



McArthur River Mine Independent Monitor

Surface Water Audit

31 May to 01 June 2023

Advisian
Worley Group

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Acronyms and abbreviations

Acronym/abbreviation	Definition
AEP	Annual Exceedance Probability
AEPAR	Annual Environmental Performance Audit Report
AMD	Acid and Metalliferous Drainage
ANCOLD	Australian National Committee on Large Dams
APP	Mill Anti-Pollution Pond
ARI	Average Recurrence Interval
CRP	Mill Concentrator Runoff Pond
DITT	Department of Industry, Tourism and Trade
EMR	Environmental Monitoring Report
EPBC	Environment Protection and Biodiversity Conservation Act 1999
EPROD	Eastern Perimeter Runoff Dam
ISO	International Organisation for Standardisation
MMA	Mining Management Act
MMP	Mining Management Plan
MRM	McArthur River Mine
NOEF	North Overburden Emplacement Facility
NT EPA	Northern Territory Environment Protection Authority
OFI	Opportunities for Improvement
PbOx	Lead Oxide
PROD	Perimeter Runoff Dam
RO	Reverse Osmosis
SPROD	Southern Perimeter Runoff Dam
SEPROD	South Eastern Perimeter Runoff Dam
TARP	Trigger Action Response Plan
TSF	Tailings Storage Facility
WDL	Waste Discharge Licence
WMD	Water Management Dam
WTP	Water Treatment Plant

Executive Summary

Advisian was commissioned by the Northern Territory Government Department of Industry Tourism and Trade (DITT) to provide Independent Monitor services for the McArthur River Mine (the Mine) as required by the Independent Monitoring Assessment Conditions of Authorisation 0059. This report presents the findings of a surface water site audit conducted between 31 May and 01 June 2023.

This audit considers the Operator's surface water management and monitoring procedures applicable to protecting the health of McArthur River from mine related impacts. The audit addresses Operator surface water processes associated with the water classification system, water quality monitoring, treatment and operations management.

The audit provides a review of surface water management activities, including the following considerations:

- Adequacy of the Surface Water Monitoring Program and fieldwork practices
- The Mine's operational water management practices including water classification, storage, inventory, treatment and managed release
- Surface water management and monitoring against stated key objectives.

Based upon the surface water quality monitoring data, the Mine continued to implement effective controls to minimise the risk of environmental harm to receiving waters of the McArthur River. The surface water monitoring results in 2022 demonstrate a high level of compliance with the Waste Discharge Licence (WDL) site-specific trigger values, in particular at the McArthur River downstream compliance point SW11.

The accumulation of Lead Oxide (PbOx) in surface water storage dams, e.g. Eastern Perimeter Runoff Dam (EPROD), is a potential risk and requires continued attention. The gypsum water treatment plant is being built to provide more capacity to treat PbOx water with construction scheduled for completion in late-2024.

This audit assessed the Operator as achieving an overall "very good" level of implementation of the Water Management Plan (WMP) through actions to address requirements, including:

- A comprehensive water management system to prevent contaminated water from entering the river system
- A system of water storages that segregates different water classes to minimise the volume of poor quality water and process water produced and maximise the reuse opportunities for cleaner water classes
- A network of interconnecting pipelines to allow water to be transferred between PRODs, Water Management Dam and process water dams to maintain a balance of water storage capacity and avoid overtopping.

This audit highlights some medium and longer-term opportunities for improvement in relation to ongoing review of the status of Acid and Metalliferous Drainage (AMD) storage liners, confirming the Concentrator Runoff Pond and Anti-Pollution Pond performance against design criteria and the commissioning of the gypsum water treatment plant to treat stored PbOx water.

The Mine has documented the managed surface water release process to comply with WDL requirements. There were no water releases to the McArthur River in the 2022/2023 reporting period.

The WMP is supported by numerous surface water monitoring programs and operational management processes that have been implemented to avoid or limit the potential transportation of contaminants to the receiving environment.

The audit has found surface water operational management and monitoring programs combine well to support the overarching environmental objective to protect the health of the McArthur River from mine related impacts.

1 Introduction

Advisian was commissioned by the Northern Territory Government Department of Industry Tourism and Trade (DITT) to provide Independent Monitor services for the McArthur River Mine (the Mine) as required by the Independent Monitoring Assessment Conditions of Authorisation 0059. This report presents the findings of a surface water site audit conducted between 31 May and 01 June 2023.

The Independent Monitor's environmental performance assessment of surface water is intended to provide transparency to the community regarding:

- Actions the McArthur River Mine Operator (the Operator) has undertaken to maintain continuous improvement in environmental performance of the Mine
- Achievement of the overarching environmental outcome arising from the Northern Territory Environment Protection Authority (NT EPA) assessment of the Overburden Management Project i.e. protect the health of McArthur River from mine related impacts at all times.

This audit considers commitments and safeguards of the Operator's surface water management and monitoring procedures as relevant to the receiving environment, including protecting the health of McArthur River from mine related impacts. The audit addresses Operator processes associated with the water classification system, water quality monitoring, treatment and operations management as documented in the Water Management Plan (WMP), version 2.0, 13 May 2022.

1.1 Audit Objectives

The review of environmental performance of the Mine considered in this report involves assessment against the audit objectives, including conduct of the following activities:

- Review the adequacy of the Surface Water Monitoring Program and fieldwork practices
- Assess the Mine's operational water management practices including water classification, storage, inventory, treatment and managed release
- Reviewing surface water management monitoring and operational management against stated key objectives.

Relevant surface water monitoring programs and operational activities were considered as part of the audit and opportunities for continuous environmental improvement identified as appropriate.

1.2 Scope – Water Management Plan

The scope of this surface water audit is to assess, using a risk-based approach, the Operator's extent of compliance and performance against the WMP. As such, the audit is focused on the Mine's artificial surface water management which includes the Mine's designated water storage facilities such as dams, ponds, sumps and sediment traps.

The WMP is an overarching management document for surface water with detailed information on identified risks and the various aspects of operational management procedures. The WMP sets out:

- Community values and beneficial uses
- Objectives of the WMP
- Background surface water quality

- Aquatic ecology setting
- Water classification systems
- Key operational factors
- Water management infrastructure
- Water treatment processes
- Controlled release of mine water
- Management tools
- Monitoring programs.

The audit did not consider compliance with regulatory approval conditions or assessment of the following topics:

- Cultural heritage and socio-economics
- Groundwater
- Water recycling
- Freshwater ecology
- Bing Bong Loading Facility
- Operator's supporting procedures (e.g. calibration and use of Hydrolab Quanta procedure)
- Environment Protection and Biodiversity Conservation (EPBC) Act 1999 Approvals 2003/954 and 2014/7210.

This audit has assessed the Mine's performance at a point in time (31 May and 01 June 2023) and has regard to performance over the previous 2 years. The audit findings are based upon samples of information available at the time of the audit as it is not possible to review all information.

1.3 Regulatory Framework

The Mine's regulatory requirements in relation to surface water management are covered in Authorisation 0059 issued under the Mining Management Act 2001 (MMA) and Waste Discharge Licence (WDL) 174 granted under the Water Act 1992. Authorisation 0059 also prescribes the roles and responsibilities of the Independent Monitor, including independent assessment of the environmental performance of the Mine. This assessment undertaken by the Independent Monitor is in addition to the environmental performance audit completed annually.

1.4 Context

Surface water movement if not managed appropriately could provide a pathway for potential contaminants from mining related activities to creek, rivers and groundwater creating the potential for environmental harm.

The water management systems at the Mine require flexibility to manage water volumes during pronounced wet and dry seasons, in addition to significant rainfall variations from year to year. This means that the water management systems must accommodate both shortages and surpluses of water, while meeting the water supply demand for mineral processing.

The Mine's water classification system has six water classes based on water quality (Class 1 – clean water to Class 6 – process water). Water at the Mine is managed to separate water classes to minimise

the volume of poor quality water and process water produced and maximise the end use opportunities for cleaner water classes.

The Mine distinguishes between natural surface water and artificial surface water. Natural surface water is found in the creeks and McArthur River near the Mine. Artificial surface water is associated with mining activities and processes and is held in man-made dam, pond and sump storage structures. Figure 1 identifies the Mine's artificial surface water storage locations.

MRM has developed a natural surface water monitoring program that specifies the sampling requirements and procedures for the monitoring of waterways around the Mine to verify water quality compliance. In water storages on the Mine site an artificial surface water monitoring program aims to identify potential contamination, determine risk, identify suitable water storage options and whether offsite discharge is necessary and within licence limits.

The WMP is supported by numerous surface water monitoring programs and operational management processes that have been implemented to avoid or limit the potential transportation of contaminants to the receiving environment, thereby protecting the health of the McArthur River.



Figure 1: Artificial surface water storages locations

Figure courtesy of MRM, Water Management Plan

2 Methodology

2.1 Approach

The approach used to conduct the audit included preparing and undertaking the following:

- Audit framework
- Audit schedule
- Audit plan
- Pre-audit scoping meetings
- Request for Information (RFI)
- Document review
- Site visit opening meeting
- Interviews
- Site inspection
- Site visit closing meeting
- Discussions on matters identified during interviews and document review.
- Audit Report (Draft and Final).

The key document which formed the basis of the audit was the WMP approved as a key component of the Mining Management Plan (MMP) approved under section 36 of the MMA in May 2022.

The WMP sets out key environmental and operational objectives for surface water. These key objectives (Table 2-1) were incorporated into an audit interview questionnaire that was utilised to assess the extent to which objectives have been achieved.

Table 2-1: Water Management Plan objectives

No.	Water Management Plan Key Objectives
1	Protect the McArthur River beneficial uses and community values from mine related impacts
2	Facilitate development of the ecosystems and their functions along the McArthur River Diversion Channel for terrestrial and aquatic flora and fauna
3	Achieve a recovering trend in the water quality and ecosystem function in creeks on the Mine site within 20 years of cessation of mining
4	Manage water resources to ensure continuous water supply for mining and ore processing operations whilst minimising water abstraction and maximising water recycling
5	Manage the operational risk of Open Pit inundation to ensure continuous mining operations and protection of the Mine's assets
6	Ensure water management is conducted in accordance with all MRM's regulatory obligations

Requirements and commitments of the Operator as set out in the WMP were collated into an audit checklist. This checklist provided another means to assess the extent of implementation of the WMP requirements.

2.2 Process

The audit was undertaken in alignment with the approach and principles of the International Organisation for Standardisation (ISO) 19011 (2018) Guidelines for auditing management systems. The key principles underpinning the audit included: integrity; fair presentation; due professional care; confidentiality; independence; and use of an objective evidence-based and risk-based approach.

The level of implementation of each WMP objective (refer Section 3.3) was assessed and a qualitative rating provided i.e. 'very good', 'good', 'satisfactory', 'poor', or 'very poor', using the rating guidelines presented in Table 2-2. In cases where more than one rating was applicable, the most conservative (lowest) score was applied.

Table 2-2: Guidelines for Implementation rating

Rating	Guidelines
Very Poor	Very low level of implementation based on sample evidence Negligible/no evidence of action Lack of plan to address requirement
Poor	Low level of implementation based on sample evidence Limited evidence of action Limited plan to address requirement
Satisfactory	Adequate level of implementation based on sample evidence Medium level of evidence of action Plan to address requirement, but not fully implemented
Good	High level of implementation based on sample evidence High level of evidence of action Implemented a plan to address requirement
Very Good	Very high level of implementation based on sample evidence Very high level of evidence of action Implemented a plan to address requirement

2.3 Reference Documents

The main reference documents considered during the audit are listed in Table 2-3.

Table 2-3: Key Reference Documents

No.	Reference Document	Document Source
1	Water Management Plan as key element of Adaptive Management Plan approved under MMA in May 2022	Operator
2	Environmental Monitoring Report (EMR) 2021-2022 ¹ sections reporting on surface water monitoring	Operator
3	Waste Discharge Licence 174-13 ² ,	DEPWS
4	Independent Monitoring Assessment Conditions, Schedule C of Variation of Authorisation 0059, unchanged since their introduction in 2006 ³	DITT
5	Annual Environmental Audit Performance Report 2022, McArthur River Mine, Independent Monitor ⁴	Advisian

2.4 Audit Team

The audit team consisted of staff from Advisian with relevant experience and qualifications (Table 2-4).

Table 2-4: Audit Report Team Members

Role	Qualifications	Number of Years' Experience
Lead Environmental Auditor	B. Eng., M.Env.Mgmt. Internationally Certified Lead Environmental Auditor	31
Assistant Environmental Auditor	B.Eng. (Env.) Mine Water Engineering Specialist	23
Technical Reviewer	B. Eng. (Mining), M.Env.Mgmt. (Sustainable Development)	20

¹ EMR meets requirements of Environmental Mining Report under MMA

² Waste Discharge Licence available on DEPWS's website - <https://ntepa.nt.gov.au/your-business/public-registers/licences-and-approvals-register/waste-discharge-licences/mining/mrm>

³ Independent Monitor Assessment Conditions available on website - <https://nt.gov.au/industry/mining/decisions/independent-monitor-for-the-mcarthur-river-mine>

⁴ Annual Environmental Performance Audit Report 2022 website - https://nt.gov.au/_data/assets/pdf_file/0010/1181458/aepar-2022.pdf

3 Key Findings

3.1 Overview

Findings of the audit are presented as narratives in the sections below:

- Section 3.2 – Audit observations
- Section 3.3 – Management Plan objectives.

Opportunities for Improvement (OFIs) and notable successes are also documented in these sections. All OFIs identified are collated in Section 4.

The Mine's surface water storage system is comprised of a network of 42 dams, ponds and sumps, refer to Figure 1.

3.2 Audit Observations

This section provides a description and an assessment of the surface water and related potential environmental issues experienced at the Mine, along with potential opportunities for improvement. Observations were compiled from the following activities:


- Mine documentation review, including the WMP
- Key site personnel interviews with:
 - Superintendent, Site Water Management
 - Superintendent, Environment.


Audit observations are set out in Table 3-1. Some observations are a statement of good practice and provide a record of what the site is currently doing well. In the majority of cases of good or satisfactory practices, there are no related actions and 'nil' has been added to the Table 3-1 Opportunities column.

Table 3-1: Audit observations and opportunities for improvement


Aspect	Item	Observations	Opportunities
Water Management Plan	1	<p>The WMP was found to be comprehensive, sophisticated and mature. The plan brings together the surface water management components in a clear and integrated manner, including:</p> <ul style="list-style-type: none"> • Obligations and regulatory requirements • Water classification system • Water balance model • Individual water storage identification, descriptions, and Trigger Action Response Plans (TARPs) • Artificial surface water monitoring programs • Surface water quality analyte monitoring suites and performance triggers 	Nil


Aspect	Item	Observations	Opportunities
		<ul style="list-style-type: none"> Annual surface water monitoring reporting. 	
Water Classification System	2	<p>The mine implements a water classification system with six water classes based on water quality. Water is managed in a way that separates different water classes to minimise the volume of poor quality water and optimise end use opportunities for cleaner water classes.</p> <p>The water classes range from Class 1 water – diverted (clean) water to Class 6 water – process water, described below:</p> <p>Class 1 – diverted (clean) water. This water is from upstream catchments that are unaffected by mining.</p> <p>Class 2 – surface water. This water is typically sourced from cleared areas and benign stockpile areas.</p> <p>Class 3 – treated water permeate. This water is permeate from the reverse osmosis (RO) Water Treatment Plant (WTP).</p> <p>Class 4 – managed release water. This water is typically sourced from surface runoff from cleared areas and/or mine water treated with bulk hydrated lime.</p> <p>This water typically has sulphate and/or metal concentrations that are higher than downstream compliance point trigger values. This water can be used for a number of end uses on site. This water can also be released to the McArthur River when there is sufficient river flow for dilution and in accordance with the WDL 174 conditions.</p> <p>Class 5 – poor quality water. This water class is typically affected by seepage from the Tailings Storage Facility (TSF) and North Overburden Emplacement Facility (NOEF), runoff from areas with exposed non-benign material and/or underground void water. This water class is contained within the Mine water management system.</p> <p>Class 6 – process water. This water is typically used within the Concentrator and TSF as well as other process streams including brine from the RO water treatment plant. This water class is contained within the Mine water management system.</p>	Nil
Artificial Surface Water	3	The artificial water storages network of 42 dams, ponds and sumps are managed to separate different water classes to avoid unnecessary mixing, to minimise the volume of poor quality water and maximise water reuse opportunities.	Nil
	4	<p>The artificial surface water (dams, ponds and sumps) monitoring network at the Mine consists of approximately 50 routine monitoring sites (WMP Figure 16b). The frequency of sampling is dictated by data use and statutory requirements such as WDL 174.</p> <p>A comprehensive artificial surface water environmental monitoring schedule is implemented. Sampling frequency varies from site to site and includes weekly, monthly and event based (e.g. commencement of waste discharge, rainfall events) sampling. The</p>	Nil

Aspect	Item	Observations	Opportunities
		typical suite of analytes monitored at artificial surface water sites is appropriate and listed in WMP Table 18.	
	5	<p>MRM has developed an artificial surface water monitoring program which specifies the sampling requirements and procedures for monitoring of water in designated water storages. The objectives of the artificial surface water monitoring program are to:</p> <ul style="list-style-type: none"> Identify potential contamination in water to determine risk and appropriate management options Identify suitable water storage options, and whether offsite discharge is a viable disposal option Collect data to assess environmental performance and provide information for contamination source investigations. 	Nil
	6	<p>The Independent Monitor witnessed in-field water sampling practices followed by suitably trained and experienced personnel in accordance with the detailed Artificial Surface Water Monitoring Procedure, PRO-2200025. The field monitoring team were observed utilising a field sheet sign-off as part of the water sample chain of custody process.</p> <p>The audit team observed:</p> <ul style="list-style-type: none"> Individual competency procedure section setting out training and qualification requirements for people conducting the sampling Triple rinsed sample bottles Duplicate samples register That water quality meter monitoring equipment is calibrated once per week Water sampling team utilising a gas safety monitoring device, to alert user to any elevated sulphur dioxide or sulphuric acid gases. <p>The surface water monitoring schedule is comprehensive and field practices were observed being implemented in accordance with industry best practice.</p> 	Nil

Aspect	Item	Observations	Opportunities
		 <p><i>Photos 1a and 1b: Artificial surface water monitoring sampling at Southern Perimeter Run Off Dam</i></p>	
Natural Surface Water	7	<p>The natural surface water monitoring site network for the Mine consists of approximately 30 monitoring locations along local waterways. Control and upstream sites are located upstream of the Mine or in unaffected catchments and are used to:</p> <ul style="list-style-type: none"> Identify background water quality concentrations upstream of the Mine Potential Impact sites located onsite or downstream of the Mine which are used to determine compliance with the site-specific trigger values specified in the WDL 174 Water quality monitoring downstream has site specific trigger values not to be exceeded which relate to TARPs. 	Nil
	8	<p>MRM has developed a natural surface water monitoring program that specifies the sampling requirements and procedures for the monitoring of waterways around the Mine site including the McArthur River, Glyde River, Barney Creek, Surprise Creek and Emu Creek. The objectives of the monitoring are to:</p> <ul style="list-style-type: none"> 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 as appropriate with WMP/protocols Identify the potential sources of contamination measured at water monitoring sites Assess the efficacy of controls implemented by MRM to prevent contamination of receiving waters downstream of the Mine site. 	Nil
	9	<p>The audit team were advised:</p> <ul style="list-style-type: none"> 33 natural surface water monitoring sites are sampled weekly Team of five full time people conducting sampling Some sample locations are not accessible by 4WD in the wet season and alternative access is by helicopter. 	Nil

Aspect	Item	Observations	Opportunities
Regulatory Compliance	10	The Environment team advises the water quality regulatory requirements contained in the Authorisation and WDL to the Superintendent, Site Water Management.	Nil
	11	Regulatory compliance activities were observed being effectively implemented over the two days of the audit. The Surface Water Monitoring Program results, performance and trends for surface water management are reported annually in the EMR. The Mine has achieved very high levels of regulatory compliance in the audit period. Refer to AEPAR 2022 (01 May 21 to 30 April 22) Sections 3.2 and 3.3 for the Independent Monitor's compliance audit findings for the Authorisation and WDL, respectively.	Nil
	12	The Mine's Obligations Register contains the relevant surface water WDL and Authorisation conditions. The Mine's Environmental Compliance team captures any WDL or Authorisation amendments with new conditions and uploads these to the Obligations Register and assigns actions as appropriate. The condition 'obligations' and associated actions are tracked utilising the 'Risk Manager System'.	Nil
	13	Water storages authorised to receive Acid and Metalliferous Drainage (AMD) affected water are listed in the Authorisation and updated as appropriate.	Nil
	14	The Surface Water monitoring results are reported annually in the EMR. In 2022 these included: <ul style="list-style-type: none"> EMR Appendix C, 2021-2022 Environmental Monitoring Schedules EMR Appendix Q, Surface Water Monitoring Report 2021/2022. Overall the Mine surface water monitoring data results achieved a very high level of compliance (EMR 2020 Section 4.2 Surface water quality).	Nil
Class 1, Diverted Water Management Infrastructure	15	Class 1 diverted (clean) water management infrastructure includes: <ul style="list-style-type: none"> McArthur River Diversion Channel, Barney Creek Diversion Channel and Little Barney Creek Diversion Channel Flood protection levees around the perimeter of the Open Pit and the NOEF Surface water diversion drains west and north of the NOEF. 	Nil
	16	A flood protection levee is constructed around the perimeter of the Open Pit to provide immunity from a McArthur River flood event of up to 0.2 % annual exceedance probability (AEP) (500-year average recurrence interval [ARI]).	Nil
	17	The Northern Diversion Drain along the boundary of the NOEF northern extension was constructed in late 2022. Hydromulch	Nil

Aspect	Item	Observations	Opportunities
		<p>seeding of the Northern Diversion Drain established quickly during the wet season of early 2022 and avoided potential erosion and sediment issues. Clean water is successfully diverted along the northern boundary of the NOEF to Emu Creek.</p>  <p><i>Photo 2: Northern Diversion drain with established revegetation in June 2023.</i></p>	
Class 2, Surface Water Management Infrastructure	18	<p>Class 2 surface water management infrastructure are runoff drains that collect and direct runoff from benign catchments to sediment management structures i.e. sediment ponds and include:</p> <ul style="list-style-type: none"> • South West Sediment Trap (SW side of the NOEF) • Bunds, drains and re-contouring within the mine levee wall that direct clean water away from the open pit • Clay borrow pits and benign rock quarries. 	Nil
Class 4, 5 and 6 Water Storage Infrastructure	19	<p>Class 4, 5 and 6 water storage facilities are dam, pond and sump infrastructure including:</p> <ul style="list-style-type: none"> • Open pit – underground void, Mill Concentrator Runoff Pond (CRP), Mill Anti-Pollution Pond (APP), Van Duncan's Dam, Lake Archer, Raw water tank, Pond 2 • TSF – TSF Cell 1, TSF Cell 2, TSF interception trench, Water Management Dam (WMD) • NOEF – SPROD, SEPROD, WPROD, EPROD, Toe sumps • Dams and Ponds. <p>A network of pipelines and pumps enable water to be transferred between key water storages.</p>	Nil
	20	<p>The artificial surface water monitoring program is a key control used when treating and transferring water between water storage facilities whilst maintaining the site's water balance. Different water classes are segregated to minimise the contamination of waters.</p> <p>Water is not transferred from any water storage structure until water quality analysis has been received and interpreted and the results confirm that the water is suitable for the destination.</p>	Nil

Aspect	Item	Observations	Opportunities
Water Management Dam	21	<p>The WMD stores Class 4 water. The dam wall was upgraded in 2023 with wall raised, clay lining, seepage area downstream of the wall renovated and a temporary geotechnical capacity limit on the dam was withdrawn.</p> <p>The upgrade to the WMD to raise the dam wall and spillway heights has given increased storage capacity and greater flexibility for on-site water reuse. The upgraded WMD potentially reduces the frequency and volume of required managed discharge to the McArthur River and further provides water storage flexibility to avoid uncontrolled overflow from other dams.</p>  <p><i>Photo 3: WMD dam wall upgrade completed, and dam returned to operations in early 2023.</i></p>	Nil
Pond liners	22	<p>The Authorisation specifies a list of 30 artificial water storages where the Mine is authorised to direct AMD water.</p> <p>The majority of these storages have either compacted clay layer or High Density Polyethylene (HDPE) liners to prevent uncontrolled discharge through seepage. However, some storages are described as having no liner or the liner status is listed as 'To Be Confirmed' for storages that were yet to be constructed at the time of the WMP.</p> <p>The Audit team were advised that the only AMD authorised storage without a liner in the WMP was Van Duncans Dam, and this is now HDPE lined.</p>	Monitor the status and suitability of type of liners for the authorised AMD storages to confirm if there is any need for liners to be installed or upgraded, especially for storages yet to be constructed.
Flood Warning System	23	<p>The flood warning system is valuable as it affords the Mine with approximately 12 to 15 hours advance notice to prepare for the arrival of floodwaters.</p> <p>The EagleIO system is used to provide flood forecasting for the Mine site. An automatic flood gauge is located upriver and provides early warning of approaching floodwater and ongoing four-hour alerts.</p> <p>However, the equipment relies on solar panel powered batteries which are unlikely to continue to work during extended periods of cloud cover, such as those experienced during long duration rainfall events in the monsoon season.</p>	Investigate an alternate power supply to the flood early warning system's current solar battery. Alternative Lithium-ion batteries may provide a significant extension of battery life.






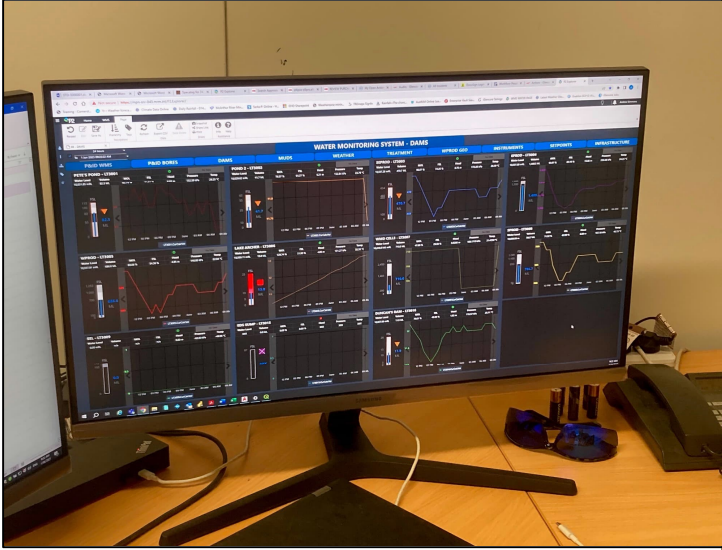
Aspect	Item	Observations	Opportunities
		Lithium-ion batteries can provide significant extension of battery life and may be able to provide power to the flood warning system for several days.	
	24	The early warning flood system provides warning of approaching flood waters by sending alerts by SMS and email. Currently alerts are received and forwarded manually and requires 24/7 staffing during flood events.	Investigate automation of the early warning flood system's 4 hourly alerts on SMS and email messages direct to relevant people, to avoid the need for 24/7 staffing to distribute the alerts.
CRP and APP	25	<p>The CRP and the APP collect concentrate rich sediment in runoff from the mill, some of which is dredged and returned to the mill for reprocessing.</p> <p>The ponds are adjoining and adjacent to Barney Creek where uncontrolled release or overtopping may potentially flow to Barney Creek. The CRP and APP have a compacted clay liner and are managed by the Mill Distribution Control System not the Site Water Management System.</p> <p>At the time of inspection, both ponds contained sediments that are likely to have a high concentration of metals and the ponds appear to have been in operation for many years. A review of the CRP and APP design, construction and operational management would be prudent to confirm that these Class 6 (process water) water storages meet the requirements of Australian National Committee on Large Dams (ANCOLD) and an Annual Exceedance Probability (AEP) for uncontrolled off-site releases of less than 1%.</p> 	<p>Consider review of the CRP and APP design, construction and operational management to confirm that these Class 6 (process water) water storages meet the requirements of ANCOLD and an AEP for uncontrolled off-site releases of less than 1%.</p> <p>Consider the benefits of adding or integrating the CRP and APP monitoring into the Mine's overall water management system.</p>

Photo 4: Concentrator Runoff Pond with Dredge

Aspect	Item	Observations	Opportunities
		 <p><i>Photo 5: Anti-Pollution Pond</i></p>	
CRP sediment reprocessing	26	A barrier wall was constructed across the CRP in 2002. This enabled a dredge to operate in different sections of the pond to recover sediment for reprocessing to maintain pond capacity, function and reduce potential overflow risk.	Nil
Slurry Pipeline near the Anti-Pollution Pond	27	<p>The slurry pipeline from mineral processing to the TSF crosses Barney Creek near the Anti-Pollution Pond. To reduce the potential risk of a spill from a pipe leak discharging directly to the water way, the HDPE slurry pipeline is 'double sleeved' encased inside a steel pipeline supported on a steel bridge structure. Double sleeving a pipeline containing potential contaminant material at waterway crossings is good practice.</p>   <p><i>Photos 6 and 7: 'Double sleeved' HDPE slurry pipeline inside a steel pipeline over Barney Creek</i></p>	Nil

Aspect	Item	Observations	Opportunities
Water Treatment, Hydrated Lime	28	<p>Water treatment aims to improve water quality to Class 4 for storage in the WMD or in other suitable structure for subsequent release in accordance with the WDL.</p> <p>Lime treatment is effective and is utilised in SEPROD and SPROD to treat water to ensure it is of suitable quality before being released.</p> <p>SEPROD provide water treatment for NOEF seepage water and lime is dosed at approximately 5 t/day.</p> <p>Audit team were advised that an automated lime slurry process with increased capacity may improve the lime dosing process efficiency. Lime builds up in pipes and pumps which causes inefficiencies for operators.</p>	Maintain operational flexibility regarding lime treatment methods and as appropriate consider alternative lime dosing mechanism process options, e.g. automated front end lime slurry, larger volume plant, to enhance efficiency.
Water Treatment, Reverse Osmosis	29	<p>The RO water treatment plant was built in 2016 and was designed to treat underground void water.</p> <p>The RO was not operated in the audit period and may be commissioned in the future.</p>	Nil
Water Treatment, Gypsum WTP, Lead Oxide (PbOx)	30	<p>The Mine's PbOx water inventory volume and associated hazardous dam risks will potentially continue to increase until the gypsum water treatment process is operational. EPROD is currently utilised for the temporary storage of PbOx affected water and hydrated lime was used in SPROD to treat PbOx water inflows.</p> <p>A gypsum WTP was under construction at the time of the audit visit, and is planned to address the PbOx affected water. The gypsum WTP is schedule to be commissioned in late 2024 and will progressively treat the backlog of stored PbOx affected water.</p>  <p><i>Photo 8: Gypsum WTP concrete foundation construction progress at the time of site audit visit.</i></p> <p>The construction of the gypsum WTP and its successful commissioning is fundamental to the Mine's ability to treat PbOx produced by the lead concentration process and deal with the stored PbOx water backlog.</p>	Proceed with the completion of the construction and commissioning of the gypsum WTP to treat the stored PbOx water.

Aspect	Item	Observations	Opportunities
Mine Water Managed Release	31	In the event of a managed water release the Environment team works closely with the Site Water Management team to ensure conditions, discharge flow rates, water quality, are within licence limits at authorised discharge point/s SEL1DP and MLDP (currently operational) and release point WMD RP.	Nil
	32	<p>The Mine has a documented managed release procedure to comply with the WDL conditions. The WDL stipulates operational and monitoring performance criteria to ensure that water from the Mine will not impact upon the values of the McArthur River.</p> <p>The water management system avoids uncontrolled discharge from dams overtopping and manages the treatment and transfer between storage of different classes of water to maintain the Mine's water balance.</p> <p>There were no water releases to the McArthur River or any other receiver in the 01 May 2022 to 30 April 2023 reporting period.</p>	Nil
Water Balance Model	33	<p>The Mine's water balance model tool is reviewed and updated by specialist consultants WRM annually and forecasts 4 years ahead and for the life of the Mine.</p> <p>WRM utilise GoldSim software to model the Mine site's water balance. A client interface to the GoldSim model would be useful to acquire to allow MRM to conduct analysis to update water balances, self-validation of data and provide more immediate operational management.</p> <p>Upon completion of the annual water balance calculations the water storage TARP's (e.g. water quality, managed release) are updated ahead of the wet season.</p>	Consider obtaining a MRM 'client' interface for the GoldSim site model for operational data analysis and more immediate water storage management.
Water storage – level monitoring	34	<p>Water storages at the Mine (for Class 4, 5 and 6 water) are operated based on water levels/volumes to limit operational risk and uncontrolled overflows. The adopted design configuration for water storages at the Mine include the Full Supply Level, Maximum Operating Level, Upper Operating Level and Lower Operating Level. In addition:</p> <ul style="list-style-type: none"> • Water storages are appropriately sized to capture and retain runoff from the contributing catchments • Water storage spillways are appropriately sized • Water storages are appropriately sealed or lined to limit seepage through the base and wall of the dam, as dictated by risk and the class of the stored water. 	Nil
	35	<p>Water storage levels are measured and recorded daily. Level sensors on the dams provide data to the SCADA systems and produce a spreadsheet. Inflow and outflow volume data is utilised in the daily storage calculation.</p> <p>The water storages' automatic level sensor data is confirmed manually each week by surveyors.</p>	Nil

Aspect	Item	Observations	Opportunities
Water Storage TARPS – dam levels	36	<p>Water storages at the Mine (for Class 4, 5 and 6 water) are operated following defined TARPs based on water levels/volumes to limit operational risk and uncontrolled overflows.</p> <p>Operating level storage (Full, Maximum, Upper and Lower) volumes for each Mine water storage is provided in WMP Appendix B Water balance modelling for the McArthur River Mine to calculate the wet season TARPs.</p>	Nil
SCADA system	37	<p>The SCADA system monitors the flows and volumes of the pipeline network that interconnect surface water storages by pumping between dams, ponds, sumps and basins.</p> <p>SCADA system provide real-time flow and level data and a daily water balance. The audit team were advised that water level sensors are installed in all the key dams.</p> <p>It may be worth considering a review of the current SCADA system to develop a business case for an upgrade of the system to include real time alarms and automatic messages to be raised in the event the system detects a potential issue or incident.</p>  <p><i>Photo 9: SCADA dam storages and pipeline flow monitoring system.</i></p>	Nil
Communication	38	<p>The audit team observed a high level of communication and cooperation on surface water monitoring and management between the Superintendent - Site Water Management and Superintendent – Environment. This good working relationship supports implementation of procedures with peer professional oversight to continuously improve surface water management performance.</p>	Nil

3.3 Water Management Plan Key Objectives

The WMP (Section 1.7) provides the key environmental and operational objectives for the risks identified in the plan. The extent to which the WMP performance objectives are met is related to the adequacy of implementation of the procedures. Based upon the audit findings a rating (i.e., 'very good', 'good', 'satisfactory', 'poor', or 'very poor') has been assigned to provide an assessment of the current level of achievement of each of the individual WMP objectives. Table 3-2 lists the WMP key objectives and the assigned performance rating based upon the audit findings.

Table 3-2: Environmental performance criteria ratings

Ref	Key Objectives	Audit Rating	Audit findings
1	Protect the McArthur River beneficial uses and community values from mine related impacts.	Very Good	<ul style="list-style-type: none"> The mine has a comprehensive water management system to prevent contaminated water from entering the river system The Operator has a broad range of surface water monitoring programs and management actions that have been developed over the Mine's life to meet the environmental objectives and these activities are appropriate and effective to protect the McArthur River Surface water monitoring results in 2022 demonstrate a high level of compliance with the WDL site-specific trigger values and in particular at the McArthur River downstream compliance point SW11 The was no water released from the Mine site in 2022.
2	Facilitate development of the ecosystems and their functions along the McArthur River Diversion Channel for terrestrial and aquatic flora and fauna.	N/A	<i>Note:</i> The scope of this audit did not examine the ecosystems along the McArthur River Diversion Channel. Refer to Independent Monitor's Annual Environmental Performance Audit Report 2023, Section 5.
3	Achieve a recovering trend in the water quality and ecosystem function in creeks on the Mine site within 20 years of cessation of mining	N/A	Future task, within 20 years of cessation of mining.

Ref	Key Objectives	Audit Rating	Audit findings
4	Manage water resources to ensure continuous water supply for mining and ore processing operations whilst minimising water abstraction and maximising water recycling.	Very Good	<ul style="list-style-type: none"> The water management systems at the Mine manage water volumes during pronounced wet and dry seasons, along with rainfall variations from year to year The water management systems accommodate both shortages and surpluses of water, while meeting the water supply demand for mineral processing The mine operates a network of interconnecting pipelines to allow water to be transferred between PRODs, WMD and process water dams to maintain a balance of water storage capacity and avoid overtopping The system of water storages segregates different water classes to minimise the volume of poor quality water and process water produced and maximise the reuse opportunities for cleaner water classes An upgrade to the WMD to raise the dam wall and spillway heights in 2023 has given increased storage capacity and greater flexibility for on-site water reuse The upgraded WMD potentially reduces the frequency and volume of managed discharge to the McArthur River and further provides water storage flexibility to avoid uncontrolled overflow from other dams. <p><i>Note:</i> The scope of this audit did not examine water abstraction (groundwater) or water recycling.</p>
5	Manage the operational risk of Open Pit inundation to ensure continuous mining operations and protection of the Mine's assets.	Very Good	<ul style="list-style-type: none"> Flood protection levees are in place around the perimeter of the Open Pit This Mine Levee Wall has been constructed to provide the Open Pit immunity from a McArthur River flood event of up to 0.2 % AEP (500-year ARI) Bunds, drains and re-contouring within the mine levee wall direct clean water away from the open pit to sediment management structures The surface water storage structure levels are managed to provided capacity, to avoid overflowing, for expected inflows ahead of each wet season

Ref	Key Objectives	Audit Rating	Audit findings
6	Ensure water management is conducted in accordance with MRM's regulatory obligations, including the Mining Management Plan, WDL 174, and EPBC Approvals 2003/954 and 2014/7210.	Very good	<ul style="list-style-type: none"> • The Mine's Obligations Register contains the relevant surface water WDL and Authorisation conditions • The condition 'obligations' and associated actions are tracked utilising the 'Risk Manager System' • The Surface Water monitoring results and compliance are reported annually in the EMR, namely: <ul style="list-style-type: none"> – EMR Appendix C, 2021-2022 Environmental Monitoring Schedules – EMR Appendix Q, Surface Water Monitoring Report 2021/2022 • Overall, the Mine surface water monitoring data results achieved a very high level of compliance with WDL 174 and the Authorisation (approval of the Mining Management Plan) • The listing of measurable performance indicators and the current TARP process allows MRM to show monitoring results are on target to be met and to comply with conditions of WDL 174 and comply with conditions of the Authorisation <p><i>Note:</i> The scope of this audit did not examine EPBC Approvals.</p>

4 Opportunities for Improvement

The OFIs identified by the audit have been presented as clear and succinct practical actions. OFI actions and their implementation aim to assist the Mine in better managing environmental risks and improve performance. It is important to note that OFIs identified by the Independent Monitor are suggestions and are not regulatory requirements.

The OFIs have been prepared at a point in time and may remain valid until changes in the Mine's circumstances and/or processes make them redundant or require their amendment. It is recommended that they are included, where possible, as control measures in the Mine's compliance and risk registers in order to become part of the actions taken to enhance surface water management. This will assist to ensure that they remain current and are amended where necessary to remain appropriate for any changes in circumstances.

Opportunities for improvement actions are listed in Table 4-1.

Table 4-1: Opportunities for improvement

Ref	Aspect	Description of Opportunity
OFI-SW23-01	Pond liners	Monitor the status and suitability of type of liners for the authorised AMD storages to confirm if there is any need for liners to be installed or upgraded, especially for storages yet to be constructed.
OFI-SW23-02	Flood warning battery	Investigate an alternate power supply to the flood early warning system's current solar battery. Alternative Lithium-ion batteries may provide a significant extension of battery life.
OFI-SW23-03	Flood Warning alerts	Investigate automation of the early warning flood system's 4 hourly alerts on SMS and email messages direct to relevant people, to avoid the need for 24/7 staffing to distribute the alerts.
OFI-SW23-04	CRP and APP design review	Consider a review of the CRP and APP design, construction and operational management to confirm that these Class 6 (process water) water storages meet the requirements of ANCOLD and an AEP for uncontrolled off-site releases of less than 1%.
OFI-SW23-05	CRP and APP monitoring integration	Consider the benefits of adding or integrating the CRP and APP monitoring into the Mine's overall water management system.
OFI-SW23-06	Lime dosing process	Maintain operational flexibility regarding lime treatment methods and as appropriate consider alternative lime dosing options to enhance efficiency.
OFI-SW23-07	Gypsum WTP	Proceed with the completion of the construction and commissioning of the gypsum WTP to treat the stored PbOx water.
OFI-SW23-08	Water Balance GoldSim	Consider obtaining an MRM 'client' interface for the GoldSim site water balance model for operational data analysis and more immediate water storage management.

5 Conclusion

Overall, the surface water management system is resilient and provides operational flexibility. The WMP is comprehensive and establishes the Mine's surface water management system for water quality requirements, water balance modelling and a monitoring program. The surface water monitoring schedule is comprehensive and field practices were observed being implemented in accordance with industry best practice.

The Mine's Site Water Management team assisted by the Environment team's full time water quality sampling team of five people together with support from an expert consultant that manages the water balance model provides comprehensive data and a deep understanding of the Mine's surface water management and performance.

Based upon the surface water quality monitoring data in the 2022 Environmental Monitoring Report, the Mine continued to implement effective controls to minimise the risk of environmental harm to downstream receiving waters of the McArthur River.

The accumulation of PbOx water in surface water storage dams, in particular EPROD, is a potential surface water risk and requires focused attention. The gypsum WTP scheduled for completion of construction in late-2024 is being built specifically to enable treatment of PbOx water.

This audit assessed the Operator to be achieving an overall "very good" level of implementation of the WMP requirements. In addition, the Operator has demonstrated effective action to address stated WMP environment and operational objectives. These findings were based upon document reviews, audit interviews and site visit audit evidence obtained that demonstrated a high level of action to address requirements. Important observations that support these findings include:

- The mine has a comprehensive water management system to prevent contaminated water from entering the river system
- The system of water storages segregates different water classes to minimise the volume of poor quality water and process water produced and maximise the reuse opportunities for cleaner water classes
- The surface water monitoring results in 2022 demonstrate a high level of compliance with the WDL site-specific trigger values in particular at the McArthur River downstream compliance point SW11
- The mine operates a network of interconnecting pipelines to allow water to be transferred between PRODs, WMD and process water dams to maintain a balance of water storage capacity and avoid overtopping.

The audit report highlights some medium and longer-term opportunities for improvement in relation to reviewing the status of AMD storage liners, confirming the CRP and APP performance against design criteria and the commissioning of the gypsum WTP to treat the stored PbOx water backlog.

The water management system minimises potential for uncontrolled discharge from dams overtopping and manages the treatment and transfer between storage of different classes of water to maintain the Mine's water balance. The WDL stipulates operational and monitoring performance criteria to ensure that water from the Mine will not impact upon the values of the McArthur River. The Mine has a documented managed release process. There were no water releases in the 2022/2023 reporting period.

The audit has found the surface water operational management and monitoring programs combine well to support the overarching environmental objective to protect the health of the McArthur River from mine related impacts.