survey Area between 2015 and 2019

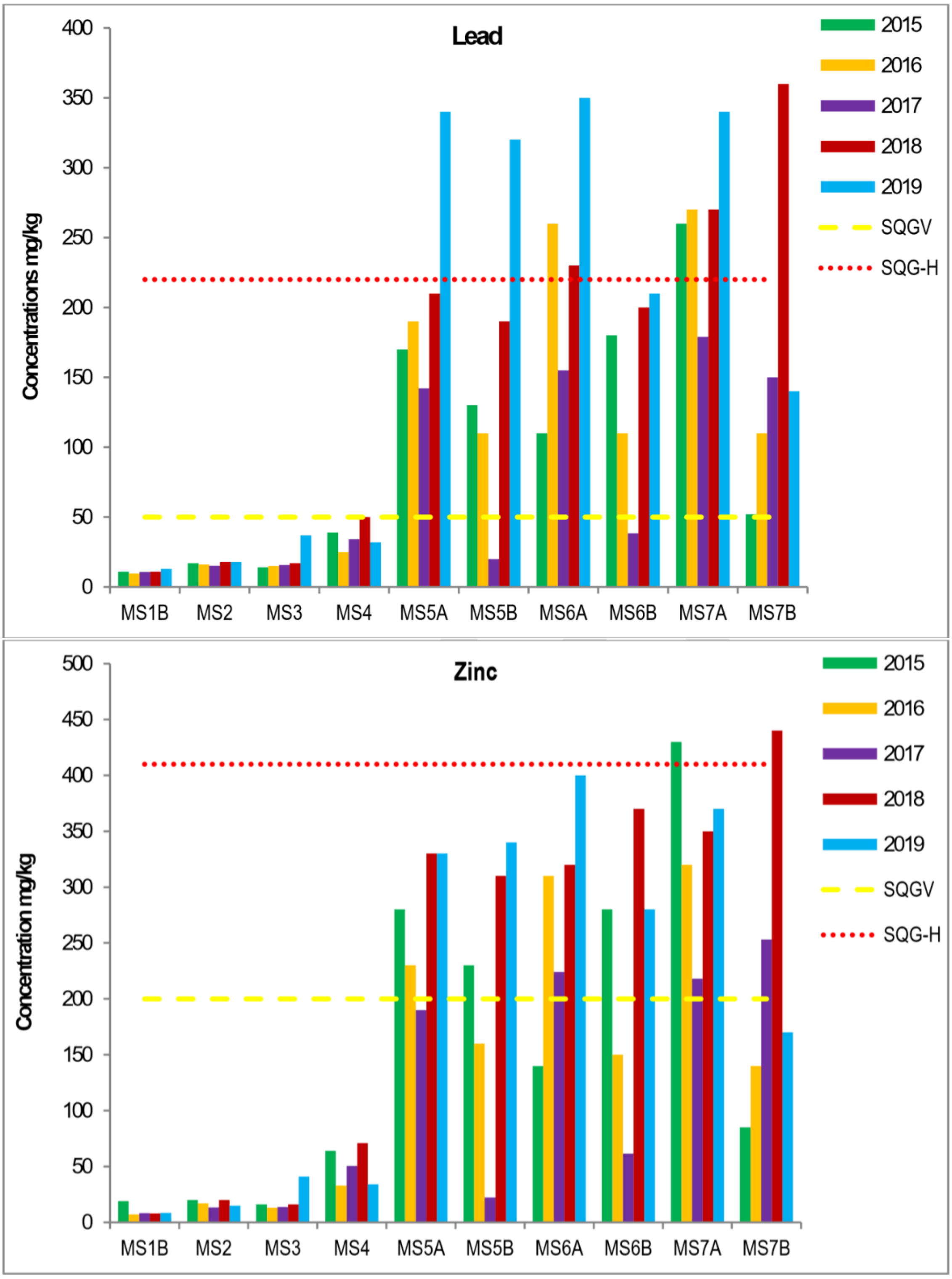


Chart 15: Comparison of Lead and Zinc Concentrations in <63 µm Fraction of Marine Sediment Collected from the Bing Bong Loading Facility Swing Basin and Maintained Shipping Channel between 2015 and 2019

No analytes investigated within the <63 µm sediment fraction of marine sediments collected from sites within the greater AMMP area were found to exceed any applicable SQGV. In relation to lead and zinc, the predominant analytes of interest within the shipping product exported from the BBLF, concentrations were well below the applicable SQGVs which are 50 mg/kg and 200 mg/kg, respectively. In general, sites in close proximity to the BBLF swing basin recorded the highest concentrations of analytes associated with the MRM shipping product and those concentrations decreased as distance increased from the BBLF.

The highest concentration of lead, outside of the swing basin itself was 37 mg/kg, recorded the BBLF (collected in the vicinity of MS3). The next highest concentrations were recorded at the nearby sites of BBW2 and BBW1, which had concentrations of 31 mg/kg and 27 mg/kg respectively. The lead isotope ratio of sediment collected at the BBLF, BBW2 and BBW1 sites, while not considered similar to the MRM shipping product, was distinctly different from remaining sites which were very similar to the PDAC. It was considered likely that the portion of lead at these three sites above regional background concentrations has originated from BBLF operations.

The highest concentration of zinc, outside of the swing basin, was 41 mg/kg recorded at BBLF, followed by 37 mg/kg and 31 mg/kg at BBW2 and BBW1 respectively, with no particular geographical pattern evident. Zinc concentrations at the majority of sample sites were considered comparable to those results reported for 2015 to 2018 (Chart 13).

Aluminium, manganese, iron and cobalt were found to remain relatively comparable with concentrations reported for previous AMMP surveys (IPE, 2015; 2016; 2017; and 2018).

Visual comparison between calculated concentrations per equivalent mass of habitat and <63 µm fraction concentrations demonstrates that direct comparison between sites does not provide a true indication of risk. For example, per equivalent mass of habitat, BBW2 and BBW1 only contain 4 and 8 % sediment particles <63 µm respectively, whereas 46 % of the sediment within the BBLF sample was <63 µm. Put simply, fauna residing at BBW1 and BBW2 has a very small chance of encountering, and subsequently ingesting, biologically available lead and zinc in comparison to fauna at the BBLF site even though the concentrations of lead and zinc within the <63 µm fraction were similar between those three sites.

In relation to the additional 10 sites investigated within the BBLF swing basin and maintained shipping channel, concentrations of Cd, Pb and Zn at sites within the swing basin were far higher than those sites investigated within the maintained shipping channel. Concentrations of Pb and Zn within shipping channel sites were considered similar to the concentrations recorded at sites in the wider AMMP study area.

Pb concentrations at sites located within the swing basin, MS5A, MS5B, MS6A and MS7A all exceeded the 220 mg/kg SQGV-High, with concentrations ranging between 320 mg/kg to 350 mg/kg. Furthermore, exceedances of the 50 mg/kg SQGV were recorded from MS6B and MS7B (210 mg/kg and 140 mg/kg, respectively).

Concentrations of zinc recorded at MS5A, MS5B, MS6A, MS6B and MS7A ranged between 280 mg/kg to 400 mg/kg, while MS7B recorded a zinc concentration of 170 mg/kg. Therefore, with the exception of MS7B, all sites within the swing basin exceeded the 200 mg/kg SQGV for zinc provided by Simpson and Batley (2016).

Consistent with previous AMMPs, the lead isotope ratios of these 10 sites showed a near linear progression toward the lead isotope ratio of MRM shipping product as sampling progressed shoreward. In particular, sites within the swing basin were found to have very similar lead isotope ratio to that of MRM shipping product.

In relation to MS5A, MS5B, MS6A, MS7A, the current results for lead indicate increased concentrations in comparison to previous years. However, the concentration of zinc at those sites was considered similar to concentrations reported by IPE (2015; 2016; 2017; and 2018). The current survey found greatly reduced concentrations of both lead and zinc at MS7B. Overall these changes in lead and zinc concentrations likely represent a redistribution of sediment within the swing basin rather than any large net input of shipping product between the 2018 and 2019 surveys. As discussed in previous reports, berthing of the MV Aburri creates high underwater turbulence which pushes sediment to the western side of the swing basin. Shipping movements by Nathan River Resources during 2018, after several years of no movements, likely counteracted that pattern of sediment movement to some degree before the 2018 AMMP (IPE, 2018). During 2019, the use of the MV Wunma, a physically large vessel with greater depth and draft than the MV Aburri, for a period of months before the current survey likely contributed to the movement of sediment to the west and seaward sections of the swing basin. Furthermore, effects of tropical cyclone Trevor which passed within the vicinity of BBLF on 23 March 2019, crossing the coast approximately 60 km to the east as a Category 4 system, cannot be discounted.

Marine Biota

The current AMMP survey found no exceedances of the relevant MPC for Pb specified by FSANZ in any of the 341 tissue samples analysed from the eight species of collected fauna.

The highest mean lead concentration within any species at any site was recorded within *Saccostrea* spp. from the BBLF, being 0.416 (± 0.014) mg/kg. This result is consistent with previous years and continues to remain well below the 2 mg/kg MPC for molluscs.

The highest mean lead concentrations for the three remaining mollusc species *Telescopium*, *Terebralia and Polymesoda* spp. were 0.056 (± 0.004) mg/kg, 0.152 (± 0.018) mg/kg, and 0.16 mg/kg, respectively. Lead concentrations within all other species investigated were considered very low.

The highest mean zinc concentration was recorded within *Saccostrea* spp. collected from the BBLF, being 504 (± 41.8) mg/kg, a result that is also consistent with previous years. Mean concentrations at BBLF were seven times higher than any other regular AMMP sample site.

Consistent with previous AMMP surveys, *S. serrata* was again found to have relatively high concentrations of zinc in comparison to other species investigated. The highest zinc concentration within that species was 78 mg/kg, recorded at East Creek, while individuals sampled from remaining sites ranged between 23 and 77 mg/kg. The highest mean concentration of zinc within *S. serrata* was recorded at the BBLF, that being 63.5 (± 7.9) mg/kg, however, this was considered to be similar to mean concentrations recorded at other sites.

Zinc concentrations within the remaining species were considered low, being consistently less than 15 mg/kg in the case of the molluscs *Telescopium* and *Terebralia*, and less than 6.5 mg/kg in the case of teleost species. Aside from that noted for *Saccostrea* spp. there was no evidence of a geographical based concentration pattern within any species.

The concentration of cadmium within a *Saccostrea* spp. sample collected at SW Island was 3.3 mg/kg, which exceeded the 2 mg/kg MPC. However, the mean concentration of this analyte at this site was 1.55 (± 0.45) mg/kg which was below the MPC. Cadmium concentrations were also high within *Saccostrea* spp. at Manta Point and Black Island, those being 1.30 (± 0.07) mg/kg and 1.23 (± 0.10) mg/kg, respectively. During the current study *Saccostrea* spp. collected at the BBLF recorded the lowest mean concentration of cadmium of any site (0.288 ± 0.019 mg/kg).

Consistent with previous studies, no correlations between fauna and water or fauna and sediment cadmium concentrations were identified. Other mollusc species were generally a factor of 10, and teleost species a factor of 100, lower than cadmium concentrations reported for *Saccostrea* spp. Within the survey area cadmium does not appear to accumulate within sampled crustacean or teleost species.

3.10.4 Non-conformances, Corrective Actions and Improvements

During the current study there were no exceedances of any relevant trigger value within filtered water samples collected from any site aside from copper and cobalt which were considered natural, widespread and consistent with monitoring since 2012.

In relation to the concentrations of analytes within the <63 µm sediment fraction, exceedances of applicable SQGVs remained confined to sample sites within the swing basin. All other evidence compiled through analysis of samples collected during the 2019 AMMP indicated that influence from operations at the BBLF on the marine environment continued to be confined to the swing basin, and a small section of tidal flat on the western side of the facility.

Environmental impacts coincide with mobilisation of sediments within the swing basin known to contain MRM shipping product. The impact on fauna within this relatively small area is essentially restricted to sessile species, species of low mobility and individuals of species which have extended residency times in the swing basin itself. Not surprisingly sessile and less mobile biota (i.e. *Saccostrea* spp., *Telescopium* and *Terebralia*) collected from the BBLF were found to have consistently higher lead levels (and in some instances also zinc) than individuals collected from other sites. Individuals of these species collected from the BBLF had lead isotope ratios close to that of the MRM concentrate while those collected on the adjacent western site, BBW1, had lead isotope ratios which approached the signature of the MRM shipping product and were distinctly higher than those of individuals collected away from the BBLF. More mobile and transient residents such as *S. serrata* and *V. buchanani* captured within this impact area did not appear to have greater metal loadings or elevated lead isotope ratio than that which would naturally occur at other sites throughout the survey area.

Data attained for *L. calcarifer* during the current study added strength to the hypothesis developed through previous AMMPs that this species does reside within the swing basin for sufficient time to uptake measurable concentrations of MRM derived lead. The current data also agreed with previous conclusions that residency time and uptake of lead is not uniform within this species. It is noted that no individual *L. calcarifer* muscle or liver sample collected from the BBLF has ever exceeded the MPC for lead.

The current data confirms previous findings from this monitoring program and the monitoring of analytes within freshwater fauna that non-lethal sampling techniques appear to be sufficient to monitor analyte concentrations within *L. calcarifer*, at least to a degree of confidence suitable for commenting on the risk to human health if consumed. Furthermore, use of non-lethal biopsy sampling allows for individuals to be tagged and possibly provide insight into residential time within the swing basin.

3.10.5 Changes for the Next Reporting Period

Previous AMMP reports have discussed there was some risk that resuspension of swing basin sediments, and subsequent movement of this sediment outside of the swing basin, could occur through increased MV Aburri movements or any additional frequency in shipping from the BBLF by other parties. Benefit likely exists in conducting finer scale sediment monitoring within the swing basin and maintained shipping channel before the 2020 AMMP. MRM will complete this work and report the results in the next reporting period. Along with this addition, the 2020 survey will consider concurrent traditional and biopsy sampling of specimens to ascertain if non-lethal sampling provides appropriate data from this species.

3.11 Rehabilitation

Rehabilitation activities at the Mine during the reporting period were undertaken in accordance with the RMP, which was developed and implemented in 2018. The focus of the RMP is to establish a rehabilitation monitoring and management system that enables MRM to progress rehabilitation activities towards completion criteria.

The scope of the RMP covers revegetation of the McArthur River and Barney Creek Diversion Channels for the period 2018 to 2020, as there are no planned changes to these landforms (as opposed to the NOEF, Open Pit and TSF, which are subject to further development). Rehabilitation of other Mine domains is briefly discussed but will be developed further in future versions of the RMP. The RMP will be subject to periodic revisions to cover periods that nominally align with future versions of the MMP with the next update to occur during the 2020-2021 reporting period.

MRM’s objectives for the rehabilitation of the McArthur River and Barney Creek Diversion Channels are to:

- facilitate the development of the ecosystem and its functions along the Diversion Channels for terrestrial and aquatic flora and fauna;
- minimise impacts on the surrounding terrestrial and aquatic environments;
- manage the geomorphological status of the Diversion Channels (e.g. reduce erosion and improve stability); and

- improve visual amenity.

MRM's performance against these objectives will be monitored and compared to performance indicators and completion criteria.

Revegetation, and the success of the works, is assessed through five monitoring programs:

- Annual Revegetation Monitoring (undertaken at the existing Mine revegetation monitoring and control sites).
- Fortnightly Revegetation Assessment (dry season) (undertaken at temporary monitoring sites established based on active revegetation sites).
- Riparian bird monitoring (Section 3.4).
- Macroinvertebrate monitoring (Section 3.6).
- Aquatic fauna monitoring (Sections 3.7 and 3.8).

Through these programs, areas can be identified that require additional work in both the short and long term. If the results of the monitoring programs identify that the revegetation areas are not meeting relevant performance indicators, MRM will consider the need to implement maintenance and management activities, such as:

- infill planting (or planting of specific species);
- weed management;
- pest management;
- cattle management;
- bushfire management;
- access control; and
- additional erosion control.

Other activities relevant to the RMP that were undertaken during the reporting period are also described in the sub-sections below, including:

- the McArthur River Diversion Channel Erosion Mitigation Civil Works Program; and
- the Purple-crown Fairy-wren Translocation Baseline Study (Appendix R).

3.11.1 Revegetation Activities

Revegetation commenced at the Barney Creek Diversion Channel in 2007 and at the McArthur River Diversion Channel in 2010. Revegetation of the McArthur River Diversion Channel continued during the reporting period, with 122,551 tubestock planted.

As described in the RMP, a number of Key Species have been identified that are considered to be most representative of the vegetation communities found along natural sections of the McArthur River. Of the tubestock planted in the reporting period, 75 % were Key Species. In addition, 47 % of all tubestock planted were grass species, which is a focus of the current rehabilitation strategy to stabilise the Diversion Channel banks, encourage water infiltration and enhance nutrient cycling.

The species planted on the McArthur River Diversion Channel during the reporting period are summarised in Table 17.

TABLE 17: SPECIES PLANTED ON THE MCARTHUR RIVER DIVERSION CHANNEL DURING THE REPORTING PERIOD

Scientific Name	Common Name	Number of Tubestock Planted on the McArthur River Diversion Channel
Acacia hammondii	Hammond's Wattle	80
Acacia holosericea	Silver Wattle	1,150
Acacia hemsleyi	Acacia Wattle	2,685
Acacia lysiphloia	Turpentine	1040
Acacia platycarpa	Ghost Wattle	40
Acacia torulosa	Torulosa Wattle	516
*Atalaya hemiglauca**	Whitewood	1,200
*Barringtonia actuangula**	Freshwater Mangrove	381
Brachychiton diversifolius	Northern Kurrajong	80
*Casuarina cunninghamiana**	River She-Oak	7,760
*Chrysopogan elongates**	Tall Tamil Grass	400
*Chrysopogan fallax**	Golden Beard Grass	14,167
*Corymbia bella**	Ghost Gum	3,805
Corymbia confertiflora	Carbeen	3,480
Dodonaea platyptera	Broad-winged Hop Bush	120
Eriachne obtusa	Wire Grass	7,240
Erythrophleum chlorastachs	Ironwood	80
*Eucalyptus camaldulensis**	River Red Gum	5,140
Eucalyptus chlorophylla	Green-leaf Box	80
Eucalyptus leucophloia	Snappy Gum	285
Eucalyptus lysiphla	-	40
*Eucalyptus microtheca**	Coolibah	40
Eucalyptus pruinosa	Silver Leaf Box	272
Ficus carpentaria	-	1,860
*Ficus racemose**	Cluster Fig	16,800
Helicteres isora	Indian Screw Tree	280
*Heteropogon contortus**	Speargrass	23,480
*Melaleuca argentea**	Silver-leaved Paperbark	4,713
*Melaleuca leucadendra**	Weeping Paperbark	3,410
*Nauclea orientalis**	Leichardt Pine	1,220
*Pandanus aquaticus**	River Pandanus	9,039
Sorghum plumosum	-	10,840

* McArthur River Key Species

3.11.2 Infill Planting

The RMP requires that, in the event that revegetation monitoring identifies that tubestock survival rates are low or that there is deficit in species distribution (e.g. development of a monoculture), MRM will undertake infill planting or planting of specific species as required to remedy the identified issue.

Prior to infill planting activities commencing, an assessment will be made to determine the required species and density to support ecosystem development and density. A minimum of one tree or shrub per square metre and >80 % grass cover is likely to be achieved through infill planting.

Infill planting was undertaken as required during the reporting period. In particular, infill planting was undertaken at the following locations:

- MRSB1 locations to replace individual plant loss throughout the dry season.
- MRMNB locations to replace plant loss as a result of water flow through the McArthur River.
- Waterline planting between SW16 and SW17 to supplement planting undertaken in previous years and to infill areas that experienced wet season mortality.

3.11.3 Weed Management

Weed management has been undertaken at the Mine and BBLF as described in the Weed Management Plan. Under this management plan, MRM will:

- manage weeds on-site in accordance with the NT *Weeds Management Act 2013*;
- liaise with relevant government departments to develop integrated management practices and procedures including the Weed Management Branch and the Parks and Wildlife Commission for the NT;
- employ an integrated weed management strategy to implement the Weed Management Plan;
- maintain a continued workforce education and awareness program including instructing personnel to check vehicles, and include presentations to permanent and contract staff and visitors during inductions;
- ensure that any equipment or machinery entering the site from interstate or other sectors of the NT undergo necessary quarantine measures, and that these goods only leave site after a 'Clean to leave site' form has been approved and signed off;
- update the Weed Management Plan to identify the targeted weed species, and management strategies and practices to prevent and control weeds; and
- review the Weed Management Plan every three years, to ensure weed management practices and strategies are effective and up-to-date.

The Mine

During the reporting period, approximately 434 hectares (ha) of land was inspected for weeds, and identified weeds were either sprayed or removed. As per the updated Weed Management Plan, weed control activities focused on the control and eradication of Class A and Class B weeds listed under the NT *Weeds Management Act 2013* (Figure 24).

Bing Bong

Approximately 124 ha of land surrounding BBLF and the historic Bing Bong Dredge Spoil (BBDS) was inspected for weeds, and identified weeds were either sprayed or removed. As described in the Weed Management Plan, this area will be inspected annually to assess for new weed growth (Figure 24).

LEGEND

Areas Targeted for Weed Control

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2020)

McARTHUR RIVER MINE

BBLF and Mine Weed Control 2019-2020 Reporting Period

Figure 24

MRM-16-01_EMR2020_224A

3.11.4 Pest Management

In accordance with the RMP, if monitoring identifies exceedances of the performance indicator for fauna disturbance (as a result of pest species), MRM will consider:

- using a range of appropriate pest control measures to minimise collateral damage to native animals (e.g. feral cat and goat trapping, and baiting wild dogs and wild pigs);
- follow-up inspections to assess the effectiveness of control measures implemented and the requirement for any additional control measures; and
- mandatory pest control for any declared pests (i.e. pigs and wild dogs) known to occur at the Mine. During the reporting period, pest management activities included:
  - Feral pig control at key locations surrounding the putrescible waste facility and McArthur River Diversion Channel.
  - Feral donkey control during dry season cattle muster events.

A focussed feral animal control program was conducted within the planned Purple-crowned Fairy-wren translocation habitat area on the 1st of October, 2019. Approximately 120 feral donkeys and seven feral pigs were euthanized during the event.

Feral animal control will continue to focus on donkeys and pigs, with some trials to be undertaken into feral cat control during the next reporting period.

3.11.5 Cattle Management

MRM currently manages a livestock-free exclusion area surrounding active operations in accordance with its Cattle Management Plan. During the reporting period, the exclusion area was maintained at 4,537 ha with weekly routine fence inspections identifying sections requiring maintenance. Maintenance and repairs were completed as soon as practicable once a need was identified (Figure 25).

During the reporting period, the electric fence along the southern section of the cattle exclusion fence was extended toward to the downstream section of the McArthur River Diversion Channel.

In accordance with the current Cattle Management Plan, 11 cattle muster events were undertaken to maintain a cattle exclusion area surrounding mining operations. Cattle musters are scheduled for six-week intervals, or within seven days of cattle being sighted within the cattle exclusion area. MRM were provided an exemption by DPIR Biosecurity to this commitment, with a period of seven weeks passing between a muster events 22 July 2019 and 6 September 2019. This exemption period allowed MRM to complete an upgrade of the cattle exclusion fence to the east of the NOEF and south of the McArthur River Diversion Channel.

Table 18 provides a summary of cattle mustering activities during the reporting period.

LEGEND

Cattle Exclusion Zone

McARTHUR RIVER MINE

Mine Cattle Exclusion Area

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

Figure 25

TABLE 18: CATTLE SIGHTINGS AND MUSTERING DURING THE REPORTING PERIOD

Date	Details	Details
10/05/2019	Cattle Muster	33 cattle mustered, 30 sampled, 4 destroyed
17/06/2019	Cattle Muster	24 cattle mustered
2/07/2019	Cattle Muster	58 cattle mustered, 55 sampled, 10 destroyed
22/07/2019	Cattle Muster	9 cattle mustered
6/09/2019	Cattle Muster	7 cattle mustered, 0 sampled, 9 destroyed
24/09/2019	Cattle Muster	0 cattle mustered, 0 sampled, 6 destroyed
01/11/2019	Cattle Muster	6 cattle mustered, 0 sampled, 0 destroyed
10/12/2019	Cattle Muster	0 cattle sighted
31/01/2020	Cattle Muster	3 cattle mustered, 0 sampled, 0 destroyed
16/02/2020	Cattle Muster	0 cattle sighted
19/04/2020	Cattle Muster	13 cattle sighted – muster called off due to safety concerns

During the next reporting period a new cattle yard will be constructed within the TSF cattle exclusion area to improve cattle mustering efficiency and meet commitments made in the Cattle Management Plan.

Bing Bong Dredge Spoil Cattle Management

During the reporting period MRM undertook cattle management at Bing Bong to address cattle access damage to the historic Bing Bong Dredge Spoil (BBDS) cell walls. A damaged section of four-strand barbed wire fence (100 m long) was replaced to prevent cattle access into the BBDS. The current BBDS cattle exclusion area is shown in Figure 26.

3.11.6 Bushfire Management

Bushfire management at the Mine is undertaken in accordance with MRM Bushfire Management Plan and in consultation with the NT Fire and Emergency Response Group located in Borroloola.

The objectives of bushfire management at the Mine are to:

- reduce unplanned fire ignition potential;
- prevent the spread of fire within and beyond the Mine area;
- protect flora, fauna and vegetation communities from inappropriate fire regimes and unplanned fire events; and
- utilise fire as a management tool to maintain and enhance native ecosystems, where applicable.

Planned controlled burns would not be conducted in revegetation areas until the plants become established to reduce the potential for mortality.

No bushfire management activities were undertaken during the reporting period.

3.11.7 Access Management

Damage by vehicles can result in the compaction of soil (which can reduce the infiltration of water into the soil and restrict root growth, and consequently reduce natural regeneration), and result in the spread of weeds and disturbance to vegetation.

LEGEND

Cattle Exclusion Zone

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

McARTHUR RIVER MINE

Bing Bong Loading Facility
Cattle Exclusion Area

Figure 26

MRM-16-01_EMR2020_226A

To reduce the degree of disturbance to the rehabilitation areas, measures will be put in place to limit access to these areas by authorised personnel only in accordance with the RMP. Measures implemented during the reporting period included:

- restricting vehicles to existing access tracks in the vicinity of rehabilitation areas;
- erecting signage denoting active rehabilitation areas; and
- including information about restricted access areas in the MRM Site Induction and Light Vehicle Surface Permit Procedure.

3.11.8 Large Woody Debris

Large Woody Debris (LWD) plays an important role in the ecology and geomorphology of streams and rivers. LWD provides aquatic fauna habitat, increases biodiversity and its breakdown forms the foundation of an aquatic food web. LWD can also significantly influence channel morphology, stream bank stability and create variation in flow which is vital for the migration and dispersal of fish. Furthermore, LWD promotes the establishment and success of riparian vegetation.

IPE (2016) concluded that the installation of LWD into the channel has remained the single most effective action taken in providing fish habitat and cites additional benefits including:

- aiding in fish migration by effectively providing 'stepping stones' that provide some respite from flow and protection from predators;
- aiding in alleviating the scouring of the channel, which has resulted in large quantities of sediment being transported and deposited at sites below the channel; and
- acting as a source of carbon, which is a basic building block in the aquatic food ecosystem.

IPE (2019) further concluded that the strategic placement of LWD at locations within the McArthur River Diversion Channel has proven to increase fish density and diversity.

IPE (2020d) also noted that:

- the placement of LWD is likely to be contributing to the progress of macroinvertebrate assemblages through creating variation in flow and microhabitat within the McArthur River Diversion Channel; and
- the continuation of placement of LWD is recommended, as it is beneficial for both invertebrate and vertebrate fauna.

Table 19 provides a breakdown of the LWD work completed to date.

TABLE 19: LARGE WOODY DEBRIS INSTALLATION SUMMARY 2010 – 2019

Year	Loads	Location
2010	200	Upstream & Downstream Channel
2011	18	Downstream Channel
2013	15	Mid-channel
2014	124	Downstream Channel
2016	74	Upstream Channel
2017	12	Mid-channel
2018	72	Mid-channel
2019	0	N/A

No placement of LWD occurred during the reporting period. It is expected that mid-channel LWD placement will resume in the McArthur River Diversion Channel during the next reporting period as more LWD becomes available due to clearing associated with the open pit expansion.

3.11.9 McArthur River Diversion Channel Erosion Mitigation Civil Works

In 2018, the Independent Monitor (IM), the ERIAS Group, for MRM prepared the *2017 - 2018 Environmental Performance Report*. The report stated that the active avulsion occurring upstream of the McArthur River Diversion Channel is an extreme risk to the mine and is likely to result in a "breach of the mine levee wall resulting in the discharge of contaminated water from the pit to Barney Creek and/or McArthur River impacting aquatic and terrestrial ecosystems".

In 2019, during the previous reporting period, MRM commissioned Hydrobiology to undertake a follow up geomorphology assessment of the major waterways that drain through the mine and an options assessment to provide a preferred option to mitigate the risk of avulsion. Updated monitoring data, including hydraulic model results, Lidar analysis, bathymetry survey of the McArthur River and site inspections, indicated that the dominant processes within the avulsion options study area had shifted from incision (approximately 2006), to incision and widening (~2008-~2015), and to shallowing and widening (approximately 2015 to approximately 2018). The trajectory suggested that the avulsion risk had reduced markedly since the previous geomorphic assessment in Hydrobiology (2016).

During the current reporting period, the McArthur River Diversion Channel Erosion Mitigation Civil Works Project was developed to address a number of recommendations arising from the 2019 Hydrobiology report.

These recommendations included:

- continuing investigations on rehabilitation and widening options within the upper and mid reaches of the McArthur River Diversion Channel; and
- investigating stabilisation or profiling options for gully confluences within the upper and mid reaches of the McArthur River Diversion Channel.

The civil works project was also designed to assist in the creation of a functioning aquatic, riparian and riverine system within the diverted section of the McArthur River.

The McArthur River Diversion Channel Erosion Mitigation Civil Works Project aimed to decrease the erosion potential of two gully confluences along the mid reaches of the McArthur River Diversion Channel by improving bank stability and flow characteristics. The works were completed within Bull Creek and a nearby unnamed tributary using a 36T excavator and a Moxy dump truck (Figure 27).

The work involved channel re-contouring and the placement of large boulders, LS-NAF riprap sized rock and sediment traps to help reduce flow velocities and subsequent erosion. Observations during the 2019-2020 wet season indicated that the mitigation works were successful at reducing erosion and improving channel stability.

In the next reporting period, MRM will continue to implement erosion mitigation activities at key locations to prevent long-term stability issues at the Mine and BBLF.

LEGEND

Diversion Civil Works

McARTHUR RIVER MINE

McArthur River Diversion Erosion Mitigation Civil Works

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

Figure 27

3.11.10 Seed Collection

During the reporting period, MRM undertook a native seed collection program on the MRM lease areas. The objectives of this program were to:

- define seed resource locations, particularly for species that are sparse or difficult to collect;
- increase the current stocks of riparian species used in the McArthur River Diversion Channel revegetation program; and
- provide date of seed resource availability to utilise in the planning of progressive rehabilitation of mining infrastructure areas.

A summary of the total seed collected is provided in Table 20.

TABLE 20: SUMMARY OF SEED SPECIES COLLECTED DURING THE REPORTING PERIOD

Scientific Name	Common Name	Seed Weight (kg)
Acacia hammondii	Hammond's Wattle	*
Acacia holoscericia	Silver Wattle	10
Atalaya hemiglauga	Whitewood	*
Chrysopogon elongates	Tall Tamil Grass	45
Eucalyptus camaldulensis	River Red-Gum	5
Ficus carpentaria	-	*
Ficus racemosa	Cluster Fig	2
Hetropogon contortus	Black spear grass	25
Nauclea orientalis	Leichardt Pine	15
Pandanus aquaticus	River Pandanus	*
Sorghum plumosum	-	7

*Collected seed weight not recorded.

MRM's revegetation activities use approximately 90 % locally sourced seed from within the mineral lease, the remaining 10 % of seed is sourced from suppliers within the Northern Territory. It is not practical for MRM to collect all of the seed used for revegetation activities onsite due to access and safety concerns associated with some species (i.e. *Eucalyptus* spp. and *Melaleuca* spp.).

During the next reporting period, MRM intends to continue this program and improve the seed resource maps to allow for long-term planning of seed collection.

3.11.11 Purple-crown Fairy-wren Translocation Baseline Habitat Assessment

During the reporting period, in accordance with the Purple-crowned Fairy-wren Translocation Plan, MRM requested EMS to undertake an assessment of the translocation area. The *McArthur River Mine Translocation Area Baseline Assessment* (EMS, 2019c) is provided in Appendix R.

EMS (2019c) presents the findings of the assessment undertaken in June 2019. The scope of work covers three main components, including a baseline ecosystem assessment of the proposed translocation area, an assessment of the Purple-crowned Fairy-wren (PCFW) population within the mine levee wall and a review of the objectives of the Translocation Plan document.

A summary of survey results is provided below:

- Four PCFW groups were identified within the translocation area, with a total of 12 individual birds sighted.
- Existing PCFW territories within the translocation area occupied approximately 14 ha (9.3 %) of approximately 150 ha of suitable habitat in June 2019.
- The total estimated cover of Cane Grass (*Chionachne cyathopoda*) within the translocation area was estimated at 236 m^2, approximately 0.015 % of riparian habitat within the translocation area.
- None of the sites identified in the June 2019 study met suitability criteria requiring additional steps outlined in Section 6.2 of the Translocation Plan (METServe, 2018), including sites that have supported long-term PCFW territories within the translocation area.
- A survey of the source PCFW population within the mine levee wall identified six individual PCFW family groups, with a total of 19 individuals observed. This is a decline on the numbers identified during an audit conducted in 2018 (23).
- There is evidence of ongoing decline of vegetation condition within the mine levee wall, including reduction in cover of Cane Grass and decline of mid-storey Freshwater Mangrove (*Barringtonia acutangula)* and canopy Weeping Paperbark (*Melaleuca leucadendra*) vegetation cover (EMS, 2019c).

Implications of Translocation Plan Suitability Criteria

The assessment included steps 1 – 3 of Section 6.2 of the Translocation Plan (METServe, 2018). EMS (2019c) found that the sites investigated during the field surveys did not meet the suitability criteria for translocation of PCFW groups, including sites that have held established PCFW territories over many years within the translocation area, suggesting that the suitability criteria are not reflective of successful habitat criteria for PCFW colonisation observed both upstream and downstream McArthur River. This indicates that these criteria require further assessment and revision to ensure that it does not cause unnecessary delay the translocation of the PCFW within the mine levee wall, which may result in a number of predictable (negative) outcomes. These outcomes are likely to be the loss of available suitable PCFW territories within the translocation area as conditions improve following the exclusion of cattle and PCFW groups naturally expand into and occupy these territories.

EMS (2019c) found that PCFW habitat quality within the mine levee wall is declining as a result of the McArthur River Diversion Channel redirecting the McArthur River around mining operations, isolating this section of the Old McArthur River Channel from natural riverine processes (e.g. water flow and flood events). As the PCFW habitat in this location continues to decline, there has been an observed decline in PCFW population size in this location. These outcomes are contrary to the objectives of the translocation plan. The results of the study indicate that the suitability criteria require adjustment to avoid a situation where overly strict criteria will unnecessarily delay the PCFW translocation, resulting in adverse outcomes for the PCFW within the mine levee wall.

Consistent with the recommendations of EMS (2019c), MRM will revise the following Translocation Plan Suitability Criteria:

- remove criteria related to canopy cover, with a caveat that translocation sites are located within suitable areas of riparian vegetation types VMU9a and VMU8a (Barden, 2017);
- translocation sites should include an area of at least 2 ha of suitable habitat which is unoccupied by PCFW prior to the release;
- translocation sites should include > 40 % cover of riparian grasses within a 2 ha area; and
- translocation sites should include a minimum of one clump or patch of Cane Grass within the 2 ha area.

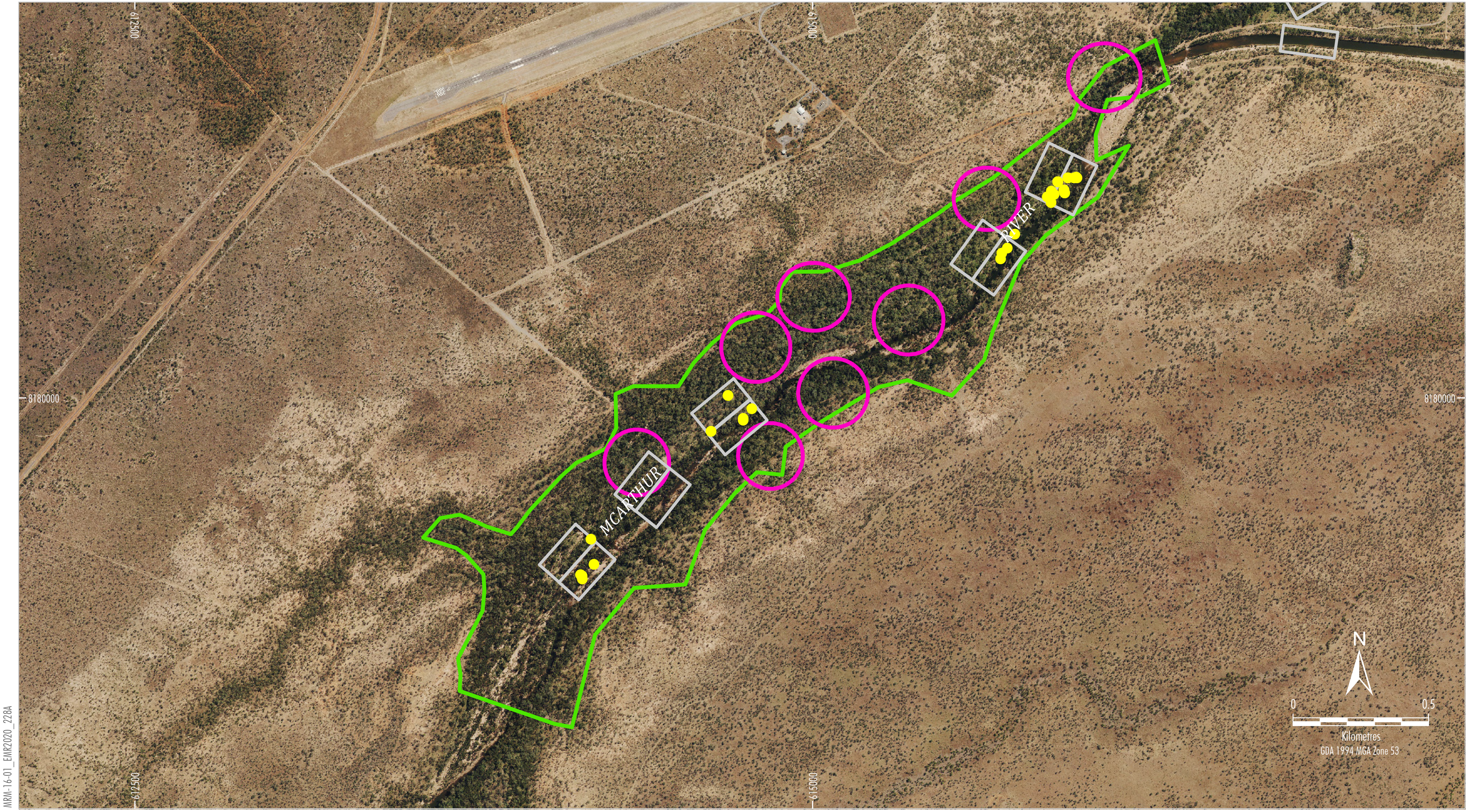
During the baseline assessment, eight locations meeting the above criteria were identified within the translocation area (Figure 28).

- Review Translocation Timing:

    1. Given the observed decline in PCFW numbers and ongoing decline in vegetation condition within the mine levee wall, translocation of the PCFW should be undertaken at the earliest opportunity. This should also be undertaken before vacant territories within the translocation area are occupied as a result of improved habitat conditions. It is expected that the translocation could be undertaken following recovery of riparian grasses over the 2019/2020 wet season and the completion of the 2020 nesting period (March – June 2020). The timing will depend to some degree on the conditions across and following the wet season, which will determine the timing of nesting and fledging. The translocation sites identified in the current survey (Figure 28) should also be re-assessed prior to the relocation of birds in 2020 to determine condition and occupation by PCFW.

Translocation Area Baseline Assessment Outcomes

Taking into consideration the recommendations provided by EMS (2019c) and conditions set out in the current PCFW Translocation Plan (MetServe, 2018), MRM will adjust the translocation timing and suitability criteria to allow translocation of the PCFW population from within the levee wall to occur during August and September 2020, within the next reporting period.



LEGEND

- PCFW Sighting Locations 2018-2019
- Suitable Translocation Sites Based on Revised 2019 Suitability Criteria
- Extent of Suitable PCFW (Riparian) Habitat VMU8a + VMU9a
- Long Term Riparian Bird Monitoring Plots

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

McARTHUR RIVER MINE

PCFW Baseline Assessment – Potential Translocation Sites

Figure 28

3.11.12 Nursery Upgrade

During the reporting period, MRM continued to upgrade the facilities at the on-site Nursery to support the revegetation program on the McArthur River Diversion Channel. The upgrade included the following changes:

- Extension of the existing hardening-off area increasing capacity by approximately 30 %.
- Installation of a concrete floor throughout the hardening-off area.
- Construction of a perimeter fence to enclose the nursery and prevent access by native fauna.
- Completion and energisation of the fit-out for the hot works shed constructed during the previous reporting period.

The nursery is currently capable of supplying up to 200,000 tubestock annually. During the next reporting period, MRM will continue to maintain the nursery facility and implement ongoing improvement as required.

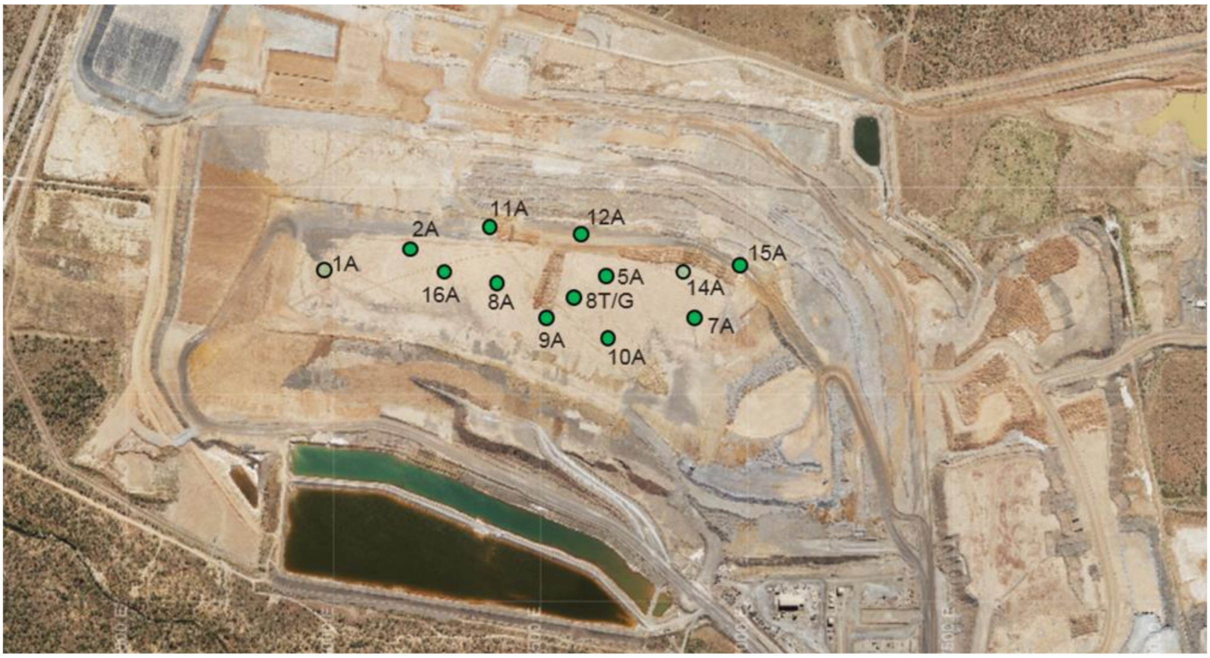
3.12 NOEF Temperatures

3.12.1 Monitoring Program Overview

Location and Purpose

Following the spontaneous combustion that occurred on the NOEF in 2013, major remediation works were undertaken on the NOEF PAF cell. The works focussed on the remediation of hot spots, primarily on the northern batter of the NOEF, which was the most affected. Remediation works included the re-excavation, cooling, relocation and compaction of combusting material; flattening of the outer batter to 1:4 gradient; and placement of a fine-grained wet season cover over the PAF cell. The remediation works of the Northern batter initiated in 2014 were completed in May 2018 with the final shallowing of the northern batter and the placement of a low air permeability layer (advection cover) over the full PAF cell to inhibit the advection of oxygen into the stockpile.

In order to gain information as to internal temperatures and to monitor the conditions within the NOEF, drilling campaigns were undertaken in 2016 and 2017 as part of the Overburden Management Project EIS (OMP EIS), concentrating on the existing NOEF PAF cell. A total of 22 temperature and gas monitoring wells were drilled with locations selected based on our understanding of the NOEF internal architecture and the special distribution of PAF material within the facility. The locations of the bores are shown in Plates 7 and 8 on the 2017 NOEF.



Note: 1A and 14A were not instrumented.

Plate 7: Location of the 2016 NOEF Temperature Monitoring Bore Network

Note: 2017 network shown in red.

Plate 8: Location of the 2017 NOEF Temperature Monitoring Bore Network

Instrumentation

All monitoring wells are instrumented with industrial grade high temperature K-type thermocouples with an operational range to 1000˚C. For gas measurements, stainless steel gas ports connected to Teflon tubing rated to 380˚C were placed at different levels which enable the measurement of internal pore gas composition. The gas ports are embedded in permeable coarse sand, and each interval is sealed by bentonite clay to limit preferential vertical movement of gases along the monitoring well.

A total of 32 thermocouples and 8 gas ports were installed in 2016 at various depth, each monitoring bore having in between two and four thermocouples with a minimum vertical separation of 10 m. In contrast, all 2017 bores were instrumented at similar levels. The vertical resolution was significantly increased with 12 thermocouple/ gas ports pairs per well. Instruments were installed at 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, and 39 m.

An example of a vertical temperature profile obtained is shown in Chart 16. The data shows quarterly temperature curves for the 4 thermocouples of bore NOEF 2016-9A from December 2016 to June 2019.

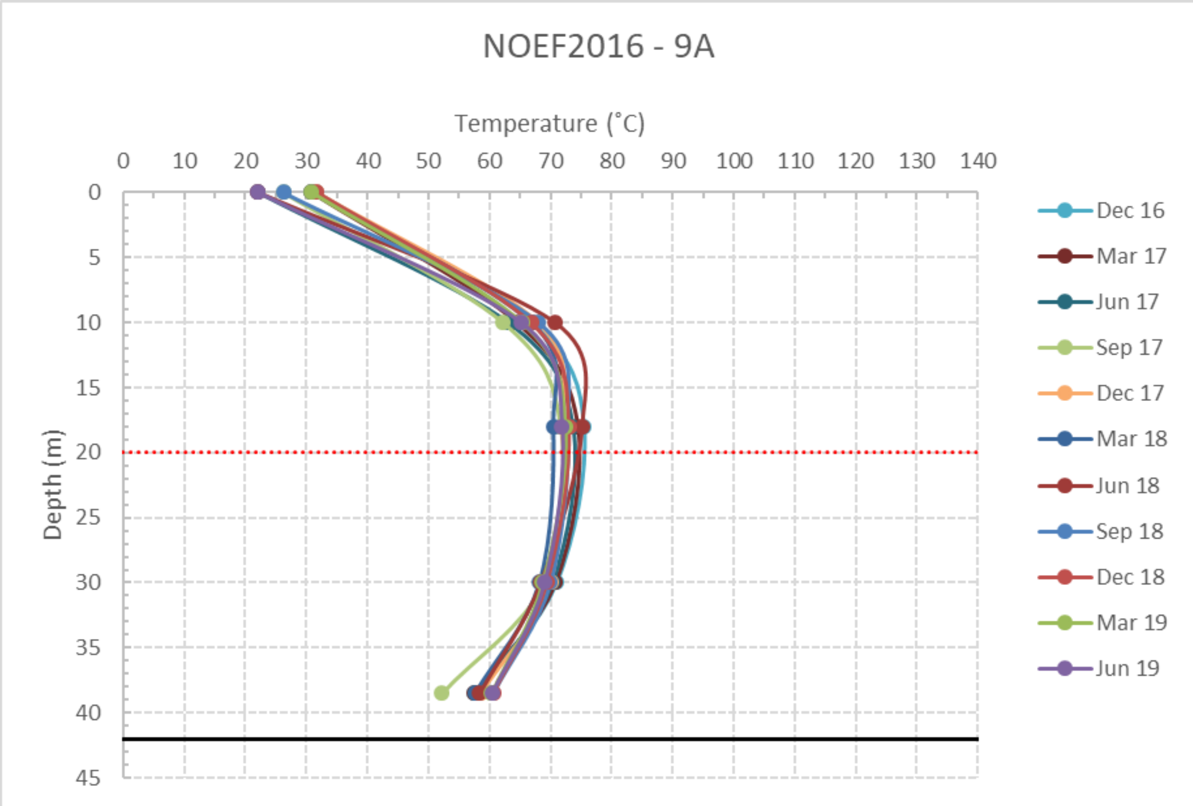


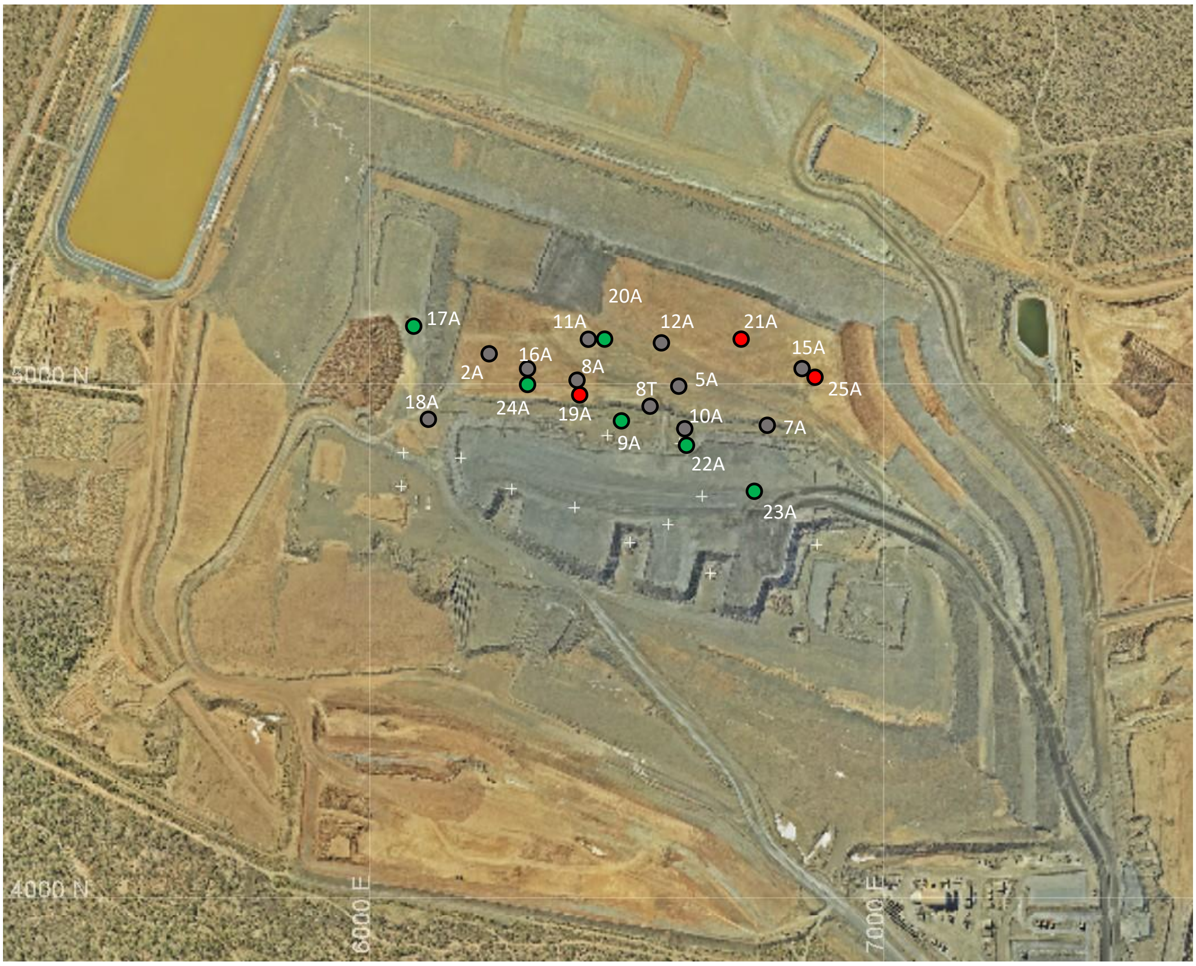
Chart 16: Vertical Temperature Profile for Site NOEF2016-9A

3.12.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

Due to the expansion and continuous increase in height the NOEF as well as ongoing operational activities in the area, significant modifications to the monitoring infrastructure had to be undertaken from July 2019 to the end of the reporting period. Two principal changes to the monitoring program infrastructure occurred over the reporting period:

1. Decommissioning of end of life bores: high temperature thermocouples have an expected operational life of 18 to 24 months and therefore the progressive failure of the instrumentation from early 2019 onwards was expected. A total of 6 bores were already out of service by June 2019 (8A, 8T, 11A, 12A and 15A) and a further 4 were decommissioned over the reporting period. The location of the decommissioned bores is shown in Plate 9.

2. Vertical extension of existing bores: in order to keep up with the vertical progression of the NOEF, the functional life of existing bores with more recent instrumentation (2017 installation) was increased by extending the instrumentation and the bore casing by an additional 6 to 10 m. This is expected to provide an additional 24 months to the monitoring program before replacement bores will be required.



Shown: Decommissioned (grey), Extended (green) and Damaged (red) Bores

Plate 9: Location of the Decommissioned, Extended and Damaged Bores on the 2019 NOEF

3.12.3 Performance during the Reporting Period

Results are reported to June 2019, as the remainder of the reporting period was devoted to the extension of the monitoring wells and measurements were not possible. Completion and resumption of measurements are expected in August 2020.

Temperature changes over time

The background temperature of the NOEF PAF cell below 10 m is on average 73˚C. Although the absolute value can appear elevated compared to other published sulfidic waste rock dump values, it is only ca 40˚C hotter than the temperature that can be expected from the mean air temperatures at the site. While at the higher end of the spectrum, temperatures 40˚C hotter than ambient are not abnormal for a high sulphide waste rock dump and indicates that oxidation rates within the core of the NOEF are not exceptionally high compared to other equivalent sites.

All the monitoring wells at background temperatures show stable temperature profiles with an apparent absence of seasonal variation. The absence of seasonal variation strongly suggest that the internal temperatures in the core of the NOEF are not affected by atmospheric conditions (air temperature, moisture, wind strength and direction, etc.) and therefore that exchanges between the NOEF core and the atmosphere are limited to the perimeter of the PAF cell and the batter regions. Temperatures have remained essentially constant over the monitoring period with a moderate amount of cooling particularly apparent in NOEF2016-5A and NOEF2017-19A (refer Chart 17).

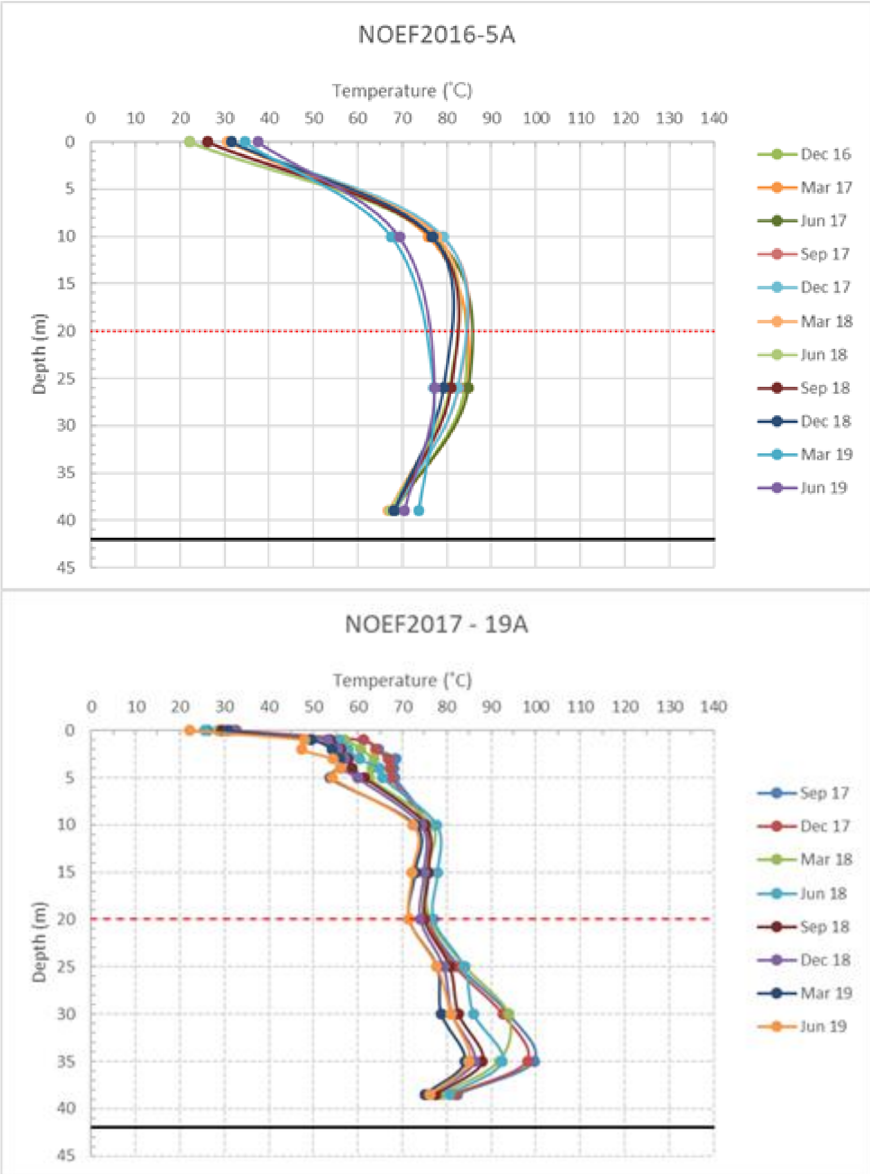


Chart 17: Background Temperature Profiles for Two Typical Monitoring Bores Showing Stable Temperatures with Progressive Cooling

The temperature profiles show a much greater variability over time with all monitoring wells having recorded significant temperature decreases over the monitoring period. Chart 18 shows the temperature differences between either December 2016 or December 2017 (as a function of the programs) and June 2019 for 6 monitoring bores. The most significant recorded temperature decreases over the period are:

- NOEF2016-8A -115 ˚C at 30 m
- NOEF2016-10A -72 ˚C at 16 m
- NOEF2016-16A -47 ˚C at 13 m
- NOEF2017-20A -25 ˚C at 20 m
- NOEF2016-21A -27 ˚C at 15 m
- NOEF2016-22A -40 ˚C at 20 m
- NOEF2016-24A -47 ˚C at 15 m

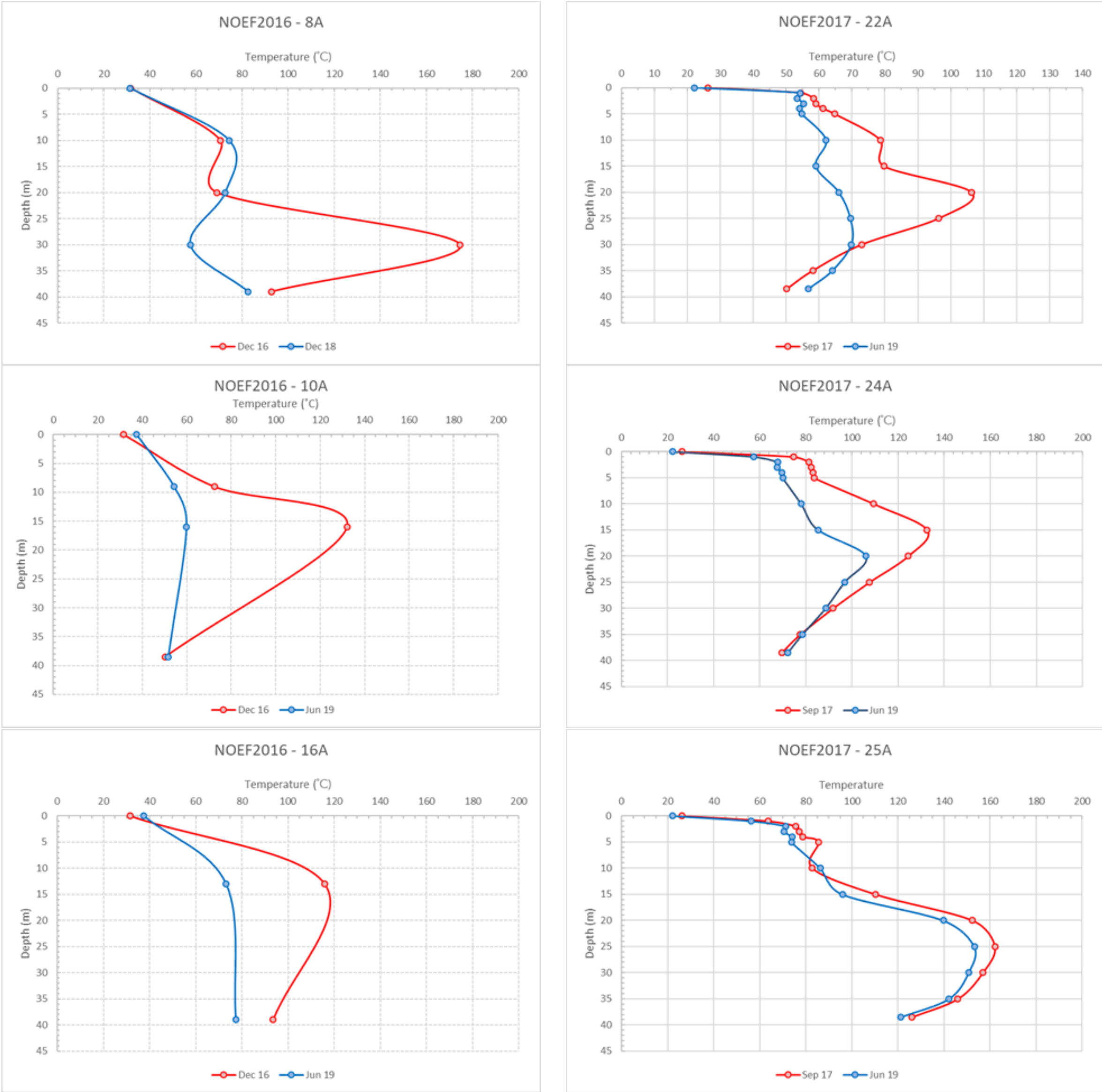


Chart 18: Elevated Temperature Profiles of NOEF Temperature Bores Showing the Degree of Cooling

Of the eight temperature wells which originally had elevated temperatures, five have cooled down to essentially background temperatures. Only three (20A, 21A and 25A) still have elevated temperatures, although all have been progressively cooling over time albeit at an average rate of 0.5˚C/month.

Spatial Temperature Distributions

The June 2019 spatial distribution of background temperatures, elevated temperatures, and out of service temperature locations are presented in Plate 10.

Shown: Background temperatures (blue), elevated temperatures (red), and out of service temperature (black) locations

Plate 10: Spatial Distribution of Background and Elevated Temperatures on the NOEF in June 2019

All monitoring bores located on the plateau of the NOEF can be considered at background temperature, indicating that the bulk of the NOEF core is comparatively cool.

The re-handling and processing of the Low Grade Ore stockpile on the south-eastern margin of the NOEF PAF cell in 2017 has resulted in a significant cooling of the area with the complete removal of reacting material from the area.

The principal area where high temperatures are observed is on the eastern half of the northern batter. The area corresponds to the last area with batter and berm configuration, and was only remediated in September 2017 with the low air permeability layer only placed in May 2018. This area is expected to progressively cool over time as air circulation is reduced.

3.12.4 Non-conformances, Corrective Actions and Improvements

Three bores (21A, 15A and 19A) were damaged over the reporting period from an interaction with heavy machinery as a result of waste rock dumping activities on the NOEF. MRM plan to replace two of the damaged bores in 2021-2022.

3.12.5 Changes for the next Reporting Period

Ongoing quarterly measurements of temperatures will continue from August 2020 for the remainder of the reporting period. However, the following changes in temperature monitoring of the NOEF will be implemented in 2020:

- Increased use of thermal imaging in order to monitor NOEF temperatures - MRM is in the process of developing a survey drone thermal imaging program that will enable a bi-monthly thermal survey of the NOEF in order to detect and manage hot spots and spontaneous combustion before it develops. In time, it is expected that in-situ temperature monitoring using thermocouples on the active NOEF will become redundant.

- CW Charlie horizontal instrumental array - A horizontal temperature and gas instrumental array is planned to be installed in the Central West Charlie PAF cell to complement the vertical temperature measurements, and expand the temperature monitoring to the new PAF cells constructed following the OMP EIS design.

3.13 Other

3.13.1 Waste Management

Waste management during the reporting period was undertaken in accordance with MRM's Waste Management Plan. Quantities of waste produced on-site during the reporting period are provided in Table 21.

TABLE 21: SUMMARY OF WASTE QUANTITIES

Waste Type	Unit	Q2 2019	Q3 2019	Q4 2019	Q1 2020	TOTAL
General waste (Non-hazardous)	t	8.20	4.05	7.80	1.00	21.05
Garden/green waste (Non-hazardous)	t	15.67	0.90	10.90	28.80	56.27
Food (Non-hazardous)	t	76.83	90.40	93.50	123.18	383.91
Contaminated to landfill	t	539.77	580.30	493.50	390.63	2004.20
Scrap metal recycled	t	540.94	390.48	0.00	0.00	931.42
Batteries recycled	t	2.49	1.58	4.00	3.72	11.79
Waste oil recycled	t	192.11	192.11	226.59	181.00	791.81
Aluminium cans recycled	t	0.90	0.90	1.50	0.90	4.20

3.13.2 Diesel Spill Remediation

On 19 May 2011, MRM discovered an open valve leaking diesel onto the ground in the vicinity of the Mine power plant. The volume of diesel lost was estimated at approximately 27,678 litres (L).

MRM immediately notified the then DME of the leak and commenced the initial remediation response. A Detailed Site Investigation and Remediation Action Plan were prepared in consultation with the DME and finalised in 2012. Since that time, remedial activities have been undertaken in accordance with these plans.

The *2011 Diesel Spill Incident - 2020 Annual Report* (MRM, 2020c) is provided in Appendix S.

3.14 Reconciliation of Environmental Management Commitments and Actions

A reconciliation of the environmental management commitments and actions is provided in Appendix B.

4 Site Water Management

Water management at the Mine and BBLF is conducted in accordance with the:

- 2013-2015 MMP Surface Water Environmental Management Plan.
- 2013-2015 MMP Groundwater Environmental Monitoring Plan.

Water management at the Mine is supported by the following monitoring programs:

- Artificial surface water quality monitoring program.
- Groundwater monitoring program.
- Surface water monitoring program.
- Fluvial sediment monitoring program.
- Macroinvertebrate monitoring program.
- Freshwater aquatic fauna abundance and diversity and metals in fish monitoring programs.
- Marine sediment, water quality and metals in biota monitoring program.

This section provides a summary of the following with respect to water management and monitoring conducted by MRM over the reporting period:

- Current conditions (e.g. site water) (Section 4.1).
- Summary of surface water monitoring results (Section 4.2).
- Summary of groundwater monitoring results (Section 4.3).
- Summary of surface water and groundwater interpretation (Section 4.4)
- Summary of marine water metal concentration results (Section 4.5).
- Summary of metalloid concentrations in near shore sediment (Section 4.6).
- Summary of metalloid concentrations in transhipment seafloor (Section 4.7).
- Reconciliation of water management commitments and actions (Section 4.8).

The review of environmental performance relating to the above has been supported by analysis from expert specialists. The analysis reports are appended as follows:

- Appendix T Environmental Monitoring Report 2019/20 - Surface Water, prepared by KCB (2020a).
- Appendix U McArthur River Mine Groundwater Annual Environmental Monitoring Report 2019/20, prepared by Pando (2020a).
- Appendix V 2019 Hydrogeological Drilling and Field Campaign (MRM, 2020d).
- Appendix W Concentrations of select bioavailable metals and lead isotope ratios within ocean water in the vicinity of the Bing Bong Loading facility as monitored by Diffusive Gradients in Thin Films 2019-2020, prepared by IPE (2020h).

- Appendix X Metal and Metalloid concentrations of near shore sediment of the Bing Bong Loading Facility, September 2019, prepared by IPE (2020i).

- Appendix Y Assessment of metals and lead isotope ratios of seafloor sediments in the McArthur River Mine Transhipment Area, November 2019, prepared by IPE (2020j).

4.1 Site Water

4.1.1 MRM Site Water Inventory

The daily rainfall dataset for the station at McArthur River Mine Airport (14704) from January 1, 1889 to April 30, 2019 (SILO record) indicates that the long-term average annual rainfall is 722 mm (KCB, 2020a). The total rainfall over the 12-month reporting period was 958.6 mm. The highest daily rainfall (168.4 mm) during the period was recorded on February 26, 2020. A total of 253.2 mm occurred during a five-day period between February 24 and 28, 2020, and was related to Cyclone Esther. Table 22 provides a summary of the site inventory for key existing water storages at the end of the reporting period.

Time series of inventories in the underground voids (UG), NOEF SPROD, NOEF SEPROD, NOEF WPROD, NOEF EPROD and the TSF WMD over the reporting period are presented in Charts 19 to 24, respectively. The following is of note with respect to water management in the major site storages:

- The Open Pit did not contain any water over the reporting period (Chart 19). The underground voids were steadily dewatered form May 1 to September 13, 2019 using the Mine Underground Dewatering System (MUDS), at which point the extraction rate had to be reduced to compensate for the very low inflows. In between the 6th and 12th of November 2019 all three MUDS pumps were lowered by an additional 11 m to enable continued supply of water for operational activities. This situation was exacerbated by the delayed 2019-2020 wet season, resulting in all surface inventories being in effect empty by January 2010. The first significant rainfall (14.8 mm) occurred on the 7th of January 2020, with a total of 934 mm of rainfall for the wet season. The significant UG storage capacity enabled the pit floor to remain dry over the reporting period.

- SEPROD was periodically filled with various sources of water for lime treatment (Chart 20). Treated water was dewatered to OP P2 and then stored in the TSF WMD.

- WPROD began the reporting period with a low inventory and was completely empty by the 23rd of December 2019 (Chart 21). NOEF WPROD was then used to store excess water from the PbOx circuit from the 16th of August to the end of the reporting period (274 ML) as well as excess TSF return water following Cyclone Esther in late February.

- The HDPE lining of NOEF SPROD was completed in January 2020 (Chart 22). The dam remained empty until the 29th of January and was subsequently used as an emergency water storage facility in accordance with conditions set by the Independent Certifying Engineer (ICE) while undergoing commissioning. Water stored included underground dewatering, NOEF surface runoff and TSF return water.

- Construction of NOEF EPROD was undertaken over the reporting period, however delays in the HDPE liner construction meant that the dam was essentially unavailable for water storage until end of March 2020 (Chart 23). As per NOEF SPROD, NOEF EPROD was used as an emergency water storage facility in accordance with conditions set by the Independent Certifying Engineer (ICE) while undergoing commissioning. It only contained 600 ML at the end of the reporting period.

- TSF WMD (Chart 24) began the reporting period with an inventory of 500 ML of treated water from NOEF SEPROD. The water was then used to supply operations until the dam was empty on the 12th of December 2019. The Maximum Operating Level (MOL) of the TSF WMD has been reduced to 1,300 ML following a dam review by GHD, and will remain low until further works to stabilise the walls are completed. No wastewater discharge occurred from the TSF WMD via the MLDP and WMD Release Point (RP) occurred over the reporting period owing to drought conditions.

TABLE 22: SITE WATER INVENTORY AT 30 APRIL 2020

Storage Name	Full Storage Level Volume (ML)	Stored Volume on 30 April 2020 (ML)
Open Pit and Mill		
Mill Anti-Pollution Pond	23	1.9
Mill CRP	27	26
Open Pit Van-Duncan's Dam (VDD)	26	11
Open Pit Pete's Pond	115	69
Open Pit Lake Archer	25	4
Open Pit East Levee Storage (OP ELS)	1,080	0
Underground Void and Open Pit (UG&OP)	3,379	3,322
Open Pit Pond 2 (OP P2)	65	47
North Overburden Emplacement Facility		
NOEF South Perimeter Runoff Dam (SPROD)	1,310	689
NOEF SEPROD	634	399
NOEF WPROD	1,263	1,000
NOEF SEL1	343	200
NOEF CW Alpha Sump (CWAS)	26	20
NOEF CW Charlie Sediment Trap (CWCST)	9	8
NOEF East Sediment Trap (NOEF EST)	76	50
NOEF EPROD	1,695	568
NOEF South West Silt Trap (SWST)	8	<1
NOEF West D Sump (WDS)	38	<1
NOEF East Drain Sump (EDS)	97	20
Tailings Storage Facility		
TSF Cell 2	750 - 950	-
TSF Mini Dam	94	21
TSF WMD	2,400	571
TSF Cell 1 Sump A (TSF C1SA)	7.5	0
TSF Cell 1 Sump B (TSF C1SB)	36	0

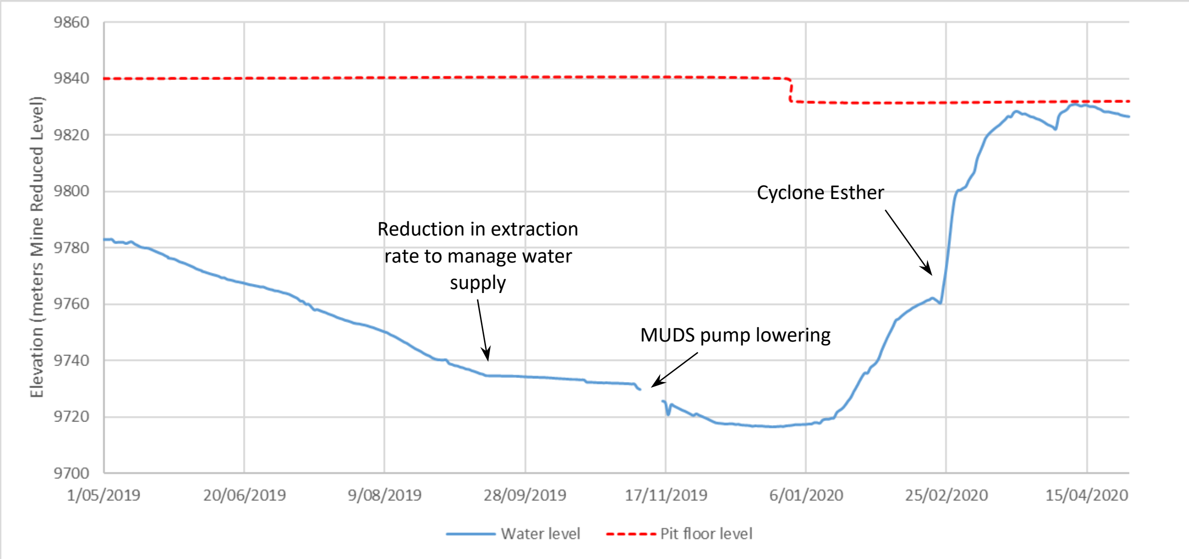


Chart 19: Recorded UG Stored Water Level, May 2019 – April 2020

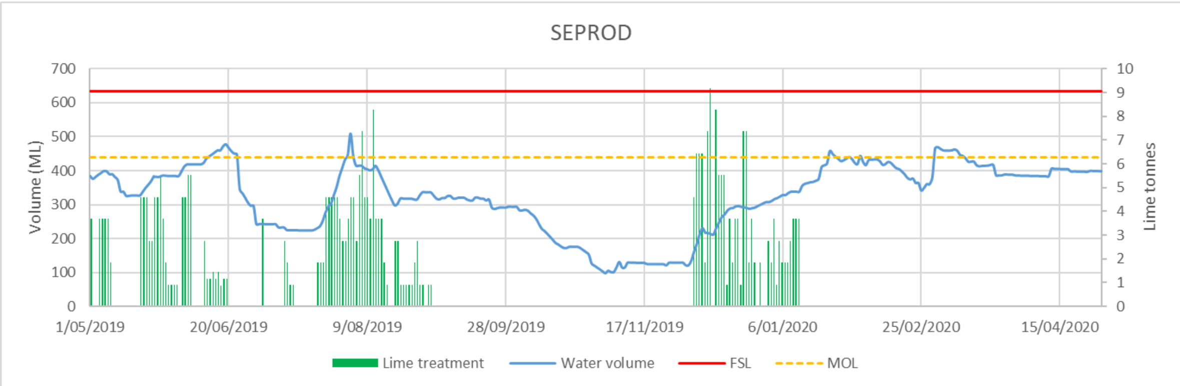


Chart 20: NOEF SEPROD Stored Volume and Water Treatment Lime Consumption, May 2019 – April 2020

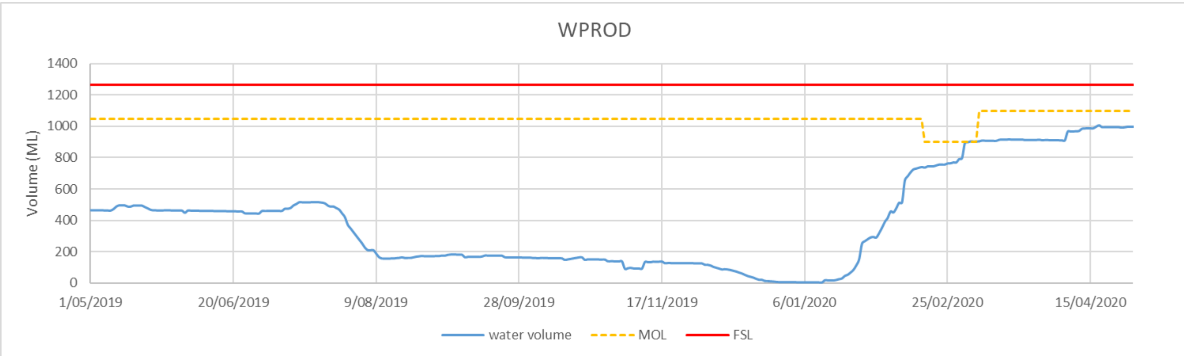


Chart 21: Recorded NOEF WPROD Stored Volume, May 2019 – April 2020

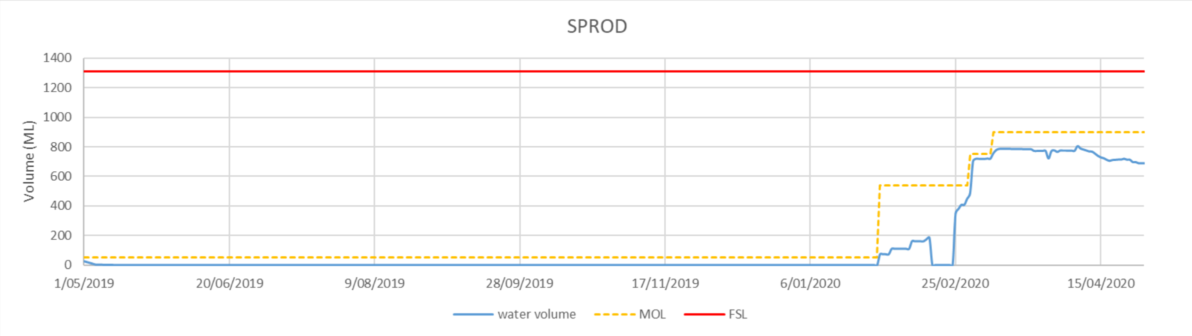


Chart 22: NOEF SPROD Stored Volume, May 2019 – April 2020

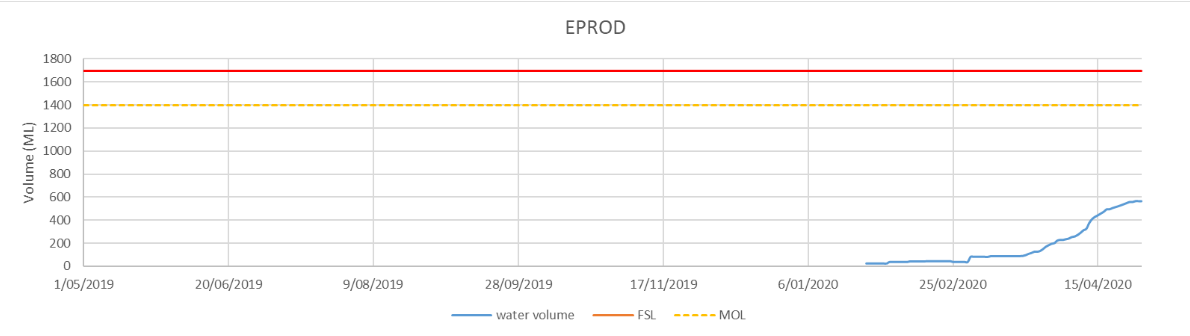


Chart 23: NOEF EPROD Stored Volume, May 2019 – April 2020

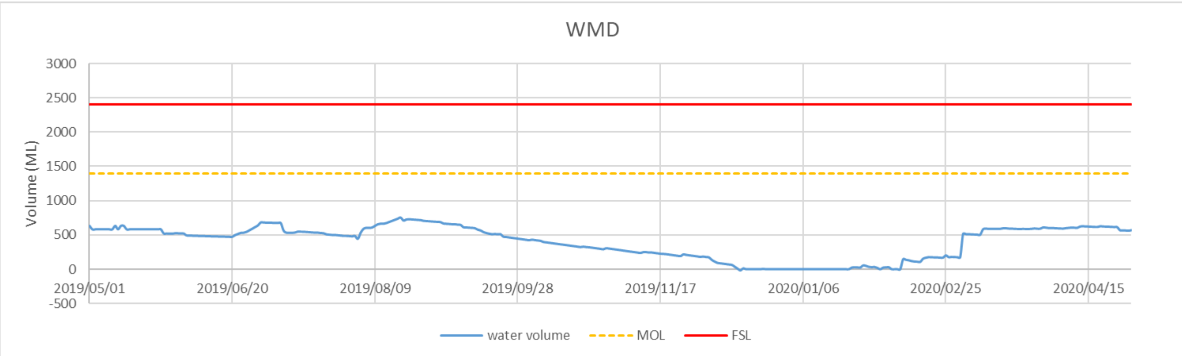


Chart 24: TSF WMD Stored Volume, May 2019 – April 2020

4.1.2 Water Treatment

Hydrated Lime

Following the previous successful lime treatment practices, pH circumneutral water from the underground void were transferred to the NOEF SEPROD facility for water treatment over the operational period. Treatment occurred via the application of a hydrated lime slurry using a lime mixing plant. The general treatment methodology involves the continuous input of mine-affected water in conjunction with a lime slurry with an ongoing extraction of treated water from the dam. During the operational period 767 ML of water was treated in NOEF SEPROD. A total of 372 t of hydrated lime was used. Chart 20 shows the inventory in NOEF SEPROD as well as the lime consumption and key operational phases during the reporting period.

Water being discharged from NOEF SEPROD is monitored for pH and zinc regularly to ensure that adequate treatment has occurred.

Treatment aims to improve the water quality to a Class 4 status for storage in the TSF WMD or other suitable structures for subsequent release in accordance with WDL 174-10. Zinc is typically the limiting contaminant of concern in the mine-affected waters. A pH of 8.7 is targeted, which effectively precipitates the majority of zinc from solution. The target zinc concentration is <1,000 µg/L, as this allows discharge using existing infrastructure at typical McArthur River wet season flows. The Class 4 maximum zinc concentration is 3,134 µg/L.

Water Treatment Plant

The reverse osmosis water treatment plan (WTP) was not operated over the reporting period. Site water shortages in November to January leading up to the wet season precluded final commissioning of the facility, as the necessary water supply was not available. Final commissioning, including reliability testing is expected by September 2020.

Artificial Water Quality

Monitoring results for the artificial surface water were analysed by KCB (2020a) and are presented in Appendix T. A summary of water quality of artificial waters at the Mine over the reporting period is presented in Table 23. The defined water class for each water storage facility is based on the median water quality concentration for each analyte over the reporting period. The location of each artificial surface water monitoring site is shown on Figure 29.

TABLE 23: TYPICAL MINE WATER QUALITY CLASSIFICATION FOR VARIOUS MINE WATER SOURCES

ASW Location	Site Code	Water Class	Limiting CoC
Mill Anti-pollution Pond	Mill APP	5	Zn_F
Mill Concentrator Runoff Pond	Mill CRP	5	Zn_F, Cd_F
Cell 2 A	TSF C2A	5	Zn_F
Cell 2B	TSF C2B	6	SO_4
Water Management Dam	TSF WMD	4c	EC, SO_4
Central West A Sump	NOEF CWAS	6	SO_4
Central West C Sediment Trap	NOEF CWCST	4a	EC, SO_4
East Drain Sump	NOEF EDS	4c	EC, SO_4, Zn_F
East Sediment Trap	NOEF EST	4a	EC, SO_4
South East Levee 1	NOEF SEL1	4a	EC, SO_4
South-East Perimeter Runoff Dam	NOEF SEPROD	4c	EC, SO_4
Southern Perimeter Runoff Dam	NOEF SPROD	5	Zn_F
Southern Perimeter Sediment Dam Culvert	NOEF SPSD Culvert	6	SO_4, Zn_F
West Perimeter Runoff Dam	NOEF WPROD	6	SO_4, Zn_F
Lake Archer	OP LA	6	SO_4, Zn_F
MUDS UGB3 Hole G	OP MUDS UGB3 HG	5	Zn_F
Pete's Pond	OP PP	5	Zn_F
Pond 2	OP P2	4c	EC, SO_4
Van Duncan's Dam	OP VDD	5	Zn_F

LEGEND

- Authorised Release Point
- Authorised Waste Discharge Location
- Water Storage

Source: *Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2020)*

McARTHUR RIVER MINE

Mine Artificial Surface Water Monitoring Locations

Figure 29

4.1.3 Managed Wastewater Release

No water was discharged under the waste discharge licence WDL174-11 over the reporting period owing to site water shortage from August 2019 to February 2020.

Managed Release Loads

Analyte loads related to managed release have been estimated for the period between May 1, 2019 and April 30, 2020 for the 2019-20 wet season and reporting period.

The managed release loads estimated for the 2019-20 period were compared to the managed release loads estimated for the 2017-18 period. It should be noted that the 2019-20 reporting period was from May to April, whereas the 2017-18 reporting period was from July to June.

The 2019-20 managed release loads for total Zn (0 kg) and total Pb (0 kg) were considerably less than the 2017-18 managed release loads for total Zn (3,429 kg) and total Pb (15.8 kg) due to no managed release occurring over the 2019-20 reporting period (Chart 25).

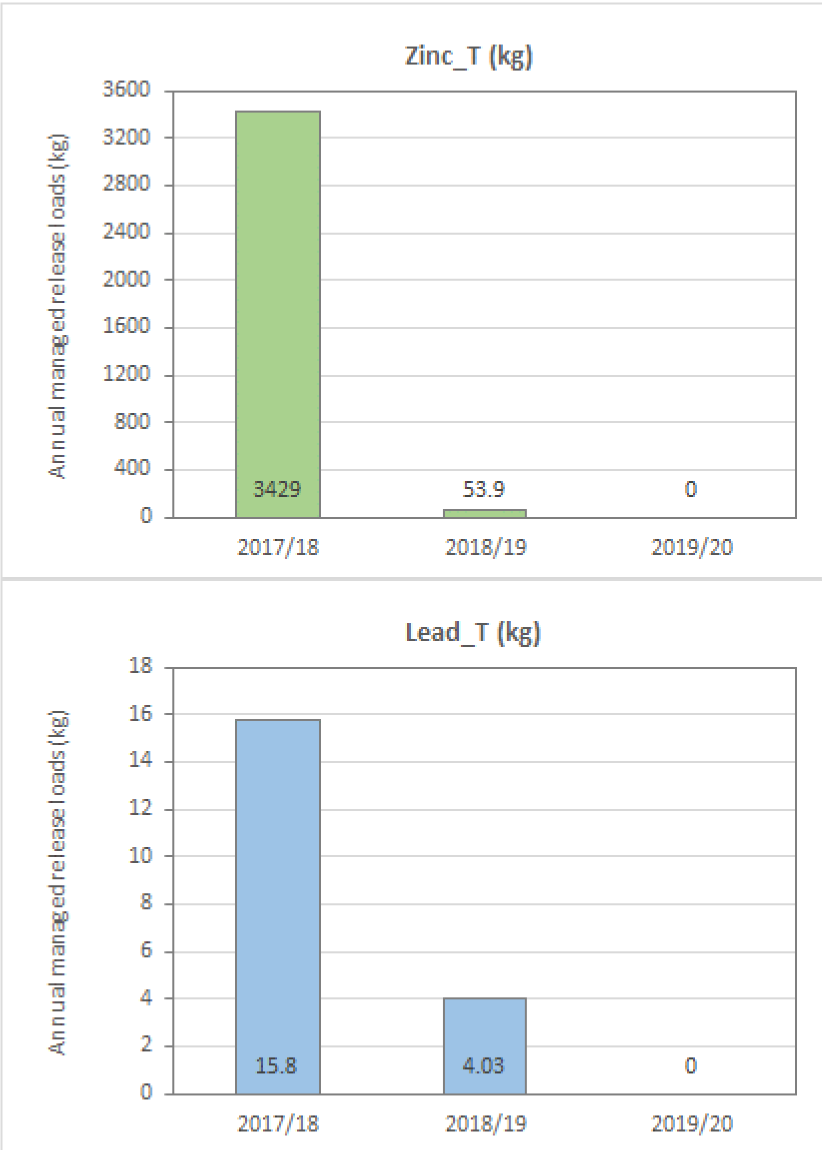


Chart 25: Managed Release Loads of Zinc and Lead for the Reporting Period

4.1.4 BBLF Site Water Inventory and Artificial Surface Water

The daily rainfall dataset for the nearby BOM station at Centre Island (14703) between 1 January 1889 and 30 April 2020 (SILO record) indicates that the long-term average annual rainfall is 933.2 mm. Approximately 690 mm of rainfall was experienced during the period between 1 May 2019 and 30 April 2020, as measured by the Bing Bong Port Gauge (14729). The highest daily rainfall (59 mm) during the period was recorded on 26 February 2020.

Table 24 provides a summary of the BBLF site inventory for key existing water storages as at 30 April 2020. The Water Management Infrastructure for BBLF is shown on Plate 11, while a schematic of the system is given on Plate 12.

TABLE 24: BBLF SITE WATER INVENTORY AT 30 APRIL 2020

Storage Name	Storage Capacity (ML)	Stored Volume on 30 April 2020 (ML)
SRP1	28	5
SRP2	31	3
SRP3	18	0

Artificial surface water quality data was collected at three locations at BBLF (SRP1, SRP2 and SRP3). The monitoring results for the reporting period are provided in KCB (2020a).

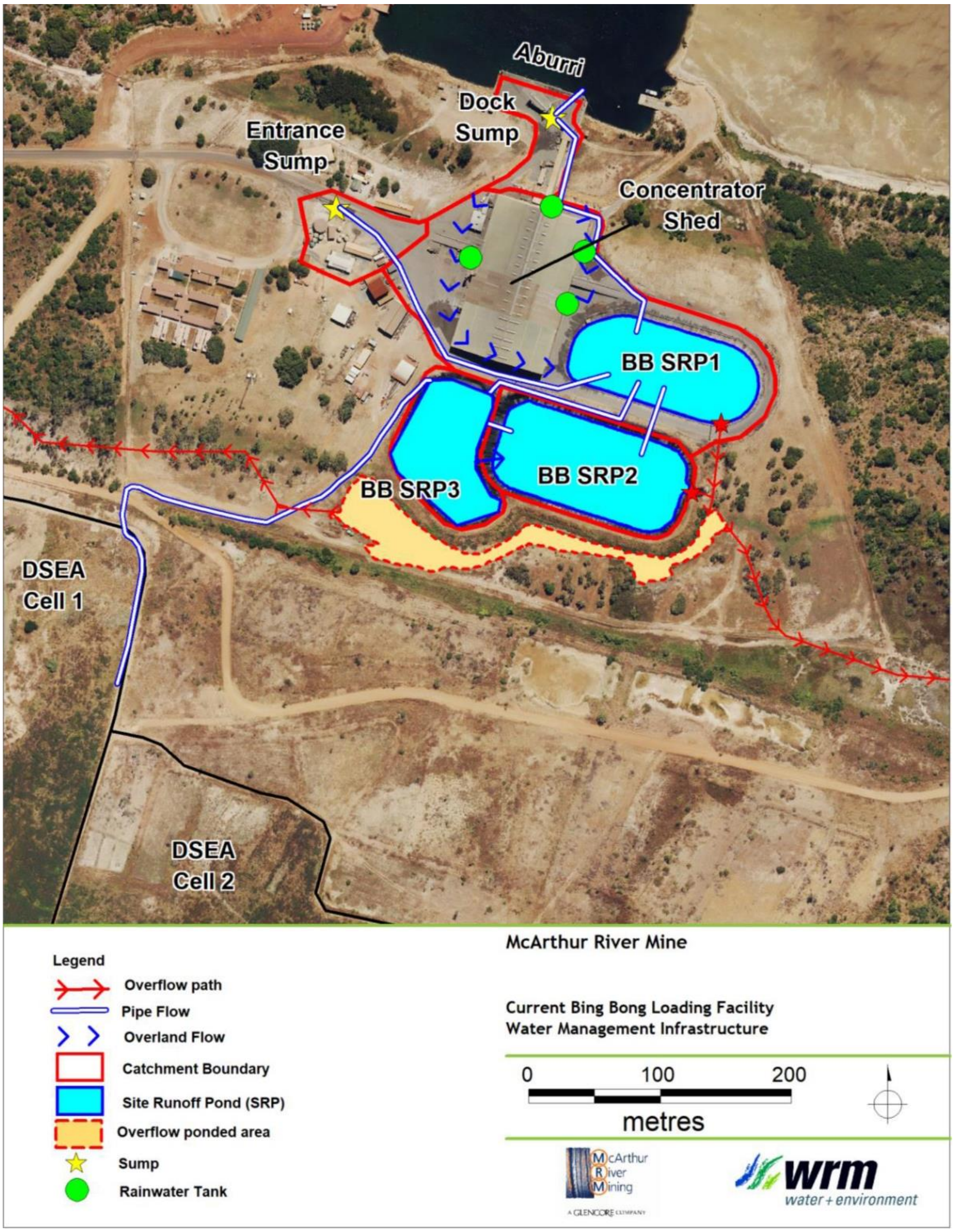


Plate 11: 2019/20 BBLF Water Management Infrastructure

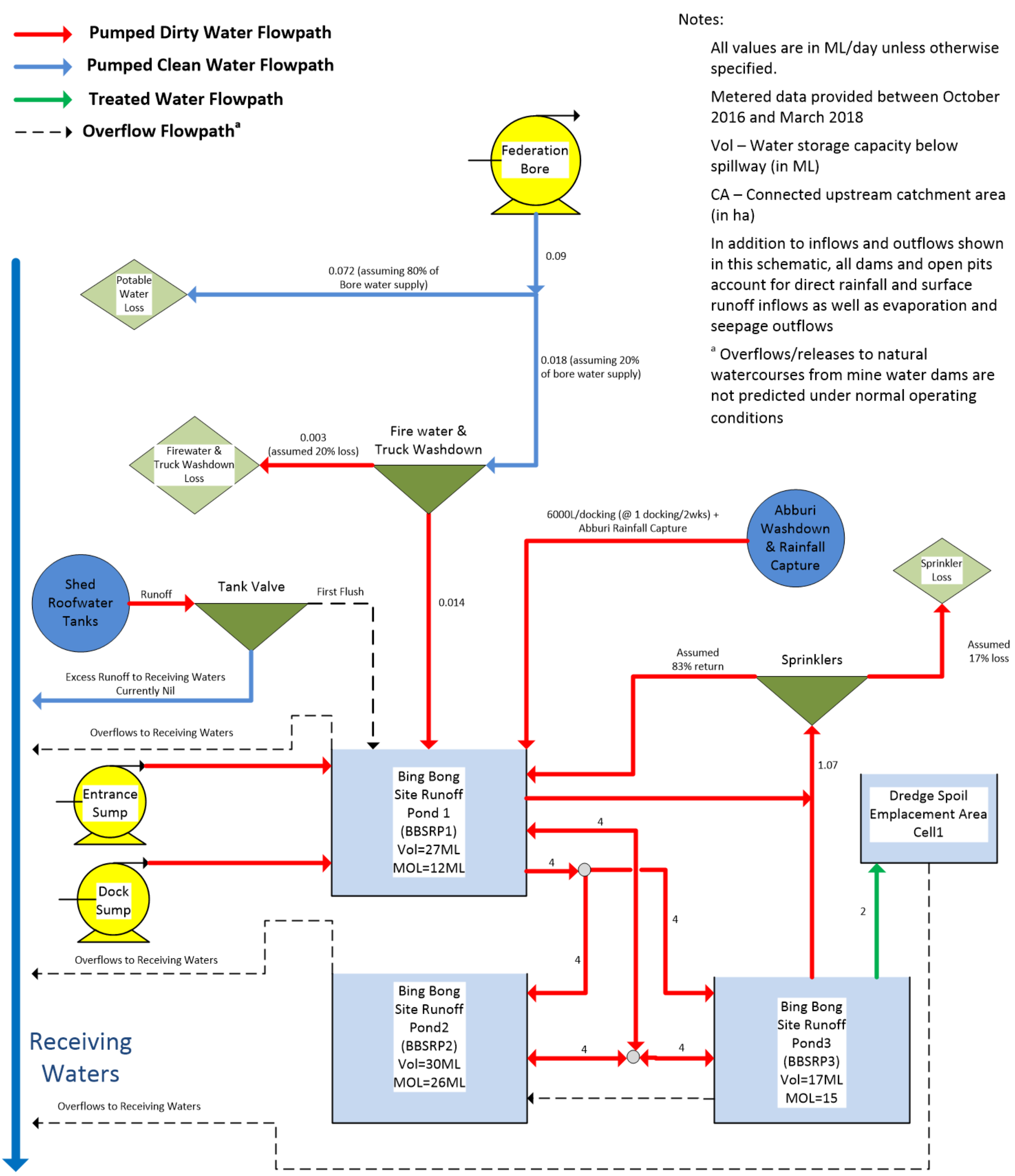


Plate 12: Schematic of 2019/20 BBLF Water Management System

4.2 Surface Water Quality

MRM operates an extensive surface water monitoring program at the Mine and BBLF. Surface water monitoring data for the reporting period, and comparison against historic data for the period 2008 to 2019, has been analysed by KCB.

The *Environmental Monitoring Report 2019/20 - Surface Water* (KCB, 2020a) is provided in Appendix T.

4.2.1 Monitoring Program Overview

The objectives of the surface water monitoring program are to:

- characterise water quality at monitoring sites upstream and downstream of mine operations;
- assess the potential impacts on the receiving waters from mine operations;
- assess the measured surface water quality against site-specific trigger values to verify compliance;
- identify the potential sources of contamination measured at water monitoring sites; and
- assess the efficacy of controls implemented by MRM to prevent contamination of receiving waters downstream of the site in the McArthur River.

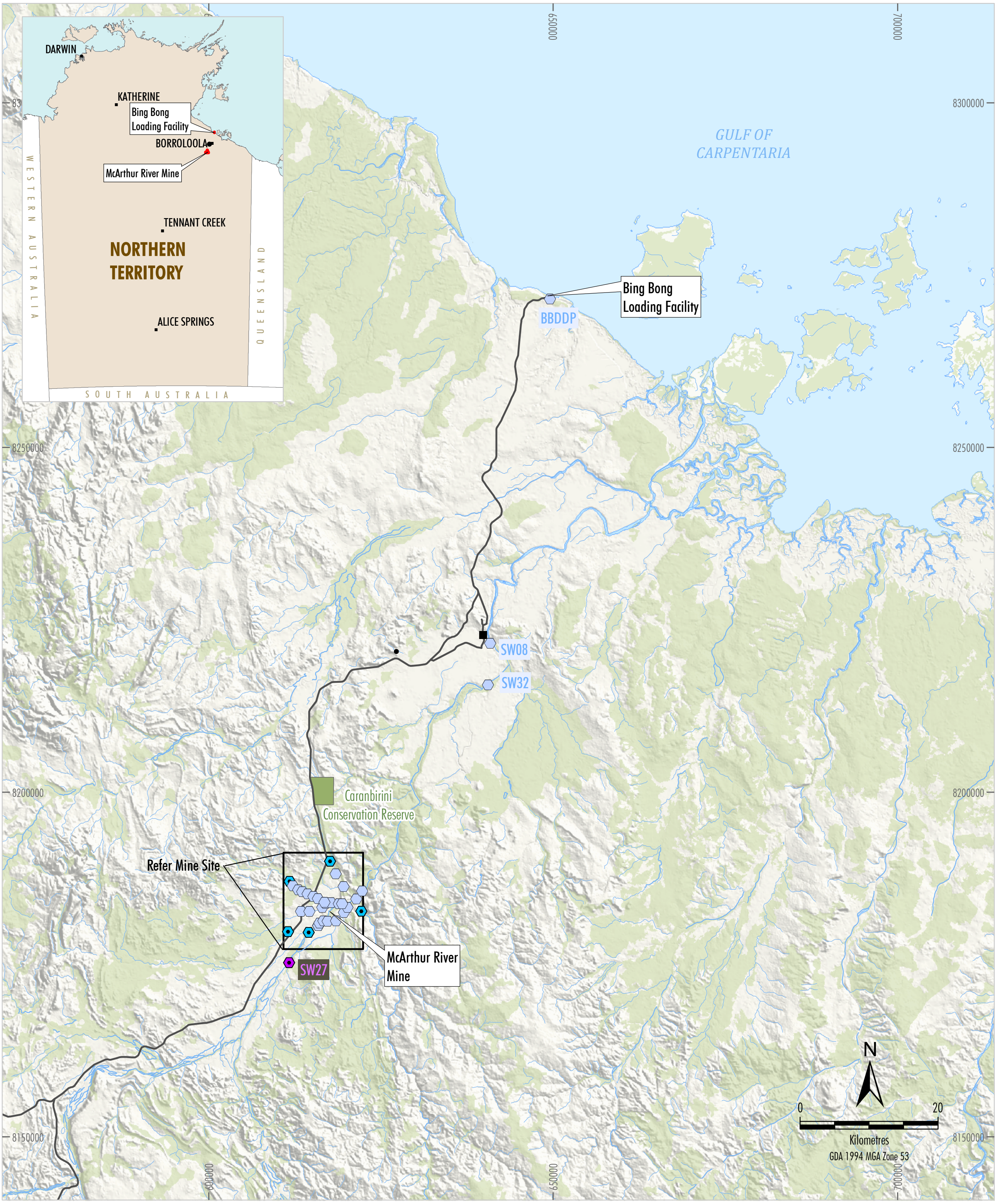
Monitoring Sites

The surface water monitoring network consists of 35 monitoring locations (Table 25) along the McArthur River, Barney Creek, Surprise Creek, Emu Creek and Glyde River, as well as one monitoring location at the BBLF (Figures 30 and 31).

TABLE 25: SURFACE WATER MONITORING PROGRAM OVERVIEW

Catchment	Monitoring Location	Site Type	Location Description
McArthur River	SW27	Upstream	McArthur River, crossing to Merlin Diamond Mine
	SW21	Control	McArthur River, between Merlin crossing and Wurrini Waterhole
	SW10	Potential Impact	McArthur River, Wurrini Waterhole
	SW07	Potential Impact	McArthur River, Djirrinmini Waterhole
	SW13	Potential Impact	McArthur River Diversion Channel, upstream of the crossing
	SW14	Potential Impact	McArthur River Diversion Channel, adjacent viewing platform
	SW15	Potential Impact	McArthur River Diversion Channel, upstream of Bull Creek
	SW16	Potential Impact	McArthur River Diversion Channel, adjacent power line crossing
	SW17	Potential Impact	McArthur River Diversion Channel, upstream of the confluence with Barney Creek
	SW12	Potential Impact	McArthur River, downstream of Barney Creek and Emu Creek and upstream of the Glyde River
	SW11	Potential Impact	McArthur River, 900 m north of the boundary of MLN1122
	SW32	Potential Impact	McArthur River, 6 km upstream of the Burketown causeway
	SW08	Potential Impact	McArthur River, Burketown causeway at Borroloola, 60 km downstream from mine site
Barney Creek	SW28	Control	Barney Creek, south-west of site, adjacent to the Carpentaria Highway

Catchment	Monitoring Location	Site Type	Location Description
	SW04	Potential Impact	Barney Creek, upstream of the Carpentaria Highway bridge
	SW22	Potential Impact	Barney Creek, adjacent MRM camp
	SW03	Potential Impact	Barney Creek, upstream of causeway
	SW18	Potential Impact	Barney Creek Diversion Channel, downstream of Surprise Creek
	SW19	Potential Impact	Barney Creek Diversion Channel, downstream of Haul Road bridge
	SW20	Potential Impact	Barney Creek Diversion Channel, lower reach
	SW06	Potential Impact	Barney Creek, south of Barramundi Dreaming, in the old McArthur River
Surprise Creek	SW29	Control	Surprise Creek, upstream of Tailings Storage Facility
	SW23	Potential Impact	Surprise Creek, upstream of Tailings Storage Facility
	SW01	Potential Impact	Surprise Creek, upstream of crossing
	SW36	Potential Impact	Surprise Creek, adjacent northwest side of Cell 1
	SW33	Potential Impact	Surprise Creek, adjacent Cell 1, at old Surprise Creek pump station
	SW02	Potential Impact	Surprise Creek, downstream of Carpentaria Highway bridge
	SW34	Potential Impact	Surprise Creek, south of the NOEF
	SW24	Potential Impact	Surprise Creek, upstream of confluence with Barney Creek Diversion Channel
Emu Creek	SW30	Control	Emu Creek, north of site, adjacent the Carpentaria Highway
	SW31	Potential Impact	Emu Creek, along cattle exclusion boundary fence.
	SW26	Potential Impact	Emu Creek, upstream of crossing
Glyde River	SW09	Control	Glyde River, upstream of confluence with the McArthur River



LEGEND

- Major Road
- River/Creek
- Control
- Potential Impact
- Upstream

Source: Geoscience Australia - Topography (2006); Department of Environment and Natural Resources (2016); MRM (2020)

McARTHUR RIVER MINE

Regional Surface Water Monitoring Sites

Figure 30

LEGEND

Control

Potential Impact

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2020)

McARTHUR RIVER MINE

Mine Surface Water Monitoring Sites

Figure 31

Upstream control/reference sites (i.e. sites that monitor background concentrations) and downstream sites are located along all local creeks and rivers, as well as the Glyde River (the catchment adjacent to the McArthur River). The monitoring site at the BBLF is located at the authorised discharge point (BBDDP) where the BBLF perimeter drain enters the Gulf of Carpentaria.

Data Collection

Water quality data from the monitoring points is collected generally on a weekly basis, with some additional monitoring undertaken during discharge events. Continuous monitoring is also undertaken for select field parameters at some sites.

Site Conditions over the Reporting Period

Climatic conditions are known to significantly influence the natural environment in the vicinity of the Mine, in particular the McArthur River and its tributaries. Whilst total rainfall over the reporting period was recorded as being above average, the majority of this rain (>97%) fell during the delayed 2019-2020 wet season, with the first significant rainfall occurring on 7 January 2020. As a result, periods of stream connectivity in the main tributaries surrounding the Mine were greatly reduced during the reporting period, compounded by the effects of the 2018-2019 wet season recording the lowest flows and rainfall of any year since 2008 (approximately 200 mm below average). For example, Aquatic Fauna Abundance and Diversity Monitoring was attempted at nine sites along the Barney Creek and Diversion Channel during the late dry season, each of which typically contain aquatic fauna during the early dry season, but all were found to be dry.

WDL Site-specific Trigger Values

Table 26 details authorised monitoring points for the Mine (SW11) and BBLF (BBDDP) as outlined in WDL 174-11, and their associated SSTVs.

Data collected at other monitoring sites is generally consistent with the parameters for which there are SSTVs at SW11, so that background and mine-influenced concentrations can be considered and trends identified (Table 26).

TABLE 26: WDL 174-11 SITE-SPECIFIC TRIGGER VALUES FOR SW11 AND BBDDP

Parameter	Abbreviation	Units	Analysis	SW11 SSTVs*	BBDDP
Field Measurements					
pH	pH	pH Units		6.0-8.5	8.0-8.4[12]
Electrical Conductivity	EC	µS/cm	In situ	1,000[7]	-
Dissolved Oxygen	DO	% saturation		85-120	-
Metals and Metalloids					
Aluminium	Al			55[1]	0.5[10]
Arsenic	As			24[1]	2.3[10]
Cadmium	Cd			1.73[3]	5.5[1]
Copper	Cu			10.97[2]	1.3[11]
Iron	Fe			300[3]	
Lead	Pb	µg/L	Filtered (0.45 µg/L)	16.6[4]	4.4[11]
Manganese	Mn			1,900[1]	80[3]
Mercury	Hg			0.6[1]	0.4[1]
Nickel	Ni			11[1]	70[1]
Zinc	Zn			62.68[2]	15[11]
Total Petroleum Hydrocarbons (TPH)					
TPH Fraction $C_6 – C_9$	N/A				
Benzene	N/A			950[13]	500[13]
TPH Fraction $C_{10} – C_{14}$	N/A	µg/L			
$C_{15} – C_{28}$	N/A			600[5]	600[9]
$C_{29} – C_{36}$	N/A				
Other					
Sulphate	SO_4	mg/L	-	341[6]	-
Nitrate	NO_3	µg/L	-	700[8]	-

Trigger Value Derivation (reproduced from WDL Condition 20):

* *SSTVs are applicable to filtered samples for metals and metalloids.*

1. *ANZECC 2000 95% TV Table 3.4.1.*
2. *Hardness Modified Trigger Value (HMTV) from the MRM Sustainability Development Water Management Plan 2010-2011.*
3. *ANZECC 2000 interim indicative working level.*
4. *TV approved by Administering Agency 2010.*
5. *Based on the aqueous solubility of mineral oils and as found in the document Intervention Value outlined in the Environmental Quality Objectives in the Netherlands (1994).*
6. *Calculated on the 80th percentile. Hydrobiology (2012) Sulphate Trigger Value for MRM Mine: 2012 prepared by McArthur River Mining.*
7. *TV approved by Administering Agency 2012.*
8. *ANZECC 2000 Moderate Reliability Trigger Value.*
9. *TV approved by Administering Agency 2013.*
10. *ANZECC 2000 Environmental concern level/indicative interim working level. Metals and Metalloids Chapter 8.3.7.1.*
11. *ANZECC 2000 High Reliability 95% Trigger Value. Metals and Metalloids Chapter 8.3.7.1.*
12. *ANZECC 2000 Default Trigger Values – Tropical Australia Table 3.3.4.*
13. *ANZECC 2000 Moderate Reliability 95% Trigger Value. Aromatic Hydrocarbons – Chapter 8.3.7.7 Table 8.3.14.*

4.2.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

The changes to the surface water monitoring program included:

- Laboratory Full ICP-MS Scan was removed for natural surface water monitoring sites and total metal concentrations analysis was removed for artificial surface water monitoring sites as they are no longer a requirement in WDL 174-11.
- SW10 located on the McArthur River (upstream of the Mine) was added to the monitoring schedule. This site is a potential refuge pool for the EPBC-listed Freshwater Sawfish.

4.2.3 Performance during the Reporting Period

Based on the findings of KCB (2020a), comparison of the monitoring results against the objectives of the monitoring program is provided below.

Comparison to Site-specific Trigger Values

KCB (2020a) analysed monitoring data from SW11 against the WDL SSTVs (Table 26). Sampling at SW11 occurs regardless of whether authorised discharge is occurring (except in times of no flow at SW11). The SSTVs are compared to water quality monitoring results for SW11. Where a result was elevated beyond an SSTV pursuant to Condition 39 of WDL 174 11, an investigation report was documented by MRM and submitted to the NT DENR.

The BBDDP receives water that is passively discharged via the dredge spoil drain, which intercepts runoff from the Bing Bong Spoil Emplacement Area. Sampling at BBDDP occurs whenever flow is present (regardless of whether rainfall has occurred) and can receive tidal water. No dredging has occurred in the swing basin since 2013.

McArthur River – Monitoring Results

A summary of the performance at the authorised monitoring site SW11 against the WDL 174-11 SSTVs is provided below, with reference to upstream sites (including the Glyde River) where relevant.

McArthur River - pH

Field pH is presented in Chart 26 for the reporting period. Measured pH values during the reporting period are generally consistent with the range of historical values. Decreases in pH are observed from January onwards, coinciding with periods of heavy rainfall. The lowest pH values were observed in the upstream monitoring location SW27, which is outside of the influence of the Mine.

There were no recorded results beyond the SSTV at SW11.

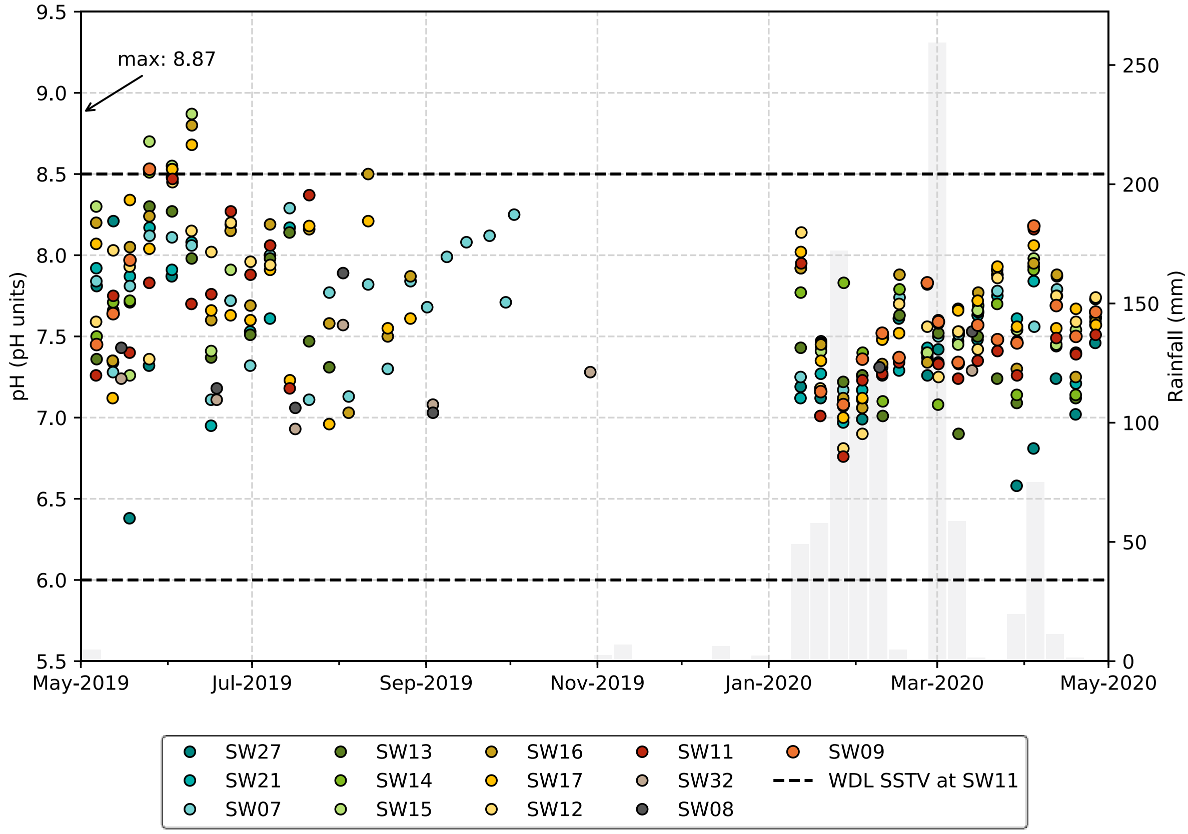


Chart 26: Reporting Period pH and Weekly Rainfall – McArthur River and Glyde River Monitoring Sites

McArthur River - Electrical Conductivity

Chart 27 presents the EC (laboratory-measured) for the reporting period. The monitoring results show an increasing trend as the dry season progresses as a result of evaporation and reduced flow volumes, and a higher contribution from groundwater expressing as surface water baseflow. Rapid decreases in EC occur as a result of the dilution provided by rainfall events from January 2020 onwards for all sites. The reporting period trends are consistent with the historical data.

There were no recorded results beyond the EC SSTV at SW11 during the reporting period.

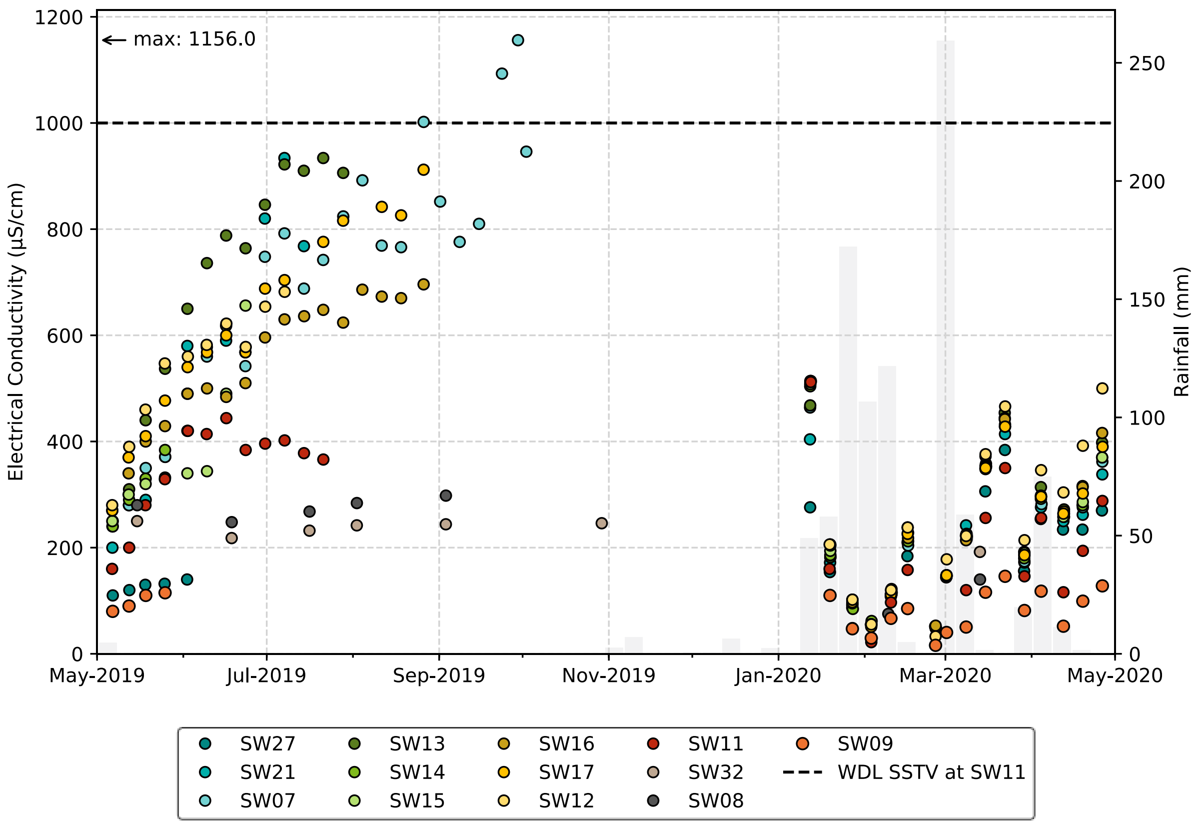


Chart 27: Reporting Period Electrical Conductivity and Weekly Rainfall – McArthur River and Glyde River Monitoring Sites

McArthur River - Sulphate

SO_4 concentrations show a similar trend to EC during the reporting period (Chart 28), with the highest concentrations recorded at SW17, downstream of the natural mineralisation present in the McArthur River Diversion Channel. Rising concentrations are recorded during the dry season, with fluctuations associated with rainfall events. The concentrations monitored during the reporting period are consistent with historical concentrations.

There were no results beyond the SO_4 SSTV at SW11 during the reporting period.

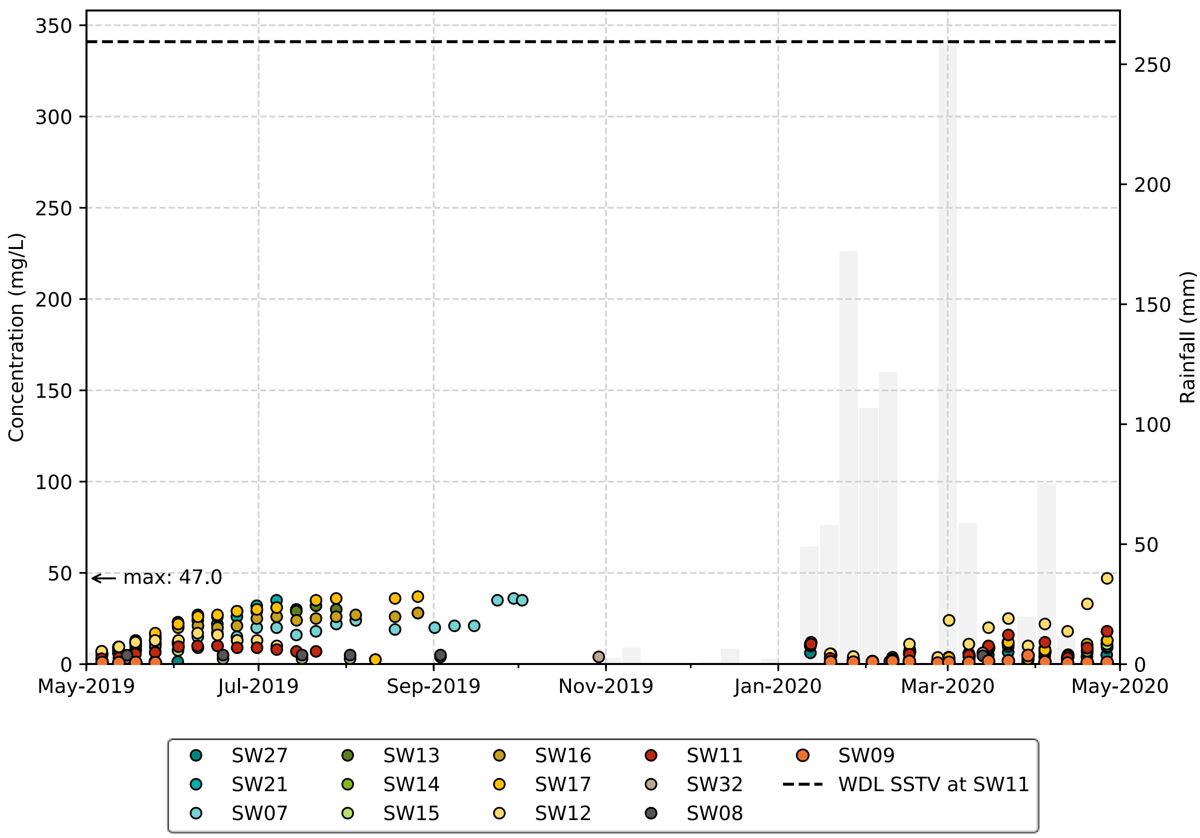


Chart 28: Reporting Period Sulphate (Filtered) and Weekly Rainfall – McArthur River and Glyde River Monitoring Sites

McArthur River - Nitrate

NO_3 concentrations are presented in Chart 29 for the reporting period. Fluctuations are observed across the majority of sites from January 2020, after which the majority of the wet season rainfall occurred.

In the reporting period, there were 11 investigation reports related to elevated results beyond the NO_3 SSTVs at SW11 submitted to NT DENR, as required by WDL 174-11. Elevated results beyond the NO_3 SSTV have occurred during most previous years since 2010. As in previous years, similar NO_3 concentrations were also observed at the Glyde River monitoring location SW09, and at SW12, but at no/few other sites. On July 1 2019, MRM undertook a high-resolution sampling campaign to more precisely determine the source of the nitrate. Water samples were collected at 100 m intervals along the Glyde River between SW09 and SW11, and along the McArthur River between SW12 and the confluence with the Glyde River. The findings indicate that the greatest NO_3 concentrations occur along the Glyde River, approximately 1 km upstream of the confluence with the McArthur River and downstream of the Glyde River monitoring location SW09 (refer Figure 32). Therefore, it is considered that the Glyde River catchment has influenced NO_3 concentrations downstream at SW11, with results beyond the SSTV determined to be unrelated to mining activities.

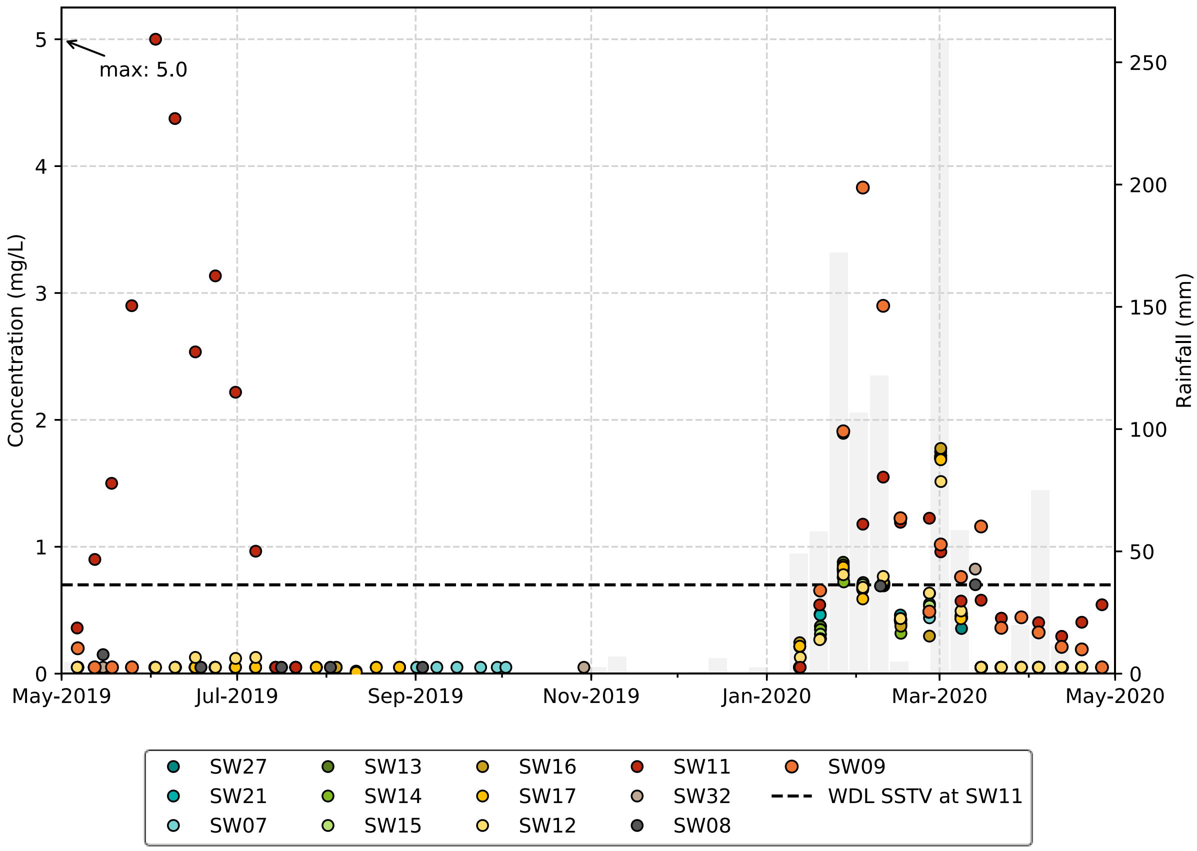


Chart 29: Reporting Period Nitrate and Weekly Rainfall – McArthur River and Glyde River Monitoring Sites

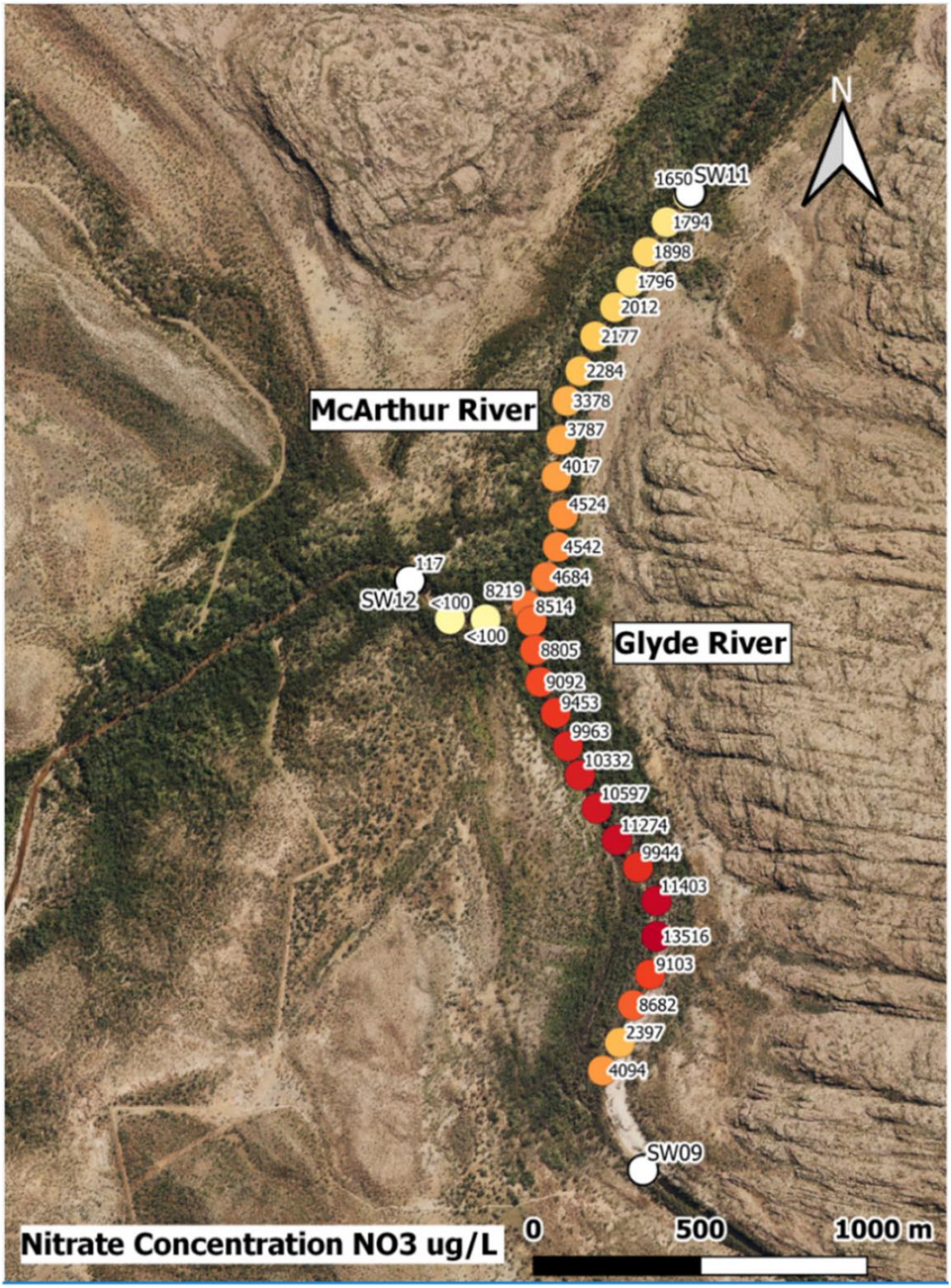


Figure 32 NO_3 Concentrations Recorded by High-Resolution Sampling Upstream of SW11

McArthur River - Dissolved Oxygen

Chart 30 presents the field DO measurements for the reporting period. The monitoring results are consistent with the ranges observed in the historical dataset.

There were three results beyond the DO SSTV during the reporting period at SW11, which were below the lower SSTV limit of 85% saturation. The elevated results generally relate to either high-flow events at the beginning of the wet season, or potentially large amounts of organic material suspended in the water, or high sediment load, all of which can affect DO concentration. The results beyond the SSTV are considered to be non-mine related. None of the three results beyond the DO SSTV triggered an investigation in accordance with Conditions 38 and 39 of WDL 174-11.

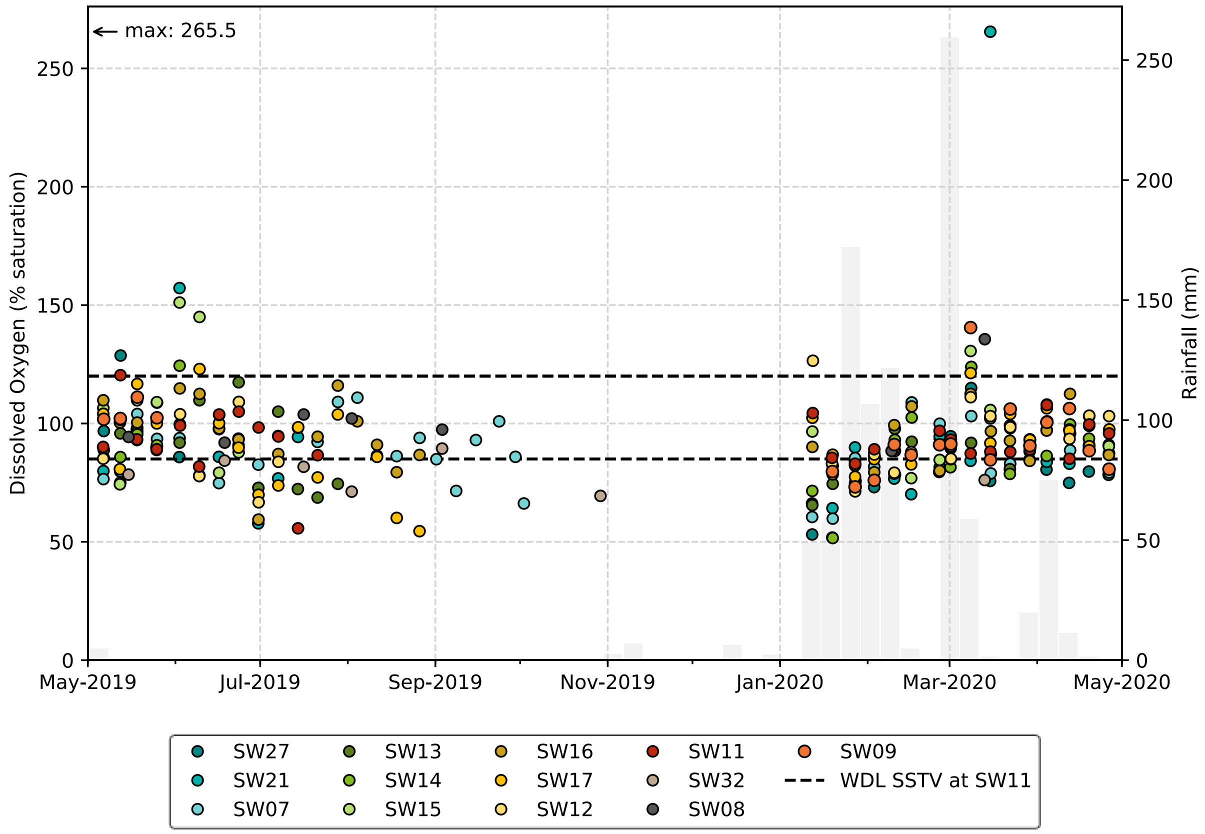


Chart 30: Reporting Period Dissolved Oxygen and Weekly Rainfall – McArthur River and Glyde River Monitoring Sites

McArthur River - Metals and Metalloids

Concentrations of filtered Zn are presented in Chart 31. Concentrations measured throughout the reporting period are within the range of historical concentrations. There were no results beyond the SSTV at SW11 for filtered Zn during the reporting period.

Concentrations of filtered Pb are presented in Chart 32. Low concentrations were recorded throughout, with many samples' concentrations below the limit of detection, consistent with the historical data. There were no results beyond the SSTV for filtered Pb at SW11 during the reporting period.

Concentrations of filtered Al are presented in Chart 33. Consistently low concentrations were recorded during the dry season, and higher concentrations were recorded during the wet season. Spikes in filtered Al, of similar concentration, are observed in the historical data, also coinciding with periods of high rainfall. The highest concentrations during the reporting period occurred following the January to March 2020 rainfall events. An increase in concentrations was recorded at all monitoring locations, including the upstream and control sites, which suggests a significant source of filtered Al in the McArthur River catchment, upstream of the Mine. There were five incidences of elevated filtered Al beyond the SSTV at SW11 occurred during the reporting period, with one investigation report submitted to NT DENR, as required by WDL 174-11. All filtered Al results beyond the SSTV were determined to be non-mine related.

Concentrations of filtered Fe are presented in Chart 34. Filtered Fe concentrations were generally stable through the dry season (with the exception of SW11 and SW09), with fluctuations through the wet season associated with the rainfall events. The data for the reporting period is generally consistent with historical data, with some exceptions slightly higher than historical data. Three consecutive results of filtered Fe beyond the SSTV at SW11 were recorded during the reporting period, requiring an investigation report to be submitted to NT DENR under WDL 174-11. No active discharge was occurring at the time of the elevated results, and they are considered non-mine related. Consistent with previous years, at the time of the results beyond the SSTV, Fe concentrations were also elevated at SW09, on the Glyde River, which indicates there is an influence from the Glyde River catchment on water quality at SW11.

There were no elevated results beyond the SW11 SSTVs over the reporting period for arsenic, cadmium, copper, lead, manganese, mercury, nickel or zinc, consistent with the historical data.

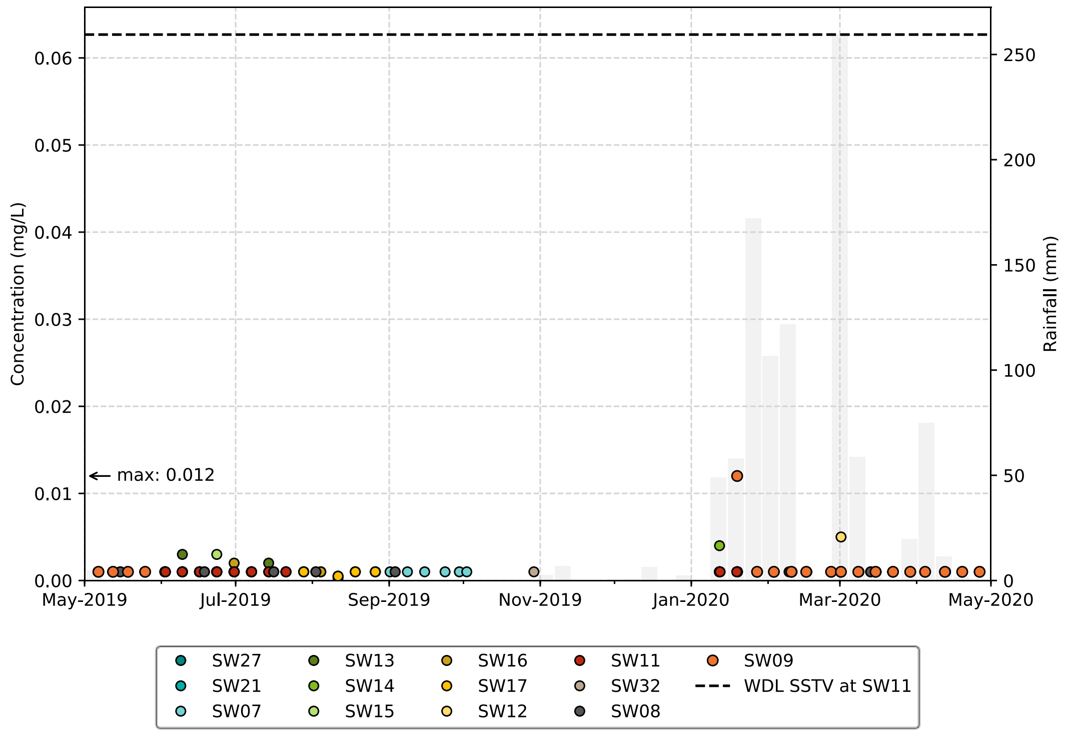


Chart 31: Reporting Period Zinc (Filtered) and Weekly Rainfall – McArthur River and Glyde River Monitoring Sites

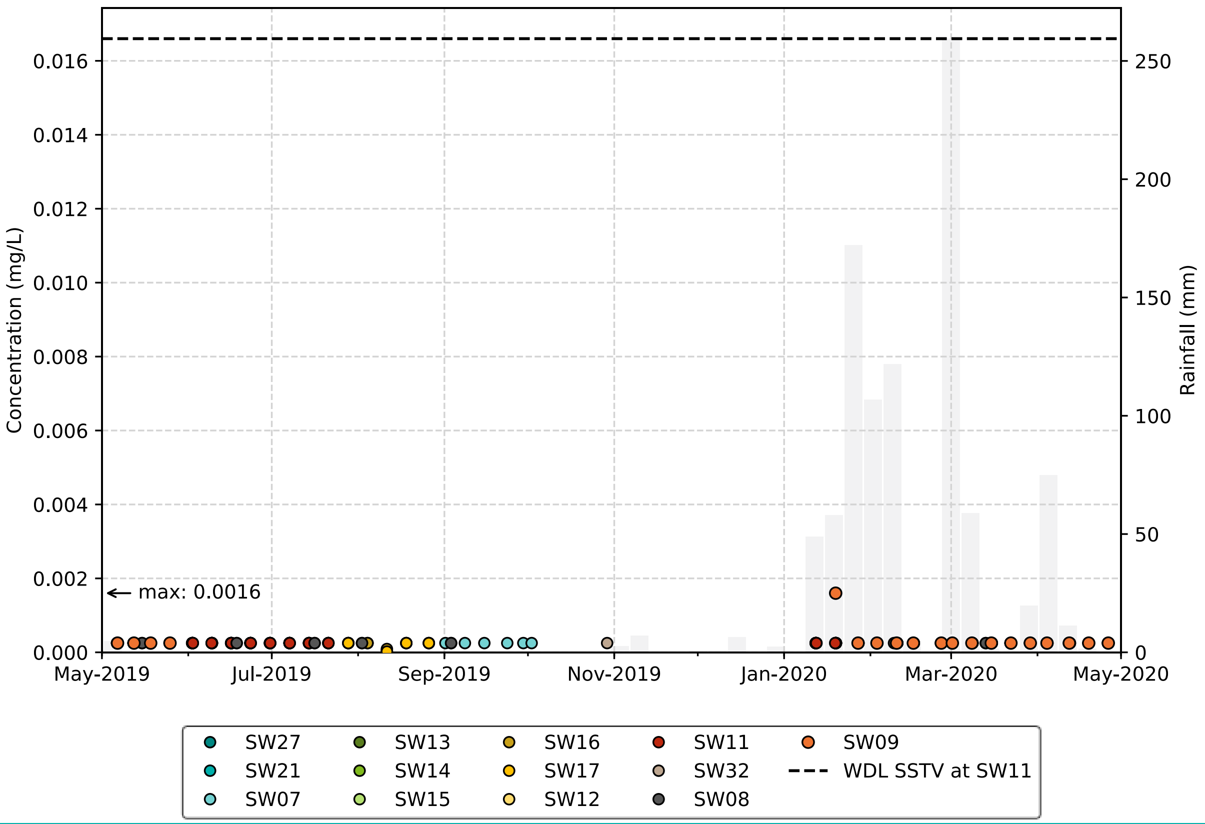


Chart 32: Reporting Period Lead (Filtered) and Weekly Rainfall – McArthur River and Glyde River Monitoring Sites

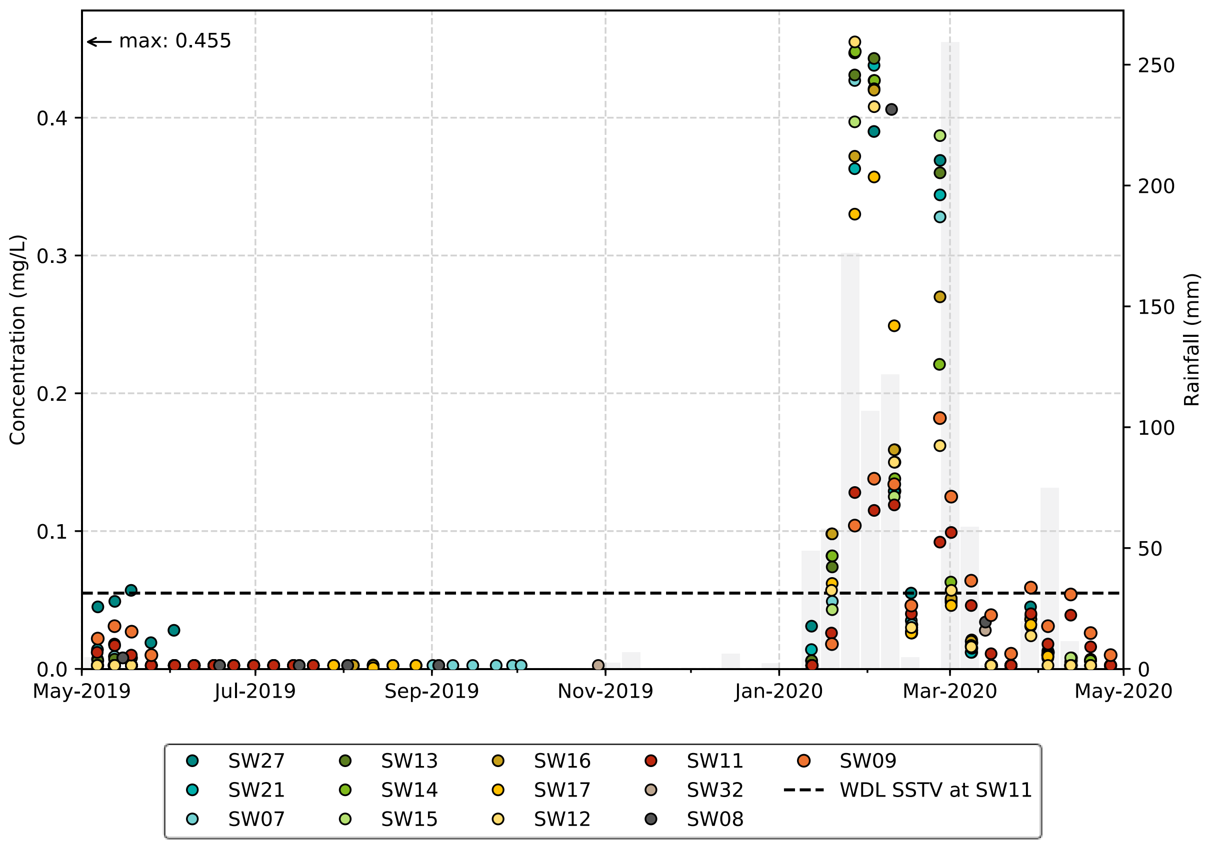


Chart 33: Reporting Period Aluminium (filtered) and Weekly Rainfall – McArthur River and Glyde River Monitoring Sites

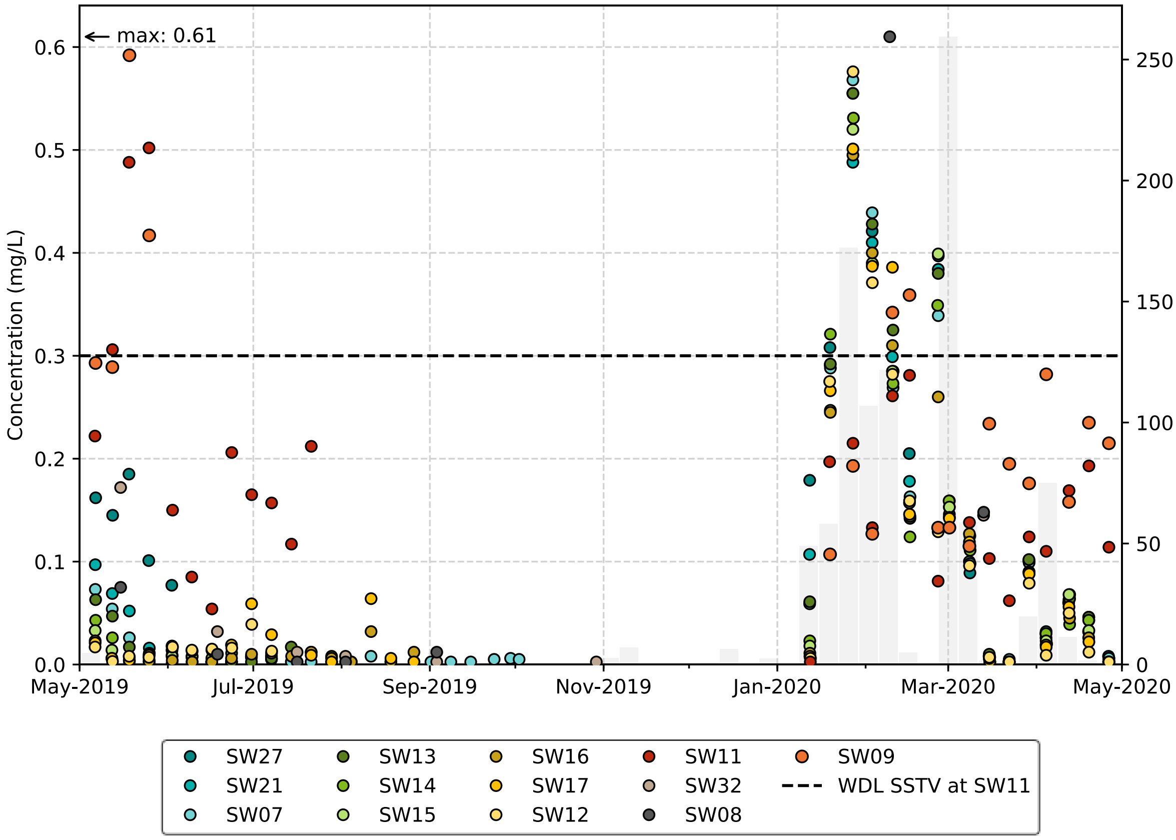


Chart 34: Reporting Period Iron (filtered) and Weekly Rainfall – McArthur River and Glyde River Monitoring Sites

McArthur River - Total Petroleum Hydrocarbons

All hydrocarbon results at SW11 for the reporting period were below the limit of reporting with no elevated results beyond the SW11 SSTV for benzene, TPH fraction C_{10}-C_{36}, C_{15}-C_{28} and C_{29}-C_{36}.

Barney Creek

Barney Creek is an ephemeral stream that is naturally dry for part of the year. The ephemeral nature of Barney Creek causes some monitoring results to be skewed due to an effect known as "evapo-concentration", which increases the perceived concentration of analytes as a result of the water evaporating.

During the current reporting period, there was no, or limited, flow through Barney Creek until a large rainfall event in January 2020. A total of 95 samples were collected from the Barney Creek monitoring locations from January 2020 onwards once flows resumed.

A review of key parameters is provided below for the reporting period. The performance for other parameters at sites along Barney Creek is detailed in KCB (2020a).

Barney Creek – Lead

A summary of the average and maximum filtered lead concentrations measured at key sites along Barney Creek is given in Table 27.

TABLE 27: COMPARISON OF MONITORING RESULTS FOR FILTERED LEAD IN BARNEY CREEK FOR THE CURRENT AND PREVIOUS REPORTING PERIODS

Monitoring Location	Average Filtered Lead Concentration (mg/L)			Maximum Filtered Lead Concentration (mg/L)		
	April 2018 – April 2019	May 2019 – April 2020	Difference	April 2018 – April 2019	May 2019 – April 2020	Difference
SW28	0.00071	0.00028	-0.00043	0.00150	0.00050	-0.00100
SW03[1]	0.00025	0.00057	0.00032	0.00025	0.00130	0.00105
SW19	0.00247	0.00031	-0.00216	0.00509	0.00070	-0.00439
SW20	0.00028	0.00033	0.00005	0.00055	0.00080	0.00025
SW06	0.00030	0.00028	-0.00002	0.00110	0.00070	-0.00040

[1] Note that the Limit of Detection for lead is 0.00025 mg/L, and any monitoring results lower than this value will be reported as the limit.

A review of the data presented in Table 27 indicates that the monitoring site with highest concentration of filtered lead within the Barney Creek in the previous reporting period (SW19 – located next to the Barney Creek Bridge in between the Open Pit and the NOEF) had a significantly lower maximum and average concentration during the current reporting period. During the reporting period, pH remained within the neutral to slightly alkaline range, with a slight decrease coinciding with the February 2020 rainfall events.

An increase in EC and SO_4 is observed downstream of the confluence with Surprise Creek.

Filtered Zn concentrations generally fluctuated following rainfall events, with SW19 experiencing the greatest fluctuations.

The concentrations monitored for all analytes during the reporting period were consistent with historical observations.

Surprise Creek

A review of key parameters is provided below for the reporting period. The performance for other parameters at sites along Surprise Creek is detailed in KCB (2020a).

A total of 114 samples were collected during the reporting period from the eight Surprise Creek monitoring locations. With the exception of three samples collected at SW36 in May 2019, all samples were collected from January 2020 onwards once flows resumed in Surprise Creek.

Circumneutral pH conditions were recorded along Surprise Creek.

Both EC and SO_4 present a similar response during the reporting period. The highest concentrations were recorded at SW36 in May 2019 prior to flow ceasing in the creek. This monitoring location is adjacent to the TSF and concentrations are influenced by TSF seepage. In general, once flows resumed, an increasing trend was observed at SW33, SW02 and SW34 located adjacent and downstream of the TSF.

The data indicates relatively low filtered Zn concentrations.

The concentrations monitored for all analytes during the reporting period were consistent with historical observations.

Emu Creek

A total of 40 samples were collected from the three Emu Creek monitoring locations. All samples were collected from January 2020 onwards once flows resumed in Emu Creek.

Circumneutral pH conditions were recorded across the three sites for the reporting period, with a slight increasing trend observed.

Results for EC, SO_4 and Zn were slightly higher at the downstream site on Emu Creek, SW26, compared to the two upstream sites (SW30 and SW31). SW26 is located east of a major structural geological boundary. These higher concentrations generally occurred following rainfall events.

The concentrations monitored for all analytes during the reporting period were consistent with historical observations.

Bing Bong Loading Facility Observations

No active dredging occurred during the reporting period and, therefore, weekly sampling was not required. BBDDP was inspected on a monthly basis for flow in accordance with WDL 174-11; however, due to the limited wet season, no flow was observed, and no samples were taken. Accordingly, there are no data for BBDDP in this report.

Performance Against the Compliance Point Triggers

In the reporting period, there were 11 investigation reports related to elevated results beyond SSTVs at SW11 submitted to NT DENR, as required by WDL 174-11. The investigation reports related to exceedance of the SSTVs for water quality parameters filtered Al, filtered Fe and NO_3.

The analyte results beyond the SSTVs were all attributable to natural processes and all were deemed non-mine related. No results were beyond the SSTV for the BBDDP over the reporting period as no flow was observed (i.e. no samples were collected).

TABLE 28: REVIEW OF ANALYTE RESULTS AGAINST WDL-174-11 SSTVS

Site	Analyte Result at SW11				Elevated Result Related to Active Discharge?	Elevated Result Triggering Investigation Report?	Investigation Report Confirms Elevated Result is from MRM Operations?
Quality Parameter	DO	Al_F	Fe_F	NO_3			
	% sat	µg/L	µg/L	µg/L			
SSTV	85 - 120	55	300	700			
May 12, 2019			306	900	No	No	No
May 18, 2019			488	1,500	No	No	No
May 25, 2019			502	2,900	No	Yes (Fe_F and NO_3)	No
June 2, 2019				5,000	No	Yes (NO_3)	No
June 9, 2019	81.8			4,375	No	Yes (NO_3)	No
June 16, 2019				2,536	No	Yes (NO_3)	No
June 23, 2019				3,135	No	Yes (NO_3)	No
June 30, 2019				2,218	No	Yes (NO_3)	No
July 7, 2019				965	No	Yes (NO_3)	No
July 14, 2019	55.7				No	No	No
January 27, 2020	83.0	128		1,894	No	No	No
February 3, 2020		115		1,178	No	No	No
February 10, 2020		119		1,549	No	Yes (Al_F and NO_3)	No
February 16, 2020				1,193	No	Yes (NO_3)	No
February 26, 2020		92		1,225	No	Yes (NO_3)	No
March 1, 2020		99		960	No	Yes (NO_3)	No

4.2.4 Non-conformances, Corrective Actions and Improvements

This review of surface water quality monitoring data collected between May 1, 2019 and April 30, 2020 indicates that the overwhelming majority of monitoring records indicate the water quality at SW11 remains within the limits defined by MRM's WDL 174-11.

There were no results beyond the SSTVs for the key metals of concern filtered zinc, lead, cadmium and arsenic at SW11 during the monitoring period. Sulphate concentrations have historically been recorded higher than the SSTV (341 mg/L), but have improved in recent years, with no results recorded beyond the SSTV since 2015.

The results beyond the SSTVs at SW11 identified during this monitoring period are not considered to be related to mining activities. Monitoring data indicate that they originate upstream of the mine (in the case of filtered aluminium or filtered iron) or in the neighbouring Glyde River catchment (in the case of nitrate).

No other non-conformances relating to downstream surface water quality were identified by KCB (2020a).

4.2.5 Changes for the Next Reporting Period

Surface water quality monitoring will be undertaken in accordance with the Water Management Plan, once approved.

4.3 Groundwater Quality and Levels

MRM operates an extensive groundwater monitoring program targeting the major hydrostratigraphic units in the vicinity of the identified sources of potential contaminants of concern, along the identified pathways and in the vicinity of surface water.

Groundwater monitoring data for the reporting period has been analysed by Pando (2020a) and is presented in the *McArthur River Mine Groundwater Annual Environmental Monitoring Report 2019/20* (Appendix U).

4.3.1 Monitoring Program Overview

The objectives of the groundwater monitoring program are to:

- characterise water quality at monitoring sites upstream of Mine operations and in zones of natural mineralisation;
- identify adverse or unexpected trends in groundwater quality that may harm the receiving beneficial uses and community values;
- assess measured groundwater quality against predicted groundwater impacts;
- validate the source – pathway – receptor model; and
- assess the efficacy of controls implemented by MRM to prevent contamination from the sources identified.

Monitoring Sites

The current groundwater monitoring network consists of over 300 groundwater monitoring bores as shown in Figures 33 and 34.

Data Collection

Groundwater sampling is typically undertaken quarterly. Groundwater level data is collected manually at each bore using a water level meter prior to commencing groundwater sampling.

The analytical suite monitored at the groundwater monitoring sites at the Mine and BBLF over the reporting period is listed in Table 29.

Continuous groundwater levels are recorded with data loggers deployed in approximately 150 monitoring bores across the site. Groundwater levels are also recorded at over 50 vibrating wire piezometers (VWPs).

TABLE 29: GROUNDWATER QUALITY ANALYTE SUITE

Category	Analytes		
Physico-chemical Parameters	pH EC Dissolved oxygen Temperature Oxidation reduction potential Turbidity Total dissolved solids	Sulphate (SO_4) Calcium (Ca) Magnesium (Mg) Sodium (Na) Potassium (K) Fluoride (F) Chloride (Cl)	Bromide (Br) Nitrate (NO_3), Ammonia (NH_3) Total nitrogen (N) Total phosphorous (P) Hardness Alkalinity
Metals and Metalloids	Aluminium (Al) Antimony (Sb) Arsenic (As) Barium (Ba) Beryllium (Be) Boron (B) Bismuth (Bi) Cadmium (Cd)	Chromium (Cr) Cobalt (Co) Copper (Cu) Nickel (Ni) Iron (Fe) Lead (Pb) Manganese (Mn) Mercury (Hg)	Molybdenum (Mo) Selenium (Se) Silver (Ag) Thallium (Tl) Uranium (U) Vanadium (V) Zinc (Zn)
Hydrocarbons[1]	Benzene	Total petroleum hydrocarbons (TPH) (C_6-C_{36})	

[1] Monitored at select sites.

Djirrinmini Waterhole

The Djirrinmini Waterhole is a permanent pool on the McArthur River located approximately 1 km upstream of the Mine site. The Djirrinmini Waterhole is supported by stream flow during the wet season and by groundwater recharge from the weathered bedrock and alluvial aquifers during the dry season.

Drawdown predictions were made in the OMP EIS, which predict a maximum drawdown of up to 0.4 m in the overburden and weathered bedrock aquifer and of up to 0.65 m in the fresh bedrock aquifer beneath and adjacent to the Djirrinmini Waterhole. An environmental objective relating to groundwater is to maintain a positive groundwater head to the waterhole.

Other Receptors

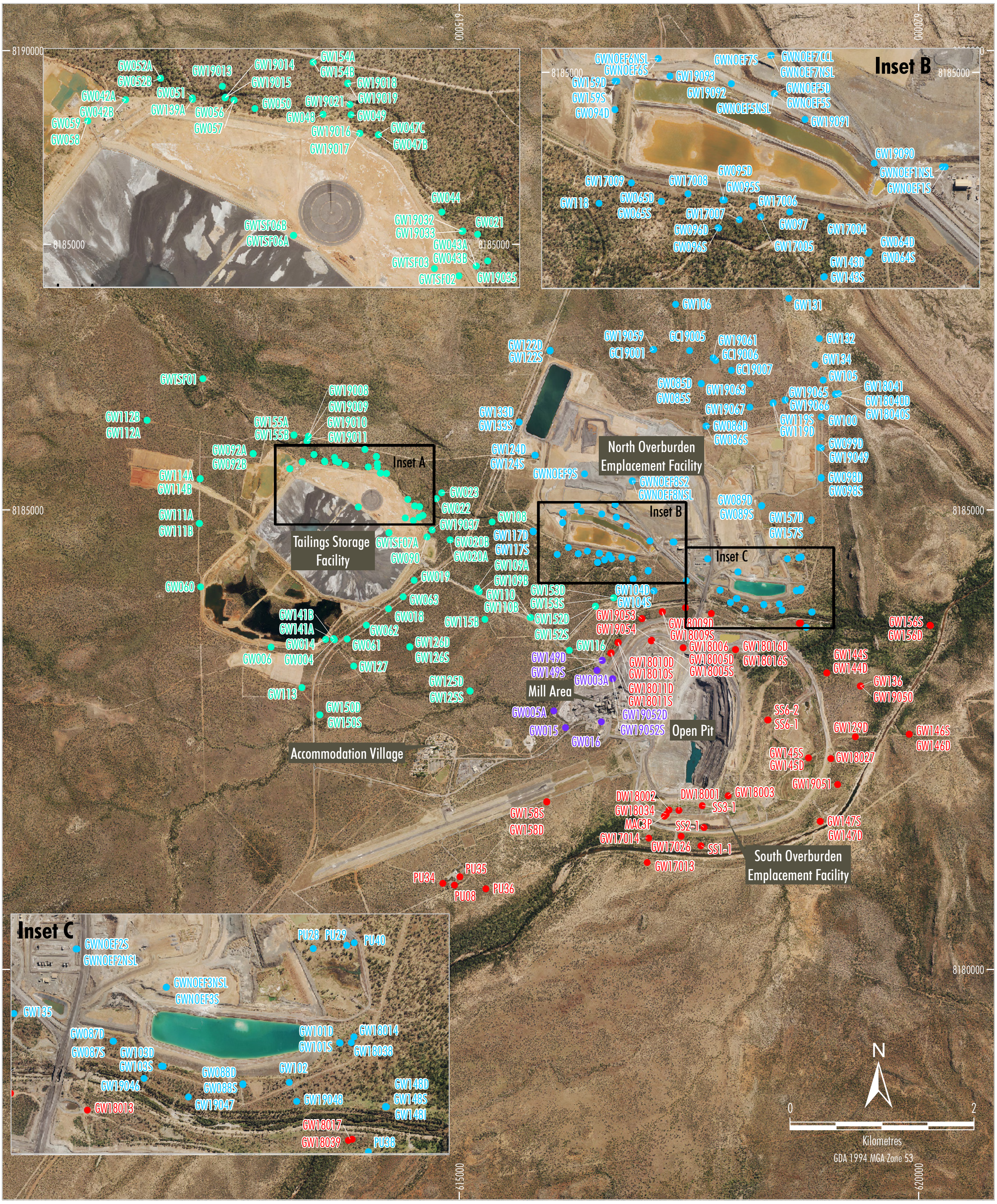
There are no environmental values for aquaculture, public water supply, agricultural supply, domestic use or industrial use relevant to groundwater in the mineral leases. There is stock watering in the wider region; however, there are no registered bores that are used for stock watering purposes in the vicinity of the Mine.

Water supply bores in the vicinity of the Mine are owned and operated by MRM.

4.3.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

Minor changes to the sampling frequency of a number of existing monitoring bores were applied during the reporting period following the yearly review of the groundwater monitoring program.

Thirty-five groundwater monitoring bores were decommissioned during the reporting period due to approved construction activities. Details of the decommissioned monitoring bores are included in *2019 Hydrogeological Drilling and Field Campaign* report (MRM, 2020d).



LEGEND

- Mine and Mill Process Area
- Mine Area
- NOEF Monitoring Site
- TSF Monitoring Site

McARTHUR RIVER MINE

Mine Groundwater Monitoring Sites

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2020)

Figure 33

LEGEND

● Bing Bong Loading Facility Area

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2020)

McARTHUR RIVER MINE

Bing Bong Loading Facility Groundwater Monitoring Sites

Figure 34

MRM-16-01_EMR2020_242A

A number of monitoring locations were installed during the reporting period, including:

- forty monitoring bores (including monitoring bores to inform the performance of the TSF Seepage Interception Trench and to refine the groundwater – surface water interactions); and
- two VWPs sites with two sensors installed at each site.

4.3.3 Performance during the Reporting Period – Groundwater Levels

Groundwater Level Trend Analysis

Groundwater levels were analysed for temporal trends using Mann-Kendall trend analyses for both the dry and the wet season (Pando, 2020a).

Groundwater levels generally respond to rainfall events and surface water levels (for bores in proximity of the watercourses), with seasonal recharge evident at most bores. Mann-Kendall trend analyses indicate an overall decrease in levels for both the dry and wet seasons at the majority of bores relating to below average rainfall conditions experienced over the recent years.

Long-term increasing groundwater levels were recorded at some monitoring bores and are attributed to proximity to an additional recharge source (e.g. SS31 – McArthur River palaeochannel), to proximity to a potential seepage source (e.g. GW102 – SEPROD and GW060 – TSF WMD), and to a decrease in abstraction volumes of nearby production bore fields (e.g. GW105 – Emu bore field).

Djirrinmini Waterhole Groundwater Levels

Bores adjacent to Djirrinmini waterhole, GW073 to GW077, showed strong seasonal responses. The bores surrounding Djirrinmini waterhole continued to experience a long-term decrease in groundwater levels for the dry and the wet seasons since monitoring began. This is largely the result of drier conditions in the last two years, suggesting that the groundwater levels have not been affected by the nearby MIMEX borefield, the Open Pit, or other mining activities.

The groundwater levels for bores GW073 to GW077 were reviewed against the bore specific leading indicators as detailed in the WMP (MRM, 2020e) (Plate 13). Based on the available data, all groundwater levels remained above the critical limit, with bores GW074, GW075 and GW077 recording some readings between the normal and control limits. No additional controls or management actions were therefore required based on MRM's Adaptive Management Plan and respective TARP (MRM, 2020b).

Groundwater Levels Spatial Patterns

Groundwater elevation contour maps are provided in Plate 14 for a sustained dry period (October 2019) and for a peak wet period (end of February 2020).

Groundwater gradients are broadly from west to east and follow regional topographic and drainage gradients, with a visible drawdown around the Open Pit and active production bore fields. Mounding may be present beneath the NOEF and beneath the TSF Cell 1. To the east of the pit, in the vicinity of the mine levee wall, groundwater levels and contours indicate a localised groundwater divide between the localised westerly gradient to the pit and easterly regional groundwater gradient.

The three main aquifers comprising alluvium (including the McArthur River palaeochannel), weathered bedrock and fresh bedrock (particularly the more localised fractured bedrock aquifer), display strong hydraulic connections.

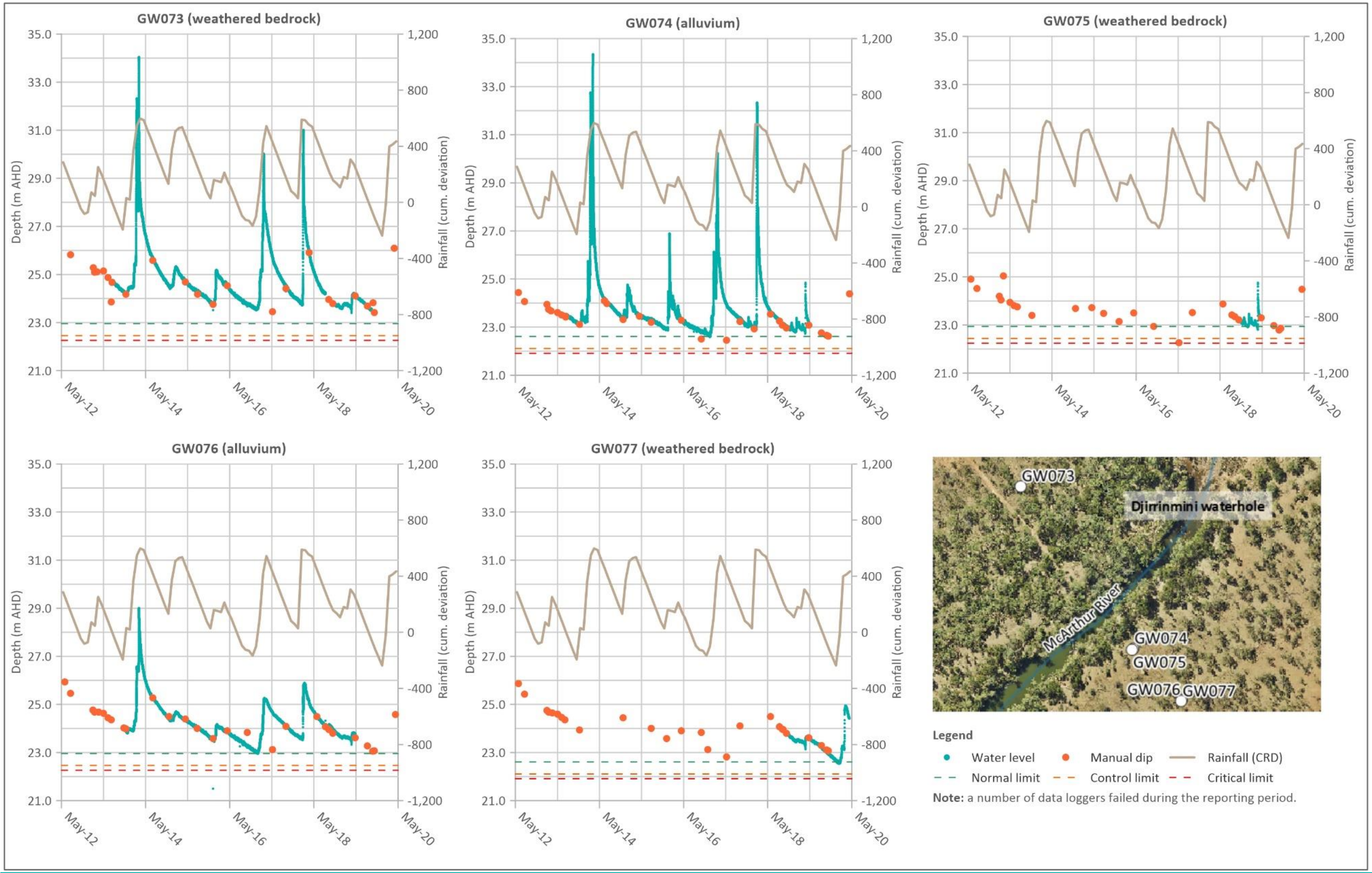


Plate 13: Groundwater Level Data Collected from Bores Surrounding the Djirrinmini Waterhole including Bore Specific Leading Indicator

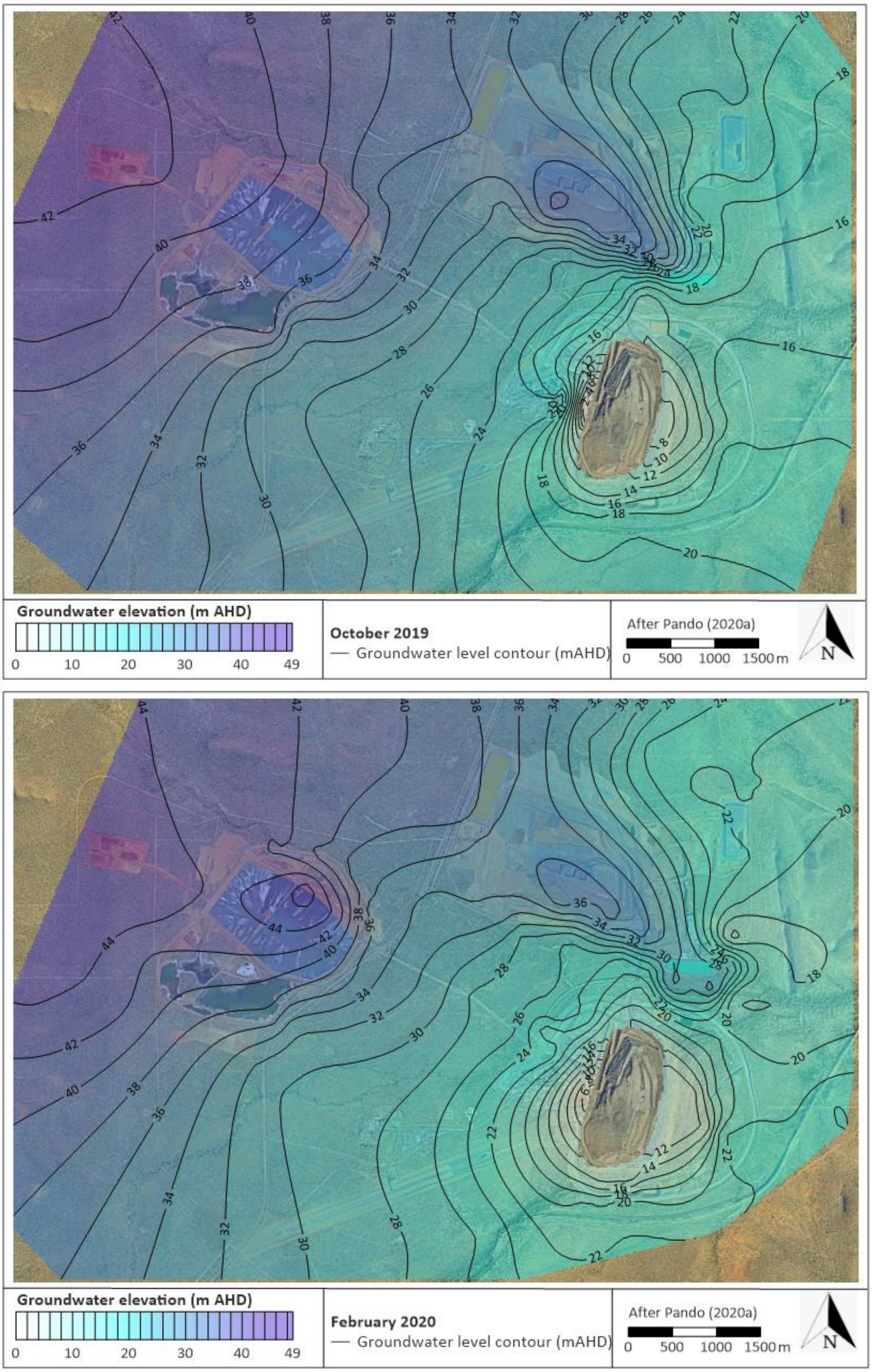


Plate 14: Groundwater Elevation Contours in the Weathered Bedrock and Alluvial Aquifers for October 2019 and February 2020

4.3.4 Performance during the Reporting Period – Groundwater Quality

Sample Collection

Over the reporting period (1 May 2019 – 30 April 2020), 559 groundwater samples were collected from the bores scheduled for regular monitoring. Seventy-two per cent of the 767 planned groundwater samples were collected. Water samples that were not collected were largely due to insufficient water present in the bores.

Groundwater Quality Trend Analysis

Groundwater quality trends were reviewed for the groundwater quality indicator parameters (field pH, sulphate, lead, zinc, arsenic and nitrate) for the wet and dry season after removing any identified outlier.

Temporal Mann-Kendall trends were calculated for monitoring locations with a suitable number of results to enable statistically viable analyses. Where statistical trend analyses were not suitable, temporal graphs were plotted inclusive of a loess smoothing curve to assist in visually identify any underlying patterns and inherent uncertainty in the data. The identified trends where then evaluated in relation to the identified sources of potential contaminants of concern, considering the effects of mineralisation and the influence of seasonality. Temporal plots and piper diagrams were also used to review groundwater quality during the reporting period (Pando, 2020a). It should be noted that the Mann-Kendall trend analysis methodology slightly differed from the previous reporting year (EMM, 2019), with trend analysis now applied to the entire dataset to identify long term trends. The data sets were analysed by wet and dry season due to the highly seasonal nature of the system.

The reporting period was within a period of lower than average rainfall. This has the potential to impact on groundwater behaviour and quality. Subsequently, surface and groundwater interactions observed historically may not have been present for the reporting period, trends which were established statistically may not continue in following years, or trends may exist but have not been detected

Trend analyses identified statistically significant long-term trends for the performance indicator analytes at a number of monitoring sites, with the majority of trends recorded for sulphate. The trends were identified in the areas of predicted impact, with metal concentrations overall low. Decreasing pH was recorded at a number of monitoring bores across site. However, pH remained overall well above 6.0 pH units during the monitoring period, not warranting further action.

Details of the areas of interest are provided below by domain. Comprehensive review and discussion are provided in Pando (2020a).

Open Pit Domain

Groundwater quality in the Open Pit domain is variable, ranging from fresh alkaline groundwater in the McArthur River palaeochannel aquifer and in proximity of the McArthur River, to slightly saline higher sulphate groundwater around the Western Overburden Emplacement Facility (WOEF) and the Eastern Levee Storage (ELS). Major ion composition in the open pit domain is mixed, indicating influence from various activities.

Groundwater bores adjacent the Mill (e.g. GW003A and GW015) continue to show influence from concentrator activities, from seepage from water storages in the area and from recharge through the WOEF. Sulphate and dissolved metal concentrations were relatively higher in this area compared to other areas in the Open Pit domain. However, concentrations were predominantly stable during the monitoring period (Plate 15).

Groundwater bores north of the Open Pit and south of the Barney Creek Diversion are influenced by recharge from the Barney Creek Diversion Channel and by seepage from water storages in the area. The indicator analytes recorded mostly stable conditions for the reporting year, with no long-term trends able to be calculated due to the length of monitoring data available (less than 2 years at most bores).

Plate 15: Historical Sulphate, pH and Zinc Concentration – Mill Area

Groundwater bores east of the Open Pit continued to be influenced by a number of water sources and flow paths, including recharge from the McArthur River Diversion, groundwater flow through mineralised areas, the historical impact from seepage of poor quality water stored in the Eastern Levee Storage (ELS) and ongoing strong vertical gradients near the Open Pit due to dewatering. Concentrations of indicator parameters were relatively stable over the monitoring period, with some improving concentrations detected (e.g. decreasing sulphate at GW129D and decreasing lead at GW130). Sulphate concentrations were typically higher in areas of mineralisation, however concentrations could also be influenced by historical seepage of poor quality water from the ELS.

Groundwater bores south of the Open Pit continued to be relatively stable and mostly dominated by recharge from the McArthur River Diversion Channel.

The increasing zinc trend documented in SS1-1 for the previous monitoring year (EMM, 2019) is no longer present. GW158D/S (located adjacent the MRM airstrip) continued to record elevated but stable sulphate concentrations; these more elevated concentrations are likely related to groundwater flow through weathered profiles of the Barney Creek Formation lithologies (similar to bores GW116 and GW110B).

Groundwater bores installed adjacent the Djirrinmini waterhole continued to be of magnesium-bicarbonate type with near neutral and fresh water conditions. This considered to reflect the rainfall recharge and flow through dolomitic bedrock, rather than a predominance of surface water recharge from the McArthur River. Salinity increased during the dry season months and is most likely related to the below average rainfall condition experienced over the last two monitoring years.

NOEF Domain

Groundwater quality in the NOEF domain is typically bicarbonate-dominated with varying proportions of calcium and magnesium. Sulphate water types are localised around SPROD and SEPROD, with sulphate-chloride recorded around SEPROD.

Monitoring bores installed in the natural ground below the NOEF recorded the highest sulphate and zinc concentrations. This is expected as groundwater at these locations are predicted to be affected by NOEF basal seepage.

Despite the increasing historical trend, sulphate and pH concentrations around SPROD were stable during this monitoring period (e.g. GW095D), with the exception of a strong increase in sulphate and a decrease in pH recorded at GW159S in March 2020 (Plate 16). Decreasing sulphate trends were detected at monitoring bores south of SPROD which historically recorded some of the highest sulphate concentrations (GW17007 and GW17009). Dissolved metal concentrations remained overall low during the monitoring period, however some long term increasing arsenic trends persisted (e.g. GW064s and GW094D). The overall improving trend at monitoring bores down hydraulic gradient form SPROD is expected to further improve due to discontinuation of SPROD usage as a water storage until its commissioning with HDPE liner in 2020. The elevated sulphate concentration detected at GW159S, together with elevated salinity, zinc and lead concentrations, is currently being investigated by MRM.

Groundwater bores in the vicinity of SEPROD continued to record relatively higher sulphate concentrations and decreasing pH trends (e.g. GW101D/S and GW102) (Plate 17). Groundwater at this location is likely affected by SEPROD seepage and is showing a generally improving trend despite lower rainfall. The OMP EIS predicts sulphate concentrations to increase further in this area due to NOEF basal seepage contributions increasing over time.

Groundwater bores north of the NOEF, in the Emu Plains area, continued to record naturally elevated sulphate concentrations and slightly more elevated arsenic concentrations (e.g. GW105 and GW1840D/S). These relatively elevated concentrations are associated with known mineralisation in the area of the Emu Fault.

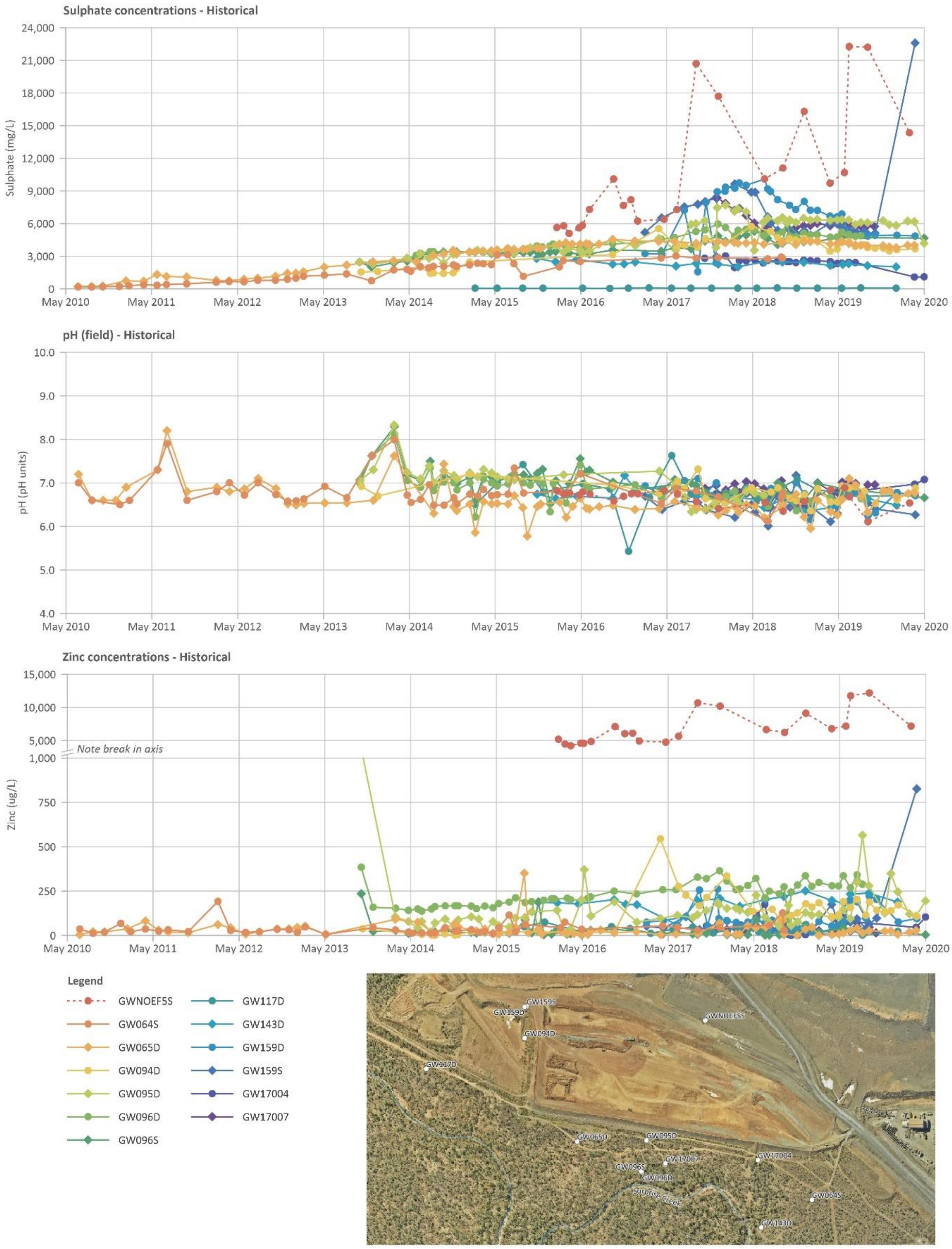


Plate 16: Historical Sulphate, pH and Zinc Concentration – SPROD Area

Plate 17: Historical Sulphate, pH and Zinc Concentration – SEPROD Area

TSF Domain

Groundwater quality in the TSF domain is typically dominated by sulphate and magnesium, with monitoring bores closest to the TSF typically exhibiting higher sulphate concentrations (greater than 3,000 mg/L). Groundwater to the east of the TSF has a different chemical signature with relatively low sulphate and higher chloride concentrations which have been attributed to natural mineralisation.

Groundwater between the TSF Cell 1 and Surprise Creek continued to record an impact from TSF seepage, with elevated sulphate concentrations present at most monitoring bores (e.g.GW021, GW047B/C and GW050) (Plate 18). GW056 continued to record an increasing long-term zinc trend, however concentrations are not considered significant (<0.1 mg/L). Anomalous responses were recorded at GW020A during the reporting period, with water quality concentrations differing from the deeper nested bore (GW020B). These bores are located in the immediate vicinity of the TSF Interception Trench Sump 5, and construction activities and dewatering are likely responsible for the different response in the shallow and deep bore. The increasing sulphate trend recorded at GW108 (EMM, 2019) was no longer present. Construction of the TSF Interception trench commenced during the reporting period. Groundwater quality downstream of the interception trench will improve once the trench has been commissioned, reducing the impact of lower quality baseflow on Surprise Creek.

Groundwater north of Surprise Creek remained mostly fresh, with some bores recording slightly elevated sulphate concentrations (GW022, GW19018 and GW19019). Sulphate and zinc concentrations at GW022 have significantly fluctuated since monitoring began in 2005. However, concentrations are not considered elevated and trend analyses established a long-term decreasing sulphate, zinc, lead and arsenic trend. Trend analyses did not identify any long-term trends for the other indicator parameters at the remaining bores north of Surprise Creek and concentrations are considered relatively stable.

Groundwater east and south-east of the TSF recorded decreasing sulphate concentrations with increasing distance from the TSF. Long-term increasing sulphate trends were recorded in bores adjacent the TSF (e.g. GW018 and GW020A/B), while decreasing trends were recorded in areas of natural mineralisation (GW126D/S). The remaining indicator parameters (pH, nitrate, lead and zinc) remained relatively stable for the reporting year.

Groundwater south of the TSF was typically stable over the monitoring period. GW014 continues to record elevated but stable concentrations of sulphate. The increasing long-term sulphate trends recorded at GW006 and GW113 (EMM, 2019) are no longer present.

Groundwater west of the TSF was typically stable over the reporting period, with the exception of increasing sulphate trends at GW058 and GW059 (located immediately west of the TSF Cell 1). The increasing zinc trend recorded at GW111A for the previous reporting (EMM, 2019) is no longer present.

Groundwater Quality Spatial Patterns

Groundwater sulphate and zinc contour maps for the reporting period are provided in Plate 19 and Plate 20 for both the dry and the wet season. To maximise available data points and to minimise interpolation artefacts during the contouring process, the contours were generated for combined data points within the alluvium and weathered bedrock aquifers.

In accordance with predictions in the OMP EIS, and as detected in the trend analysis, elevated sulphate concentrations were observed around the NOEF, the TSF and across the mineralized zones (east of the Mill and north-east of the NOEF). Sulphate concentrations are overall similar between wet and dry seasons.

Despite elevated concentrations of zinc in the sources (e.g. TSF and NOEF), zinc concentrations were typically low (< 1 mg/L) during the reporting period, confirming that the mobility of dissolved metals is significantly lower than the more conservative elements as sulphate. This is in accordance with the OMP EIS predictions that state that attenuation is an important process in limiting the rate of migration of dissolved metals.

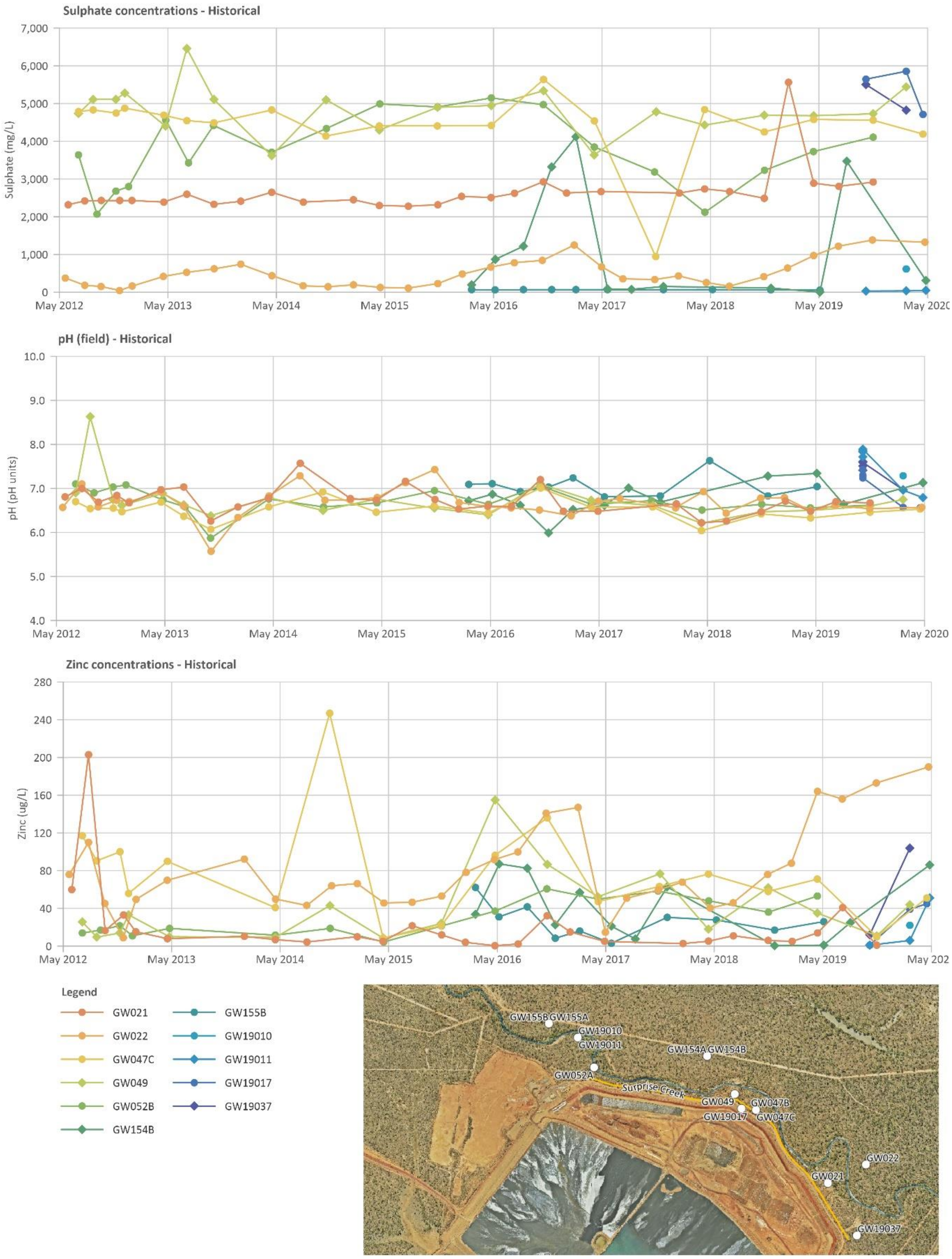
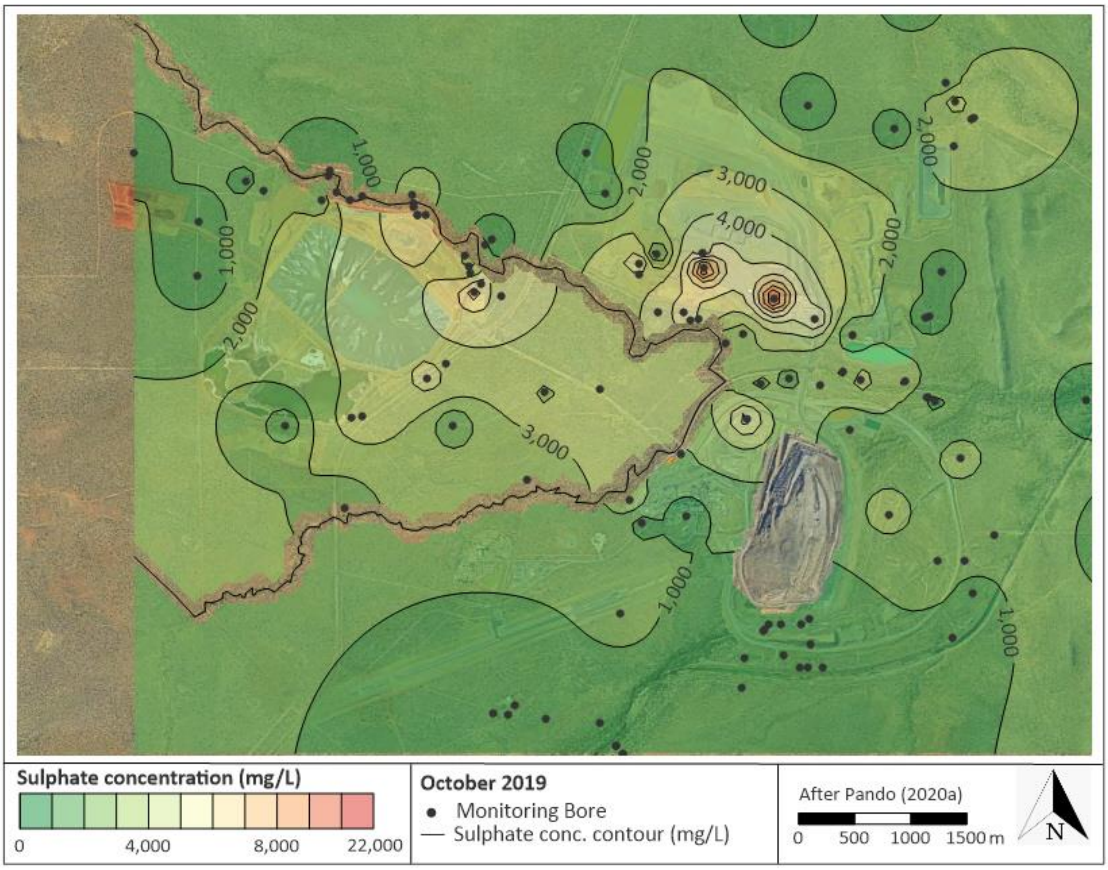


Plate 18: Historical Sulphate, pH and Zinc Concentration – TSF Interception Trench Area



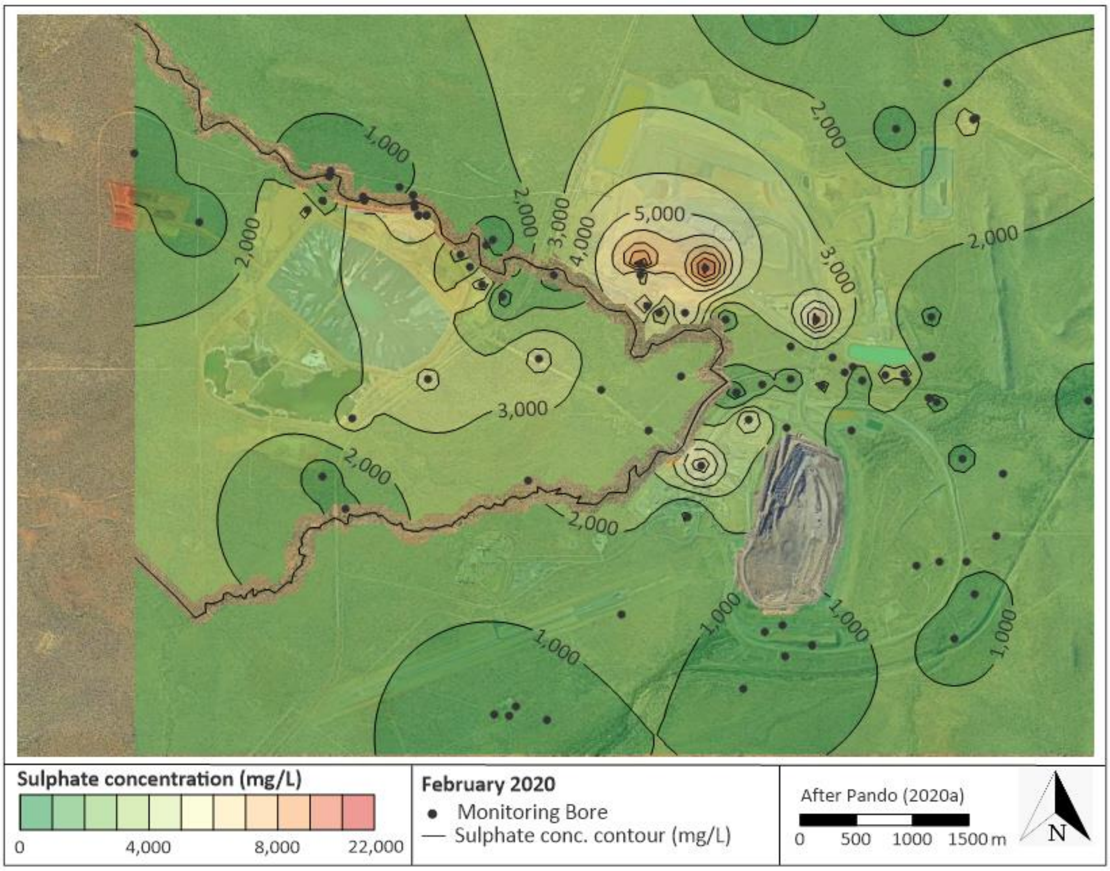
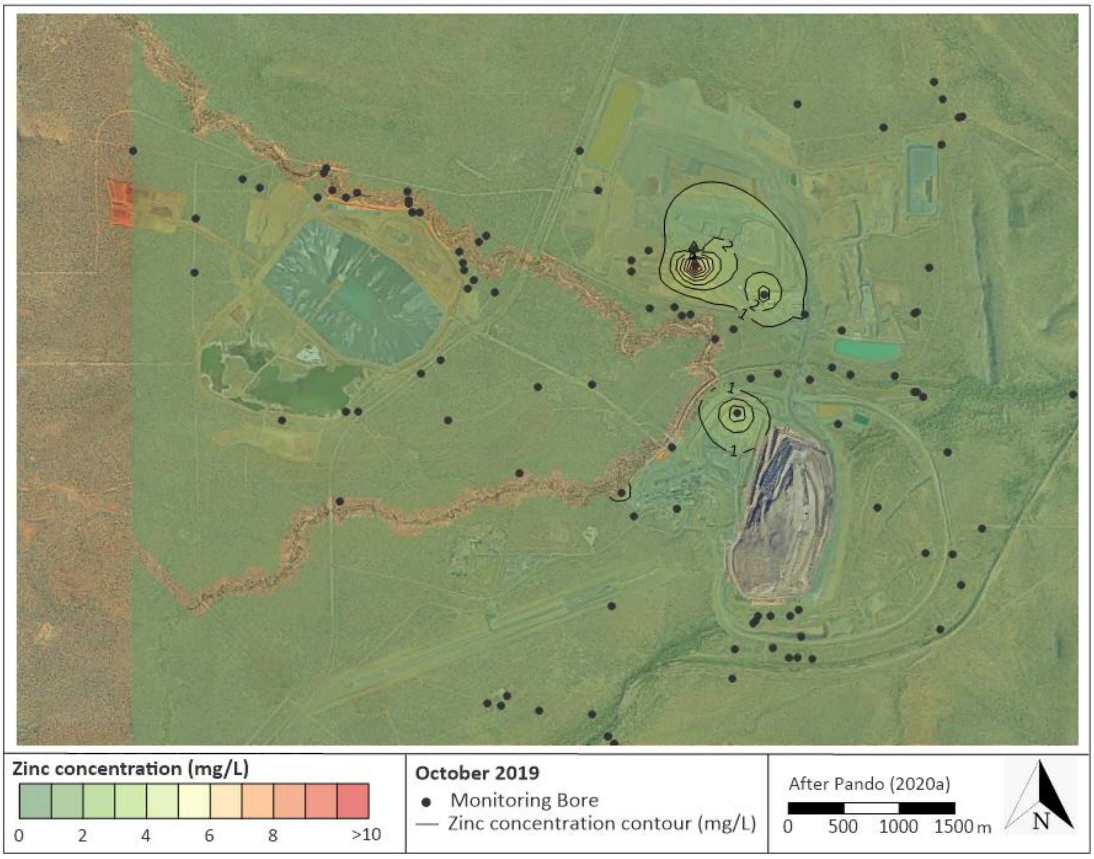


Plate 19: Sulphate Concentration Contours in the Weathered Bedrock and Alluvial Aquifers for October 2019 and February 2020



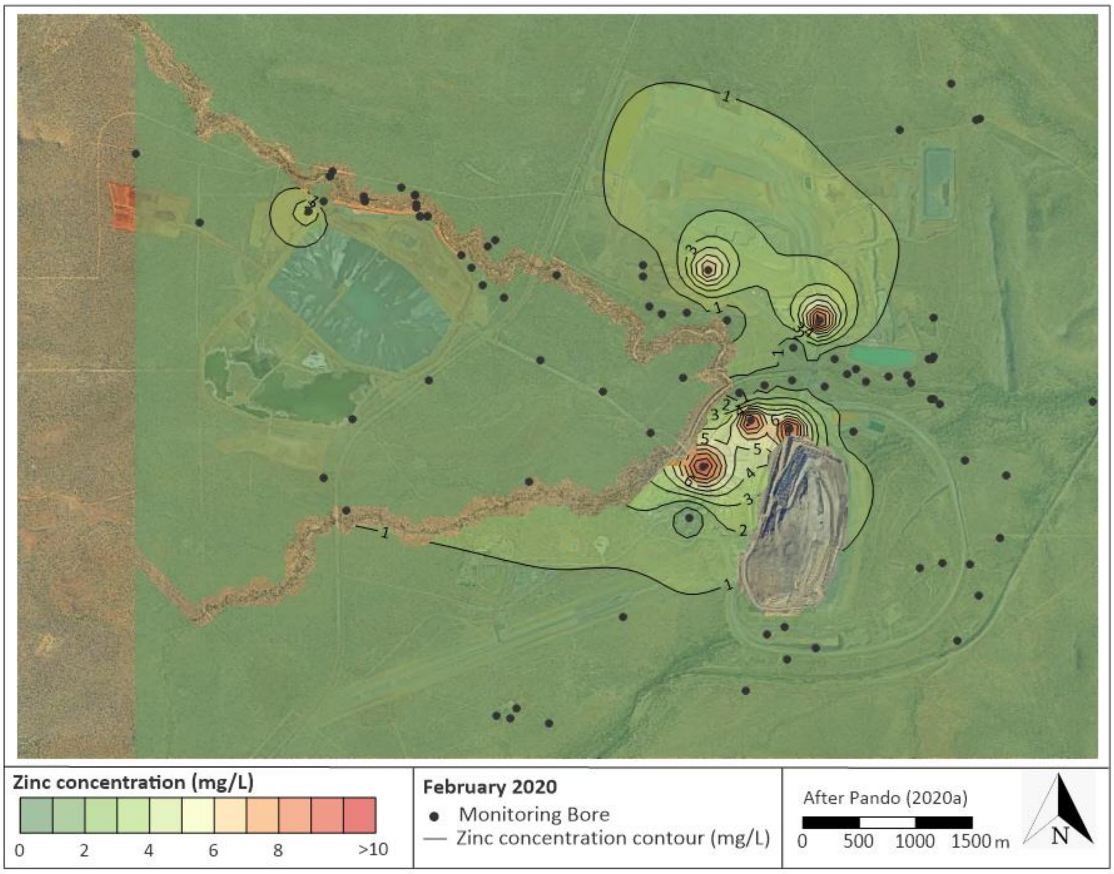


Plate 20: Zinc Concentration Contours in the Weathered Bedrock and Alluvial Aquifers for October 2019 and February 2020

4.3.5 BBLF Performance during the Reporting Period

Twenty-two groundwater quality samples were collected at BBLF over the reporting period.

Most monitoring bores recorded ongoing relatively stable groundwater quality conditions with arsenic, lead and zinc recording insignificant concentrations. Some increasing trends were recorded, with and increasing sulphate trend at GWBB008A and decreasing pH at a number of monitoring bores (whilst remaining above 6.0 pH units).

4.3.6 Non-conformances, Corrective Actions and Improvements

The 2019 field and drilling program (MRM, 2020d) was undertaken between May and December 2019 to further characterise the groundwater system at MRM, quantify aquifer parameters and further refine the groundwater component of the source-pathway-receptor model. The program included:

- microgravity survey;
- geological mapping;
- mineralized zones investigations;
- stable isotopes investigations;
- bore audit; and
- raw water supply review.

A detailed report on the program is presented in Appendix V.

In addition to the 2019 field and drilling program, the conceptual hydrogeological models for the different domains at the Mine and BBLF were updated to include the additional data collected since submission of the OMP EIS:

- Open Pit domain – Pando (2020b).
- NOEF domain – KCB (2020b).
- TSF domain – KCB (2019).
- BBLF domain – EMM (2020).

4.3.7 Changes for the Next Reporting Period

The current groundwater monitoring network consists of over 300 groundwater monitoring bores as shown in Figures 33 and 34. MRM continues to review and refine the groundwater monitoring program as part of the development of the Adaptive Management Plan. It is anticipated that under future revisions of the Adaptive Management Plan, a subset of the bores shown on Figures 33 and 34 will be analysed to assess the environmental risk associated with major infrastructure and facilities.

Any major changes to the monitoring program or list of sites used to assess environmental risk will be sought under revision of the Adaptive Management Plan.

4.4 Surface Water and Groundwater Interpretation

The groundwater and surface water systems surrounding the Mine are highly connected, with one system often influencing the other. Interactions between groundwater and surface water were evaluated using chemical signatures in conjunction with water levels in both the groundwater and surface water systems.

4.4.1 Summary

The key mechanisms for groundwater – surface water interactions are summarised below, with more details provided by domain further below. In summary:

- The driving mechanisms for interaction between groundwater and surface water at the Mine are rainfall recharge, flood water recharge, aquifer storage, regional flow and seepage migration from water storage facilities and from overburden facilities.
- In general, groundwater provides baseflow to the watercourses and diversions across the Mine during dry periods, when surface water levels are low or absent, as groundwater levels typically recede slower than surface water levels. During the wet season, when significant flows and flooding occurs, the watercourses and diversions across the Mine act as loosing streams, becoming a source of water to surrounding aquifers.
- Natural mineralisation is present in a number of areas outside of the main ore body, which can result in elevated analyte concentrations (e.g. sulphate, metals) within the groundwater. Groundwater that flows through a mineralized zones and reports to surface water can impact surface water quality (e.g. in the McArthur River Diversion Channel in the proximity of the Cooley prospects).
- Geological structures, and the hydraulic and geology properties of materials between them, have varying degrees on influence on groundwater pathways and surface water quality.
- Groundwater leaves the system via discharge to watercourses and diversions, and shallow evapotranspiration.

4.4.2 Open Pit

- There is no (or insignificant) flow or discharge of groundwater from the Open Pit to the McArthur River (Diversion Channel) or the Barney Creek Diversion Channel in recent times (Pando, 2020b).
- No singular or discrete groundwater pathways to the underground voids were identified to provide a rapid response to high rainfall or river flows. Groundwater flow via true fractured ground and faults into voids is not expected to vary significantly from season to season and is conceptualised to occur from numerous (of the order of hundreds) small to moderate scale faults and fracture zones rather than just a few major scale fault zones (Pando, 2020b).
- The Djirrinmini waterhole continues to be sustained by groundwater. The monitoring bores in the area continue to record magnesium-bicarbonate water type with near neutral and fresh water conditions (Pando, 2020a). This is considered to reflect local groundwater conditions of rainfall recharge and flow through dolomitic bedrock, rather than a predominance of surface water recharge (Pando, 2020b).

4.4.3 NOEF

- Groundwater can be influenced by various sources including rainfall, the various water storage facilities, the NOEF, aquifer storage and to a lesser extent Surprise Creek and the Barney Creek Diversion Channel.

- Potential preferential flow paths have been identified as the alluvium, karstic zones and adjacent to faults (KCB, 2020b).

- Geology and structures are a key component of groundwater movement and water quality, resulting in different groundwater signatures (KCB, 2020b). Geology and structures are also critical in defining the areas of groundwater baseflow contributions. For example, increased groundwater baseflow contributions are identified in the lower reaches of the Barney Creek Diversion Channel, in the more preamble Cooley Dolomite, east of the Western Fault (KCB, 2020b).

- Limited evidence of groundwater baseflow has been recorded over the last monitoring years in Surprise Creek and the Barney Creek Diversion Channel, likely as a function of below average rainfall conditions (KCB, 2020b).

- Sulphate concentrations in groundwater baseflow in the eastern part of the Barney Creek Diversion Channel are predicted to significantly increase over time due to increased NOEF basal seepage contribution. However, groundwater levels are predicted to decrease to below the invert of the Barney Creek Diversion Channel from 2022/23 until the establishment of the pit lake (2067) due to the expansion of the Open Pit (and more specifically due to breaching through the Western Fault). This will result in reduced groundwater baseflow to the diversion channel during life of mine (KCB, 2020b).

- Improved water management around SPROD, including the installation of the HDPE liner, are showing an improvement in water quality around this water storage facility. SPROD's influence on groundwater loads reporting to Surprise Creek will continue to decline (KCB, 2020b).

4.4.4 TSF

- Typical groundwater flow is vertical through the alluvium and weathered bedrock and, depending on the location, drains into Surprise Creek though the alluvium (where present) or through fractures and voids within the weathered bedrock (Pando, 2020a).

- Groundwater gradients north of the TSF are from the TSF towards Surprise Creek. Groundwater elevations of bores between the TSF and the creek are often higher than the invert level of Surprise Creek implying baseflow is provided to the creek throughout the wet and the dry seasons (KCB, 2020a). Groundwater levels north of Surprise Creek record hydraulic gradients to the creek (Pando, 2020a).

- Groundwater bores along the immediate south-western perimeter of the WMD show a response to water levels in the WMD, indicating hydraulic connection at these locations (Pando, 2020a).

- Sulphate concentrations fluctuate along Surprise Creek. Water quality is fresh upstream and increases in sulphate and salinity concentrations moving past the TSF, to then subsequently dilute and decrease further downstream, but again increase slightly in sulphate when close to NOEF (KCB, 2020b). These fluctuations in sulphate and electrical conductivity occur at discrete areas in the creek which are likely flow paths for the discharging groundwater seepage from the TSF (KCB, 2020b). Bores closest to the TSF typically exhibit higher sulphate concentrations (>3000 mg/L). Mann-Kendall trend analyses established sulphate increases in multiple boreholes along the southern bank of Surprise Creek (on the same side as the TSF) (GW021, GW047B/C, GW049, GW050, GW052B, GW152D/S) (Pando, 2020a).

- The Surprise Creek Seepage Interception Trench is currently being constructed to mitigate seepage impacts to the Surprise Creek. Monitoring of existing bores together with the installation of new bores will provide a better understanding of the groundwater - surface water interactions in the area and how these change with the completion and commissioning of the seepage interception trench.

4.4.5 Bing Bong

- Groundwater flow is radial away from the centre of the site where a groundwater mound has been identified. The mounding is likely due to a combination of seepage of water from the dredge ponds, relative topography of the site or local geology (EMM, 2020). Groundwater levels are above sea level during both the dry and wet season, indicating that groundwater will eventually drain towards the sea.

- Groundwater levels respond strongly to rainfall recharge in the wet season. There are some saline groundwater influences of seepage, likely from the dredge basins and tidal mixing (EMM, 2020).

- Shallow groundwater is brackish with a TDS of 5,000-10,000 mg/L; the deeper groundwater is saline, matching the profile of seawater; and the deepest sandstone aquifer has hypersaline water, with TDS levels frequently around 70,000 to 100,000 mg/L (EMM, 2020). Significant fluctuations in salinity in the hypersaline zone have been recorded and could be considered connate (formation) water, as well as possible affected by the surrounding geology and historical salt flat setting, and the effects of the freshwater seawater interface (including salinity and subsequently density differences and its subsequent effect on hydraulic head) (EMM, 2020). Evaporation and associated concentration of salts from water in the dredge ponds is likely to have occurred, however salinities of groundwater greater than seawater are not observed in the upper two aquifers (EMM, 2020).

4.5 Marine Metal Concentration

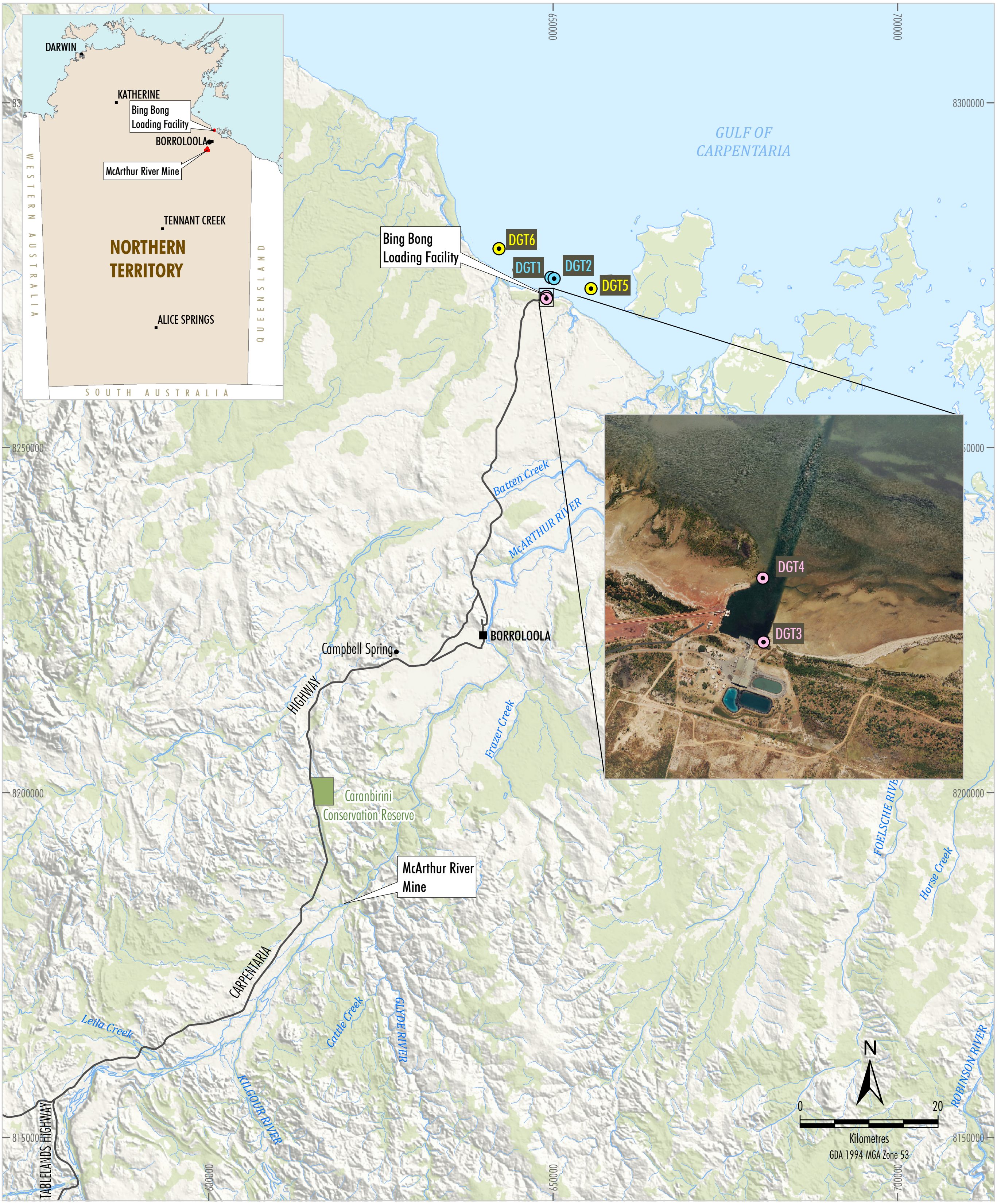
MRM undertakes quarterly sampling of marine water quality in the Gulf of Carpentaria using diffusive gradients in thin films (DGT) passive samplers to monitor operations at the BBLF. The program specifically aims to detect if operations at the BBLF are introducing mine-derived contamination into the marine ecosystem and subsequently impacting the immediate surrounds and broader marine environment.

4.5.1 Monitoring Program Overview

The concentrations of DGT-labile metals in seawater around BBLF were monitored from 9 May 2019 to 19 March 2020. Quarterly sampling (May-19, Aug-19, Jan-20 and Mar-20) was performed at six monitoring sites (DGT1–6) (Figure 35). The swing basin sites DGT3 and DGT4 had to be located such that they did not interfere with the operation of the MV Aburri barge.

The potentially bioavailable fraction of metals can be represented by concentrations of DGT-labile metals. These were compared to relevant ANZG (2018) default guideline values (DGVs) for marine water.

Lead isotope ratios determined for DGT were subsequently compared graphically to the MRM shipping product lead isotope ratio ($^{207}Pb/^{206}Pb$ = 0.9582 and $^{208}Pb/^{206}Pb$ = 2.2222), lead isotope ratio of relevant AMMP sites (IPE, 2020h), and to PDAC values ($^{207}Pb/^{206}Pb \approx 0.83$ and $^{208}Pb/^{206}Pb \approx 2.06$) derived from Stacey and Kramers (1975).



LEGEND

Major Road

River/Creek

DGT Monitoring Site

Channel

Coastal

Swing Basin

McARTHUR RIVER MINE

DGT Monitoring Sites

Source: Geoscience Australia - Topography (2006); Department of Environment and Natural Resources (2016); Australian Institute of Marine Science (2019); MRM (2020)

Figure 35

4.5.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

MRM's 2018-2019 Operational Performance Report did not identify any changes for the 2019-2020 DGT monitoring program, therefore no changes we made during this reporting period.

4.5.3 Performance during the Reporting Period

Results presented below represent a summary of the quarterly DGT data (for DGT1–6) for the reporting period. For all results, including raw data, refer to the report *Concentrations of select bioavailable metals and lead isotope ratios within ocean water in the vicinity of the Bing Bong Loading facility as monitored by Diffusive Gradients in Thin Films 2019-2020* (IPE, 2020h) (Appendix W).

To ensure protection of the aquatic ecosystem within the swing basin (considered a slightly to moderately disturbed marine system), the concentrations of DGT-labile Zn, Pb, and Cu should be less than their respective ANZG (2018) marine DGVs for 95 % species protection, whereas DGT-labile Cd and Ni concentrations should remain below their respective ANZG (2018) 99 % protection level.

During the reporting period, the DGT-labile concentrations of Zn, Pb, Cd, Co, Cu, Fe, Mn and Ni measured at all monitoring sites were below the relevant ANZG (2018) water quality criteria, and within the range of historical values.

The average concentration of DGT-labile Zn and Pb for 2019-2020 deployments compared to ANZG (2018) DGVs for 95 % and 99 % species protection in marine water are presented in Chart 35 and Chart 36 respectively.

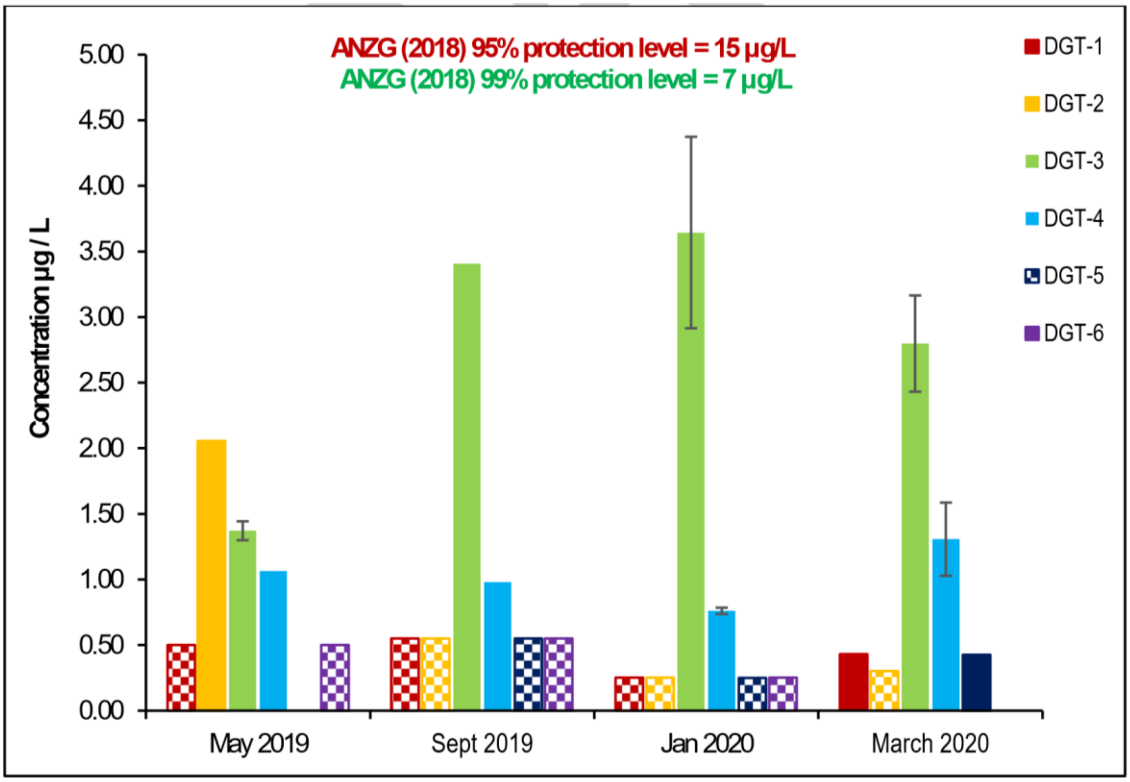


Chart 35: Mean Concentrations of DGT-labile Zinc Recorded via Quarterly DGT Deployments between May 2019 and March 2020

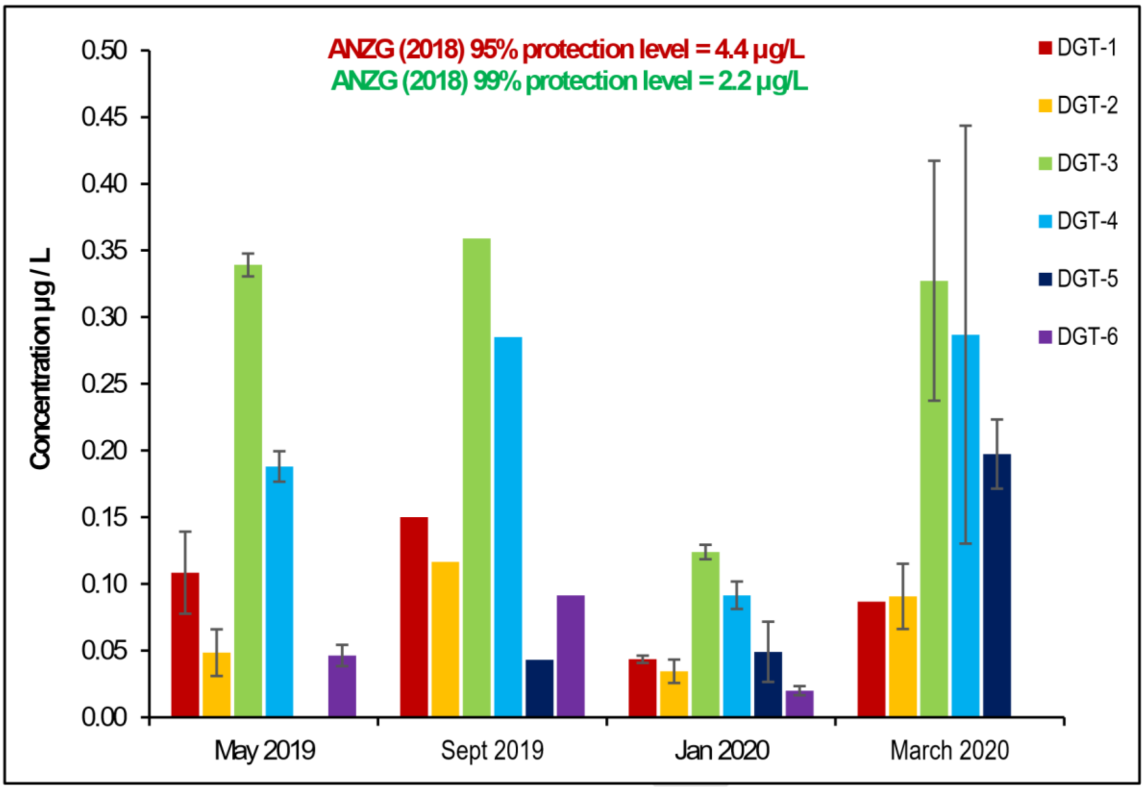


Chart 36: Mean Concentrations of DGT-labile Lead Recorded via Quarterly DGT Deployments between May 2019 and March 2020

4.5.4 Non-conformances, Corrective Actions and Improvements

The concentrations of DGT-labile metals in 2019-20 were below the relevant ANZG (2018) marine water quality guidelines. Operations at the BBLF did not appear to increase the bioavailable concentrations of Zn, Pb, Cd, Co, Cu, Fe, Mn and Ni within marine waters to a level which would adversely affect the surrounding marine environment.

4.5.5 Changes for the Next Reporting Period

No significant changes are planned to the 2020-21 DGT monitoring program. Monitoring will continue to be undertaken on a quarterly basis with sampling targeted to coincide with loading and shipping operations at BBLF where possible.

4.6 Metal and Metalloid Concentrations in Near Shore Sediment

MRM undertakes annual sampling of near shore sediments in the Gulf of Carpentaria to monitor potential contamination of marine sediments proximal to the BBLF. The program aims to identify whether metals or metalloids are being introduced into the near shore sediments as a result of mining operations. Elevated analyte concentrations of near shore sediment may occur from the direct deposition of dust as a result of concentrate handling and barge loading operations. It may also occur indirectly where tidal and barge induced currents transport and deposit material from the swing basin to near shore areas. MRM operates an extensive near shore sediment monitoring program including sampling of the sediments in the intertidal zone to the east and west of the facility. During the reporting period, near shore sediments were sampled in September 2019 (Appendix X).

4.6.1 Monitoring Program Overview

Monitoring Sites

Consistent with previous surveys, five sampling zones were revisited during the current study, as were the Western Control (WC) and Eastern Control zones (see Figure 36). Three of these zones were considered to be potential impact zones at which heavy metals may be directly introduced. Those zones being to the immediate west (Zone 2) and east (Zone 3) of the swing basin and adjacent the dredge spoil drain outfall (Zone 4). Two sampling zones to the immediate west (Zone 1) and east (Zone 5) of the mine lease boundaries were also sampled, these were considered to be reference sites from which background metal concentrations could be determined. Two additional reference sites (the WC and EC zones) located approximately 3.0 km west and east of the swing basin respectively, were also sampled to provide additional background data.

Metal and metalloid concentrations presented below are based on the analysis of As, Cd, Cu, Pb, Tl and Zn. For further results, such as soluble ion concentrations, refer to *Metal and Metalloid concentrations of near shore sediment of the Bing Bong Loading Facility, September 2019* (IPE, 2020i).

Sediment Quality Guidelines Values

Following the recommendations of the *Sediment quality assessment: a practical guide* (Simpson and Batley, 2016), MRM uses SQGVs to compare to the metal concentrations analysed by dilute acid extraction (DAE) for the near shore sediment samples. This represents the bioavailable concentrations of metals in the sediment. The recommended SQGVs and upper guideline (SQG-High) are provided in IPE, 2020i.

4.6.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

There were no significant changes to the near shore sediment monitoring program during the reporting period.

MRM-16-01_EMR2020_237A

LEGEND

Near Shore Sediment Monitoring Site

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

McARTHUR RIVER MINE

Bing Bong Loading Facility Near Shore Sediment Monitoring Sites

Figure 36

4.6.3 Performance during the Reporting Period

Comparison of mean As, Cd, Cu, Pb and Zn concentrations to relevant SQGVs and Tl to the calculated interim value found no exceedances during the current study (see Chart 37). For the majority of these analytes, mean concentrations were generally comparable between near shore zones with the exception of Pb and Zn within Zone 2. The mean concentration of lead was 39.7 (± 6.3) mg/kg within Zone 2 and 26.7 (± 5.95) mg/kg within Zone 3 which was higher than the mean concentrations of other zones which ranged from 11.3 (± 0.7) to 20.3 (± 2.7) mg/kg. The Zn mean concentration within Zone 2 and Zone 3 was 109.6 (± 23) and 36.9 (± 9.0) mg/kg, respectively. Zinc concentrations in all other zones ranged from 7.8 (± 0.4) to 19.7 (± 3.4) mg/kg.

There was no discharge from authorised discharge point BBDDP during the reporting period.

In relation to the BBDDP and within the DSD sites investigated, no analytes for which a SQGV exists were found to be in exceedance (which in the case of lead is 50 mg/kg and 200 mg/kg for zinc). Furthermore, analyte concentrations were below or comparable to near shore reference zones, indicating that the current management of dredge spoil ponds is containing any potential contamination of metals on adjacent tidal flats. Cadmium and copper concentrations at all sites were well below respective SQGV.

Results from the quality assurance program showed that the relative percentage difference of the vast majority of duplicate samples was within acceptable criteria.

4.6.4 Non-conformances, Corrective Actions and Improvements

The current study found no exceedance of any applicable SQGV within any sample collected at the BBDDP, DSD or Drain Outflow. Furthermore, mean concentrations of product related analytes within the BBDDP, DSD and Drain Outflow sites were for the most part comparable to those recorded within reference zones, indicating that the current management of dredge spoil ponds is adequate for containing the mobilisation of metals onto the adjacent tidal flats.

Exceptions to this were thallium, zinc and cadmium concentrations which, although well below concentrations likely to cause environmental harm, were higher at these three locations in comparison to reference sites, and more similar to concentrations recorded in Zone 3.

Although concentrations encountered at the BBDDP, DSD and Drain Outflow were either within the range considered 'normal' for marine sediments or were low in comparison to the applicable SQGV there is merit in continued monitoring of these areas particularly in consideration of changing sand berm morphology between the BBDDP and Zone 4 which has increased the likelihood of discharge from the BBDDP settling in the Drain Outflow area as oppose to Zone 4.

4.6.5 Changes for the Next Reporting Period

No significant changes to the near shore sediment monitoring program are planned for the next reporting period.

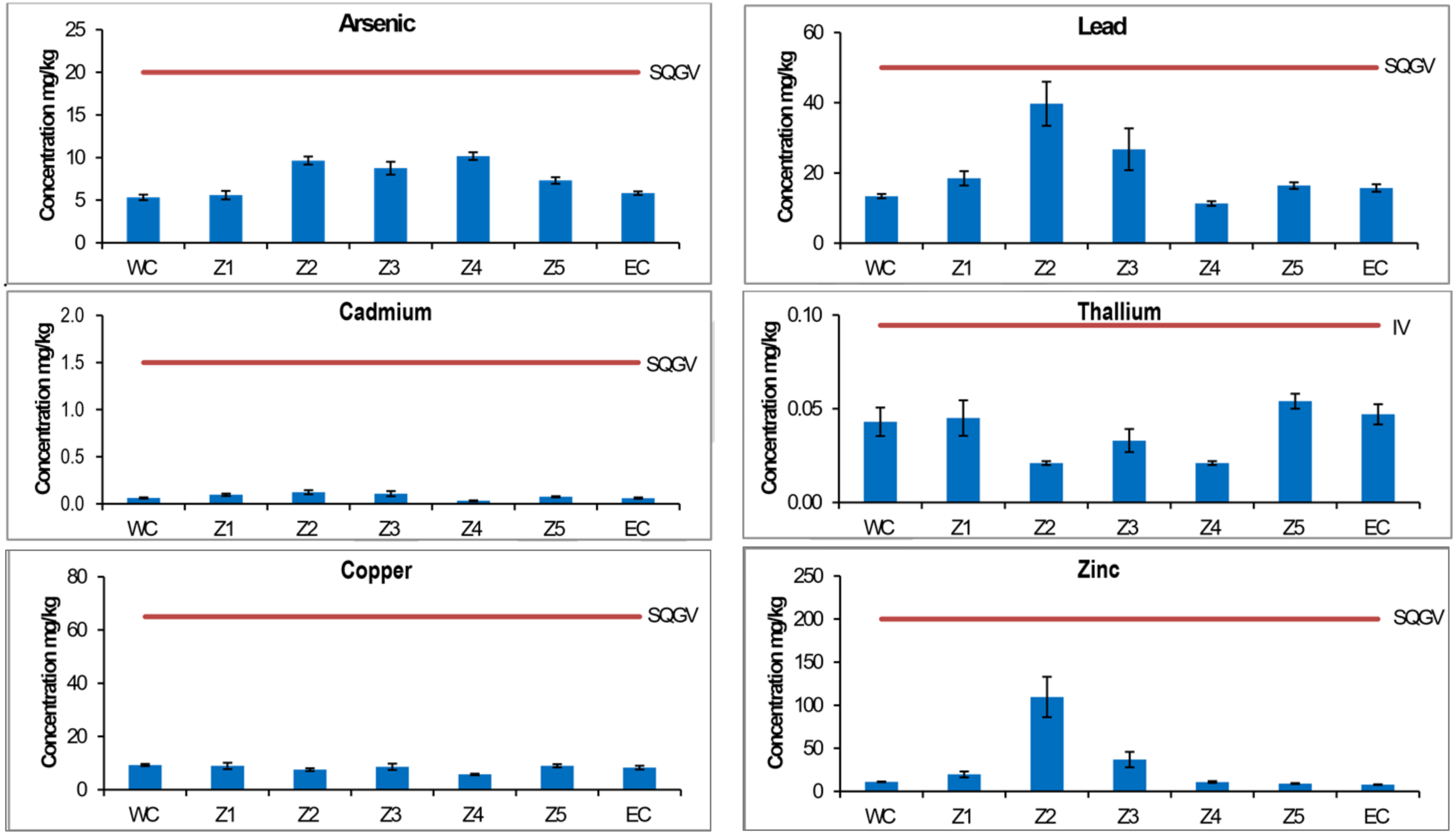


Chart 37: Mean Concentrations of Metals and a Metalloid in the <63 µm Fraction of Sediment Collected from Each Zone during September 2019

4.7 Metal and Metalloid Concentrations in Transhipment Seafloor Sediment

The concentrate produced by MRM is transferred by purpose-built barge to bulk carrier export vessels in an area located in the Gulf of Carpentaria between 20 and 30 km north-east of the BBLF, known as the Transhipment Area. MRM undertakes annual sampling of Transhipment Area seafloor sediments to determine whether MRM operations in this area are impacting on sediment quality. The extensive monitoring also includes sampling of seafloor sediments at an appropriately located Control Area. During the reporting period, transhipment sediments were sampled in November 2019.

4.7.1 Monitoring Program Overview

Monitoring Sites

Marine seafloor sediment samples were collected from 15 sites within the defined Transhipment Area and from 15 sites within the defined Control Area (see Figure 37), located approximately 5 km to the east of the Transhipment Area. Collection of sediment for the current study took place on 23 November 2019.

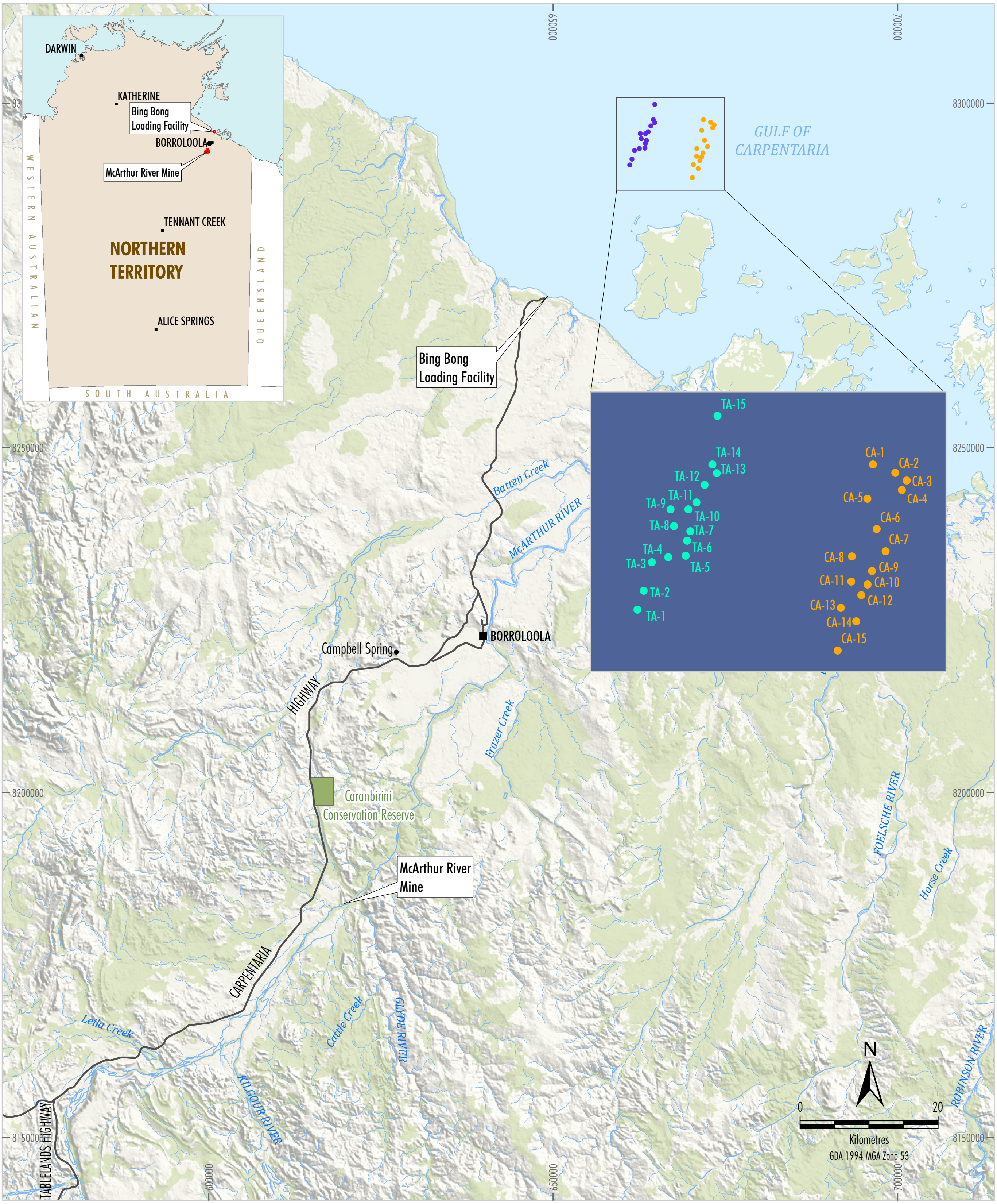
For additional information on collection, analytical methods and results, refer to *Assessment of metals and lead isotope ratios of seafloor sediments in the McArthur River Mine Transhipment Area, November 2018* (Appendix Y).

Sediment Quality Guidelines Values

Following the recommendations of the *Sediment quality assessment: a practical guide* (Simpson and Batley, 2016), MRM uses SQGVs to compare to the metal concentrations collected by DAE of the transhipment sediment samples (representing the bioavailable concentrations of metals in the sediment).

4.7.2 Changes Made to the Monitoring Program or Techniques during the Reporting Period

There were no significant changes to the transhipment sediment monitoring program during the reporting period.



LEGEND

- Major Road
- River/Creek
- Control Monitoring Sites
- Transhipment Monitoring Sites

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

McARTHUR RIVER MINE

Transhipment Seafloor Sediment Monitoring Sites

Figure 37

4.7.3 Performance during the Reporting Period

Analyte concentrations within the <63 µm fraction of all samples collected in 2019 were found to be well below any applicable SQGV. With reference to lead and zinc concentrations within the Transhipment Area, the highest concentrations recorded were 28 mg/kg and 83 mg/kg, respectively. These concentrations were approximately 50 % of the SQGV for lead and less than 40 % of SQGV for zinc. These findings are considered comparable to concentrations reported in 2016, 2017, 2018 and 2019.

Comparison of mean concentrations between the Control Area and Transhipment Area revealed similar concentrations within both areas for the majority of analytes, the exceptions being zinc and, to a lesser extent, lead (see Chart 38). The mean concentration of zinc within the Transhipment Area was 30.5 (± 5.44) mg/kg, which was approximately 200 % higher than the mean concentration of zinc within the Control Area (9.26 ± 0.12 mg/kg). In relation to lead, the concentration within the Transhipment Area was approximately 45 % higher at 15.6 (± 1.07) mg/kg than Control Area which was 11.1 (± 0.09) mg/kg.

The overall analysis of the <63 µm fraction of seafloor sediment samples collected in 2019 showed analyte concentrations to be comparable to those concentrations reported previously by IPE and maximum analyte concentrations continue to be well below applicable SQGVs. Furthermore, samples with slightly higher concentrations of lead and zinc remained localised to the main concentrate transfer location in the vicinity of the BB1 anchorage. When the percentage contribution of the <63 µm fraction within the whole sediment habitable fraction is taken into account, the variations in analyte mean concentrations between Transhipment Area and Control Area are minimal. Therefore, it is considered unlikely that anthropogenic activities associated with the transfer of shipping concentrate have resulted in measurable detrimental impacts within the benthic community and surrounding environment.

4.7.4 Non-conformances, Corrective Actions and Improvements

No non-conformances, corrective actions or improvements were noted.

4.7.5 Changes for the Next Reporting Period

No changes to the transhipment monitoring program are planned for the next reporting period.

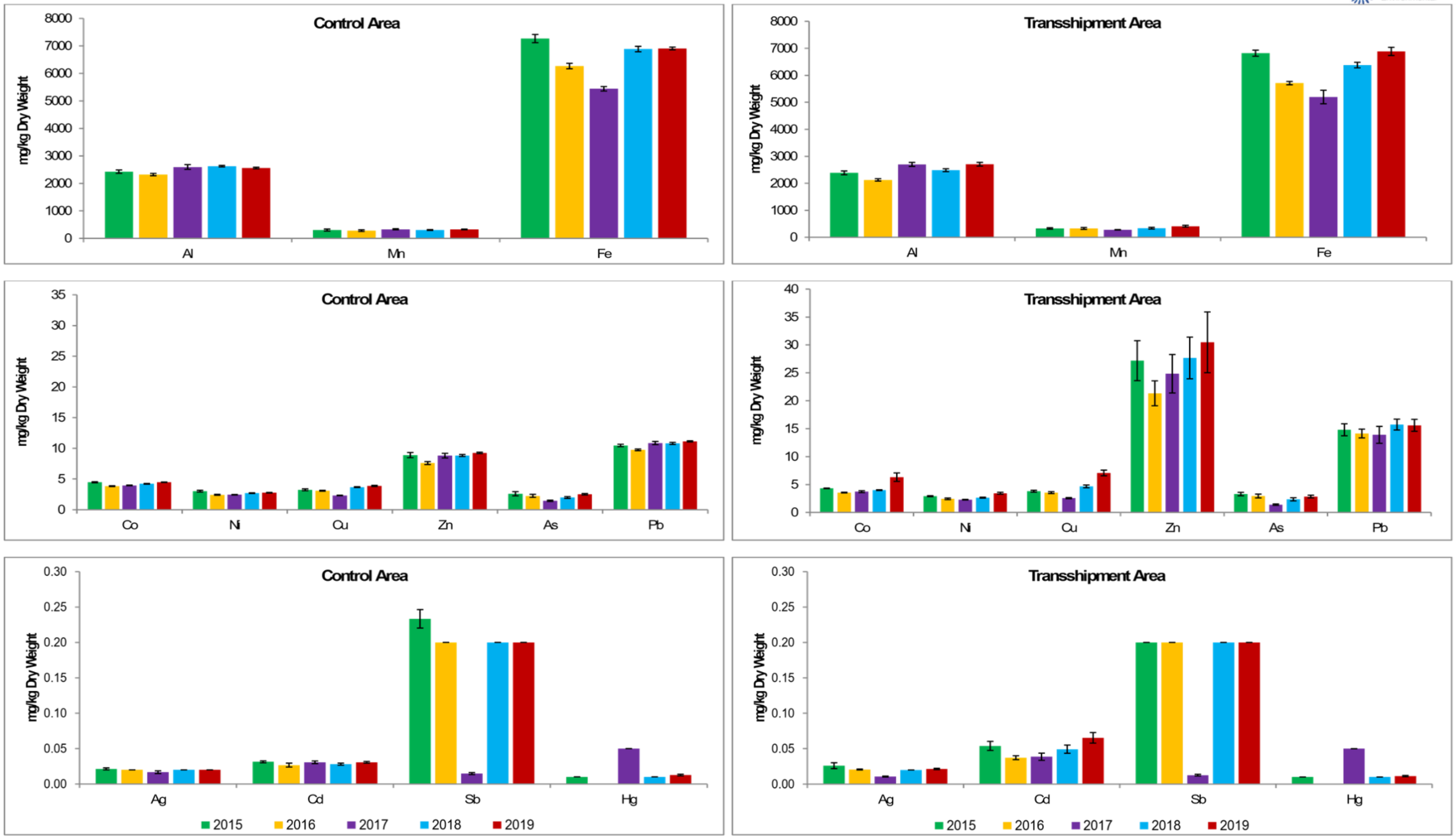


Chart 38: Comparison of Mean Metal Concentrations Within the <63 µm Fraction of Seafloor Sediment Collected between 2015 and 2019

4.8 Reconciliation of Water Management Commitments and Actions

A reconciliation of the water management commitments and actions is provided in Appendix B.

5 Discussion

This section provides a holistic review of the environmental performance at the Mine site over the reporting period. A weight-of-evidence assessment has been undertaken by considering results of key monitoring programs to determine whether there are any areas of environmental risk that require further management to ensure the protection of the McArthur River beneficial uses and community values from mining impacts.

Source Pathway Receptor Conceptual Site Model

A source-pathway-receptor (SPR) conceptual site model has been developed by MRM to determine environmental risks from potential contaminant sources (e.g. areas of the Mine associated with high environmental risk) to a receptor (e.g. McArthur River). This is summarised in Figure 38.

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

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

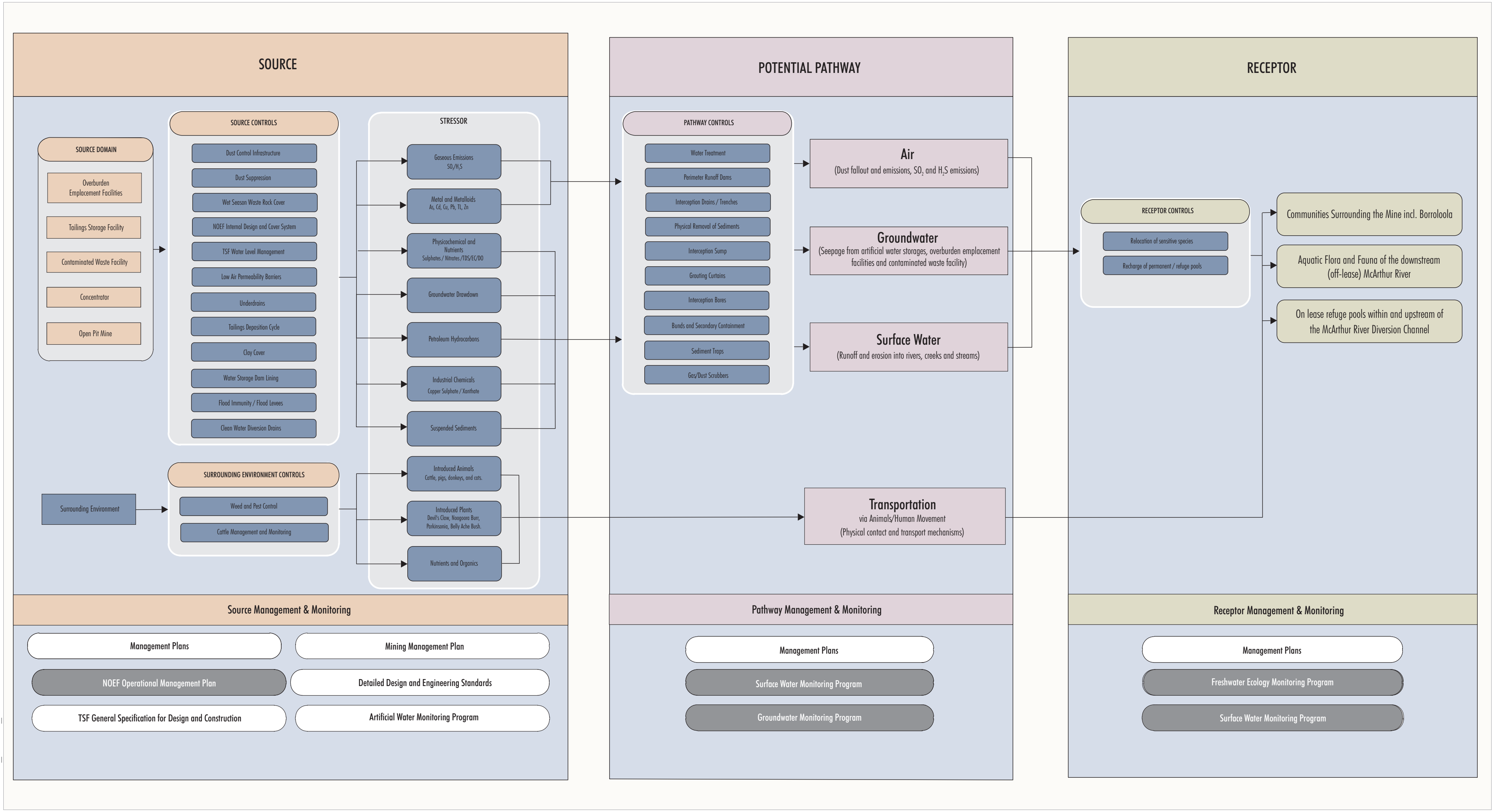
Principal sources of environmental risk at the Mine include the release of acid mine drainage and the transport of potential contaminants associated with mining and processing activities. Practices that prevent or limit these sources are the most effective controls for minimising potential risk to the receiving environment.

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

The potential receptors of the contaminants of potential concern at the Mine are the aquatic flora and fauna of the downstream (off lease) McArthur River and communities surrounding the Mine. Air quality and metals in aquatic fauna monitoring results for the reporting period indicate that there was very low risk of impacts to community health from the Mine. Therefore, discussion in this section focuses on potential ecological impacts to the McArthur River.

A holistic analysis of dust, surface water, fluvial sediment, macroinvertebrate and biota monitoring data has been completed for sites along, and proximal to, Surprise Creek, Barney Creek and the McArthur River. Emu Creek was excluded from the holistic assessment as the mining activities during the reporting period are further away and monitoring data indicates that there are no environmental risks of concerns for Emu Creek. Using the SPR model, and based on the findings of the specialists' monitoring reports, the key sources, stressors and pathways have been identified as those listed in Table 30.

With respect to the health of the downstream McArthur River, monitoring data indicate that the potential impacts to Surprise and Barney Creeks are of higher consequence than the direct impacts on the McArthur River.



MRM-16-01_EMR2020_001A

McARTHUR RIVER MINE

Source - Pathway - Receptor Conceptual Site Model

Figure 38

TABLE 30: SUMMARY OF KEY SOURCES, STRESSORS AND PATHWAYS

Domain	Source	Stressor	Pathway	Catchment Reported to
NOEF	Waste rock (dust from hauling) PRODs	Metals and metalloids Physicochemical and nutrients Suspended sediment	Surface water runoff Air Groundwater (basal seepage)	Barney Creek Surprise Creek
Mill	Mill and processing plant (dust)	Metals and metalloids	Surface water runoff Air	Barney Creek
		Metals and metalloids Physicochemical and nutrients	Groundwater	Barney Creek
TSF	Tailings Active cell process water	Metals and metalloids Physicochemical and nutrients	Groundwater	Surprise Creek
		Metals and metalloids Physicochemical and nutrients Suspended sediment	Surface water runoff Air	Surprise Creek
Open Pit	Open Pit and water storages	Metals and metalloids Physicochemical and nutrients	Groundwater	Largely contained within Open Pit and its catchment

Climatic Conditions over the Reporting Period

Climatic conditions are known to significantly influence the natural environment in the vicinity of the Mine, in particular the McArthur River and its tributaries. Whilst total rainfall over the reporting period was recorded as being above average, the majority of this rain (greater than 97%) fell during the delayed 2019-2020 wet season, with the first significant rainfall occurring on 7 January 2020.

As a result, periods of stream connectivity in the main tributaries surrounding the Mine were greatly reduced during the reporting period, compounded by the effects of the 2018-2019 wet season recording the lowest flows and rainfall of any year since 2008 (approximately 200 millimetres below average). For example, Aquatic Fauna Abundance and Diversity Monitoring was attempted at nine sites along the Barney Creek and Diversion Channel during the late dry season, each of which typically contain aquatic fauna during the early dry season, but all were found to be dry.

Surprise Creek

Surprise Creek is an ephemeral creek originating from the west of the Mine that flows north of the TSF and south of the NOEF into the Barney Creek Diversion Channel. No flow was reported at any sites along Surprise Creek between May 2019 and late December 2020.

The main sources of mining-related contaminants of potential concern reporting to Surprise Creek have been identified as:

1. groundwater seepage from the TSF;
2. groundwater seepage from SPROD and the NOEF; and
3. dust generated at the TSF and NOEF that is deposited within the Surprise Creek catchment and subsequently transported to Surprise Creek in surface water runoff.

Waters in Surprise Creek are fresh upstream of the TSF, with sulphate and salinity concentrations increasing adjacent to and downstream of the TSF. Sulphate and salinity concentrations, then subsequently dilute and decrease further downstream, but increase again increase south of slightly in sulphate when close to the NOEF.

Groundwater quality at sites near to the TSF were generally consistent with historical observations and no adverse trends of concern were observed. The TSF-influenced baseflow to Surprise Creek is the main contributor to elevated water salinity, however, this is expected to improve after the TSF Interception Trench has been commissioned in late 2020 (Plate 21).

Despite the increasing historical trend, sulphate and pH concentrations around SPROD were generally stable during this monitoring period, with a number of notable exceptions. These included an increase in sulphate and a decrease in pH recorded at monitoring site GW159S (located immediately west of SPROD) in March 2020. These also included decreasing sulphate trends at monitoring bores south of SPROD which historically recorded some of the highest sulphate concentrations (GW17007 and GW17009). The overall improving trend at monitoring bores down hydraulic gradient of SPROD is expected to further improve as SPROD was HDPE-lined prior to the 2019-2020 wet season (Plate 21).

Metal concentrations in surface water were generally consistent with historical observations, with a number of samples recorded at the limit of reporting when consistent flows were observed (e.g. Pb, Cd, Cu). Concentrations were also lower for a number of analytes compared to previous years.

Fluvial sediment concentrations along Surprise Creek were generally consistent with historical concentrations. The bioavailable concentrations of arsenic, cadmium and copper in fluvial sediments from all sample sites were found to be below the relative SQGV.

Bioavailable concentrations of lead in fluvial sediments collected at a number of sites within Surprise Creek was found to exceed the SQGV but not the SQGV-High value. All sites that exceeded the SQGV for lead were within or directly adjacent operational areas. This finding is consistent with years prior, however, concentrations of lead recorded during 2019 at potentially impacted Surprise Creek sites were lower than those for the previous reporting period.

Following an exceedance of the SQGV for bioavailable zinc in fluvial sediment at Sites FS36 in the previous reporting period, all sites along Surprise Creek were below the SQGV level during the current reporting period.

While some elevation of analyte concentrations is observed downstream of operational areas, no adverse trends in surface water or fluvial sediment were identified at sites along Surprise Creek. Importantly, there were no exceedances of the MPCs for lead recorded at biota monitoring sites along Surprise Creek. The contribution of lower quality baseflow on Surprise Creek is expected to improve following the commissioning of the TSF Interception Trench and HDPE-lining of SPROD.

Plate 21: Construction of the TSF Interception Trench (top) and HDPE Lining of SPROD (bottom)

Barney Creek

Barney Creek is an ephemeral creek originating from the southwest of the Mine that flows through the Barney Creek Diversion Channel around the western and northern perimeter of the mine levee wall and into the McArthur River. No flow was reported at any sites along Barney Creek between May 2019 and early January 2020.

The main potential sources of mining-related contaminants of potential concern reporting to Barney Creek have been identified as:

1. dust from the Mill and associated handling and transportation of raw and product materials in this area.
2. dust associated with haulage of waste rock over the Barney Creek Bridge.
3. groundwater seepage from the SEPROD and the NOEF in the lower reach of the Barney Creek Diversion Channel.
4. groundwater seepage from the Mill area to the upper reach of the Barney Creek Diversion Channel.

Groundwater impacts along Barney Creek Diversion Channel are predicted to occur over the life of mine, with the more conservative elements (such as sulphate) reporting to the diversion channel in the short- to medium-term and dissolved metals predicted to report to the diversion channel in the long-term as the natural attenuation in the aquifer is limiting the rate of migration of dissolved metals. In terms of potential impacts to the receiving environment, other contamination pathways (e.g. dust fallout landing within the catchment) are considered to be more relevant to water and sediment quality in the Barney Creek Diversion Channel over the short term. Notwithstanding, the concentrations of contaminants of potential concern have been considered to identify any potential unexpected trends or risks associated with groundwater.

There were no discharges or releases from the WMD, MLDP or SEL1 DP during the reporting period.

Groundwater concentrations for sulphate, pH and zinc in the area between the Mill and Barney Creek Diversion Channel remain stable and no adverse trends have been identified. This is likely due to the Open Pit drawing the water table down in this area creating an eastward flow away from the Barney Creek Diversion Channel. Groundwater bores in the vicinity of SEPROD continued to record relatively higher sulphate concentrations, however, these concentrations are within the OMP EIS predictions. Groundwater at this location is likely affected by SEPROD seepage and is showing a generally improving trend despite lower rainfall.

Metal concentrations in surface water were generally consistent with historical observations. Notable decreases in concentrations of sulphate, EC and zinc were observed at sites along Barney Creek compared to previous years. No adverse surface water quality trends have been identified at sites along Barney Creek.

Based on the monitoring data, the primary sources contributing to the metals in the Barney Creek Diversion Channel fluvial sediment are dust associated with the Mill area and haulage of waste rock across Barney Creek Haul Road Bridge. Deposited dust landing within the Barney Creek catchment can be transported to Barney Creek via surface water runoff in the catchment.

Consistent with the previous two reporting periods, total dust deposition measured as total insoluble matter was highest adjacent to the Barney Creek Bridge. However, the highest lead and zinc dust loads have been identified at sites in close proximity to the Mill (due to the processing and handling of high materials with high concentrations in this area), which recorded the next highest level of total deposited dust. These two dust sources are considered to be the primary contributors to the elevated metal concentrations in fluvial sediment and biota at sites along the Barney Creek Diversion Channel.

Data attained during the reporting period identified decreases in the concentrations of analytes associated with the Mine within dust, fluvial sediment and biota when compared to the previous reporting period. It is likely that the removal of zinc and lead rich sediment at FS19 played a role in reducing concentrations directly downstream at FS20 and FS06 during 2019 (Plate 22). In addition, the Barney Creek Bridge 'wings' were extended prior to the wet season to reduce surface water runoff reporting from the bridge into Barney Creek.

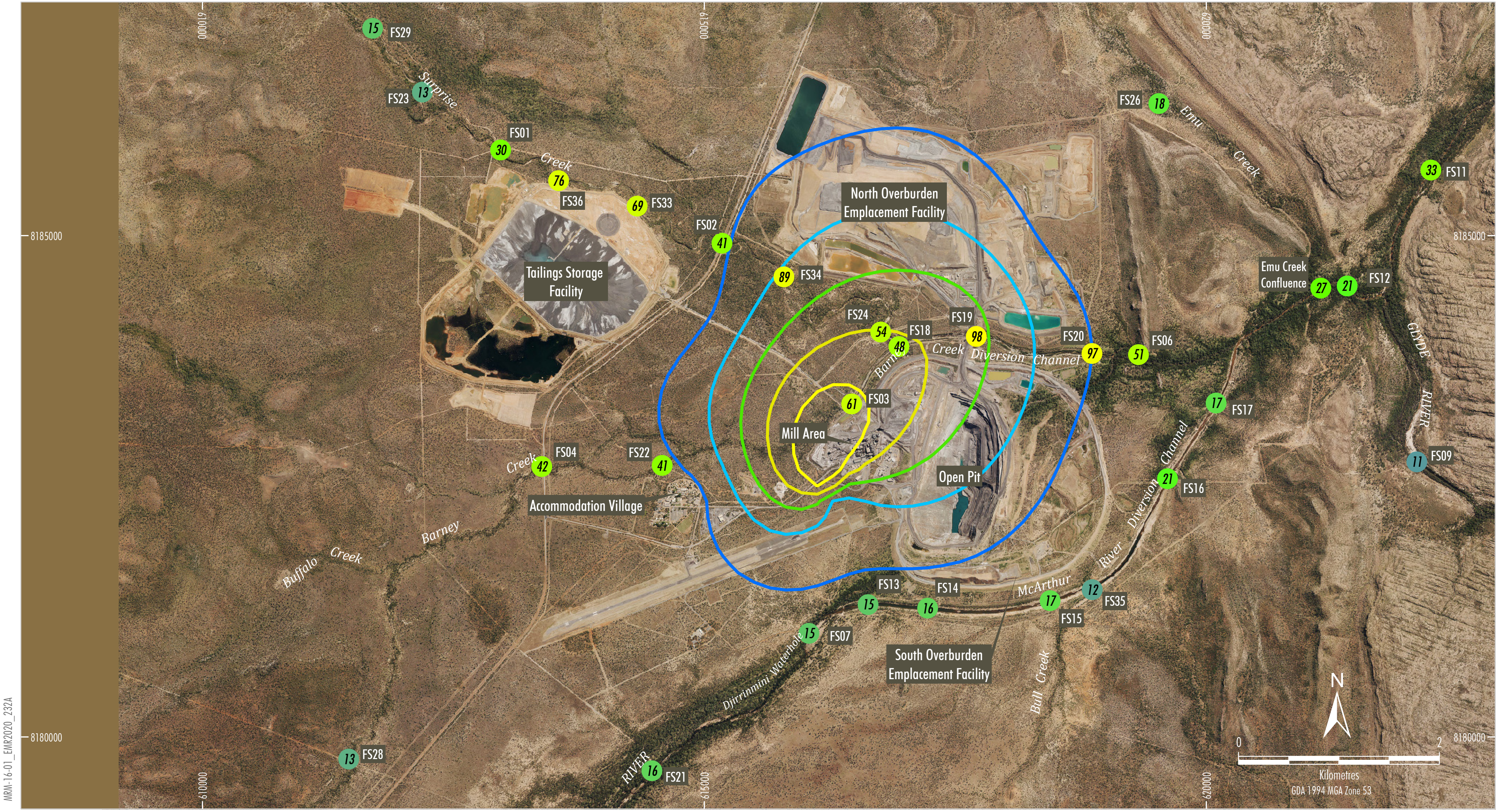
However, the elevated concentrations of lead in fluvial sediment along the Barney Creek sites downstream of the Mill has resulted in the mean lead concentration of *M. splendida* at FS03 (adjacent the Mill) of 0.575 mg/kg, which marginally exceeded the current MPC for lead in fish of 0.5 mg/kg. However, this was less than half the concentration recorded at this site in 2018 of 1.26 mg/kg. Consistent with previous years was the finding that *M. splendida* collected from sites directly adjacent operational areas within Barney and Surprise Creeks exhibit lead concentrations five to ten times higher than other sites. This finding correlates with the fluvial sediment monitoring which recorded an exceedance of the SQGV for bioavailable lead at sites near the Mill area and Barney Creek Bridge.

The correlation between the dust lead loads and fluvial sediment lead concentrations is depicted on Figure 39, and between dust lead loads and biota lead concentrations on Figure 40. Similarly, the correlation between the dust zinc loads and fluvial sediment zinc concentrations is depicted on Figure 41, and between dust zinc loads and biota zinc concentrations on Figure 42

IPE recommends investigating the viability of extending this remediation program to include the lower reach of Barney Creek in the vicinity of FS20 and FS06 to further reduce the likelihood of this sediment reaching the McArthur River.

Overall, the contribution of loads from dust to the local surface water system is considered to be the main driver of fluvial sediment quality and concentrations of metals in biota.

Plate 22: Sediment Removal from Barney Creek and Barney Creek Bridge Sump



LEGEND

Annual Average Lead Load in Deposited Dust (mg/m²/month)

- 1
- 2
- 3
- 4
- 5

May 2019 Bioavailable Lead in Fluvial Sediment Results

41 May 2019 Bioavailable Lead in Fluvial Sediment Results (mg/kg)

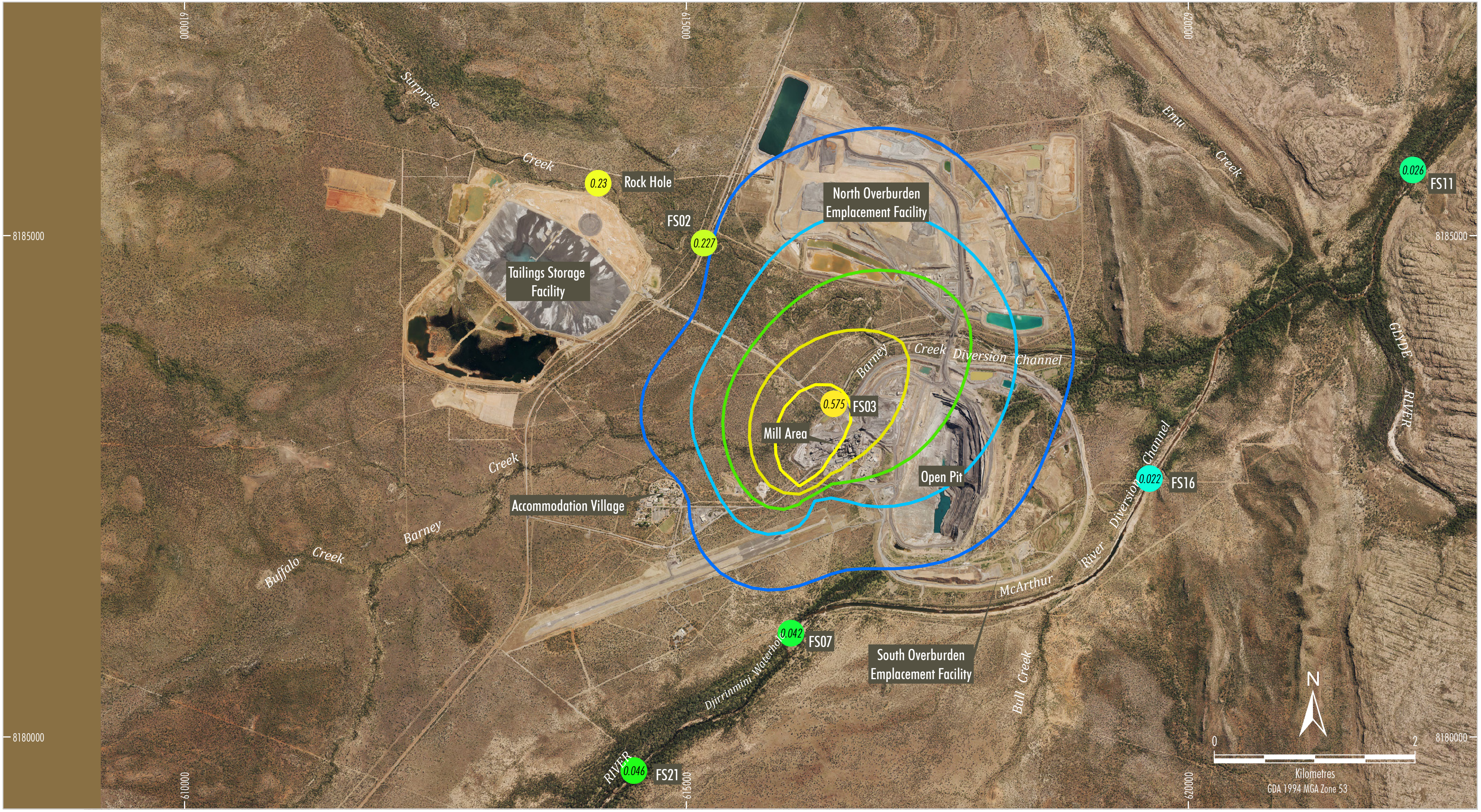
220 (SQGV - High)
100
50 (SQGV)
0

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2020)

McARTHUR RIVER MINE

Annual Average Lead in Deposited Dust and May 2019 Fluvial Sediment Results for 2019/2020

Figure 39



LEGEND

Annual Average Lead Load in Deposited Dust (mg/m²/month)

- 1
- 2
- 3
- 4
- 5

Annual Average Lead in Aquatic Fauna

0.227 Annual Average Bioavailable Lead in *M.splendida* Trunk Average (mg/kg)

Note: *M.splendida* is only one of three environmental indicator species collected.

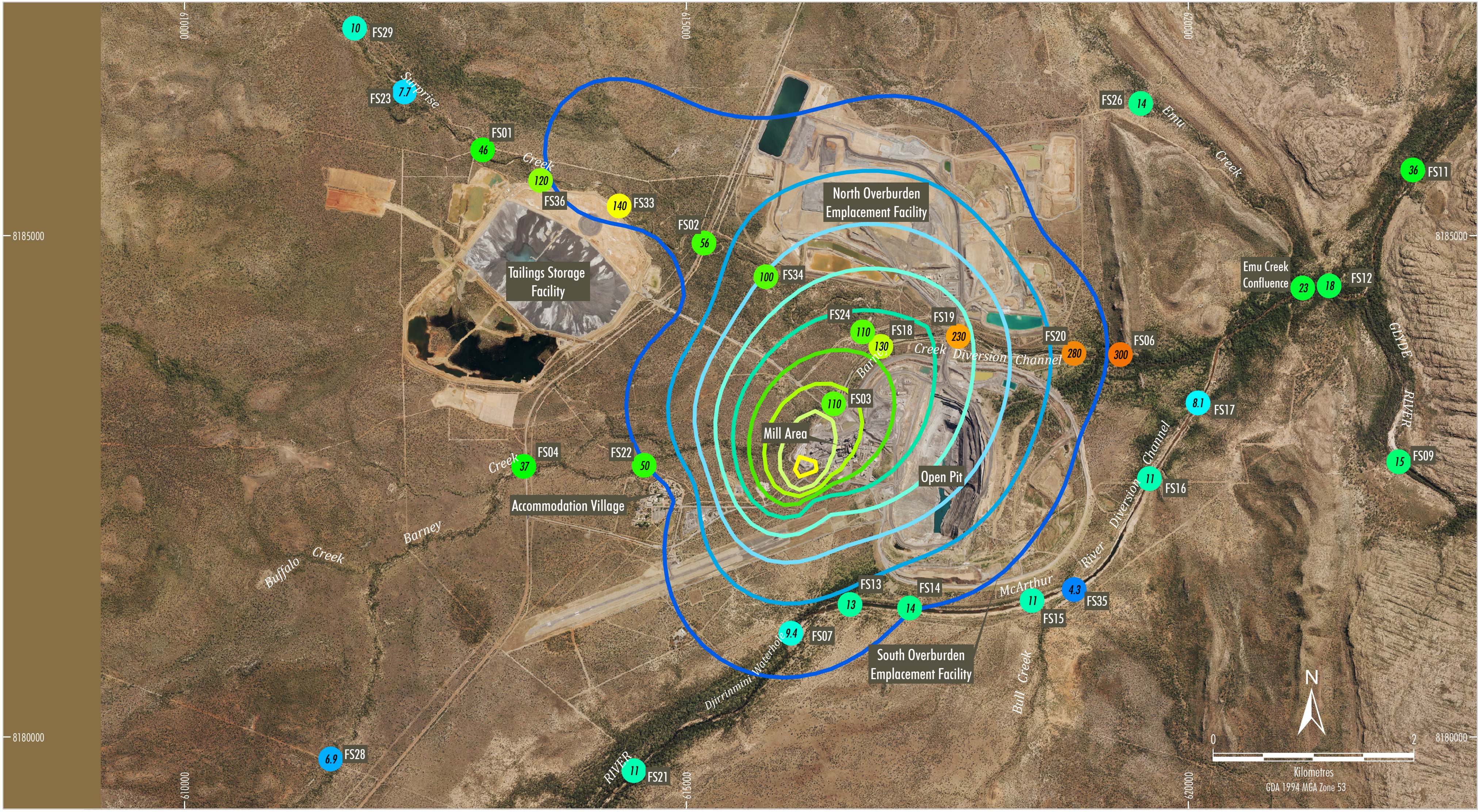
1.0
0.5 (MPC)
0

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2020)

McARTHUR RIVER MINE

Annual Average Lead in Deposited Dust and Aquatic Fauna for 2019/2020

Figure 40



LEGEND

Annual Average Zinc Load in Deposited Dust (mg/m²/month)

10
20
30
40
50
60
70
80
90

May 2019 Bioavailable Zinc in Fluvial Sediment Results

May 2019 Bioavailable Zinc in Fluvial Sediment Results (mg/kg)

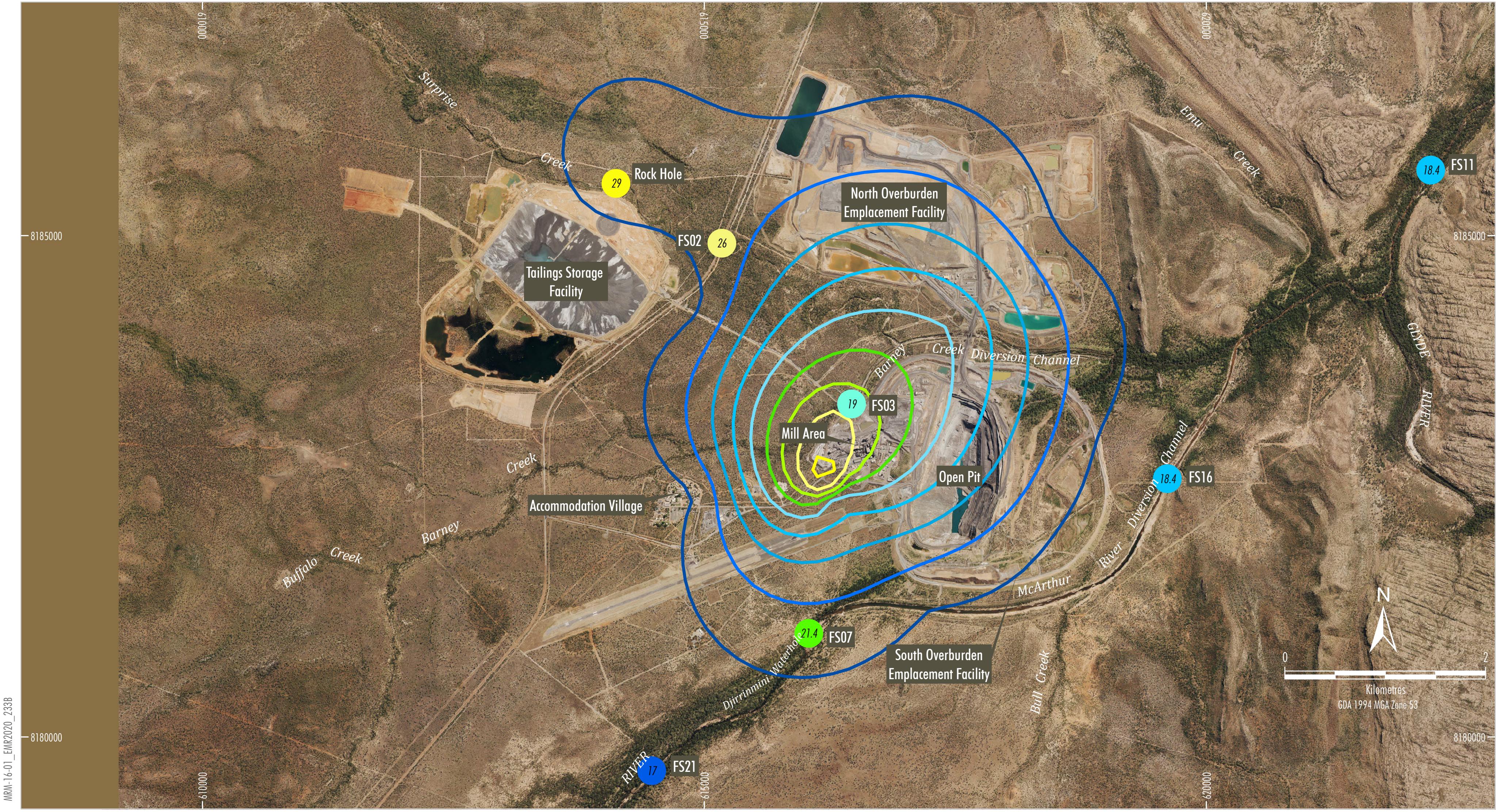
410 (SQGV-High)
300
200 (SQGV)
100
0

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2020)

McARTHUR RIVER MINE

Annual Average Zinc in Deposited Dust and May 2019 Fluvial Sediment Results for 2019/2020

Figure 41



LEGEND

Annual Average Zinc Load in Deposited Dust (mg/m²/month)

10
20
30
40
50
60
70
80
90

Annual Average Zinc in Aquatic Fauna

21.4 Annual Average Bioavailable Zinc in *M.splendida* Trunk Average (mg/kg)

Note: *M.splendida* is only one of three environmental indicator species collected.

Source: Orthophoto MRM (2018); Department of Environment and Natural Resources (2016); MRM (2020)

McARTHUR RIVER MINE

Annual Average Zinc in Deposited Dust and Aquatic Fauna for 2019/2020

Figure 42

McArthur River Health

No elevated results beyond the SSTVs for the key metals of concern (zinc, lead, cadmium, copper, arsenic) have been identified at SW11 over the reporting period. Historically, sulphate concentrations were occasionally elevated beyond the SSTV, but in recent years the records have shown an improvement in performance, with no results beyond the sulphate SSTV since 2015.

The results beyond the SSTVs at SW11 identified in the reporting period were restricted to filtered aluminium, filtered iron, nitrate and dissolved oxygen. No elevated results beyond SSTVs were found to be related to Mine activities and are considered to be as a result of natural river processes and contributions from areas upstream of the Mine or in the neighbouring Glyde River catchment.

Overall, the fluvial sediment and biota monitoring showed that the Mine's operations continue to have little measurable effect on the McArthur River, and that elevated tissue metal concentrations are limited to Barney and Surprise Creek sites within operational areas.

In addition, the current data continues to support past conclusions that there has been no observable decline in species diversity or abundances in waters upstream and downstream of the mineral lease, outside of that which would be considered to be natural variation as a result of variable seasonal flows or changes in river bed morphology.

Conclusions and Recommended Management Measures

The holistic assessment using the SPR model identified that deposited dust from the Mill and haulage of materials across the Barney Creek bridge are the main contributors to elevated metals in fluvial sediment and biota along Barney Creek. The measures and investigations outlined in Table 31 will be carried out during the next reporting period to reduce the potential risk to biota associated with dust from these sources.

TABLE 31: DUST MITIGATION MEASURES TO BE UNDERTAKEN DURING THE NEXT REPORTING PERIOD

Identified Contaminant Source	Measures to be Undertaken in next Reporting Period	Timing
Dust impacts associated with haulage across Barney Creek Bridge	• Trial of dust suppression binders / additives for watering of haul roads. • Investigate the viability of extending the sediment removal program to include the lower reach of Barney Creek in the vicinity of FS20 and FS06. This will be dependent on safe machinery access, AAPA and water licensing approvals. • Annual assessment and management of sediments along the Barney Creek batters, sump and creek bed near the Barney Creel Bridge. • Further planned use of the newly commissioned water trucks to reduce wheel-sourced dust from vehicle movements.	2020-21 reporting period.
Dust impacts associated with the Mill operations	• Trial of dust suppression binders / additives in the Mill area. • Investigate options for providing a clean water source to the Primary Crusher/ ROM hopper, to allow for improved operation of the recently installed dust suppression system. • Further planned use of the newly commissioned water trucks to reduce wheel-sourced dust from vehicle movements.	2020-21 reporting period.

In consideration of all monitoring results for the reporting period, the performance required to protect the downstream beneficial uses and environmental values of the McArthur River is being achieved and the current monitoring and management measures being implemented are appropriate, with the recommended additional measures to further reduce the risk associated with lead fallout.

Groundwater trends continue to remain generally stable and within the predictions of the OMP EIS. However, the elevated sulphate concentration detected at monitoring site GW159S, together with elevated salinity, zinc and lead concentrations, should be investigated to determine the cause and if further action is required.

6 Incident Reporting

A reconciliation of all environmental incidents at the Mine internally and externally reported from 1 May 2019 to 30 April 2020 is provided in Appendix Z.

This includes incidents which were reported to DPIR under section 29 of the *Mining Management Act* and the NT EPA under section 14 of the *Waste Management and Pollution Control Act*.

Information recorded when an incident is identified includes the following:

- Incident number (used for tracking purposes).
- The date of the incident.
- A brief description of the findings of the investigation following incident identification.
- Actions taken.
- Any further actions required.

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8 Abbreviations

Acronym	Definition
%	per cent
2013-2015 MMP	2013-2015 Mining Management Plan
ACL	added contaminant limits
Ag	silver
Al	aluminium
AMMP	annual marine monitoring program
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Governments
AQMP	Air Quality Management Plan
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
As	arsenic
B	boron
BBDDP	Bing Bong Dredge Spoil Discharge Point
BBDS	Bing Bong Dredge Spoil
BBLF	Bing Bong Loading Facility
Bi	bismuth
CCLs	compacted clay liners
Cd	cadmium
cm	centimetres
Co	cobalt
CoC	Contaminant of Concern
CPCe	Coral Point Count with Excel extension
Cr	Chromium
CRP	Concentrator Runoff Pond
Cu	copper
CW	Central West
CWAS	CW Alpha Sump
CWCST	CW Charlie Sediment Trap
DAE	dilute acid extraction
DBH	Diameter at Breast height
DENR	NT Department of Environment and Natural Resources
DGT	diffusive gradients in thin films
DME	NT Department of Mines and Energy
dmtpa	dry metric tonnes per annum
DoH	Department of Health
DPIR	NT Department of Primary Industry and Resources
DSD	Dredge Spoil Drain
EC	electrical conductivity
EIL	ecological investigation levels
EIS	Environmental Impact Statement
EMS	Ecological Management Services Pty Ltd

Acronym	Definition
EMM	EMM Consulting Pty Ltd
Environmental Assessment Act	NT Environmental Assessment Act, 1982
EPROD	Eastern Perimeter Runoff Dam
ESP	exchangeable sodium percentage
EST	East Sediment Trap
EVASE	Eastern Vent Raise
F	fluoride
Fe	iron
FSANZ	Food Standards Australia and New Zealand
g/m^2/month	grams per square metre per month
GHD	GHD Pty Ltd
ha	hectares
HDPE	high density polyethylene
Hg	mercury
HIL	health-based investigation levels
HMP	Heavy Medium Plant
HMTV	Hardness Modified Tigger Value
HVAS	High Volume Air Sampler
ICP-AES	Cold Vapour Generation Inductively Coupled Atomic Emission Spectrometry
ICP-MS	inductively coupled plasma mass spectrometry
IM	Independent Monitor
IPE	Indo-Pacific Environmental
ISQG	interim sediment quality guideline
IV	interim value
KBA	Key Biodiversity Area
km	kilometres
kt	kilotonnes
L	litres
L/s	litres per second
LFDPE	low-density polyethylene
LFZ	Lower Fold Zone
LGO	low-grade ore
LOM	Life of Mine
LWD	large woody debris
m	metres
m^3	cubic metres
mAHD	metres Australian Height Datum
Mg	manganese
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
Mining Zone	mining activity throughout the lease
ML/day	megalitres per day
mm	millimetre
Mo	molybdenum
MOE	Ontario Ministry of the Environment

Acronym	Definition
MOL	Maximum Operating Level
MPC	Maximum Permitted Concentration
MRM	McArthur River Mining Pty Ltd
Mt	million tonnes
MTL	Maximum tolerable Level
Mtpa	million tonnes per annum
MUDS	Mine Underground Dewatering System
NAF	non-acid forming
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measures
Ni	nickel
NO_3	nitrate
NOEF	North Overburden Emplacement Facility
NRETAS	NT Department of Natural Resources, Environment, the Arts and Sport
NRR	Nathan River Resources
NSW EPA	New South Wales Environment Protection Authority
NT	Northern Territory
NT EPA	NT Environment Protection Authority
OMP	Overburden Management Project
OP ELS	Open Pit East Levee Storage
OP P2	Open Pit Pond 2
ORPS	Old ROM Pad Sump
PAF	potentially acid forming
Pb	lead
PbIR	Pb isotope ratios
PDAC	Present Day Average Crustal
PER	Public Environmental Report
ppm	parts per million
QA/QC	quality assurance and quality control
Reference Zone	sites well out of the mining lease
RMP	Rehabilitation Management Plan
RMP	Revegetation Monitoring Procedure
RMP	Rehabilitation Management Plan
ROM	run-of-mine
RP	Release Point
RPD	relative percent difference
RRV	Ross River virus
S	sulphur
SAR	sodium absorption ratio
Sb	antimony
Se	selenium
SO_2	sulphur dioxide
SPROD	South Perimeter Runoff Dam
SQGVs	sediment quality guideline values

Acronym	Definition
SRP1	Site runoff pond 1
SRP2	Site runoff pond 2
SRP3	Site runoff Pond 3
SSTV	site-specific trigger values
SWA	Safe Work Australia
SWST	South West Silt Trap
t	tonne
TA	Transhipment Area
TARP	Trigger Action Response Plan
TBA	Total Basal Area
TDS	total dissolved solids
TEOM	Tapered Element Oscillating Microbalance
the Mine	McArthur River Mine
TAS	Todoroski Air Sciences Pty Ltd
Tl	thallium
TPH	Total Petroleum Hydrocarbons
TSF	Tailings Storage Facility
UG&OP	underground void and open pit
USEPA	United States Environmental Protection Authority
U	uranium
VDD	Van-Duncan's Dam
VOA	Variation of Authorisation
WC	Western Control [zone]
WDS	West D Sump
WMD	Water Management Dam
WOEF	West Overburden Emplacement Facility
WPROD	Western PAF Run-Off Dam
WRM	WRM Water & Environment Pty Ltd
WTP	Water Treatment Plant
XRF	X-Ray Fluorescence
Zn	zinc
µg/L	micrograms per litre
$\mu g/m^3$	micrograms per cubic metre
µm	micrometre

McArthur River Mining

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