Acid and Metalliferous Drainage (AMD) Management Plan

Nathan River Project, Northern Territory

Nathan River Resources

Revision No 7
June 2024

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Report

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File:	PES19017
Author(s):	Carel van der Westhuizen
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Synopsis:	This document details the Acid and Metalliferous Drainage (AMD) Management Plan for the Nathan River Project of Nathan River Resources (NRR) based upon a detailed assessment of the acid metalliferous/mine drainage (AMD) and metal leaching potential of waste rocks and the potential impacts to the local and wider environment. It takes due cognisance of the conditions of approval by the then Department of Sustainability Environment, Water, Population and Communities (SEWPaC), the then Northern Territory Department of Mines and Energy, all the earlier Mine and AMD Management Plans and the comments of the Peer Reviews by Amanzi Consulting in November 2019, LWR Consulting Services in June 2024 and the Department of Environment and Energy in December 2019. This latest revision, No. 7, has been updated to continue mining of the Danehill and Zabeel open pits as well as the proposed new Ponting and Border open pits.

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Table of Contents

Abbreviations **5**

Executive Summary **9**

1. Introduction **10**

- 1.1 Project Description 10
- 1.2 Scope of Work 18
- 1.3 Earlier Investigations and Assessments 18

2. AMD Management **22**

- 2.1 Pre-Mining, Mining and Care and Maintenance AMD Management 22
- 2.2 AMD Risk Assessment 22
- 2.3 AMD Management Plan 24

References **44**

Figures

Figure 1.1: Mine Layout. 16

Figure 1.2: Danehill and Zabeel Pit Shells and Waste Rock Dumps. 17

Tables

Table 1.1: Summary of Investigations and Assessments. 18

Table 2.1: AMD Risk Assessment and Mitigation Measures. 23

Table 2.2: AMD Management. 24

Appendices

Appendix A: Constructed Waste Rock Dumps and Containment Cells.

Appendix B: Independent Technical Review: LWR Consulting Services, 2024.

Appendix C: Waste Rock Sampling Procedure.

Appendix D: Danehill and Zabeel Block Models.

Appendix E: Environment Monitoring Report and NRP Water Management Plan.

Abbreviations

Abbreviations	
ADWG	Australian Drinking Water Guideline
AHD	Australian Height Datum
AMIRA	Australian Mineral Industries Research Association
AMDMP	Acid Mine Drainage Management Plan
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASLP	Australian Standard Leaching Procedure
C&M	Care and Maintenance
CSM	Conceptual Site Model
DO	Dissolved Oxygen
DoE	Commonwealth Department of Environment
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
DITT	Northern Territory Department of Industry, Tourism and Trade
DPIR	Northern Territory Department of Primary Industry and Resources
DSO	Direct Shipping Ore
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EMS	Environmental Management System
GDE	Groundwater Dependent Ecosystem
KYM	Kyalla Siltstone Member
LGO	Low Grade Ore
MCP	Mine Closure Plan
MMP	Mine Management Plan
MSM	Moreak Sandstone Member
NRR	Nathan River Resources
NRP	Nathan River Project
NT EPA	Northern Territory Environment Protection Authority
ORP	Oxidation Reduction Potential
RBIOP	Roper Bar Iron Ore Project
SEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities
SIM	Sherwin Ironstone Formation

Abbreviations	
TDS	Total Dissolved Solids
TSF	Tailings Storage Facility
TSS	Total Suspended Solids
WDL	Waste Discharge Licence
WDR	Western Desert Resources
WMMP	Water Management and Monitoring Plan
WRD	Waste Rock Dump
Units	
bcm	Bank Cubic Metre
cm	centimetre
d	day
ha	hectare
hr	hour
kg	kilogram
km	kilometre
m	metre
mm	millimetre
mg/L	milligram per litre
µg/L	micro-gram per litre
min	minute
yr	year
s	second
t	tonnes
µS/cm	micro-Siemens per centimetre

Discipline

Acronym	Parameter Definition/(Determination)	Unit
ABA	The acid-base accounting test was developed in 1974 to evaluate coal mine waste and was modified by Sobek *et al*. in 1978. Acid-Base Accounting is a test to assess the potential of a material to produce both acid and neutralisation potential.	
AC	Acid Consuming: materials with a capacity to neutralise acid.	kgH_2SO_4/ton
AFP	Acid Formation Potential is the potential for a material to produce acid.	kgH_2SO_4/ton
AMD	Acid Metalliferous/Mine Drainage – originates when sulfide material is exposed to the atmosphere. This causes the formation of sulfuric acid and the potential outflow of acidic and usually highly metal-rich water into the environment. Potential sulfide-bearing material includes waste rock from overburden, interburden, and processed ore (tailings).	
ANC	Acid Neutralising Capacity (Laboratory Analysis) - is the measure of acid neutralising capacity, usually expressed by carbonates (e.g. calcite and dolomite) and silicates.	kgH_2SO_4/ton

Acronym	Parameter Definition/(Determination)	Unit
APR	Acid Potential Ratio (Calculation) – is the ratio of ANC/MPA and is used to classify material as either NAF or PAF (see definitions below).	
APP	Acid producing potential; also referred to acid generating potential (AGP).	kgH_2SO_4/ton
ARD	Acid Rock Drainage – the use of this term indicates natural weathering and oxidation unmined outcrops of sulfide bearing materials.	
CaO	Calcium Oxide.	%
EDS	Energy Dispersive Spectroscopy (EDS) Analyses	
Fe	Iron	
GAI	Geochemical Abundance Index.	
Kinetic Testing	Tests results provide information on the rate of sulphide reaction over time, time periods for reaction, and control techniques which can optimise treatment and control to address the specific severity and duration of reaction.	
LC	Low Capacity.	
MgO	Magnesium Oxide.	%
MPA	Maximum Potential Acidity or APP (Acid Production Potential) (Calculation) - It is determined by multiplying the Sulfide-S values (in %) by 30.6, which accounts for the reaction stoichiometry for the complete oxidation of pyrrotite and pyrite by O_2 to $Fe(OH)_3$ and H_2SO_4. MPA does not consider the effect of any acid consuming materials in the rock material.	kgH_2SO_4/ton
NAF	Non-Acid Forming (Calculation). Materials are classified as NAF if either: - Sulfide-S < 0.3%, or - Sulfide-S ≥ 0.3% and NAPP is negative with ANC/MPA ≥ 2.0 (see also PAF definition below)	
NAG	Net Acid Generation or NAP (Net Acid Production) (Laboratory Analysis) –hydrogen peroxide is used to accelerate the oxidation of sulphides present in the material. The acid produced may be partially or totally consumed by acid neutralising components in the material. The pH of the solution is determined and then titrated to pH 7. This gives a value for the Net acid or neutralizing potential of the sample.	kgH_2SO_4/ton
NAPP	Net Acid Producing Potential (Calculation) - NAPP = MPA - ANC. Conceptually, a negative NAPP indicates all acid produced is neutralised and a positive NAPP indicates the material is net acid producing.	kgH_2SO_4/ton
NNP	Net Neutralising Potential (Calculation) - NNP = ANC - MPA. Conceptually, a positive NNP indicates all acid produced is neutralised and a negative NAPP indicates the material is net acid producing. NNP is a conservative measure as it tends to overestimate the acid producing potential because it does not differentiate between acid producing and non-acid producing forms of sulfur.	kgH_2SO_4/ton
NPR	Neutralization Potential Ratio: NPR = NP/AP; If the NPR value is <1, the material is considered acid producing and if the NPR value is >3, the material is considered non-acid producing.	
PAF	Potential Acid Forming (Calculation). Materials are classified as PAF if either: - Sulfide-S ≥ 0.3% and NAPP is positive, or - Sulfide-S ≥ 0.3% and NAPP is negative, but ANC/MPA < 2.0 (see also NAF definition above).	
SEM	Scanning Electron Microscopy (SEM) Analyses	
SOR	Sulfide Oxidation Rate - Sulfide reaction over period of time.	mgSO_4/kg/ week
Static Testing	A static test determines both the total acid generating and total acid neutralizing potential of a sample.	

Acronym	Parameter Definition/(Determination)	Unit
Sulfide-S	Sulfide Sulfur (Calculation) – is the sulfur in the material present as sulphide. Sulfide Sulfur = Total-S - Sulfate-S	%(w/w)
Total-S	Total Sulfur (Laboratory Analysis) – is the total sulfur in a material in all its forms.	%(w/w)
UC	Uncertain Waste Rock Classification	

Executive Summary

Nathan River Resources (NRR) requested Pendragon Environmental Solutions to update the Acid Mine Drainage Management Plan, Version 5, November 2021, to continue mining at the Danehill, Zabeel, Ponting and Border open pits coupled with the management of potentially acid forming (PAF) materials at the Danehill, Zabeel and Ponting Waste Rock Dumps (WRDs).

The management options detailed in this Acid Mine/Metalliferous Drainage Management Plan (AMDMP) are designed to promote best practice and continuous awareness and environmental improvement by means of a life-cycle approach towards AMD management and detailed ecological and human health risk assessments documented in several assessments during the environmental approvals process and thereafter. The framework articulated in these documents aims to focus on early identification of AMD risk to focus the effort on prevention or minimisation rather than control or treatment. It also allows for frequent reviews and continual improvement.

The AMD risk assessments and management measures taken to date, indicate that with appropriate design and operational control measures, the residual AMD risk is medium at worst and manageable with effective controls. Any residual risk would be monitored during implementation of the AMDMP to confirm that the design and operational control measures are effective.

1. Introduction

1.1 Project Description

Nathan River Resources (NRR) requested Pendragon Environmental Solutions to revise and update the Acid Mine Drainage Management Plan, Version 5, November 2021, to continue mining at the Danehill (previously referred to as Area F East) and Zabeel (previously referred to as Area E) open pits coupled with the management of potentially acid forming (PAF) materials at the Danehill and Zabeel Waste Rock Dumps (WRDs). This document takes due cognisance of the Mine Management Plans (MMPs) for Stage 1A: Danehill Saddle and Zabeel North and Stage 1B: Danehill East detailed below.

The Mining Management Plan 2023, Stage 1A Amendment

- The previous operator, Western Desert Resources (WDR) commenced mine construction and operations in 2013 following the approval of the Roper Bar Iron Ore Project (RBIOP) Environmental Impact Statement (EIS) under the previous Environmental Assessment Act. NRR currently holds an approved mining authorisation (1062-01). The NRP was placed into care and maintenance (C&M) in November 2021, with the recommencement of minor operations in March 2023 following the approval of the low-grade ore (LGO) MMP amendment. Activities which are currently approved at the NRP include processing, sorting, haulage and transhipment of the existing LGO stockpiles.
- NRR is proposing an amendment to the Mining Management Plan (MMP) approved by authorisation 1062-01 to allow the recommencement of mining operations within the existing disturbed Danehill and Zabeel mining areas. A short-term mining operation (six months) will focus on mining the Danehill pit saddle (350m long, 50m wide and 25m below current ground level), a land bridge between the east and west pits, and Zabeel North open-cut pit (Stage 1A: 500m long, 130m wide and 25m below current surface). Ore mined from these areas will supplement the processing of LGO, with the majority of the processing, haulage and transhipment activities currently approved to remain the same.
- To facilitate mining activities proposed in this amendment, dewatering and internal water transfers are required. In order to begin mining the Danehill saddle, water levels in both Danehill pits need to be lowered. Water which has accumulated in the Zabeel North pit will also require dewatering. All water will be managed on-site, transferring water to and from other approved water storages/pits with no discharge to the environment.

  The Danehill saddle mining will require approximately 720 ML of water to be dewatered from the two pits combined. The majority of the Danehill pit water is proposed to be transferred and stored in the Zabeel South pit for the duration of Stage 1A as no mining operations are proposed in Zabeel South during the MMP period. In addition to Zabeel South, water will be transferred to other storages with capacity and used for dust suppression supply. A small volume of water (< 50 ML) has accumulated in the Zabeel North pit which also requires dewatering. This water will be transferred to Zabeel South or other storages with capacity prior to mining operations commencing.
- Approximately 151,000 tonnes (t) of > 40% iron (Fe) ore will be extracted from the Danehill saddle mining area which is scheduled for completion within six months of receiving an approval.

  An estimated 205,000 t of waste rock (< 40% Fe) will be removed from the saddle mining area and placed in the existing Danehill WRD; the maximum height of the WRD will increase to 25 m above surrounding surface level, an increase of 15 m from its current height.

  No potentially-acid-forming (PAF) material is expected; the existing Danehill resource model indicates a small amount of PAF 10 m below the maximum depth of saddle mining in Stage 1A. However, should PAF material be encountered during the Stage 1A mining, it will be managed in accordance with this document and placed within the existing PAF cell of the Danehill WRD.

- Approximately 482,000 t of > 45% Fe ore will be mined from the Zabeel North pit simultaneously with the Danehill saddle and is expected to be completed within six months of commencement.

  An estimated 1,245,622 t of waste rock (< 45% Fe) will be placed in the existing Zabeel WRD; the height of the WRD will increase by 8 m from its current height, with a proposed final height of approximately 30 m above the surrounding surface level.

  No potentially-acid-forming (PAF) material is expected; the existing Zabeel North resource model shows no PAF within the area targeted for mining in Stage 1A. However, should PAF material be identified; it will be managed in accordance with this document and placed within the existing PAF cell at the Danehill WRD.

  No PAF material has historically been stored on the Zabeel WRD; the only dedicated PAF cell at the NRP is located at the Danehill WRD.

The Mining Management Plan 2024, Stage 1B Amendment

- This MMP amendment, referred to Stage 1B, seeks to amend the activities currently authorised by Variation of Authorisation 1062-01 under the Stage 1A MMP amendment. The Stage 1B MMP amendment proposes the recommencement of mining operations within the currently inactive Danehill East open-cut pit limited to the confines of the existing pit shell. The proposed recommencement of mining in the Danehill East pit is the next key milestone for the NRP to return to full scale operations since the NRP was put into C&M in November 2021. Stage 1B will commence after the completion of Stage 1A and will extend operations to late 2025.

  The proposed Danehill East pit at the end of the Stage 1B MMP period will be 1,222m long, 207m wide and 60m deep (the pit depth will be extended to -40mRL, a further 25 m from the current pit floor level).

- Approximately 3,570,000 tonnes (t) of material are proposed to be removed from the Danehill East pit during Stage 1B:

Direct Shipping Ore (DSO; >50% Fe):	520,000 t.
Low Grade Ore (LGO; >30% - <50% Fe):	435,000 t.
Waste (<30% Fe):	2,615,000 t.

- In-floor sumps and dewatering infrastructure for Stage 1A will remain in place within the Danehill East. Dewatering infrastructure will maintain dry floor conditions throughout Stage 1B. Drill and blasting activities will continue to be required as for Stage 1A.

- Waste material removed from the Danehill East pit during Stage 1B is anticipated to be non-acid forming (NAF). Despite most material having a sulfur concentration below 0.3 %, a small volume (<2,000 t) of LGO material in the eastern extent of the pit contains sulfur above 0.3 %. This material will be crushed, blended and shipped with DSO material. The average sulfur content for all material proposed to be removed from the Danehill East pit remains well below 0.3 %:

Material Type	SiO2 (%)	Al2O3 (%)	Sulfur Content (%)
DSO	11.0	2.1	0.03
LGO	29.5	2.7	0.04
Waste	58.6	9.5	0.10
Average	**33.0**	**4.8**	**0.06**

- Material at the NRP with iron grade less than 30 % is classified as waste and will be placed in a designated WRD. All the waste material removed from the Danehill East pit will be placed in the existing Danehill WRD adjacent and upstream of the Danehill open pits. This WRD is well established and currently stores all waste from the Danehill pits since the commencement of the NRP. The WRD contains a PAF cell for storing all PAF materials from the NRP. The design of the Danehill WRD will not differ from the design currently authorised by the Stage 1A MMP amendment as has adequate capacity to store waste material from both the Stage 1A and 1B operations.

- Current wastes stored at the NRP include:

Material Type	Danehill WRD	Zabeel North WRD	Zabeel South WRD
NAF	3,546,000 bcm	444,594 bcm	1,435,000 bcm
PAF	119,196 bcm	0 bcm	152,000 bcm
PAF as a % of Total Waste	**3.3 %**	**0 %**	**9.6 %**

Employing the global assay data, inclusive of all material types across the Danehill and Zabeel deposits:

Statistical Parameter	Danehill East	Zabeel
Number of measurements, n	27,039	47,209
Minimum % S	0.0	0.0
Maximum % S	9.1	10.8
Average % S	0.1	0.2
Standard Deviation	0.2	0.1
PAF (>0.3 % S) as a % of n	**11 % (3,089)**	**7 % (2,203)**

Indicates that both the Stage 1A and Stage 1B operations are likely to encounter, if any, relatively small volumes of PAF materials with more than sufficient volumes of NAF to contain these problematic materials.

- Any unexpected PAF waste material encountered during Stage 1B, will be managed in accordance with this document and placed in the existing PAF cell at the Danehill WRD.
- Stage 1B does not require a waste discharge licence (WDL); mine-affected water will continue to be appropriately managed onsite without the need to discharge to the receiving environment.

To facilitate mining operations dewatering and internal water transfers are required. Dewatering of the Danehill East and West pits will commence, transferring approximately 450 ML of mine-affected water to the inactive Zabeel South pit. Onsite water management will operate in accordance with the NRP Water Management Plan and Trigger Action Response Plan which were updated to reflect the water management strategy to be implemented in Stage 1B.

- Stream diversions will not be required or proposed for Stage 1B.

The Mining Management Plan 2024-2025

- This MMP details continuation of mining during Stages 1A and 1B above and outlines future activities relevant to this AMDMP, including:
  - Amalgamation of the Zabeel North (500m long, 159m wide and 25m deep) and South (680m long, 195m wide and 45m deep) pits into the Zabeel Ultimate Pit (1,340m long, 350m wide and 92m deep).
  - Amalgamation of the Zabeel North and South WRDs across the diverted Pandanus drainage line.
  - Construction and mining of the Stage 1 Ponting Pit (1,160m long, 145m wide and 42m deep) and

    the Border Pit (625m long, 72m wide and 35m deep).

  - Establishment and storage of waste rock in the Ponting WRD.

- Following Stage 1A, NRR intends to amalgamate the Zabeel North and South pits. Initial construction of the Zabeel Ultimate Pit will mine through the existing land bridge between the north and south pits after diversion of the Pandanus Creek for about 350 m around the Zabeel mining area.

  Approximately 9.7 Mt of material will be removed from the Zabeel Ultimate Pit:

  - DSO (>50% Fe): 1,294,376 t with an average Sulfur concentration of 0.10%.
  - LGO (>30% - <50% Fe): 240,078 t. with an average Sulfur concentration of 0.15%.
  - NAF Waste (<30% Fe): 7,617,250 t with an average Sulfur concentration of 0.11%.

    PAF Waste (< 30% Fe): 555,368 t with an average Sulfur concentration of 0.43%.

  All waste material, including PAF, will be stored on the existing Zabeel WRD or on the Zabeel West WRD. PAF material will be appropriately stored in the PAF cell proposed for the Zabeel WRD.

  Approximately 300,000 t of LGO from previous operations remains stockpiled on the Zabeel South WRD. NRR plans to haul this material to the Zabeel ROM for processing during the MMP period. Removal of the LGO stockpile from the Zabeel WRD will further increase capacity and avoid the need for further WRD footprint expansions.

- NRR intends to construct a new open pit, the Ponting Stage 1 Pit, approximately 1.5 km west of the existing Danehill West Pit, targeting DSO and BDSO in the SIF up-strike from Danehill which has not yet been exposed in operations at the NRP.

  An estimated 6.23 Mt of material will be removed:

  - DSO (>50% Fe): 602,170 t with an average Sulfur concentration of 0.02%.
  - LGO (>30% - <50% Fe): 79,533 t. with an average Sulfur concentration of 0.01%.
  - NAF Waste (<30% Fe): 5,547,424 t with an average Sulfur concentration of 0.09%.

    PAF Waste (< 30% Fe): 1,218 t with an average Sulfur concentration of 0.34%.

  All NAF waste material removed from the Ponting Pit will be placed in the Ponting WRD adjacent to the open pit. The small amount of PAF will be selectively handled, transported and stored in the PAF cell of the Danehill WRD to ensure that the Ponting WRD contains NAF material only.

- In addition to the Ponting Pit, NRR intends to construct another new open pit, referred to as the Border Pit, located approximately 3 km west of the existing Danehill West pit on ML 28963. The Border pit will be mined concurrently with the Ponting Pit to ensure DSO and BDSO grades can meet contractual obligations.

  An estimated 995,271 t of material will be removed:

  - DSO (>50% Fe): 183,101 t with an average Sulfur concentration of 0.01%.
  - LGO (>30% - <50% Fe): 23,296 t. with an average Sulfur concentration of 0.01%.
  - NAF Waste (<30% Fe): 788,874 t with an average Sulfur concentration of 0.06%.

    PAF Waste (< 30% Fe): nil.

  All NAF waste material removed from the Border Pit will be placed in the Ponting WRD. At the completion of mining, the pit void will be used for storing water.

- Groundwater modelling completed during the RBIOP EIS did not include the Ponting pit (Area F – Pit 3) and/or Border Pit (Area F Pit 4). Despite this, given the pit's proximity to Danehill, the groundwater inflow rate of 2 ML/day predicted for the Danehill pits (to depths of 100m) has been applied to the Ponting pit which is considered conservative owing to the drawdown influences of the deeper/larger Danehill pits. In-floor sumps and pumps will be implemented if and when required for removing groundwater and rain to maintain access and dry floor conditions for mining operations.

To facilitate mining operations outlined for the MMP period, dewatering and internal water transfers are essential. All water captured onsite is currently stored in a series of sediment ponds and existing open-cut pits, effectively preventing mine-affected water from entering the surrounding environment. The NRP water management system is continuously updated and informed by a water balance model (WRM, 2024), which models and forecasts water inventories across various climatic conditions. Integrated with the WMS is the NRP Water Management Trigger Action Response Plan, crucial for the effective management of the water inventory during the wet season which aims to prevent uncontrolled discharge of water from the NRP.

As of June 2024, NRR does not hold a waste discharge license. However, in preparation for the 2024/25 wet season, an application for a licence will be lodged later in 2024 to provide for the discharge of surplus water.

A review of the **Environmental Mining Report (NRR, December 2023)** elicited the following:

- There were no environmental incidents and/or material environmental harm.
- No environmental instructions were issued to NRR during the 2023 reporting period.
- Surface water monitoring:

  Water quality monitored at 17 locations across the NRP incorporate natural surface waters (tributaries and watercourses, assessed against ANZECC criteria) as well as artificial water storages (dams and open pits, assessed against the same criteria for comparative purposes).

  - The median and average values for pH and electrical conductivity (EC) in both natural and mine waters exceed their guideline values or targets but are comparable to the reference sites.
  - The median and average values for sulfate and nitrate in mine waters exceed their guideline values or targets but are comparable to the reference sites.
  - The median and average value for the heavy metals iron, cadmium, copper, iron, manganese, nickel and zinc in mine waters, in particular the Danehill and Zabeel pits, exceed their guideline values or targets but are comparable to the reference sites.
  - Mine-affected water remains contained as part of the NRP water management system and has not interacted with the receiving environment.
- Groundwater monitoring:

  Groundwater level and water quality (assessed against the ANZECCC criteria for stock drinking water) is monitored at 15 groundwater monitoring bores located across the NRP.

  - The median and average values for pH (between 6.0 and 8.1 recorded at all monitoring locations) and Total Dissolved Solids (TDS) exceed their guideline values or targets but are comparable to the reference sites.
  - The median and average values for sulfate and calcium exceed their guideline values or targets but are comparable to the reference sites.
  - The median and average value of only cadmium exceed its guideline value or target but is comparable to the reference sites. Concentrations for aluminium, arsenic, boron, chromium, cobalt, copper, nickel, selenium, uranium and zinc are below the guideline value or target or at the limit of reporting.
  - There is a saline (with typically elevated concentrations of sulfate) groundwater system at the

NRP owing to the marine origins of the geological regime. Elevated sulfate concentrations in groundwater are considered not to be due to mining activities, but rather is reflective of normal groundwater conditions.

This AMDMP acknowledges and continues to include the findings of the November 2019 peer review by Amanzi Consulting and subsequent comments by the Commonwealth Department of Environment and Energy in December 2019 as well as the latest peer review by LWR Consulting Services dated June 2024. This document also supports the current and/or proposed MMPs detailed above.

The current and proposed future mine layout and ultimate pit designs for the existing Danehill (Area F) and Zabeel (Area E) open pits appear in Figures 1.1 and 1.2 overleaf. Reference should also be made to the block models and layouts.

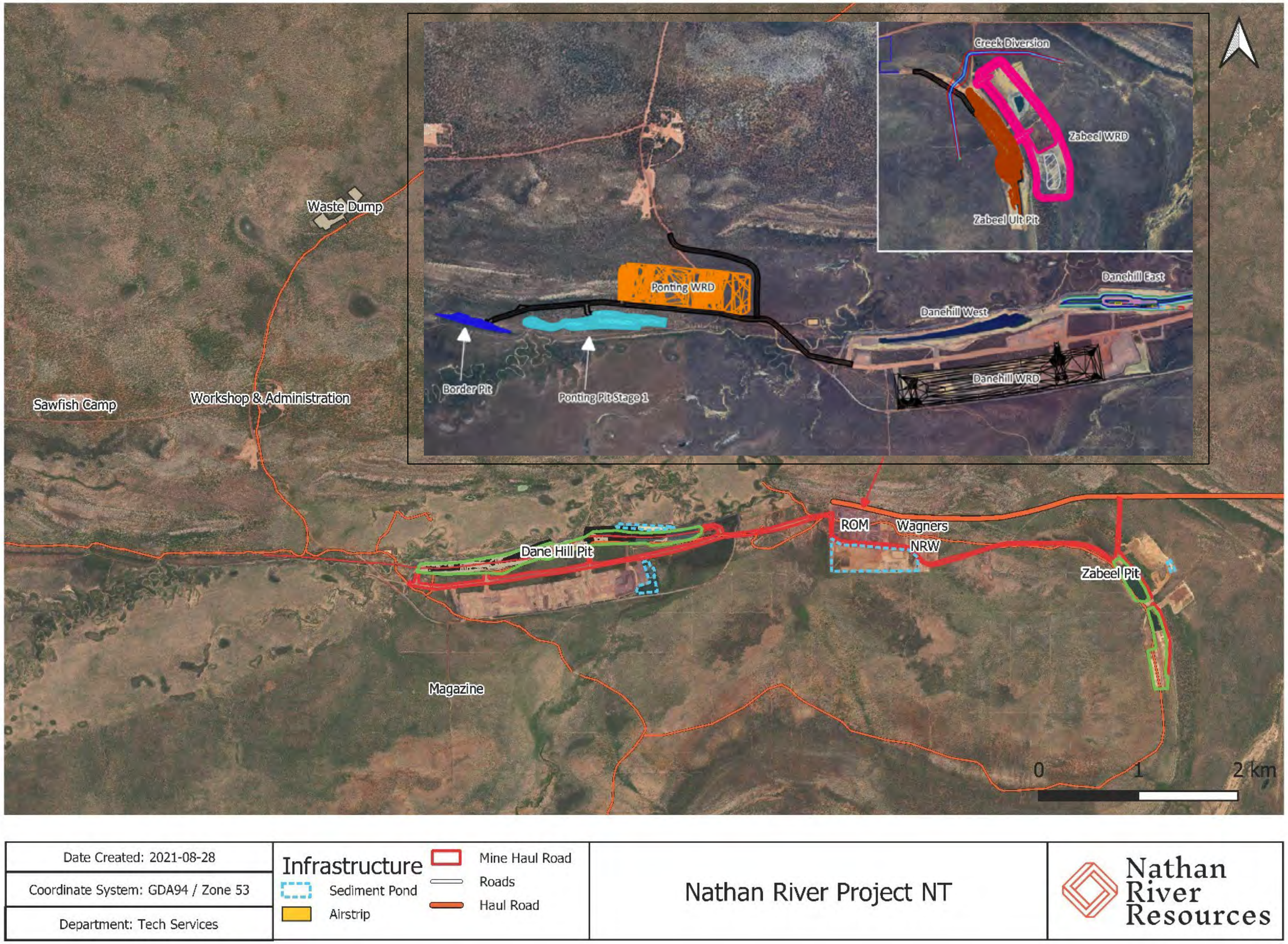
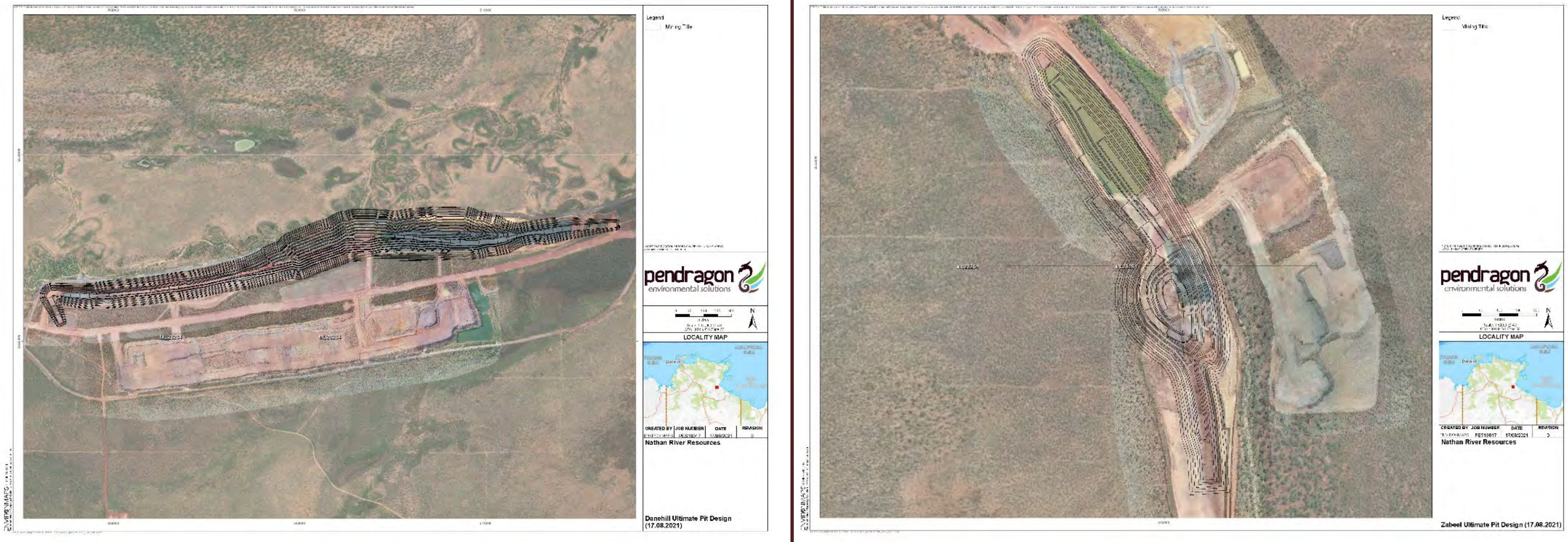


Figure 1.1: Mine Layout.



Danehill Open Pit (formerly Arera F)

Zabeel Open Pit (formerly Area E)

Figure 1.2: The existing Danehill and Zabeel Pit Shells and Waste Rock Dumps.

1.2 Scope of Work

Revise and update the 2021-2023 Acid Mine Drainage Management Plan, Version 4, December 2019, to incorporate mining and management of potentially acid forming (PAF) materials at the Danehill and Zabeel open pits.

1.3 Investigations and Assessments

Investigations and assessments undertaken to date with relevance to AMD and taken due cognisance of in compiling this document include:

Table 1.1: Summary of Investigations and Assessments.

Date	Entity	Investigation, Assessment, Comment
May 2012	WDR	Draft Environmental Impact Assessment (EIS). Including a report titled *Acid Metalliferous/Mine Drainage (AMD) and Management*, Roper Bar Project Area, Western Desert Resources Ltd, which documented a detailed investigation and assessment of the acid mine/metalliferous drainage and metal leaching potential of waste rocks and ore to ascertain the potential impacts to the local and wider environment. The salient findings of these investigations and assessments indicated that potential acid forming (PAF) materials are present and will require appropriate management to prevent impacts on the local and surrounding downstream receiving environments. To ensure that the environmental risks are inhibited, a preliminary risk assessment and framework for AMD management were also included in the EIS.
August 2012	WDR	Supplementary Environmental Impact Statement including a revised report titled *Acid Metalliferous/Mine Drainage (AMD) and Management*, Roper Bar Project Area, Western Desert Resources Ltd addressing comments made on the Draft EIS.
September 2012	NTEPA	Environmental Assessment Report and Recommendations
December 2012	DoE	Decision on Approval of Action (Approved with Conditions) received from the Federal Department of Sustainability, Environment, Water, Population and Communities. The conditions of approval by the NT Environmental Protection Agency (EPA) previously the Department of Natural Resources, Environment the Arts and Sport (NRETAS) and the Department of Sustainability Environment, Water, Population and Communities (SEWPAC, 2012) have also been considered in the current revision. Amongst others, the EPA indicated that: *to be substantiated with static and kinetic test results that indicate oxidised rock do offer real buffer (net acid consuming NAC potential). While it may be assumed that materials generating acid drainage can be mixed with acid consuming material in a waste rock dump to produce alkaline drainage, neither the proportion nor the amount of acid generating material, nor the degree of mixing required is known with any certainty and quantities of each material would need to be known. Blended NAG tests, column tests and field piles can be used to evaluate various mix ratios but generally a degree of conservatism is required to ensure an adequate excess of buffering is available (NRETAS 2012).* SEWPaC/DPIR indicated that to protect freshwater sawfish (*Pristis microdon*), the person taking the action must submit an Acid Mine Drainage Management Plan (AMDMP) for approval of the Minister which must include: **Condition 9:** a. Sampling and analysis procedures that will be employed to identify potential acid forming (PAF) materials. b. Design details and management strategies of proposed encapsulation beds, waste rock dumps, drainage systems, sediment traps, seepage diversion barriers, collection ponds and embankments. c. A strategy for the ongoing monitoring of PAF material, including threshold trigger levels and mitigation responses.

Date	Entity	Investigation, Assessment, Comment
		Condition 10: Actions required under a) to c) must be consistent with the Managing Acid and Metalliferous Drainage Handbook (Australian Government, 2007) and any subsequent versions of this document. **Condition 11:** The person taking the action must ensure the AMDMP is reviewed by an independent technical reviewer to provide advice to the person taking the action on the development and review of the AMDMP. The person taking the action must nominate an independent technical reviewer. The independent technical reviewer must be approved by the Minister in writing. **Condition 12:** The person taking the action must ensure that the independent technical reviewer undertakes the following: a) Provide advice on the sampling and analysis procedures, design details and management strategies and the strategy for the ongoing management of PAF material. b) Provide advice on exceedance of trigger values and recommended changes to PAF material management practices, through the AMDMP, as required. **Condition 13:** The person taking the action must provide to the Minister copies of all advices and recommendations made by the independent technical reviewer and an explanation of how the advices and recommendations will be implemented or an explanation of why the person taking the action does not propose to implement certain recommendations. This information must be provided to the Minister when the AMDMP is submitted for approval. **Condition 14:** The AMDMP must be submitted for approval by the Minister at least 60 days prior to the start of mining, unless otherwise approved in writing by the Minister. **Condition 15:** Mining must not start until the AMDMP has been approved by the Minister. The approved AMDMP must be implemented. **Condition 16:** For the ongoing protection of freshwater sawfish (Pristis microdon), the AMDMP must be reviewed annually from the date of first approval of the AMDMP (until two years following the closure of Area F East Pit 3) by the independent technical reviewer, to enable continuous improvement and adaptive management of PAF material management. From two years following the closure of Area F East Pit 3, the AMDMP must be reviewed by the independent technical reviewer once every three years for the remaining life of the project. The person taking the action must provide to the Minister, a copy of all advice and recommendations made by the independent technical reviewer and an explanation of how the advice and recommendations will be implemented or an explanation of why the person taking the action does not propose to implement certain recommendations. If the independent technical reviewer recommends that the approved AMDMP be varied, then the approved AMDMP must be varied in accordance with condition 5.
May 2013	WDR	Submission of Mining Management Plan. Including a report titled *AMD Risk Assessment and Management*, Western Desert Resources which also documented the results of preliminary kinetic testing: The initial investigations and assessments, coupled with commitments made during the approvals process, indicated the need for further assessment of materials falling in the uncertain category and PAF mine spoils to ascertain whether these materials will produce net acidity over the long-term. Consequently, WDR established six columns for leach (kinetic) testing to determine and assess the long-term reactivity of sulphides and buffering capacities of mine spoils including metal loading and toxicities.

Date	Entity	Investigation, Assessment, Comment
		Preliminary observations after 17 weeks of testing indicated that: - High pH and large sulphate concentrations indicated rapid activity of buffering minerals. The onset of circumneutral pH (normally >6.0) in the leachates indicates the presence and steady activity of carbonates (and silicates) with acid neutralizing capacities in excess of acid produced by the oxidation of sulfides. - The subsequent short-term behaviour of pH and solute loadings are indicative of slow sulfide reactions and dominance by buffering capacities. The pyrite oxidation rates calculated for exposed surface areas averaged a slow 2.25E-11mol/m^2/s. - The pH and solute loading patterns have not yet shown the peak of the AMD zone. The time lag when acid or alkaline conditions sets in and commences to control the weathering environment was also not detected. - The results and observations to date are inconclusive and kinetic testing should continue until clear patterns of acid and/or base production are confirmed. - The Mine Management Plan (MMP) should consider and incorporate these preliminary observations and continue to employ these tests as tools of the AMD Risk Assessment and Management Plan and their continual reviews. SRK commented in a document titled *Roper Bar Independent Technical Review,* Report Prepared for Commonwealth Bank of Australia, SRK Consulting (Australasia) Pty Ltd, June 2013, Section 8.1.5 Waste Dumps and AMD Potential. Their comments, where relevant, were incorporated in a subsequent revision of the AMDMP.
June 2013	Golders	The salient findings and key recommendations of the independent technical review of the 2013 AMDMP and associated documentation, including risk assessments and chapters of the EIS. A detailed response was submitted by Pendragon Environmental Solutions in July 2013. The AMDMP was considered sufficiently comprehensive for the scale of operations and could readily inform the Mine Closure Plan. The response indicated that material characterisation and kinetic testing was to be expanded continually as part of grade control and the results fed into the mine block model to inform further sampling and analysis.
September 2014	WDR	WDR placed into receivership: production ceased, and care and maintenance phase entered.
November 2015	WDR	Updated Care and Maintenance Plan lodged with DPIR. Including a report prepared by GHD titled *Roper Bar Iron Ore Project, Acid and Metalliferous Drainage Management Plan*, Care and Maintenance – Mining Management Plan, November 2015. This document takes due cognisance of the contents of this latest AMDMP for Care and Maintenance.
November 2019	Amanzi Consulting	Independent Peer Review. The comments, issues and gaps raised in this review were addressed in Revision 4 of this document.
December 2019	Pendragon Environmental Solutions	2020-2023 Acid Mine Drainage Management Plan, Revision 4. This management plan was prepared to facilitate mining outlined in Section 1.1: Project Description and was subsequently amended to include the comments of a peer review and the Commonwealth Department of Environment and Energy (DEE) now the Department of Agriculture, Water and the Environment (DAWE).
December 2019	Pendragon Environmental Solutions	2020-2023 Acid Mine Drainage Management Plan, Revision 4. This management plan was prepared to facilitate mining outlined in Section 1.1: Project Description and was subsequently amended to include the comments of a peer review and the Commonwealth Department of Environment and Energy (DEE) now the Department of Agriculture, Water and the Environment (DAWE).

Date	Entity	Investigation, Assessment, Comment
June 2024	Pendragon Environmental Resources	Review and assessment of the following documents and data: ▪ Mine Management Plan Stage 1A. ▪ Mine Management Plan Stage 1B. ▪ Mine Management Plan 2024. ▪ Environmental Monitoring 2023. ▪ Environmental Monitoring Database. ▪ Global assays for the Danehill and Zabeel mining areas.
June 2024	LWR Consulting Services	Independent Peer Review and Table 1 Checklist (Appendix B). A response to the review may also be found in Appendix A.

2. AMD Management

The management option detailed in this document is designed to promote best practice and continuous awareness and environmental improvement by means of a life-cycle approach towards AMD management and detailed risk assessments and is consistent with the following documents:

- *Acid Metalliferous/Mine Drainage (AMD) and Management*, Roper Bar Project Area Western Desert Resources Ltd, EcOz, 2012.
- *AMD Risk Assessment and Management*, Western Desert Resources Limited, Pendragon Environmental Solutions, 2013a.
- The Independent Technical Review, Golders, 2013 included in Appendix B of this document.
- *Acid and Metalliferous Drainage Management Plan, Care and Maintenance - Mining Management Plan*, Roper Bar Iron Ore Project, Western Desert Resources Limited, GHD, 2015.
- Technical Review: AMDMP for the Roper Bar Mine, Northern Territory, Amanzi Consulting, 2019.
- *2020-2023 Acid Metalliferous/Mine Drainage and Management*, Nathan River Project, Nathan River Resources, Revision 4, December 2019.

The framework articulated in these documents aims to focus on early identification of AMD risk to focus the effort on prevention or minimisation rather than control or treatment. It also allows for frequent reviews and continual improvement. This AMDMP is to be included in the MMPs for Stages 1A and 1B.

2.1 Pre-Mining, Mining and Care and Maintenance AMD Management

Pre-mining investigative activities included AMD investigations and assessments (EcOz, 2012) which indicated that materials with a potential to produce acidity (PAF) are present at the site. Because of the need to classify materials as either net acidic or alkaline, column leach (kinetic) testing was implemented (Pendragon Environmental Solutions, 2013b). This latter document included a detailed risk assessment and management plan for operations. A subsequent AMDMP (GHD, 2015) was prepared for Care and Maintenance. A revised AMDMP, taking due cognisance of all the earlier work (Pendragon Environmental Solutions, 2019), was prepared to re-commence mining activities. Whilst these documents were considered in preparing this AMDMP, they are not included.

Investigations committed to in the above during the EIS process included pre-mining ore grade control including field measurements complemented where needed with laboratory analytical investigations. This phase of the mine spoil characterisation will fundamentally assist with the quantification of PAF/NAF materials and therefore with the refinement of the block models.

2.2 AMD Risk Assessment

Ecological and human health risk assessments were undertaken (EcOz, 2012; Pendragon Environmental Solutions, 2013 and GHD, 2015) to determine the risks associated with the AMD materials at the site taking due cognisance of:

- PAF materials identified during various geochemical assessments.
- Metals leaching potential of the different materials.
- The MMP and schedule.

- Baseline environment and sensitive receptors.

The AMD risk assessments are *source focused* and consequently not an exhaustive assessment and study of downstream impacts; they were completed to provide a high level understanding of AMD risk using a source-pathway-receptor model (INAP, 2009). The general approach to the risk assessment followed standards and leading practice guidelines including:

- AS/NZS 4360:2004 Risk Management.
- AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines.
- Managing Acid and Metalliferous Drainage (DITR, 2007).
- The Global Acid Rock Drainage Guide (INAP, 2009).

The risk assessment was informed by detailed geochemical assessments and the MMP and schedule and also acted as an information gap analysis (GHD, 2015). The gap analysis indicated that the laboratory acid base accounting and metals leaching data sets are both too small to be statistically significant. To improve confidence in these data sets, additional sampling and analysis would be required to inform AMD risk and management strategies in subsequent revisions of this document. Consequently, laboratory XRF data was used to inform the AMD risk assessment. This data set indicated that (GHD, 2015):

- *There is a relatively small volume of PAF material present on site and that forward risk can be readily managed and/or mitigated.*
- *There were no elevated metals concentrations present in the three main geological units on site relative to the median crustal abundance of those same metals. However, some minor metals and contradictory sulfate leaching were evident requiring additional analysis.*

The AMD risk assessments to date indicate that with appropriate design and operational control measures, the residual AMD risk is medium at worst and manageable with effective controls. Any residual risk would be monitored during implementation of the AMDMP to confirm that the design and operational control measures are effective.

Table 2.1: AMD Risk Assessment and Mitigation Measures.

Aspect	Impact	Design Control Measure	Operational Management Measure
PAF material causing uncontrolled AMD	Downstream water quality (low pH, elevated sulfate and metals) impacts on ecological values. Reputational Risk.	Clay lined PAF cells within WRDs. Selective materials handling and placement. Separate, clean, dirty and contaminated water drainage systems. Surface water management basins.	AMD Management Plan Water Management Plan Mine schedule and geochemical modelling. Controlled and managed site drainage and release.
Acid, Metalliferous and Saline Drainage			
WRD and ROM pads leaching metals	Downstream water quality (elevated metals) impacts on ecological values.	Compacted WRD and ROM pad base. Use of NAF material.	AMD Management Plan. Water Management Plan. Controlled and managed site drainage and release. Ongoing cover trials during DSO.
WRD design and cover material	Rainfall ingress into WRDs resulting in downstream water quality (low pH, elevated sulfate and heavy metals):	Use of NAF material. Determine a suitable cover design.	

Aspect	Impact	Design Control Measure	Operational Management Measure
	impacts on ecological values.		
LGO, DSO, BDSO, DMSO and SIDO stockpiles leaching AMD and elevated waste mineralisation	Downstream water quality impacts.	Compacted ROM pad base. Separate clean, dirty and contaminated water systems. Controlled and managed site drainage and release.	AMD Management Plan. Waste Discharge Licence.
Dispersive waste management	Rehabilitation issues including tunnel erosion and landform failure.	Selective cap material. Ameliorate/amend material to increase calcium content.	Rehabilitation Management Plan. Inspection and monitoring.
In-pit exposed PAF material causing poor pit water quality post closure	Groundwater leaching AMD into pit becoming either an AMD sink or source.	Future Beneficiated Ore Project - mine out PAF area.	AMD Management Plan.

2.3 AMD Management Plan

The AMDMP detailed below supports current and potential future mining operations and maintain the structure in accordance with the conditions for approval and Sections 4, 6, 7 and 9 and Appendix 1 (Commonwealth of Australia, 2016) and the *Technical Review: AMDMP for the Roper Bar Mine, Northern Territory*, Amanzi Consulting, 2019).

Table 2.2: AMD Management.

Responsibility and Accountability	Operator:	NRR Services Pty Ltd (ABN: 38 634 895 800) https://www.nathan-river.com/ Postal and Physical Address: 47 Callantina Road, Hawthorn, Victoria, 3122 Key Contact Person(s): Simon Peat, Chief Executive Officer Phone: +61 418 124 024 e-mail: Simon.peat@nathan-river.com
	Assisted by:	Pendragon Environmental Solutions
Objective, Purpose and Operational Policy	To achieve best practice AMD management at the Nathan River Project. The principal objective is to manage AMD risk resulting from oxidising sulphidic mine waste such that local and downstream environmental values are not at risk. To ensure appropriate systems, processes, procedures, resources, facilities and capacities are in place to manage the risk of AMD throughout the life of mine, adequately and effectively. To provide for the classification of waste materials and validation and monitoring procedures for the effective handling and long-term storage of wastes. Materials are not to be disturbed, nor excavated, and/or are not to be placed without facilities with adequate capacities. Maintain disturbances within the limits required for construction. All construction/site workers will be made aware of this document to ensure that acid generating materials are handled and managed effectively.	

9a. Sampling and Analysis Procedures employed to identify potential acid forming (PAF) materials (Handbook, 2016).

4.2 Sampling for Identification and Characterisation.

4.2.1 Overview

Sampling for identification and material characterisation were undertaken between 2012 and 2014 (EcOz, 2012; PES, 2013a and WDR, 2014). Subsequent analysis included assessments when the mine was placed in administration but did not include sampling (GHD, 2015) other than extending the database for kinetic leach column testing from 17 weeks (PES, 2013b) to 76 weeks (GHD, 2015). No further sampling and analysis, including monitoring of the kinetic leach columns were undertaken after May 2014.

The primary aim was to define the main lithologies and geological units and mine ore and waste materials based on Fe content. Material with an iron content <30% is classified as waste and is transported directly to the WRD's where it is managed according to their PAF, NAF, UC or AC sub-classifications.

Multiple test methods with increasingly detailed sampling and analysis facilitated materials characterisation with geochemical classification of mine materials into PAF, NAF and UC categories and assessing risk using a Source-Pathway-Receptor model (PES, 2013a and GHD, 2015).

Material characterisation was undertaken:

- to meet the conditions for approval of the Environmental Impact Statement (EIS) by the NT EPA; and
- subsequently, to meet the requirements of the EPBC Act conditions for approval;

including:

- Sampling and analysis to identify PAF materials in accordance with industry best practice and statutory guidelines.
- Develop management strategies and designs for WRD's with containment/encapsulation cells and drainage systems comprising diversion/containment bunds/channels, embankments, sediment traps, seepage diversion barriers and collection ponds.
- A strategy for the ongoing management and monitoring of PAF material, including threshold trigger levels and mitigation responses.

by employing:

- Static geochemical laboratory testing on (PES, 2013a):
    - 24,457 (12,007 in pit) laboratory XRF measurements (5,433 of the KYM, 14,380 of the SIM and 4,644 of the MSM) of Total S (%), CaO (%) and MgO (%) from 3,125 drill holes;
    - 204 (60 in pit) ABA/NAG Total S from 47 drill holes;
    - 17 samples by WDR in 2014 as a quality assurance check/validation of the NAPP data set and subsequent classification of the WST unit (the bulk of which was from the upper weathered material at Roper Bar);

  sufficient to populate a geological block model with reliable distribution of NAPP data on the ore and the mine waste streams including ore, overburden and discards.
- Kinetic leach column testing on representative samples for key lithologies and waste materials specifically those identified as PAF or UC.

Geochemical testing included:

- Mineralogical assessments by XRD, XRF, SEM and EDS.
- Static (ABA) testing, Maximum Potential Acidity (MPA), Net Potential Ratio (NPR) and Net Acid Production Potential (NAPP).
- Metal assessments using the Geochemical Abundance Index (GAI) and laboratory Australian Standard Leaching Procedure (ASLP).
- Kinetic testing: column leach construction, sampling and analyses with laboratory testing and ASLP.

	Sufficient sampling and analysis have been undertaken to establish a block model and inform future sampling protocols, analytical needs and ongoing test work, to confirm findings and direct adjustments to risk assessments and management plans (Amanzi, 2019). Despite the NAF classification for all units in the kinetic leach columns, small pockets of PAF were confirmed by geochemical block modelling (GHD, 2015). Materials on site will be managed using NAF < 0.3% Total S < PAF as the classification tool in the site assessment procedure (Appendix C). Using Total S (the acid forming nature of the material) as a classification tool is a conservative approach. This approach excludes consideration of acid neutralising minerals including CaO and MgO. Additional validation sampling and laboratory geochemical analytical results in future will inform the refinement of this approach minimizing expected PAF volumes by inclusion of the effective acid neutralising or buffering capacity of certain minerals i.e. future classification will be based on static NAPP and acid buffering characteristics curves (ABCC) rather than simply using Total S values. Therefore, the PAF volumes shown in Section 4.4 below are inherently conservative and would likely represent an upper estimate.
4.2.2 In-place mine materials	Sampling and analysis prior to mining enabled *in situ* material identification and characterisation (EcOz, 2012 and PES 2013a). Two hundred and four samples were obtained from fifty-eight exploration boreholes in various geological horizons and rock types present at the mine including: ▪ Zabeel: Area E: East and South Pits. ▪ Danehill: Area F: East Pits 1, 2 and 3 and the West Pit. Samples were obtained from the main lithologies including sandstones and oolitic sandstone, siltstones and clays from the main geological units i.e. the Kyalla Siltstone Member (KYM), the Moroak Sandstone Member (MSM) and the Sherwin Iron Member (SIM). Further sampling and analysis for static testing to be undertaken during the 2020-2023 Mine Plan include 75, 140 and 27 samples from the KYM, MSM and SIM respectively (refer Section 4.9 below).
4.2.3 Existing exposed mine materials	Danehill and Zabeel open pits coupled with the PAF containment cell in the Danehill WRD.
4.3 Static Geochemical Tests **4.3.1 Field measurements**	**Static Geochemical Tests (EcOz, 2012, PES, 2013a and GHD, 2015)** **Field measurements** included pH, electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO) and temperature (T) of the column leachates.
4.3.2 Mineralogical analysis	**Mineralogical Analysis (EcOz, 2012 and PES, 2013a)** ▪ Fifty-six samples were analysed using X-ray powder diffraction (XRD). ▪ Forty-six samples representing the principal waste rock streams were analysed by Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Spectrometer Analysis (SEM-EDS) techniques. ▪ Sulfur assessment by XRF analysis of fifty-one laboratory analysed samples.
4.3.3 Elemental composition	**Elemental Composition (EcOz, 2012 and PES, 2013a):** ▪ Laboratory X-Ray Fluorescence (XRF) of 24,457 samples for Total S%, CaO and MgO; other analytes included: Al_2O_3, Fe, Mn, Mo, P, SiO_2, TiO_2 and K_2O.

	▪ Leaching of eighty-five samples employing ASLP; the results were plotted on Piper diagrams to classify leachates: Owing to hardness (calculated from Ca and Mg as $CaCO_3$), most leachates classify as soft with five samples moderately soft to very hard. Dominant very soft leachates is indicative of low Ca and Mg concentrations having a low buffering capacity with the potential to influence water management and treatment. Most of the samples from E East and South produced Na-K-HCO_3 type leachates and a significant number of samples from F-East Pits 2 and 3 produced Na-K-SO_4-Cl type leachates. A small number of samples from F West and F East Pit 1 also produced Na-K-HCO_3 type leachates. About 40% of samples produced leachates with no dominant anions or cations.
4.3.4 Acid base accounting	**Acid Base Accounting and NAG testing (EcOz, 2012 and PES, 2013a):** To characterise the materials at the site, including the materials that will make up the WRD, two hundred and four samples were submitted for laboratory ABA and NAG testing. One hundred and seventy-five of these samples came from the KYM, MSM and SIM units within the mine disturbance area. A standard suite of analyses, using prescribed methods by an accredited laboratory, was used to determine the acid base chemistry for all waste materials: ▪ pH and EC of paste solutions. ▪ Oxidation pH. ▪ Total S and sulphate sulfur. ▪ Acid Neutralising Capacity (ANC), carbonate alkalinity (as $CaCO_3$) and Net Acid Generation (NAG). From the laboratory analytical data, Maximum Potential Acidity (MPA), Net Acid Producing Potential (NAPP) and the Acid Potential Ratio (APR) values were calculated. In summary, geochemical static test work reporting included: ▪ Descriptions of methods used in the sampling and analysis. ▪ Records of the initial results of characterisation of *in-situ* materials. ▪ Records of the leachate chemistry from the waste materials. ▪ Assessment of the geological sequence to determine PAF, NAF or UC by lithology. ▪ Identification and characterisation of the potential sources of AMD in the East and West Pit WRD's ▪ A preliminary mine waste balance and a mine waste management option including the placement of PAF material within containment cells in the WRD's. ▪ Document a risk assessment process and provide a risk assessment for the management of mine wastes.
4.3.5 Net acid generation test	**Net Acid Generation Testing (EcOz, 2012 and PES, 2013a):** Refer discussion above.
4.3.6 Sulfur and carbon speciation	**Sulfur and Carbon Speciation (EcOz, 2012, PES, 2013a and GHD, 2015):** Refer discussion above.
4.3.7 Sample classification	**Sample Classification (PES, 2013a and GHD, 2015)**

Material types are classified according to iron content:

- Mine wastes (WST) are materials with <30% Fe content subdivided into geological units KYM, SIM, MSM and sub-units of fresh and weathered (oxidised).
- Ore types are defined by Fe content >30%: Direct Shipping Ore (DSO) >60%, Blended Direct Shipping Ore (BDSO) 54-60%, Dense Media Separation Ore (DMSO) 45-54%, Siderite Ore (SIDOO) 30-54% and LOI >10% and Low Grade Ore (LGO) both fresh and weathered.

Materials are also characterised as (Commonwealth of Australia, 2016 and other relevant AMD standards and guidelines):

- Non Acid Forming (NAF).
- Potentially Acid Forming (PAF).
- Uncertain (UC, material that cannot be classified definitively as PAF or NAF).
- Acid consuming (AC).

The AMD characteristics of the different lithologies, including weathered (oxidised) and fresh, are classified according to Total S content: Low S <0.3% and High S >0.3%. Using Total S (%) is a conservative approach as sulfate sulfur, which may have neutralising sulfates, is excluded.

Calculated parameters for material characterisation include:

- The Maximum Potential Acidity (MPA) values (in kgH_2SO_4/t) of the samples were calculated by multiplying the Sulfide-S values (in %) by 30.6. The multiplication factor of 30.6 accounts for the reaction stoichiometry for the complete oxidation of pyrrotite and pyrite by oxygen to $Fe(OH)_3$ and H_2SO_4.
- The Net Acid Producing Potential (NAPP) values (in kgH_2SO_4/t) were calculated from the MPA and Acid Neutralisation Capacity (ANC) values: NAPP = MPA - ANC.
- The Acid Potential Ratios (APR) were calculated from the relationship ANC/MPA.

  The more conservative APR criteria for the NAF Category reflects the need to compensate for the availability of alkalinity forms for neutralisation of acid produced through pyrite oxidation. A material is likely potential to produce acidity if $1 \leq APR \leq 2$; however this assessment relates to whether ANC and MPA are calculated free of errors and to local conditions with regard to sulfide form, morphology and concentration.

The ABA static testing program (EcOz, 2012) yielded geochemical characterisation, as a % of all samples tested: NAF 52%, PAF 34% and Uncertain 14%. These might be skewed due to the preference at the time to target the materials most likely to generate acidity. Using NAPP calculations indicated that the volume of PAF materials are small and that volumes can be estimated using the Total S (%) grade cut off of 0.3% (GHD, 2015) which is considered conservative as it excludes CaO and MgO minerals with a neutralising capacity.

4.4 AMD Block Modelling and Materials Scheduling

WDR populated a block model for the E East Pit and combined F-Pit (F East and F West 1 to 4, Appendix D; updated to include the MMP for 2024) with their XRF dataset. They included NAG test data (EcOz, 2012) and were undertaking additional validation sampling and assessment to supplement the ABA/NAG dataset (PES, 2013a) at the time the operation was placed into administration.

The data set comprised (locations are included in Appendix D):

- 24,457 (12,007 in pit) laboratory XRF measurements (5,433 of the KYM, 14,380 of the SIM and 4,644 of the MSM) of Total S (%), CaO (%) and MgO (%) from 3,125 drill holes.
- 204 (60 in pit) ABA/NAG Total S from 47 drill holes (PES, 2013a).

No sampling and analysis were done after the mine was placed in administration (GHD, 2019).

Total S values <0.3%S or 10kgH_2SO_4/t are considered UC (DITR, 2007) that will be subject to further sampling and analysis in terms of this plan.

The block model, currently based on coarse sampling and a conservative 0.25% Total S (PAF) cut-off, will be reviewed from time to time as required and upon further sampling and analysis, including lithological modelling with closer-spaced pre-production sampling, to delineate AMD risk within the pit shell and to determine appropriate management of mine waste.

There is good spatial correlation between the geochemical model, the laboratory XRF dataset and the geological block models. With regard to data set correlation there is a very good correlation between the ABA and laboratory XRF Total S data sets. The laboratory (ABA) derived NAPP data shows a significantly lower NAPP value in comparison to the estimated assay NAPP value (laboratory XRF) indicating that the latter does not consider all neutralising minerals unlike the laboratory ABA titration method (GHD, 2015).

The spatial variability assessment indicated that sulphur grade has been adequately represented by the sample density of the laboratory XRF data along approximate 100m section lines at E East and on 150m section lines or better at F East and F West well within the limits shown in the correlogram (GHD, 2015).The order of magnitude sampling assessment showed that an adequate number of geochemical samples had been obtained in the laboratory XRF dataset to undertake a preliminary geochemical assessment; however, further laboratory testing is required to increase ABA data, including metals, to ensure the AMD risk assessment can be improved over the life of mine at Roper Bar (GHD, 2015).

A detailed assessment of the 2019 *global* XRF dataset:

Area	n	Min	Max	Ave	StDev	Total S > 0.30%	
						n	%
Mine Wide	101,440	0.001	10.784	0.071	0.198	4,680	4.6
E (Zabeel)	29,132	0.001	9.097	0.086	0.208	1,689	5.8
F (Danehill)	51.082	0.001	10.784	0.068	0.216	2,335	4.6
Danehill	3,147	0.001	1.329	0.071	0.111	112	3.6
B	7,104	0.001	2.400	0.065	0.155	352	5.0
C	275	0.003	1.290	0.053	0.121	10	3.6
D	10,208	0.001	3.720	0.048	0.089	127	1.2
Hellsgate	492	0.001	1.410	0.139	0.189	55	11.2

indicated that the average Total S concentrations in all mining areas are below the threshold of 0.30% whilst the percentage of samples exceeding the threshold in the Danehill and Zabeel open pits vary between 3.6% and 5.8%. This is comparable to the earlier findings (GHD, 2015) on a dataset of 24,456 laboratory XRF samples from the E East and F East mining areas which revealed that 10.5% and 5.1% (respectively) of the samples contained Total S > 0.3% (i.e. a MPA value less than 10 kg H_2SO_4/t). Thus, assuming conservatively that Total S is a surrogate for reactive pyrite, this gives an indication of the potential for acid generation to occur.

Consequently, the earlier conclusions (GHD, 2015) that the laboratory XRF data set showed that there is a relatively small volume of PAF material on site, and that forward risk can be readily managed and/or mitigated and that with appropriate design and operational control measures, the residual AMD risk is medium at worst and manageable with effective controls remain valid.

The latest assessments of assay data for the Danehill and Zabeel deposits:

Statistical Parameter	Danehill East	Zabeel
Number of measurements, n	27,039	47,209
Minimum % S	0.0	0.0
Maximum % S	9.1	10.8
Average % S	0.1	0.2
Standard Deviation	0.2	0.1
PAF (>0.3 % S) as a % of n	**11 % (3,089)**	**7 % (2,203)**

indicates that both the current and proposed Stage 1A and Stage 1B operations are likely to encounter, if any, relatively small volumes of PAF materials with more than sufficient volumes of NAF to contain these problematic materials.

Materials Schedule

The mining activities to date focussed on the Danehill and Zabeel deposits where the ore body has been exposed during the previous mining operation. The initial pit design will remain within the current footprint of the existing pit limits and contains approximately 2.5 Mt of ore (Fe > 45%), 1.5 Mt of low-grade ore (Fe 30% – 45%), 190 Kt of PAF material and 9.5 Mt of waste rock (NAF).

Waste rock will be stored in the existing Danehill and Zabeel WRDs and PAF materials will be stored in the existing PAF storage area in the Danehill WRD (Appendix A). The wastes currently stored at the NRP include:

Material Type	Danehill WRD	Zabeel North WRD	Zabeel South WRD
NAF	3,546,000 bcm	444,594 bcm	1,435,000 bcm
PAF	119,196 bcm	0 bcm	152,000 bcm
PAF as a % of Total Waste	**3.3 %**	**0 %**	**9.6 %**

The revised mining and waste schedule for Stages 1A and 1B and the 2024 MMP are:

Mining Area	DSO/LGO	Waste	PAF
		(t)	
Stage 1A (2024)			
Danehill Saddle	151,000	205,000	0
Zabeel North Pit	482,000	1,245,622	0
Stage 1B (2024 to 2025)			
Danehill	955,000	2,615,000	0
Mine Management Plan (2024o 2025)			
Zabeel Ultimate Pit	1,534,454	7,617,250	555,368
Ponting Pit	681,703	5,547,424	1,218
Border Pit	206,397	788,874	
Note: wastes include only NAF and PAF materials.			

WRD Capacities (bcm)		Total	PAF Volume to Date	Available PAF Volume
Danehill [NAF waste from Danehill and PAF waste from Danehill and Zabeel (earlier operations) and Ponting (new mining)]	-	12,235,200	119,196	695,000 within new PAF cell from 36RL to 51RL

Zabeel (NAF waste and PAF from Zabeel Ultimate Pit)	WRD (incorporating the South and North WRD's)	3,665,000	0	360,000
	West (NAF material)	500,000	0	0
Ponting (NAF waste from Ponting and Border pits)	-	2,975,000	0	0

4.5 Geochemical Kinetic Column Leach Testing

Whereas static tests provide geochemical information on the existing composition of a sample, kinetic tests provide longer term data which incorporate the effects of secondary minerals (Ca, Mg, Fe, and Mn hydr[oxides]) which may impact the quality of surface and ground water drainage (Pendragon Environmental Solutions, 2013b). Consequently, kinetic testing was implemented, following a risk assessment (Ecoz, 2012 and PES, 2013a), to inform WRD designs and the management of PAF materials during mining operations. Static testing indicated that PAF materials predominantly occur below 30m depth.

Six columns, containing primarily weathered and fresh KYM from pit samples and drill cuttings, were constructed as two sets of columns, with a mixture of PAF and NAF materials, one set representing low sulfide spoils and the other set high sulfide spoils concentrations, were constructed to assess mine waste materials (PES, 2013b).

The subsequent analysis of sampling data after week 17 (PES, 2013b) indicated that:

- Columns 1 and 2 were confirmed as PAF.
- Column 5 was UC.
- Column 3 confirmed as NAF.
- Columns 4 and 6 were found to be UC.
- The leachate qualities observed are indicative of spoil materials that have been weathered naturally.
- High pH and large sulfate concentrations indicate fast reaction of buffering minerals and the release of diluted accumulated acidity and readily available sulfate salts. The circumneutral pH (normally >6.0) in the leachates indicates the presence and steady activity of carbonates (and silicates) with acid neutralizing capacities in excess of the acid produced by sulfide oxidation.
- The subsequent short-term behaviour of pH and solute loadings are indicative of slow sulfide reactions and dominance by buffering capacities. The pyrite oxidation rates averaged a rather slow 2.25E-11mol/m^2/s.
- The peak of the AMD zone at which high sulfide oxidation and acid generation exceed or are lower than acid neutralising capacities has not been observed. The time lag when acid or alkaline conditions sets in and commences to control the weathering environment was also not detected.
- The results and observations between 22 November 2012 and 22 March 2013 (first 17 weeks) were inconclusive and it was recommended that kinetic testing should continue until clear patterns of acid and/or base production are confirmed.

The kinetic geochemical column leach data was updated to May 2014 and re-interpreted (GHD, 2015); the salient findings were:

- Kinetic testing assisted with validating the predictive work completed using the laboratory XRF and static ABA datasets and understanding the rate of any acid forming and neutralising reactions, and therefore, the AMD temporal risk.
- The data indicated that all six columns returned circumneutral pH values and EC's that exceed the 99% ANZECC trigger values indicating the potential for saline drainage from the KYM unit. Slightly elevated Al, Fe, and Mn concentrations relative to the 99% ANZECC trigger values may indicate a potential stored acidity pool. Whilst Cd, Cr, Cu, Pb, Ni and Zn have limited mobility, the results will be used as indicative of the potential drainage water quality.

	▪ Column 1 (fresh KYM material; PAF): the materials classify as PAF(LC) with a NAPP value of 5.48kgH_2SO_4/t. Although pyritic sulfur was present (1% pyrite), the relationship between total alkalinity, acidity and pH indicated that the inherent neutralizing capacity (ANC) was effective for at least the first 76 weeks of testing. ▪ Column 2 (fresh and weathered KYM material; PAF): the materials also classify as PAF(LC), with a NAPP value of 0.31kgH_2SO_4/t. Although pyritic sulfur was present (4% pyrite), the relationship between total alkalinity, acidity and pH indicated that the neutralizing capacity was effective in neutralising acid for at least the first 76 weeks of testing. ▪ Column 3 (weathered KYM material; NAF): the materials classify as NAF with a NAPP value of -7.94kgH_2SO_4/t. Pyritic sulfur was not identified. The relationship between total alkalinity, acidity and pH indicated that the neutralizing capacity (ANC) was effective in negating acid generation for the 76 weeks of testing. ▪ Column 4 (fresh and weathered KYA material; NAF): the materials classify as NAF with a NAPP value of -11.03kgH_2SO_4/t. Although pyritic sulfur was identified as being present by SEM, the relationship between total alkalinity, acidity and pH indicated that the inherent neutralizing capacity was effective for the 76 weeks of testing. ▪ Column 5 (fresh KYA material; NAF): despite being selected as an elevated sulfur column, the materials classify as NAF with a NAPP value of -5.54kgH_2SO_4/t. Although pyritic sulfur was identified by SEM as being present, the relationship between total alkalinity, acidity and pH indicated that the inherent neutralizing capacity was effective for the 76 weeks of testing. ▪ Column 6 (fresh KYA material; NAF): the materials classify as NAF with a NAPP value of -6.13kgH_2SO_4/t. Although pyritic sulfur was identified by SEM as present, the relationship between total alkalinity, acidity and pH indicated that the inherent neutralizing capacity was effective for the 76 weeks of testing. Monitoring of the columns ceased when the mine was placed in administration. The columns have been damaged by fire since; however, given the small volumes of PAF materials contained in large volumes of NAF and since mining to date has not impacted the downstream environment, further column testing will not be undertaken.
4.5.2 Oxygen consumption tests	To date laboratory oxygen consumption testing has not been undertaken during any of the earlier investigations.
4.5.3 Oxygen penetration tests	These tests, used in tailings storage facilities (TSF's), will not be undertaken; there will be no TSF at the mine.
Scaling-up of laboratory test results **4.6.1 Pilot-scale field tests** **4.6.2 Large to full scale field tests**	Not undertaken and/or required yet as geochemical testing indicated that small volumes of PAF can be contained in cells within the waste rock dump (WRD). The WRD will be monitored: visual observations for leachates and or precipitation of salts coupled with water quality monitoring in the open pits, sedimentation ponds, streams and monitoring bores (refer Section 9 below).
Estimating and modelling pollutant generation and release rates **4.7.1 Overview** **4.7.2 AMD prediction using empirical test results**	Laboratory ASLP metal leaching and Kinetic Leach Column testing were undertaken between 2012 and 2014 and further testing will be undertaken during the 2020-2023 Mine Plan which will form the basis for AMD predictions using the Conceptual Site Model and empirical methodologies. Computer modelling is not warranted given the scale of mining and low risk of AMD. During kinetic leach testing (PES, 2013b), the acidity load during the first flush event (total acidity as compared to total alkalinity) were relatively high in Columns 1 and 5, whilst in the others alkalinities were dominant. The highest acidity concentrations occurred in Columns 1 and 5 and the lowest in Columns 2 and 3. Although alkalinity concentrations remained dominant, with an increasing trend in time, acidity in Columns 4 and 5 slightly increased in week 17:

4.7.3 AMD prediction using computer models

Date	Acidity as $CaCO_3$ (mg/L)					
	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
22/11/2012	32	4	7	6	24	8
18/12/2012	22	10	6	6	10	10
31/01/2013	15	8	6	9	13	7
13/03/2013	14	8	9	20	18	15
30/04/2013	10	5	6	19	12	11

The alkalinity-acidity balance and sulfate concentrations indicated that sulfides in contrast to the buffering materials of the samples, react slowly (PES, 2013b). Elevated pH due to constant alkaline material dissolution is unfavourable for the oxidation of FeS_2 as this reduces the catalytic effect of bacteria and precipitates iron oxides which partially coats the available sulfide surfaces and reduce the rates of sulfide oxidation and acid generation.

9b. Design details and management strategies of proposed encapsulation beds, waste rock dumps, drainage systems, sediment traps, seepage diversion barriers, collection ponds and embankments (Handbook, 2016).

6.1 Management of WRD's to minimise AMD

6.1.1 General considerations

PAF waste is managed by placing PAF waste in existing and future containment cells in existing and future WRD's

An estimated 53,000t of PAF mined during active operations in 2014 was placed in the PAF Cell constructed and operated by Theiss for WDR at Danehill. The open PAF Cell was later covered with 1.2 m thick NAF material followed by a rock and soil layer some 0.5 m thick that was track rolled and subsequently shaped for drainage by the Administrators in 2014/2015 prior to the 2014-2015 wet season. The materials stored have been classified as low risk (GHD, 2015).

NRR recognises and is aware that prevention will help avoiding many of the long-term issues and difficulties faced at mine rehabilitation and closure and that planning for closure is a fundamental component of mine planning; therefore, identifying any PAF material is essential to facilitate effective and successful long term management. Consequently, NRR will continue to develop appropriate AMD design and operational controls to minimise forward closure risks.

The broader AMD strategy was developed within the context of a future planned beneficiated ore project designed to maximise asset value; hence, the overall waste rock management strategy over the life of the mine includes open pit rehabilitation.

6.1.2 Conventional end-dumped WRDs

Construction of the WRDs employing paddock dumping for the large volumes of NAF waste and end dumping for relatively small volumes of PAF facilitates effective management and placement of wastes with the view to minimise the potential for and control of AMD and self-heating.

Reference should also be made to Appendix A and discussions under paragraphs 6.1.4 and 6.1.5 below.

6.1.3 Oxidation rate and lag time to production of AMD

When sulfide oxidation rates (SORs) were compared in relation to time (days), the rate of sulfate production substantially declined for all columns (PES, 2013b). A preliminary calculated pyrite oxidation rate averaged $2.25^{-11}mol/m^2/s$ ranging from 5.88^{-12} $mol/m^2/s$ to $7.26^{-11}mol/m^2/s$. The lowest SOR was observed in Column 2 and the highest in Column 3. Even though the SORs appear to indicate influences by the quality of leaching solutions, column water content, irrigation rate and availability of oxygen, these are comparative to SORs obtained by different researchers at various mining sites within Australia and overseas (Bennett et. al., 2000).

6.1.4 Construction methods for WRDs to minimise AMD production	Construction of the WRD's (Appendix A) included: ▪ AMD risks and waste rock management strategies and measures were identified, developed and implemented (Table 2.1 and PES, 2013a). ▪ Potential sources of AMD are inhibited and minimised by: o Installing a store and release cover to inhibit oxygen and moisture ingress. o Paddock dumping of waste rock in WRD with end dumping of PAF into lined cells with intermediate covers during the wet season to prevent/minimise exposure. o Encapsulation of PAF in 100,000m^3 volume containment cells constructed of NAF KYM within the WRD; cells have 2.5m thick bases and covers and 4.0m thick side covers. o Potential backfilling and submergence of PAF wastes in open pits in future when available. o Ongoing identification and characterising of AMD generating wastes. ▪ The base of the WRD will be constructed with 2m thick weathered impermeable NAF KYM. ▪ The cap of the WRD will be 1.2m thick NAF MSM covered by rock armour and 0.5m soil, placed and profiled for erosion control and slope stabilisation. ▪ Water management infrastructure: interception trenches, bunds/berms and sediment/ containment dams to control, capture and evaporate storm runoff. The current WRD's and PAF cells (at Danehill and Zabeel, refer Appendix A) have sufficient capacity for the current operations. Available capacities are continuously reviewed to ensure that sufficient capacities exist if, where and when required - refer Section 4.4 above. Stockpiling of the LGO will not continue during Stages 1A and B. Low grade ores will be blended with the high-grade direct shipping ores and exported. To provide greater certainty of the amount of PAF waste requiring management, drilling and sampling will be undertaken on 50m lines during grade control. Sampling and analysis will be undertaken in accordance with Section 9 below. Grade control drilling on every 4th drill line (nominally 50m line spacing, 10m hole spacing) is extended into waste areas to give an initial understanding and assessment of PAF. A representative number is then sampled just prior to mining. The spacing of these holes varies based on blast parameters. These assays fine tune the PAF dig boundaries. NRR have not yet found a way to model PAF as it does not appear to follow geological boundaries and is an internal sedimentary feature, likely diagenetic pyrite. The current geological model is a marine fan environment. PAF represents areas where organic matter existed or was deposited, these areas will be thin and patchy along strike. The reason why NRR treated more PAF than originally predicted is due to mining dilution i.e. the current conservative waste rock sampling procedure ends up encapsulating a larger area as PAF because samples represent a full bench/ mining unit.
6.1.5 Minimising self-heating and AMD potential	Self-heating of the PAF materials has not been observed. Self-heating and AMD potential are prevented or minimised through mine waste handling and storage as detailed in discussions above and below. When sulfide oxidation rates (SORs) were compared in relation to time (days), the rate of sulfate production substantially declined for all columns (PES, 2013b). A preliminary calculated pyrite oxidation rate averaged 2.25^{-11}mol/m^2/s ranging from 5.88^{-12} mol/m^2/s to 7.26^{-11}mol/m^2/s. The lowest SOR was observed in Column 2 and the highest in Column 3. Even though the SORs appear to indicate influences by the quality of leaching solutions, column water content, irrigation rate and availability of oxygen, these are comparative to SORs obtained by different researchers at various mining sites within Australia and overseas (Bennett et. al., 2000).

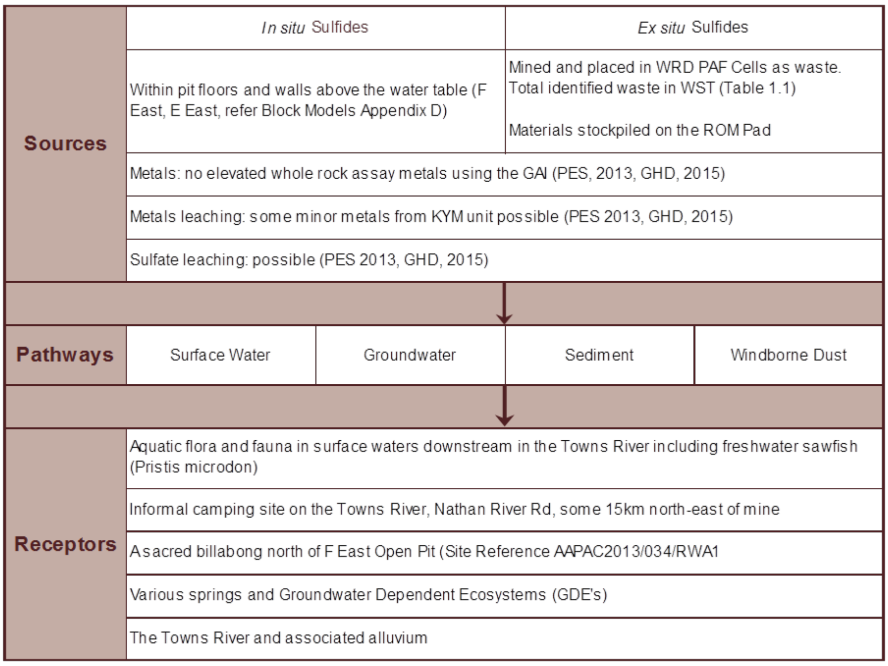
	Reference should also be made to the discussion under paragraph 6.1.4 above. AMD management was initially based on exploratory drilling which delineated the ore bodies extending to depths beyond that currently mined. Current and future ongoing AMD management and PAF identification is based on grade control and targeted drilling of material zones identified as containing PAF. Mining activities to date produced (and will produce in future) mineral waste streams classified as either: ▪ weathered (oxidised) overburden comprising the Kyalla Siltstone Member (KYM), the Moroak Sandstone Member (MSM) and a small amount of Sherwin Iron Formation (SIM) that grades <30% Fe (SIM); and/or ▪ weathered and/or unweathered (un-oxidised) fresh rock KYM, SIM and MSM surrounding the ore body that require removal during cutbacks to access the SIM ore. A portion of the waste stream was re-used during earlier operations for: ▪ The weathered (oxidised) KYM waste to construct the base of the WRDs and ROM pads. ▪ The weathered (oxidised) portion of the MSM will be used as capping material on the final WRD landforms. The management strategies for the two main mineral waste streams remain: ▪ Stockpile the weathered component of the MSM for future use as WRD capping materials. Use weathered KYM overburden (classified as NAF) for future construction material for infrastructure including WRD and ROM pad bases. ▪ Stockpile, store and retain weathered and fresh rock mineral wastes (KYM and MSM and a small amount of waste rock comprising <30% Fe from the SIM) generated through cutbacks to access in the WRDs. These materials may have the potential to contain PAF and are to be stored in the PAF Cell in the Danehill and/or Zabeel WRDs in accordance with this AMD strategy. Undertake further ongoing operational geochemical assessment and sampling, including the exposed pit walls, to validate the findings of the geochemical and risk assessments to date (refer Section 9).
6.1.6 Minimising AMD risk at sites dominated by PAF waste rock	The site is not dominated by PAF wastes: ▪ The volumes of PAF materials are small (Table 5, page 21, GHD 2015): Total % PAF in waste and ore is <1%. ▪ The PAF waste for the 2020-2023 Mining Plan was estimated at 2% compared to 72% NAF materials (refer Section 1.1).
6.2. Management of tailings to minimise AMD **6.2.1 Overview** **6.2.2 Water covers for tailings** **6.2.3 Covers for tailings**	The Stage 1A and 1B MMPs (refer Section 4.4 above) entail removal of ore for processing by crushing which does not generate tailings.
6.3 Soil cover systems for waste rock **6.3.1 Covers on flat tops** **6.3.2 Treatment of outer slopes**	Refer Appendix A and Section 6.1 above.

6.3.3 Cover design and performance	
6.4 Blending and co-disposal of wastes	There is no blending, other than LGO with DSO, or co-disposal of waste.
Section 7: Treatment of AMD (Handbook 2016)	
Management measures to prevent and contain AMD are appropriate and adequate. In the absence of AMD, treatment of AMD is not required; however, if AMD is detected, best practice treatment technologies and systems will be implemented.	
9c. A strategy for the ongoing monitoring of PAF material, including threshold trigger levels and mitigation responses (Handbook, 2016).	
9.1 Introduction	Ongoing monitoring of PAF material under this plan is aligned and integrated with the: ▪ NRR Environmental Management System (MET00264379-029, November 2019); the EMS details the system for identifying, managing and monitoring environmental risks in accordance with AS 14001:2015. ▪ NRR Water Management and Monitoring Plan (MET00266522-011); the WMMP is a more specific/targeted supporting management and monitoring plan to support the MMPs. ▪ Stage 2 MMP - WRM water quality trigger values (MET00266251-004) and 2023 Environmental Mining Report - NRP (MET00330229-004). These documents (included in Appendix E) provides a review of water quality data to derive trigger values suitable for the receiving waters at the mine as well as water quality reporting in terms of the EIS. Overarching discussion of the performance evaluation process may be found in Section 9 of the EMS. Objectives and targets (note: trigger values are referred to as a type of target in these documents) appear in Section 6.3 of the EMS. Reference should also be made to the 2023 Environmental Monitoring Table 10-1 (surface water) and Table 10-3 (groundwater) in the WMMP. Strategies and systematic approaches for ongoing monitoring of PAF materials are detailed in the earlier AMDMP's (references: PES 2013a, GHD 2015). NRR is committed to provide adequate financial, human, technical and other resources in their operational budgets to ensure that continued monitoring will be in strict accordance with this document. Whilst there is a low risk of AMD post-mining, adequate provision will be made for mine closure. Current provisions include: ▪ A dedicated environmental officer will be responsible for undertaking the surface water monitoring program (to be undertaken as part of the environment officer's overall site responsibilities). ▪ External groundwater specialist has been budgeted for and will be engaged to monitor and report on groundwater quality in accordance with the WMMP. ▪ Sampling and analysis work for the on-going geochemical testing program, including both *in situ* testing undertaken ahead of mining plus sampling and analysis of disturbed samples once placed in the dump to confirm the material characterisation. Budget allowance (based on sample numbers, approximately 300, in AMDMP): $50,000. Sample characterisation during mining and grade control blast hole drilling, will be by Total %S by XRF measurement in an on-site laboratory run by Intertek with field duplicates every 25 samples. The level of sampling and analysis is in accordance with the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (the JORC Code) which is a professional code of practice that sets minimum standards for Public Reporting of minerals Exploration Results, Mineral Resources and Ore Reserves.

	Visual observations of the WRD's are undertaken monthly during the wet and early dry season with no indication of water ponding or precipitation of salts at the surface. Surface water samples are obtained monthly from the water retention and sediment dam RBSP01, which drains the Danehill WRD; the analytical data are collated in the NRR Surface Water Monitoring Data database. Monitoring of water quality in proximity of the mine to date (Appendix E) indicates that: **Surface Water and Impoundments:** ▪ Surface flows are highly irregular, and most samples are obtained from pools rather than flowing water. ▪ There is little difference in all analytes between the upstream (RBSW02) and downstream RBSW04) monitoring locations. pH is around 7.3 and EC 155µS/cm. Elevated concentrations of metals (Al, As, Fe and Mn), particularly Al above the trigger levels, occur up and downstream of the mine with no net increase in a downstream direction. Mean SO_4 concentrations are below 4mg/L. ▪ The water quality (potentially a mixture between rainwater as the pits are currently flooded and groundwater influx) in the open pits (FE1, 2 and 3) have pH's between 6.0 and 8.1 and EC's between 1,542µS/cm and 2,499µS/cm. These waters have markedly higher elevated Mn and SO_4 concentrations than the surrounding surface waters. ▪ The water in the WRD sediment pond (RBSP01) has a pH of 7.8 and an EC of 6,702µS/cm. Metal concentrations are also elevated. **Groundwater:** ▪ Groundwater quality is highly variable with a small difference between the upstream (RBGW01, MB18 and MB01) and downstream bores (RBGW02). ▪ Mean pH range between 6.2 and 7.2 and mean EC's between 7,405µS/cm and 14,578µS/cm. These waters have markedly higher elevated metal and SO_4 concentrations than the surrounding surface waters. Trends in the water monitoring data to date (Appendix E) indicate that: ▪ It is evident that natural causes i.e. rainfall and evaporation impact water quality. ▪ Mean pH of surface (including open pits and WRD) and ground waters fall in a band between 6 and 8 and predominantly around the 7 level. The higher pH's are associated with impounded mine waters. ▪ Larger EC's, SO_4 and metal concentrations are associated with the open pits and WRD but there is no distinct indication (between upstream and downstream monitoring locations) and/or trend that mining has impacted the downstream receiving environment.
9.2 Performance Evaluation	Refer Appendix 1 Table A1 – Elements of an AMD Monitoring Program below. The following performance criteria will be met to confirm effective handling and management of waste materials: ▪ No discharge of water that was in contact with PAF waste materials unless permitted and in compliance with a Waste Discharge Licence (WDL). Contaminated water will be contained and evaporated. ▪ Maintain ambient downstream surface and groundwater qualities particularly pH. ▪ Maintain soil pH in the range 6.0 to 8.5 or at ambient pH values. ▪ Account for all sources of acidity: Total S >0.30 % S. ▪ Monitor grade control bores at 10m lines and 1m sample intervals for Total S with PAF >0.30% Total S in an on-site laboratory with QA/QC. ▪ Monitor blast holes at 10m intervals to delineate extent of PAF. ▪ Selective materials with Total S values of between 0.25% and 0.30% will undergo further testing by measurement of paste pH and/or NAG pH. Paste pH values of <4.6% and NAG pH levels of <4.5% will trigger the requirement for laboratory analytical assessment of ABA. Total S values of >0.3% will trigger the requirement for further field paste pH and NAG measurement and ABA laboratory assessment.

	NRR has a response process applicable to identified objectives and targets in the event a trigger value is exceeded (EMS, NRR 2019a; WMMP, NRR 2019b and Appendix E of this plan). The trigger value exceedance response process is detailed in Section 9.1.3 (includes explanatory text as well as a flowchart of the response process) of the EMS and also in Section 11 of the WMMP. Monitoring parameters were identified based upon risk, analytical data obtained thus far and Appendix 1. Default trigger values (Performance Evaluation Criteria) are to be employed (based on ANZECC/ARMCANZ [99% Ecosystem Protection], ADWG [Livestock] and relevant AMD guidelines) until site specific triggers are developed and approved as part of this plan. Upon exceedance of a trigger value the following will be undertaken: ▪ Initial validation of data via a review of the monitoring result(s) against the Performance Evaluation Criteria. This will include collection and analysis of confirmatory samples and comparison of results against any upstream (reference) and downstream (receiving environment) monitoring locations. o If the upstream (reference) value is the same as the downstream (receiving environment) value or exceeds the trigger value, then no further action will be taken; or o If the upstream (reference) value is less than the downstream (receiving environment) value and the downstream value exceeds the trigger value an investigation will commence. ▪ If the internal review confirms that a target (trigger value) was exceeded, and is potentially mine derived, NRR will provide written notification to the administering authority within 24 hours and include a justification of why an investigation commenced. ▪ Where an exceedance of a trigger level has occurred and is being investigated then no further reporting will be undertaken for subsequent trigger events for that monitoring parameter. Incident investigation: ▪ Incident investigations will be undertaken in accordance with both Section 29 of the NT Mining Management Act as well as in accordance with the ANZECC/ARMCANZ 2000 Guidelines with the goal to identify and mitigate potential sources of environmental harm (this may include additional follow up monitoring to confirm initial monitoring results). ▪ Within 10 business days after notifying the administering authority of a potential mine derived trigger exceedance, or receipt of follow-up monitoring results (whichever is the latter), the outcome of the investigation will be provided to the administering authority, including the results and interpretation of any samples collected and analysed, outcomes of actions taken at the time to prevent or minimise environmental harm and corrective actions to mitigate potential impacts from the exceedance and to prevent a recurrence of the incident. Management responses: Based on the recommendations of the incident investigation, NRR will: ▪ Prepare a report on corrective actions for subsequent review by the administering authority. ▪ Update/modify relevant environmental management plans (EMPs) via the existing MMP process (this may include updates to analytical parameters, targets/trigger levels, operational procedures and/or management and monitoring plans). ▪ Implement corrective actions. In addition, EMPs may be updated following on regular performance reviews by management.
9.3 Conceptual Site Model (CSM) of AMD Processes	The conceptual site model (CSM) considers the source, pathway receptor concept (INAP, 2009).

The source material risk was obtained from earlier geochemical assessments (PES, 2013a and GHD, 2015) with the receptors (summary by GHD, 2015) drawn from the Roper Bar EIS (EcOz, 2012).



<table>
<tr><td rowspan="5">Sources</td><td colspan="2"><i>In situ</i> Sulfides</td><td colspan="2"><i>Ex situ</i> Sulfides</td></tr>
<tr><td colspan="2">Within pit floors and walls above the water table (F East, E East, refer Block Models Appendix D)</td><td colspan="2">Mined and placed in WRD PAF Cells as waste. Total identified waste in WST (Table 1.1)
Materials stockpiled on the ROM Pad</td></tr>
<tr><td colspan="4">Metals: no elevated whole rock assay metals using the GAI (PES, 2013, GHD, 2015)</td></tr>
<tr><td colspan="4">Metals leaching: some minor metals from KYM unit possible (PES 2013, GHD, 2015)</td></tr>
<tr><td colspan="4">Sulfate leaching: possible (PES 2013, GHD, 2015)</td></tr>
<tr><td>Pathways</td><td>Surface Water</td><td>Groundwater</td><td>Sediment</td><td>Windborne Dust</td></tr>
<tr><td rowspan="5">Receptors</td><td colspan="4">Aquatic flora and fauna in surface waters downstream in the Towns River including freshwater sawfish (Pristis microdon)</td></tr>
<tr><td colspan="4">Informal camping site on the Towns River, Nathan River Rd, some 15km north-east of mine</td></tr>
<tr><td colspan="4">A sacred billabong north of F East Open Pit (Site Reference AAPAC2013/034/RWA1</td></tr>
<tr><td colspan="4">Various springs and Groundwater Dependent Ecosystems (GDE's)</td></tr>
<tr><td colspan="4">The Towns River and associated alluvium</td></tr>
</table>

AMD risk assessments in accordance with Section 2.1 and Table 2.1 above (PES, 2013a and GHD, 2015) concluded that:

- The risk is considered low and manageable. The volume of PAF materials is small when compared with the volume of NAF materials available for containment.
- With appropriate design and effective control measures, the residual AMD risk will remain low through the care and maintenance phase.

AMD risks will be monitored in accordance with this document.

9.4 Monitoring

Refer Appendix 1 Table A1 – Elements of the AMD Monitoring Program below. Monitoring of:

- the constructed landforms: Open Pits, WRD's, ROM Pads, LGO stockpiles, surface water control measures,
- surface and ground water; and
- exposed materials in the open pit walls and pit wall seepage,

provide critical feedback to confirm that the operational measures and controls are effective for their stated aim.

An outcomes-based approach is utilised as informed by adaptive management to meet site specific trigger values that are to be developed over time as data is gathered.

Geochemical Monitoring

Additional geochemical monitoring was identified during a gap analysis (GHD, 2015) to refine the AMD risk from all key lithologies and increasing the confidence in the AMD strategy and management.

Laboratory XRF analysis on samples obtained during grade control and subsequent blast holes, coupled with targeted drilling to refine the lateral and vertical extent of PAF materials particularly where there is a paucity in data, remains the primary measures for determining Total S. This methodology provides for an auditable process with quality data despite longer turn-around times.

	Static Testing A better understanding of the pyritic sulfur content is required, particularly for the weathered KYM, MSM and SIM units where much of the Total S may be non-reactive. This will be achieved by having the samples (in addition to Total S) analysed for detailed Acid Base Accounting. Recommended sample numbers are (GHD, 2015): ▪ 75 samples from the KYM, ▪ 140 samples from the MSM; and ▪ 27 samples from the SIM units, which in terms of sample frequencies equate to 1 sample from each of the lithologies per 200,000t DSO mined. **Kinetic Testing** The six kinetic columns established earlier have been destroyed by fire and monitoring was discontinued when the mine was placed in care and maintenance in 2015. Owing to the low AMD risk considering the relatively small volumes of PAF irregularly distributed throughout the Danehill and Zabeel deposits compared to very large volumes of NAF, kinetic testing will not be required for Stages 1A and 1B. **Surface and Groundwater Monitoring** The locations, sampling procedures, schedule and analytes for surface and ground water monitoring with reference to AMD are entirely consistent with the WMP and are therefore not replicated here. Analytes with specific reference to AMD monitoring include pH, EC, acidity and alkalinity, sulfate and metals particularly aluminium, arsenic, iron and manganese.
9.4.1 Monitoring Parameters	Refer Appendix 1 Table A1 – Elements of the AMD Monitoring Program below.
9.5 Data storage, evaluation and reporting	Assay results are received from the laboratory, verified for QA/QC, then imported into the database. Spatial results are imported into Surpac for the delineation of PAF outlines in the flitch dig plans (refer Appendix C).

Appendix 1: Table A1 – Elements of the AMD Monitoring Program.

The facilities at the mine are tabulated below:

Facility	Component	Parameters Measured	Frequency	Monitoring Methodologies and Trigger Values (Performance Evaluation Criteria)[*1]
General	Rock Type	Lithology, weathering state, sulfide and carbonate content	Log all drill core	Sections 4.4, 9.1, 9.2 and 9.4
	Surface water: up- and downstream	Flow rate	Event based	Sections 9.1, 9.2 and 9.4 and Appendix E ANZECC-ARMCANZ 2000 (99% Ecosystem Protection)
		Field Water Quality Parameters: pH, EC/TDS, DO and ORP	Daily/weekly/monthly event based	
		Laboratory: TSS, acidity, alkalinity, major chemistry, metals	Daily/monthly/event based	
	Groundwater: up- and down-gradient	Groundwater levels, flow rate, direction	Quarterly	Sections 9.1, 9.2 and 9.4 and Appendix E ADWG 2018 (Livestock)
		Field Water Quality Parameters: pH, EC/TDS, DO and ORP	Bi-annual	

		Laboratory: TDS, acidity, alkalinity, major chemistry, metals/metaloids	Bi-annual	
	Site Water Balance	Flow rate, pump rate, acidity load	Daily	Sufficient but not excessive volume of water
		Water levels and volumes in storage facilities	Daily	
	Discharge Points	Flow rates	Daily/event based	Water quality parameters for Waste Discharge Licence Sections 9.1, 9.2 and 9.4 and Appendix E ANZECC-ARMCANZ 2000 (99% Ecosystem Protection)
		Field Water Quality Parameters: pH, EC/TDS, DO and ORP	Daily/event based	
		Laboratory: TDS, acidity, alkalinity, major chemistry, metals/metaloids	Monthly/quarterly/event	
	Production Geochemistry	Geochemical classification of soil/rock (static tests)	Waste characterisation drilling, grade control drilling and blast holes	Sections 9.2 and 9.4 >0.3% Total S PAF
WRD's, Ore Stockpiles	Waste rock and ore materials	Production rates, mass/volume of waste rock and ore piles	Daily	Sections 4.4 Mine Schedule, 9.2 and 9.4
		Geochemical characterisation of lithologies (static and kinetic tests)	As required	Sections 9.2 and 9.4 >0.3% Total S PAF
	Surface water runoff and seepage	Flow rates	Monthly	Sections 9.2 and 9.4
	Surface water quality	Field Water Quality Parameters: pH, EC/TDS, DO and ORP	Monthly/event	Sections 9.2 and 9.4 Water quality criteria for site use and Waste Discharge Licence (WDL). ANZECC-ARMCANZ 2000 (99% Ecosystem Protection) ADWG 2018 (Livestock)
		Laboratory: TDS, acidity, alkalinity, major chemistry, metals/metaloids	Monthly	
	Groundwater	Water levels in stockpiles/WRD	Monthly/event	Sections 9.2 and 9.4
	Groundwater: up- and down-gradient and at the WRD/stocpiles	Field Water Quality Parameters: pH, EC/TDS, DO and ORP	Bi-annual	Sections 9.2 and 9.4 Water quality criteria for site use and Waste Discharge Licence (WDL). ANZECC-ARMCANZ 2000 (99% Ecosystem Protection) ADWG 2018 (livestock)
		Laboratory: TDS, acidity, alkalinity, major chemistry, metals/metaloids	Bi-annual	
Open Pits	Pit-wall material (cone of depression)	Lithology, weathering state, sulfide and carbonate content	As mining progresses (representative samples from each lithology and weathering state)	Sections 4.4, 9.1, 9.2 and 9.4
	Pit stormwater and influx	Dewatering pump flow rates	Daily	Sections 9.2 and 9.4

	Pit water quality	Field Water Quality Parameters: pH, EC/TDS, DO and ORP	Monthly	Sections 9.2 and 9.4 Water quality criteria for site use and Waste Discharge Licence (WDL). ANZECC-ARMCANZ 2000 (99% Ecosystem Protection) ADWG 2018 (Livestock)
		Laboratory: TDS, acidity, alkalinity, major chemistry, metals/metaloids	Monthly	
	Pit groundwater (cone of depression)	Groundwater levels, flow rates for dewatering bores	Quarterly	Sections 9.2 and 9.4
		Field Water Quality Parameters: pH, EC/TDS, DO and ORP	Bi-annual	Sections 9.2 and 9.4 Water quality criteria for site use and Waste Discharge Licence (WDL). ANZECC-ARMCANZ 2000 (99% Ecosystem Protection) ADWG 2018 (Livestock)
		Laboratory: TDS, acidity, alkalinity, major chemistry, metals/metaloids	Bi-annual	

99% Aquatic Ecosystem Protection (ANZECC-ARMCANZ):

pH	**EC**	**DO**	**Ag_F**	**Al_F**	**As_F**	**B_F**	**Cd_F**	
6 to 8	20 to 250	80 to 110	0.02	27	0.8	90	0.06	
Cu_F	**Fe_F**	**Mn_F**	**Mo_F**	**Ni_F**	**Pb_F**	**Se_F**	**U_F**	**Zn_F**
1	300	1.2	34	8	1	5	0.5	2.4
EC in µS/cm; DO in % and metal concentrations in µg/L.								

Stock Drinking Water Limits (ADWG):

pH	**EC**	**Al_F**	**As_F**	**B_F**	**Cd_F**	**Cr_F**	**Cu_F**	**Mn_F**	**Mo_F**
4 to 9	5,970	5,000	500	5,000	10	1,000	1,000	10,000	150
Ni_F	**Pb_F**	**Se_F**	**U_F**	**Zn_F**	**Al_T**	**As_T**	**Cd_T**	**Cr_T**	**Cu_T**
1,000	100	34	200	20,000	5,000	500	10	1,000	1,000
Mn_T	**Ni_T**	**Pb_T**	**Se_T**	**Zn_T**	**Ca_F**	**Mg_F**	**Sulphate**		
10,000	1,000	100	34	20,000	1,000	1,000	1,000		
EC in µS/cm; metal concentrations in mg/L.									

Elements of Monitoring Program: to be reviewed continuously and expanded pending trends in monitoring data.

AMDMP Review	This AMDMP will be implemented prior to commencing with the Stage 1A and 1B MMPs and will be updated frequently where required and for future operations. There is a statutory requirement for the AMDMP to be reviewed: ▪ In accordance with Condition 16 of the Commonwealth Environmental and Biodiversity Conservation Act 1999 (EPBC) approval for the ongoing protection of the freshwater sawfish (*Pristis microdon*), the AMDMP must be reviewed annually from the date of first approval of the AMDMP (until two years following the closure of Area F-East Pit 3 (now referred to as Area F West Pit 1) by the independent technical reviewer, to enable continuous improvement and adaptive management of PAF material management.

	▪ From two years following the closure of Area F-East Pit 3 (now referred to as Area F West Pit 1), the AMDMP must be reviewed by the independent technical reviewer once every three years for the remaining life of the project. Furthermore, any activity not previously authorised under the approved AMDMP must be incorporated into a revised AMDMP for review and approval by the Commonwealth Minister for the Environment in accordance with Condition 5. Revised plans would not be approved by the Minister unless they provided equivalent or improved environmental outcomes over time. Item 3 of the Schedule under the NT DME (now Department of Industry, Tourism and Trade, DITT) approval, it is required that the MMP must at intervals not exceeding 12 months from the anniversary of the date of the authorisation (or such other date as nominated by WDR and as approved by the Minister), be reviewed. Since the AMDMP forms an attachment to the MMP annual reviews are required notwithstanding the Commonwealth conditions of approval. In general, the annual review of the AMDMP will be guided by the assessment of risks (Table 2.1 and associated procedure) and will be developed in a staged approach to: ▪ Evaluate and incorporate new potential hazards and their associated impacts. ▪ Accommodate design modifications due to variability between predicted and actual constructed landforms. ▪ Avoid negative consequences from design-non-conformances. The revised AMDMP will be used to inform future revisions of the Mine Closure and Rehabilitation Plan for the site.
Contingency Plan	Contingency plans are required where residual risk remains after the application of AMD prevention and control measures. Contingency planning therefore include targeted monitoring, trigger levels for actions and specific responses in case a certain event occurs i.e. a failure mode is the potential for AMD seepage from a waste rock pile, then monitoring can be established for sulfate concentrations in waste rock seepage as an early indicator of potential AMD formation. Following the above if significant increases in sulfate concentrations are measured, then the most appropriate contingency measure such as temporary or permanent covers and/or drainage collection and treatment will be implemented. Where monitoring parameters exceed trigger values, a *root cause* analysis will be undertaken whereby the causal link for the water quality exceedance will be determined to then implement a corrective action, including an alternate management strategy if necessary, to eliminate future risk of a repeat. Future revisions of this document would also inform forward AMD risk management by providing a more robust data set to inform AMD risk, and therefore, any adjusted management strategy.

References

Amanzi Consulting, 2019: *Technical Review: AMDMP for the Roper Bar Mine, Northern Territory.*

Australian and New Zealand Environment Conservation Council (ANZECC) (2000): *Australian and New Zealand Guidelines for Fresh and Marine Water Quality,* Volume 1, Chapters 1 - 7, National Water Quality Management Strategy. Canberra, ACT.

Australian/New Zealand Standard AS/NZS 4360:2004: *Risk Management*.

Australian/New Zealand Standard AS/NZS ISO 31000:2009: *Risk Management – Principles and Guidelines*.

Department of Industry, Innovation and Science (DIIS),2016: Preventing Acid and Metalliferous Drainage, DIIS, Canberra, referred to as Handbook 2016 in this document.

EcOz, 2012: Acid Metalliferous/Mine Drainage (AMD) and Management, Roper Bar Project Area Western Desert Resources Ltd.

GARD 2009. The International Network for Acid Prevention (INAP), 2009. Global Acid Rock Drainage Guide (GARD Guide), http://www.gardguide.com.

GHD, 2015: *Roper Bar Iron Ore Project, Acid and Metalliferous Drainage Management Plan, Care and Maintenance - Mining Management Plan*, Western Desert Resources Limited.

Golders, 2013: *Review of Material Characterization Reports and Acid Mine Drainage Management Plan for the Roper Bar Iron Ore Project*, Roper Bar Project Area Western Desert Resources Ltd.

METServe, 2019: *Nathan River Mine Management Plan.*

Nathan River Resources, 2019a: *Environmental Management System* (MET00264379-029).

Nathan River Resources, 2019b: *Water Management and Monitoring Plan* (MET00266522-011).

Nathan River Resources, 2023: 1A - Mining Management Plan (MET00319325-009).

Nathan River Resources, 2023: 2023 Environmental Mining Report - NRP (MET00330229-004).

Nathan River Resources, 2024: Stage 1B Mine Management Plan (MET00326450-005).

Nathan River Resources, 2024: Global Assay Data Excel File XRF_PAF_0001-PAF_0020.

Nathan River Resources, 2024: Block Model Report.

Nathan River Resources, 2024: NRP Water Management Plan.

Northern Territory Environment Protection Agency, 2013: *Environmental Assessment Guidelines, Acid and Metalliferous Drainage.*

Pendragon Environmental Solutions, 2013a: *AMD Risk Assessment and Management*, Western Desert Resources Limited.

Pendragon Environmental Solutions, 2013b: *AMD Column Leach (Kinetic) Testing, Roper Bar Iron Project.*

Pendragon Environmental Solutions, 2019: 2020-2023 Acid Mine and Metalliferous Drainage Management Plan, Revision 4. Nathan River Resources.

Pendragon Environmental Solutions, 2021: Acid Mine and Metalliferous Drainage Management Plan, Revision 5. Nathan River Resources.

Schmieder, *et. al.*, 2012: *Oxygen Consumption Techniques to Quantify Acidity Generation Rates*, 1st International Acid and Metalliferous Drainage Workshop, Beijing China.

WRM Environment and Water, 2019: *Nathan River Mine Surface Water and Groundwater Quality Assessment*, Nathan River Resources Pty Ltd.

Appendices

Appendix A: Constructed Waste Rock Dumps and Containment Cells.

Appendix B: Independent Technical Review: LWR Consulting Services, 2024.

Appendix C: Waste Rock Sampling Procedure.

Appendix D: Danehill and Zabeel Block Models.

Appendix E: Environmental Monitoring Report and NRP Water Management Plan.

Appendix A: Constructed Waste Rock Dumps and Containment Cells.

NATHAN RIVER PROJECT
PAF CELL DESIGNS

DANEHILL AND ZABEEL WASTE ROCK DUMPS

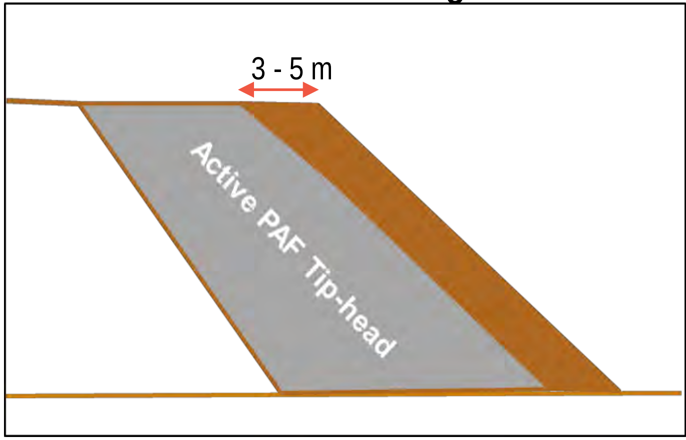
JUNE 2024

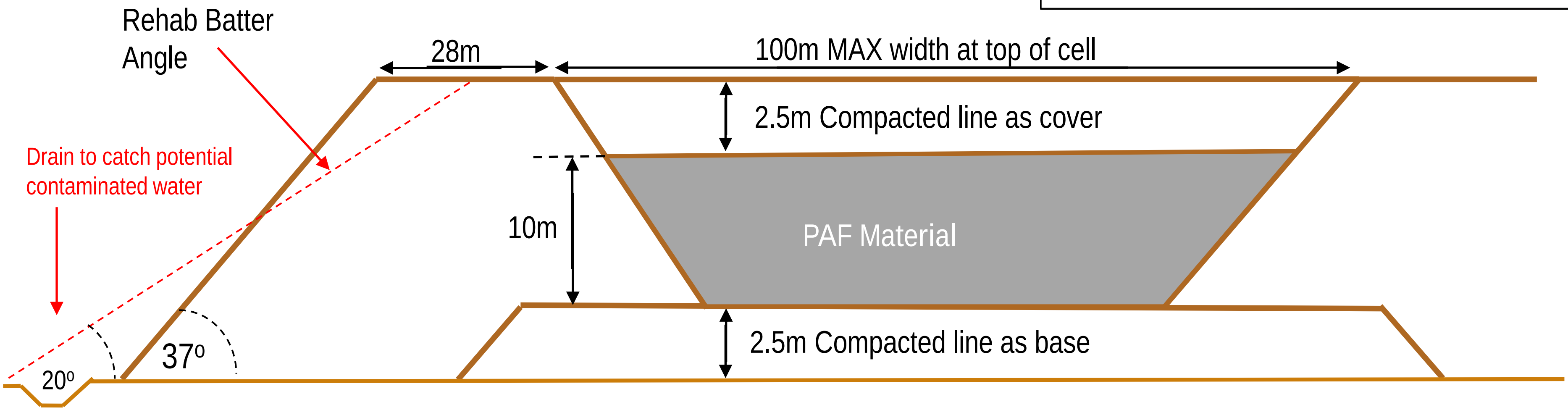
CONSTRUCTION GUIDELINES

See below the minimum requirements for construction of a PAF cell (AMD MP 2024)

- All PAF cell must be constructed at the centre of the dump, encapsulated by NAF.
- Nominal design of 100m x 100m x 10m.
- Compacted base, sides and cover constructed out of NAF.
- Minimum base and cover thickness of 2.5m (post compaction).
- Minimum side width of 28 m to ensure PAF is a minimum of 13m away from rehab batter.
- Open face of PAF tip-head should be sealed by 3 - 5m of compacted NAF material.

PAF Cell Batter Design



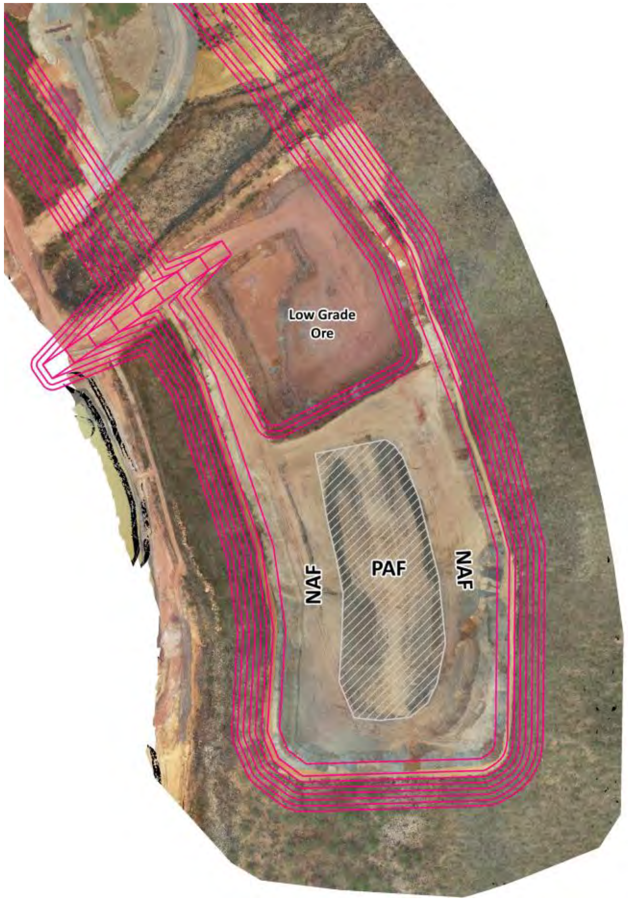


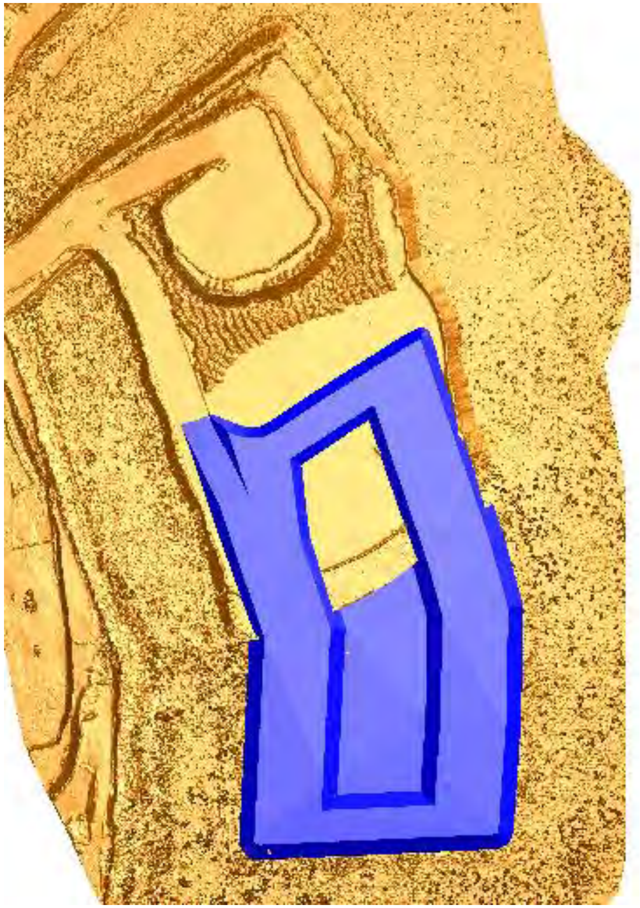
PAF CELL DESIGN CAPACITIES

	Zabeel WRD	Danehill WRD
Current NAF Stored	1,879,594 bcm	3,546,000 bcm
Current PAF Cell Stored	152,000 bcm	119,196 bcm
PAF requiring storage during MMP period	193,700 bcm	1,000 bcm
PAF Cell Capacity	360,000 lcm	652,483 lcm
Total Storage Capacity at the end of MMP period	3,664,095 lcm	6,900,000 lcm

ZABEEL WRD PAF CELL DESIGN

- Excavate previously dumped NAF capping ontop of PAF material approximately 2 m.
- Use this material and other available NAF to commence dumping out NAF fingers.
- PAF material paddock dumped in PAF cell area, constructing lifts to 10 m high. Each lift is traffic compacted.
- Final lift includes placement of 2.5 m of NAF material, traffic compacted and encapsulates PAF material by NAF material.





ZABEEL WRD PAF CELL CONSTRUCTION - STAGE 1

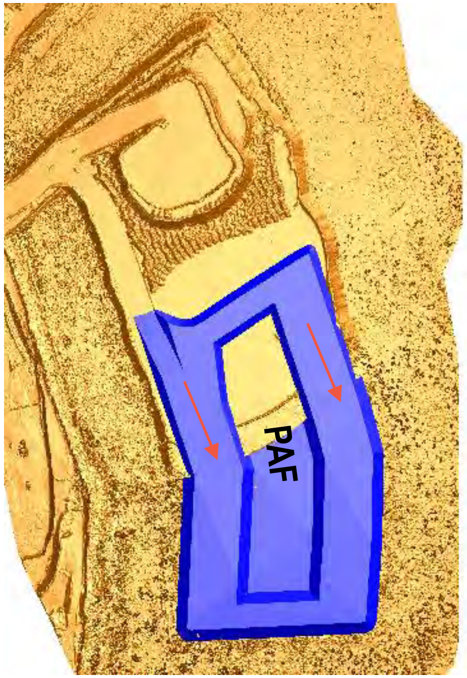
Prior to the MMP period:

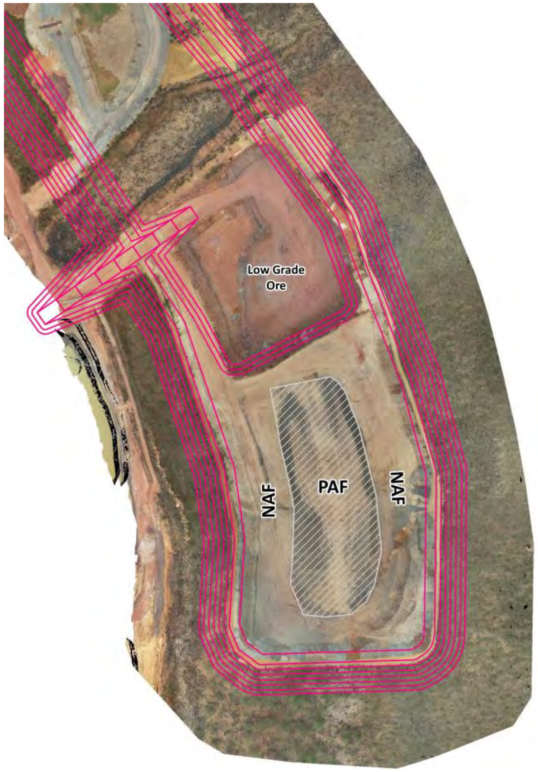
- Cleared vegetation on 20RL and paddock dump 2.5 m NAF basal layer to southern boundary using traffic compaction and conducted insitu testing.
- Paddock dumped NAF material lifting to 27RL continuing traffic compaction.
- Placement of 152,000 bcm of PAF material within cell footprint.
- PAF material fully capsulated with 1.5 m of compacted NAF and domed to shred water during C&M period.

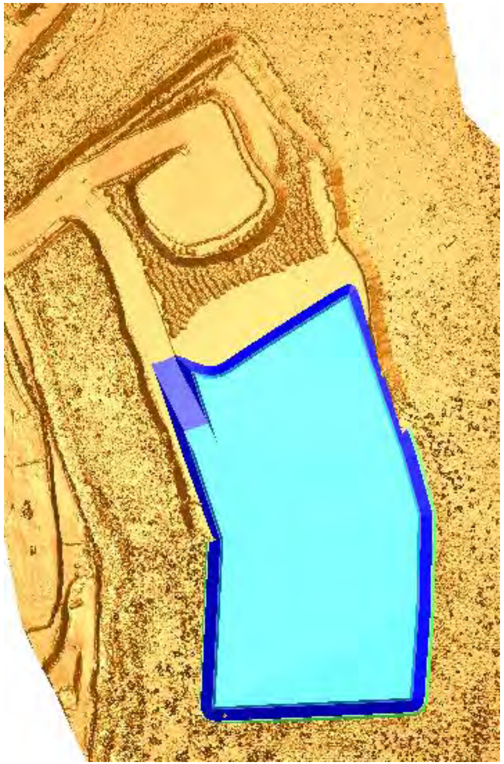
ZABEEL WRD PAF CELL CONSTRUCTION - STAGE 2

During MMP period:

- Construction of NAF fingers to 32RL, lifting 5 m from current surface.
  - Compacted paddock dump area
  - Base +35 m wide to ensure minimum 28 m wide top of cell finger.
- Existing NAF capping on PAF material at 30RL to be excavated to dump further PAF inside cell fingers.
  - PAF tip-head must not get within 65 m of active NAF tip head.
- Further lift of NAF fingers to final WRD dump height to 40RL.
- Encapsulate PAF material with 2.5 m of NAF material.



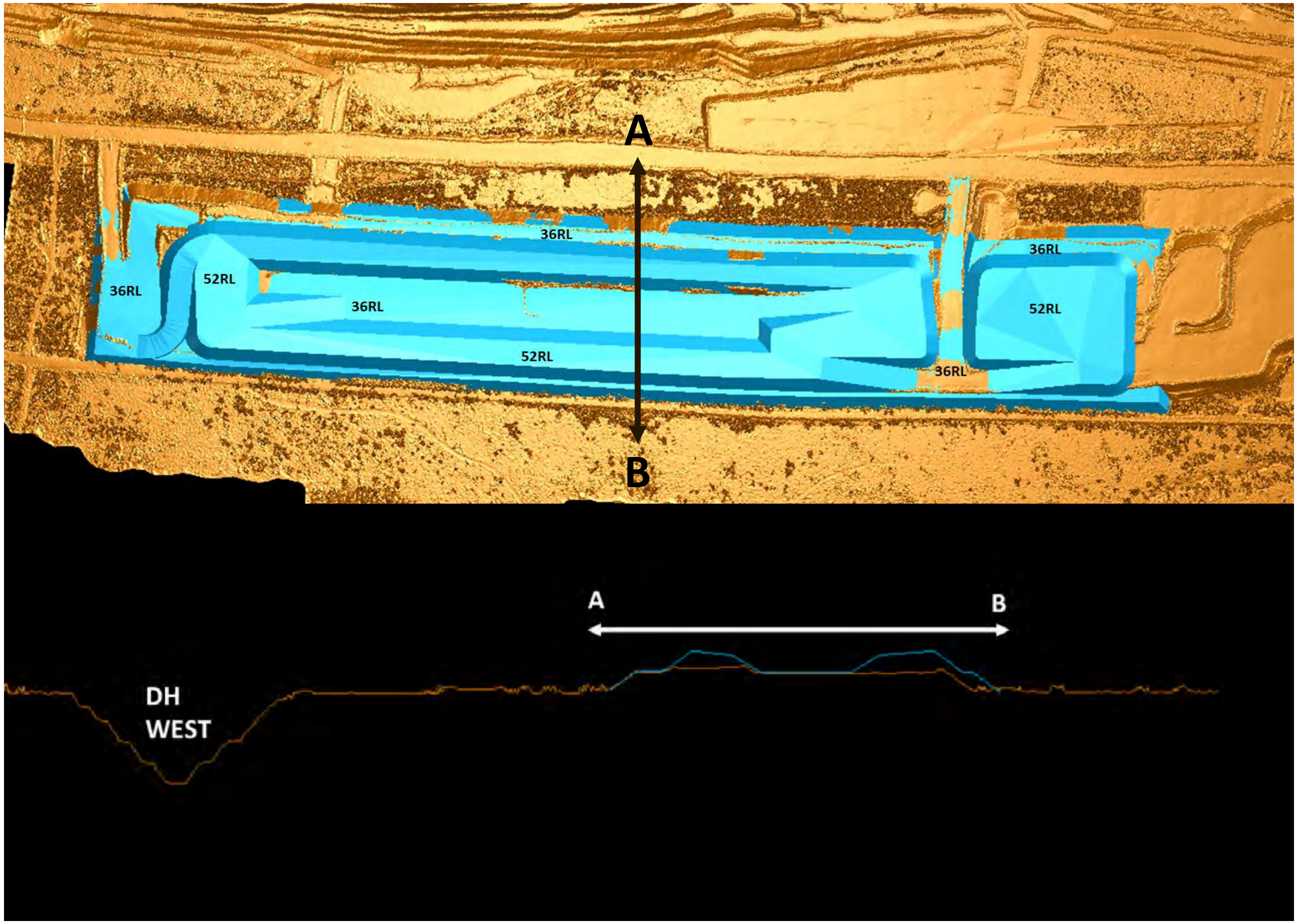




DANEHILL WRD PAF CELL CONSTRUCTION – STAGE 1

Prior to MMP period:

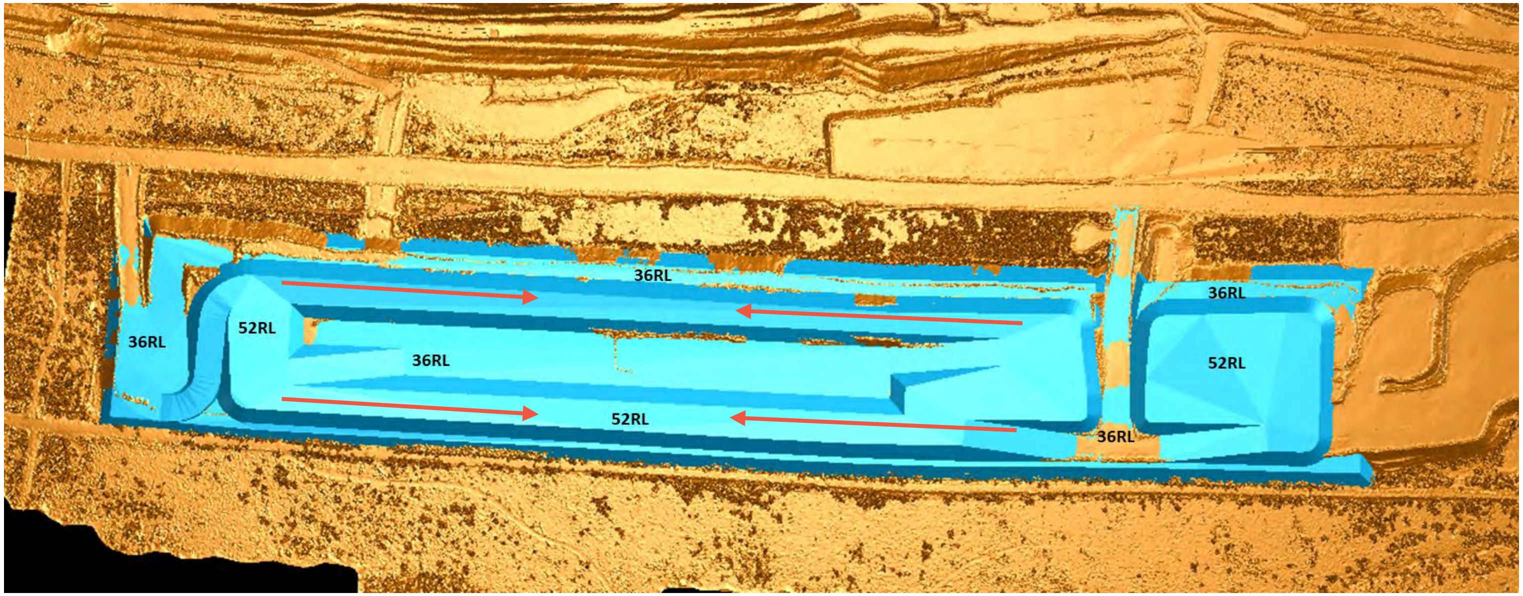
- Paddock dumped NAF material to lift WRD surface from 36RL to 52RL, building fingers around the intended PAF cell footprint.
- Increase of 16 m to maximum WRD height of 30 m above ground level. Traffic compaction and conducted insitu testing of 36 RL and 52 RL surfaces.



DANEHILL WRD PAF CELL CONSTRUCTION – STAGE 2

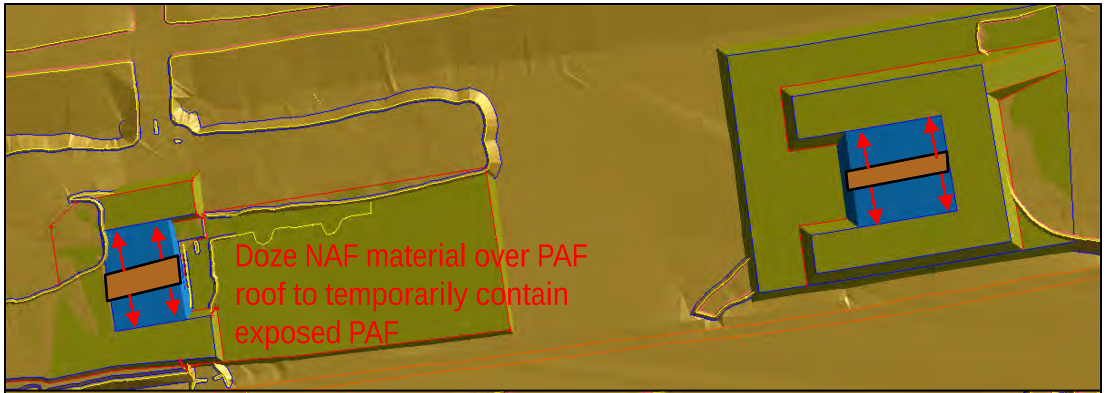
During MMP period

- Continued paddock dump of NAF material to create NAF fingers at 52 RL.
- PAF material will be dumped within the void between the built-up NAF fingers. PAF tip-head must not get within 65 m of the active NAF tip head to ensure separation between the two waste materials.
- Paddock dumped PAF material will be compacted immediately after placement.



DANEHILL WRD PAF CELL CONSTRUCTION - STAGE 2 CONT.

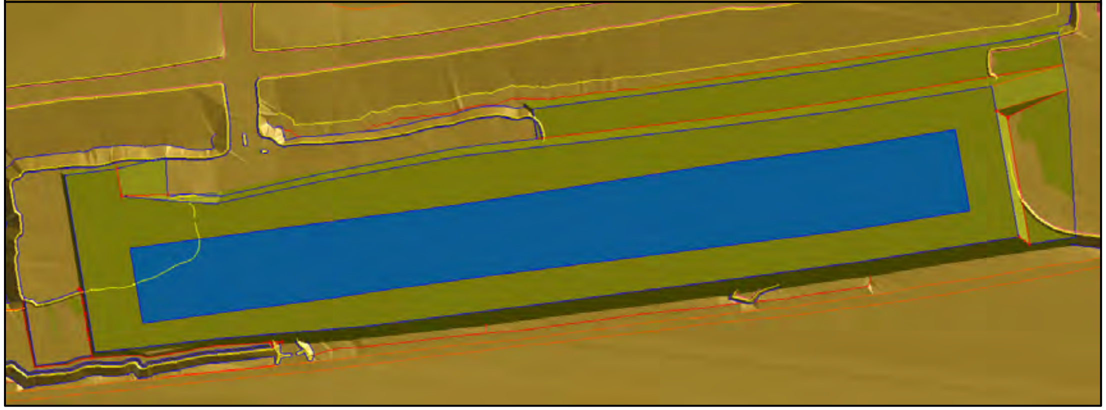
Paddock dump centre island (3 loads wide) to ensure NAF material available for temporary containment of PAF cell roof during wet.



Doze NAF material over PAF roof to temporarily contain exposed PAF

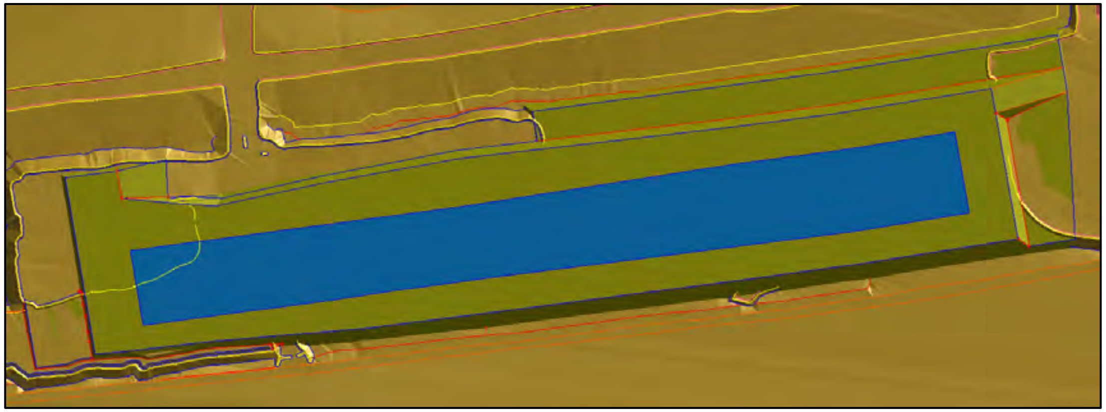
Continue extending NAF fingers as PAF cell progresses.

Join external NAF fingers and fill void with PAF.



DANEHILL WRD PAF CELL CONSTRUCTION – STAGE 2 CONT.

Paddock dump, level and compact a 2.5 m cover over PAF surface to adequately cap PAF cell.



Appendix B: Independent Technical Review: LWR Consulting Services, 2024.

Our Reference: pes19017_nathan river resources wd\
response letter to peer review.docx

Your Reference:

pendragon
environmental solutions
ABN: 92 147 485 416

Leaders in Environmental Practice

27 June 2024

METServe
310 Edward St
Brisbane City QLD 4000

For Attention: Emerson Pollard

Dear Emerson

Independent Peer Review on 2024 NRP AMDMP

This review provides an independent assessment of the Pendragon Environmental Solutions 2024 Acid Mine Drainage Management Plan (AMDMP, Revision 6 dated June 2024), for the Nathan River Project (NPR) Roper Bar Iron Ore Mine, Northern Territory. The review, undertaken by LWR Consulting Services, focused on the consistency of the Department of Industry, Innovation and Science (DIIS) Preventing Acid and Metalliferous Drainage 2016 Handbook and specifically, Sections 4, 6, 7, 9 and Appendix 1.

We have pleasure in providing the responses tabulated overleaf.

We trust that the response will meet with your approval. Please do not hesitate to contact us should you have any queries and/or require additional information.

Yours sincerely
Pendragon Environmental Solutions

Carel van der Westhuizen ***(MSc Hydrogeol, CEnvP SC, AffilIEAust, MEIANZ, MAIG, MALGA)***
Principal Hydrogeologist and Site Contamination Specialist

LWR Consulting Services Peer Review	Pendragon Environmental Solutions Response
2.1.2 Mining Management Plan 2023 Stage 1A Amendment Page 3: AMDMP 2024 makes no reference to the volumes of water to be abstracted and stored. Inclusions of water volume data in the AMDMP would assist the understanding of the risk of mine affected water being released. Additional information regarding the final landforms of both pits, if available, would assist understanding of potential long-term risks of AMD.	The section Mining Management Plan 2023, Stage 1A Amendment, page 10 of the AMDMP, was amended to include these details.
2.1.3 The Mining Management Plan 2024 Stage 1B Amendment Pages 3 and 4 AMDMP 2024 makes no reference to the volumes of water to be abstracted and stored. Inclusions of these figures in the AMDMP could demonstrate effectiveness and adequacy of on-site mine affected water storage facilities to contain mine affected drainage, and thereby assist the understanding of the risk of mine affected water being released. The inclusion of the planned final landform and land use of the Danehill Pit could be mentioned to demonstrate controls and mitigation of AMD formation during rehabilitation, mine closure and post closure.	The section The Mining Management Plan 2024, Stage 1B Amendment, pages 11 and 12 of the AMDMP, was amended to include these details.
2.1.4 The Mining Management Plan 2024 – 2025 The AMDMP 2024 contains no information on dewatering requirements for the new Ponting Pit. It is suggested that information on dewatering needs, if any, and on the future use of the Ponting Pit void would be useful in the context of AMD management, rehabilitation and mine closure, and post closure planning. The Border Pit final void will used for water storage. Information on the landform design for the Border pit final void and the expected Border pit lake water qualities would be useful additions to the AMDMP to explain measures and contingency plans for AMD management during operation, closure and post closure phases of Border pit operations.	The section Mining Management Plan 2024-2025, pages 12 to 15 of the AMDMP, was amended to include these details.
2.2 Management of Mine Affected Water It would be very useful to have a summary of all the surface water and groundwater hydrochemical water monitoring and analytical results. Trends in these results could be used to detect early signs of AMD generation.	Appendix E, and particularly the 2023 Environmental Mining Report, include a detailed discussion of surface and ground water monitoring and trends in addition to the NRP Water Management Plan. Consideration will be given to a targeted water quality assessment pertaining to the open pits and immediate monitoring locations.
4. The AMD Management Plan Some structure of the DoE Checklist used in AMDMP 2024 has not been maintained in Table 2.2 of the AMDMP. As a result of this, information is contained in a table column that transgresses across section divisions in the table rows. This leaves the reader to sort out the information that belongs to a particular section. For consistency, ease of reference, and for the easy finding of information, separation of these headings into component rows in the order in which they are numbered is suggested.	Table 2.2 was amended.

LWR Consulting Services Peer Review	Pendragon Environmental Solutions Response
This structure is missing in parts of Section 4 and Section 6. The individual subsections affected are: 4.3, 4.3.1 to 4.3.7; 4.7, 4.7.1 to 4.7.3 and 6.1, 6.1.1 to 6.1.5; and 6.3, 6.3.1 to 6.3.3. Section 4.3 requires the separation of the information into rows corresponding to the Section title i.e. rows are required to run across the table for items 4.3.1 to 4.3.7 to achieve separation. Headings in the column have been included so placing this information into the correct section row should be straightforward. The individual sub-sections of Section 6 of the Table 2.2 noted above require editing. The following observations are made about the individual paragraphs that occur in the blocks of text that transgress across sub-section rows. • Paragraph 1 deals with PAF placement and construction of the Danehill WRD (Area F East WRD). Firstly, it is suggested that the latest naming convention for the WRDs is used as these are the terms to be used going forward with the new MMPs. Secondly, an introduction to this text, as part of the General Consideration subsection, could be added to help clarity. For example, “PAF waste is to be managed in WRD containment cells. The Danehill WRD has an estimated 53,000t of PAF”, This should demonstrate management measures taken to minimise AMD production. • Paragraph 2 discusses sulfide reduction rates (SORs). This paragraph does not follow the order of the Table headings and should occur in a row numbered 6.1.5. • Paragraphs 3 and 4 deal with WRD and PAF cell capacity and LGO stockpiles. This could be put into the context of the section heading 6.1.4? • Paragraphs 5 and 6 contain information on identifying AF material using grade control borehole chips to sample lithologies. The WRD sampling program has relevance to 6.1.4 and 6.1.5. • Paragraph 6. This paragraph deals with AMD models and conservative waste rock sampling procedures. This information could be placed in section 6.1.5. • Paragraphs 7 and 8. Essentially these are statements, regarding rehabilitation and reducing potential impacts of AMD post closure. They could part of 6.1.5 or could be moved to 6.1.1? • Paragraph 9 is possibly appropriate to section 6.1.5. The actions that are planned should be emphasised. For example state that: PAF identification will be ongoing using grade control and targetted drilling. KYM waste material will be used for WRD and ROM pads. Weathered MSM will be used for capping material WRDs. Weathered and fresh KYM and MSM rock wastes and when appropriate SIM with < 30% Fe for use in encapsulating PAF. • Paragraph 10. Is an action point committing to undertake further geochemical assessment. It might be more appropriately placed in section 6.1.5? • Paragraph 11. This deals with WRD construction and should be placed in section 6.1.4. • Paragraph 12. This statement deals with self-heating and should be placed in section 6.1.5.	

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5.2 The Checklist: Table 1 4.2.3 Existing exposed mine materials AMDMP Table 2.2 P24 notes exposed materials in the Danehill and Zabeel open pits and the Danehill WRD. These could include ore and overburden in pit faces, waste in waste rock dumps, and materials exposed in stockpiles. These materials were originally assessed by PES (2013). Further sampling and testing to be undertaken. 6.1.2 Conventional end-dumped WRDs AMDMP 2024 Table 2.2 Appendix A WRD main construction is by Paddock Dumping. End dumping of PAF occurs into the PAF containment cells. Containment cells are lined. They have no direct outside contact with air because they prevent oxygen ingress. AMD production is minimised end tipping of PAF. 6.1.5 Minimising self-heating and AMD potential AMDMP Table 2.2 P32 Self-heating has not been identified at Roper Bar. Both self-heating and AMD potential will be prevented or minimised through mine waste handling and storage as outlined in 6.1.1 and 6.1.4 of this Checklist.	Consideration will be given to: ▪ Sampling of the materials in the exposed pit walls and seepage during operations to assist in characterisation and prediction of future pit void water qualities.
Abbreviations in the AMDMP need updating. The acronym NPR is listed in the abbreviations table but contains no definition. Is this an acronym for Net Potential Ratio? NRP occurs as an abbreviation in the text of the AMDMP but is not defined in the Abbreviations list. Is this an abbreviation for Nathan River Project?	Abbreviations updated.
Referencing needs to be checked. The usual referencing for the AMD Handbook is DIIS (Department of Industry, Innovation and Science) (2016) Preventing Acid and Metalliferous Drainage, DIIS, Canberra.	References updated.

TECHNICAL REPORT

Technical Review: 2024 AMDMP for the Roper Bar Iron Ore Mine, Northern Territory

Report prepared for

Nathan River Resources and METServe

LWR
CONSULTING SERVICES
ABN 97 271 204 293

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Table of Contents

Page

1.0 Introduction……………………………………………………………………. 1
1.1 Scope of the Review………………………………………………………… 1
1.2 Review Methodology………………………………………………………… 1
1.3 The Purpose of AMDMP 2024……………………………………………… 2

2.0 The Review …………………………………………………………………….. 2
2.1 Mining Activities……………………………………………………………… 2
2.1.1 Existing Mining Activities and Plans……………………………………….. 2
2.1.2 The Mining Management Plan 2023 Stage 1A Amendment …………………... 2
2.1.3 The Mining Management Plan 2024 Stage 1B Amendment …………… …….. 3
2.1.4 The Mining Management Plan 2024 to 2025…………………………………….. 4
2.2 Management of mine affected water……………………………………………… 5

3.0 AMD Risk Assessment ……………………………………………………… 5

4.0 AMD Management Plan………………………………………………………… 6

5.0 The Review Checklist……………………………………………………………… 7
5.1 Introduction…………………………………………………………………………… **7**
5.2 The Checklist………………………………………………………………………. **7**

6.0 Recommmendations and closing comments ………………………………… 19

7.0 References……………………………………………………………………… 20

Tables

Page
Table 1 The Checklist………………………………………………………………………. 7-19

Summary

This report presents findings of a technical review of Revision 6 of the Acid and Metalliferous Drainage Management Plan developed by Pendragon Environmental Solutions in June 2024 for Nathan River Resources.

This review has found the approaches, methods and procedures followed and reported in the AMDMP 2024 are leading practice. It also ascertained that the Acid and Metalliferous Drainage Management Plan aligns with the Australian Government Department of Industry, Innovation and Science Acid Mine and Metalliferous Drainage Handbook 2016, and the Commonwealth Department of Environment Checklist, as well as leading international and national practices in AMD management.

The AMDMP 2024 updates previous versions by outlining the AMD Management measures required for three new Mining Management Plans, Amendment 2023 Stage 1A, Amendment 2024 Stage 1B, and the Mining Management Plan 2024 covering the period 2024 to 2025. Each plan will amend the existing Mining Authority.

The revision of the AMDMP has addressed the findings of previous reviews.

These findings provide confidence that appropriate measures have been taken and these are suitable for application at the new mining activities to minimise or prevent AMD impacts on environment values during operations and mine closure, and post mining.

The geochemical test work of mining material and subsequent characterisation of mined materials demonstrate that low volumes of PAF material and high volumes of NAF occur. The use of Total Sulfur for classifying mining material samples is an appropriate method to outline PAF and NAF material and confirm waste placement procedures. Application of selective mining and selective waste deposition in designed WRDs and PAF encapsulation containment cells have been effective in AMD prevention and control.
Ore processing is mechanical. Therefore, no mine tailings are produced and there is no requirement for tailings assessment and storage.

Water quality monitoring of natural surface water systems, groundwater and of mine water storage facilities show no acidic drainage. AMD prevention measures are effective such that AMD water treatment is not required.

Ongoing assessment of surface water and groundwater monitoring results will track any future changes in water qualities and act as an early warning system for AMD development as the new MMPs are implemented. On site storage of surface water affected by mining will continue to prevent impact to receiving environments.

The responsibility for surface and mine water monitoring has been assigned to the mine site Environmental Officer.

Contract hydrogeologists will perform groundwater monitoring.

This review agrees with the findings of the AMDMP that the risk of AMD development at Roper Bar Mine is low to medium.

1. Introduction

This report presents findings of an independent third-party review of the sixth revision of the Acid and Metalliferous Drainage Management Plan, (herein referred to as AMDMP 2024), developed by Pendragon Environmental Solutions (PES 2024) for the Nathan River Resources (NRR) Roper Bar Iron Ore Mine (RBM), Northern Territory.

Independent review of the AMDMP is a requirement of Condition 16 of the Commonwealth Environmental and Biodiversity Conservation Act 1999 (EPBC).

Mr Emerson Pollard (Senior Consultant–Environment), Mining and Energy Technical Services Pty Ltd (METServe), working on behalf of NRR, requested Dave Salmon (LWR Consulting) to perform this review for NRR.

1.1 Scope of the review

The scope of this technical review is the assessment of the AMDMP 2024 for the consistency and alignment with;

- The Australian Government Department of Industry, Innovation and Science (DIIS) Preventing Acid and Metalliferous Drainage Handbook 2016 (the Handbook) specifically with sections 4,6,7,9 and Appendix 1 of the Handbook.
- AMD management international and national leading practices.

The scope includes the completion of the Department of Environment (DoE) AMDMP review checklist (The Checklist).

1.2 Review methodology

The review was completed according to the LWR Consulting Proposal (LWR 2024) submitted to METServe and NRR and agreed to by NRR 6 June 2024.

The work entailed the review of all relevant information, including the previous 2019 review, the latest AMDMP (PES 2024) the results of geochemical test work and mine water monitoring and comparison of this information to The Handbook (DIIS 2016) and international and national best practice such as the GARD guide (GARD 2009).

The format for the review report follows that used in the review of the PES 2019 AMDMP by Amanzi Consulting (2019). The format includes the use of the DoE review Checklist originally requested by the DoE for the 2019 review (Amanzi Consulting 2019). This approach to the 2024 review was confirmed by email sent by METServe, on behalf of NRR, to LWR Consulting.

The Checklist was completed by following the DoE directives provided with the Checklist supplied for the 2019 review report (Amanzi Consulting 2019). The directives require;

- *An outline of how the* AMDMP *document is consistent with the different sections of the Handbook.*
- *An explanation of why guidance in the Handbook is not relevant to the Roper Bar Project if the* AMDMP *document does not address or is inconsistent with the respective section of the Handbook and how that inconsistency will improve PAF management (and give references etc to substantiate that claim).*
- *Comment on Where and How the Topics in Sections 4,6,7,9 and Appendix 1 of the Handbook are addressed within the* AMDMP *document.*

The completed Checklist is provided in Section 5 of this review report.

1.3 The purpose of AMDMP 2024

The purpose of AMDMP 2024 is to update previous versions of the AMDMP and to include assessment of the AMD Management measures required for three new Mining Management Plans (MMP). The three new MMPs are:

- MMP 2023 Stage 1A Amendment which applies for the reinstatement of mining activities in the Danehill and Zabeel pits.
- MMP 2024 Stage 1B Amendment proposing the recommencement of mining within the Danehill East pit to commence after MMP Stage 1A is completed.
- MMP 2024 to 2025 applies for the continuation of mining under MMP Stage1A and Stage 1; the merging of the Zabeel North and South Pits into the Zabeel Ultimate Pit; the merging of the Zabeel North and South WRDs into one WRD; the construction and mining of the Ponting Pit and the Border Pit; and the establishment of a WRD at the Ponting Pit.

2. The Review

This review assesses the consistency of the AMDMP 2024 (PES 2024) to the requirements of the DIIS 2016 Handbook and the DoE Checklist of Sections 4,6,7,9 and Appendix 1 of the Handbook, and to international and national AMD guidelines for AMDMP development.

2.1 Mining Activities and Plans

The potential risks of AMD development from mining, materials handling and storage, and the suitability of the geochemical testing methods and monitoring undertaken, during existing mining activities and those planned under the three new MMPs, was undertaken. The detailed review of how the AMDMP addresses the risk of AMD for each new MMP is given in the Checklist in Section 5 below.

Each new MMP will involve an amendment to the Mining Authorisation 1062-01 (MA).

2.1.1 Existing Mining Activities

RBM was placed into Care and Maintenance in November 2021. In March 2023, a MMP amendment allowed recommencement of processing, sorting, haulage and transhipment of existing Low Grade Iron Ore (LGO) stockpiles. No mining of *in situ* material has occurred. The risk of AMD development from these existing activities is low.
These activities reduce the size of the stockpile and the footprint of mined material stored on site. They also reduce issues associated with seepage and runoff of mine affect drainage from stockpiles. This aligns with the Handbook and best international practice.

2.1.2 Mining Management Plan 2023 Stage 1A Amendment

AMDMP 2024 contains a summary of the AMD implications of the planned changes involved in restarting mining operations within the existing disturbed areas of the Danehill open pit (previously called Area F East) and Zabeel open pit (previously called Area E).
The AMDMP classifies the risk of AMD development as low due to these planned activities, because no PAF material is expected to be encountered during mining of these pits. The plan also contains an assessment of existing AMD information and geochemical sampling programs that demonstrates the low-risk classification.
These methods are suitable to assess risk of AMD development during the planned mining. Placement of NAG waste in the WRDs at both pits will be according to the WRD design described in Appendix A of AMDMP 2024. The WRD designs align with the Handbook and International WRD design practice.

AMDMP 2024 provides contingency planning, a requirement in the Handbook, if PAF is encountered during these operations. Any PAF material encountered will be placed in the existing PAF cells within the Danehill and Zabeel WRDs. The PAF cell design is described in Appendix A of AMDMP 2024. The design of the PAF encapsulation cell within the WRD aligns with the Handbook and International WRD design practice.

Tonnages of the waste rock that will report to the WRDs are provided. Expected changes to the Danehill and Zabeel WRDs are described.

The Danehill and Zabeel pits will require dewatering to enable the planned mining activities. The AMDMP provides results of surface water quality monitoring of water storages in the mining areas including the mining pits. The results show that there are no signs of AMD being produced. Since all mine site water will be managed and stored on site, within approved water storage facilities, no mine affected water will be discharged.

AMDMP 2024 makes no reference to the volumes of water to be abstracted and stored. Inclusions of water volume data in the AMDMP would assist the understanding of the risk of mine affected water being released.

Additional information regarding the final landforms of both pits, if available, would assist understanding of potential long-term risks of AMD.

The AMDMP has addressed AMD management for this MMP, and the actions planned align with the Handbook.

2.1.3 The Mining Management Plan 2024 Stage 1B Amendment

Description of the planned recommencement of mining operations within the existing pit shell of the Danehill East open pit is given in the AMDMP 2024.

The risk of AMD formation from this planned operation is recorded as low in the AMDMP. The mining material has been characterised. The waste is expected to be only NAF and will be placed in the Danehill WRD.

A small volume (<2000tonnes) of LGO material has been identified to contain total S above 0.3%. The risk of this material causing AMD on site is low, but the RBM plans to extract it, crush it, and blend it with DSO material for export. This will reduce the risk of AMD formation.

If PAF material is unexpectedly mined the contingency plan is to place it in the PAF cell within the Danehill WRD. The material handling and PAF cell design is provided in Appendix A of AMDMP 2024. Material handling and PAF cell design aligns with the Handbook and International guidelines.

This planned operation will continue to 2025. It will extract a total of 3,570,000 tonnes of material of which 2,615,000t will be NAG waste that will be stored in the WRD and be available for PAF cell encapsulation.

The Danehill Pit requires dewatering to enable the planned mining activities. The AMDMP provides results of surface water quality monitoring of storages in the mining areas including the mining pits. The results show that there are no signs of AMD being produced. Since all mine site water will be managed and stored on site within approved water storage facilities no water will be discharged. This is aligned to AMD management guidelines.

AMDMP 2024 makes no reference to the volumes of water to be abstracted and stored. Inclusions of these figures in the AMDMP could demonstrate effectiveness and adequacy of on-site mine affected water storage facilities to contain mine affected drainage, and thereby assist the understanding of the risk of mine affected water being released.

The inclusion of the planned final landform and land use of the Danehill Pit could be mentioned to demonstrate controls and mitigation of AMD formation during rehabilitation, mine closure and post closure.

2.1.4 The Mining Management Plan 2024 – 2025

The AMMDP summarises the mining activities planned in this Amendment and notes the implications to AMD management.

The plan describes the continuation of mining covered in MMP Stage 1A and Stage 1B Amendments and future mining activities. The implications to AMD management from Stages 1A and 1B are recorded in paragraphs 2.1.3 and 2.1.4 above.

The impacts on AMD management that might result from the planned mining activities are recorded in the AMDMP.

MMP 2024 plans the creation of the Zabeel Ultimate Pit by merging the Zabeel North and Zabeel South Pits. Mining of the Ultimate Pit has risk of AMD production from the estimated 555,368 tonnes of PAF material to be extracted. This risk will be managed by expanding the WRD storage by merging of the Zabeel North and Zabeel South WRDs. A new PAF encapsulation cell will be built within the enlarged Zabeel WRD. An estimated 7,62Mt of NAG waste will be stored in the new WRD.

Selective mining of the PAF waste in the Zabeel Ultimate Pit and its placement in the encapsulation cell within the planned Zabeel WRD will reduce the risk of AMD formation. These material handling methods and PAF cell design will be according to Appendix 1 of the AMDMP. Material handling and PAF cell design align with the Handbook and International guidelines.

The MMP 2024 also plans the development of two new open pits, The Ponting Pit and the Border Pit. A new WRD, the Ponting WRD, is planned to store NAG waste rock mined from these new pits.

An estimated 1,218t of PAF will be mined from the Ponting Pit. This PAF will be placed in the PAF encapsulation cell within the Danehill WRD. The material handling and PAF cell design will be according to that in Appendix 1 of the AMDMP and this aligns with Handbook and International guidelines. The risk of AMD formation resulting from mining in the Ponting Pit is classed as low.

The AMDMP 2024 contains no information on dewatering requirements for the new Ponting Pit. It is suggested that information on dewatering needs, if any, and on the future use of the Ponting Pit void would be useful in the context of AMD management, rehabilitation and mine closure, and post closure planning.

The AMDMP indicates that there will be no PAF extracted from the Border Pit.

The Border Pit final void will used for water storage. Information on the landform design for the Border pit final void and the expected Border pit lake water qualities would be useful additions to the AMDMP to explain measures and contingency plans for AMD management during operation, closure and post closure phases of Border pit operations.

2.2 Management of Mine Affected Water

The AMDMP 2024 contains some findings from the Environmental Mining Report produced by NRR December 2023. The findings about natural surface water, surface mine affected water and groundwater monitoring results recorded in the AMDMP, although broad, are demonstrate that acidic mine water is not being generated.

It would be very useful to have a summary of all the surface water and groundwater hydrochemical water monitoring and analytical results. Trends in these results could be used to detect early signs of AMD generation.

The AMDMP 2024 notes that mean and average values of the hydrochemical analyses of surface water on site exceed guideline values. pH ranges from 6.0 to 8.1 and Electrical Conductivity (EC) ranges from 1542 µS/cm to 2499 µS/cm. Manganese (Mn) and sulfate (SO_4) are elevated compared to the natural surface water systems. The mean SO_4 levels in the natural surface waters are <4mg/L.

The water in the WRD sediment pond has a pH of 7.8 and EC 6702µS/cm. Unfortunately, no SO_4 results were supplied.

It is unclear as to whether the elevated concentrations found in pits, currently flooded after being in Care and Maintenance, are related to mining activities. Blasting and excavation breaks rock material increasing the area of exposed faces to oxygen and moisture. This can lead to conditions that can enhance AMD generation. However, non-mining related factors such as rainfall, evaporation and groundwater inflow to surface facilities could also influence the results.

The AMDMP 2024 notes that mean and average values of the groundwater analyses have elevated pH, Total Dissolved Solids (TDS), SO_4, Calcium (Ca) and Cadmium (Cd), and metals. The groundwater system is naturally saline. No influence from mining activities on groundwater is believed to have occurred.

Ongoing monitoring and the assessment of changes in water quality that might be indicative of mining influences will be required as the new MMPs are implemented. This would align with AMD Management guidelines.

3. AMD Risk Assessment

An AMD risk assessment is tabulated in Table 2.1 of the AMDMP 2024. It lists the design and control measures and the operational management measures to deal with potential impacts from various aspects (mining activities). The production of a risk assessment is in line with the Handbook. The approaches taken follow AMD leading practice.

Geochemical test work, performed according to the Handbook guidelines, has characterised the three main lithologies the KYM, MSM and SIM, defined ore in terms of Fe content, and classified waste rock geochemically into NAF or PAF. PAF has been found to occur in small quantities and only within the SIM lithologies. Because PAF volumes are small they can be effectively managed using selective mining for their extraction and selective placement for their storage in PAF cells in WRDs. These methods align with the Handbook.

Sufficient geochemical data has been produced to enable Total Sulfate (TS) levels in samples to be used to define PAF materials with confidence.

Ongoing geochemical and hydrochemical monitoring will give early warning of any change in this condition and any ineffectiveness of management measures.

The conclusion in the AMDMP that there is a low to medium risk of acid mine drainage development is justified.

4. The AMD Management Plan

AMDMP 2024 uses both written and tabulated formats. Comments in sections 1 to 3 of this review refer mainly to the written portions of AMDMP 2024.

The Tabulated part of the AMDMP 2024 is contained in Table 2.2, pages 22 to 40. The Table in AMDMP 2024 is adapted from the Checklist supplied by DoE for reviewing the AMDMP.

Some structure of the DoE Checklist used in AMDMP 2024 has not been maintained in Table 2.2 of the AMDMP. As a result of this, information is contained in a table column that transgresses across section divisions in the table rows. This leaves the reader to sort out the information that belongs to a particular section. For consistency, ease of reference, and for the easy finding of information, separation of these headings into component rows in the order in which they are numbered is suggested.

This structure is missing in parts of Section 4 and Section 6. The individual subsections affected are: 4.3, 4.3.1 to 4.3.7; 4.7, 4.7.1 to 4.7.3 and 6.1, 6.1.1 to 6.1.5; and 6.3, 6.3.1 to 6.3.3.

Section 4.3 requires the separation of the information into rows corresponding to the Section title i.e. rows are required to run across the table for items 4.3.1 to 4.3.7 to achieve separation. Headings in the column have been included so placing this information into the correct section row should be straightforward.

The individual sub-sections of Section 6 of the Table 2.2 noted above require editing. The following observations are made about the individual paragraphs that occur in the blocks of text that transgress across sub-section rows.

- Paragraph 1 deals with PAF placement and construction of the Danehill WRD (Area F East WRD).
  - Firstly, it is suggested that the latest naming convention for the WRDs is used as these are the terms to be used going forward with the new MMPs.
  - Secondly, an introduction to this text, as part of the General Consideration subsection, could be added to help clarity. For example, *"PAF waste is to be managed in WRD containment cells. The Danehill WRD has an estimated 53,000t of PAF……."* , This should demonstrate management measures taken to minimise AMD production.
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- Paragraphs 5 and 6 contain information on identifying AF material using grade control borehole chips to sample lithologies. The WRD sampling program has relevance to 6.1.4 and 6.1.5.
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- Paragraph 9 is possibly appropriate to section 6.1.5. The actions that are planned should be emphasised. For example state that:
  - PAF identification will be ongoing using grade control and targetted drilling.
  - KYM waste material will be used for WRD and ROM pads.
  - Weathered MSM will be used for capping material WRDs.
  - Weathered and fresh KYM and MSM rock wastes and when appropriate SIM with < 30% Fe for use in encapsulating PAF.

- Paragraph 10. Is an action point committing to undertake further geochemical assessment. It might be more appropriately placed in section 6.1.5?
- Paragraph 11. This deals with WRD construction and should be placed in section 6.1.4.
- Paragraph 12. This statement deals with self-heating and should be placed in section 6.1.5.
- Paragraph 13. Section 6.1.6 is not applicable to RBM and this paragraph explains why this is the case. No further action is required at this time nor for the new MMPs under this section.

Table 2.2 Section 6.1.2 entitled “Conventional end-dump WRDs” does not appear to have been addressed. Comment could be made on why Paddock Dumping is used for the RBM WRDs and End Dumping for PAF placement.

Information on the methods of placement of waste materials in WRD storage facilities also have relevance to Sections 6.1.4 “Construction methods for WRDs to minimise AMD production” and 6.1.5 “Minimising self-heating and AMD potential” in terms of reducing the risk of AMD production and prevention of self- heating. Reference to WRD and PAF cell construction information (Appendix A) could be made and demonstrate alignment with the Handbook and other guidelines.

5. The Review Checklist

5.1 Introduction

A Checklist provided by DoE for use in the 2019 review by Amanzi Consulting, is used again in this 2024 review following instruction from METServe. The Checklist is also structured to deal specifically with Conditions 9 and 10 of the Mining Approval December 2012.

The application of the Checklist in this review is outlined in Paragraph 1.2 above.

The AMDMP 2024 (PES 2024) was compared to the Handbook guidelines Sections 4, 6, 7, 9 and Appendix 1 and is reported in the Checklist Table 1 below.

This review found the AMDMP 2024 (PES 2024) is tabulated to address those parts of the Handbook included in the DoE review Checklist.

AMDMP 2024 Table 2.2 reports existing approaches that are specific to the Danehill and Zabeel mining areas. There is little mention of the latest 2023 and 2024 MMPs. However, these items have been discussed in the body of the text, Section 1 of the AMDMP 2024.

This review found the content of the AMDMP has specifically addressed DoE Checklist Section as follows.

- Section 4 (Acid mine drainage characterisation and prediction) has been addressed according to the guidelines in the Handbook and the Checklist.
- Section 6 (Managing Sulfidic materials to prevent AMD) has been addressed according to the guidelines in the Handbook and the Checklist.
- Section 7 (AMD treatment) is, at this stage of mine development, not required because AMD prevention measures are effective.
- Section 9 (Performance evaluation and monitoring) has been addressed according to the guidelines in the Handbook and the Checklist.
- Appendix 1 of the Handbook (Table A.1 Elements of an AMD monitoring program) has been addressed.

5.2 The Checklist: Table 1

Handbook 2016 topics	Where/how addressed in AMDMP 2024
9a Sampling and analysis procedures that will be employed to identify potential acid forming (PAF) materials.	
4.2 Sampling for characterisation. ***4.2.1 Overview***	**Where** AMDMP 2024 Table 2.2 p23-24 and AMDMP 2024 text p9-13 (References: GHD 2015, PES 2013, PES 2019, Amanzi 2019) **How** Definition of main geological materials, lithologies and mining material for sampled and tested and characterised by dividing material into ore and waste based on Fe content is provided. Multiple test methods with increasingly detailed sampling and materials characterisation have been used. Geochemical classification of mining materials into PAF, NAF, UC, and AC and assessing risk of AMD using Source-Pathway-Receptor analysis has occurred. Specialist expert AMD consultants have been used for the work. Characterisation was done to meet the Environmental Protection Agency (EPA) conditions for approval of the Environmental Impact Statement (EIS). Later investigations and reports addressed SEWPaC requirements that included: • Sampling and analysis procedures that will be employed to identify PAF materials. • Design details and management strategies of proposed encapsulation beds (cells), waste rock dumps, drainage systems, including sediment traps, seepage diversion barriers, collection ponds and embankments. • A strategy for the ongoing monitoring of PAF material, including threshold trigger levels and mitigation responses. Earlier work that was performed, followed Australian Government AMD Guidelines in the 2007 Handbook and included: • Static geochemistry test work on several hundred samples with sufficient samples to populate the geological block model with reliable distribution of NAPP data on the ore and the waste streams: the mining discards, and pit backfill overburden material. • Kinetic tests for 1 to 2 representative samples for key lithologies and waste materials specifically those identified as PAF or UC. Geochemical Test Work completed includes: • Static (ABA) testing: including maximum potential acidity (MPA), Net Potential Ratio (NPR), and Net Acid Production Potential (NAPP). • Kinetic testing: column leach construction and analyses and ALPS. • Mineralogical Assessment: by XRD, XRF and EDS. • Metal assessment: using geochemical abundance index (GAI).
4.2.2 In-place mine materials	**Where** AMDMP Table 2.2 Page 24 (References: EcOz 2012, PES 2013, GHD 2015, Amanzi Consulting 2019) **How** Initial work prior to mining established material characteristics. Two hundred and four (204) samples from fifty-eight (58) exploration boreholes

	were sampled and analysed from various geological horizons and rock types found in mining areas: • Area E: East Pit and South Pit. (Now called the Zabeel Pit) • Area F: East Pit 1, East Pit 2, East Pit 3, and the West Pit (now called the Danehill Pit). Samples were taken of the main lithologies including sandstones and sandstone oolites, (50% of the lithotypes in the area); siltstones, oolites, oolitic sandstone, and clays. This established the main geological units: • KYM- the Kyalla Siltstone Member. • MSM -the Moroak Sandstone Member. • SIM – the Sherwin Iron Member. The degree of weathering of materials was recorded and used in classification of materials tested. During operations, grade control and blast hole samples selected and analysed. No sample composites are used. Enough sampling has been completed to establish a block model of the different materials and of PAF material to inform future sampling protocols, analytical needs and ongoing test work, to confirm findings and direct adjustments to risk assessment and management plans.
4.2.3 Existing exposed mine materials	**Where** AMDMP Table 2.2 P24 notes exposed materials in the Danehill and Zabeel open pits and the Danehill WRD. These could include ore and overburden in pit faces, waste in waste rock dumps, and materials exposed in stockpiles. These materials were originally assessed by PES (2013). Further sampling and testing to be undertaken.
4.3 Geochemical static tests ***4.3.1 Field Measurements***	**Where** AMDMP 2024 Table 2.2 P24-P25 **How** On-site field measurements pH, EC, TDS, DO, T°C. XRF analysis for Total %S. Total S% defines PAF as >0.3%. Test methods align with the Handbook.
4.3.2 Mineralogical analysis	**Where** AMDMP Table 2.2 p24. (References EcOz 2012 and GHD 2015) **How** Early work involved: • Analysing fifty-six (56) samples using X-ray powder diffraction (XRD). • Forty-six (46) samples representing the principle waste rock streams were analysed by scanning electron microscopy (SEM) and energy dispersive X-ray spectrometer analysis (SEM-EDS) techniques. • Sulfur assessment was done by XRF analysis of fifty-one (51) laboratory analysed samples or field measurements. Test methods align with the Handbook.
4.3.3 Elemental composition	**Where** AMDMP 2024 P24-P25. EcOZ 2012 PES 2013 **How**

	Laboratory X-Ray Fluorescence (XRF) of 24,457 samples for Total S% and 25,387 samples for CaO and MgO. Other analytes included: Al_2O_3, Fe, Mn, Mo, P, SiO_2, TiO_2 and K_2O Geochemical leach testing of eighty-five (85) samples was performed using de-ionised water in accordance with the Australian Standard Leaching Procedures (ASLP). The results were plotted on Piper diagrams to classify leachate types.
4.3.4 Acid base accounting	**Where** AMDMP 2024 Table 2.2 P25. (Reference: EcOz 2012, PES 2013, and GHD 2015). **How** Two hundred and four (204) samples subject to ABA and NAG. One hundred and seventy-five (175) samples were from the mine disturbance area i.e. within the KYM, MSM and SIM units. Static test work used to determine lithological characterisation and assessing the characteristics of the combination of these materials that will make up the WRD. A standard suite of analyses was performed using standard testing methods from an accredited laboratory (ALS). The acid base chemistry was determined for all waste materials by: • pH and EC of paste solutions. • Oxidation pH. • Total S and sulphate sulfur. • Assessing the Acid Neutralising Capacity (ANC) carbonate alkalinity (as CaCO3) and the Net–Acid Generation (NAG). • Calculating Maximum Potential Acidity (MPA), Net Acid Producing Potential (NAPP) and the Acid Potential Ratio (APR). In summary the geochemical static test work report includes: • Descriptions of methods used in the analysis. • Records of the initial characterisation results of most in-situ materials. • Records of the leachate's chemistry from the waste material. • Assessment of the geological sequence to determine PAF, NAF or UC by lithology. • Identification of the potential sources of AMD in the East and West Pit waste rock dumps. • Provides an initial mine waste balance and a mine waste management option including the placement of PAF material within the dumps. • Documented a risk assessment process and provide a risk assessment for the management of the waste Total S% all sulfur assumed to be pyritic as per Handbook.
4.3.5 Net acid generation test	Where As above in 4.3.4 AMDMP 2024 p25 and PES 2019 4.3.4
4.3.6 Sulfur and carbon speciation	**Where** AMDMP Table 2.2 P25
4.3.7 Sample classification	**Where** AMDMP Table 2.2 P25-P26 (Reference**s:** PES 2013, GHD 2015, Amanzi 2019 AMDMP review). **How**

	Mining material types are grouped according to iron content: • Mining waste (WST) is material with <30% Fe content. Rock waste is predominantly KYM and MSM, with small quantities of weathered SIM. • Ore types are defined by Fe content > 30% and include Direct Shipping Ore (DSO) >60%; Blended Direct Shipping Ore (BDSO) 54-60%; Dense Media Separation Ore (DMSO) 45-54%: Siderite Ore (SIDOO) 30-54% and LOI > 10%, and Low-Grade Ore (LGO) both fresh and weathered. Geochemical characterisation of the Roper Bar Mine materials is according to the 2016 Handbook and other AMD standards and guidelines. The following materials were identified. • Non-Acid Forming (NAF). • Potentially Acid Forming (PAF). • Uncertain (UC material that cannot be definitively classified as PAF or NAF. • Acid consuming (AC). AMD characteristics of the different lithologies, both weathered (oxidised) and fresh lithological units, are classified according to Total Sulfur content, e.g. Low Sulfur <0.3% and High Sulfur >0.3%. Total S% conservative approach as assumes all S is pyritic. Parameters that are calculated from the test results and used to characterise lithologies included Net Potential Ratio (NPR) sums Ca Mg oxides against Total S content (excluding sulfate sulfur); Net Acid Production Potential (NAPP) sums Ca Mg oxides against Total %S content (excluding sulfate sulfur); and Acid Potential ratios – the ratio of ANC/MPA. Total S % are conservative estimations as they exclude sulfate sulfur which may have neutralising sulfates.
4.4 AMD block modelling and materials scheduling	**Block Model** **How** Western Desert Resources produced the original geological Block model, and this has been regularly updated, including for the MMP 2024. It correlates well with the geochemical model and the laboratory XRF dataset. **Where** AMDMP Table2.2 P26-P27 and (GHD 2015). **Materials Scheduling** **How** Mining materials scheduling **Where** AMDMP p27-28 covers the Danehill and Zabeel mining areas including DSO, LGO, Waste (NAF) and PAF. It also schedules the three MMPs MMP2023 Stage 1A, MMP 2024 Stage 1B and MMP 2024 plan 2024 to 2025. WRD capacities are provided.
4.5 Geochemical kinetic tests	**Where** AMDMP 2024 Table 2.2 P28-P29. (References: PES 2013, GHD 2015) **How** Column leach testing has been done as per the Handbook. No further kinetic column testing envisaged because PAF volumes are very small and risk of AMD low. Contingency for further testing as new MMPs implemented.
4.5.1. Column leach and humidity cell tests	**Where** AMDMP Table 2.2 p28-30. (References: PES 2013 and GHD 2015) **How**

	Six (6) columns were established to assess mining waste materials. Five (5) “tons” (sic) of drill cuttings and pit samples of waste materials, were broken down to sizes of blasted broken waste, sieved and packed into six (6) separate columns. The columns were set up to account for • Results of static testing, which showed PAF material dominantly occurs at 30 m depth below surface and to account • Mixing of PAF and NAF materials; a result of blasting. The materials mostly comprised KYM weathered material. One set of columns represented low sulfide spoil concentrations and the other set high sulfide concentrations after blasting. The sources and the combination of the materials used in the column are described in PES (2013). A dataset was generated from November 2012 to May 2014 (PES 2013). Kinetic testing is stated to have been performed based on results of the AMD risk assessment, of conceptual waste rock dump designs, and the handling of PAF material during mining operations. The results of the analyses confirmed the outcomes of the static testing for all columns except columns 4 and 6. • Columns 1 and 2 were confirmed as PAF. • Column 5 was UC. • Column 3 confirmed as NAF. • Columns 4 and 6 were found to be UC. The leachate qualities observed are indicative of spoil materials that have been naturally weathered. The AMDMP records these columns having been damaged by a fire. It also notes that no further column testing is planned because of the low risk of AMD generation due to small volumes of PAF and the results of monitoring, which suggests all actions to prevent of reduce AMD are effective. (See 4.5.2 below).
4.5.2 Oxygen consumption tests	**Where** AMDMP 2024 Table 2.2 P30. PES AMDMP 2019 **How** No laboratory oxygen consumption tests have been performed. PES AMDMP 2019 suggested these may be done to determine pyrite oxidation rates for all geological units and in place of column leach tests. Small volumes of PAF and low risk of AMD formation means presently no need for further testing.
4.5.3 Oxygen penetration tests	**Where** AMDMP 2024 Table 2.2 P30. **How** No tests performed. These tests are primarily used in tailings facilities. Processing of ore at RBM only involves dry handling. No tailings are generated.
Scaling-up of laboratory test results ***4.6.1 Pilot-scale field tests***	**Where** AMDMP 2024 Table 2.2 p30. **How** Geochemical testing and ongoing monitoring have been sufficient and rigorous enough to determine that PAF in small volumes can be handled in containment cells encapsulated within the waste rock dump.

4.6.2 Large to full scale field tests	**Where** AMDMP 2024 Table 2.2 P30 **How** Monitoring for visual signs of seepage and precipitates from existing WRD and stockpiles plus and ongoing water quality monitoring.
Estimating and modelling pollutant generation and release rates ***4.7.1 Overview***	**Where** AMDMP Table 2.2 P30 **How** ASLP testing metal leaching potential from KYM, SIM, and MSM in addition to data from Kinetic Test Leach columns is suggested in the AMDMP.
4.7.2 AMD prediction using empirical test results	**Where** AMDMP Table 2.2 P30. **How** Acidity load estimates from column leach test results provided.
4.7.3 AMD prediction using computer models	**Where** AMDMP Table 2 p30. **How** Not warranted due to the small scale of mining and the low risk of AMD.
9b. Design details and management strategies of proposed encapsulation beds, waste rock dumps, drainage systems, sediment traps, seepage diversion barriers, collection ponds and embankments;	
Management of waste rock dumps to minimise AMD ***6.1.1 General considerations***	**Where** AMDMP 2024 Table 2.2 P30 Table 2.2 Section 4.4 P24 Volumes and tonnes Section 1 P9 to P12 Appendix A Danehill and Zabeel WRD design Appendix C Waste rock sampling procedure. **How** Proactive AMD source minimisation and prevention. A waste rock management strategy has been developed. WRD design is based on material characterisation and selective handling and deposition of materials. PAF to be deposited in Cells designed to be encapsulated within the WRDs. Available capacity in PAF cells continuously reviewed. With the implementation of Stages 1A and 1B amendments stockpiling of LGO will no longer occur. LGO will be blended with DSO for export. Samples of material from grade control drilling will be used to assess materials but specifically for PAF materials identification and to enable estimates of the PAF volumes to be managed. Paddock Dumping of PAF waste material rather than End Dumping which reduces potential for oxidation of PAF. Danehill and Zabeel WRDs base and cover to be constructed of weathered impermeable NAF (KYM) compacted to no less than 2.5 metres (m) thickness to encapsulate PAF cell material. WRD side with minimum 28 metres from PAF cells.

	WRD cap will have rock armour and soil of 0.5m thickness placed and profiled for erosion control and slope stabilisation. WRD store and release cover system planned to inhibit oxygen and moisture ingress. Future planned pit backfilling of waste when pit space available. Backfilling in-pit can only commence as mining progresses extraction to the full depth of the resource. Ongoing identification of AMD generating waste with PAF assessment on grade drilling drill samples (Appendix C). Civils works to control AMD generation and control and contain water, including stormwater levees and ROM pad levees, sediment dams and temporary levee around F East pits and WRDs have been defined (GHD 2015).
6.1.2 Conventional end-dumped WRDs	**Where** AMDMP 2024 Table 2.2 Appendix A **How** WRD main construction is by Paddock Dumping. End dumping of PAF occurs into the PAF containment cells. Containment cells are lined. They have no direct outside contact with air because they prevent oxygen ingress. AMD production is minimised end tipping of PAF.
6.1.3 Oxidation rate and lag time to production of AMD	**Where** AMDMP Table 2.2 P31. PES 2013 **How** Rates estimated from kinetic test columns. AMD production would be minimised / prevented by placing PAF in containment cells within the dump and, in future if PAF is backfilled into the pit.
6.1.4 Construction methods for WRDs to minimise AMD production	**Where** AMDMP Table 2.2 P31 and Appendix A PES 2019, GHD 2015 **How** Use of suitable construction materials: • NAF waste both weathered and fresh material stockpiled for future use as WRD encapsulation and capping material. • NAF weathered waste rock (MSM) stockpiled for use as WRD capping. • NAF weather KYM used for infrastructure construction such as WRD pad, ROM stockpile pad bases - AMDMP Table 2.2 p18. Management measures aimed to reduce generation and transport of oxidation products: • Paddock dumping of waste rock. • PAF waste materials contained in KYM, MSM and SIM are stored in PAF Cell in Danehill and Zabeel WRD. • Future pit backfilling of waste rock / and PAF cells when pit space allows. • Various water management infrastructure interception trenches, containment dam, bunds/berms, interception drains to reduce moisture contact with WRD. WRD design and construction: • A store and release cover is proposed to inhibit oxygen and moisture ingress into the facility and into PAF cell.

	• 2.5 metre thick base of NAF KYM. • 2.5 m thick cover of NAF KYM and NAF MSM rock armour / erosion control. • 4m thick side cover of NAF KYM. • The base of the WRD will extend beyond the sides of the planned WRD landform to include the catch drains and bunds. • Storage of PAF material in 100 000 m^3 cells that will be encapsulated in NAF KYM within the WRDs. • PAF cell covered with 1.2 m thick layer of NAF material followed by rock and eventually rock armour and soil that will be track rolled and shaped for drainage. • Interception of runoff drainage trenches, stormwater levees, ROM stockpile pad levees, temporary levee around F East pits and WRD.
6.1.5 Minimising self-heating and AMD potential	**Where** AMDMP Table 2.2 P32 **How** Self-heating has not been identified at Roper Bar. Both self-heating and AMD potential will be prevented or minimised through mine waste handling and storage as outlined in 6.1.1 and 6.1.4 of this Checklist.
6.1.6 Minimising AMD risk at sites dominated by PAF waste rock	**Where** AMDMP Table 2.2 P32 and P28 (Reference: GHD 2015) **How** Roper Bar is not dominated by PAF. The volumes of PAF are small (Table 2.2 P28) GHD 2015 Table 5 on page 21 indicated a total % PAF in waste and ore at <1%. Estimated PAF volumes currently stored are Danehill 119196bcm and Zabeel 152,000bcm. NAF stored at Danehill 3,546,000 and at Zabeel 1,435,000. Expected total PAF tonnes of PAF Stage 1A and PAF Stage 1B is zero tonnes from Danehill and Zabeel pits. Percentage PAF in waste and Ore mined is zero. Expected total PAF tonnes in the MMP 2024 are 556,586t. The total waste estimate is 13,953,546t and of ore 2,422,554t in the Zabeel Ultimate, Ponting and Border pits.
Management of tailings to minimise AMD ***6.2.1 Overview***	**Where** AMDMP (Table 2.2 P32) and Reference: GHD 2015) **How** The ore processing methods described will not generate tailings. The processing of the iron ore involves crushing and dense media separation only.
6.2.2 Water covers for tailings	Not applicable. Tailings are not generated (Refer to Section 6.2.1)
6.2.3 Covers for tailings	Not applicable. Tailings are not generated (Refer to Section 6.2.1)

Soil cover systems for waste rock and tailings ***6.3.1 Covers on flat tops***	**Where:** AMDMP Table 2.2 Appendix A **How** Soil cover system for the WRD is described in Section 6.1.4 NAF waste (specifically both weathered and fresh material MSM) is stockpiled for use as WRD capping material. This material will be compacted and profiled.
6.3.2 Treatment of outer slopes	**Where** AMDMP Table 2.2 Appendix A **How** Rock armour and soil, slopes compacted and profiled as noted above.
6.3.3 Cover design and performance	**Where** AMDMP 2024 Appendix A. **How** Store and release cover system. PAF encapsulation cell has worked since commissioning in 2014 and to date. No AMD seepage found.
6.4 Blending and co-disposal of wastes	**Where** AMDMP 2024 Table P32 and Appendix A. **How** No blending of NAG and PAF wastes occurs or is planned to occur as PAF will be encapsulated in a cell within the WRD.
7.1 Why and when do we need to treat?	**Where** AMDMP 2024 Table P33. **How** No treatment required as the AMD prevention and management measures have been successful to date and no AMD has been generated.
7.2 General considerations for the selection of treatment systems	**Where** AMDMP 2024 Table 2.2 P33. **How** Not applicable at this time because no AMD generated.
Treatment technologies—active or passive? ***7.3.1 Overview***	**Where** AMDMP 2024 Table P33. **How** Not applicable at this time because no AMD has been generated.
7.3.2 Active treatment systems	**Where** AMDMP 2024 Table 2.2 P33. **How** Not applicable at this time because no AMD has been generated.

7.3.3 Passive treatment systems	**Where** AMDMP 2024 Table P33 **How** Not applicable at this time because no AMD has been generated.
9c). A strategy for the ongoing monitoring of PAF material, including threshold trigger levels and mitigation responses;	
9.1 Introduction	**Where** AMDMP 2024 Table P33. Appendix C and Appendix E. (References: NRR EMS System 2019, NRR Water management and Monitoring Plan and PES 2013, GHD 2015). **How** A systematic approach to monitoring mine waste and checking for PAF material is outlined in Appendices C and E and PES 2013. NRR commits to providing financial, human technical and other required resources in their operating budgets for water and geochemical monitoring is discussed in the AMDMP 2024. A dedicated environmental officer is responsible for surface water monitoring. Visual observations of the WRDs monthly during the wet season and no signs of AMD have been found. Budget provision has been made for a contract groundwater specialist to do groundwater sampling. A budget of $50,000 for Geochemical testing approximately 300 samples has been provided. Sample characterisation during mining will be by XRF providing Total %S values in an on-site laboratory to be run by Intertek. Appendix E reviews water quality data to obtain trigger levels for receiving waters. Analysis of waste material protocol in Appendix C.
9.2 Performance evaluation	**Where** AMDMP Table 2.2, P34-P36. **How** Performance Criteria are listed in Table 2.2 p34: • Zero discharge of water in contact with waste material. • Maintain ambient downstream water and groundwater qualities particularly pH. • Soil pH between pH 6.0 to 8.5. • Inventory of all sources of acidity defined by Total S of <0.3%. • Trigger levels – Total %S used. • Monitor grade control bores at 10 m lines and 1 metre sample interval. • Monitor blast bores at 10m intervals for total S. Trigger Levels are discussed in the AMDMP Table 2.2 P35 Material with Total S values of between 0.25% and 0.3% will undergo further field testing by paste pH and or NAG pH measurement. Paste pH values of <4.6% and NAG pH levels of <4.5% trigger the requirement for laboratory analytical assessment of ABA. Total S values of >0.3% trigger the requirement for field paste pH and NAG measurement and ABA laboratory assessment. Exceedance of Trigger Values requires an incident investigation and report to be reviewed by Regulatory Authority.

9.3 Conceptual site model of AMD processes	**Where** AMDMP 2024 Table 2.2 P36 and GHD (2015). **How** Conceptual site model based on Source, Pathway, Receptor Concept. This agrees with International Standard Practice INAP 2009.
9.4 Monitoring	**Where** AMDMP Table 2.2 p36 -P37. **How** Water monitoring in: • Constructed landforms WRDs, ROM pads, LGO stockpiles and other surface water control infrastructure. • Surface water. • Ground water. • Pit wall seepage. Analytes pH, EC, acidity, alkalinity, SO_4, Al, As, Fe and Mn with some results given in Section 9.1 above. Geochemical monitoring as mentioned in section ??? above with static Testing: XRF on grade control samples for Total S%. Planned additional samples for pyritic S since parts of Total S non-reactive. Kinetic testing: No additional testing needed for MMP Stage1A and Stage 1B.
9.4.1 Examples of parameters to monitor on site	**Where** AMDMP Table 2.2 p37-P38 **How** Listed in Appendix 1 AMDMP 2024 P37-P38
9.5 Data storage, evaluation and reporting	**Where** AMDMP 2024 Table 2.2 P34 **How** NRR water database for storage, evaluation and reporting.
Appendix 1 Table A1 – Elements of an AMD monitoring program.	**Where** AMDMP Table 2.2 P37-P40. **How** The table contains information on the components of the AMD Monitoring Program, the parameters to be measured, the frequency of measurements and Performance Evaluation Criteria. Cross references to other sections of the Checklist and to references and guidelines are given. This Appendix also provides information on the following Aspects. *AMDMP Reviews P39-P40* • Annual reviews by independent technical reviewer in respect of Condition 16 of the EPBC Approval - the protection of the Sawfish. This frequency of this review will be guided by an assessment of AMD risks. • Review every three years for the life of the project Each revision of the AMDMP will be used to update the Mine Closure and Rehabilitation Plan.

	Contingency Plans Table P40 These are specifically designed to deal with residual risk after the AMD prevention and control measures have been applied. Commitment to additional monitoring use of temporary and permanent covers, and drainage collection and treatment as required.

6. Recommendations and closing comments

AMDMP 2024 updates previous AMDMPs and includes the AMD Management measures required for three new Mining Management Plans (MMP). These MMPs amend the existing Mining Authority 1062-01 (MA).

AMDMP 2024 focuses on early detection of the risk of AMD and the management measures to prevent or minimise AMD development. AMD assessment and prevention management measures follow leading practice in approaches, methods, and procedures and will reduce the need for AMD control and treatment.

The AMDMP provides evidence that it aligns with the Handbook guidelines.

This update of the AMDMP has addressed the recommendations given in the previous review (Amanzi Consulting 2019) of the AMDMP 2019.

The surface water, groundwater, and mining water storage and drainage facilities water quality monitoring results indicate effectiveness of the AMD management measures implemented.

Financial provision for ongoing geochemical monitoring and assignment of monitoring responsibilities to the Environmental Officer as been stated in this revision.
The AMDMP identifies that additional geochemical test work maybe required with the implementation of the new MMPs. It also indicates the need for kinetic testing will be based on risk of AMD should monitoring show changes. Presently, no further kinetic column testing envisaged because PAF volumes are very small and risk of AMD low.

PAF material handling and containment have been successfully implemented. Diagrammatic representations of PAF cell design are included in Appendix A of the AMDMP. The design is aligned to the Handbook.

Abbreviations in the AMDMP need updating.
The acronym NPR is listed in the abbreviations table but contains no definition. Is this an acronym for Net Potential Ratio?
NRP occurs as an abbreviation in the text of the AMDMP but is not defined in the Abbreviations list. Is this an abbreviation for Nathan River Project?

Referencing needs to be checked. The usual referencing for the AMD Handbook is
DIIS (Department of Industry, Innovation and Science) (2016) Preventing Acid and Metalliferous Drainage, *DIIS, Canberra.*

7. References

Documents referred to and found to contain pertinent information included:

- Amanzi Consulting 2019 Technical Review: AMDMP for the Roper Bar Mine, Northern Territory.
- EcOz 2012 Acid Metalliferous / Mine Drainage (AMD) and Management. Western Desert Resources Roper Bar Project. Report DW120007-C0302. Report prepared by EcOz Environmental Services, June 2012.
- DIIS (Department of Industry, Innovation and Science) (2016). *Preventing Acid and Metalliferous Drainage*, DIIS, Canberra.
- GARD 2009. The International Network for Acid Prevention (INAP), 2009. Global Acid Rock Drainage Guide (GARD Guide). http://www.gardguide.com
- GHD 2015 Acid and metalliferous Drainage Management Plan, Care and Maintenance -Mining Management Plan, Roper Bar Iron Ore Project, Western Desert Resources Limited, GHD 2015.
- PES 2013 AMD risk assessment and management. Western Desert Report Reference No: PES11009. Report prepared by Pendragon Environmental Solutions, April 2013.
- PES 2024 Acid and Metalliferous Drainage (AMD) Nathan River Project, Northern Territory Revision 6.

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Appendix C: Waste Rock Sampling Procedure.

1. PURPOSE

This procedure outlines the methods required to collect and analyse geochemical samples of waste material mined at Roper Bar for the purpose of confirming the performance of the block model in its role to identify any potentially acid forming (PAF) material for selective handling and placement.

2. SCOPE

This procedure is applicable to waste rock sampling of blast drill holes, mine faces, pit floor sampling and wall sampling. This procedure forms a part of the Nathan River Project Acid Metalliferous Drainage Management Plan.

3. RESPONSIBILITIES

The Geology Department is responsible for the identification and communication of PAF locations. The Mining Department is responsible for the transport and storage of PAF. The Environmental Department is responsible for the monitoring of surface and ground water to identify whether any acid mine drainage is occurring.

The Manager/Supervisor shall ensure that:

- Waste rock is adequately characterised, and sampling and analysis for quality assurance takes place;
- Any identified PAF is communicated in a timely fashion to the Mining Department;
- Adequate resources are available to conduct waste sampling;
- Adequate training is given to all staff using this procedure.

The OHS Officer will:

- Ensure that all related sampling procedures are being adhered to by all workers;
- Ensure that all workers involved in sampling procedures have been adequately trained in conducting hazard analyses and managing risk associated with waste rock sampling;
- Respond immediately to all identified substandard conditions, hazards, defects, or noncompliance to the sampling procedures.

The Worker:

- Will participate in any team identified as needed to develop procedures for protection as required;
- Will inspect and asses the blast pattern environment and deem it safe to work in;
- Is required to record the findings of all potential hazards;
- Is required to record the findings of all equipment inspections;
- Will report immediately to the supervisor any identified defects, hazards, or substandard conditions;
- Will abide by all waste rock sampling procedures.

4. DEFINITIONS

Detailed geochemical assessments have correlated exploration data captured from waste rock laboratory assays, portable XRF data and laboratory-based acid base accounting (ABA) tests (refer to AMDMP for full details). These assessments have determined that a simple and conservative definition of PAF at Roper Bar geochemically is:

NAF < Total Sulphur 0.3% < PAF

With the addition of closely spaced grade control drillholes within the mining areas it is practical to interrogate the model to identify areas of potentially acid forming (PAF) material. Quality assurance sampling will occur on an ongoing basis to confirm the accuracy of the model.

5. PROCEDURE

The working files for the waste rock sampling are within Z:\MTS\Geology\Waste Rock Sampling

- Consult with Geologist to obtain a digital and hard copy of upcoming blasts with identified holes requiring sampling.
- On a daily basis check with engineers and drilling contractor on the status of drilling on blast patterns and any upcoming loading of explosives.
- Plan the sampling of the pattern with the drilling schedule to ensure there are sufficient holes to be sampled and that there is no interference with loaded holes. (Figure 1).
- The sampling pattern provided should not discriminate by stratigraphy and frequency will be sufficient to provide required number of samples per month.
- Use positive communication with the drillers/shot firers when entering and leaving the pattern.
- Under no circumstances is it safe to enter a drill pattern if blast holes have been loaded. Loaded shots will be cordoned off with YELLOW cones.
- Ensure that completion of sampling can be undertaken prior to explosive loading of the holes. Sampling of spoils after loading of explosive may contaminate the sample and poses a risk to the laboratory.
- Areas of low grade ore on the margins of the waste are to be included in the waste sampling pattern. Sample up to the ore boundary; the map will have the ore zones delineated.
- When sampling the blast hole spoils, minimise the amount of spoil from re-entering the drilled hole. With the bottom of the trenching shovel facing away, strike the point vertically into the cone as close to the hole collar as possible. Draw the shovel back and away from the hole, spreading a cross section of spoil away from the centre of the cone. Carefully collect a trenching shovel blade of drill spoil and place in a sequentially numbered calico bag and secure. (Figure 2). The assay sample weight should be 2 – 3 kg.
- Ensure the sample is recorded on the Waste Rock Sample Sheet recording the Blast Hole ID, Sample ID and Shot ID.
- All fields and header details of the Sheet are to be completed with the relevant information (Figure 3). The “Unit” field must be filled out for all samples, as this is used in characterising the waste. Generally, the shot will be either all “KYM“ (Kyalla Member- on the southern side of the ore at F-East (Dane Hill) and at the western side of the ore at E-East (Zabeel) or “MSM” (Moroak Sandstone- on the northern side of the ore at F-East (Dane Hill) and the eastern side of the ore at E-East (Zabeel).

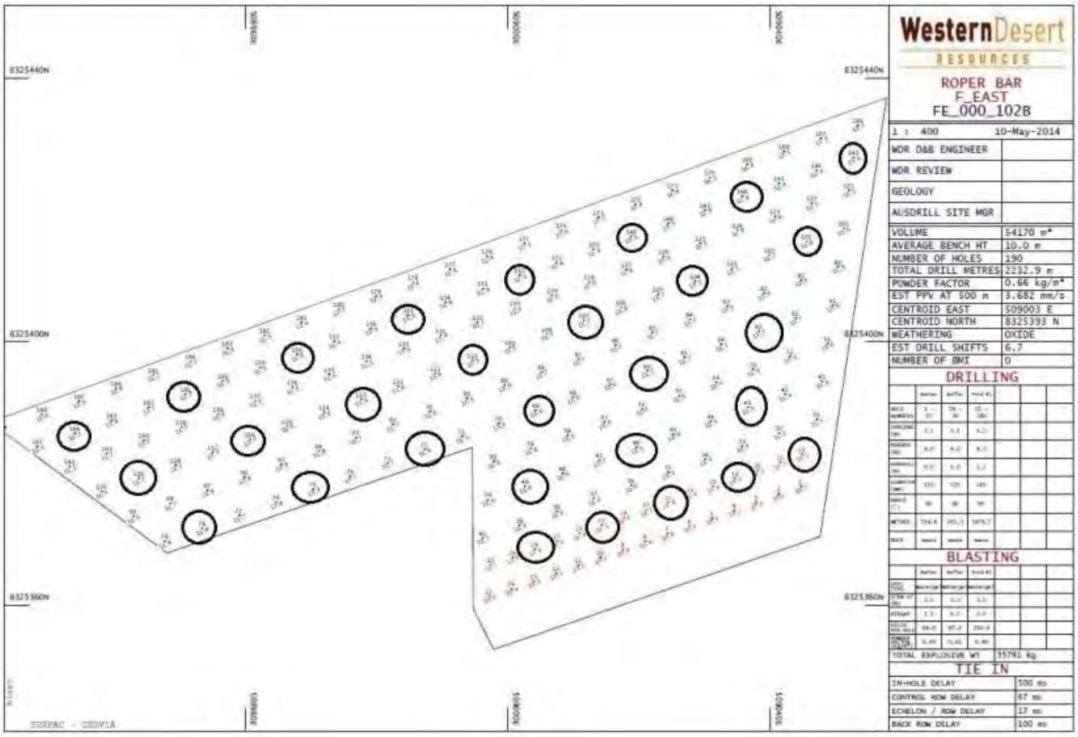


Figure 1: Blast pattern map showing coverage of collected waste samples from drill spoils.

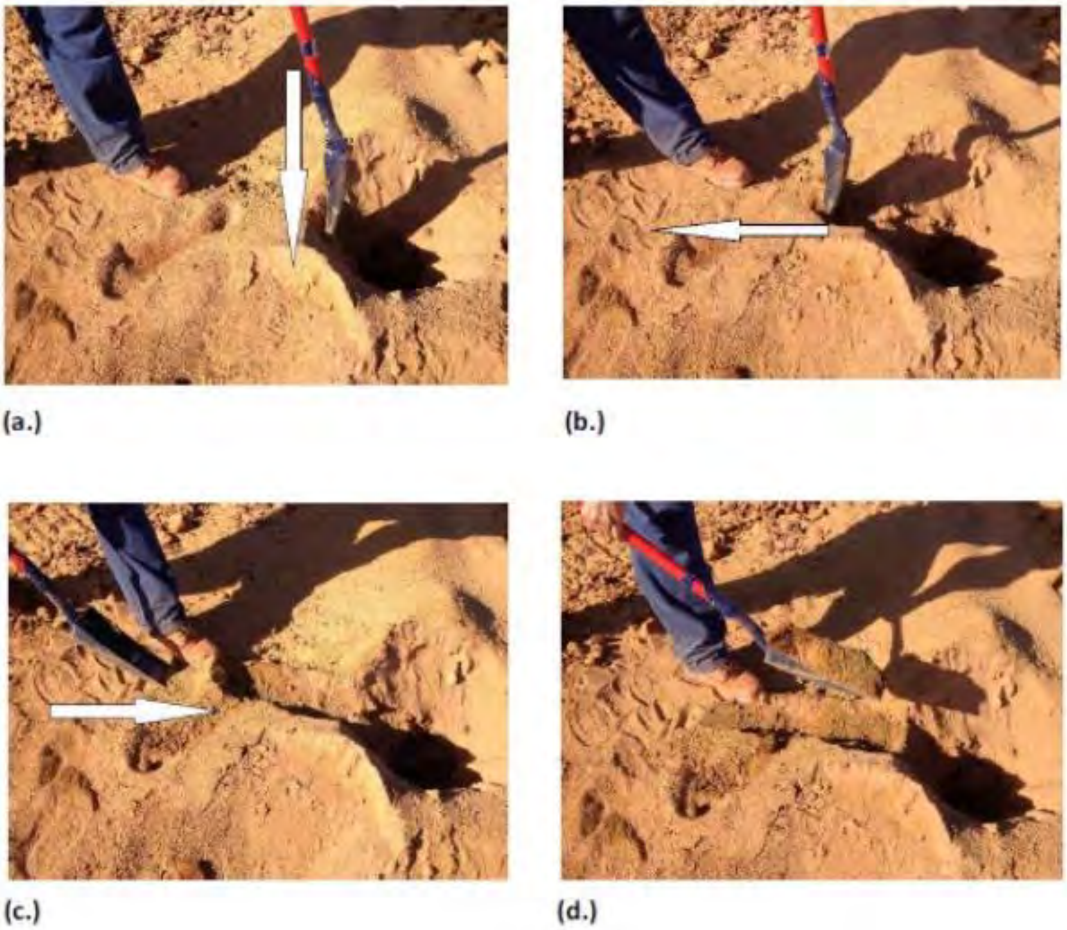
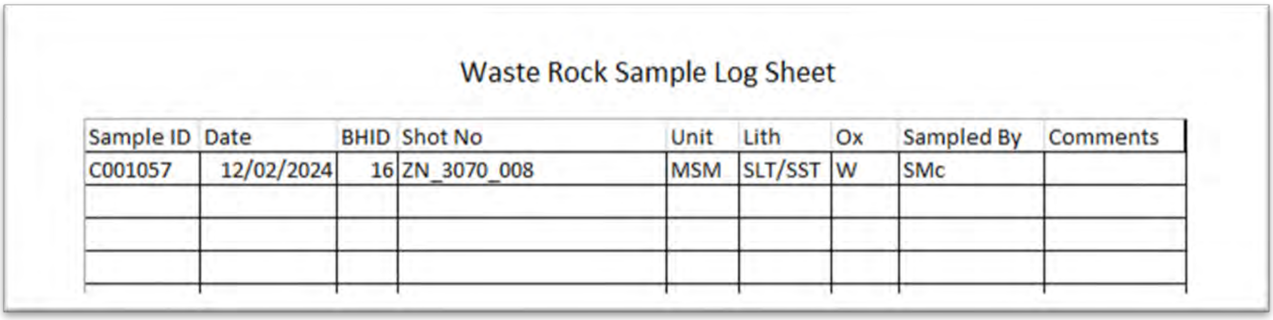


Figure 2: Blast hole spoils collection procedure.



Waste Rock Sample Log Sheet

Sample ID	Date	BHID	Shot No	Unit	Lith	Ox	Sampled By	Comments
C001057	12/02/2024	16	ZN_3070_008	MSM	SLT/SST	W	SMc	

Figure 3: Waste Rock Sample Log Sheet

- Once the requisite data has been entered for the Sample Sheet, and the data entered onto the server, samples are to sent off site for analysis.
- Approximately 10-15 samples per month are required for full environmental and geochemical test work at an offsite laboratory.
- Ensure the on-site lab sets aside ~1kg of these designated pulps to store in a dry secure location for monthly submission.
- Full geological information from these waste samples (including lithology and mineral abundance) needs to be recorded for ongoing waste characterisation studies.
- At the end of each calendar month the designated waste rock samples are to be sent to the off-site laboratory for acid-base accounting (ABA) testing and full geochemical analysis.

5.1 Data Processing and Intepretation

Polygons need to be generated for areas identified as > 0.3 % S (PAF) by the block model. This step is included in the procedure for creating ore blocks. These are saved and communicated to Mining/Engineering/Survey for mark out and incorporation into the mining plan.

PAF material should be mined preferentially if possible. The hanging wall waste, which may include PAF, is always mined first and prior to the mining of ore.

Results from offsite quality assurance samples must be reviewed by the mine geologists. If areas are identified that do not align with the model, further investigation and process review may be required.

5.2 Environmental Implications

No environmental implications.

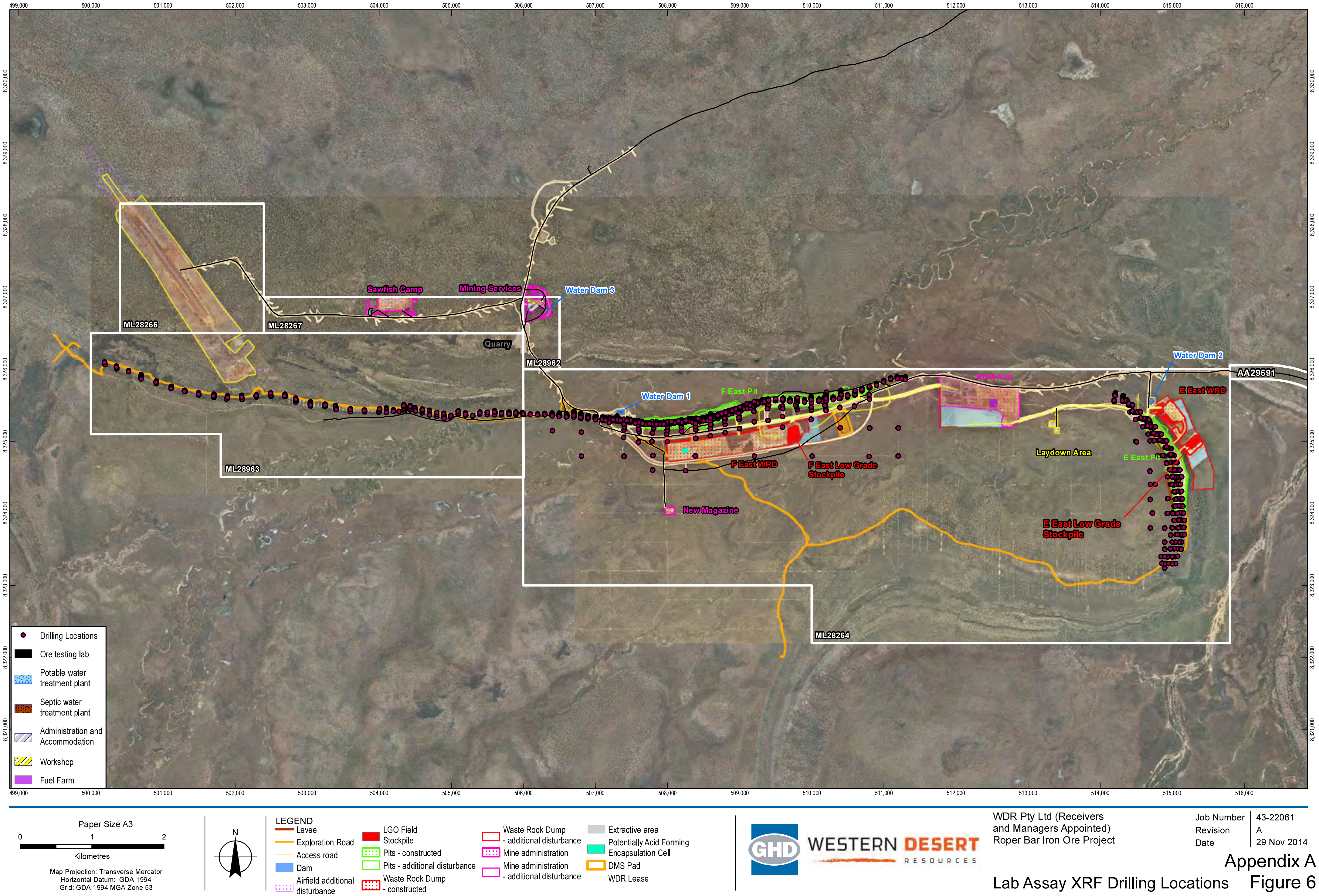
5.3 Health and Safety Implications

- This procedure is not to be completed on nightshift due to insufficient lighting. Dayshift only.
- Working on blast pattern, be careful and follow driller/shot firers’ instructions.
- No smoking, naked flames or metal implements permitted on loaded shot.
- Correct PPE to be worn where applicable. Hard Hat, ear plugs, safety glasses gloves etc.
- Complete a Take Five and assess potential risks prior to commencing task.

5.4 Legal Requirements

None

Appendix D: Danehill and Zabeel Block Models.



Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

WDR Pty Ltd (Receivers
and Managers Appointed)
Roper Bar Iron Ore Project

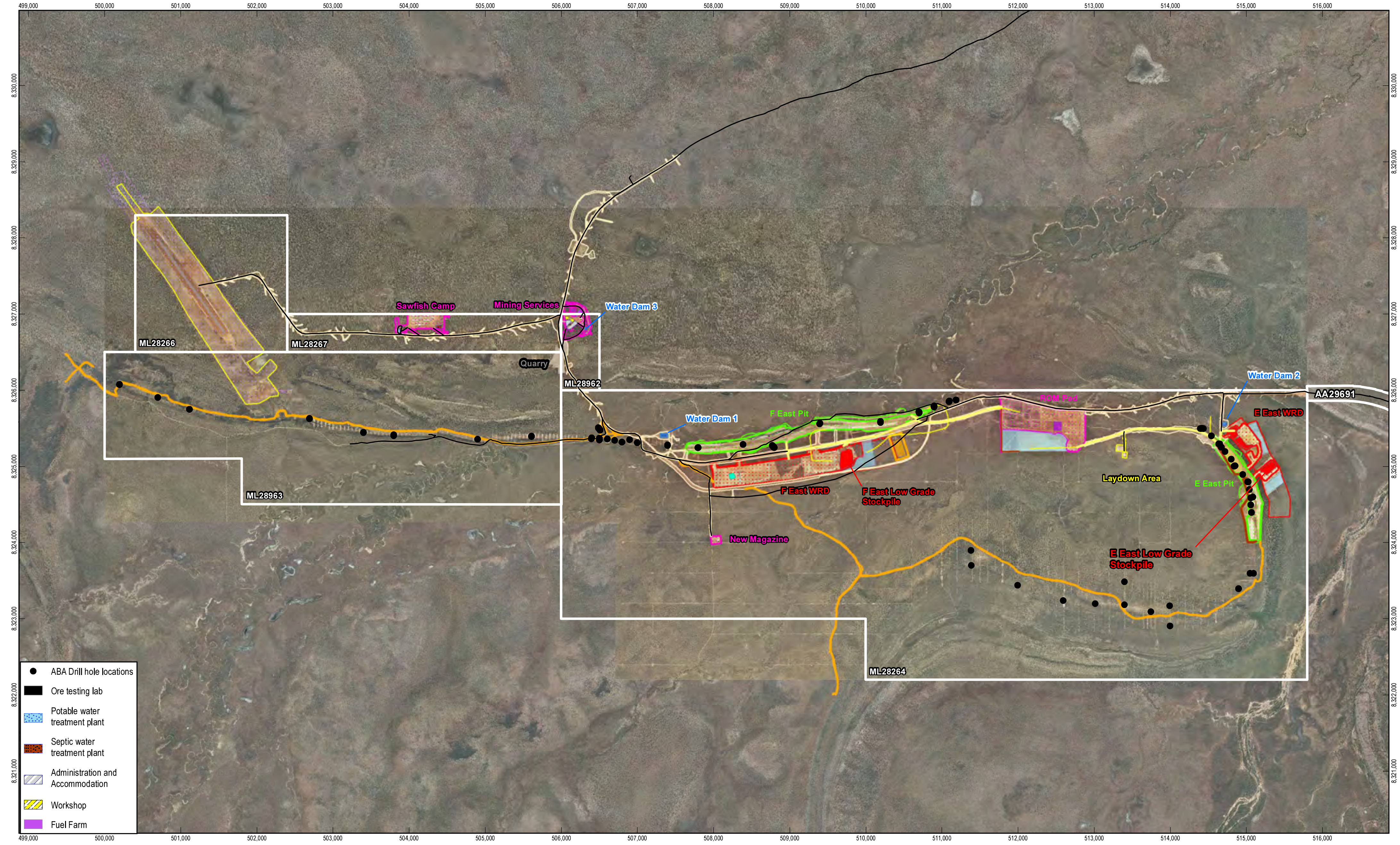
Job Number	43-22061
Revision	A
Date	29 Nov 2014

Appendix A
Lab Assay XRF Drilling Locations Figure 6

G:\43\22061\GIS\Maps\MXD\43_22270_059_rev_a1.mxd

145 Ann Street Brisbane QLD 4000 Australia **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

Data source: GHD: Digitised Infrastructure, Drilling Locations (2014); Western Desert Mining: Infrastructure Layout, Imagery (2014)



Paper Size A3

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

LEGEND

- Levee
- Exploration Road
- Access road
- Dam
- Airfield additional disturbance
- LGO Field Stockpile
- Pits - constructed
- Pits - additional disturbance
- Waste Rock Dump - constructed
- Waste Rock Dump - additional disturbance
- Mine administration
- Mine administration - additional disturbance
- Extractive area
- Potentially Acid Forming Encapsulation Cell
- DMS Pad
- WDR Lease

GHD WESTERN DESERT RESOURCES

WDR Pty Ltd (Receivers and Managers Appointed)
Roper Bar Iron Ore Project

ABA Drill Hole Locations

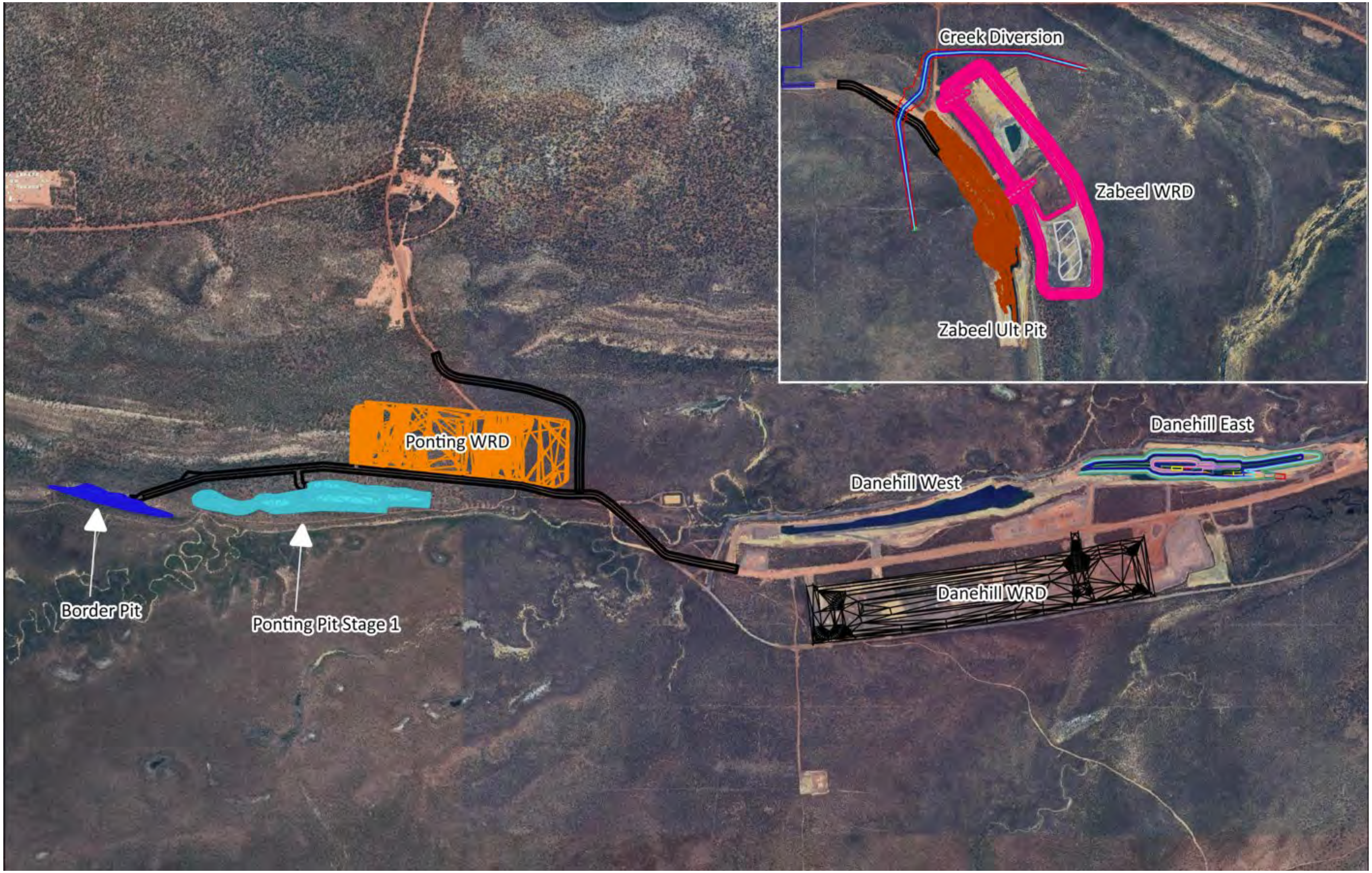
Job Number	43-22061
Revision	A
Date	29 Nov 2014

Appendix A
Figure 7

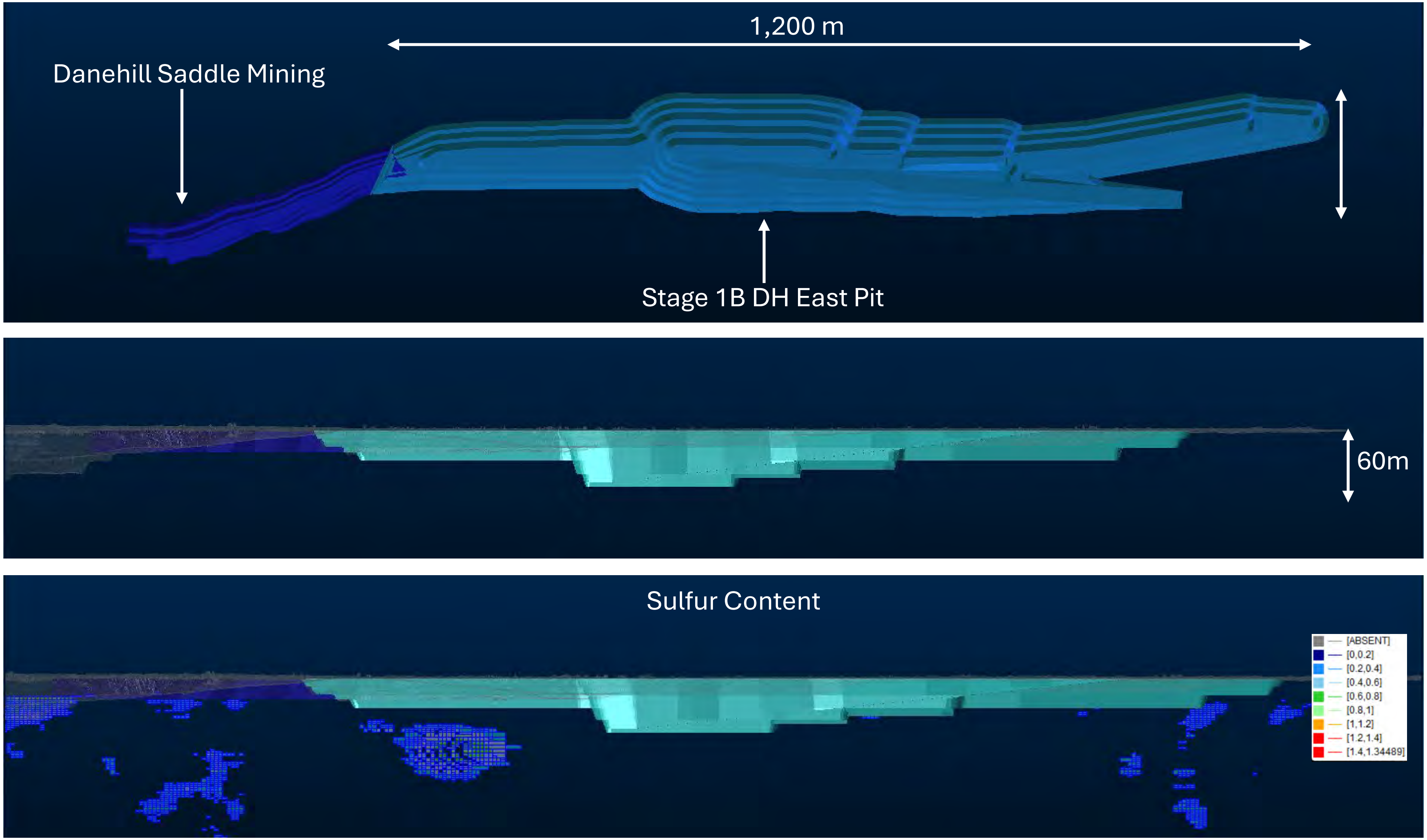
G:\43\22061\GIS\Maps\MXD\43_22270_060_rev_a1.mxd

Data source: GHD: Digitised Infrastructure, Drilling Locations (2014); Western Desert Mining: Infrastructure Layout, Imagery (2014)

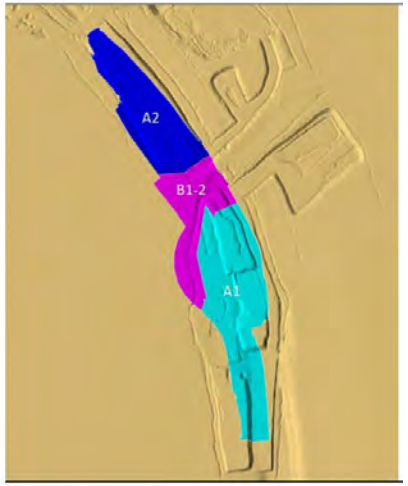
2024 Mine Management Plan Layouts and Block Models



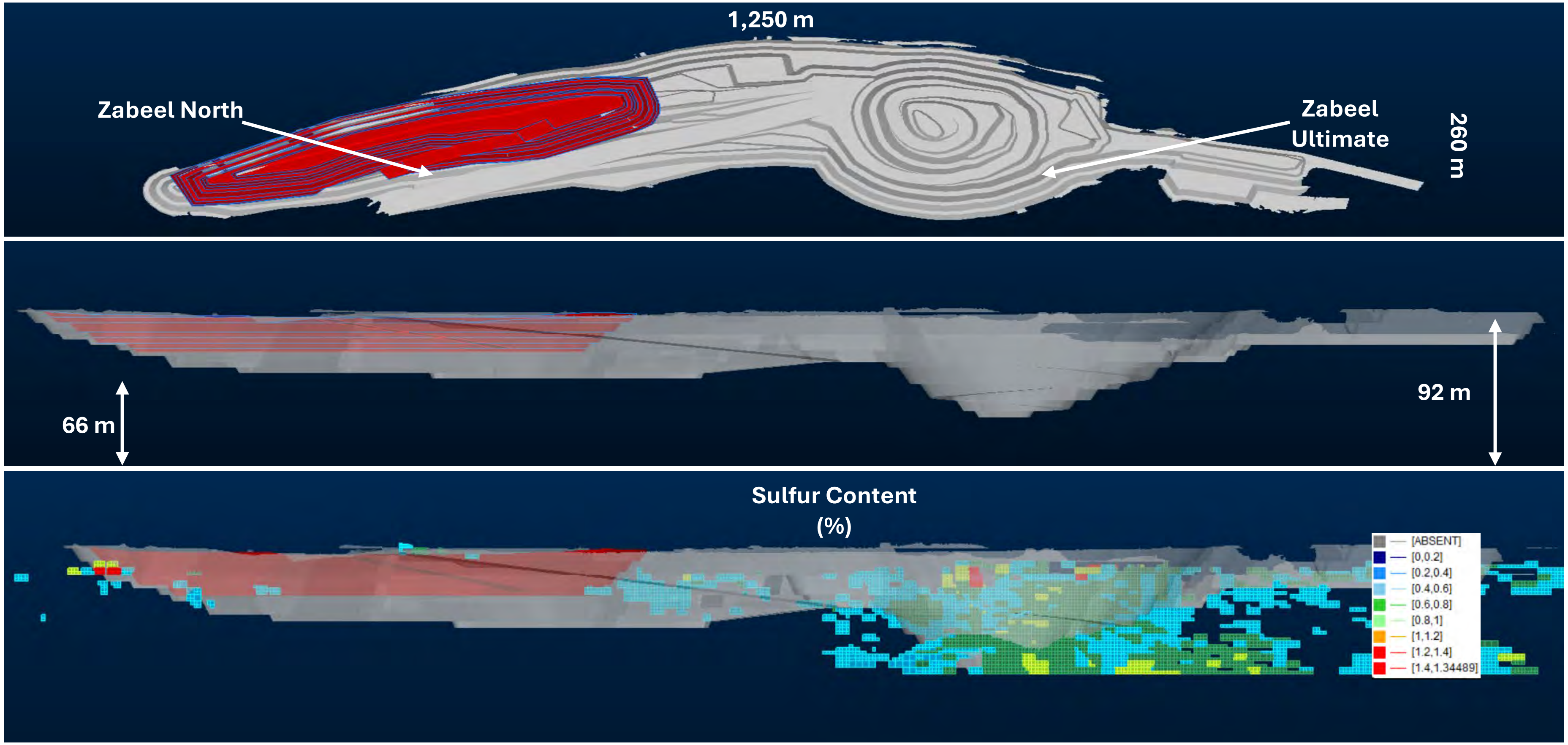
NRP Overarching Site Layout.



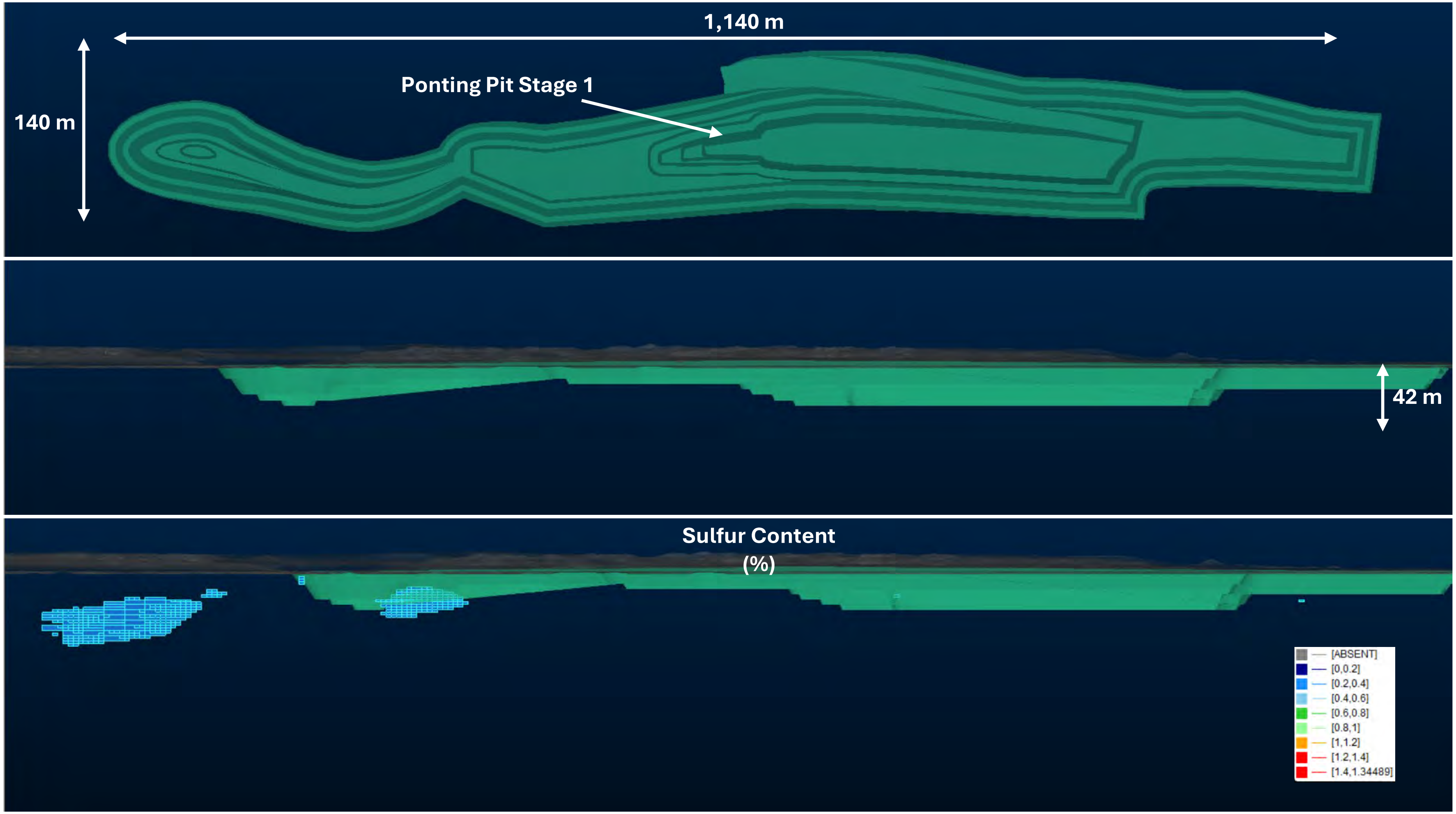
Danehill East Pit Design for Stage 1B



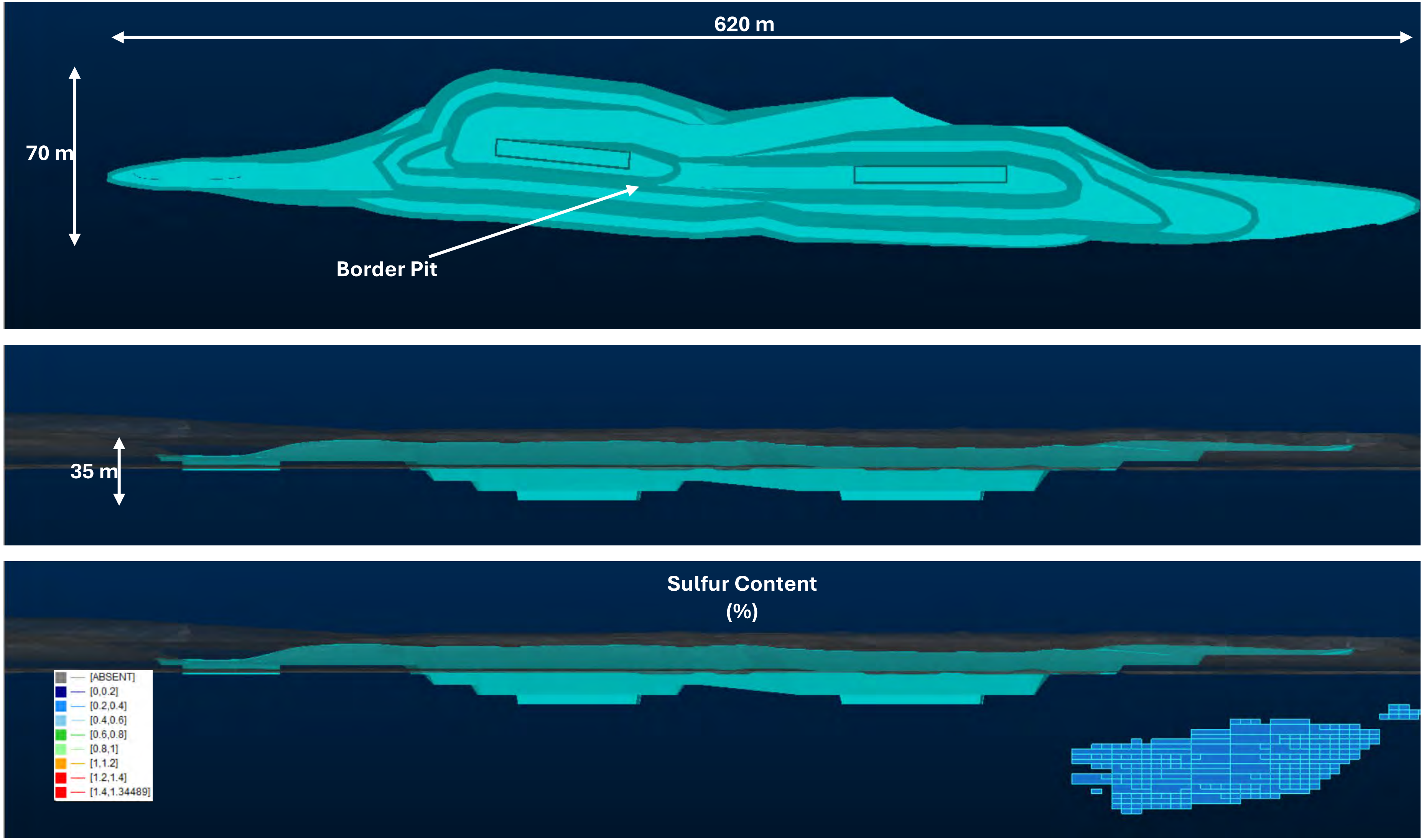
Zabeel Ultimate Pit Scheduling



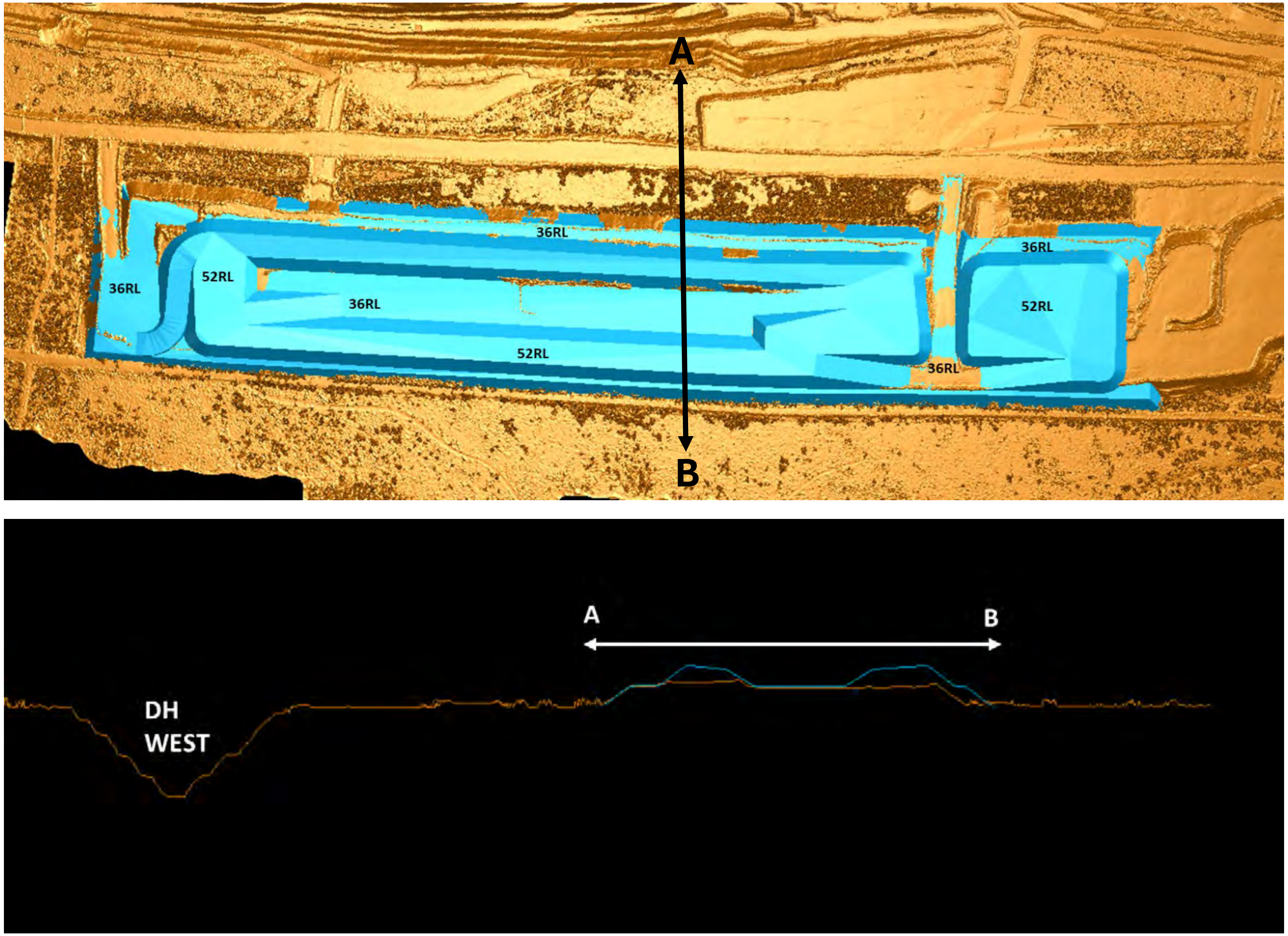
Zabeel Ultimate Pit Design



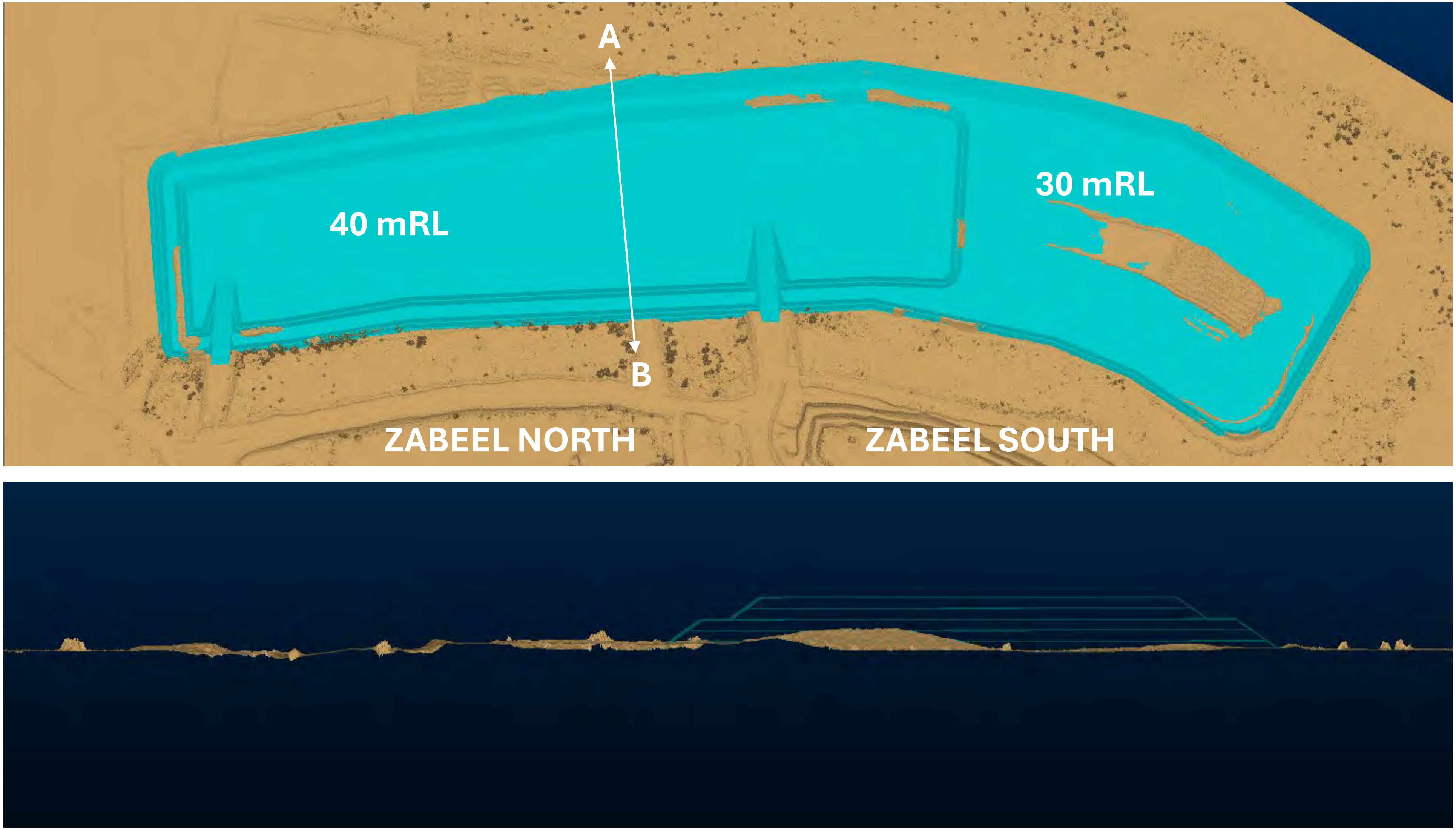
Ponting Pit Stage 1 Design



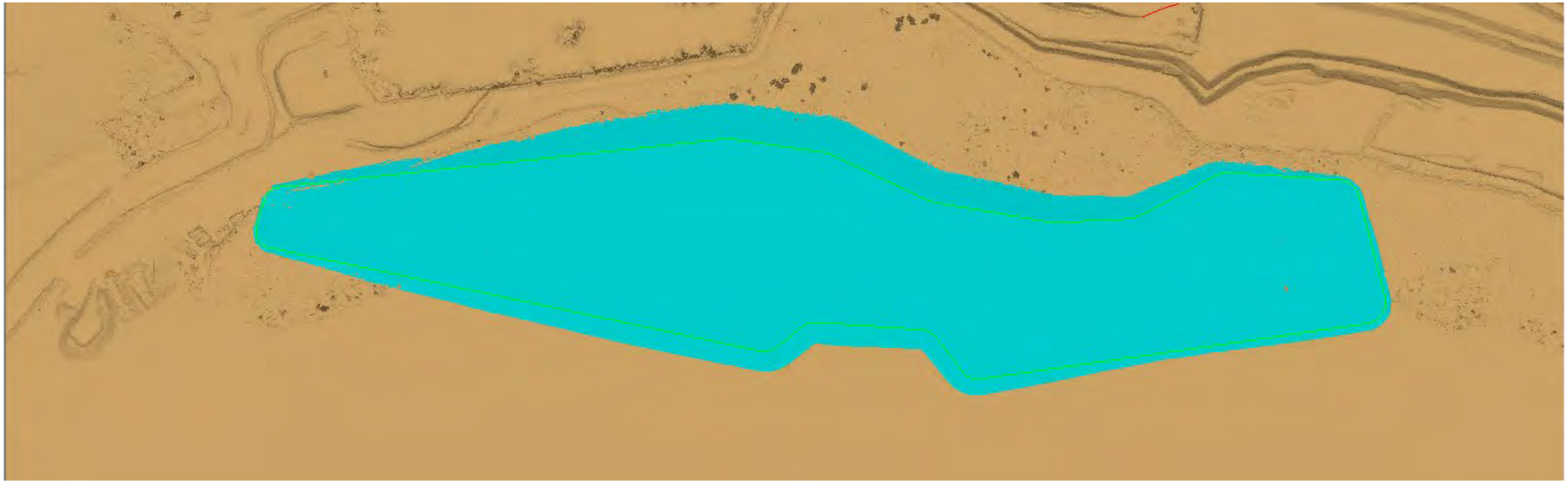
Border Pit Design

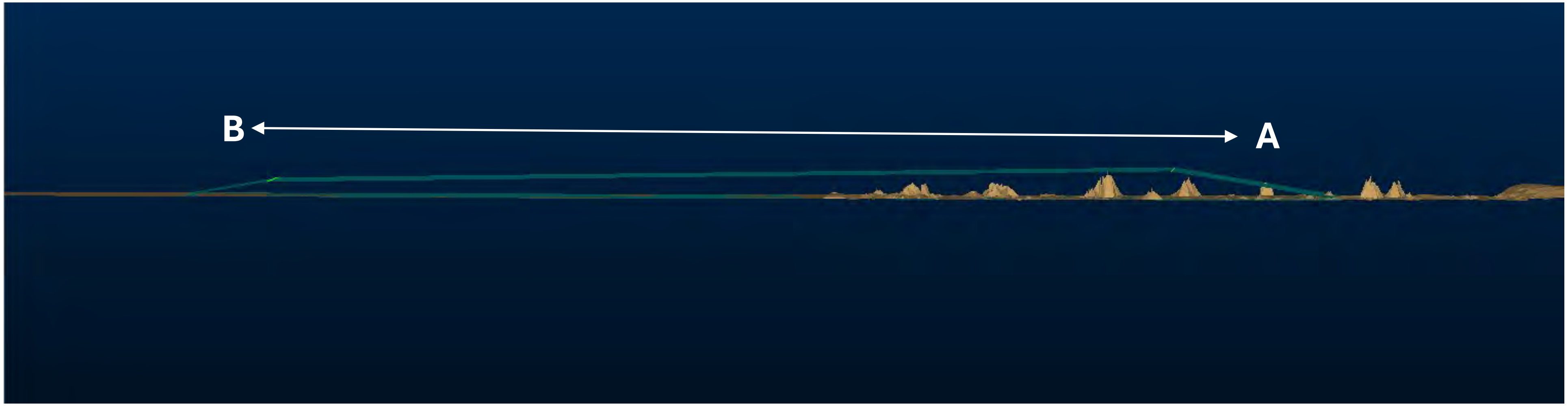


Danehill WRD Design



Zabeel WRD Design





Zabeel West WRD Design

Appendix C – Geochemical Model Output

F West Pits 1 – 4 – Final

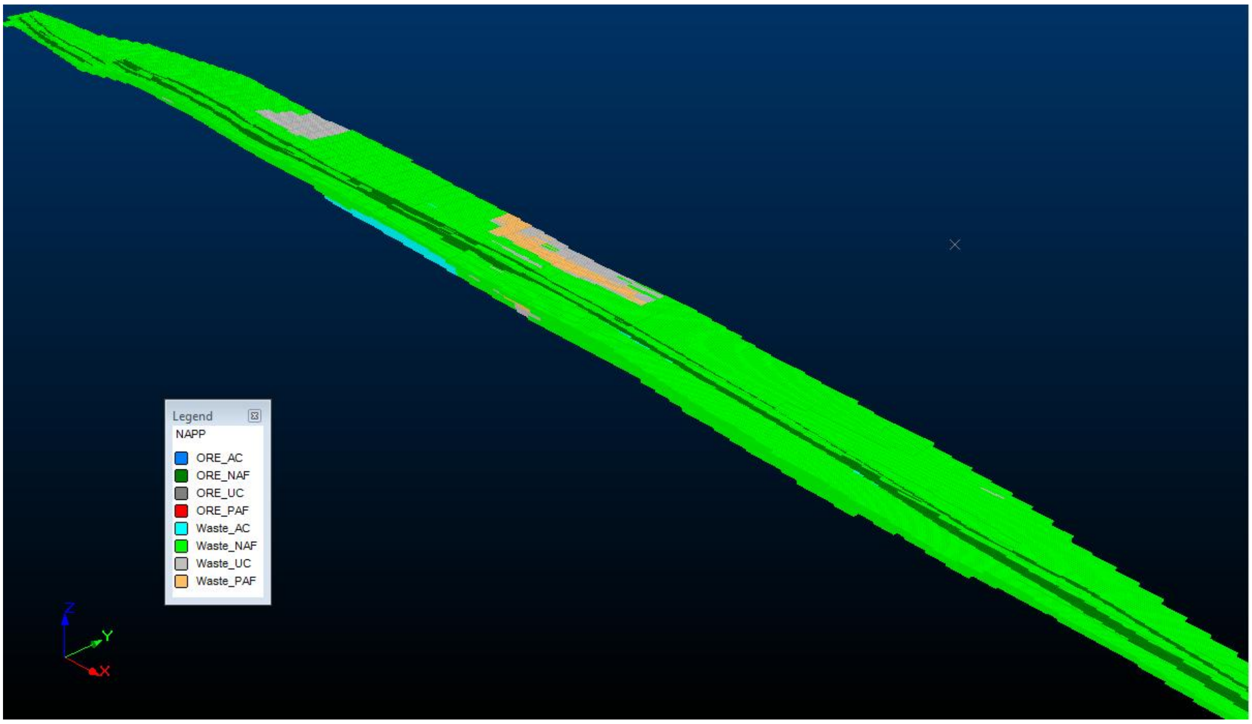


Figure 1 F West 1 Pit looking NW – classified using NAPP values. Perspective view.

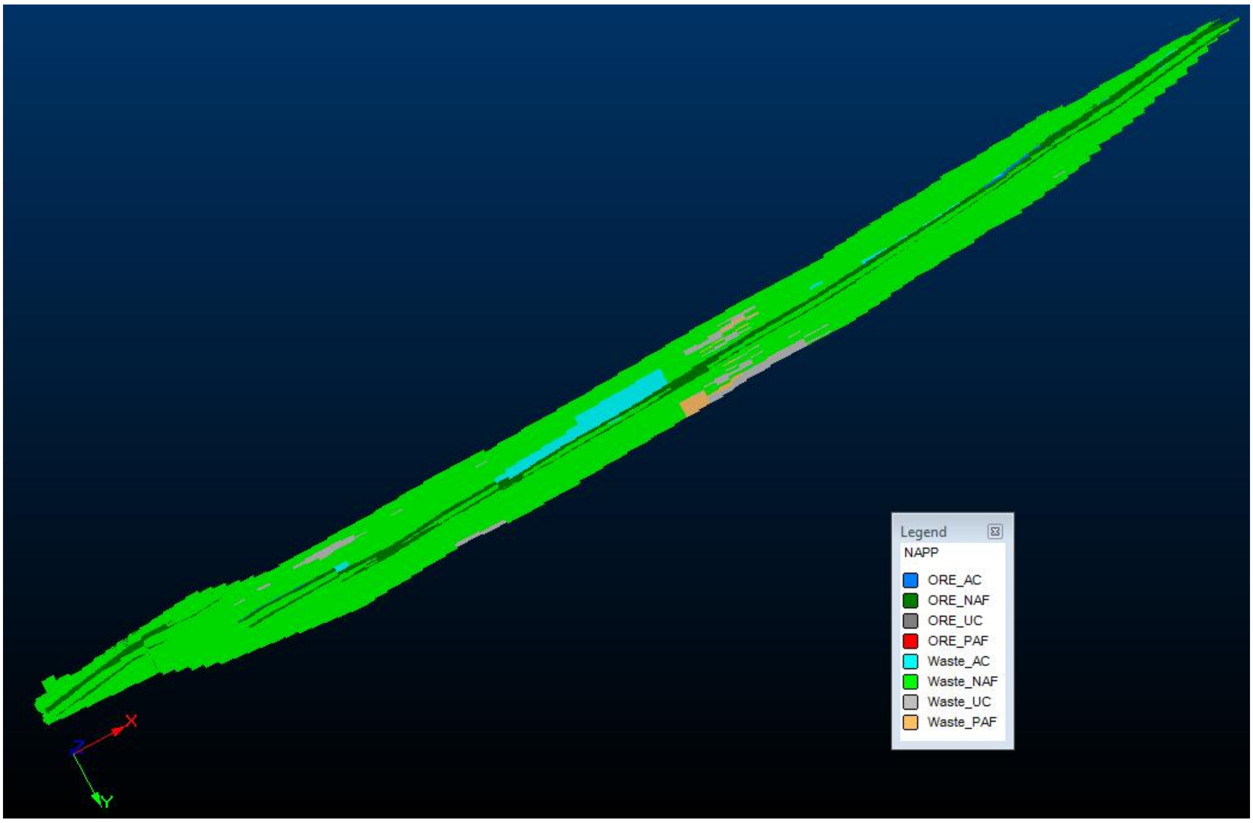


Figure 2 F West 1 Pit looking SE – classified using NAPP values. View from beneath.

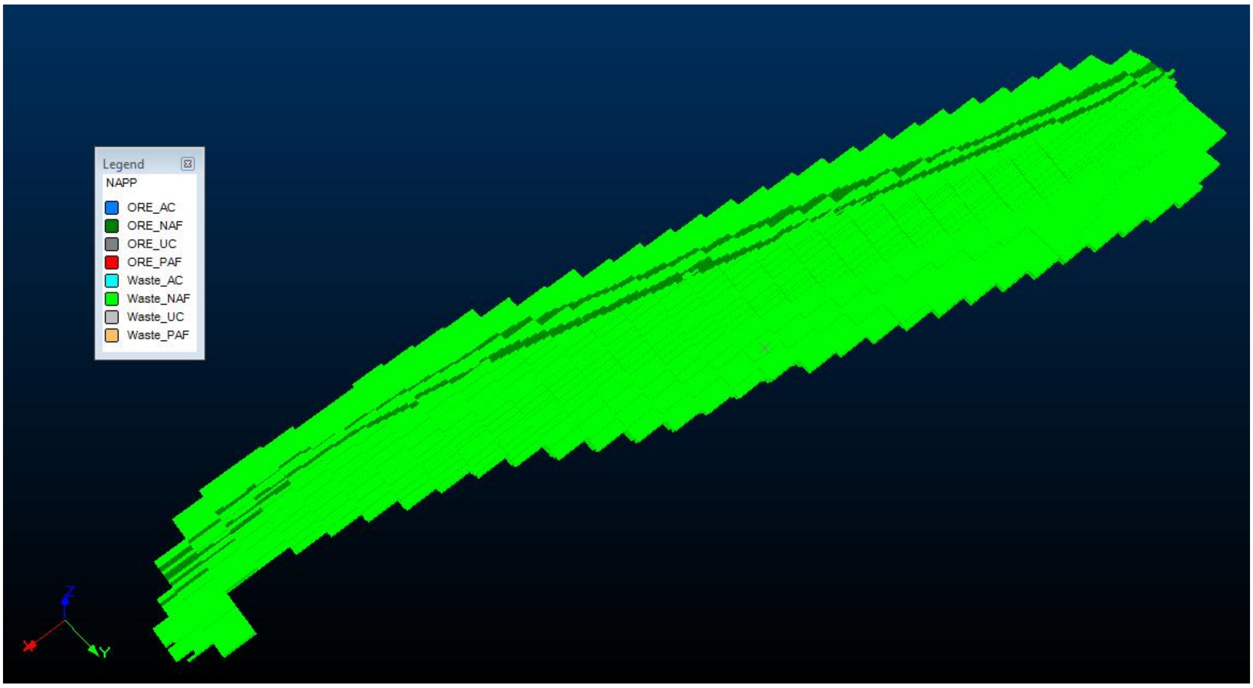


Figure 3 F West 2 Pit looking NW – classified using NAPP values. Perspective view.

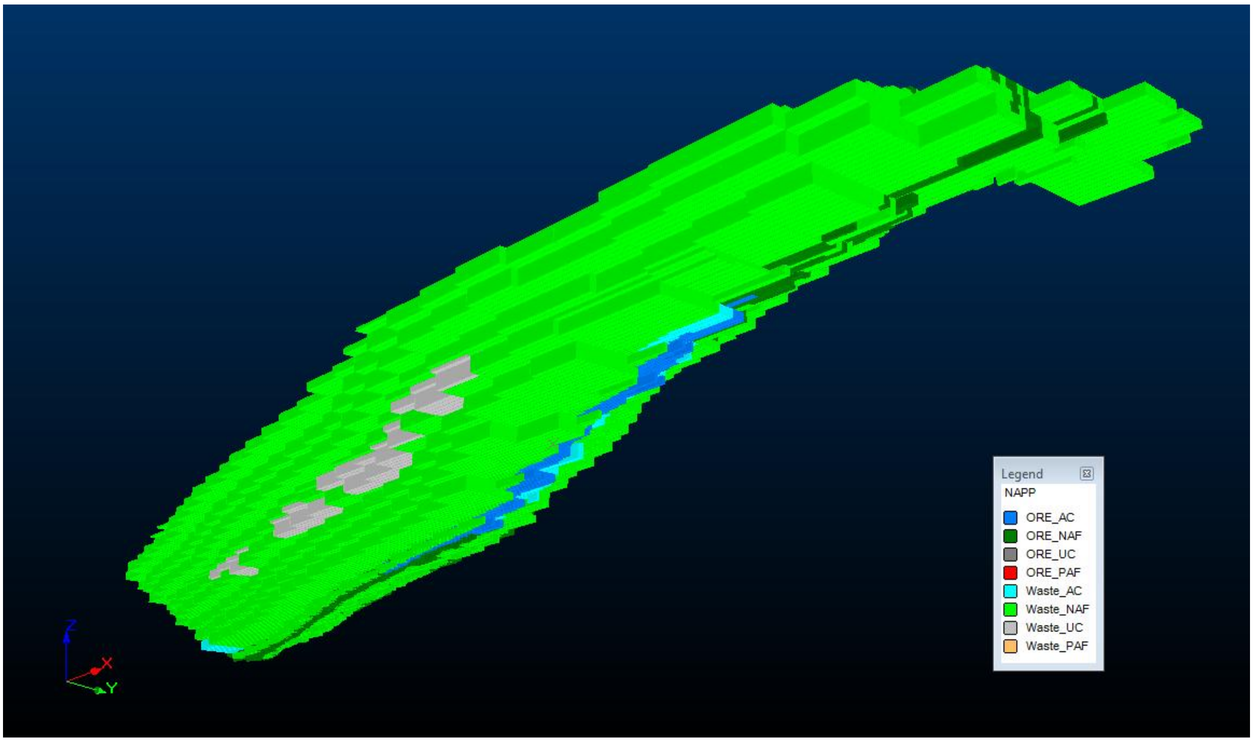


Figure 4 F West 2 Pit looking NW – classified using NAPP values. View from beneath.

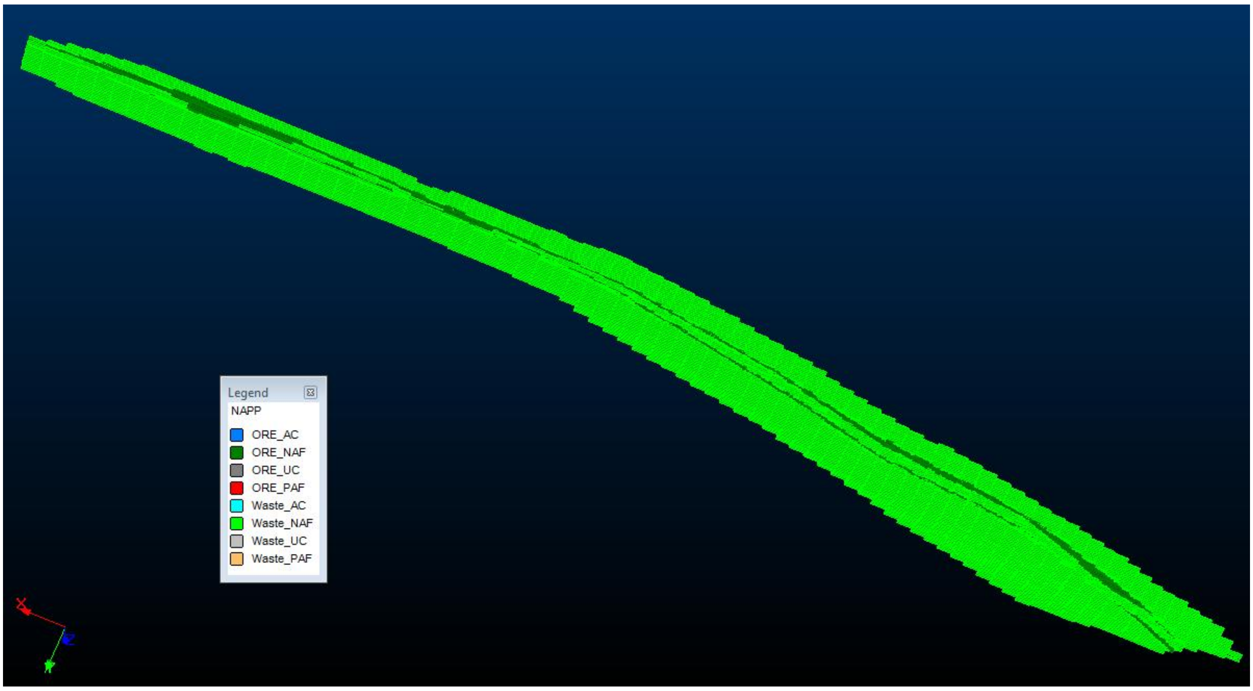


Figure 5 F West 3 Pit looking NW – classified using NAPP values. Perspective view.

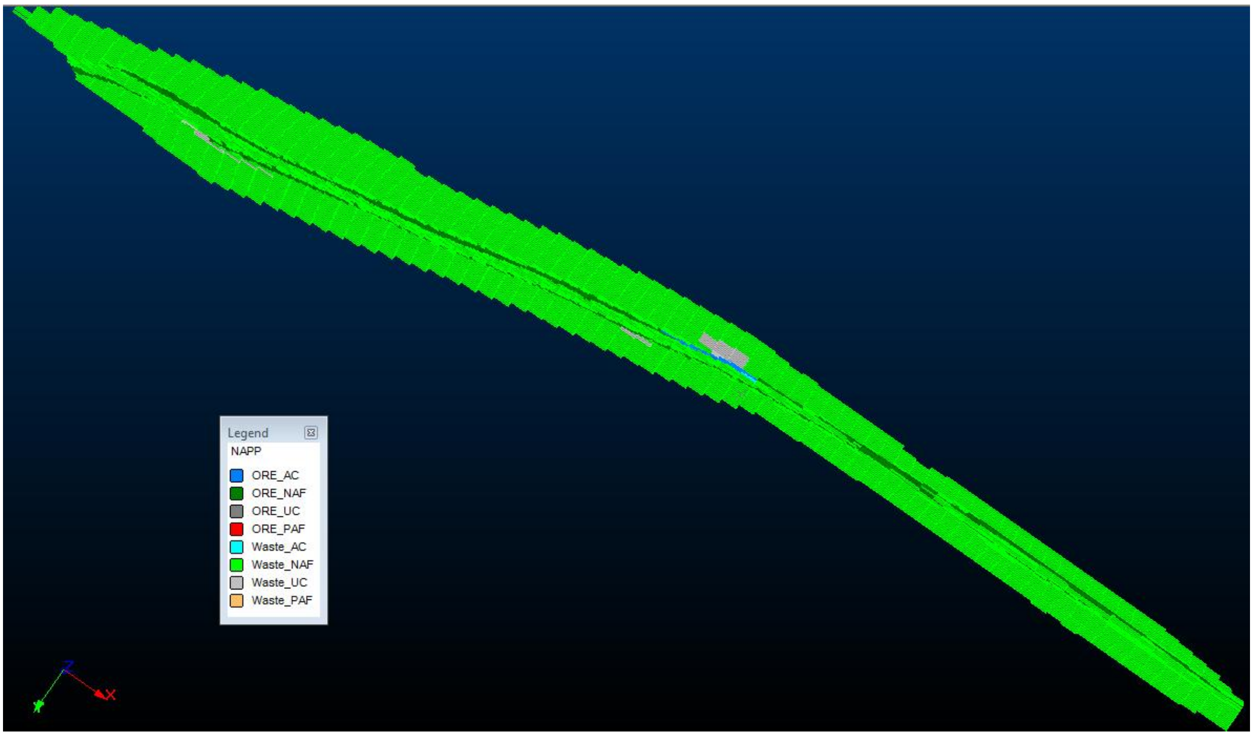


Figure 6 F West 3 Pit looking NW – classified using NAPP values. View from beneath.

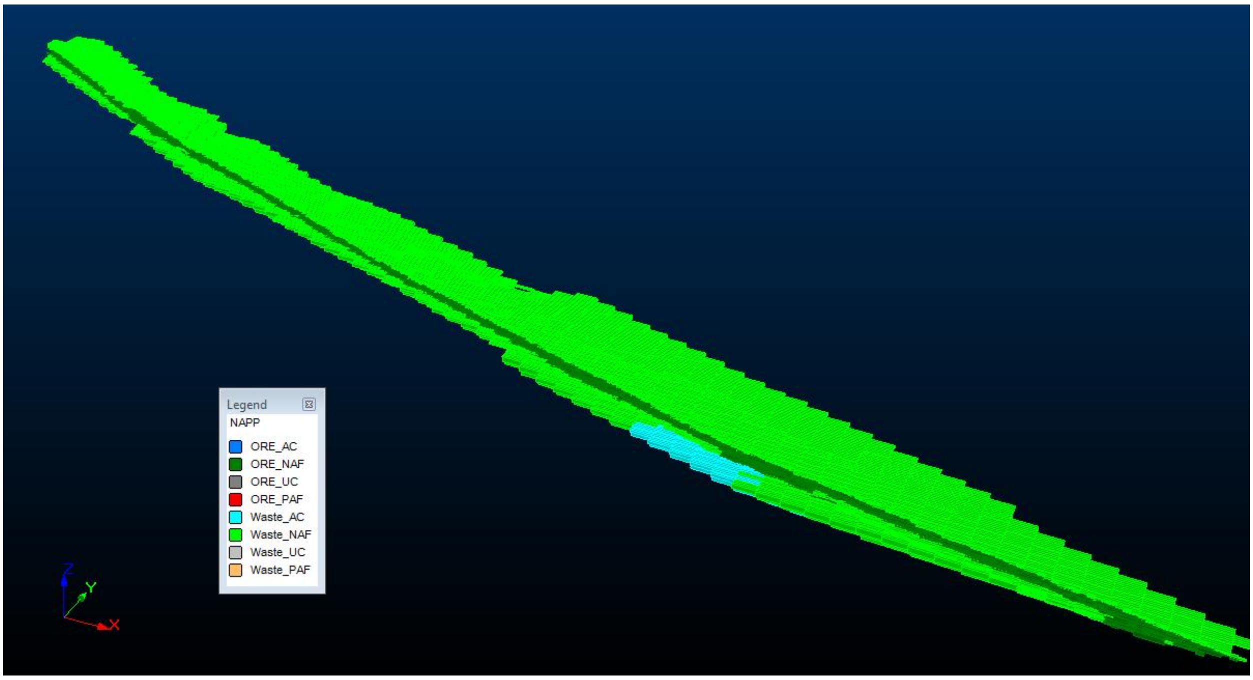


Figure 7 F West 4 Pit looking NNW – classified using NAPP values. Perspective view.

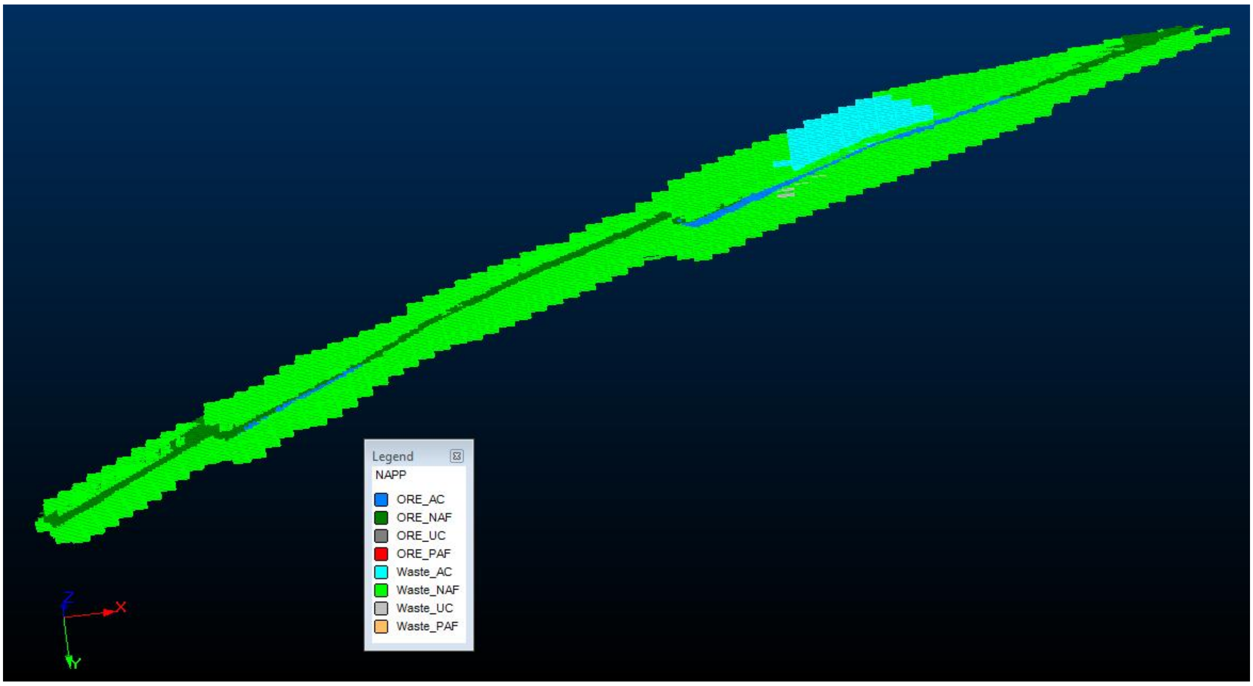


Figure 8 F West 4 Pit looking SE – classified using NAPP values. View from below.

F East Pit – Year 1

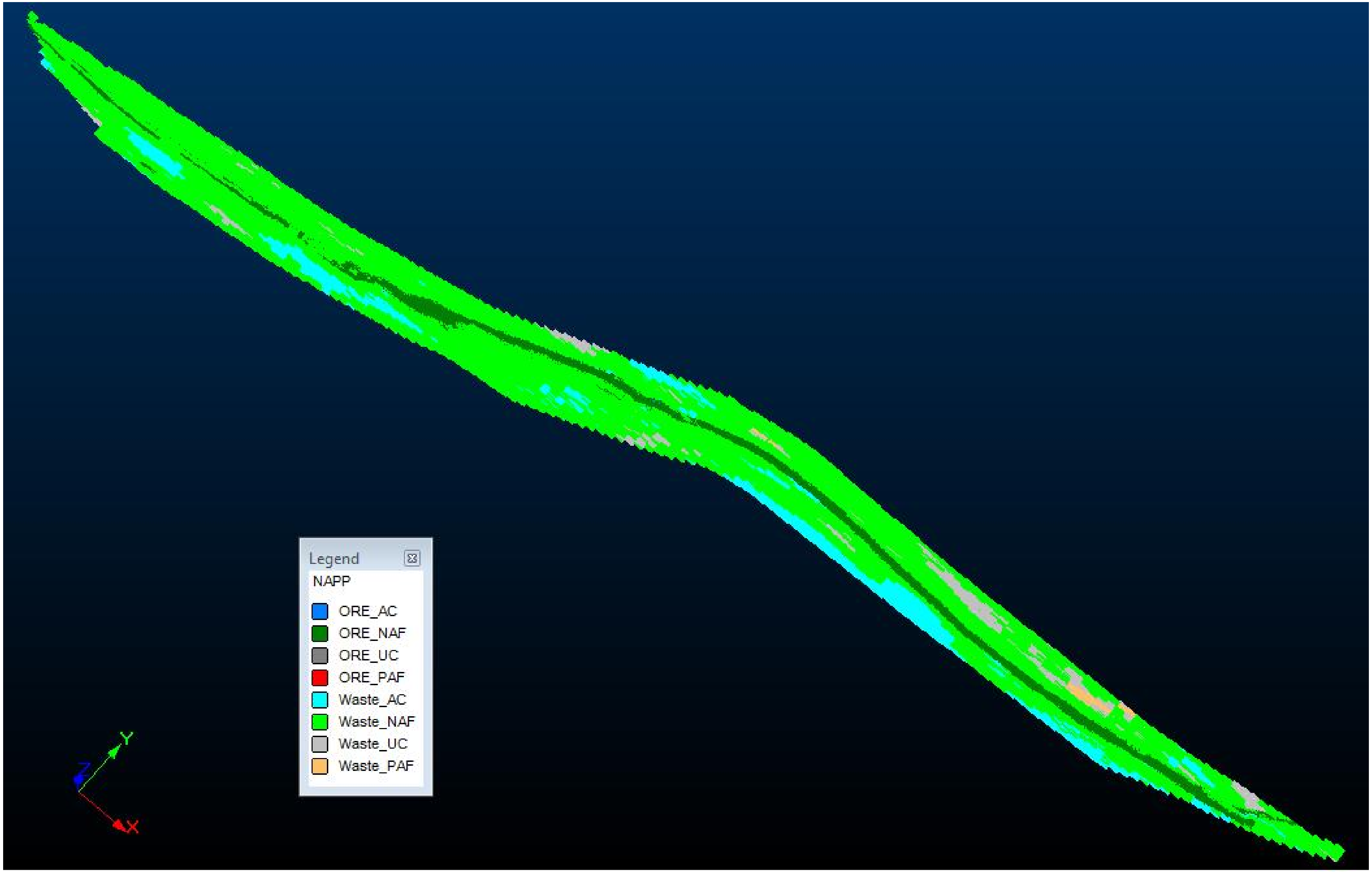


Figure 7 F East Year 1 Pit looking NW – classified using NAPP values. Perspective view.

F East Pit – Final

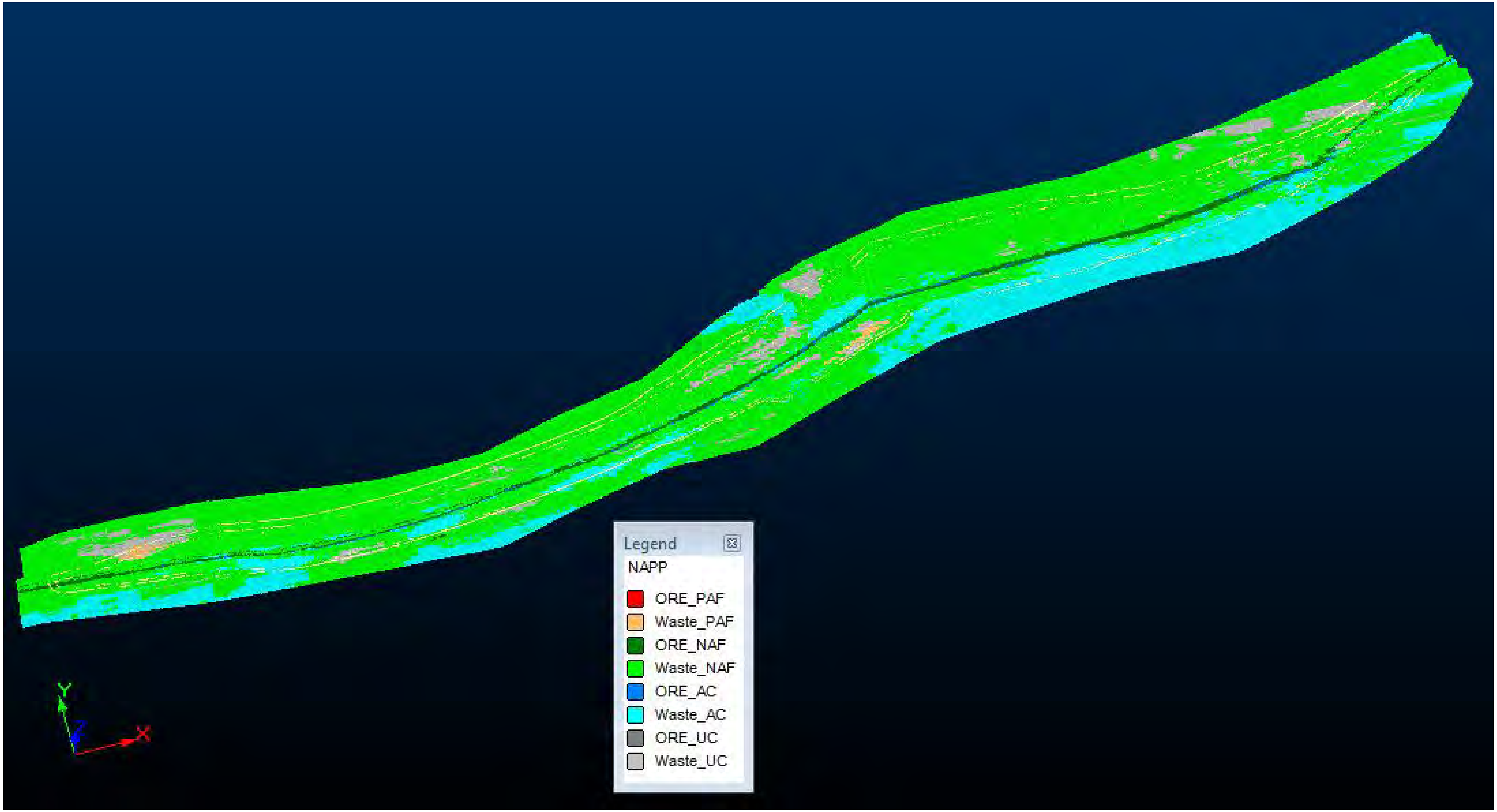


Figure 8 F East Final Pit Wall looking NE – classified using NAPP values. Perspective view.

E East Pit – Year 1

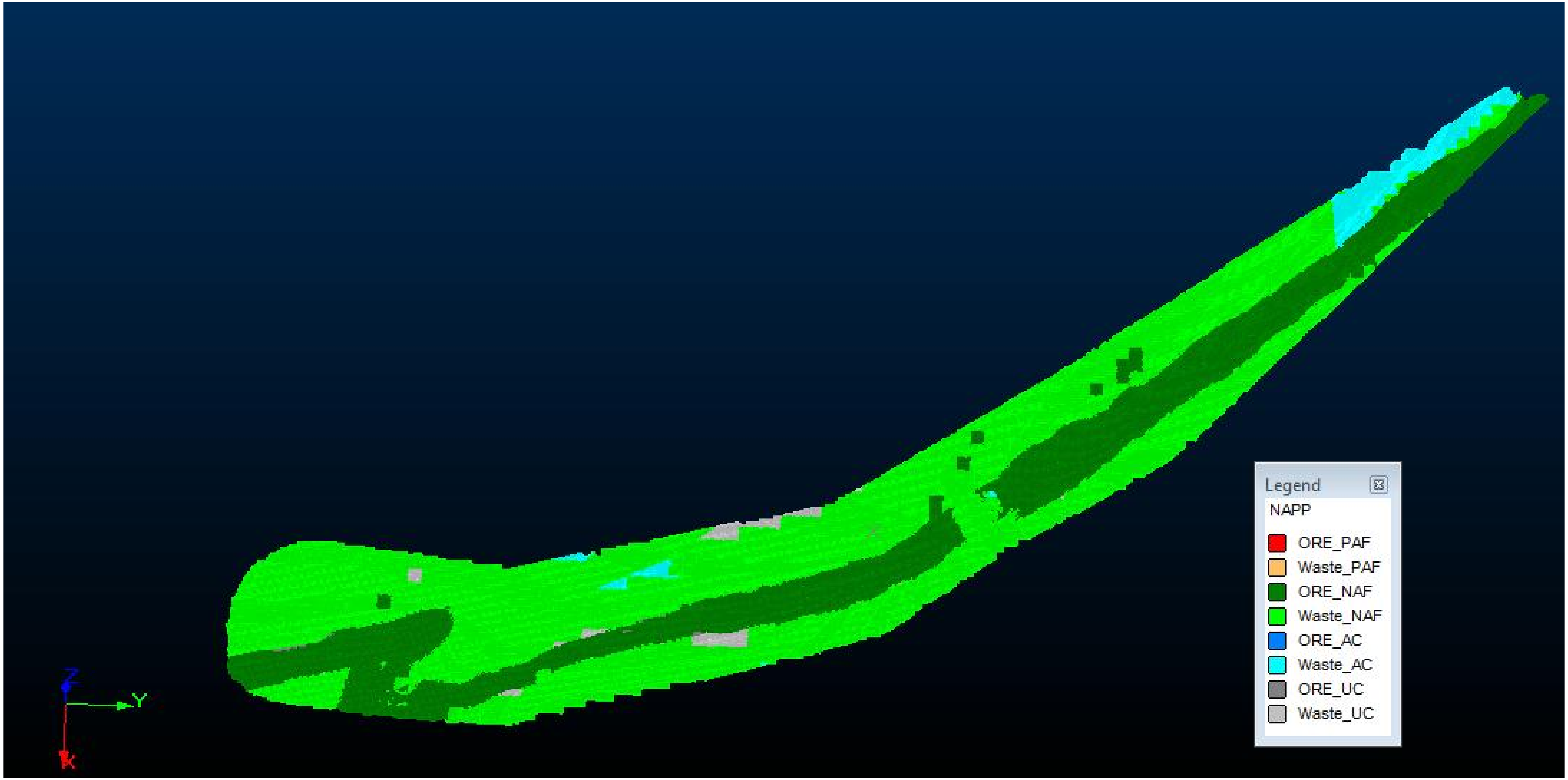


Figure 9 E East Pit Material Mined Year 1 looking from above – classified using NAPP values. Perspective view.

E East Pit – Year 1

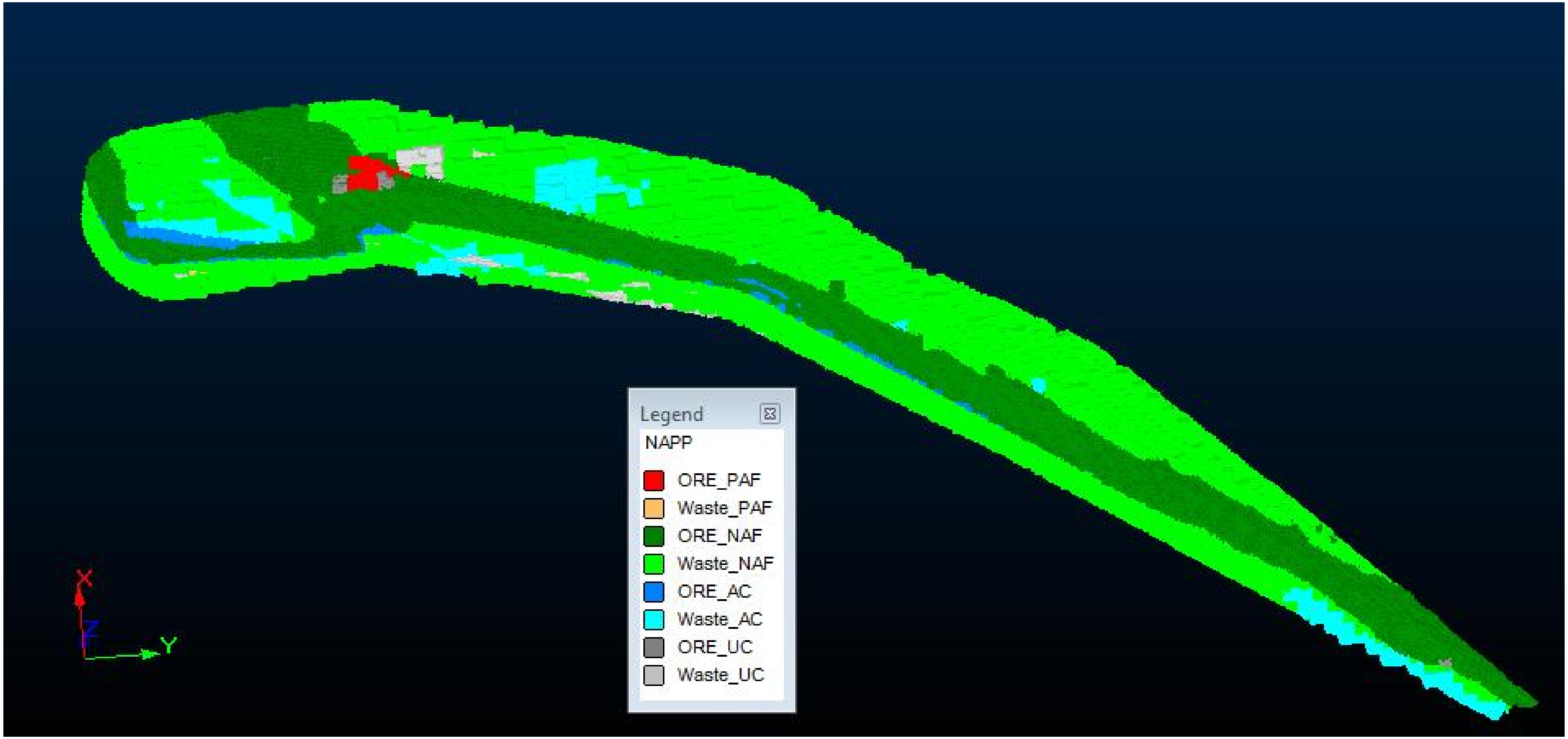


Figure 10 E East Pit Material Mined Year 1 looking from below – classified using NAPP values. Perspective view.

E East Pit – Final

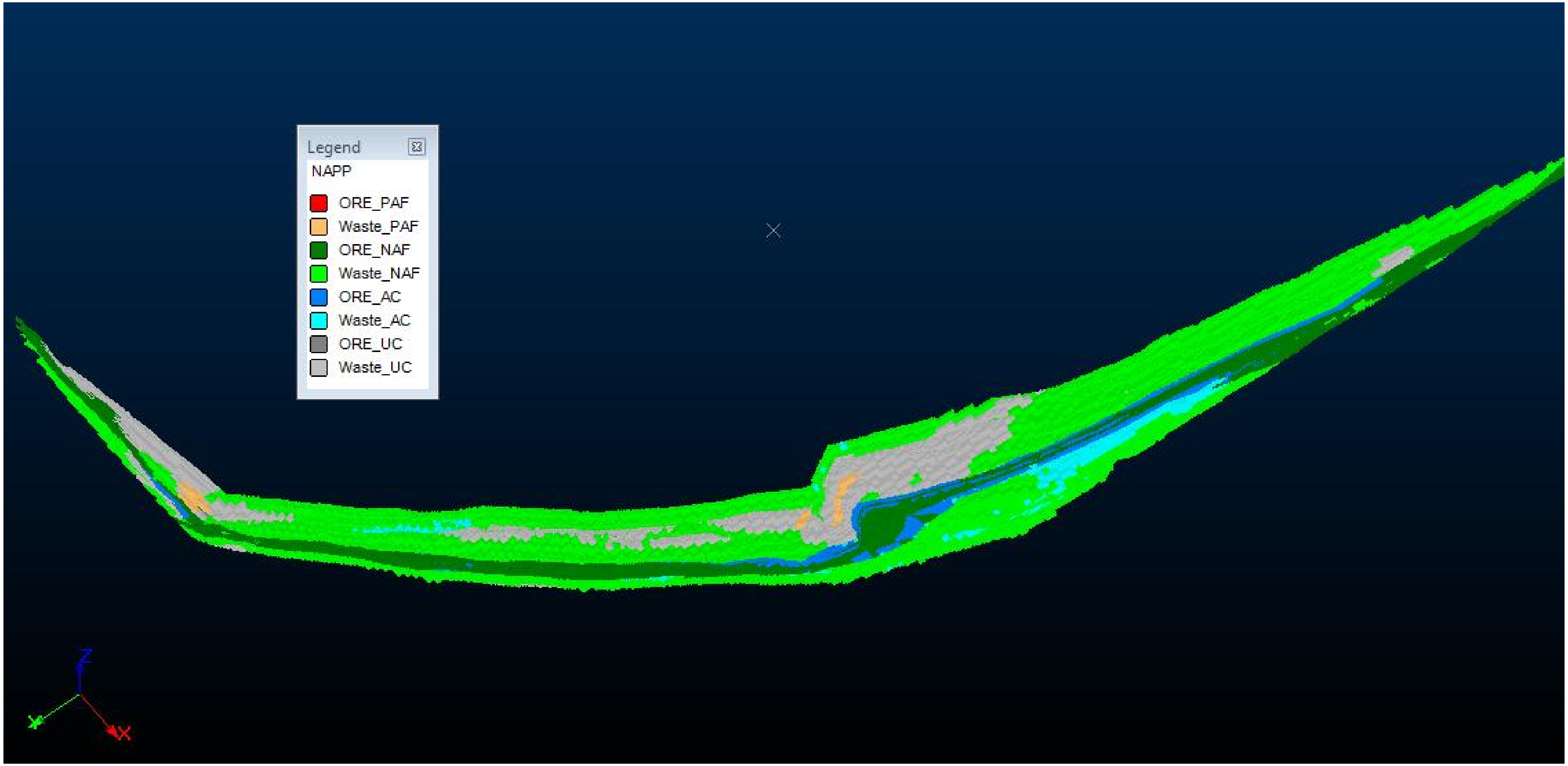


Figure 11 E East Final pit shell from beneath – classified using NAPP values. Perspective view looking NE

Appendix D – Geostatistics

GeoStatistics

Geochemical Model Validation

Grade block models were provided to GHD by WDR for the E East Pit and for the combined F-Pit Area (F East, F West 1 to 4). The block model contained estimates for total sulfur (%) and for CaO and MgO (%), as well as other elements used in metals assessments. The model grades were compared spatially against the laboratory assay XRF data and the Niton (handheld) XRF data, composited to 3 m lengths for total sulfur (%) only.

Generally; the laboratory assay XRF (LXRF) data is concentrated around the ore zones (SIM unit) and the Niton XRF (HXRF) data is from the waste zones (KYM and MSM units).

There is good spatial correlation between the two datasets and the respective block models, representative sections and plans are shown in the following sections (Figure 1 to Figure 13 inclusive).

E East pit Block Model Comparison – Total S (%)

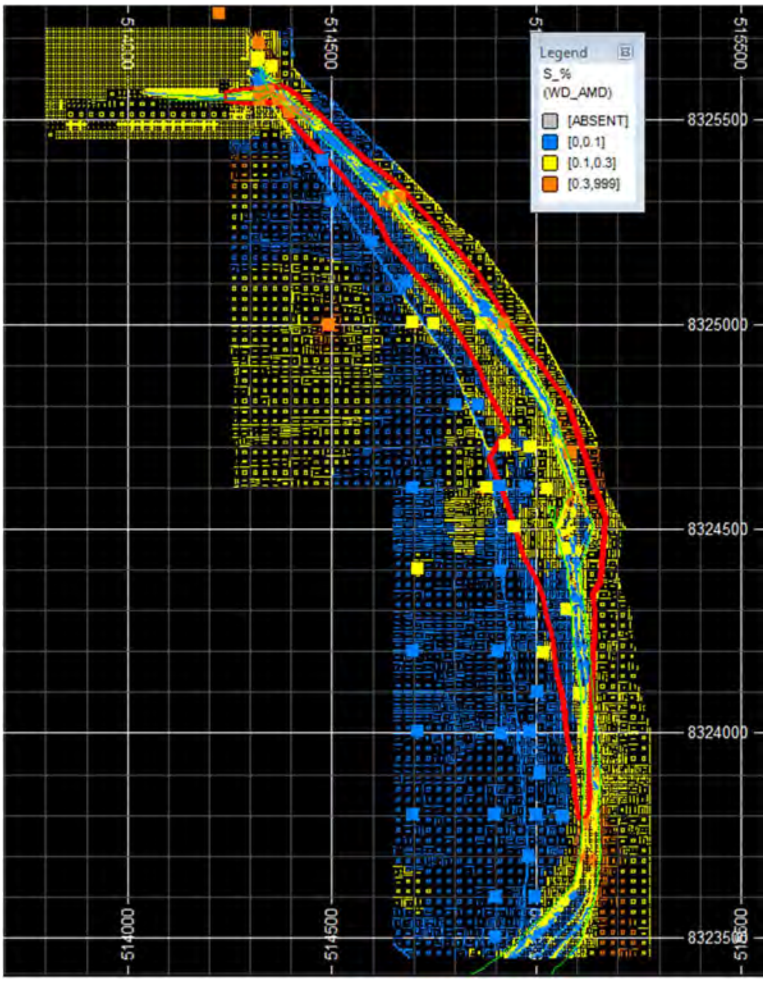


Figure 1 Plan View (0 mRL) – Block Model and HXRF data (large solid squares) coloured by Total S (%) – E East Final Pit Outline (Red)

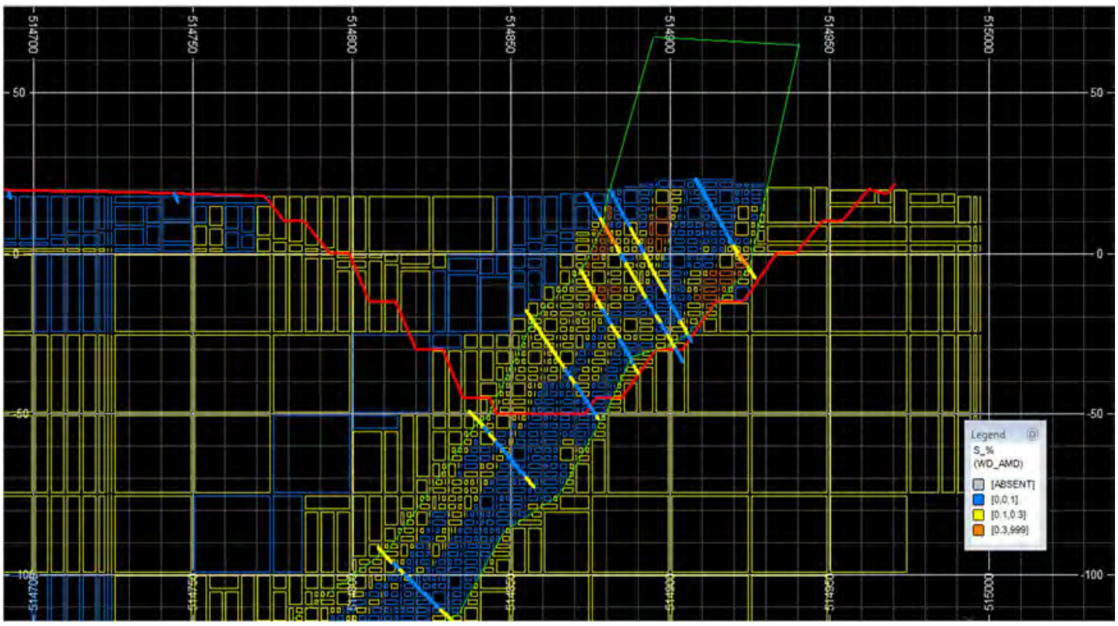


Figure 2 W-E Cross Section (8,325,000 mN) – Block Model and LXRF data (Drill Traces) coloured by Total S (%) – E East Final Pit Outline (Red), SIM Unit (green line).

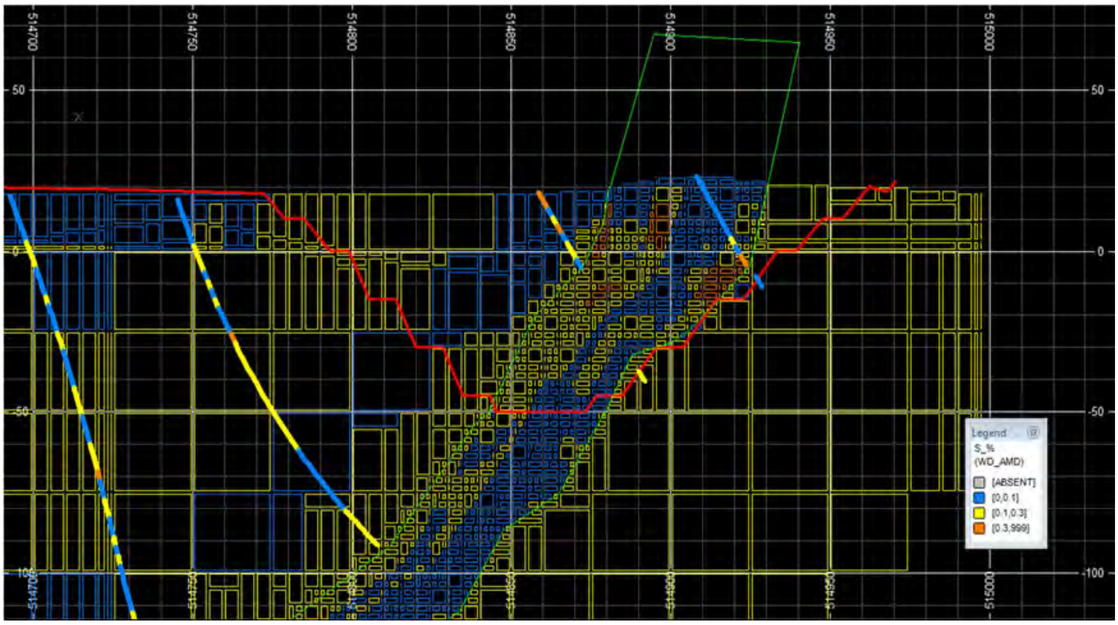


Figure 3 W-E Cross Section (8,325,000 mN) – Block Model and HXRF data (Drill Traces) coloured by Total S (%) – E East Final Pit Outline (Red), SIM Unit (green line).

F Pits (F East & F West 1 to 4) Block Model Comparison – Total S (%)

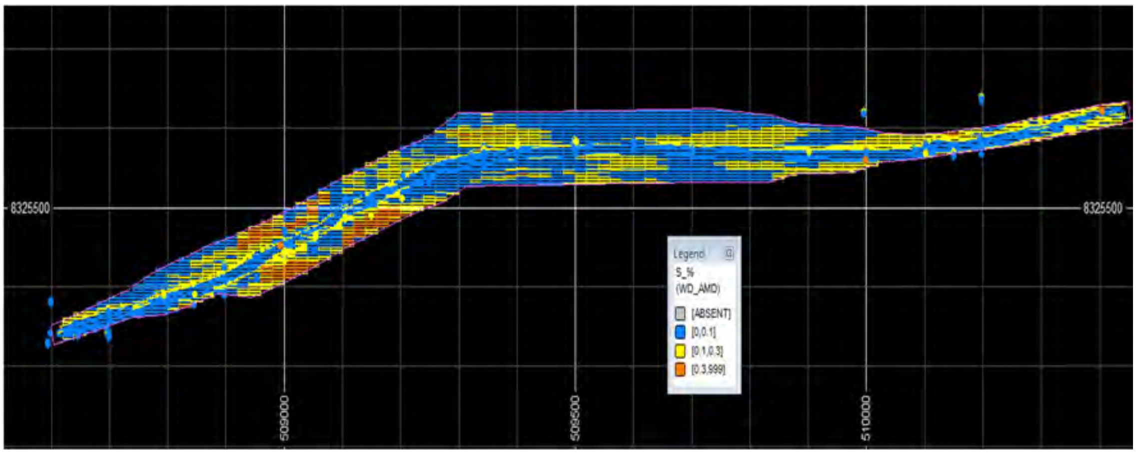


Figure 4 Plan View (-30 mRL) – Block Model and LXRF data (large solid dots) coloured by Total S (%) – F East Final Pit Outline (Purple)

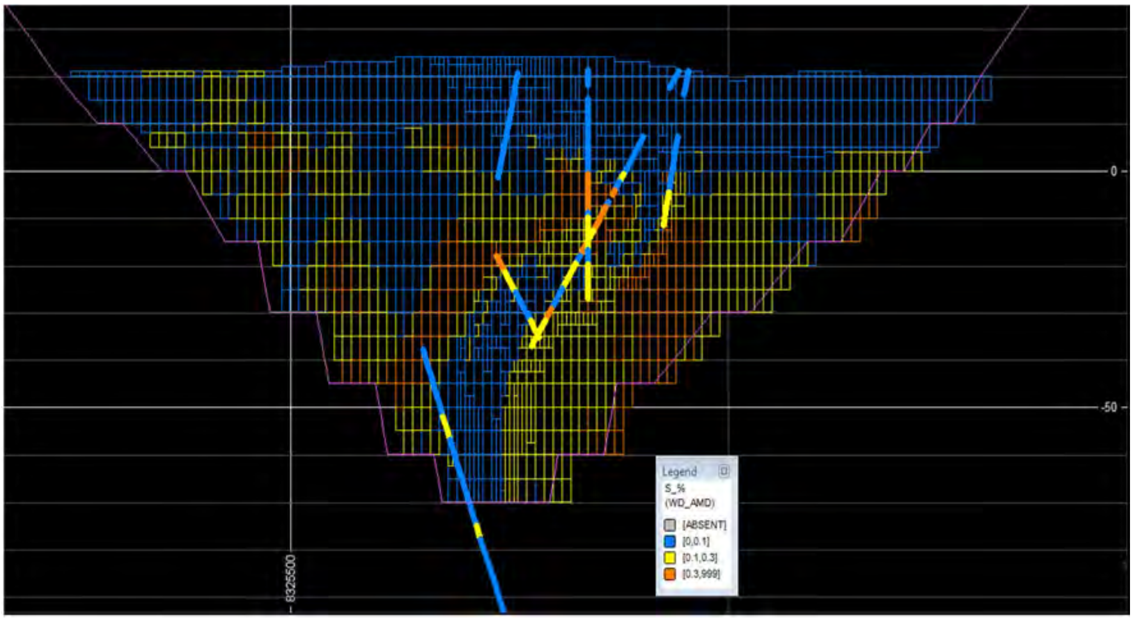


Figure 5 N-S Cross Section (509,000 mE) – Block Model and LXRF data (Drill Traces) coloured by Total S (%) – F East Final Pit Outline (Purple).

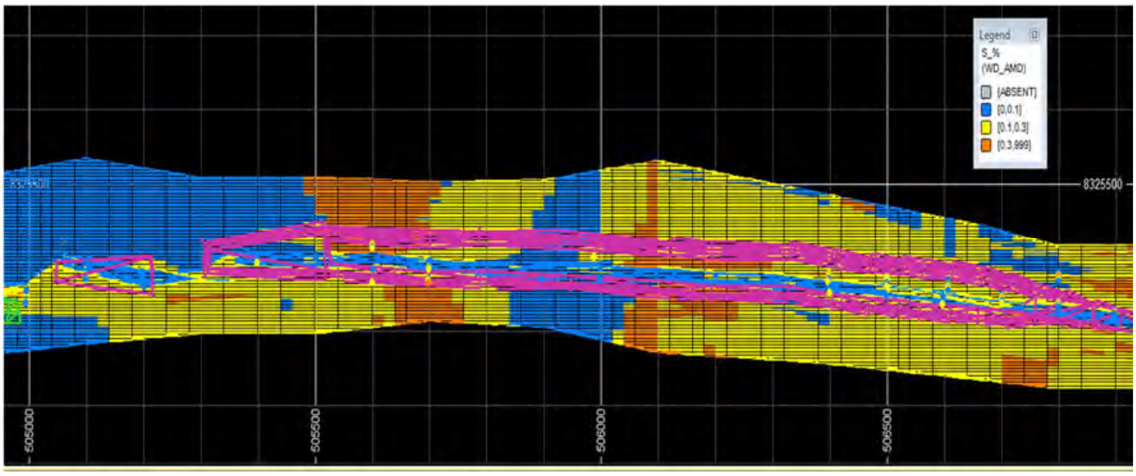


Figure 6 Plan View (5 mRL) – Block Model and LXRF data (large solid dots) coloured by Total S (%) – F West 1 Pit Outline (Purple)

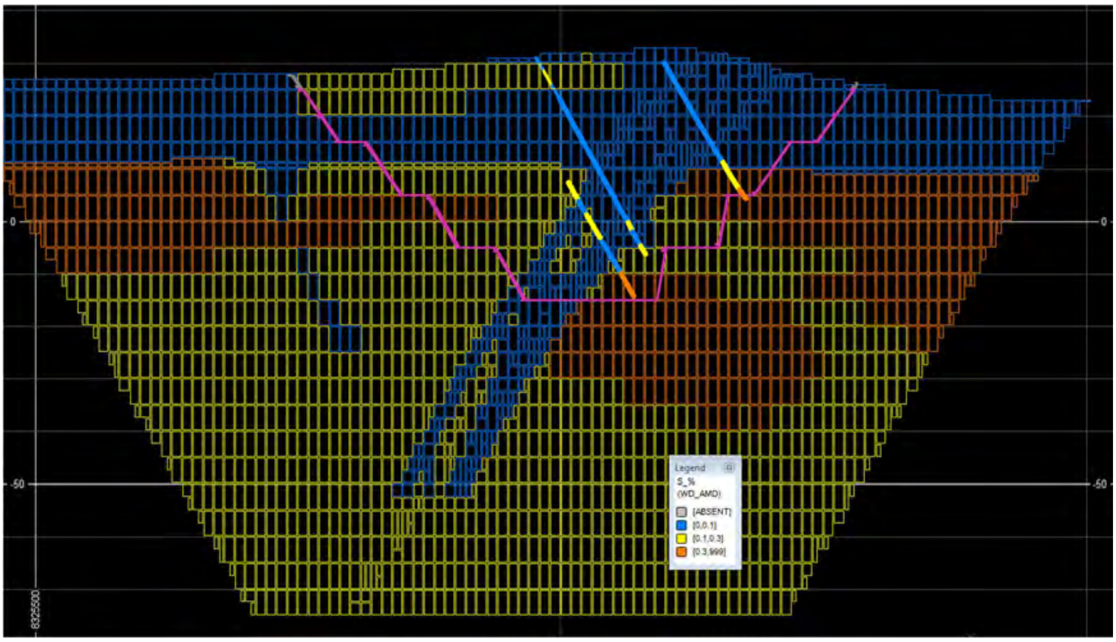


Figure 7 N-S Cross Section (505,700 mE) – Block Model and LXRF data (Drill Traces) coloured by Total S (%) – F West 1 Pit Outline (Purple).

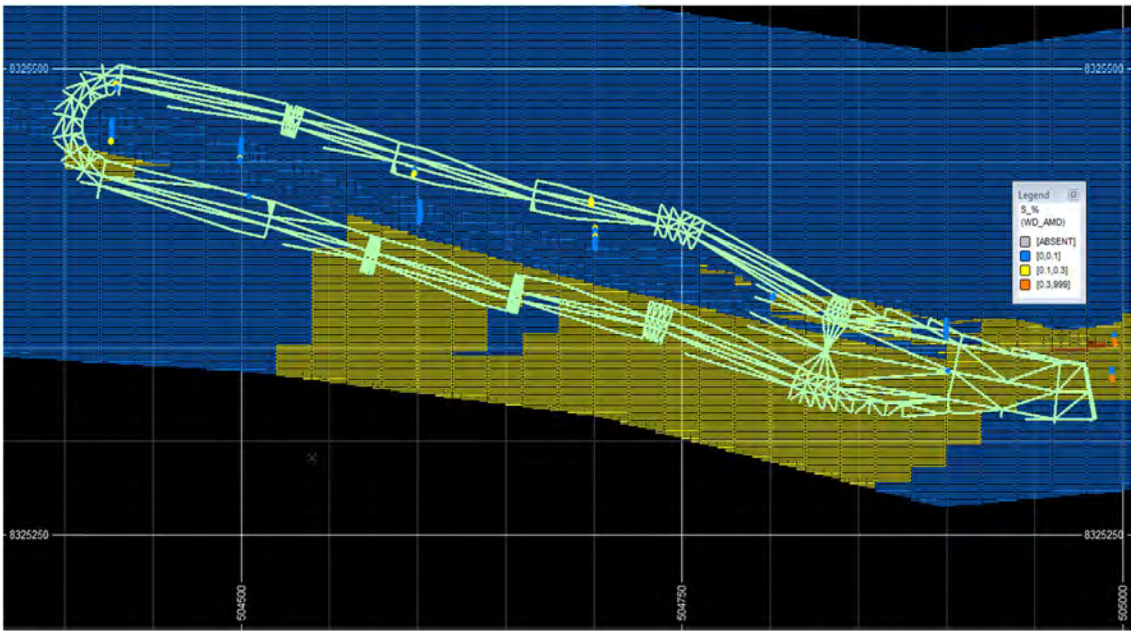


Figure 8 Plan View (5 mRL) – Block Model and LXRF data (large solid dots) coloured by Total S (%) – F West 2 Pit Outline (Lt. Green)

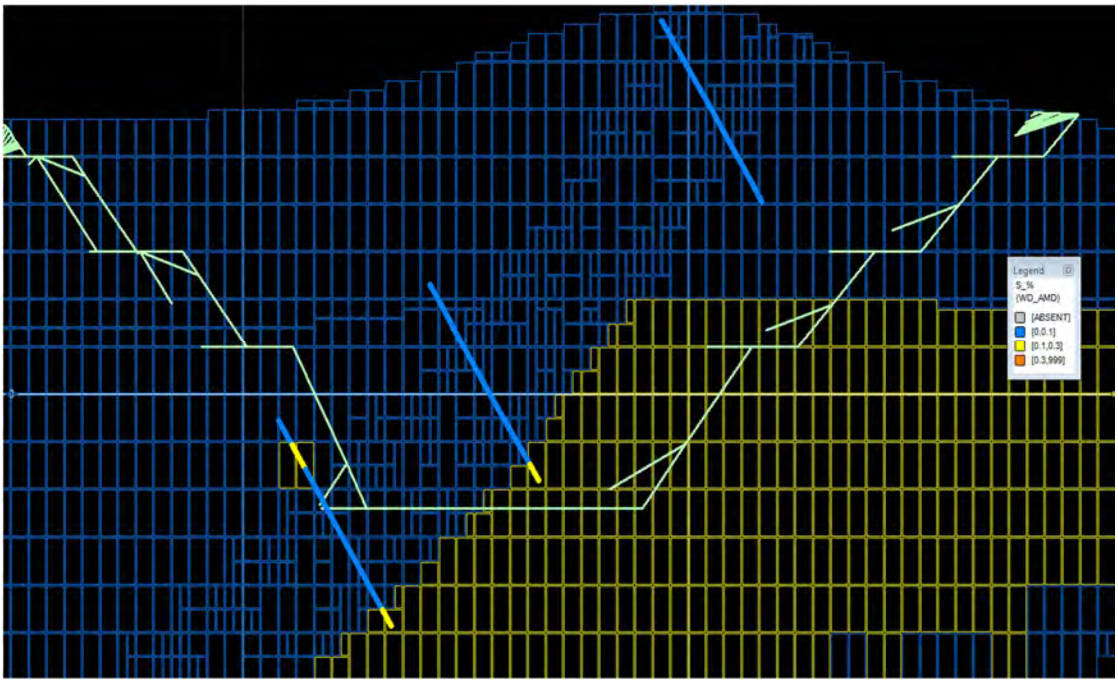


Figure 9 N-S Cross Section (504,600 mE) – Block Model and LXRF data (Drill Traces) coloured by Total S (%) – F West 2 Pit Outline (Lt. Green).

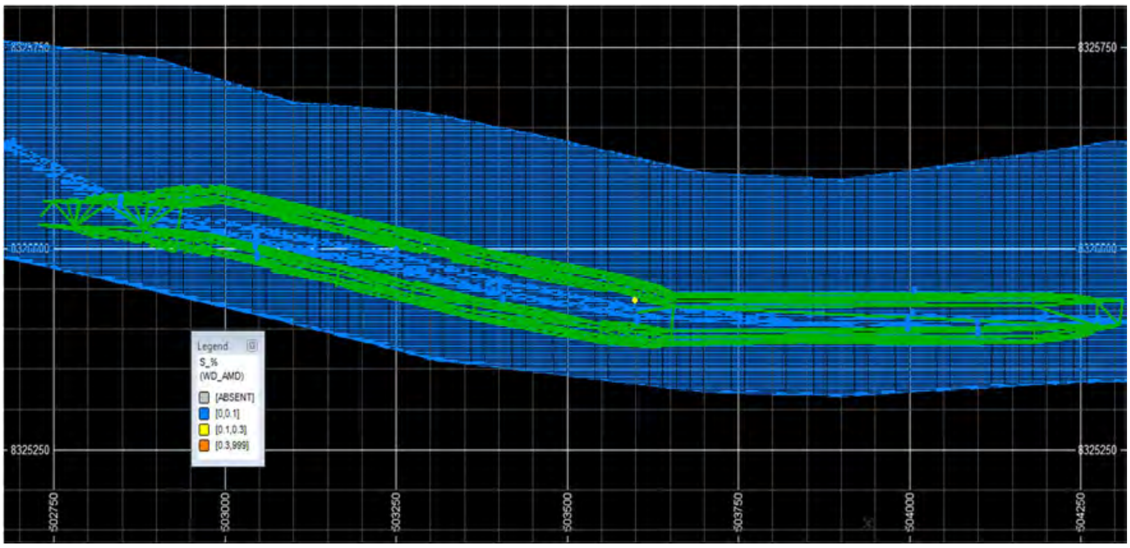


Figure 10 Plan View (20 mRL) – Block Model and LXRF data (large solid dots) coloured by Total S (%) – F West 3 Pit Outline (Green)

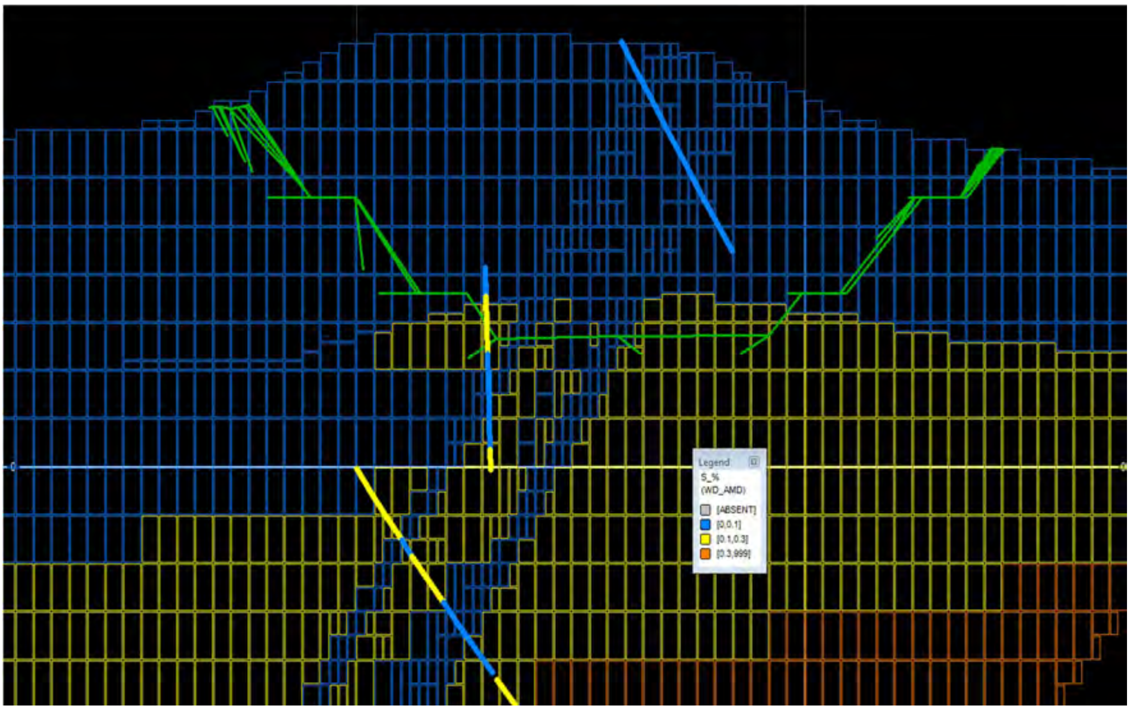


Figure 11 N-S Cross Section (503,600 mE) – Block Model and LXRF data (Drill Traces) coloured by Total S (%) – F West 3 Pit Outline (Green).

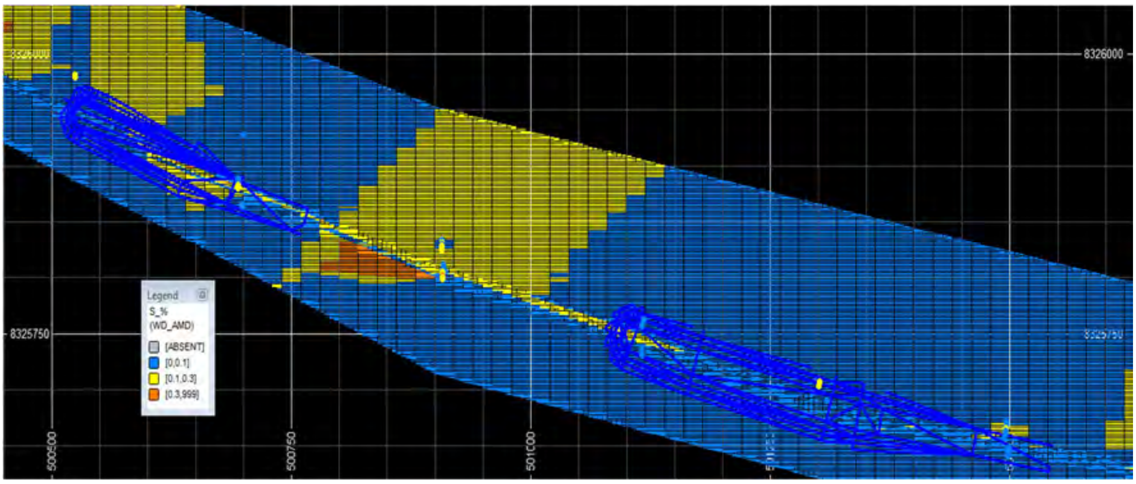


Figure 12 Plan View (20 mRL) – Block Model and LXRF data (large solid dots) coloured by Total S (%) – F West 4 Pit Outline (Blue)

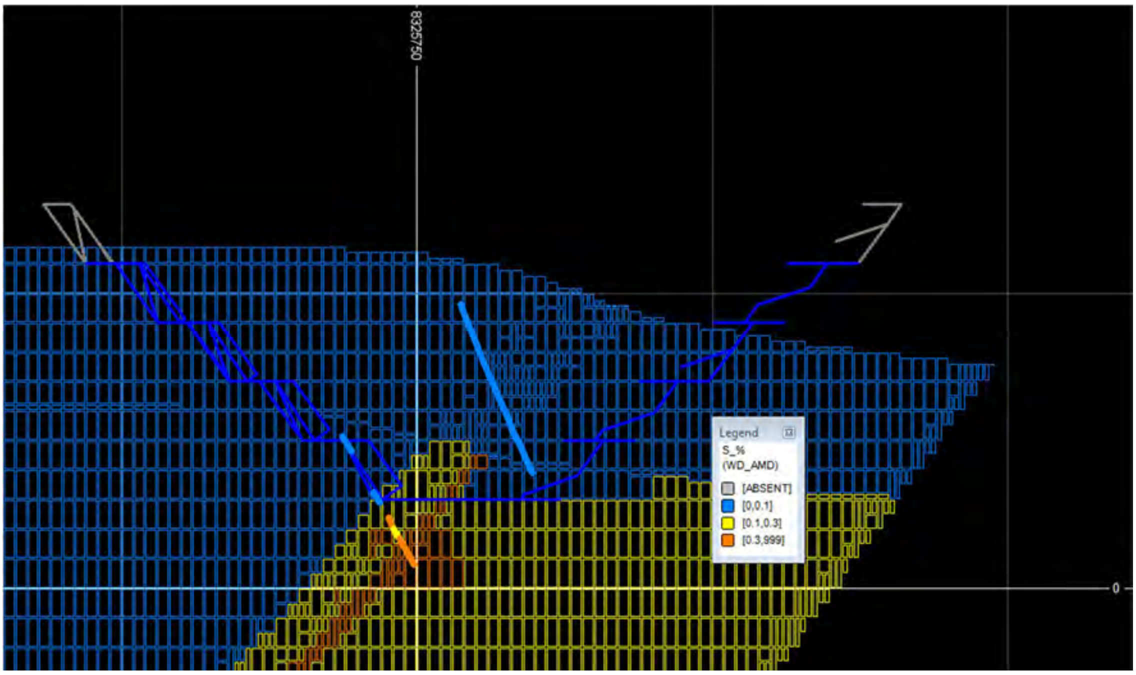


Figure 13 N-S Cross Section (501,100 mE) – Block Model and LXRF data (Drill Traces) coloured by Total S (%) – F West 4 Pit Outline (Blue).

Correlation of geochemical data sets

In order to correlate the data sets provided, LXRF data was correlated against laboratory ABA data (where the same data sample was used).

Data was compared by direct linear correlation or by Quantile – Quantile (Q-Q) Plots. The Q-Q Plot application is meant to compare the distribution of a variable with a distribution of another variable. For each selected variable, the quantiles from its distribution (calculated using the cumulated histogram) are plotted on a graphic (along the vertical axis) versus the quantiles from a reference distribution (along the horizontal axis).

The Q-Q plot of two similar distributions will be distributed along the first bisector of the graphic. If the two distributions differ, the Q-Q plot will move away from the straight line.

The comparison was only based on data that could be directly compared; therefore, the following datasets were used:

- Laboratory assay XRF to laboratory ABA:
    - Total Sulphur % – 115 samples.

Total Sulfur

Laboratory assay XRF to laboratory ABA

A good correlation was noted using a traditional linear scatter plot (Figure 14). The comparison shows there is a good correlation between the two data sets.

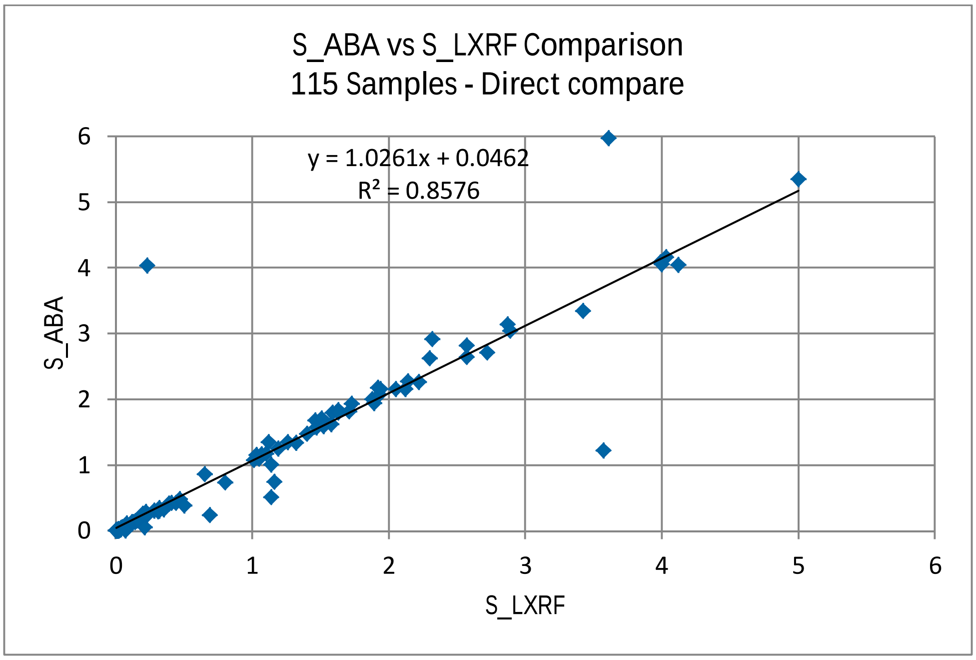


Figure 14 Scatter Plot - Linear Regression of Laboratory assay XRF (LXRF) against Laboratory ABA (ABA) data

The implications for the total sulfur correlations shown above pertain to forward site validation sampling when classifying mineral waste (Appendix B).

Laboratory assay XRF to laboratory ABA

This was not compared, as only Total S data was extracted from the ABA data for spatial comparison work. i.e. there was no comparable ABA data set as the ABA test used the acid neutralising capacity (ANC) test, which is undertaken by titration. It considers all neutralising minerals, not simply calcium.

Conclusions on data set correlation

For total sulfur there was a very good correlation between the ABA and laboratory XRF data. CaO and laboratory titration based neutralising capacity were not compared.

Sample numbers

There is arguably no 'right' number of samples that should be collected; rather, several publications provide guidance toward obtaining a representative sample density. For example, Price (2007), Miller (2013) and the (then) Queensland Department of Mines and Energy (DME) have provided guidance on geochemical sampling numbers / density (see below). The correct number, however, relates to a level of statistical significance for which the AMD risk becomes acceptable based on the proposal.

For example, Price (2007), Miller (2013) and DME (1995) provide the following recommended sample number by major lithological unit as shown below in Equation 1.

Equation 1: $n = 25 \times \sqrt{x}$.

(Where x = Million tonnes (MT) of material per major lithological unit).

Therefore, and based on the above formula, a rule of thumb to be quasi-representative is around 250 samples per 100 MT of material per major lithology. This is referred to herein as 'order of magnitude' sampling (see below). At Roper Bar, the three major lithological units are KYM, SIM and MSM.

With regard to sampling densities, DITR (2007) recommend that at pre-feasibility stage; 'Several hundred representative samples of high and low grade ore, waste rock and tailings should be collected for geochemical test work. i.e. Sufficient samples to populate a block model with a reliable distribution of net acid production potential (NAPP) data on ore, waste and wallrock'.

Further, DITR (2007) recommend that at feasibility stage, 'Improve density of NAPP data for block model if necessary, and conduct sufficient NAG test work to cross check NAPP data for key lithologies. If there are still insufficient data to assess AMD potential and provide a convincing management plan for approval, additional sampling, test work and refinement of block models will be required.

Three approaches were used to assess sampling densities at Roper Bar to determine if an appropriate number of samples have been collected. Each is discussed below.

Order of magnitude sampling

The total number of laboratory assay XRF and ABA samples used in the geochemical assessment (Appendix A) of this document were shown in Appendix A. Table 1 below shows:

- The total approximate tonnes of each of the three main geological units planned to be mined over the life of the DSO project;
- The approximate sampling density required according to the equation above to be representative, based on the total approximate tonnes of each geological unit; and
- The actual XRF (laboratory assay) and ABA total sulfur sample numbers used to undertake the preliminary and detailed geochemical characterisation sections within this document (Appendix A).

Table 1 Total sulfur sampling densities (E East and F East only)

Geological unit	Approx. final DSO Project mined tonnes	Approx. sample number required[1]	Actual total S sample number (LXRF)[3]	Actual total S sample number (ABA)[4]

	(MT)			
KYM	25.2	125	5,433	50
SIM	27.3	131	14,380	104
MSM	42.4	163	4,643	23
Total	**94.8**	**419**	**24,456**	**177**^{2}

1: Based on the equation shown above for F East and E East pits only – excludes F West pits so volumes may vary from Appendix A.

2: 27 of the 204 ABA samples were from non-mined lithologies and were therefore excluded from Table 1. 175 of the 204 samples were used in the geochemical model.

3: Lab XRF dataset provided by WDRL.

4: Provided by Pendragon (2012).

Based on the data provided in Table 1 above, an appropriate number of laboratory XRF geochemical samples have been collected to undertake the geochemical assessment (Appendix A); however, an insufficient number of laboratory geochemical analyses have been undertaken to undertake. That is to say, that the sample set provided by Pendragon, *on its own*, is insufficiently large to base a statistically confident geochemical assessment upon to inform an AMD risk assessment.

Moreover, not only is the ABA dataset too small in numbers, the initial acid base accounting (ABA) mine waste characterisation sampling and analysis completed by Pendragon (2012) (Appendix K of EcOz 2012) for assessing the AMD risk at Roper Bar appears to have been targeted, rather than random. Pendragon (2012) were provided the geological database containing laboratory assay XRF data and focused on samples with higher relative total sulfur concentrations for laboratory ABA testing. This has the effect of skewing the data set and returning higher mean and median total sulfur concentrations than the XRF data set (refer to Table 2 below). This is despite there being good correlation between total sulfur results between the laboratory assay XRF data set and the laboratory ABA data set; when the same samples are compared (this Appendix).

Table 2 Total S (%) mean and median by data set

Data Set	Sample numbers	Mean (%)	Median (%)
Laboratory XRF – E East Model	6,219	0.14	0.08
Laboratory XRF – F East Model	18,237	0.08	0.02
ABA (Pendragon 2012)	177	0.75	0.20

In addition, the 204 ABA samples collected were the total or global dataset, of which a subset of 177 were in the relevant geological groups (KYM, SIM, MSM), of which 60 samples were located within proposed pit shells; a sample size too small on which to attempt geostatistics.

However, the fact that a statistically representative XRF data set was been generated, allowed that XRF dataset to inform the AMD risk assessment (Appendix A). WDR propose to increase statistical confidence in the ABA dataset by collecting additional samples through operations in accordance with the site procedure attached as Appendix B. Moreover, the geochemical risk assessment would be routinely updated using the increased data set as an input.

Drill hole spacing

Variography

In order to gauge appropriate sample spacing in the laboratory (LXRF) data set was used. Samples were further divided into the following 12 sub-divisions, based on spatial location, oxidation and lithology;

- F Pit Area
  - Oxide – SIM
  - Oxide – KYA
  - Oxide – MSM
  - Fresh – SIM
  - Fresh – KYA
  - Fresh – MSM
- E East Area
  - Oxide – SIM
  - Oxide – KYA
  - Oxide – MSM
  - Fresh – SIM
  - Fresh – KYA
  - Fresh – MSM

Oxidation state (Oxide – combined oxide and transitional material, and Fresh is material below the Top of Fresh oxidation level).

Variography was used to assess the minimal sampling density to represent total sulphur grade continuity. Variogram is used as a generic word to designate the function characterizing the variability of variables versus the distance between two samples.

No sample compositing was used. So in order to reduce the variability and therefore contain any outlier data, and improve the variogram, the data was transformed into Gaussian space using a Hermite polynomial curve-fitting function within the Geovariance Isatis geostatistical software package. Also, no unfolding was applied to the dataset, so the ranges of grade continuity shown will be conservative; and in reality will be longer than portrayed. The models used were E East and F East (Figure 15) as supplied by WDR.

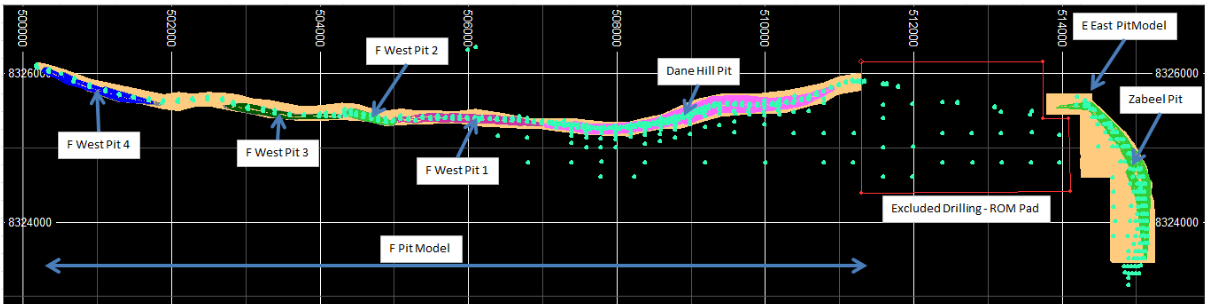


Figure 15 Location Plot of LXRF data – Plan View

Experimental correlograms were calculated and modelled using the Isatis geostatistical package and are shown below.

F Pit Area – SIM Oxide

A total of 2,283 samples were used to represent the F Pit area SIM oxide. Refer to Figure 16 for sample locations in plan view.

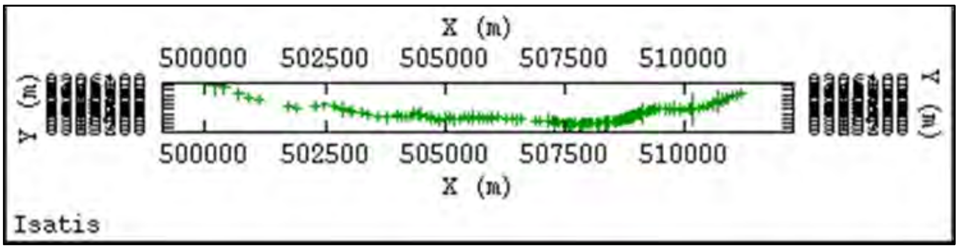
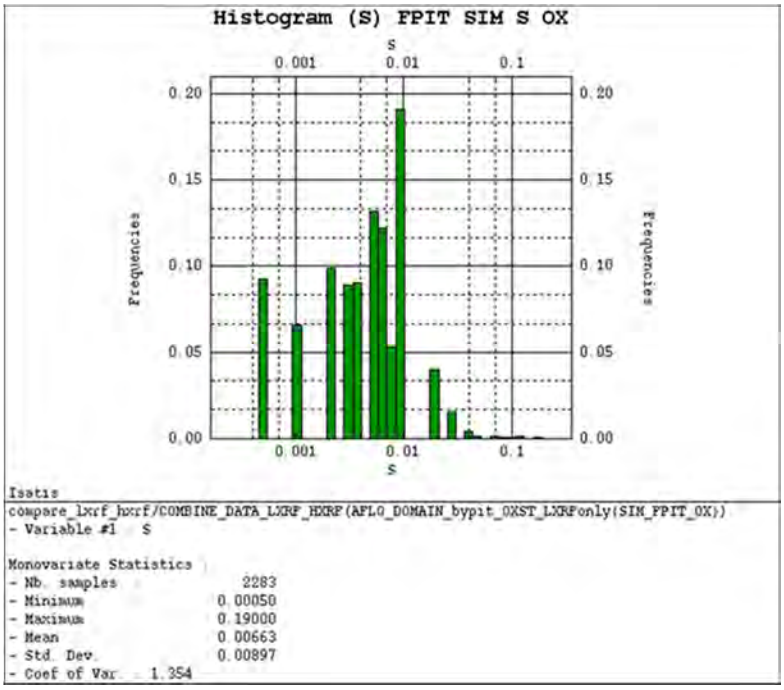


Figure 16 Base Map of LXRF Sample Locations for F Pit area – Plan view

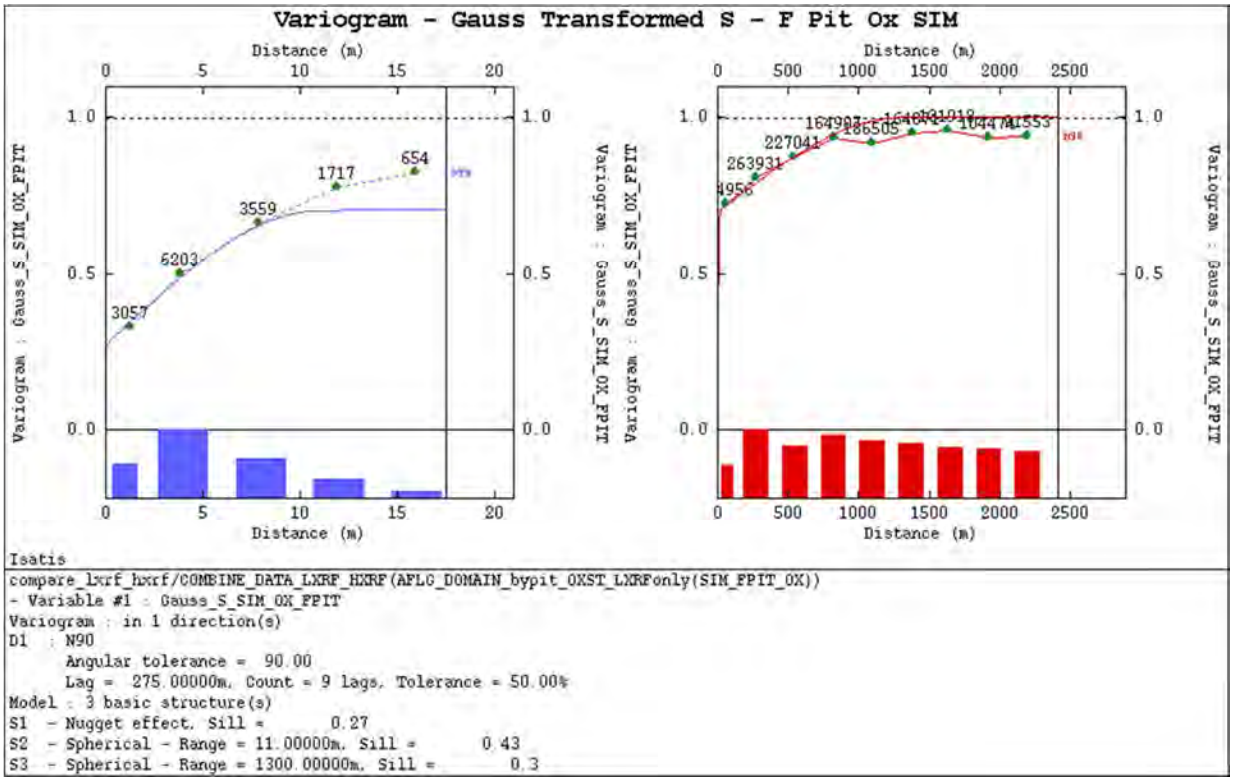
The log-histogram of the data is shown in Figure 17. An omnidirectional, 2 structure spherical model was fitted to the Gaussian transformed data, and is shown in Figure 18.



```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(SIM_FPIT_OX))
- Variable #1   S

Monovariate Statistics
- Nb. samples              2283
- Minimum               0.00050
- Maximum               0.19000
- Mean                  0.00663
- Std. Dev.             0.00897
- Coef of Var.    1.354
```

Figure 17 Log-Histogram of LXRF Data



```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(SIM_FPIT_OX))
- Variable #1 : Gauss_S_SIM_OX_FPIT
Variogram : in 1 direction(s)
D1   : N90
       Angular tolerance =  90.00
       Lag =  275.00000m, Count = 9 lags, Tolerance = 50.00%
Model : 3 basic structure(s)
S1   - Nugget effect, Sill =        0.27
S2   - Spherical - Range = 11.00000m, Sill =        0.43
S3   - Spherical - Range = 1300.00000m, Sill =         0.3
```

Figure 18 Variogram Model – Gaussian Transformed Data (Left – down-hole variogram / Right - isotropic variogram)

It shows a low relative nugget of 27%. The short-range structure contributes a significant portion of the non-nugget variance (43%) and has a range approximating the cross-strike drill spacing of 20 - 30 m. The overall range is 1,300 m, which is in excess of the along strike drill spacing of 150 m to 50 m.

F Pit Area –KYA Oxide

A total of 695 samples were used to represent the F Pit area KYA oxide. Refer to Figure 19 for sample locations in plan view. The log-histogram of the data is shown in Figure 20.

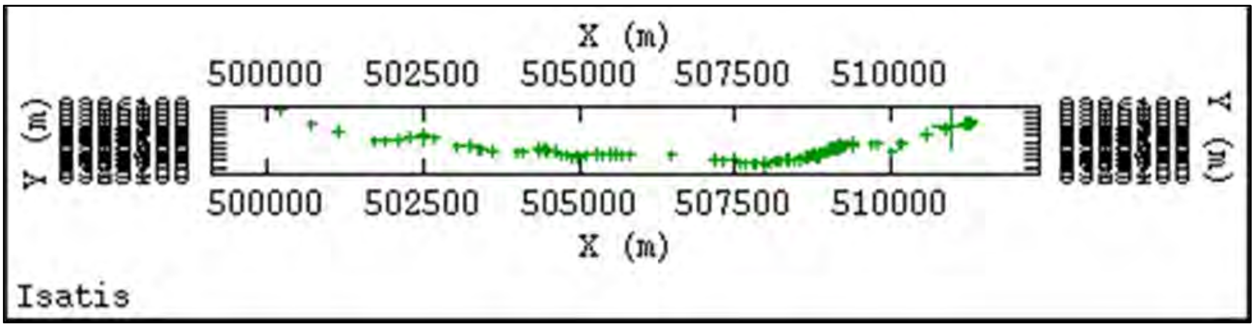
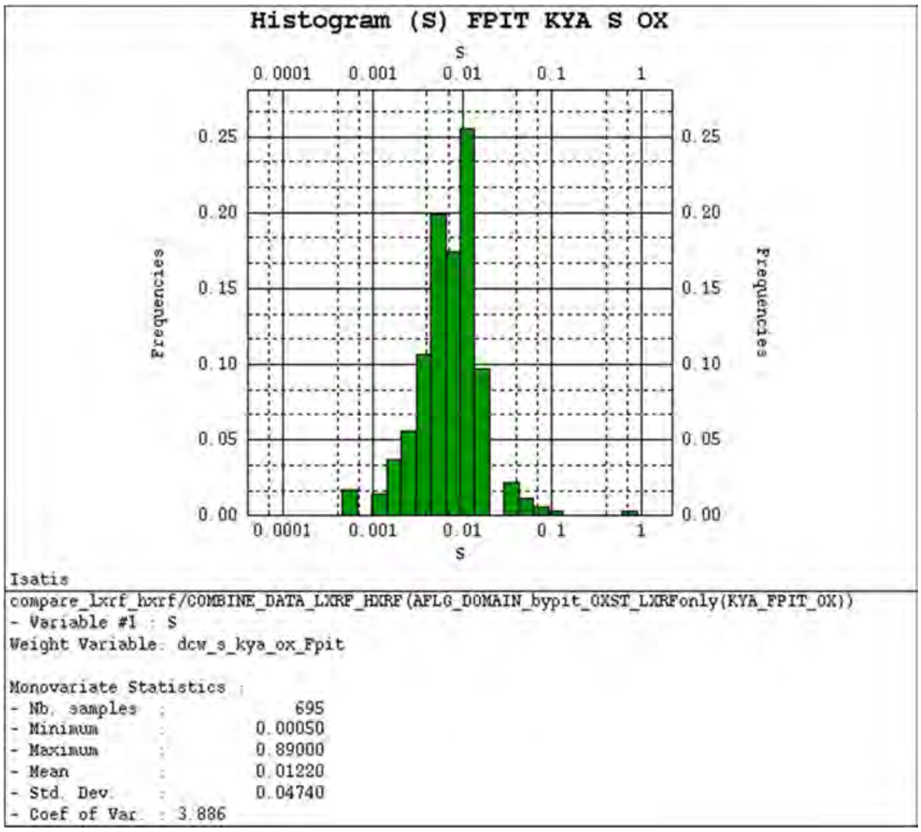


Figure 19 Base Map of LXRF - Sample Location – Plan view

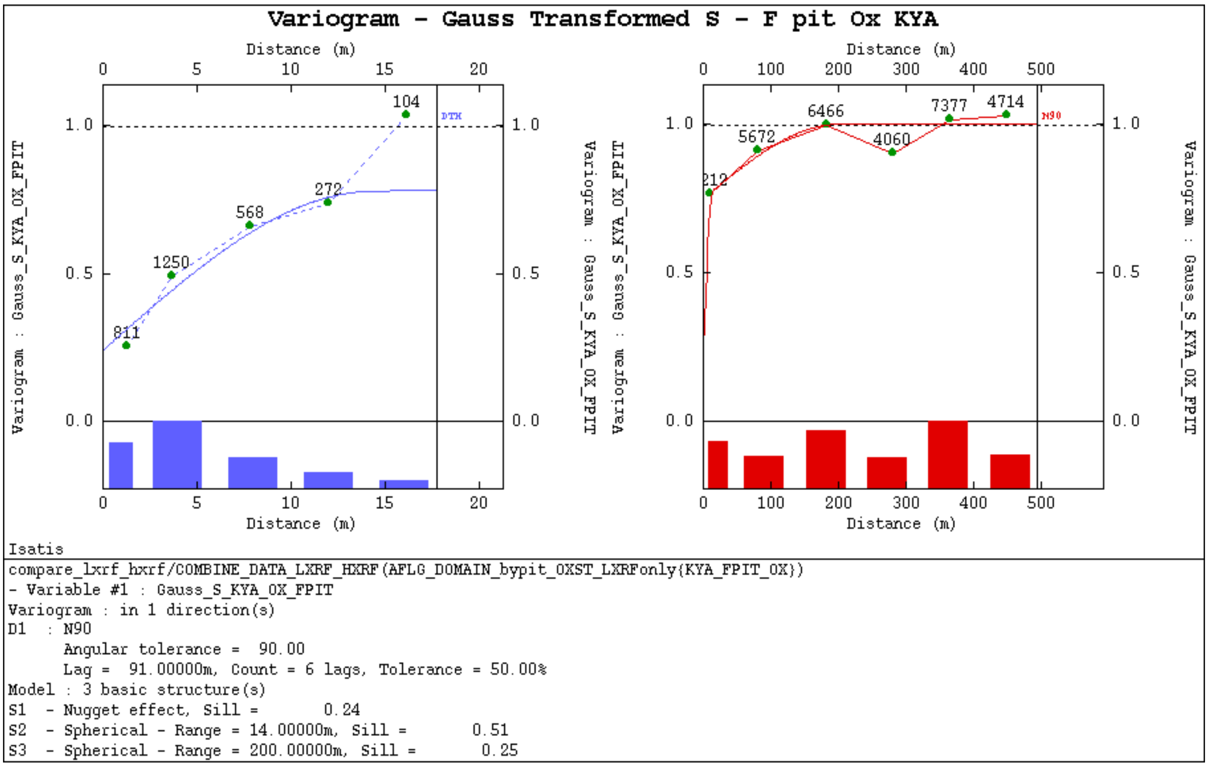


```
Isatis
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(KYA_FPIT_OX))
- Variable #1 : S
Weight Variable: dcw_s_kya_ox_Fpit

Monovariate Statistics :
- Nb. samples  :          695
- Minimum      :      0.00050
- Maximum      :      0.89000
- Mean         :      0.01220
- Std. Dev.    :      0.04740
- Coef of Var. : 3.886
```

Figure 20 Log-Histogram of Laboratory XRF (LXRF) Data

An omnidirectional, 2 structure spherical model was fitted to the Gaussian transformed data, and is shown in Figure 21.



```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly{KYA_FPIT_OX})
- Variable #1 : Gauss_S_KYA_OX_FPIT
Variogram : in 1 direction(s)
D1   : N90
      Angular tolerance =  90.00
      Lag =  91.00000m, Count = 6 lags, Tolerance = 50.00%
Model : 3 basic structure(s)
S1  - Nugget effect, Sill =       0.24
S2  - Spherical - Range = 14.00000m, Sill =       0.51
S3  - Spherical - Range = 200.00000m, Sill =       0.25
```

Figure 21 Variogram Model – Gaussian Transformed Data (Left – down-hole variogram / Right - isotropic variogram)

It shows a low relative nugget of 24%. The short-range structure contributes a significant portion of the non-nugget variance (51%) and has a range approximating the cross-strike drill spacing of 20 - 30 m. The overall range is 200 m, which is in excess of the along strike drill spacing of 150 m to 50 m.

F Pit Area –MSM Oxide

A total of 1,137 samples were used to represent the F Pit MSM oxide zone (Figure 22). The log-histogram of the data is shown in Figure 23.

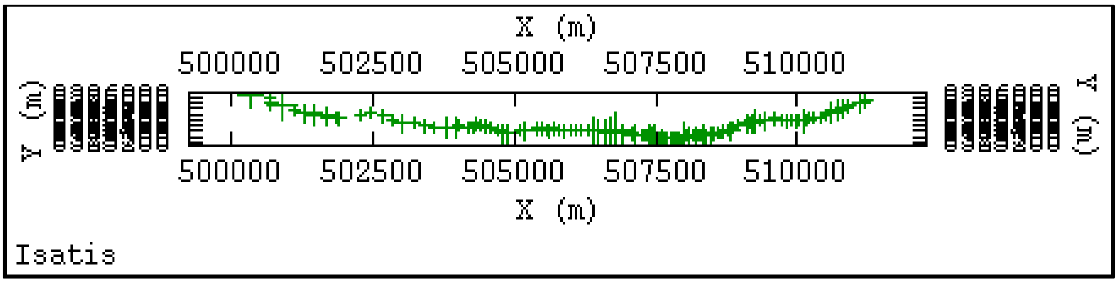
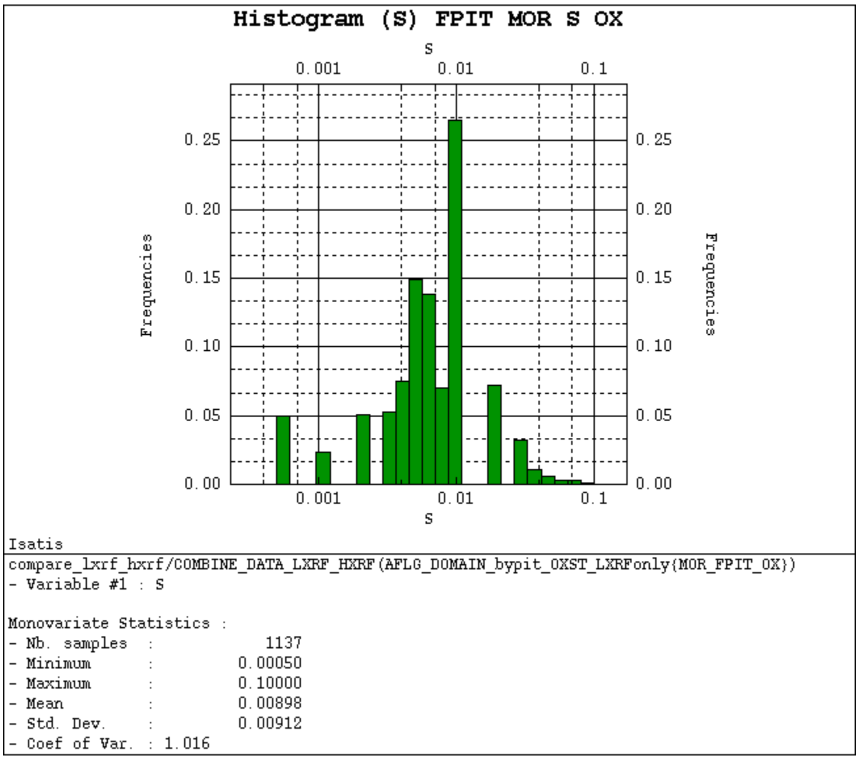


Figure 22 Base Map of LXRF - Sample Location – Plan view

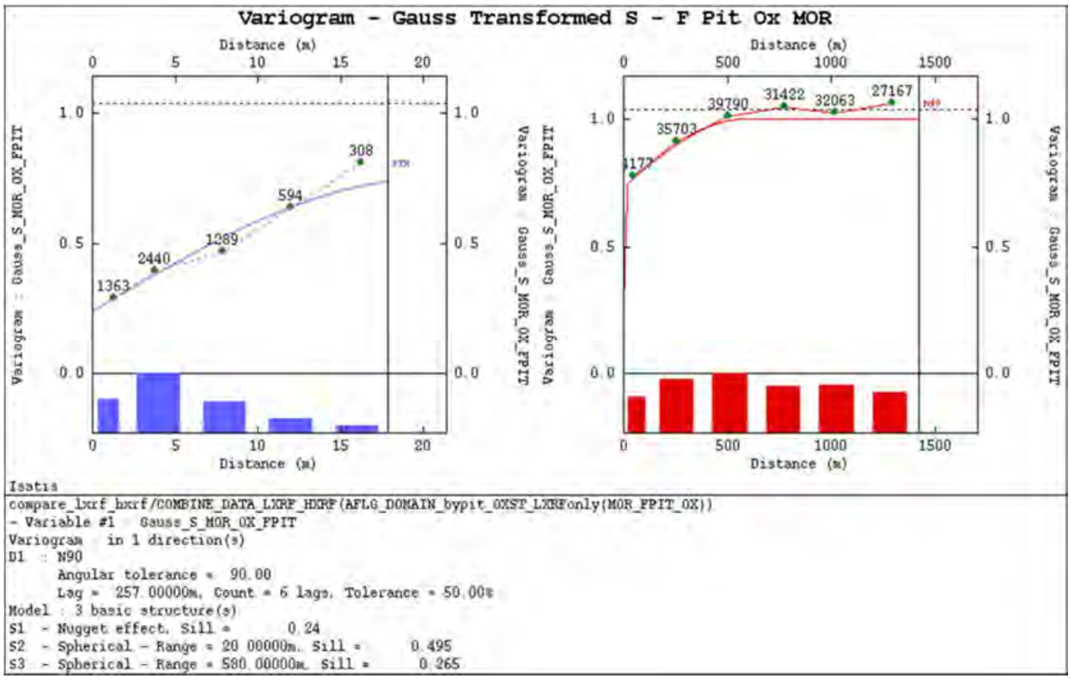


```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(MOR_FPIT_OX))
- Variable #1 : S

Monovariate Statistics :
- Nb. samples   :          1137
- Minimum       :       0.00050
- Maximum       :       0.10000
- Mean          :       0.00898
- Std. Dev.     :       0.00912
- Coef of Var.  : 1.016
```

Figure 23 Log-Histogram of LXRF Data

An omnidirectional, 2 structure spherical model was fitted to the Gaussian transformed data, and is shown in Figure 24.



```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(MOR_FPIT_OX))
- Variable #1   Gauss_S_MOR_OX_FPIT
Variogram   in 1 direction(s)
D1  : N90
      Angular tolerance =  90.00
      Lag =  257.00000m, Count = 6 lags, Tolerance = 50.00%
Model : 3 basic structure(s)
S1  - Nugget effect, Sill =        0.24
S2  - Spherical - Range = 20.00000m, Sill =      0.495
S3  - Spherical - Range = 580.00000m, Sill =      0.265
```

Figure 24 Variogram Model – Gaussian Transformed Data (Left – down-hole variogram / Right - isotropic variogram)

It shows a low relative nugget of 24%. The short-range structure contributes a significant portion of the non-nugget variance (49.5%) and has a range approximating the cross-strike drill spacing of 20 - 30 m. The overall range is 580 m, which is in excess of the along strike drill spacing of 150 m to 50 m.

F Pit Area –SIM Fresh

A total of 6,876 samples were used to represent the F Pit Area – SIM Fresh (Figure 25). The log-histogram of the data is shown in Figure 26.

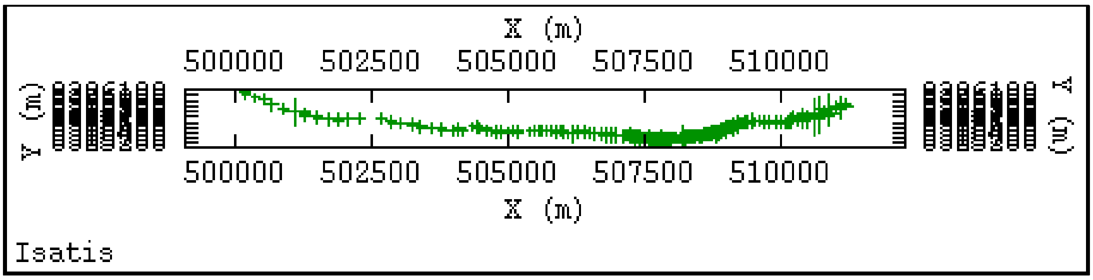
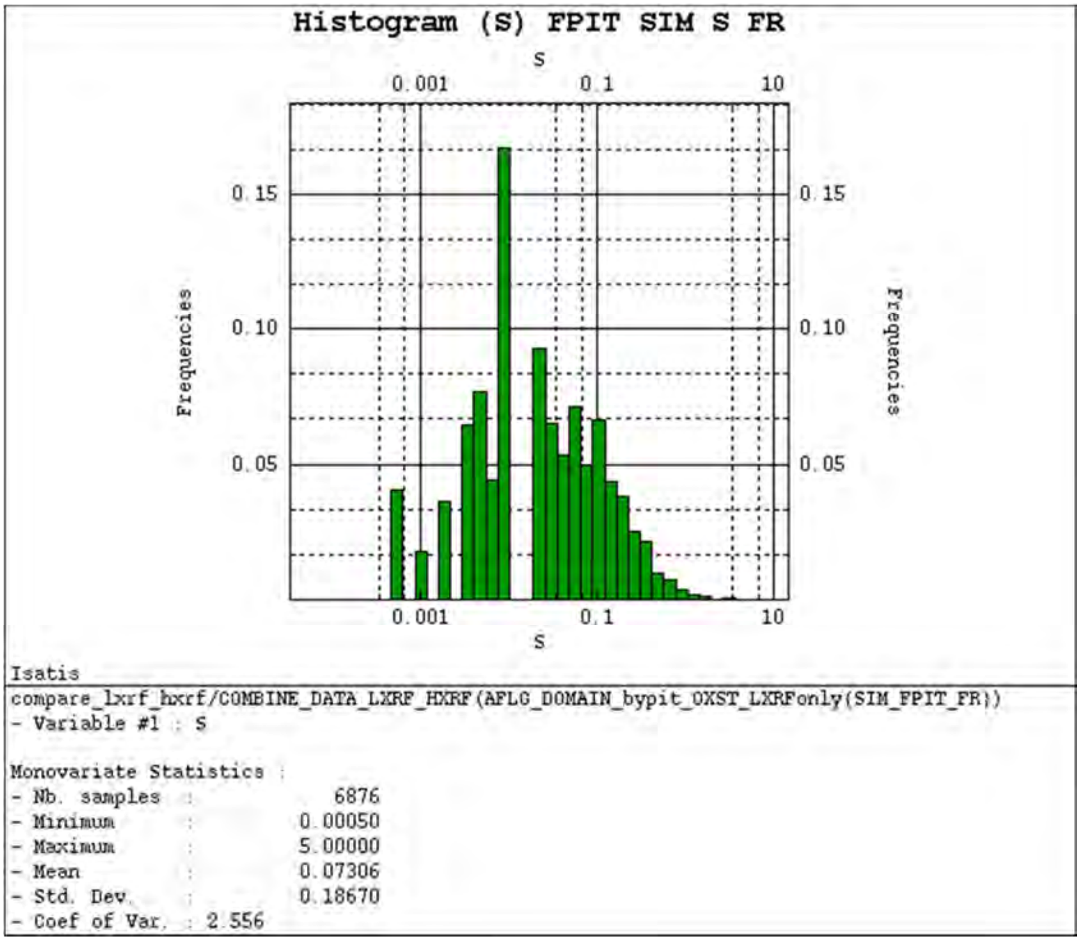


Figure 25 Base Map of LXRF - Sample Location – Plan view

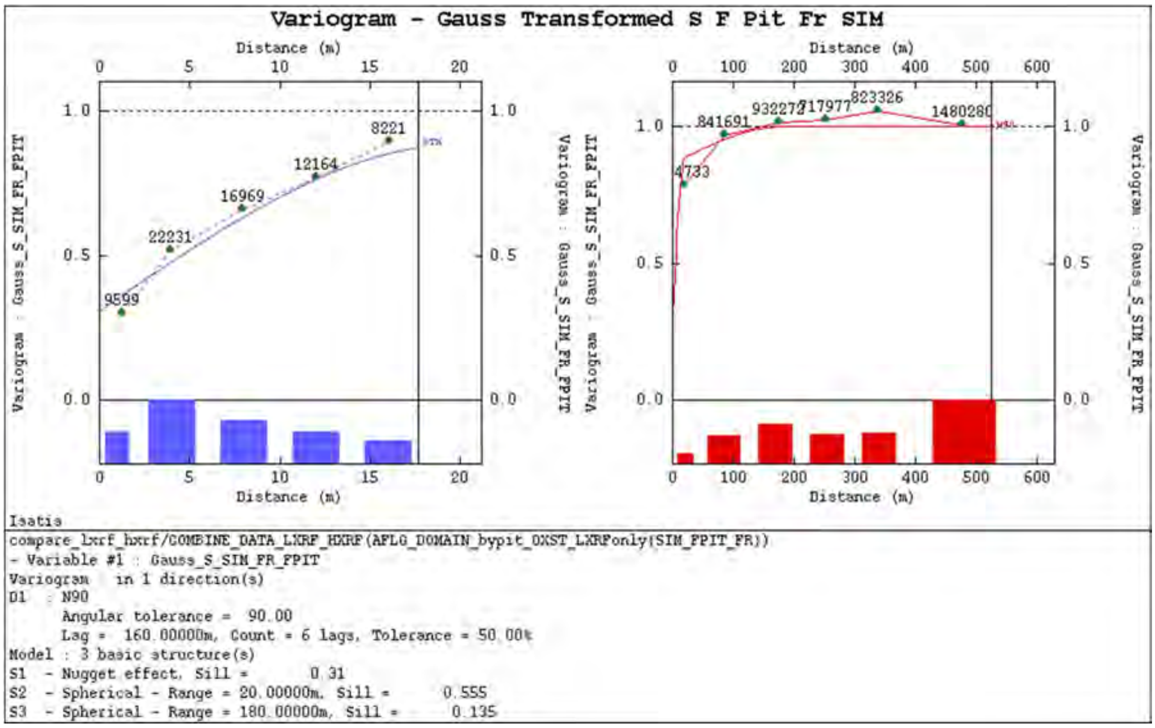


```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(SIM_FPIT_FR))
- Variable #1 : S

Monovariate Statistics :
- Nb. samples    :           6876
- Minimum        :        0.00050
- Maximum        :        5.00000
- Mean           :        0.07306
- Std. Dev.      :        0.18670
- Coef of Var.   : 2.556
```

Figure 26 Log-Histogram of Laboratory XRF (LXRF) Data

An omnidirectional, 2 structure spherical model was fitted to the Gaussian transformed data, and is shown in Figure 27.



```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(SIM_FPIT_FR))
- Variable #1 : Gauss_S_SIM_FR_FPIT
Variogram   in 1 direction(s)
D1   : N90
      Angular tolerance =  90.00
      Lag =  160.00000m, Count = 6 lags, Tolerance = 50.00%
Model : 3 basic structure(s)
S1   - Nugget effect, Sill =        0.31
S2   - Spherical - Range = 20.00000m, Sill =      0.555
S3   - Spherical - Range = 180.00000m, Sill =      0.135
```

Figure 27 Variogram Model – Gaussian Transformed Data (Left – down-hole variogram / Right - isotropic variogram)

It shows a low relative nugget of 31%. The short-range structure contributes a significant portion of the non-nugget variance (55.5%) and has a range approximating the cross-strike drill spacing of 20 - 30 m. The overall range is 180 m, which is in excess of the along strike drill spacing of 150 m to 50 m.

F Pit Area –KYA Fresh

A total of 4,398 samples were used to represent the F Pit KYA fresh zone (Figure 28). The log-histogram of the data is shown in Figure 29.

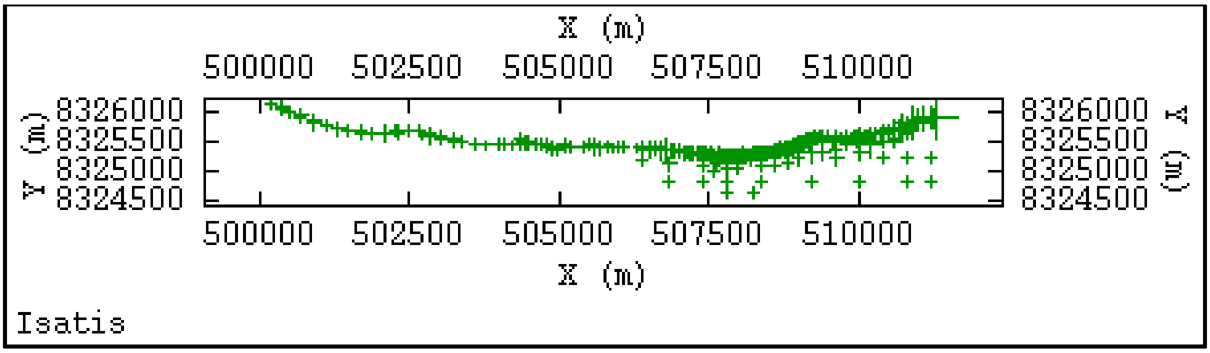
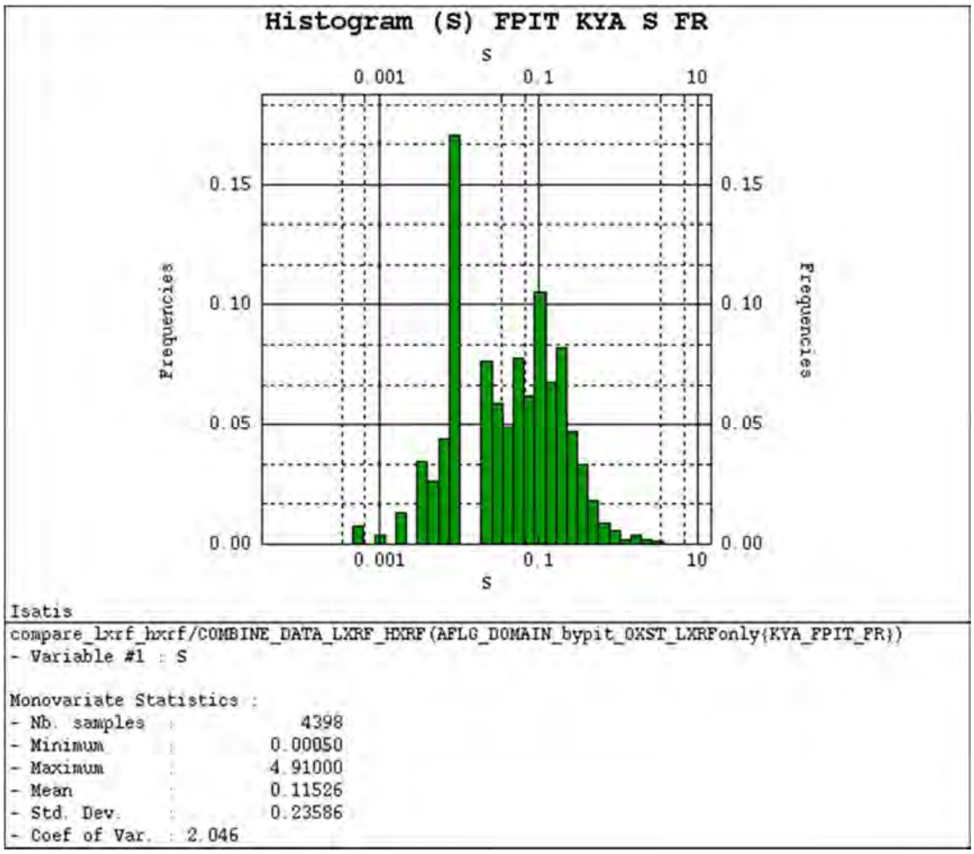


Figure 28 Base Map of LXRF - Sample Location – Plan view

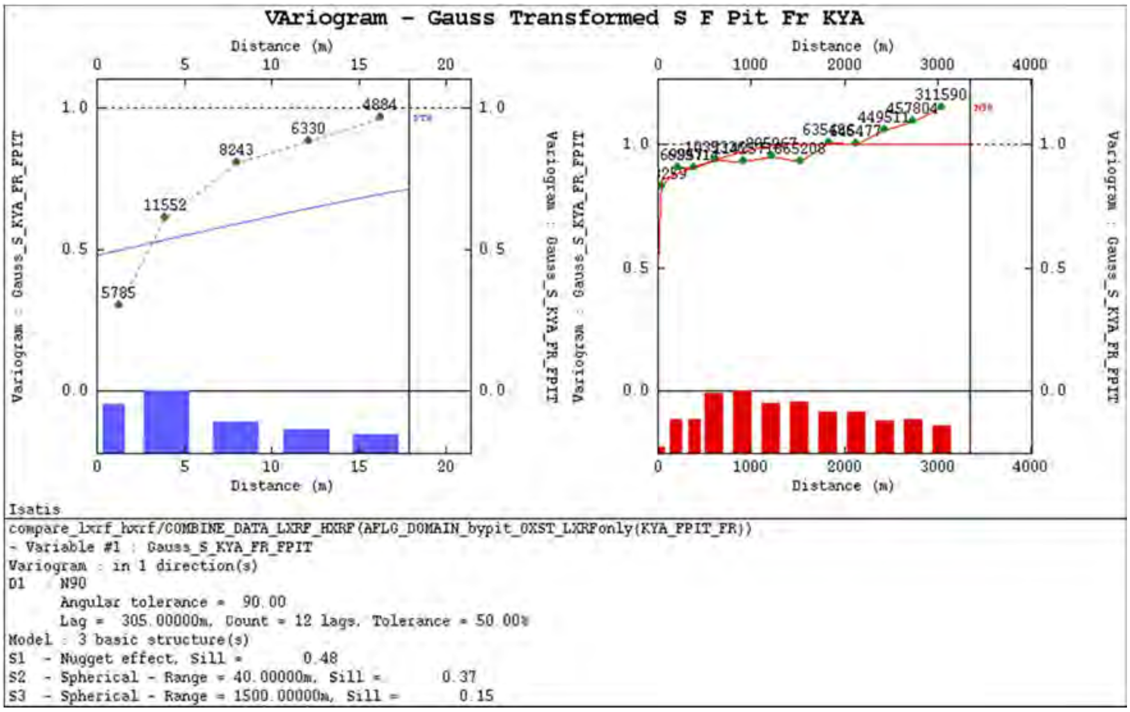


```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(KYA_FPIT_FR))
- Variable #1 : S

Monovariate Statistics :
- Nb. samples   :        4398
- Minimum       :     0.00050
- Maximum       :     4.91000
- Mean          :     0.11526
- Std. Dev.     :     0.23586
- Coef of Var.  : 2.046
```

Figure 29 Log-Histogram of LXRF Data

An omnidirectional, 2 structure spherical model was fitted to the Gaussian transformed data, and is shown in Figure 30.



```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(KYA_FPIT_FR))
- Variable #1 : Gauss_S_KYA_FR_FPIT
Variogram : in 1 direction(s)
D1    N90
      Angular tolerance =  90.00
      Lag =  305.00000m, Count = 12 lags, Tolerance = 50.00%
Model : 3 basic structure(s)
S1  - Nugget effect, Sill =        0.48
S2  - Spherical - Range = 40.00000m, Sill =        0.37
S3  - Spherical - Range = 1500.00000m, Sill =        0.15
```

Figure 30 Variogram Model – Gaussian Transformed Data (Left – down-hole variogram / Right - isotropic variogram)

It shows a moderate relative nugget of 48%. The short-range structure contributes a significant portion of the non-nugget variance (37%) and has a range approximating the cross-strike drill spacing of 20 - 30 m. The overall range is 1,500 m, which is in excess of the along strike drill spacing of 150 m to 50 m.

E East Pit Area –SIM Oxide

A total of 1,270 samples were used to represent the E East SIM oxide zone (Figure 31). The log-histogram of the data is shown in Figure 32.

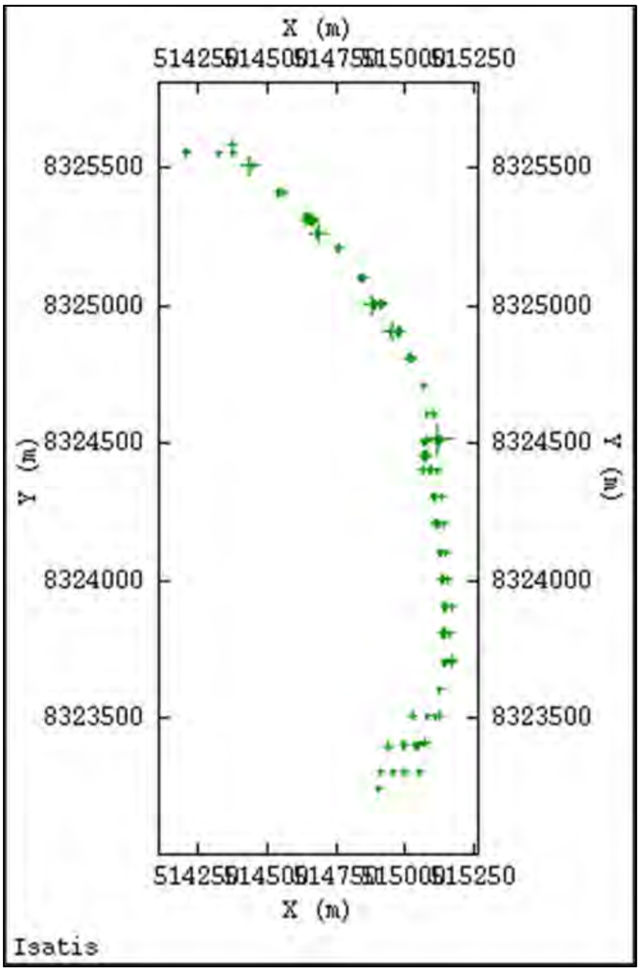
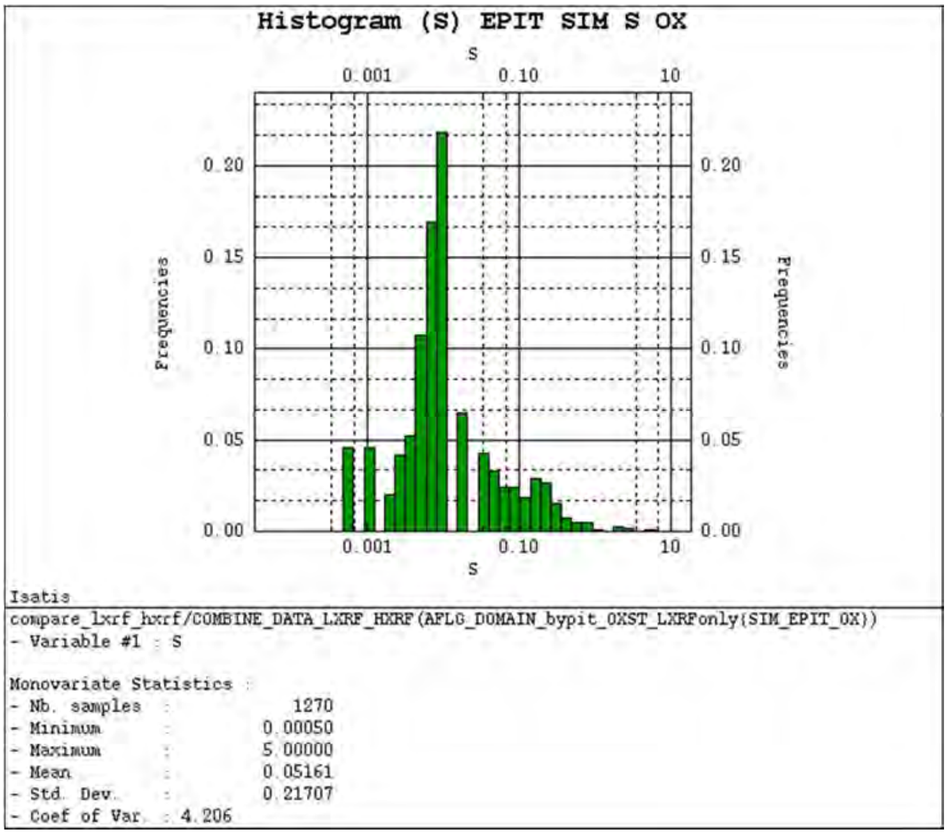


Figure 31 Base Map of LXRF - Sample Location – Plan view

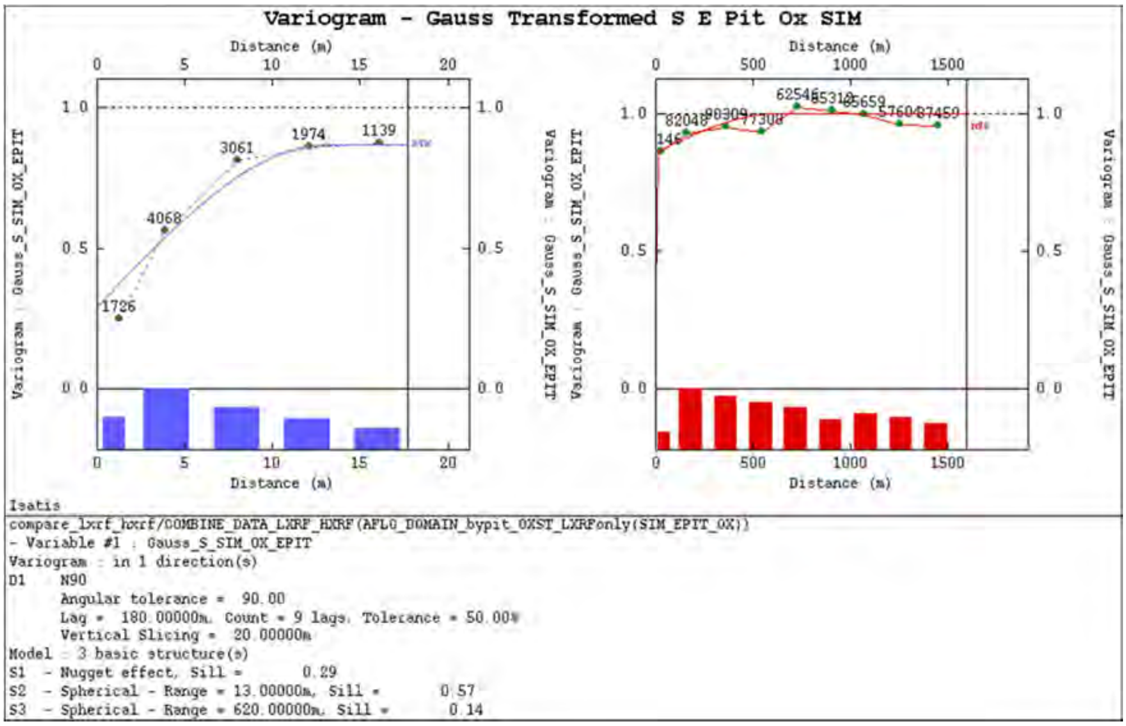


```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(SIM_EPIT_OX))
- Variable #1 : S

Monovariate Statistics :
- Nb. samples   :         1270
- Minimum       :      0.00050
- Maximum       :      5.00000
- Mean          :      0.05161
- Std. Dev.     :      0.21707
- Coef of Var.  : 4.206
```

Figure 32 Log-Histogram of LXRF Data

An omnidirectional, 2 structure spherical model was fitted to the Gaussian transformed data, and is shown in Figure 33.



```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(SIM_EPIT_OX))
- Variable #1 : Gauss_S_SIM_OX_EPIT
Variogram : in 1 direction(s)
D1     N90
       Angular tolerance =  90.00
       Lag =  180.00000m, Count = 9 lags, Tolerance = 50.00%
       Vertical Slicing =  20.00000m
Model : 3 basic structure(s)
S1   - Nugget effect, Sill =        0.29
S2   - Spherical - Range = 13.00000m, Sill =        0.57
S3   - Spherical - Range = 620.00000m, Sill =        0.14
```

Figure 33 Variogram Model – Gaussian Transformed Data (Left – down-hole variogram / Right - isotropic variogram)

It shows a low relative nugget of 29%. The short-range structure contributes a significant portion of the non-nugget variance (57%) and has a range approximating the cross-strike drill spacing of 20 - 30 m. The overall range is 620 m, which is in excess of the along strike drill spacing of 150 m to 50 m.

E East Pit Area –KYA Oxide

A total of 131 samples were used to represent the E East KYA oxide zone (Figure 34). The log-histogram of the data is shown in Figure 35.

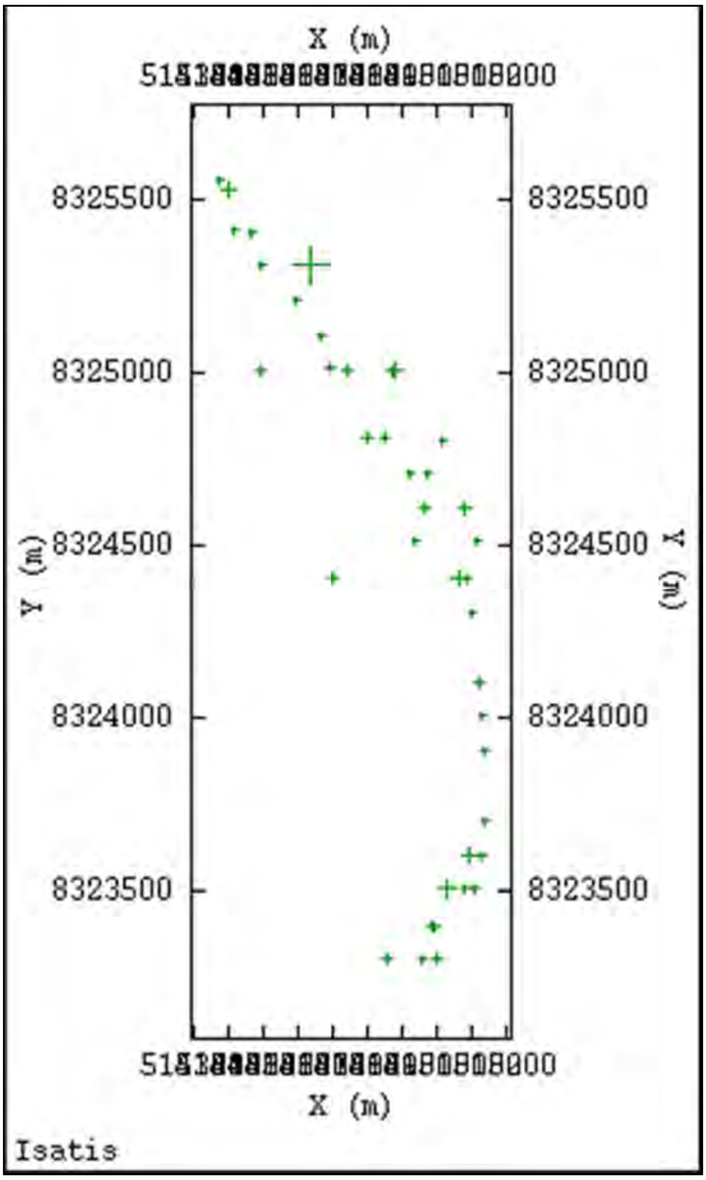
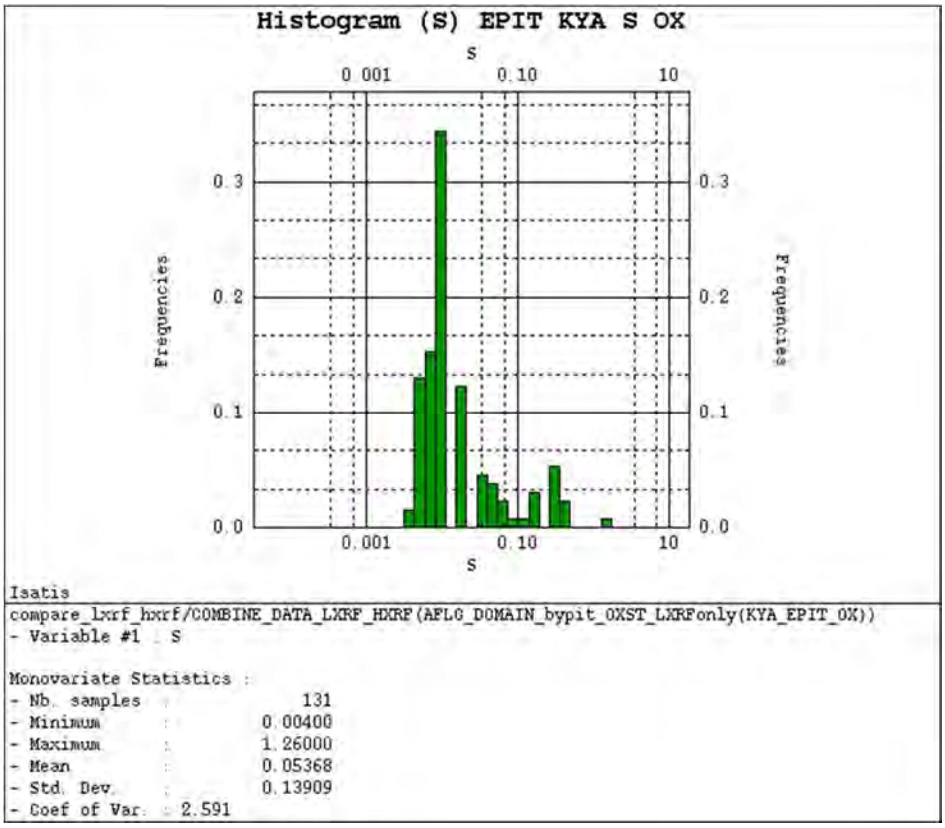


Figure 34 Base Map of LXRF - Sample Location – Plan view

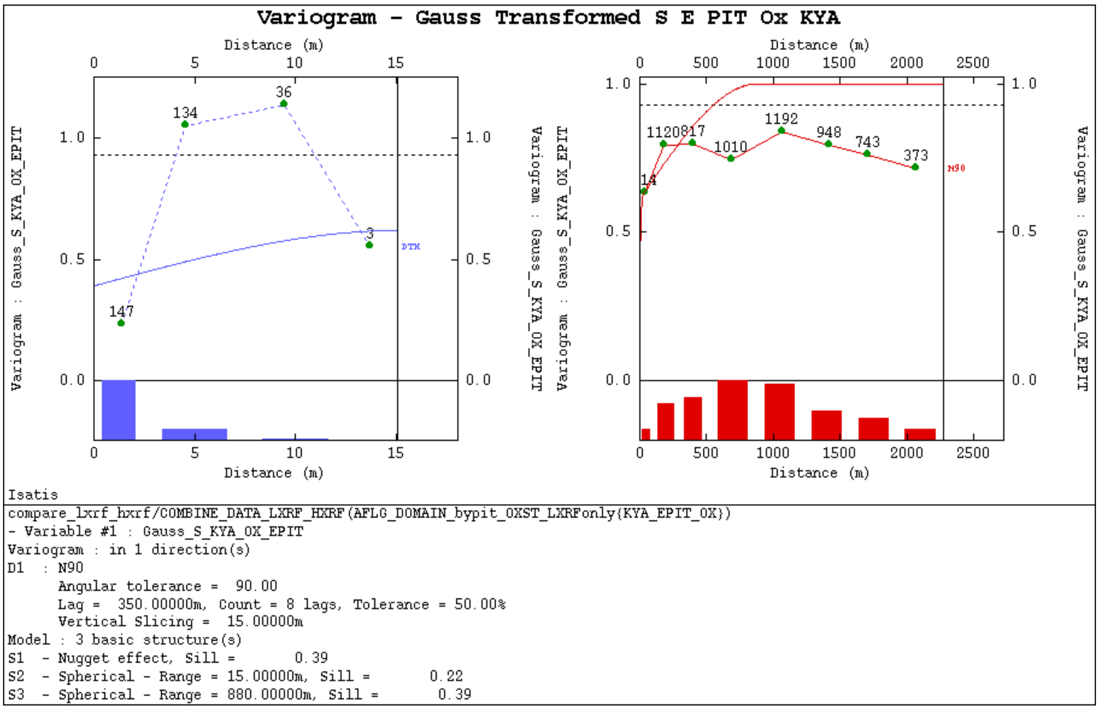


```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(KYA_EPIT_OX))
- Variable #1 : S

Monovariate Statistics :
- Nb. samples   :          131
- Minimum       :      0.00400
- Maximum       :      1.26000
- Mean          :      0.05368
- Std. Dev.     :      0.13909
- Coef of Var.  : 2.591
```

Figure 35 Log-Histogram of LXRF Data

An omnidirectional, 2 structure spherical model was fitted to the Gaussian transformed data, and is shown in Figure 36.



```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly{KYA_EPIT_OX})
- Variable #1 : Gauss_S_KYA_OX_EPIT
Variogram : in 1 direction(s)
D1   : N90
       Angular tolerance =  90.00
       Lag =  350.00000m, Count = 8 lags, Tolerance = 50.00%
       Vertical Slicing =  15.00000m
Model : 3 basic structure(s)
S1   - Nugget effect, Sill =        0.39
S2   - Spherical - Range = 15.00000m, Sill =       0.22
S3   - Spherical - Range = 880.00000m, Sill =       0.39
```

Figure 36 Variogram Model – Gaussian Transformed Data (Left – down-hole variogram / Right - isotropic variogram)

Based on the limited amount of samples (131), a poor variogram was generated. It shows a moderate relative nugget of 39%. The short-range structure contributes a significant portion of the non-nugget variance (22%) and has a range approximating the cross-strike drill spacing of 20 - 30 m. The overall range is 880 m, which is in excess of the along strike drill spacing of 150 m to 50 m.

E East Pit Area –MSM Oxide

A total of 88 samples were used to represent the E East MSM oxide zone (Figure 37). The log-histogram of the data is shown in Figure 38.

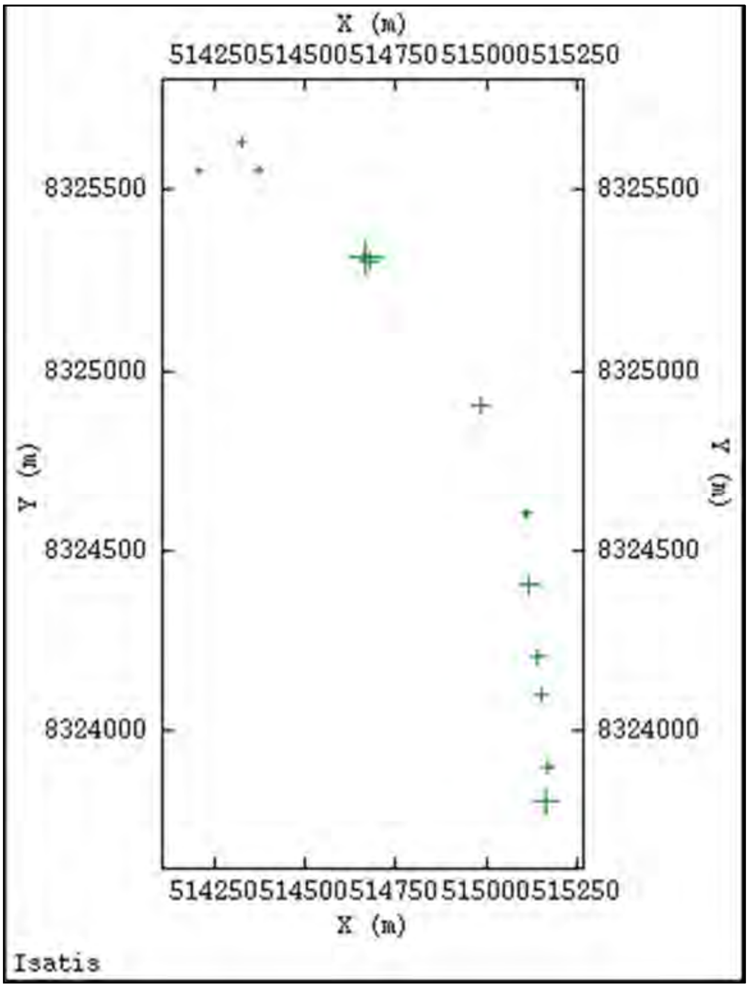
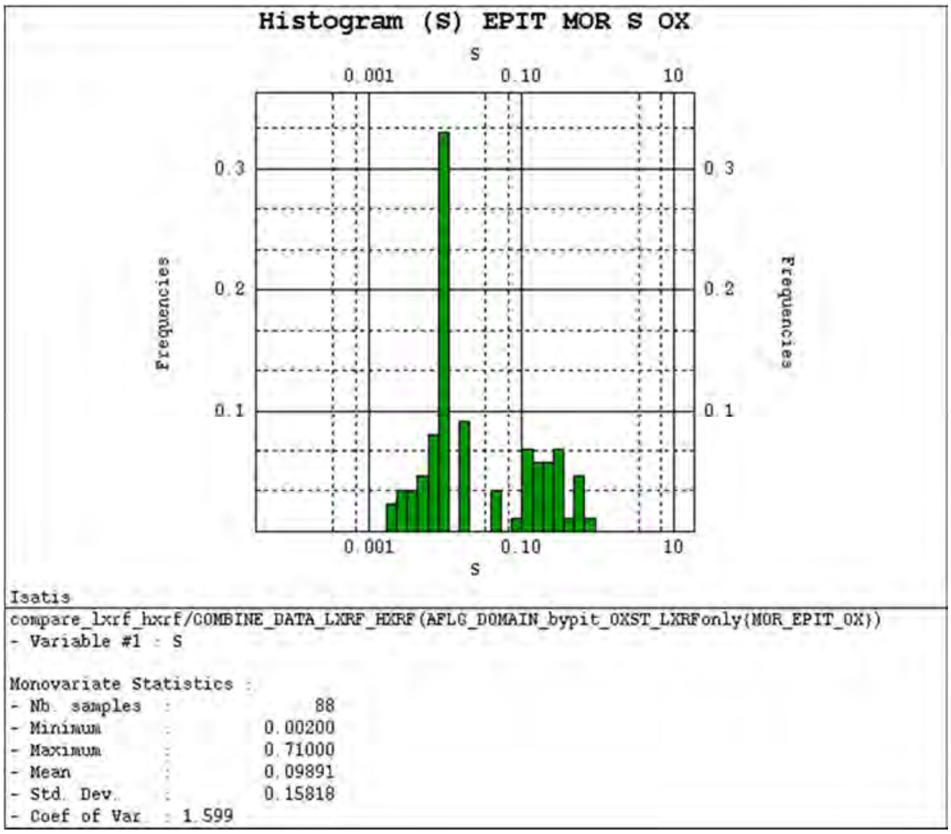


Figure 37 Base Map of LXRF - Sample Location – Plan view

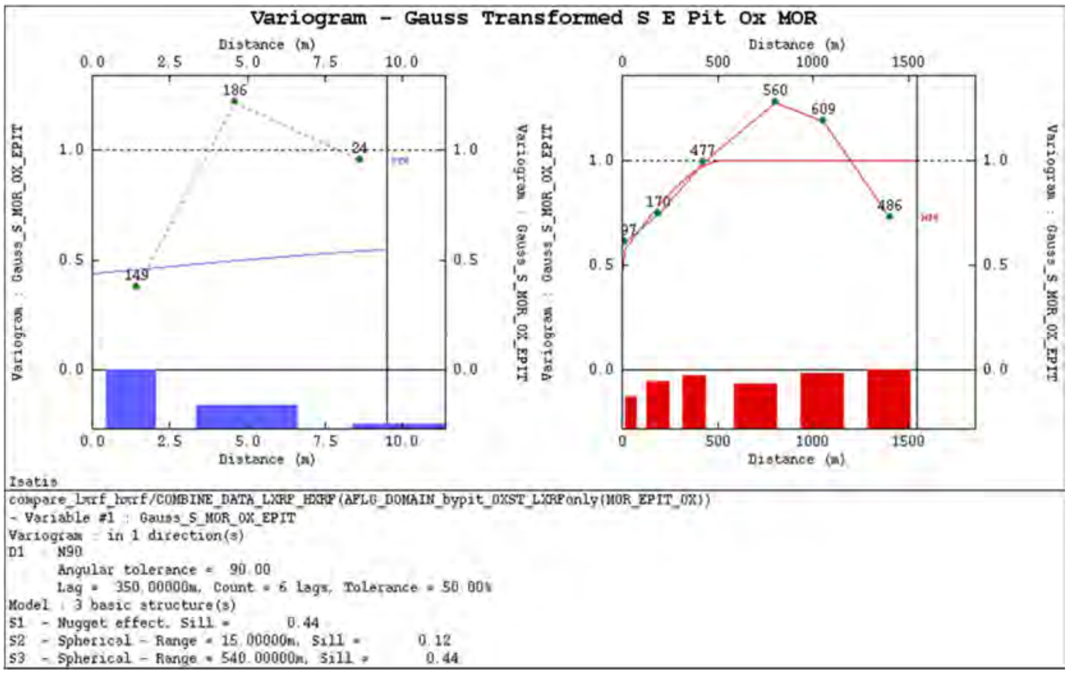


```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(MOR_EPIT_OX))
- Variable #1 : S

Monovariate Statistics :
- Nb. samples   :            88
- Minimum       :       0.00200
- Maximum       :       0.71000
- Mean          :       0.09891
- Std. Dev.     :       0.15818
- Coef of Var.  :  1.599
```

Figure 38 Log-Histogram of LXRF Data

An omnidirectional, 2 structure spherical model was fitted to the Gaussian transformed data, and is shown in Figure 39.



```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(MOR_EPIT_OX))
- Variable #1 : Gauss_S_MOR_OX_EPIT
Variogram : in 1 direction(s)
D1 : N90
     Angular tolerance =  90.00
     Lag =  350.00000m, Count = 6 lags, Tolerance = 50.00%
Model : 3 basic structure(s)
S1  - Nugget effect, Sill =       0.44
S2  - Spherical - Range = 15.00000m, Sill =       0.12
S3  - Spherical - Range = 540.00000m, Sill =       0.44
```

Figure 39 Variogram Model – Gaussian Transformed Data (Left – down-hole variogram / Right - isotropic variogram)

Based on the limited amount of samples (88), a poor variogram was generated. It shows a moderate relative nugget of 44%. The short-range structure contributes a small portion of the non-nugget variance (12%) and has a range approximating the cross-strike drill spacing of 20 - 30 m. The overall range is 540 m, which is in excess of the along strike drill spacing of 150 m to 50 m.

E East Pit Area –SIM Fresh

A total of 3,951 samples were used to represent the E East SIM fresh zone (Figure 40). The log-histogram of the data is shown in Figure 41.

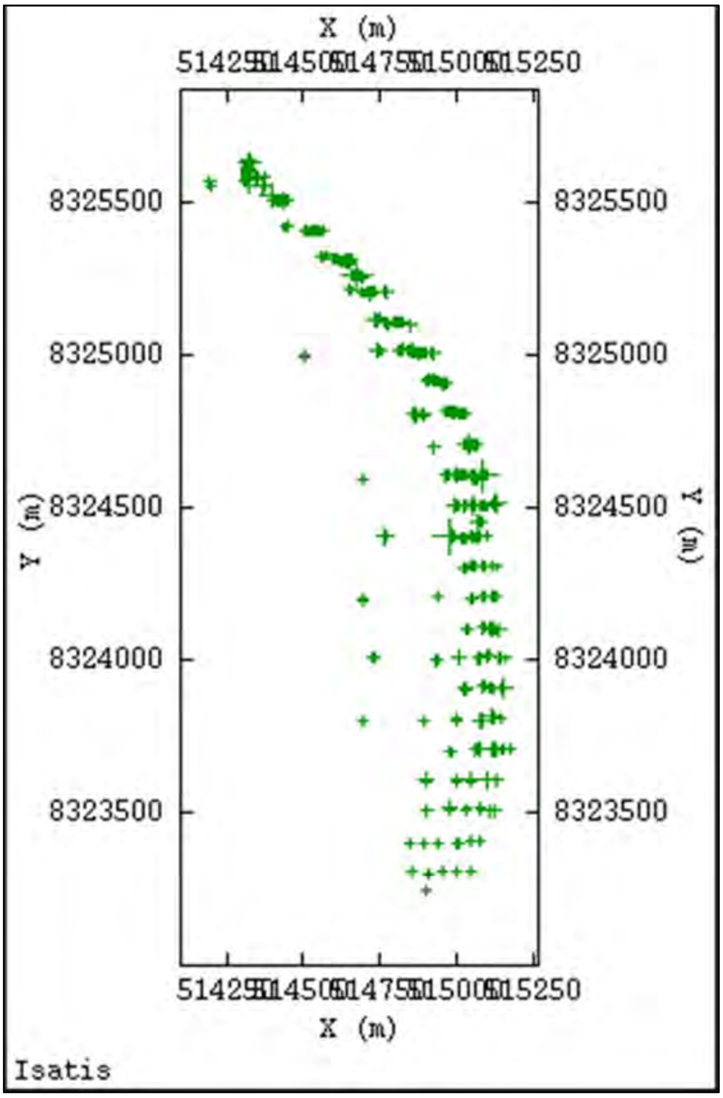
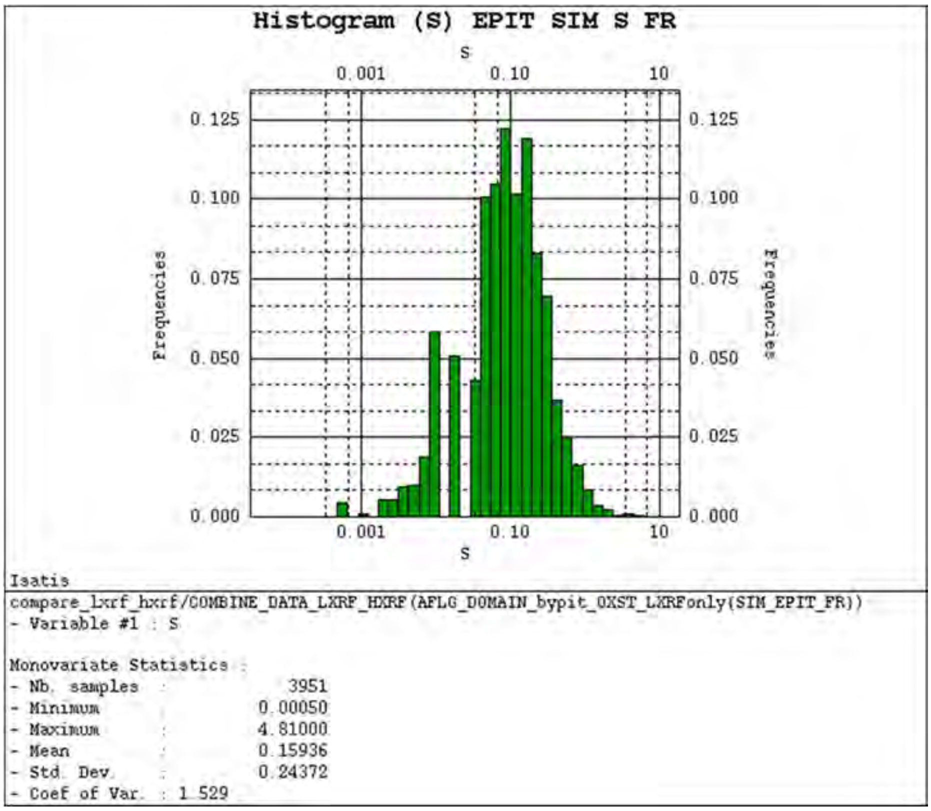


Figure 40 Base Map of LXRF - Sample Location – Plan view

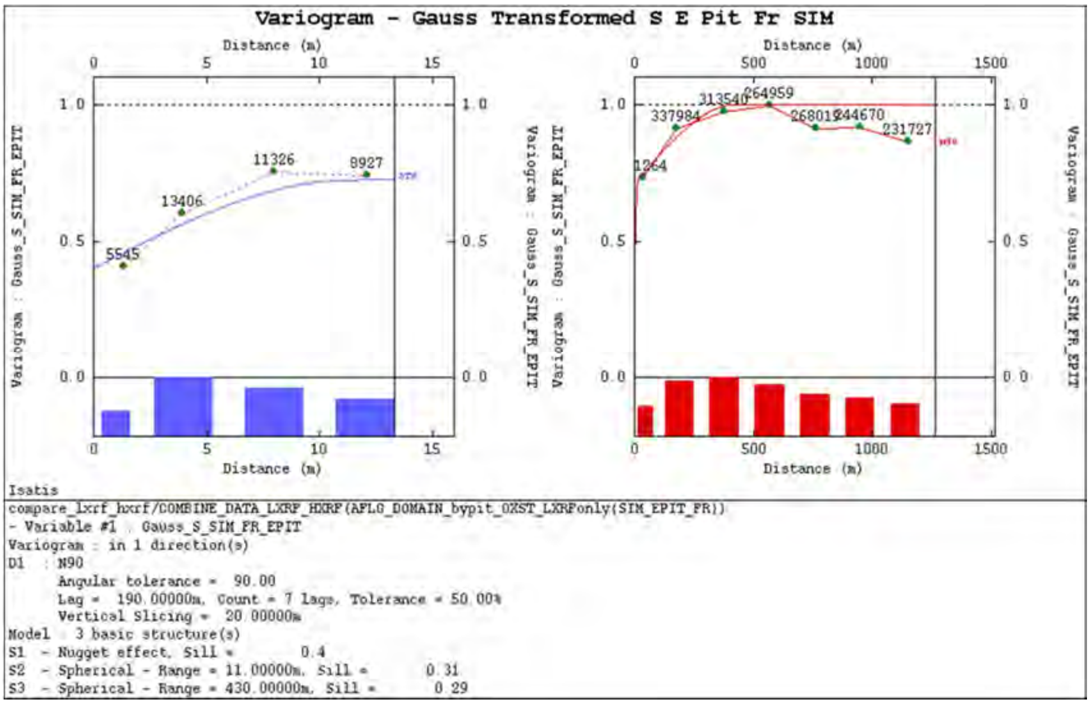


```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(SIM_EPIT_FR))
- Variable #1 : S

Monovariate Statistics :
- Nb. samples   :        3951
- Minimum       :     0.00050
- Maximum       :     4.81000
- Mean          :     0.15936
- Std. Dev.     :     0.24372
- Coef of Var.  :  1.529
```

Figure 41 Log-Histogram of LXRF Data

An omnidirectional, 2 structure spherical model was fitted to the Gaussian transformed data, and is shown in Figure 42.



```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(SIM_EPIT_FR))
- Variable #1 : Gauss_S_SIM_FR_EPIT
Variogram : in 1 direction(s)
D1   : N90
       Angular tolerance =  90.00
       Lag =  190.00000m, Count = 7 lags, Tolerance = 50.00%
       Vertical Slicing =  20.00000m
Model : 3 basic structure(s)
S1  - Nugget effect, Sill =         0.4
S2  - Spherical - Range = 11.00000m, Sill =       0.31
S3  - Spherical - Range = 430.00000m, Sill =       0.29
```

Figure 42 Variogram Model – Gaussian Transformed Data (Left – down-hole variogram / Right - isotropic variogram)

It shows a moderate relative nugget of 40%. The short-range structure contributes a significant portion of the non-nugget variance (31%) and has a range approximating the cross-strike drill spacing of 20 - 30 m. The overall range is 430 m, which is in excess of the along strike drill spacing of 150 m to 50 m.

E East Pit Area –KYA Fresh

A total of 209 samples were used to represent the E East KYA fresh zone (Figure 43). The log-histogram of the data is shown in Figure 44.

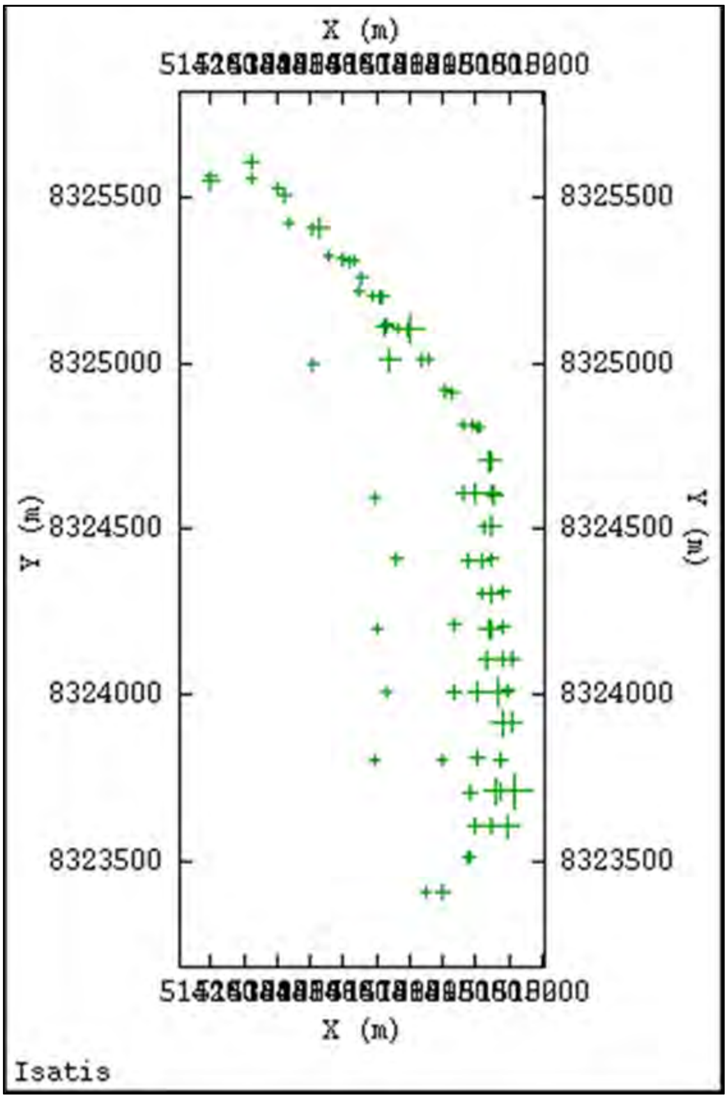
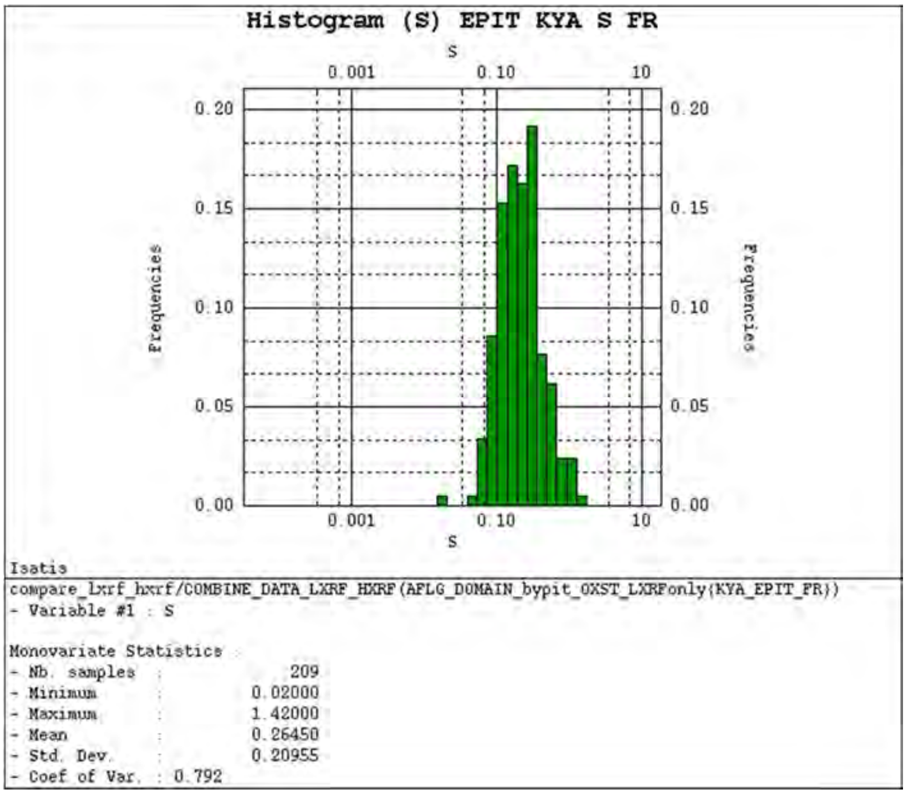


Figure 43 Base Map of LXRF - Sample Location – Plan view

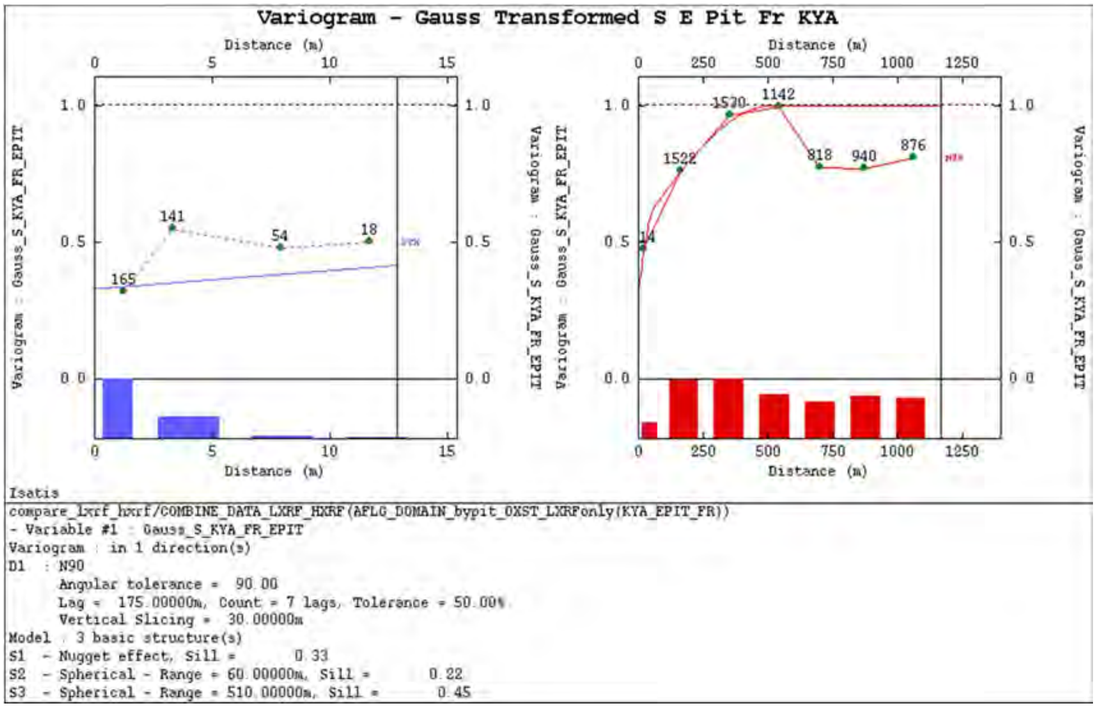


```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(KYA_EPIT_FR))
- Variable #1 : S

Monovariate Statistics :
- Nb. samples     :          209
- Minimum         :      0.02000
- Maximum         :      1.42000
- Mean            :      0.26450
- Std. Dev.       :      0.20955
- Coef of Var.    :  0.792
```

Figure 44 Log-Histogram of LXRF Data

An omnidirectional, 2 structure spherical model was fitted to the Gaussian transformed data, and is shown in Figure 45.



```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(KYA_EPIT_FR))
- Variable #1 : Gauss_S_KYA_FR_EPIT
Variogram : in 1 direction(s)
D1   : N90
      Angular tolerance =  90.00
      Lag =  175.00000m, Count = 7 lags, Tolerance = 50.00%
      Vertical Slicing =  30.00000m
Model : 3 basic structure(s)
S1  - Nugget effect, Sill =        0.33
S2  - Spherical - Range = 60.00000m, Sill =        0.22
S3  - Spherical - Range = 510.00000m, Sill =        0.45
```

Figure 45 Variogram Model – Gaussian Transformed Data (Left – down-hole variogram / Right - isotropic variogram)

It shows a moderate relative nugget of 33%. The short-range structure contributes a significant portion of the non-nugget variance (22%) and has a range approximating the cross-strike drill spacing of 20 - 30 m. The overall range is 510 m, which is in excess of the along strike drill spacing of 150 m to 50 m.

E East Pit Area –MSM Fresh

A total of 570 samples were used to represent the E East MSM fresh zone (Figure 46). The log-histogram of the data is shown in Figure 47.

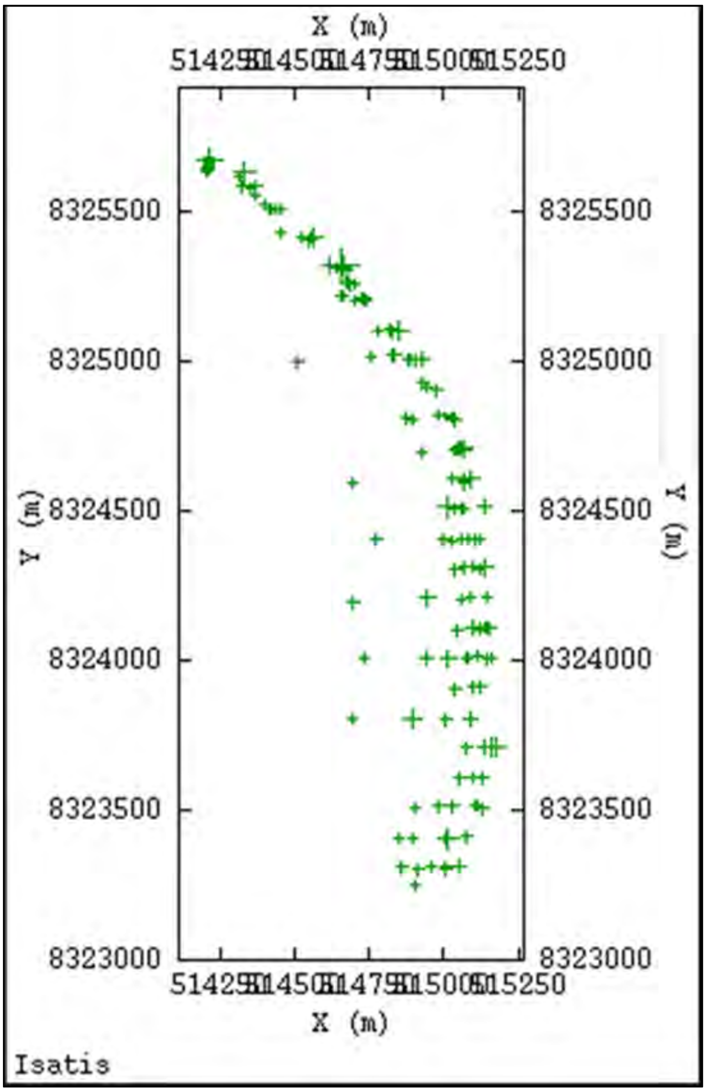
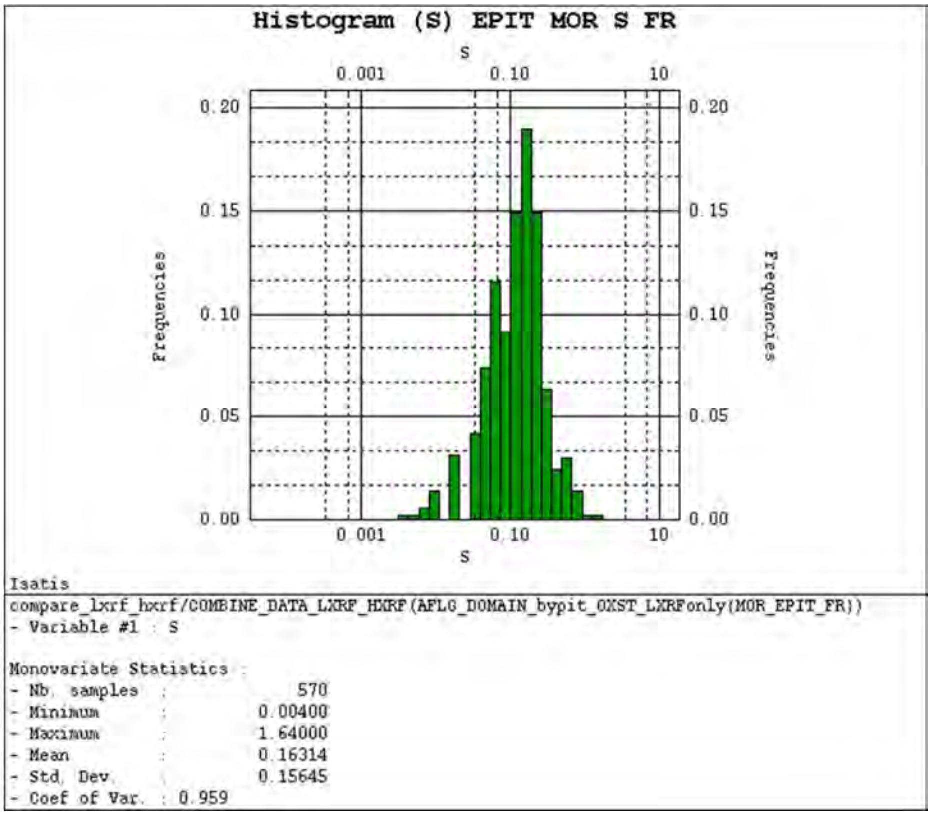


Figure 46 Base Map of LXRF - Sample Location – Plan view

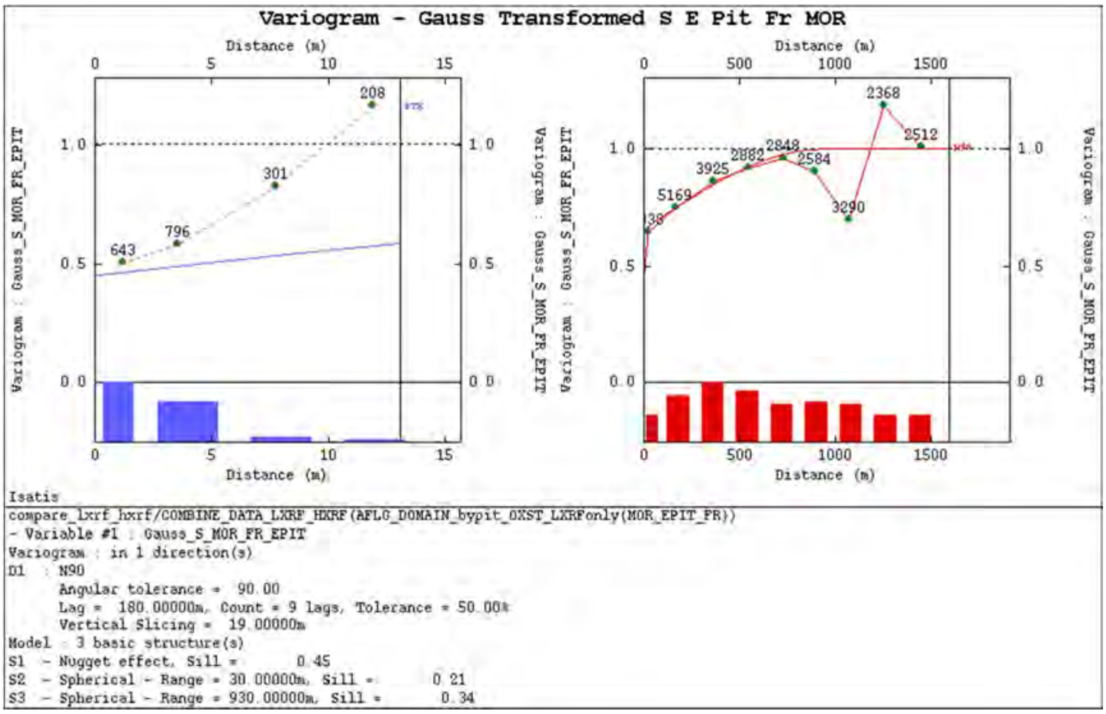


```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(MOR_EPIT_FR))
- Variable #1 : S

Monovariate Statistics :
- Nb. samples   :          570
- Minimum       :      0.00400
- Maximum       :      1.64000
- Mean          :      0.16314
- Std. Dev.     :      0.15645
- Coef of Var.  : 0.959
```

Figure 47 Log-Histogram of LXRF Data

An omnidirectional, 2 structure spherical model was fitted to the Gaussian transformed data, and is shown in Figure 48.



```
compare_lxrf_hxrf/COMBINE_DATA_LXRF_HXRF(AFLG_DOMAIN_bypit_OXST_LXRFonly(MOR_EPIT_FR))
- Variable #1 : Gauss_S_MOR_FR_EPIT
Variogram : in 1 direction(s)
D1   : N90
       Angular tolerance =  90.00
       Lag =  180.00000m, Count = 9 lags, Tolerance = 50.00%
       Vertical Slicing =  19.00000m
Model : 3 basic structure(s)
S1   - Nugget effect, Sill =        0.45
S2   - Spherical - Range = 30.00000m, Sill =        0.21
S3   - Spherical - Range = 930.00000m, Sill =        0.34
```

Figure 48 Variogram Model – Gaussian Transformed Data (Left – down-hole variogram / Right - isotropic variogram)

It shows a moderate relative nugget of 45%. The short-range structure contributes a significant portion of the non-nugget variance (21%) and has a range approximating the cross-strike drill spacing of 20 - 30 m. The overall range is 930 m, which is in excess of the along strike drill spacing of 150 m to 50 m.

Variogram summary

The spatial variability study showed that the sulphur grade continuity has been adequately represented by the sample density of the LXRF data set. The LXRF data has been collected on an approximate 100 m section lines along strike in the E East Area and 150 m section lines or better along strike, at the F East Area; well within the limits shown in the variogram study. Refer to Table 3.

Table 3 Summary of Variography Ranges Estimated for Sulphur by Region

Region	Number of Samples	Variogram Range - Sulphur
F Pit Area – SIM Oxide	2,283	1,300 m
F Pit Area – KYM Oxide	695	200 m
F Pit Area – MSM Oxide	1,137	580 m
F Pit Area – SIM Fresh	6,876	180 m
F Pit Area – KYM Fresh	4,398	1,500
F Pit Area – MSM Oxide	2,848	910 m
E East Area – SIM Oxide	1,270	620 m
E East Area – KYM Oxide	131	880 m
E East Area – MSM Oxide	88	540 m
E East Area – SIM Fresh	3,951	430 m
E East Area – KYM Fresh	209	510 m
E East Area – MSM Oxide	570	930 m

The spatial variability study showed that the sulphur grade continuity has been adequately represented by the sample density of the LXRF data. The LXRF data has been collected on approximate 100 m section lines at E East, and on 150 m section lines or better at F East and the F West pits; well within the limits shown in the correlogram study.

Conclusions

The geostatistical summary provided herein E shows that the geochemical model provided good spatial correlation between the laboratory XRF dataset and the geological block models.

With regard to data set correlation, for the total sulfur there was a very good correlation between the ABA and laboratory XRF data sets.

The laboratory (ABA) derived NAPP data shows a significantly lower NAPP value in comparison to the estimated (laboratory XRF) assay NAPP value, showing that the assay datasets do not consider all neutralising minerals in their readings, unlike the laboratory ABA titration method.

The spatial variability study showed that the sulphur grade continuity has been adequately represented by the sample density of the laboratory XRF data. The laboratory XRF data has been collected on approximate 100 m section lines at E East, and on 150 m section lines or better at F East and the F West pits; well within the limits shown in the correlogram study.

The order of magnitude sampling assessment showed that an appropriate number of geochemical samples had been collected in the laboratory XRF dataset to undertake a preliminary geochemical assessment (Appendix A). However, an insufficient number of laboratory geochemical samples had been collected to undertake the preliminary geochemical assessment (Appendix A).

That is to say, that the sample set provided by Pendragon, *on its own,* is insufficiently large to base a statistically confident geochemical assessment upon to inform an AMD risk assessment. Therefore, the laboratory XRF assay data set was utilised in combination with the Pendragon (2012) data to ensure a representative data set was used to inform site AMD risk. A forward sampling schedule has been provided to bolster the laboratory (Pendragon) ABA data (including metals) to ensure the AMD risk assessment can be better informed over the life of mine at Roper Bar.

Appendix E: Environment Monitoring Report and NRP Water Management Plan

ENVIRONMENTAL
MINING
REPORT 2023

OPERATOR DETAILS

Name of Mine	Nathan River Project (NRP)	
Name of Mine Operator	NRR Services Pty Ltd (NRR)	
Operational ML / AA	AA29691	ML28264
	AA29692	ML28963
	ML28267	ML28962
	ML28266	ML29628

EMR Reporting Period	1 January 2023 – 31 December 2023	
Reporting Officer	Name:	Simon Peat
	Title:	Chief Executive Officer
	Signature:	
	Date:	13 February 2024

TABLE OF CONTENTS

1.0 INTRODUCTION 4

1.1 Scope 4

2.0 ANNUAL HIGHLIGHTS 6

2.1 Mining Activities 6

2.2 Environmental Performance Summary 7

3.0 MINE CLOSURE 7

4.0 COMMITMENT REGISTER 7

5.0 ENVIRONMENAL INSPECTIONS AND INSTRUCTIONS 8

6.0 ENVIRONMENTAL MANAGEMENT AND PERFORMANCE 14

6.1 Surface Water Monitoring 14

6.2 Discussion of Surface Water Monitoring Data 21

6.3 Groundwater Monitoring 25

6.4 Discussion of Groundwater Results 31

6.5 Discharge Monitoring during Dewatering 33

6.6 Sediment Monitoring 33

6.7 Discussion of Sediment Results 36

6.8 Biological Monitoring 36

6.9 Dust Monitoring 36

7.0 CONCLUSIONS 41

8.0 REFERENCES 42

FIGURES

Figure 1-1: NRP Regional Location 5

Figure 6-1: Surface Water Monitoring Locations – Mine 17

Figure 6-2: Surface Water Monitoring Locations – BBLF 18

Figure 6-3: Groundwater Monitoring Bore Locations – Mine 27

Figure 6-4: Groundwater Monitoring Bore Locations – BBLF 28

Figure 6-5: Sediment Monitoring Locations 35

Figure 6-6: Dust Monitoring Locations – Mine 38

Figure 6-7: Dust Monitoring Locations - BBLF 39

TABLES

Table 4-1: Summary of Compliance with Primary Project Approval Condition's and the Mining Authorisation 8

Table 5-1: Actions and status from DITT Inspection at the NRP 9

Table 6-1: NRP Surface Water Monitoring Locations........ 14

Table 6-2: High Level Overview of Surface Water Monitoring Results 19

Table 6-3: Groundwater Monitoring Bore locations and construction details. 26

Table 6-4: High Level Overview of Ground Water Monitoring Results 29

Table 6-5: Sediment Monitoring Locations 34

Table 6-6: NRP Depositional Dust Monitoring Locations 37

Table 6-7: Depositional Dust Total Insoluble Matter 40

APPENDICIES

Appendix A: Compliance with Recommendations from Roper Bar Iron Ore Phase 1 Project Environmental Assessment Report and Recommendations by the NT EPA

Appendix B: Compliance against EPBC Approval 2012/6246

Appendix C: Compliance with Mining Authorisation 1062-01

Appendix D: Environmental Monitoring Data - 2023

Appendix E: Water Management and Monitoring Plan 2019 - NRR

Appendix F: Dust Management Plan 2022 – NRR

Appendix G: Environmental Incident Investigation Report December 2023 - BBLF

Appendix H: Bing Bong Haul Road Bridge Remediation Works 2023

1.0 INTRODUCTION

The Nathan River Project (NRP) (previously referred to as the Roper Bar Iron Ore Mine (RBIOM)) is operated by NRR Services Pty Ltd (NRR) since acquiring the NRP from the previous operators, Western Desert Resources (WDR) in 2019. The NRP is located approximately 530 kilometres (km) southeast of Darwin within the Gulf of Carpentaria and is comprised of three main operation domains: the Mine, the haul road and the Bing Bong Loading Facility (BBLF). The mine is located within mining leases (ML) 28962, 28267, 28266, 28963 and 28264. The haul road, privately owned and operated by NRR, stretches for 171 km, connecting the Mine and the BBLF allowing the haulage of material to the BBLF. The BBLF is situated within ML 29628, located on the south-western coast of Gulf of Carpentaria approximately 50 km north of Borroloola. Glencore's McArthur River Mine operates a larger loading facility at the BBLF and is the overarching controller of the Port. The regional location of the NRP is presented in **Figure 1-1**.

The previous operator, WDR commenced mine construction and operations in 2013 following the approval of the Roper Bar Iron Ore Project (RBIOP) Environmental Impact Statement (EIS) under the previous *Environmental Assessment Act.* Upon acquiring the NRP (then known as RBIOP), NRR submitted a Mining Management Plan (MMP) in accordance with the *Mining Management Act 2001 (MMA)*, receiving approval in the form of mining authorisation 1062 to commence operations in 2020. NRR currently operates the NRP under the variation of authorisation 1062-01 which was granted by the Department of Tourism, Industry and Trade (DITT) on 24 October 2023.

1.1 Scope

This 2023 Environmental Mining Report (EMR) for the NRP has been prepared to meet statutory reporting requirements under Section 37(3)(e) of the MMA and Variation of Authorisation 1062-01. This EMR covers the reporting period from 1 January 2023 to 31 December 2023.

Legend

🟥 Tenement Boundaries

Source: Geoscience Australia 2006, Northern Territory Government (Department of Industry, Tourism and Trade) 2022, Nathan River Resources 2018-2020, METServe 2023, Earthstar Geographics.

Nathan River Project

Regional Location

0 5 10 20

Kilometers

Scale: 1:640,000 (A4)

14/06/2023

Datum: GDA2020
Projection: MGA53

FIGURE 1-1

METSERVE
Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\MMP\BM001_NR_MMP_Regional_Location.aprx

2.0 ANNUAL HIGHLIGHTS

NRR received approval of the Low-Grade Ore (LGO) MMP Amendment in October 2022, authorising the initial restart of operations at the NRP since going into care and maintenance (C&M) in November 2021. This MMP amendment, referred to as the LGO operation, focused on repairing project critical infrastructure (e.g. Sawfish camp, haul road, communications), onboarding and mobilsation of contractors and equipment to the NRP, and significant mine planning and design. In addition to this, NRR commenced the processing and sorting of LGO material which remained from the previous operation (prior to C&M), along with the restart of haulage and transhipment operations in June 2023.

In October 2023, a further MMP amendment was approved by DITT referred to Stage 1A. Stage 1A represents the next stage of the NRP restart, focusing on the following activities:

- Recommencement of mining which will target the Danehill pit saddle and Zabeel North open-cut pit;
- Processing and sorting of ore;
- Haulage of ore to the BBLF; and
- Transhipment of ore from the BBLF.

Although approval of Stage 1A operations was received in October 2023, NRR did not commence these activities in 2023, only since commencing in 2024. The approval of the Stage 1A MMP amendment was a significant milestone for the NRP.

2.1 Mining Activities

Mining activities which have occurred over the 2023 EMR period include:

- Processing, screening and sorting of LGO material;
- Civil works to facilitate processing and maintain / repair existing mine infrastructure; and
- Commencement of material removal from the Danehill Saddle mining area.

Ancillary activities such as haulage to and transhipment operations at the BBLF also occurred during the EMR period. An estimated 350,000 tonnes of iron ore was processed, hauled, shipped and supplied to market in 2023. NRR considers this to be a significant achievement given the NRP was in C&M less than 12 months ago.

NRR began removing material from the Danehill Saddle mining area in December 2023 as authorised by the Stage 1A MMP amendment. Mining of the Danehill Saddle and Zabeel North pit will continue throughout 2024.

2.2 Environmental Performance Summary

One reportable environmental incident occurred during the EMR period which relates to dust emissions associated with transhipment activities at the BBLF. An environmental incident notification was submitted to DITT on 22 December 2023 after NRR was notified by DITT of a complaint against NRR's BBLF operation. Since the time of the incident, several immediate dust mitigation measures have been implemented and a detailed investigation on the incident has been recently submitted to DITT outlining the details of the incident. This incident investigation report is provided in **Appendix G** for reference.

Aside from this one reportable incident, no other environmental incidents or material environmental harm is considered to have occurred during the 2023 EMR period.

3.0 MINE CLOSURE

Mine rehabilitation activities were not conducted during the 2023 reporting period. A conceptual mine closure design was included within the overarching 2019 MMP. Prior to the C&M period, work commenced on developing a standalone Mine Closure Plan for the NRP by a specialist closure consultant. However, this scope was put on hold following the decision to suspend operations in December 2021. Upon the recommencement of mining activities in 2024, mine closure planning will recommence and NRR expects to finalise the NRP Mine Closure Plan in June 2024.

4.0 COMMITMENT REGISTER

Performance against the NT EPA recommendations (EPA Assessment Report 70) and the conditions imposed by the Federal Government under the *Environmental Protection and Biodiversity Conservation Act* (EPBC 2012/6242) are included in **Appendix A** and **B** respectively.

Operational phase commitments and obligations arise from the Project's EIS commitments, Environmental Management System and the MMP which along with a range of supporting environmental management plans, are approved as part of the Mining Authorisation 1062-01. It is not considered practicable to demonstrate compliance against all operational commitments and obligations and the approach is taken to assess compliance against relevant conditions in the Mining Authorisation and otherwise to report by exception. **Appendix C** provides an overview of compliance against key conditions within Mining Authorisation 1062-01 (issued October 2023). **Table 4-1** provides a summary overview of compliance against the primary project approval conditions and Mining Authorisation 1062-01.

As 2023 was the first year of the recommencement of activities at the NRP, minor changes have occurred in regards to the compliance of the Project's Primary Approvals reported in the 2022 EMR.

Table 4-1 - Summary of Compliance with Primary Project Approval Condition's and the Mining Authorisation

Approval	No of applicable obligations	Fully Complaint	Partially Compliant	Non-compliant	Other
NT EPA Assessment Report	20	15	1	0	4
EPBC Approval 2012/6242	24	14	6	0	4
NT Mining Authorisation 1062-01	41	34	6 (3 materially compliant)	1	0

5.0 ENVIRONMENAL INSPECTIONS AND INSTRUCTIONS

One environmental inspection was conducted by DITT on 2 October 2023 during the reporting period. **Table 5-1** below summarises the required actions which DITT has recommended for NRR to address, along with a status on implementing this action as of February 2024.

No environmental instructions were issues to NRR during the 2023 reporting period.

Table 5-1 Actions and status from DITT Inspection at the NRP

NRP Area	DITT Recommendation	NRR Response
BBLF	Prior to 31 October 2023, undertake the necessary upgrades and remediation works to the BBLF sediment pond to prevent discharge of sediment laden waters off the mine lease.	NRR have completed remediation on BBSP02 since the DITT inspection in an attempt to improve the function and operation of the sediment pond. Remediation of the inlet into the sediment pond has been complete which included the clearing of the main drainage line which reports to BBSP02, along with the installation of riprap along the inlet of BBSP01. Clearing of reporting drainage lines and installation of riprap has been done in an effort to settle out suspended solids before entering the pond. The BBSP02 spillway was also raised to improve the storage capacity of the pond and reduce the risk of spilling to the receiving environment.
	Before the 2023-2024 Wet Season commences i.e. 31 October 2023, provide a brief update of the activities undertaken by NRR to be Wet Season ready at both the BBLF and at the mine with consideration of water free board inventory, pumping and water holding infrastructure, discharge licence and seepage mitigation. Please note, Condition 47 of Authorisation 1062-01 which requires submission of an ICE-endorsed "as-constructed" report of all water holding structures each wet season.	Prior to the commencement of the 23-24 wet season, NRR installed water management infrastructure which allows the transfers of water between BBSP02, BBSP03 and BBSP04. Since the installation of this infrastructure, BBSP02 has been dewatered to BBSP03 (which had sufficient capacity) to ensure BBSP02 does not spill to the receiving environment during the 2023-24 wet season. To date during the 2023-24 wet season, BBSP02 has not spilled to the receiving environment and is not anticipated given the ability to transfer water from this sediment pond to other water storages at the BBLF.

		No new water storage structures have been constructed at the BBLF during the EMR period, hence no 'as-construction' reports for new structures are not available.
Haul Road	Provide an overview of the road and bridge maintenance in the next EMR submission with independent advice on the stability of all problematic bridges.	NRR has undertaken significant stabilisation works across all haul road bridges in consultation with WSP throughout the early part of 2023, prior to haulage activities commencing. **Appendix H** outlines the remediation works completed. In addition to grading and watercarts operating on the unsealed sections of the haul road, NRR has engaged F&J Bitumen to undertake pothole repairs and remediation of sealed road sections that have deteriorated. This will extend to re-sealing of the smaller sections of unsealed road in the short term. Longer term, NRR will continue with an active road maintenance program.
	Continue the management of the weed *Parkinsonia aculeata* at the BBLF and provide an update on this issue in the next EMR submission.	No management of *Parkinsonia aculeata* has been completed since the DITT inspection due to access being limited to areas during the wet season. NRR plans to conduct a weed management campaign of *Parkinsonia* at the BBLF after the wet season (once access allows) between March and May. Advice on the NT.GOV.AU website outlines that March to May is the most effective time of year to treat this weed. NRR intends to follow this advice and seek advice on treatment methods from the NT.GOV.AU website.
Zabeel Area	Undertake monitoring of the Zabeel PAF cell for physical integrity of the cap as well as downstream water quality. Remediate the cell cap as needed and provide update in the next EMR submission.	No remediation works have been completed since the DITT inspection. Despite this, downstream water quality at RBSW09 will be frequently monitored throughout the 2023-24 wet season to identify any influence

		on downstream water quality associated with the Zabeel waste rock dumps. NRR intends to remediate the capping with NAF material and delineate this area to ensure NRP personnel are aware and can be frequently monitored. Repairs will commence once access allows post-wet season.
	Discuss in the next EMR submission, impacts to Pandanus Creek from mining activity at Zabeel (if any).	No mining activity has occurred in the Zabeel mining area since October 2021. No environmental impacts to Pandanus Creek are considered to have occurred during the EMR period.
	Due to previous failure, the Zabeel Water Storage Pond is not to be used for water storage until it is demonstrated to be fit for purpose.	Zabeel Water Storage Pond (referred to as RBSP07) has not been used as a water storage during the EMR period or is proposed to be used in the future. NRR intends to backfill this decommissioned water storage with waste rock material in the upcoming 2024 dry season once the storage has been dewatered.
	If intending to utilise rainwater currently captured in the Zabeel Water Storage Pond for dust suppression, ensure the water is of suitable quality.	As outlined above, RBSP07 has not received any pumped inflows during the EMR period and is not proposed as a water storage. Over subsequent wet seasons, RBSP07 has accumulated surface run-off and rainfall and holds approximately 40 megalitres currently. NRR proposed to install a temporary water cart fill point at RBSP07 and utilise the accumulated water for dust suppression purposes around the Zabeel mining area. Water quality of RBSP07 (provided in **Appendix D**) indicates water is of appropriate quality for dust suppression purposes.
ROM Pond	Undertake the corrective actions recommended by the ICE report for the ROM pond, including installation of the spillway, mitigation of the	NRR have completed the corrective actions recommended by the ICE report for the ROM Pond (referred to as RBSP02). The following works have been completed:

	erosion of the embankments and the culvert, and installation of piezometers.	• Inlet culvert has been blocked off preventing water from moving between the ROM pad and RBSP02; • Repair of gully erosion on RBSP02 banks; and • Installation of the spillway pipe on the western wall of RBSP02. NRR are considering the installation of piezometers around the perimeter of RBSP02. NRR intends to provide the 'as-constructed' report for RBSP02 to DITT shortly. This report will satisfy the conditional approval of RBSP02 and subsequently the commissioning of RBSP02.
Danehill Area	Mark the location of the PAF cell on the Danehill waste rock dump on the ground, in order to ensure staff are aware of the location and to enable visual monitoring of the cell.	The location of the PAF cell was temporarily marked out using survey paint after the DITT inspection. NRR intends to re-mark this area after the wet season as markings have been partially washed off owing to rainfall.
	If the Danehill waste rock pond is to be used as first point of mine-affected water storage to Zabeel South, then it must be verified to be fit for purpose. NRR needs to demonstrate it in their Wet Season Readiness report.	The Danehill waste rock pond (referred to as RBSP01) is used as the main water source for dust suppression activities at the NRP. As storage capacity becomes available in RBSP01, water is transferred from the Danehill pits to RBSP01, ensuring a continuous water source for dust suppression operations within the Danehill mining area. RBSP01 is considered to be 'fit for purpose' to store mine-affected water. Should seepage of mine-affected water occur from RBSP01, water is expected to report to the Danehill East pit as a result of the groundwater gradient moving in this direction / cone of depression imposed by the Danehill East pit. In the event that RBSP01 exceeds its storage capacity, water will inundate the irrigation area adjacent to the pond, and eventually report to the Danehill East pit should water exceed the

		capacity of the irrigation area. All water is contained within RBSP01 and the adjacent irrigation area by the levee wall which surrounds the Danehill mining area.

6.0 ENVIRONMENTAL MANAGEMENT AND PERFORMANCE

6.1 Surface Water Monitoring

Surface water quality was monitored at 17 surface water monitoring locations across the Mine and two at the BBLF during the 2023 reporting period. Surface water monitoring locations incorporate natural surface waters (tributaries / watercourses) as well as artificial water storages (dams / open pits). All surface monitoring locations are presented in **Figure 6-1** and **Figure 6-2**, with details provided in **Table 6-1**. Further details on the surface water quality monitoring program implemented at the NRP are provided in the Water Management and Monitoring Plan (NRR 2019) (**Appendix E**). Monitoring of natural and artificial surface water locations outlined in **Table 6-1** occurs on a monthly basis should flowing conditions exist along the tributary/watercourse or sufficient water exist in the water storage. Water quality recorded at natural surface water monitoring locations are compared against the default ANZECC (2000) guidelines for tropical lowland rivers (physical and chemical parameters) and the ANZ Guidelines (2018) for toxicants at the 95% species protection level (ANZECC 2000; ANZG 2018). ANZECC 2000 and ANZG 2018 guidelines are only directly applied to natural surface water monitoring sites and are not applied to artificial surface waters as this water is not interacting with the receiving environment. Such guidelines have been used in this section for comparative purposes only for artificial surface water monitoring locations.

Table 6-1 – NRP Surface Water Monitoring Locations

Monitoring Location	Description	Purpose	Easting	Northing
RBSW01	Towns River	Reference	504457	8325044
RBSW02	Towns River	Upstream	506970	8325291
RBSW04	Towns River	Impact	509379	8325889
RBSW08	Drainage line	Impact	511484	8325873
RBSWDS	Towns River	Impact / Downstream compliance	511090	8327142
RBSW14	Towns River	Impact	522667	8336830
RBSWPU	Pandanus Creek	Upstream	514889	8324845
RBSW09	Pandanus Creek	Impact	515467	8325500

RBSW13	Magaranyi River	Impact	518316	8324677
RBSW15	Magaranyi River	Impact	517786	8325162
Stormwater retention basins				
RBSP01	Danehill Stormwater Pond	Mine-affected water storage	510025	8325111
RBSP02[1]	ROM Pad Stormwater Pond		511878	8325349
RBSP03[2]	Zabeel Stormwater Pond - North		515133	8325541
Open Pits				
FE1	Danehill East Pit 1	Mine-affected water storage	509460	8325548
FE2	Danehill West Pit 2		509144	8325474
FE3	Danehill West Pit 3		507786	8325257
EEA	Zabeel North Pit		514785	8325176
EEB	Zabeel South Pit		515087	8324699
BBLF Sediment Ponds				
BBSP01	Bing Bong Sediment Pond 1	Sediment ponds	647935	8271552
BBSP02	Bing Bong Sediment Pond 2		648154	8271592

Notes:

[1] RBSP02 was not commissioned in 2023. Monitoring will not commence until dam is commissioned.

[2] RBSP03 has not been constructed.

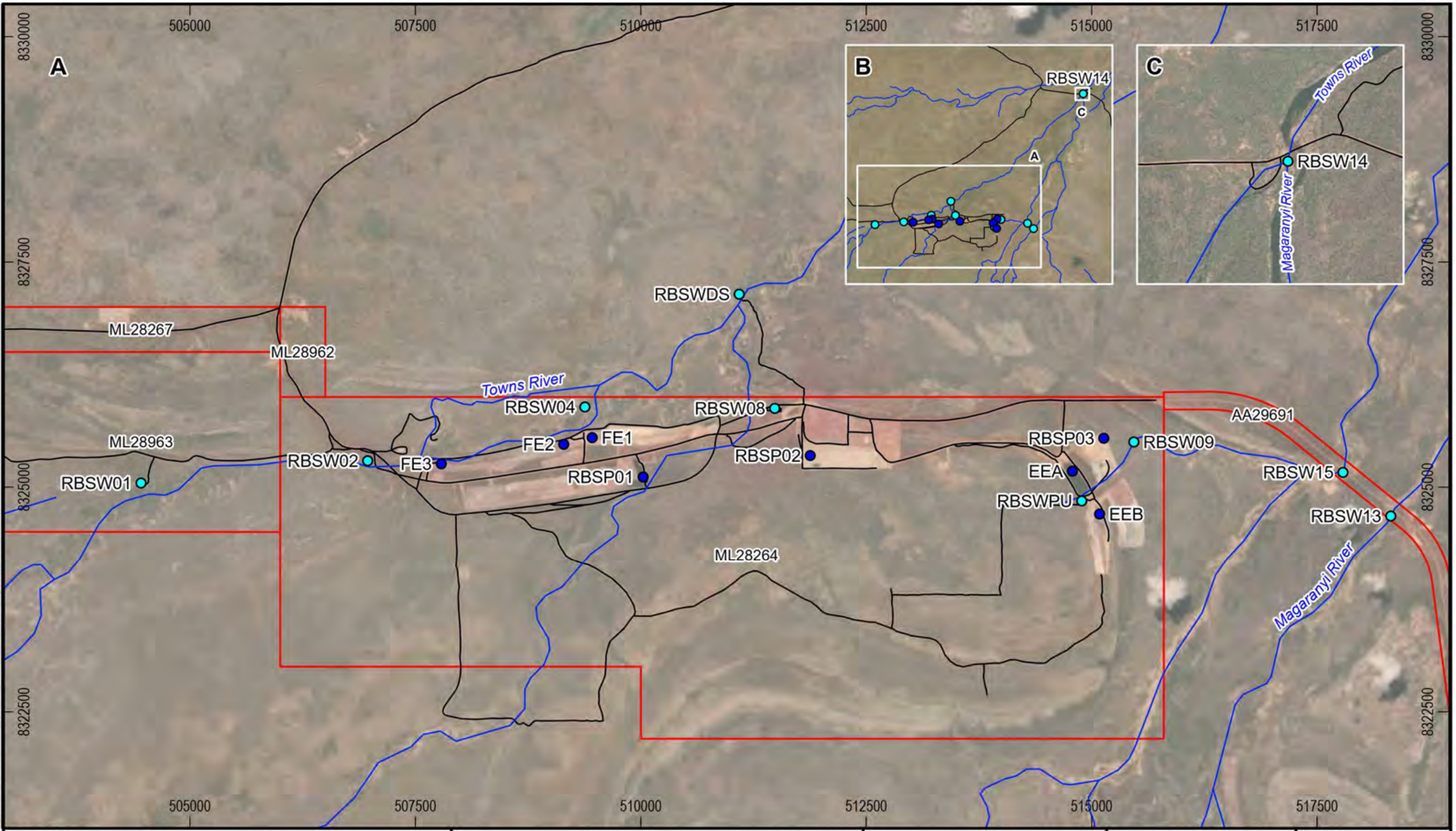
Coordinates projected in GDA94 Zone 53.

The surface water monitoring program specified in the WMMP (NRR 2019) was recommenced in 2022 and was implemented throughout the 2023 reporting period. Despite the resumption of the natural surface water monitoring program, a poor wet season over the 2022-2023 period limited the number of samples which could be collected. Ephemeral drainage lines and watercourses surrounding the NRP (e.g. Towns River, Magaranyi River and Pandanus Creek) had limited flow over the 2022-2023 wet season which only results in two monitoring events in January and February across majority of the natural surface water monitoring locations. No natural surface water monitoring occurred in late 2023 owing to the lack of flow across all natural surface water monitoring sites.

Artificial surface water monitoring was conducted each month for the majority of 2023 except for the months of March, April and May. Monitoring was not conducted over these months owing to a lack of staff availability. Monitoring of the two BBLF sediment ponds were not completed in 2023 as these storages were dry or had insufficient water for sampling throughout 2023.

Table 6-2 provides a high-level performance overview of water quality recorded at natural surface water and artificial surface water monitoring locations in 2023 by comparing the mean and median values of laboratory results from each of the monitoring location against the water assessment quality criteria outlined in the WMMP (NRR 2019). A traffic light approach is used to provide a simple means of demonstrating compliance status. Summarised laboratory results are provided for selected parameters in **Table D1** of **Appendix D**.

Further discussion of 2023 surface water monitoring results are provided in **Section 6.2**.



Legend

- Access Tracks
- Watercourses
- Tenement Boundaries

Surface Water Monitoring Locations

- ● Artifical Sites (Dams/Pits)
- ● Natural Surface Water Sites

Source: Northern Territory Government (Department of Environment, Parks and Water Security 2021; Department of Industry, Tourism and Trade 2022), Nathan River Resources 2018-2020, METServe 2023, Earthstar Geographics.

Nathan River Project

Surface Water Monitoring Locations - Mine

0 0.5 1 2

Kilometers

Scale: 1:60,000 (A4)

3/02/2023

Datum: GDA2020
Projection: MGA53

FIGURE 6-1

Nathan River Resources

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\EMR\BM001_NR_EMR_Surface_Water_Monitoring_Sites_Mine.aprx

Legend

● Surface Water Monitoring Locations

▭ Tenement Boundaries

Source: Northern Territory Government (Department of Industry, Tourism and Trade) 2022, Nathan River Resources 2018-2020, METServe 2023, Maxar.

Nathan River Project

Surface Water Monitoring Locations - Bing Bong Loading Facility

0 50 100 200

Meters

Scale: 1:6,000 (A4)

3/02/2023

N

Datum: GDA2020
Projection: MGA53

FIGURE 6-2

Nathan River Resources

METSERVE
Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\EMR\BM001_NR_EMR_Surface_Water_Monitoring_Sites_BBLF.aprx

Table 6-2 High Level Overview of Surface Water Monitoring Results

Parameter	Guideline Value (WMMP, 2019)	Artificial Surface Waters	Natural Surface Waters	Comments
pH	5.5 - 8.5	🟠	🟠	Danehill pits, RBSW02 and RBSW04 exceeded the lower pH limit of 5.5.
Electrical Conductivity	1,021 µS/cm	🟠	🟠	Danehill pits, RBSP01 and RBSP02 exceeded the EC guideline value. RBSW14 also exceeded.
Turbidity	194 NTU	🟢	🟢	No exceedances.
Ammonia	0.9 mg/L	🟠	🟢	Zabeel pits exceeded ammonia guideline value.
Nitrate	0.7 mg/L	🟠	🟢	Zabeel pits and FE1 exceeded nitrate guideline value.
Sulphate	500 mg/L	🟠	🟢	Danehill pits and RBSP01 exceeded sulphate guideline value.
Aluminium	1,050 µg/L	🟠	🟢	Danehill pits and RBSP01 exceeded aluminium guideline value.
Arsenic	13 µg/L	🟢	🟢	No exceedances.
Boron	520 µg/L	🟢	🟢	No exceedances.
Cadmium	0.2 µg/L	🟠	🟢	FE2 exceeded cadmium guideline value.
Chromium	10 µg/L	🟢	🟢	No exceedances.
Copper	2 µg/L	🟠	🟢	Danehill pits exceeded copper guideline value.
Iron	300 µg/L	🟠	🟢	Danehill pits exceeded iron guideline value.
Lead	4 µg/L	🟢	🟢	No exceedances.

Parameter	Guideline Value (WMMP, 2019)	Artificial Surface Waters	Natural Surface Waters	Comments
Manganese	1,900 µg/L	🟠	🟢	Danehill pits, Zabeel south and RBSP01 exceeded manganese guideline value.
Nickel	11 µg/L	🟠	🟢	Danehill pits, Zabeel south and RBSP01 exceeded nickel guideline value.
Selenium	10 µg/L	🟢	🟢	No exceedances.
Silver	1 µg/L	🟢	🟢	No exceedances.
Zinc	16 µg/L	🟠	🟢	Danehill pits and RBSP01 exceeded zinc guideline value.
Mercury	0.2 µg/L	🟢	🟢	No exceedances.
🟢	Median and average values of all sites below the guideline value / target or at limit of reporting			
🟠	Median and average value in excess of guideline value / target at one or more sites, but comparable to reference sites			
🔴	Median and average value in excess of guideline value / target at one or more sites, and in excess of reference sites			

Notes: <LOR results have been halved for the purpose of determining medians and average, hence will tend to overestimate actual levels.

6.2 Discussion of Surface Water Monitoring Data

6.2.1 Physiochemical parameters

pH

The majority of natural surface water monitoring locations recorded pH within the guideline values of 5.5 – 8.5 pH units during 2023, with exception of RBSW02, RBSW04 and RBSWDS. RBSW02, RBSW04 and RBSWDS averaged pH measurements of 5.39, 4 and 4.4 respectively. These pH averages are based upon one or two sampling events owing to the lack of flowing conditions and are not considered to be a representative average. RBSW02 is located along the Towns River upstream of any influence from the NRP. This indicates that low pH conditions begin upstream of the NRP and are considered not to be influenced by NRP activities.

Mine-affected water stored in the Danehill Pits (FE1, FE2 and FE3) and Zabeel South Pit (EEB) averaged pH measurements below the guideline value of 5.5. A shift in pH conditions was identified in December 2022 and confirmed in Q1 2023, whereby pH of the Danehill and Zabeel South pits remained below 5 pH units for the duration of 2023. **Plate D1** of **Appendix D** presents the long-term pH trends for pit water storages at the NRP. Despite the decrease in pH observed across all NRP pits, pH has remained steady for majority of 2023, and remains above 3.5 pH units within the slightly acidic range. The recent decline in pH has facilitated the mobilisation of heavy metals such as aluminium and iron into solution, causing an increase in metal concentrations within mine-affected water stored in the pits. Further discussion of pit water quality, specifically metal concentrations is provided in **Section 6.2.3** below.

Electrical Conductivity

Electrical conductivity (EC) measured across all natural surface water monitoring locations remained below the locally derived EC target of 1,020 µS/cm during 2023. This is comparable to historical EC trends.

Both Danehill pits along with RBSP01 and RBSP02 all recorded EC measurements above the locally derived EC target. Long-term EC trends for the NRP pit water storages are presented in **Plate D1** of **Appendix D** and demonstrates that EC did not significantly change from historical trends in 2023. EC recorded at RBSP01 varied throughout 2023 attributed to the rise and fall of the water level caused by water use for dust suppression activities. EC measured in RBSP02 is considered to be evapo-concentrated surface run-off as it did not receive any pumped inflows over the 2023 reporting period.

6.2.2 Nutrients and Ions

Ammonia

No natural surface water monitoring locations exceeded the ANZG 2018 guideline for ammonia during 2023.

Slightly elevated ammonia concentrations were recorded at the Zabeel North and South pits, recording averages of 1.68 and 2.49 mg/L respectively. Ammonia concentrations in the Zabeel pits exceed the 95% species protection toxicant value of 0.9 mg/L (ANZG 2018). Elevated ammonia concentrations are thought to be caused by residual blasting chemicals contained within the Zabeel pits from previous mining activities. Despite the elevated ammonia concentrations, this water was contained within the respective pit storages for the entirety of 2023, preventing the release of contaminated water to the external environment. All water which was contained in Zabeel North pit has since been dewatered to Zabeel South and has remained dry since August 2023.

Nitrate

No natural surface water monitoring locations exceeded the ANZG 2018 guideline for nitrate during 2023.

Both Zabeel North and South pits along with Danehill West pit recorded elevated nitrate concentrations recording averages of 0.95 mg/L, 1.61 mg/L, and 1.56 mg/L respectively. These averages exceed the ANZG 2018 guideline value of 0.7 mg/L. Similar to ammonia, elevated nitrate concentrations in the open-cut pits are considered to be caused by residual blasting chemicals contained within these pits from previous mining operations. Despite the elevated nitrate concentrations, this water was contained within the respective pit storages for the entirety of 2023, preventing the release of contaminated water to the external environment.

Sulphate

No natural surface water monitoring locations exceeded the ANZG 2018 guideline for sulphate during 2023.

Sulphate concentrations of mine-affected water is typically higher compared to natural surface water given the additional exposure mine-affected water has with mineralised material. Mine-affected water sulphate concentrations are heavily influenced by the oxidation of exposed geologic material containing sulphur. Despite this, average sulphate concentrations at RBSP02 and both Zabeel pits remained under the guideline value of 500 mg/L throughout 2023. However, RBSP01 and both Danehill pits averaged above 500 mg/L throughout 2023, with average concentrations of 895.9 mg/L and 873.7 mg/L respectively. Similar to RBSP01's EC measurements recorded in 2023, sulphate concentrations at RBSP01 varied owing to the periodic rise and fall of water levels in the pond due to dust suppression use and water transfers. Varying water levels throughout 2023 is considered to have evapo-concentrated water stored in RBSP01 during periods of low water volume, increasing sulphate concentrations during these periods.

Sulphate concentrations of mine-affected water stored in the Danehill pits has historically been elevated given the exposure of mineralised sulphur / oxidated sulphate exposed in the existing pit shell. Despite the elevated sulphate concentrations, results collected in 2023 are comparable to historical trends and is not considered to have changed materially over the 2023 reporting period.

6.2.3 Metals and Metalloids

All natural surface water monitoring locations recorded filtered metal and metalloid concentrations below the corresponding 95% species protection toxicant values where guideline values are applied (ANZG 2018). Metal / metalloid concentrations recorded at monitoring locations downstream of the NRP were comparable or lower than concentrations recorded upstream of the NRP. This suggests that activities at the NRP did not impact downstream water quality during the 2023 reporting period.

Metal concentrations of mine-affect water stored in the open-cut pits have increased since the NRP entered care and maintenance in December 2021. The increase in metal concentrations within the pits coincides with the decrease in pH observed over 2023 as detailed in **Section 6.2.1.** Of particular interest is the increase of aluminium, iron, manganese, nickel and zinc concentrations in mine-affected water stored in the Danehill and Zabeel pits. **Plate D1** in **Appendix D** shows the long-term trends of these metals across each pit storage. As shown in the **Plate D1**, metal concentrations peaked in January 2023 and have since declined and stabilised for the majority of 2023 although remaining elevated.

Since identifying the deteriorating water quality in pit water at the NRP in 2023, NRR engaged geochemical specialists Pendragon, authors of the current Acid Mine Drainage Management Plan (Pendragon 2021). Pendragon undertook an initial desktop investigation into the source/mechanism behind the change in pit water quality across the Danehill and Zabeel pits. The desktop investigation highlighted that the lack of pit dewatering over two subsequent wet seasons (2021-2022 and 2022-2023) has allowed a large amount of surface water to accumulated in the open-cut pits at the NRP. The accumulated surface water has increased water volumes within the pits and has saturated / inundated areas of PAF exposed in the as-mined surface of the existing pits. Coupled with high groundwater levels surrounding the pits over the subsequent water seasons has also saturated areas of unexposed PAF, which in-turn has reported to the pits as groundwater levels decreased throughout the dry season, providing an additional source of acidity to the pits. The observed decrease in pH within the pits has facilitated the mobilisation of previously sorbed metals into solution, elevating the metal concentration of mine-affected water. Importantly, all mine-affected water remains contained within the mine pit storages as part of the NRP water management system and has not interacted with the receiving environment.

Moving forward, NRR intends to contain mine-affected water until a water treatment strategy is developed and implemented. Work on a water treatment strategy has commenced in 2024. It should be again noted that the application of ANZG 95% species protection water quality values to artificially stored mine-affected water is only for guidance and specifically relevant if off-site waste discharge was to occur. Given a valid WDL was not held by NRR during 2023, the strict application of such guideline values for compliance purposes is considered unnecessary and should only be used for comparative purposes.

6.3 Groundwater Monitoring

Groundwater level and quality is monitored at 15 groundwater monitoring bores located across the Mine as well as four monitoring bores at the BBLF. Groundwater monitoring bore locations are presented in **Figure 6-3** and **Figure 6-4,** with details provided in **Table 6-3**. Further details regarding the current groundwater monitoring program are outlined in the WMMP (NRR 2019). During the C&M period in 2022, monitoring of groundwater level was reduced from quarterly to bi-annual owing to the lack of mining activity and resources (approved by DITT 14 July 2022). In July 2022, DITT agreed to a reduction in the monitoring frequency of groundwater level from quarterly to bi-annual. This revised monitoring frequency was continued in 2023.

Groundwater level and quality was monitored at the locations in **Table 6-3** twice during 2023, typically coinciding with pre- and post- wet season conditions. Groundwater quality results are assessed against the ANZECC 2000 guidelines for stock drinking water. Stock drinking water guidelines have been applied to the NRP as stock watering is the only potential use for groundwater in the area beside industrial uses such as dust suppression.

Table 6-4 provides a high-level performance overview of groundwater quality for the Mine and the BBLF monitoring bores in 2023 by comparing the median and average results against the ANZECC 2000 stock drinking guidelines (Table 10-4, WMMP (NRR 2019)). A traffic light approach has been used to provide a simple means of demonstrating compliance status. The WMMP outlines an ANZECC (2000) stock drinking guidelines for TSS of 5,000 mg/L. Upon review of the ANZECC (2000) guideline, such guideline for TSS do not exist. It is assumed that this is an error in Table 10-4 of the WMMP, and the ANZECC (2000) for total dissolved solids (TDS) will be applied.

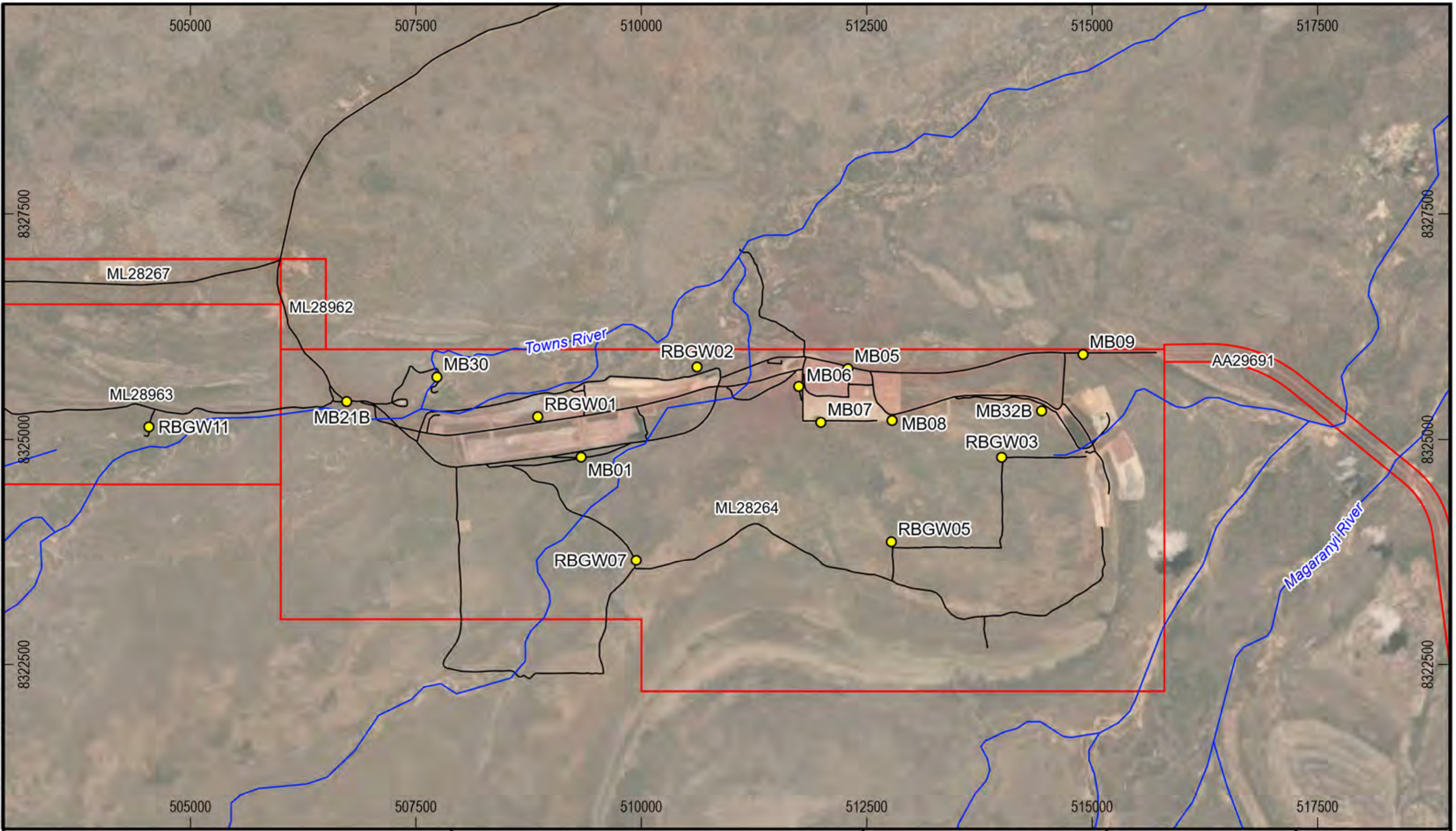
Further discussion of groundwater monitoring data collected during 2023 is provided in **Section 6.4** for those parameters which are amber or red traffic light as assigned in **Table 6-4**. No discussion of groundwater level data has been included as no corresponding assessment criteria is outlined in the WMMP (NRR 2019). The full data set of groundwater quality and level data collected over the 2023 EMR period are presented in **Table D2** within **Appendix D**.

Table 6-3 – Groundwater Monitoring Bore locations and construction details

Bore ID	Purpose	Easting	Northing	Monitoring Interval (mbgl)	Total Depth (mbgl)
MB01	Impact	509332	8324803	12 – 36	36
MB05	Impact	512290	8325785	12 – 36	36
MB06	Impact	511745	8325588	12 – 36	36
MB07	Impact	511990	8325189	12 – 36	36
MB08	Impact	512780	8325210	12 – 36	36
MB09	Background	514898	8325943	11 – 35	36
MB21B	Impact	506732	8325420	19 – 20	20
MB30	Impact	507733	8325692	4 – 7	7
MB32B	Impact	514438	8325316	42 – 60	60
RBGW01	Impact	508848	8325244	49 – 79	79
RBGW02	Impact	510619	8325806	69 – 102	102
RBGW03	Impact	513986	8324813	49 – 79	79
RBGW05	Reference	512747	8323880	53 – 87	87
RBGW07	Reference	509934	8323667	101 – 125	125
RBGW11	Reference	504497	8325175	42 – 72	72
Bing Bong Loading Facility					
BBMB01	Impact	647877	8271430	10 – 16	16
BBMB02	Impact	647789	8271811	9 – 18	18
BBMB03	Impact	648322	8271827	4 – 10	10
BBMB04	Impact	648293	8271631	1 - 10	10

Note:

Coordinates projected in GDA94 Zone 53.
mbgl – meters below ground level.



Legend

● Groundwater Monitoring Locations

— Access Tracks

— Watercourses

▭ Tenement Boundaries

Source: Northern Territory Government (Department of Environment, Parks and Water Security 2021; Department of Industry, Tourism and Trade 2022), Nathan River Resources 2018-2020, METServe 2023, Earthstar Geographics.

Nathan River Project

Groundwater Monitoring Locations - Mine

0 0.5 1 2

Kilometers

Scale: 1:60,000 (A4)

3/02/2023

N

Datum: GDA2020
Projection: MGA53

FIGURE 6-3

Nathan River Resources

METSERVE
Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\EMR\BM001_NR_EMR_Groundwater_Bore_Monitoring_Sites_Mine.aprx

Legend

● Groundwater Monitoring Locations

▭ Tenement Boundaries

Source: Northern Territory Government (Department of Industry, Tourism and Trade) 2022, Nathan River Resources 2018-2020, METServe 2023, Maxar.

Nathan River Project

Groundwater Monitoring Locations - Bing Bong Loading Facility

0 50 100 200

Meters

Scale: 1:6,000 (A4)

3/02/2023

N

Datum: GDA2020
Projection: MGA53

FIGURE 6-4

Nathan River Resources

METSERVE
Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\EMR\BM001_NR_EMR_Groundwater_Monitoring_Sites_BBLF.aprx

Table 6-4 High Level Overview of Ground Water Monitoring Results

Parameter	Guideline Value (WMMP, 2019)	Mine Monitoring Bores (Impact)	BBLF Monitoring Bores (Impact)	Comments
pH	6 – 8 pH units	🟠	🟢	All monitoring bores recorded pH levels between 6 – 8 pH units. MB08 recorded a pH of 8.1 in July 2023. This result is considered to within the bore's historical pH range.
Total Dissolved Solids (TDS)	5,000 mg/L	🟠	🟠	Several Mine and BBLF monitoring bores exceeded the TDS guideline value.
Calcium	1,000 mg/L	🟠	🟠	Two BBLF (BBMB01 & 02) and one Mine (RBGW02) exceeded the Calcium guideline value.
Sulphate	1,000 mg/L	🟠	🟠	Several mine monitoring bores included reference bore exceeded the sulphate guideline value. Three BBLF monitoring bores also exceeded.
Aluminium	5,000 µg/L	🟢	🟢	All monitoring bores recorded below the guideline value for aluminium.
Arsenic	500 µg/L	🟢	🟢	All monitoring bores recorded below the guideline value for arsenic.
Boron	5,000 µg/L	🟢	🟢	All monitoring bores recorded below the guideline value for boron.
Cadmium	10 µg/L	🟠	🟢	One Mine monitoring bores exceeded the cadmium guideline value. All BBLF monitoring bores recorded below the guideline value.
Chromium	1,000 µg/L	🟢	🟢	All monitoring bores recorded below the guideline value for chromium.

Parameter	Guideline Value (WMMP, 2019)	Mine Monitoring Bores (Impact)	BBLF Monitoring Bores (Impact)	Comments
Cobalt	1,000 µg/L	🟢	🟢	All monitoring bores recorded below the guideline value for cobalt.
Copper	1,000 µg/L	🟢	🟢	All monitoring bores recorded below the guideline value for copper.
Lead	100 µg/L	🟢	🟢	All monitoring bores recorded below the guideline value for lead.
Nickel	1,000 µg/L	🟢	🟢	All monitoring bores recorded below the guideline value for nickel.
Selenium	20 µg/L	🟢	🟢	All monitoring bores recorded below the guideline value for selenium.
Uranium	200 µg/L	🟢	🟢	All monitoring bores recorded below the guideline value for uranium.
Zinc	20,000 µg/L	🟢	🟢	All monitoring bores recorded below the guideline value for zinc.
ND	No data available			
🟢	Concentrations of all sites below the guideline value / target or at limit of reporting			
🟠	Value in excess of guideline value / target at one or more sites but comparable to reference sites			
🔴	Value in excess of guideline value / target at one or more sites and in excess of reference sites			

[1] <LOR results have been halved for the purpose of determining medians and average, hence will tend to overestimate actual levels.

6.4 Discussion of Groundwater Results

6.4.1 Physiochemical Parameters

pH

All monitoring bores located at the mine recorded pH values between 6 – 8.1 pH units and BBLF bores between 6.9 – 7.9 pH units in 2023. These pH ranges are in line with historical trends reflecting neutral pH conditions. No significant changes in pH have been recorded throughout 2023, indicating no material changes in water chemistry have occurred or are anticipated to occur in the immediate future.

Total Dissolved Solids

MB01, MB06, MB08, MB09, RBGW02 and RBGW11 recorded TDS values of > 10,000 mg/L (EC of > 15,000 µS/cm) which is classified as highly saline groundwater (Mayer et *al,* 2005). MB32B and RBGW01 recorded TDS concentrations of > 4,000 mg/L, classified as saline groundwater. The remaining six groundwater bores were classified as marginal to brackish in accordance with Mayer *et al* (2005).

Although highly saline groundwater was recorded at impact bores during the reporting period, the reference bore, RBGW11, was also classified as saline indicating a generally saline groundwater system at the NRP owing to the marine origins of the geologic formations.

TDS concentrations measured at all four BBLF monitoring bores exceeded the ANZECC 2000 guidelines during the 2023 reporting period. Typical of shallow groundwater within close proximity to the ocean, groundwater is classified highly saline to brine, and is comparable to historical data.

6.4.2 Cations and Anions

Calcium

Calcium concentrations exceeded guideline values at two BBLF monitoring bores (BBMB01 and BBMB02) and one Mine monitoring bore (RBGW02). The groundwater system at the NRP (Mine and BBLF) comprises of marine and non-marine sedimentary rock formations, whereby aquifers within formations of marine origins are typically elevated in salinity and ion concentrations such as calcium.

Calcium concentrations recorded at BBMB01, BBMB02 and RBGW02 in 2023 are comparable to historical data. Elevated calcium recorded at these three groundwater bores are not considered to be attributed to NRP activities, rather is reflective of baseline conditions. It should be noted that the impacts of high calcium concentrations in stock water supply may cause minor gastrointestinal issues and is not lethal (ANZECC 2000).

Sulphate

Similar to TDS, sulphate concentrations also exceeded the 1,000 mg/L guideline value at MB01, MB06, MB08, MB09 and RBGW02 in 2023. Sulphate concentrations recorded at the five exceeding monitoring bores ranged from 1,160 – 4,790 mg/L. Despite exceeding the corresponding guideline value, sulphate concentrations are comparable to historical data.

All four BBLF monitoring bores recorded sulphate concentrations above the guideline value of 1,000 mg/L in 2023 with sulphate concentrations ranging between 1,870 – 7,160 mg/L. Concentrations recorded during the 2022 monitoring period are comparable to historical sulphate trends previously recorded at BBLF monitoring bores.

As mentioned in **Section 6.4.1**, groundwater at these five monitoring bores are classified as saline, and typically corresponds to elevated sulphate concentrations. Elevated sulphate concentrations recorded at these groundwater monitoring bores are not considered to be attributed to NRP activities, rather is reflective of normal groundwater conditions.

Excessive concentrations of sulphate in water typically cause diarrhoea in stock, but animals generally avoid water containing high sulphate concentrations (ANZECC 2000). Given the corresponding TDS values for these monitoring bores, groundwater at these locations are considered to be of limited use for stock watering.

6.4.3 Metals and Metalloids

One groundwater monitoring bore at the Mine, MB09, exceeded the corresponding cadmium ANZEEC 2000 guideline value of 10 µg/L recording a concentration of 79.6 µg/L in June 2023. Despite exceeding the corresponding cadmium guideline value in June 2023, cadmium concentrations of 8.1 µg/L were recorded in December 2023. MB09 has not previously triggered the ANZECC guideline for cadmium and the concentration recorded in June 2023 is considered to be an anomaly given concentrations have returned below the guideline value and are aligned with historical concentrations.

All other filtered metal and metalloid results collected during the 2023 monitoring period from the Mine and BBLF groundwater monitoring bores were below the corresponding AZEECC 2000 guideline values.

6.5 Discharge Monitoring during Dewatering

NRR's Waste Discharge Licence (WDL) 246-01 expired in May 2022. NRR did not hold a permit to discharge water to the receiving environment over the 2023 reporting period. Given no WDL was current in 2023, no discharge occurred during the EMR reporting period.

NRR are currently assessing the requirement for a WDL for future operations. If off-site discharge is deemed to be required, NRR will submit an application for a WDL to the NT Department of Environment, Parks and Water Security (DEPWS) for consideration.

6.6 Sediment Monitoring

Sediment monitoring is conducted at nine monitoring locations along the Towns River, Magaranyi River and Pandanus Creek. Sediment monitoring locations align with location of natural surface water monitoring sites. Monitoring locations are presented in **Figure 6-5** and details provided in **Table 6-5**. Further details on the sediment monitoring program implemented at the NRP are outlined in the WMMP (NRR 2019). No sediment monitoring is currently implemented at the BBLF.

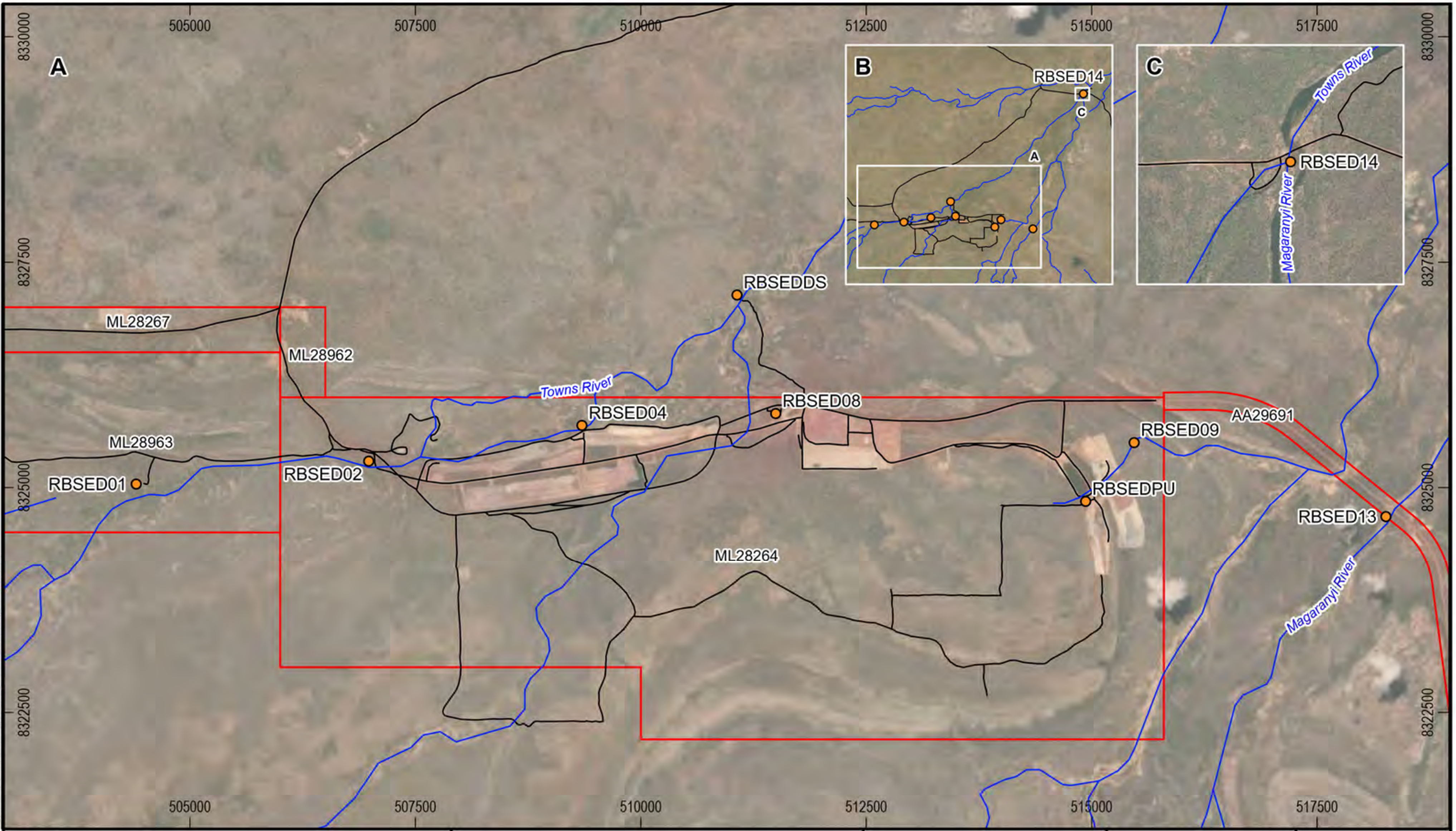
Sediment samples are collected in accordance with *Simpson & Batley (2016): Sediment Quality Assessment* and follow the *NEPM schedules B 1 (1999) and B 2 (2011)* and *Australian Standard AS/NZS 5667.12-1999: Water quality - Sampling, Part 12: Guidance on sampling of bottom sediments.* NRR conducts sediment monitoring on an annual basis, typically collected during the dry season when the least amount of surface water is present/watercourses are dry.

Laboratory results for particle size and selected metals/metalloids are discussed in **Section 6.7**, whereby metal concentrations have been compared to Toxicant Default Guideline Value (DVG) for sediment quality (ANZG 2018).

Table 6-5 - Sediment Monitoring Locations

Monitoring Location	Description	Purpose	Easting	Northing
RBSED01	Towns River	Reference	504403	8325037
RBSED02	Towns River	Upstream	506982	8325291
RBSED04	Towns River	Impact	509346	8325688
RBSED08	Drainage line	Impact	511495	8325820
RBSEDDS	Towns River	Impact / Downstream compliance	511066	8327136
RBSED14	Towns River	Impact	522679	8336828
RBSEDPU	Pandanus Creek	Upstream	514932	8324845
RBSED09	Pandanus Creek	Impact	515470	8325497
RBSED13	Magaranyi River	Impact	518262	8324676

Note: Coordinates projected in GDA94 Zone 53.



Legend

● Sediment Monitoring Locations

Access Tracks

Watercourses

Tenement Boundaries

Source: Northern Territory Government (Department of Environment, Parks and Water Security 2021; Department of Industry, Tourism and Trade 2022), Nathan River Resources 2018-2020, METServe 2023, Earthstar Geographics.

Nathan River Project

Sediment Monitoring Locations

0 0.5 1 2

Kilometers

Scale: 1:60,000 (A4)

3/02/2023

Datum: GDA2020
Projection: MGA53

FIGURE 6-5

Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\EMR\BM001_NR_EMR_Sediment_Monitoring_Sites_Mine.aprx

6.7 Discussion of Sediment Results

6.7.1 Particle Size Analysis

Results for sediment particle size analysis were highly variable between monitoring locations with limited variation between impact and reference sites observed. All samples were composed primarily of sand and gravel, inline with previous monitoring results.

6.7.2 Physical Parameters

Laboratory results for physical parameters such as pH and electrical conductivity (EC) are presented in **Table D3** of **Appendix D**. pH ranged from 4.6 to 7.9 pH units across all monitoring locations reflecting an acidic to neutral pH condition. All monitoring locations recorded EC below 1,000 µS/cm with the exception of RBSED14 which recorded an EC of 2,650 µS/cm. RBSED14 is located at the tidal interface along the downstream reaches of the Towns River, hence sediment is expected to be more saline than upstream monitoring sites.

6.7.3 Metals and Metalloids

Metal and metalloid laboratory results is provided in **Table D3** of **Appendix D**. All sediment monitoring locations recorded metal and metalloid concentrations below all ANZG (2018) default guideline values – low (DGV-Low) during the 2023 reporting period.

Iron concentrations across many of the sediment monitoring locations were high but comparable to historical results. Reference site RBSED01 recorded iron concentrations of 8,930 mg/kg, indicating the area surrounding the NRP is naturally elevated in iron. ANZG (2018) does not consider iron in sediment to be a contaminate of concern to aquatic ecosystems, hence no DGV exists for such analyte. Alkali metals such as lithium, rubidium and strontium concentrations recorded across all monitoring locations in 2023 were either below the limit of reporting or comparable with historical results.

6.8 Biological Monitoring

No biological monitoring was completed in 2023. NRR intends to undertake the next biological monitoring program at the cessation of flow after the 2023-2024 wet season.

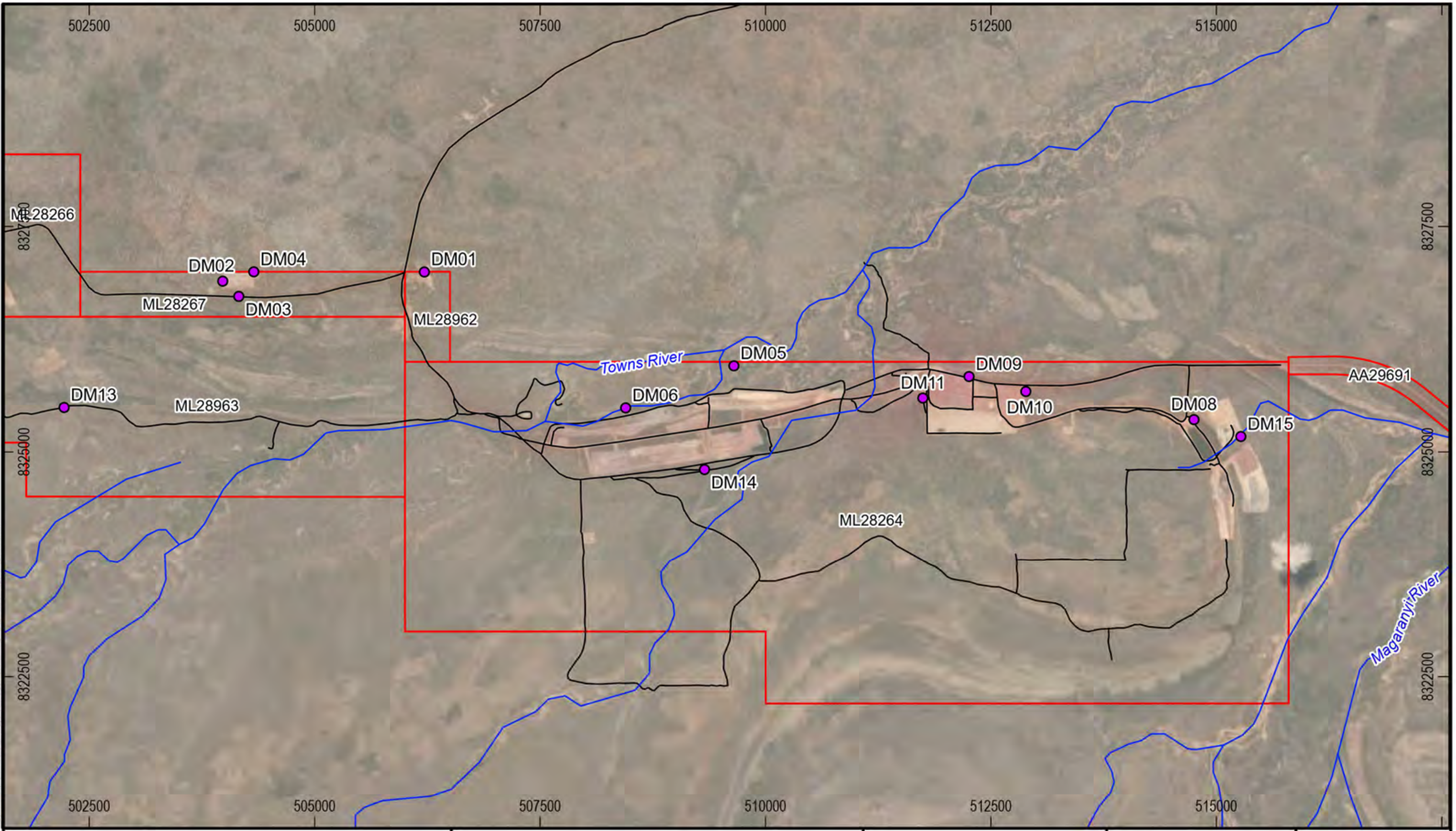
6.9 Dust Monitoring

Depositional dust monitoring was conducted at 12 locations across the Mine, along with six monitoring locations at the BBLF. Depositional dust monitoring locations are shown in **Figure 6-6** and **Figure 6-7,** with details presented in **Table 6-6**. The dust monitoring program is detailed in the Dust Management Plan (NRR 2022) approved with the LGO MMP amendment. The program intends to follow Australian Standard *AS3580.10.1:2003 (R2014), Method for sampling and analysis of ambient air; Method 10.1: Determination of Particulates – Deposited Matter – Gravimetric Method.*

Table 6-6 – NRP Depositional Dust Monitoring Location

Monitoring Location	Description	Purpose	Easting	Northing
DM01	Workshop Area	Impact	506129	8327082
DM02	Sawfish Camp	Impact	506067	8326895
DM03	Sawfish Camp	Impact	506103	8326796
DM04	Sawfish Camp	Impact	506322	8326850
DM05	North Danehill Pit	Impact	509648	8325955
DM06	North Danehill Pit	Impact	508448	8325488
DM08	Zabeel North	Impact	514713	8325374
DM09	ROM Pad	Impact	512245	8325936
DM10	ROM Pad	Impact	512906	8325617
DM11	ROM Pad	Impact	511687	8325549
DM13	Upstream Towns River	Reference	502497	8325422
DM14	South Danehill WRD	Impact	509322	8324803
DM15	Zabeel WRD	Impact	515270	8325170
Bing Bong Loading Facility				
BBDM01	BBLF	Impact	647881	8271438
BBDM02	BBLF	Impact	647790	8271809
BBDM03	BBLF	Impact	648327	8271833
BBDM04	BBLF	Impact	648304	8271624
BBDM05	BBLF	Impact	648811	8271827
BBDM06	BBLF	Impact	648767	8271707

The dust monitoring program was suspended upon the commencement of the care and maintenance period as no mining activities were occurring. Upon the recommencement of operations in March 2023, the depositional dust monitoring program was re-implemented in November 2022 prior to the start-up of operations. Depositional dust monitoring was conducted on a monthly basis at the locations specified in **Table 6-6** throughout 2023 with exception of March, April and May. Despite this, depositional dust gauges remained in place over this three-month period and data has been averaged across the three-monthly sample collection period.



Legend

Access Tracks

Watercourses

Tenement Boundaries

● Depositional Dust Monitoring Locations

Source: Northern Territory Government (Department of Environment, Parks and Water Security 2021; Department of Industry, Tourism and Trade 2022), Nathan River Resources 2018-2020, METServe 2023, Earthstar Geographics.

Nathan River Project

Depositional Dust Monitoring Locations - Mine

0 0.5 1 2

Kilometers

Scale: 1:60,000 (A4)

3/02/2023

N

Datum: GDA2020
Projection: MGA53

FIGURE 6-6

Nathan River Resources

METSERVE
Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\EMR\BM001_NR_EMR_Depositional_Dust_Monitoring_Sites_Mine.aprx

Legend

- ● Depositional Dust Monitoring Locations
- 🟥 Tenement Boundaries

Source: Northern Territory Government (Department of Industry, Tourism and Trade) 2022, Nathan River Resources 2018-2020, METServe 2023, Maxar.

Nathan River Project

Depositional Dust Monitoring Locations - Bing Bong Loading Facility

0 50 100 200

Meters

Scale: 1:6,000 (A4)

3/02/2023

Datum: GDA2020
Projection: MGA53

FIGURE 6-7

Nathan River Resources

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\EMR\BM001_NR_EMR_Depositional_Dust_Monitoring_Sites_BBLF.aprx

6.9.1 Discussion of Depositional Dust Monitoring Results

Depositional dust monitoring data collected over the 2023 reporting period is provided in **Appendix D, Table D4**. Performance criteria outlined in the Dust Management Plan (NRR 2022) include the following:

- No annual Total insoluble matter (TIM) exceedances of 4 g/m^2/month (cumulative impact) at the nearest sensitive receptor; and
- No annual TIM exceedances of 2 g/m^2/month (incremental impact) at the nearest sensitive receptor.

TIM along with ash content analysis can be used to determine if deposited dust emissions are associated with activities which generate organic dust (e.g. fire) or inorganic dust (e.g. mining). Ash content is defined as the fraction of sample matter which remains in a sample after the sample has been combusted in laboratory conditions. Contrary to this, TIM is defined as the amount of sample matter which does not dissolve in water. Should ash content be significantly different from the sample's corresponding TIM, this indicates that a large proportion of sample matter is organic in nature (e.g. dust emissions from fire) and was able to be combusted. The extended data set which includes both ash content and TIM results is presented in **Table D4** of **Appendix D**.

To identify if NRP has exceeded the annual TIM performance criteria, TIM results have been averaged for specific sites over the 2023 reporting period and compared to the 4 g/m2/month exceedance value. Performance criteria only apply to dust monitoring sites which are considered to be closest to the nearest sensitive receptor. The nearest sensitive receptors to the Mine and the BBLF are the Sawfish Camp and the MRM accommodation camp at the BBLF respectfully. DM02, DM03 and DM04 monitoring sites are located around the perimeter of the Sawfish Camp and are considered representative of dust conditions at the Sawfish Camp receptor. BBDM06, located on the boundary which NRR and MRM share at the BBLF and is the closest monitoring site to the MRM BBLF operation, however, is not considered to be fully representative of dust conditions at the receptor given the BBLF camp is over 200 m away from this monitoring site. Table 6-7 provides the average TIM results for these sites with comparison to the performance criteria.

Table 6-7: Deposition Dust Total Insoluble Matter

Monitoring Locations	Performance Criteria	Average Total Insoluble Matter
	g/m^2/month	
Reference Sites - Mine		
DM13	4	2.7
Impact Sites - Mine		
DM02	4	0.5
DM03	4	1.3

Monitoring Locations	Performance Criteria	Average Total Insoluble Matter
DM04	4	0.2
Reference Sites - BBLF		
BBDM01	4	1.8
Impact Sites - BBLF		
BBDM06	4	3.6

Evident by **Table 6-7**, none of the depositional dust monitoring sites closest to the nearest sensitive receptors averaged above the 4 g/m^2/month performance criteria. Despite this result, dust emissions at the BBLF operation were an issue and subject to a compliant and an environmental incident. As described in Appendix G, NRR takes dust generation at the BBLF seriously and has implemented controls to reduce dust emissions from BBLF operations. NRR will continue to implement depositional dust monitoring at the BBLF and the Mine, as well as implementing further dust monitoring in 2024 to inform the proactive management of dust emissions across the NRP operations.

7.0 CONCLUSIONS

The EMR provides information to inform DITT on the NRP's environmental compliance and performance during the 2023 reporting period.

The NRP has been materially compliant with conditions and recommendations arising from the EPBC 2012/6242 approval, EIS recommendations report, and Mining Authorisation 1062-01. Majority of the environmental monitoring outlined in the LGO and Stage 1A MMP amendment has been completed in 2023. Monitoring which was not completed during 2023 will recommence in 2024 during the restart of mining operations. As outline in **Section 2.2**, one environmental incident was recorded. An investigation report has been submitted to DITT for assessment and is provided in **Appendix G** for reference.

As the NRP continues to transitions from LGO operations to the recommencement of mining, all environmental monitoring programs will be implemented along with all environmental practises outlined in the overarching 2019 MMP.

8.0 REFERENCES

Australian Standard AS/NZS 5667.12-1999: Water quality Sampling, Part 12: Guidance on sampling of bottom sediments.

Australian Standard AS3580.10.1:2003 (R2014), Method for sampling and analysis of ambient air; Method 10.1: Determination of Particulates – Deposited Matter – Gravimetric Method.

Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, October 2000), prepared by the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018), prepared by the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ). https://www.waterquality.gov.au/guidelines/anz-fresh-marine

EcOZ (2022). Dust Management Plan, Nathan River Resources Project. EcOz Pty Ltd, 2022.

Mayer, XM, Ruprecht, JK & Bari, MA (2005). Stream salinity status and trends in south-west Western Australia.

Department of Environment, Salinity and land use impacts series, Report No. SLUI 38

NRR (2019). Water Management and Monitoring Plan (WMMP). Subject to departmental review and approval.

Simpson & Batley (2016): Sediment Quality Assessment. A Practicable Guide.

Appendix D

Environmental Monitoring Data - 2023

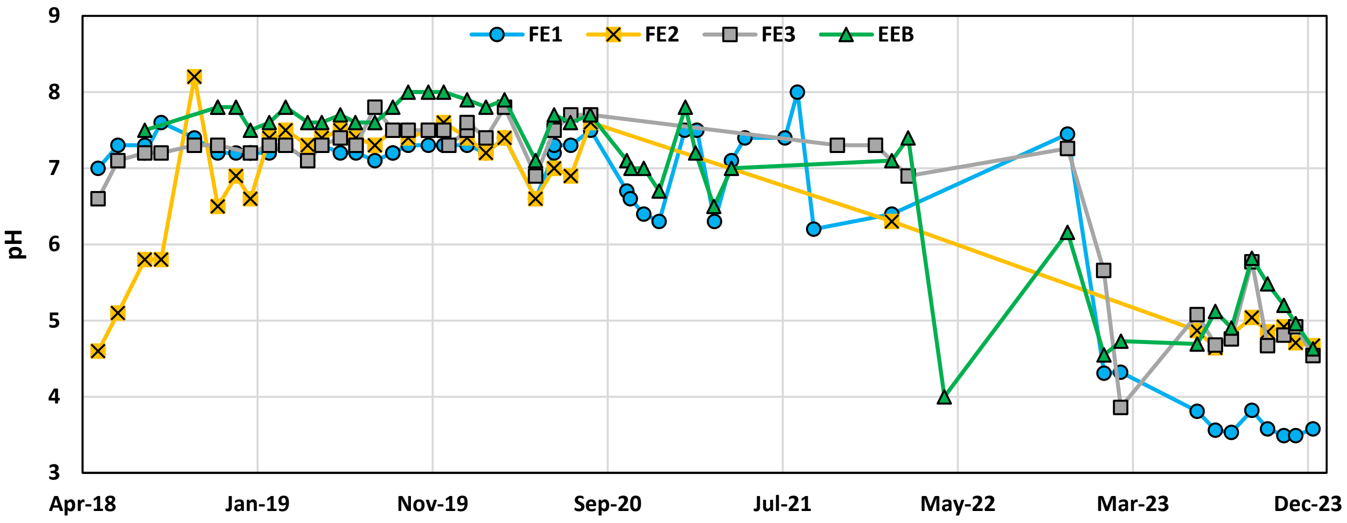
Table D1: 2023 Surface Water Monitoring Results

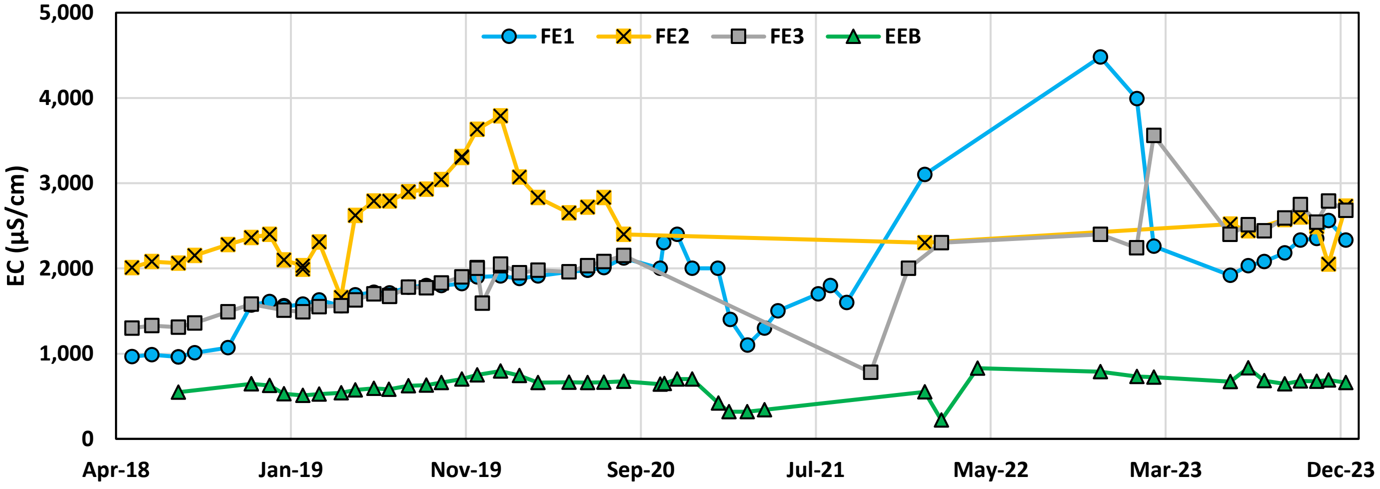
Monitoring Location		pH	EC	Turbidity	NH3	NO3	SO4	Al	As	B	Cd	Cr	Cu	Fe	Mn	Ni	Zn
Units		pH units	µS/cm	NTU	mg/L			µg/L									
EEA	Average	6.60	510.33	41.53	1.69	0.96	84	105	0.67	98.33	0.05	0.5	0.5	71.67	3.33	0.67	2.5
	Median	6.65	472	28.3	0.04	1.14	73	130	0.5	90	0.05	0.5	0.5	80	3	0.5	2.5
	Max	6.66	844	75	5	1.72	146	180	1	180	0.05	0.5	0.5	110	6	1	2.5
	Min	6.48	215	21.3	0.02	0.01	33	5	0.5	25	0.05	0.5	0.5	25	1	0.5	2.5
	n	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
EEB	Average	5.05	704.22	4.54	2.49	1.61	246.56	425.56	0.5	155.56	0.14	0.5	1.56	1707.78	7794.44	55.78	11.83
	Median	4.96	684	3.1	2.42	1.49	249	200	0.5	160	0.2	0.5	0.5	1390	7800	49	10
	Max	5.82	832	12	3.17	2.01	266	1340	0.5	180	0.2	0.5	5	3820	8580	83	27
	Min	4.55	647	1.6	1.79	1.39	224	110	0.5	100	0.05	0.5	0.5	120	6750	42	2.5
	n	9.00	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
FE1	Average	3.77	2411.11	3.01	0.50	1.57	727.67	6055.56	0.5	242.22	0.09	0.5	2.33	3738.89	11005.56	61.44	48.22
	Median	3.58	2260	2	0.49	1.02	684	6490	0.5	240	0.1	0.5	2	2020	11600	58	44
	Max	4.32	3990	8.9	0.67	5.08	1080	7620	0.5	360	0.1	0.5	9	15500	14500	80	76
	Min	3.49	1920	0.3	0.38	0.99	573	1260	0.5	160	0.05	0.5	0.5	1070	3130	52	37
	n	9.00	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
FE2	Average	4.84	2445.00	8.12	0.70	6.55	948.00	2030.00	0.5	333.33	0.22	0.5	3	543.33	4523.33	59.5	97.17
	Median	4.86	2505	1.2	0.74	6.56	933	1810	0.5	355	0.2	0.5	3	480	4435	60	104.5
	Max	5.04	2600	42.3	0.94	6.68	1230	2690	0.5	400	0.3	0.5	4	920	5030	65	109
	Min	4.64	2050	0.8	0.46	6.42	696	1620	0.5	240	0.2	0.5	2	320	4290	54	64
	n	6.00	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
FE3	Average	4.91	2646.67	6.39	0.73	5.58	945.33	2360.56	0.5	314.44	0.19	0.5	3.67	3040.00	5726.67	60.33	87.33
	Median	4.81	2540	2.8	0.71	6.41	961	1680	0.5	310	0.2	0.5	3	700	4500	57	98
	Max	5.77	3560	28.6	1.04	6.61	1040	9280	0.5	380	0.3	0.5	12	23400	17300	100	112
	Min	3.86	2240	0.8	0.5	2	811	5	0.5	220	0.05	0.5	0.5	140	2670	33	23
	n	9.00	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
RBSP01	Average	6.03	2511.25	2.39	0.50	1.38	895.88	1143.13	0.5	258.75	0.06	0.5	0.56	113.13	5636.88	20.88	21.44
	Median	6.72	2560	2.15	0.18	0.82	836	10	0.5	250	0.05	0.5	0.5	25	155.5	1.5	2.5
	Max	7.84	3050	7.1	1.59	3.82	1150	5610	0.5	360	0.1	0.5	1	730	17600	62	72
	Min	3.73	1730	0.3	0.06	0.02	638	5	0.5	160	0.05	0.5	0.5	25	3	0.5	2.5
	n	8.00	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
RBSP02	Average	6.95	1196.11	7.50	0.08	1.09	145.56	21.67	0.56	95	0.05	0.5	0.5	28.89	12.78	0.5	2.5

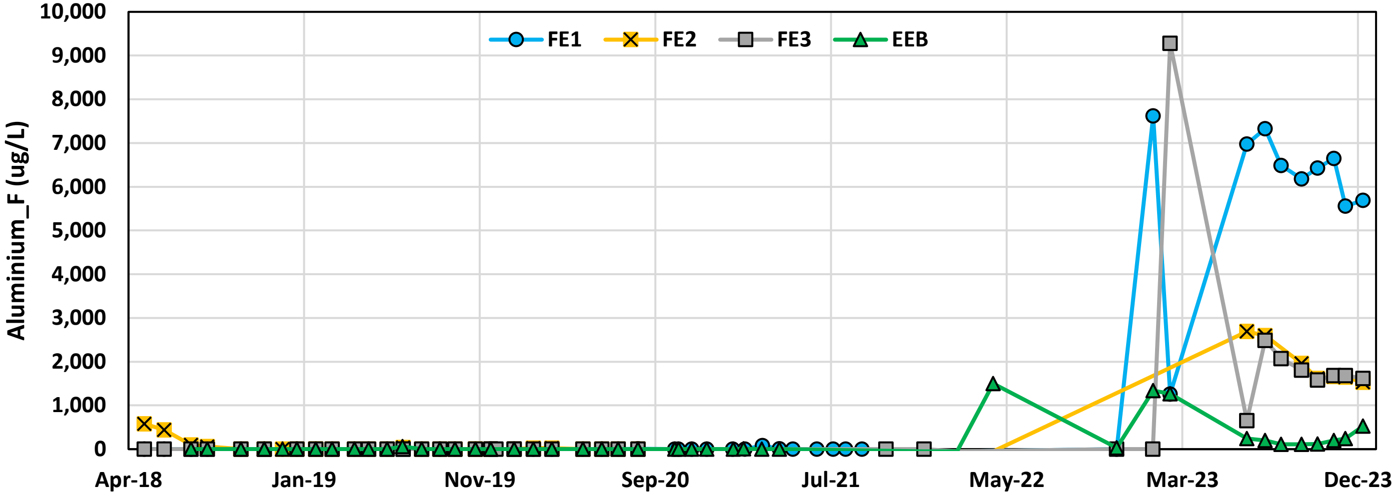
Monitoring Location		pH	EC	Turbidity	NH3	NO3	SO4	Al	As	B	Cd	Cr	Cu	Fe	Mn	Ni	Zn
	Median	7.01	1070	5.2	0.02	1.17	130	20	0.5	80	0.05	0.5	0.5	25	6	0.5	2.5
	Max	7.64	1940	32.5	0.27	1.54	221	80	1	210	0.05	0.5	0.5	60	52	0.5	2.5
	Min	5.62	608	1.2	0.001	0.54	100	5	0.5	25	0.05	0.5	0.5	25	0.5	0.5	2.5
	n	9.00	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
RBSP07	Average	6.74	2925	1.15	0.24	7.1	323	5	0.5	135	0.05	0.5	0.5	25	2.5	0.5	2.5
	Median	6.74	2925	1.15	0.24	7.1	323	5	0.5	135	0.05	0.5	0.5	25	2.5	0.5	2.5
	Max	6.75	3870	1.2	0.45	7.82	421	5	0.5	180	0.05	0.5	0.5	25	4	0.5	2.5
	Min	6.73	1980	1.1	0.03	6.38	225	5	0.5	90	0.05	0.5	0.5	25	1	0.5	2.5
	n	2.00	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
RBSW01	Average	6.38	43	36.7	0.05	0.001	0.5	180	0.5	25	0.05	0.5	0.5	210	2	0.5	2.5
	Median	6.38	43	36.7	0.05	0.001	0.5	180	0.5	25	0.05	0.5	0.5	210	2	0.5	2.5
	Max	6.38	43	36.7	0.05	0.001	0.5	180	0.5	25	0.05	0.5	0.5	210	2	0.5	2.5
	Min	6.38	43	36.7	0.05	0.001	0.5	180	0.5	25	0.05	0.5	0.5	210	2	0.5	2.5
	n	1.00	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
RBSW02	Average	5.39	59.5	55.25	0.0255	0.0505	8	300	0.5	25	0.05	0.5	0.5	225	4.75	0.5	9.25
	Median	5.39	59.5	55.25	0.0255	0.0505	8	300	0.5	25	0.05	0.5	0.5	225	4.75	0.5	9.25
	Max	6.44	100	75	0.05	0.1	15	530	0.5	25	0.05	0.5	0.5	290	9	0.5	16
	Min	4.33	19	35.5	0.001	0.001	1	70	0.5	25	0.05	0.5	0.5	160	0.5	0.5	2.5
	n	2.00	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
RBSW04	Average	3.93	108	35.8	0.03	0.001	16	50	1	25	0.05	0.5	0.5	160	11	0.5	2.5
	Median	3.93	108	35.8	0.03	0.001	16	50	1	25	0.05	0.5	0.5	160	11	0.5	2.5
	Max	3.93	108	35.8	0.03	0.001	16	50	1	25	0.05	0.5	0.5	160	11	0.5	2.5
	Min	3.93	108	35.8	0.03	0.001	16	50	1	25	0.05	0.5	0.5	160	11	0.5	2.5
	n	1.00	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
RBSW08	Average	6.41	504	102	0.04	0.38	64	5	1	25	0.05	0.5	0.5	25	30	1	2.5
	Median	6.41	504	102	0.04	0.38	64	5	1	25	0.05	0.5	0.5	25	30	1	2.5
	Max	6.41	504	102	0.04	0.38	64	5	1	25	0.05	0.5	0.5	25	30	1	2.5
	Min	6.41	504	102	0.04	0.38	64	5	1	25	0.05	0.5	0.5	25	30	1	2.5
	n	1.00	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RBSW09	Average	6.31	136.5	39.7	0.0055	0.0655	11	80	0.5	37.5	0.05	0.5	0.5	235	64	1	2.5
	Median	6.31	136.5	39.7	0.0055	0.0655	11	80	0.5	37.5	0.05	0.5	0.5	235	64	1	2.5
	Max	6.42	154	46.6	0.01	0.13	15	80	0.5	50	0.05	0.5	0.5	240	125	1	2.5
	Min	6.20	119	32.8	0.001	0.001	7	80	0.5	25	0.05	0.5	0.5	230	3	1	2.5

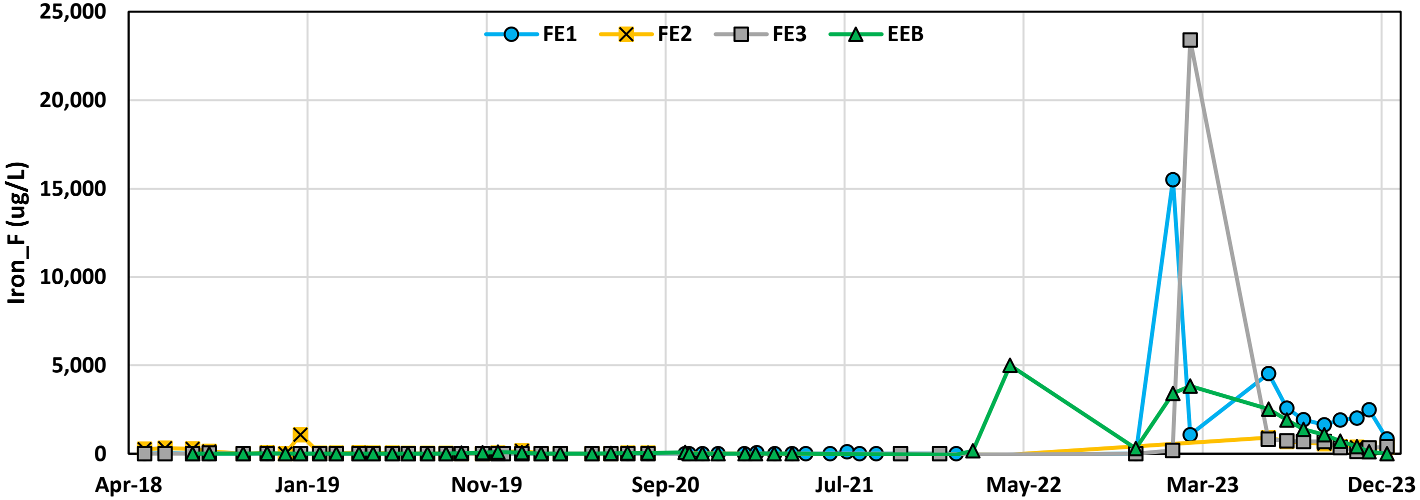
Monitoring Location		pH	EC	Turbidity	NH3	NO3	SO4	Al	As	B	Cd	Cr	Cu	Fe	Mn	Ni	Zn
	n	2.00	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
RBSW13	Average	6.08	47.5	33	0.07	0.1	3.25	75	0.5	25	0.05	0.5	0.5	195	5	0.5	2.5
	Median	6.08	47.5	33	0.07	0.1	3.25	75	0.5	25	0.05	0.5	0.5	195	5	0.5	2.5
	Max	6.67	50	47.5	0.12	0.16	6	100	0.5	25	0.05	0.5	0.5	290	9	0.5	2.5
	Min	5.49	45	18.5	0.02	0.04	0.5	50	0.5	25	0.05	0.5	0.5	100	1	0.5	2.5
	n	2.00	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
RBSW14	Average	6.95	1016	52.5	0.025	0.0155	34.5	7.5	0.5	52.5	0.05	0.5	0.5	52.5	7.5	0.5	2.5
	Median	6.95	1016	52.5	0.025	0.0155	34.5	7.5	0.5	52.5	0.05	0.5	0.5	52.5	7.5	0.5	2.5
	Max	7.08	1840	62.4	0.03	0.03	67	10	0.5	80	0.05	0.5	0.5	80	14	0.5	2.5
	Min	6.82	192	42.6	0.02	0.001	2	5	0.5	25	0.05	0.5	0.5	25	1	0.5	2.5
	n	2.00	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
RBSW15	Average	5.77	27	74.9	0.03	0.0555	1.25	240	0.5	25	0.05	0.5	0.5	210	2.5	0.5	2.5
	Median	5.77	27	74.9	0.03	0.0555	1.25	240	0.5	25	0.05	0.5	0.5	210	2.5	0.5	2.5
	Max	5.95	36	99.5	0.04	0.11	2	320	0.5	25	0.05	0.5	0.5	230	4	0.5	2.5
	Min	5.59	18	50.3	0.02	0.001	0.5	160	0.5	25	0.05	0.5	0.5	190	1	0.5	2.5
	n	2.00	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
RBSWDS	Average	4.38	109	38.1	0.02	0.001	16	30	0.5	25	0.05	0.5	0.5	120	14	0.5	2.5
	Median	4.38	109	38.1	0.02	0.001	16	30	0.5	25	0.05	0.5	0.5	120	14	0.5	2.5
	Max	4.38	109	38.1	0.02	0.001	16	30	0.5	25	0.05	0.5	0.5	120	14	0.5	2.5
	Min	4.38	109	38.1	0.02	0.001	16	30	0.5	25	0.05	0.5	0.5	120	14	0.5	2.5
	n	1.00	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RBSWPU	Average	6.52	127.5	14.4	0.001	0.001	3.5	115	0.5	25	0.05	0.5	0.5	320	1.25	0.75	2.5
	Median	6.52	127.5	14.4	0.001	0.001	3.5	115	0.5	25	0.05	0.5	0.5	320	1.25	0.75	2.5
	Max	6.79	139	18.1	0.001	0.001	5	140	0.5	25	0.05	0.5	0.5	410	2	1	2.5
	Min	6.25	116	10.7	0.001	0.001	2	90	0.5	25	0.05	0.5	0.5	230	0.5	0.5	2.5
	n	2.00	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

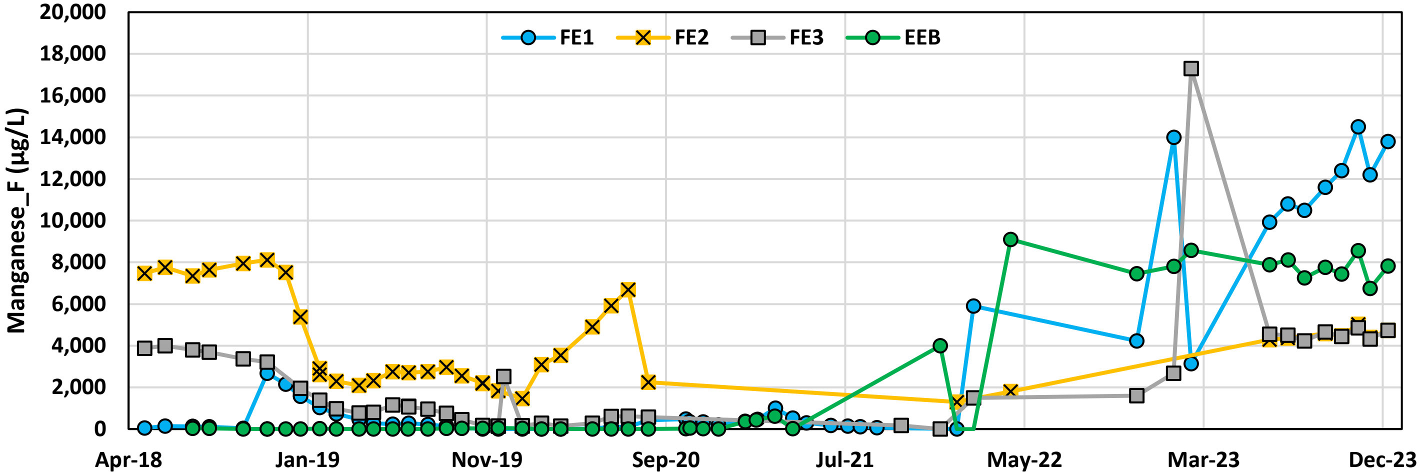
Notes: Ag, Hg, Pb and Se have been omitted from Table D1 as all concentrations are below the corresponding limit of reporting.


FE1
FE2
FE3
EEB
pH
9
8
7
6
5
4
3
Apr-18
Jan-19
Nov-19
Sep-20
Jul-21
May-22
Mar-23
Dec-23

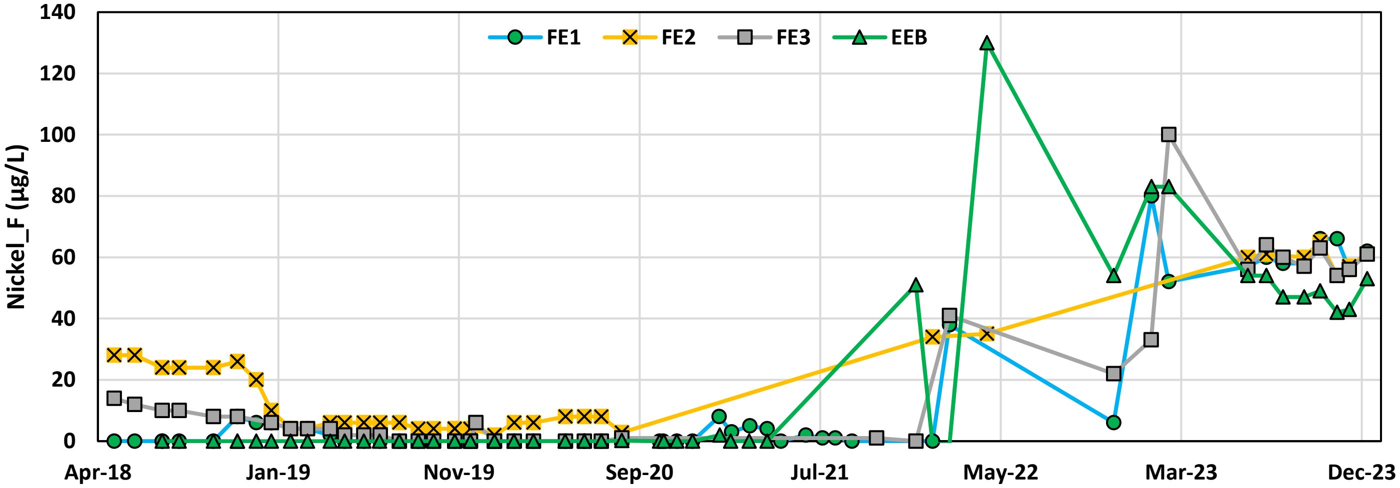

FE1
FE2
FE3
EEB
EC (µS/cm)
5,000
4,000
3,000
2,000
1,000
0
Apr-18
Jan-19
Nov-19
Sep-20
Jul-21
May-22
Mar-23
Dec-23


FE1
FE2
FE3
EEB
Aluminium_F (ug/L)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Apr-18
Jan-19
Nov-19
Sep-20
Jul-21
May-22
Mar-23
Dec-23


FE1
FE2
FE3
EEB
Iron_F (ug/L)
25,000
20,000
15,000
10,000
5,000
0
Apr-18
Jan-19
Nov-19
Sep-20
Jul-21
May-22
Mar-23
Dec-23



FE1
FE2
FE3
EEB
Manganese_F (µg/L)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Apr-18
Jan-19
Nov-19
Sep-20
Jul-21
May-22
Mar-23
Dec-23



FE1
FE2
FE3
EEB
Nickel_F (µg/L)
140
120
100
80
60
40
20
0
Apr-18
Jan-19
Nov-19
Sep-20
Jul-21
May-22
Mar-23
Dec-23

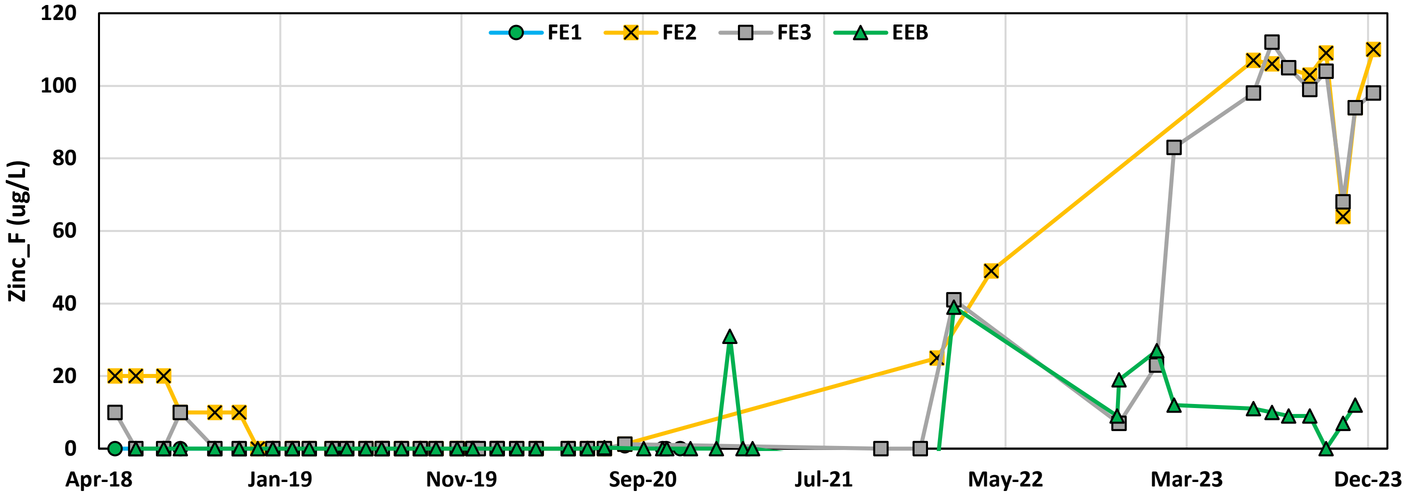


Plate D1 – Long-term water quality trends of NRP Open-cut Pits

Table D2: 2023 Groundwater Monitoring Results

Monitoring Location	Date	SWL	pH	EC	TDS	SO4	Ca	Al	As	B	Cd	Co	Cu	Pb	Mo	Ni	U	Zn
		mbTOC	pH units	µS/cm	mg/L			µg/L										
BBMB01	25/6/23	1.94	6.9	103,000	91,200	7,270	1,330	*50*	*5*	1,700	*0.05*	18	11	*5*	*5*	16	22	*25*
BBMB01	9/12/23	1.91	7.6	103,000	91,900	6,810	1,120	*50*	*5*	1,720	*0.05*	11	*5*	*5*	*5*	14	18	55
BBMB02	25/6/23	3.51	7.3	68,200	54,900	5,750	1,400	720	*5*	1,450	*0.05*	*5*	12	*5*	*5*	*5*	*5*	*25*
BBMB02	9/12/23	4.03	7.7	7,050	4,120	74	33	*5*	4	1,910	*0.05*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*2.5*
BBMB03	25/6/23	2.68	7.8	11,600	7,560	1,160	223	*5*	*0.5*	720	*0.05*	1	3	*0.5*	3	15	11	11
BBMB03	9/12/23	3.03	7.9	8,080	4,860	750	146	*5*	*0.5*	770	*0.05*	*0.5*	*0.5*	*0.5*	3	10	14	8
BBMB04	25/6/23	2.11	7.1	57,800	47,700	5,940	805	*50*	*5*	1,920	*0.05*	*5*	*5*	*5*	*5*	31	17	*25*
BBMB04	9/12/23	2.44	7.6	66,400	51,700	5,830	956	*50*	*5*	2,150	*0.05*	*5*	*5*	*5*	*5*	12	16	*25*
MB01	22/6/23	8.65	7.4	28,500	20,600	1,160	142	*50*	*5*	930	*0.05*	*5*	14	*5*	*5*	14	*5*	*25*
MB01	7/12/23	8.74	8.0	31,500	22,500	753	145	*50*	*5*	1,050	*0.05*	*5*	21	*5*	*5*	24	*5*	56
MB05	23/6/23	2.38	6.3	4,200	3,120	116	28	180	*0.5*	210	0.3	27	72	*0.5*	2	129	*0.5*	150
MB05	7/12/23	3.07	6.7	4,400	2,610	135	30	150	*0.5*	220	0.2	23	40	*0.5*	4	113	*0.5*	131
MB06	23/6/23	No Access																
MB06	8/12/23	1.29	7.9	29,500	23,100	1,540	585	*50*	*5*	920	*0.05*	*5*	*5*	*5*	*5*	*5*	*5*	*25*
MB07	23/6/23	6.80	7.4	3,750	2,350	208	72	*5*	*0.5*	360	*0.05*	1	*0.5*	*0.5*	*0.5*	2	*0.5*	*2.5*
MB07	8/12/23	6.95	8.0	1,470	816	68	34	*5*	*0.5*	420	*0.05*	1	1	*0.5*	*0.5*	2	*0.5*	6
MB08	23/6/23	9.32	7.5	20,300	15,300	1,240	109	*5*	*0.5*	1,240	0.3	2	*0.5*	*0.5*	3	36	8	6
MB08	8/12/23	-	8.1	21,300	14,700	1,220	77	*5*	*0.5*	1,640	*0.05*	*0.5*	2	*0.5*	*0.5*	3	10	*2.5*
MB09	23/6/23	5.23	7.1	37,100	34,400	4,240	347	*50*	*5*	310	79.6	*5*	142	*5*	*5*	19	*5*	815
MB09	7/12/23	5.54	7.7	30,800	23,500	3,030	225	*50*	*5*	700	8.1	*5*	102	*5*	*5*	17	*5*	160
MB21B	22/6/23	17.18	7.1	834	453	*0.5*	2	*5*	3	180	*0.05*	1	1	*0.5*	1	15	*0.5*	25
MB21B	7/12/23	17.44	7.5	893	442	*0.5*	1	*5*	2	220	*0.05*	*0.5*	2	*0.5*	*0.5*	2	*0.5*	*2.5*
MB30	22/6/23	Dry																
MB30	7/12/23	Dry																
MB32B	23/6/23	10.92	7.5	7,210	4,940	320	127	*5*	4	620	*0.05*	*0.5*	*0.5*	*0.5*	*0.5*	18	*0.5*	9
MB32B	7/12/23	11.99	7.6	5,720	3,740	233	105	*5*	3	840	*0.05*	*0.5*	2	*0.5*	*0.5*	*0.5*	*0.5*	*2.5*
MB33B	23/6/23	No Access																
MB33B	7/12/23	No Access																
RBGW01	23/6/23	4.17	7.3	14,800	10,400	233	142	*5*	*0.5*	1,450	*0.05*	*0.5*	*0.5*	*0.5*	*0.5*	1	*0.5*	8
RBGW01	8/12/23	5.44	7.8	10,400	7,130	169	98	*5*	*0.5*	1,340	*0.05*	*0.5*	2	*0.5*	*0.5*	*0.5*	*0.5*	*2.5*
RBGW02	23/6/23	10.25	6.0	42	36	*0.5*	*0.5*	70	*0.5*	*25*	*0.05*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	7

Monitoring Location	Date	SWL	pH	EC	TDS	SO4	Ca	Al	As	B	Cd	Co	Cu	Pb	Mo	Ni	U	Zn
RBGW02	8/12/23	10.21	7.7	66,900	52,000	4,790	1,350	*50*	*5*	1,070	*0.05*	*5*	*5*	*5*	*5*	*5*	*5*	*25*
RBGW03	22/6/23	14.14	7.6	352	238	*0.5*	6	*5*	*0.5*	450	*0.05*	*0.5*	*0.5*	*0.5*	*0.5*	2	*0.5*	*2.5*
RBGW03	7/12/23	14.04	7.6	199	114	*0.5*	2	*5*	*0.5*	440	*0.05*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*2.5*
RBGW05	22/6/23	11.50	6.7	182	124	6	1	*5*	1	60	*0.05*	*0.5*	*0.5*	*0.5*	*0.5*	6	*0.5*	16
RBGW05	7/12/23	11.83	7.4	189	95	3	1	*5*	1	60	*0.05*	*0.5*	2	*0.5*	*0.5*	7	*0.5*	14
RBGW07	22/6/23	12.70	6.6	177	267	11	2	*5*	*0.5*	70	*0.05*	*0.5*	*0.5*	*0.5*	*0.5*	9	*0.5*	28
RBGW07	7/12/23	11.59	7.1	166	86	7	2	*5*	*0.5*	60	0.2	*0.5*	2	*0.5*	*0.5*	8	*0.5*	23
RBGW11	22/6/23	11.53	7.3	21,200	15,800	915	366	*5*	*0.5*	1,780	*0.05*	*0.5*	*0.5*	*0.5*	*0.5*	5	*0.5*	21
RBGW11	7/12/23	12.73	7.8	14,000	9,330	590	217	*5*	*0.5*	1,960	*0.05*	*0.5*	*0.5*	*0.5*	*0.5*	3	*0.5*	11

Notes: NS – Not Sampled SWL – Standing Water Level mbTOC – meters below Top of Casing

Results highlighted blue & italic are below the limit of reporting. Such results have been halved for the use in statistical analysis.

Cr and Se have been omitted from Table D2 as all concentrations are below the corresponding limit of reporting.

Table D3: 2023 Sediment Monitoring Results

		Monitoring Location								
		RBSED01	**RBSED02**	**RBSED04**	**RBSED08**	**RBSWDS**	**RBSEDPU**	**RBSED09**	**RBSED13**	**RBSED14**
	Date	21/06/2023	21/06/2023	21/06/2023	21/06/2023	21/06/2023	21/06/2023	21/06/2023	21/06/2023	21/06/2023
Al	mg/kg	2,600	3,140	4,990	8,630	4,260	2,250	1,480	1,620	1,630
Sb		*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*
As		1.44	1.6	2.09	3.86	1.08	1.86	*0.5*	*0.5*	1.34
Ba		8.8	15.5	26.6	193	25.2	12.9	13.1	10.4	13.4
B		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Cd		<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cr		15.2	13.2	12.4	34	11.8	14.5	7.9	8.7	8.9
Co		1.9	2.6	5	15.4	3.9	2.2	1.5	1	2.4
Cu		3	4.8	5.2	13.6	4.8	3.1	1.8	1.9	2.8
Fe		8,930	8,390	14,700	28,700	9,390	10,800	2,960	6,390	6,720
Pb		2.6	4.5	4.1	12.5	4.5	3	1.5	1.7	2.2
Li		1.2	2	5	6.6	1.9	1.4	1.5	0.6	1.4
Mn		44	52	58	249	74	62	49	15	32
Hg		*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	0.01	*0.005*	*0.005*	*0.005*
Mo		0.3	0.3	0.4	0.5	0.2	0.3	*0.05*	0.2	0.3
Ni		1.4	1.8	3.1	8.9	2.3	2.1	1.1	*0.5*	1.6
Rb		5.6	7.2	9	18.1	8.8	5.7	5.1	3	4
Se		0.3	0.7	0.6	1.2	0.6	0.9	0.4	0.2	0.4
Ag		*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
Sr		2	2.7	2.7	6.9	5.5	5.4	1.2	1.3	11.8
U		0.2	0.3	0.4	0.7	0.3	0.3	0.1	0.2	0.7
V		24	23.5	23.8	47.6	24.8	28.7	9.9	20.9	23.1
Zn		1.3	3.7	5.3	6.3	6.1	3.2	2.1	*0.5*	2.8

Notes: NS – Not Sampled

Results highlighted blue & italic are below the limit of reporting. Such results have been halved for the use in statistical analysis.

Table D4: 2023 Dust Monitoring Results

Sample Location ID	Sample Date - Start	Sample Date - End	Ash Content	Combustible Matter	Total Insoluble Matter
			g/m^2/month		
BBDM01	14/12/2022	12/01/2023	0.2	0	0.2
BBDM01	13/01/2023	7/02/2023	0.2	0.1	0.3
BBDM01	3/02/2023	25/06/2023	0.3	0.2	0.5
BBDM01	25/06/2023	21/07/2023	0.3	0.2	0.5
BBDM01	21/07/2023	18/08/2023	0.2	0.1	0.3
BBDM01	18/08/2023	24/09/2023	2.9	*0.05*	2.9
BBDM01	24/09/2023	23/10/2023	0.5	*0.05*	0.5
BBDM01	23/10/2023	9/12/2023	6.2	0.3	6.5
BBDM01	7/12/2023	15/01/2024	4.4	0.3	4.7
BBDM02	14/12/2022	12/01/2023	0.3	0	0.3
BBDM02	12/01/2023	7/02/2023	0.3	1.3	1.6
BBDM02	3/02/2023	25/06/2023	0.3	0.5	0.8
BBDM02	25/06/2023	21/07/2023	2.3	0.5	2.8
BBDM02	21/07/2023	18/08/2023	2.1	0.4	2.5
BBDM02	18/08/2023	24/09/2023	5.6	0.5	6.1
BBDM02	24/09/2023	23/10/2023	0.2	*0.05*	0.2
BBDM02	23/10/2023	9/12/2023	0.9	0.1	1
BBDM02	7/12/2023	15/01/2024	1.3	0.6	1.9
BBDM03	14/12/2022	12/01/2023	0.2	0	0.2
BBDM03	12/01/2023	7/02/2023	0.5	0.2	0.7
BBDM03	2/02/2023	25/06/2023	0.6	0.4	1
BBDM03	25/06/2023	21/07/2023	1	0.2	1.2
BBDM03	21/07/2023	18/08/2023	0.4	*0.05*	0.4
BBDM03	18/08/2023	24/09/2023	3.9	0.4	4.3
BBDM03	24/09/2023	23/10/2023	0.1	*0.05*	0.1
BBDM03	23/10/2023	9/12/2023	3	0.2	3.2
BBDM03	7/12/2023	15/01/2024	1.7	0.4	2.1
BBDM04	13/12/2022	12/01/2023	0.7	0.5	1.2
BBDM04	12/01/2023	7/02/2023	0.1	0.4	0.5
BBDM04	3/02/2023	25/06/2023	0.3	0.4	0.7
BBDM04	25/06/2023	21/07/2023	0.3	0.3	0.6

Sample Location ID	Sample Date - Start	Sample Date - End	Ash Content	Combustible Matter	Total Insoluble Matter
BBDM04	21/07/2023	18/08/2023	0.1	0.3	0.4
BBDM04	18/08/2023	24/09/2023	3.2	0.7	3.9
BBDM04	24/09/2023	23/10/2023	0.8	0.3	1.1
BBDM04	23/10/2023	9/12/2023	10.5	0.6	11.1
BBDM04	7/12/2023	15/01/2024	7.1	0.9	8
BBDM05	12/01/2023	7/02/2023	11.9	0.4	12.3
BBDM05	3/02/2023	25/06/2023	1	0.1	1.1
BBDM05	25/06/2023	21/07/2023	1.4	0.2	1.6
BBDM05	21/07/2023	18/08/2023	43.7	1.6	45.3
BBDM05	18/08/2023	24/09/2023	26.1	0.8	26.9
BBDM05	24/09/2023	23/10/2023	6.4	0.2	6.6
BBDM05	23/10/2023	9/12/2023	33.5	1	34.5
BBDM05	7/12/2023	15/01/2024	12	0.5	12.5
BBDM06	3/02/2023	25/06/2023	1.7	0.8	2.5
BBDM06	25/06/2023	21/07/2023	0.7	0.1	0.8
BBDM06	21/07/2023	18/08/2023	2.4	0.5	2.9
BBDM06	18/08/2023	24/09/2023	5.4	0.4	5.8
BBDM06	24/09/2023	23/10/2023	0.9	0.1	1
BBDM06	7/12/2023	15/01/2024	8.2	0.2	8.4
DM01	13/01/2023	22/06/2023	1.6	0.5	2.1
DM01	23/06/2023	21/07/2023	0.4	0.4	0.8
DM01	21/07/2023	18/08/2023	0.7	0.1	0.8
DM01	18/08/2023	24/09/2023	1.4	0.4	1.8
DM01	24/09/2023	22/10/2023	1.7	0.1	1.8
DM01	22/10/2023	6/12/2023	0.5	0.7	1.2
DM01	6/12/2023	15/01/2024	1	0.4	1.4
DM02	13/12/2022	11/01/2023	0.1	0.2	0.3
DM02	13/01/2023	7/02/2023	0.2	0.5	0.7
DM02	7/02/2023	22/06/2023	0.2	0.3	0.5
DM02	22/06/2023	21/07/2023	0.5	0.3	0.8
DM02	21/07/2023	18/08/2023	0.5	0.9	1.4
DM02	18/08/2023	22/10/2023	0.9	1.4	2.3
DM02	22/10/2023	6/12/2023	0.4	0.5	0.9

Sample Location ID	Sample Date - Start	Sample Date - End	Ash Content	Combustible Matter	Total Insoluble Matter
DM02	6/12/2023	15/01/2024	0.5	0.8	1.3
DM03	13/12/2022	11/01/2023	0.2	0.3	0.5
DM03	13/01/2023	7/02/2023	0.1	0.1	0.2
DM03	7/02/2023	22/06/2023	0.2	0.1	0.3
DM03	22/06/2023	21/07/2023	0.1	0.1	0.2
DM03	21/07/2023	18/08/2023	0.1	0.4	0.5
DM03	18/08/2023	22/10/2023	1.1	0.1	1.2
DM03	22/10/2023	6/12/2023	0.7	0.1	0.8
DM03	6/12/2023	15/01/2024	0.7	0.4	1.1
DM04	13/12/2022	13/01/2023	0.2	0.3	0.5
DM04	13/01/2023	7/02/2023	0.1	0.2	0.3
DM04	7/02/2023	22/06/2023	13.6	1.1	14.7
DM04	22/06/2023	21/07/2023	3.7	5.8	9.5
DM04	21/07/2023	18/08/2023	0.9	2	2.9
DM04	18/08/2023	22/10/2023	0.4	0.2	0.6
DM04	22/10/2023	6/12/2023	0.4	0.2	0.6
DM04	6/12/2023	15/01/2024	0.4	1.7	2.1
DM05	6/12/2023	15/01/2024	0.6	0.2	0.8
DM06	13/12/2022	13/01/2023	1.4	0.3	1.7
DM06	12/01/2023	7/02/2023	0.3	*0.05*	0.3
DM06	13/01/2023	7/02/2023	0.1	0.1	0.2
DM06	6/12/2023	15/01/2024	0.4	0.2	0.6
DM07	6/12/2023	15/01/2024	1.9	0.7	2.6
DM08	13/12/2022	13/01/2023	0.3	0	0.3
DM08	13/01/2023	7/02/2023	0.2	*0.05*	0.2
DM08	7/02/2023	22/06/2023	0.1	0.3	0.4
DM08	22/06/2023	21/07/2023	0.1	0.2	0.3
DM08	21/07/2023	18/08/2023	0.1	0.3	0.4
DM08	18/08/2023	24/09/2023	0.1	0.3	0.4
DM08	24/09/2023	22/10/2023	0.1	0.1	0.2
DM08	22/10/2023	6/12/2023	0.3	0.2	0.5
DM08	6/12/2023	15/01/2024	4	0.8	4.8
DM09	13/12/2022	11/01/2023	0.3	0.3	0.6

Sample Location ID	Sample Date - Start	Sample Date - End	Ash Content	Combustible Matter	Total Insoluble Matter
DM09	13/01/2023	7/02/2023	0.1	*0.05*	0.1
DM09	7/02/2023	22/06/2023	2.8	0.7	3.5
DM09	22/06/2023	21/07/2023	0.6	0.3	0.9
DM09	21/07/2023	18/08/2023	1.9	0.3	2.2
DM09	18/08/2023	24/09/2023	4.7	2.4	7.1
DM09	24/09/2023	22/10/2023	0.7	0.2	0.9
DM09	22/10/2023	6/12/2023	9.3	0.7	10
DM09	6/12/2023	15/01/2024	7.6	0.7	8.3
DM10	11/11/2022	7/02/2023	0.2	0.1	0.3
DM10	7/02/2023	22/06/2023	0.4	0.2	0.6
DM10	22/06/2023	21/07/2023	0.1	0.3	0.4
DM10	21/07/2023	18/08/2023	0.2	0.3	0.5
DM10	18/08/2023	24/09/2023	1.2	0.3	1.5
DM10	24/09/2023	22/10/2023	0.2	0.2	0.4
DM10	22/10/2023	6/12/2023	1.4	0.3	1.7
DM10	6/12/2023	15/01/2024	3.5	0.6	4.1
DM11	13/12/2023	6/12/2023	4.1	0.3	4.4
DM13	13/01/2023	22/06/2023	0.1	0.1	0.2
DM13	22/06/2023	21/07/2023	<0.1	0.6	0.6
DM13	21/07/2023	18/08/2023	0.1	0.1	0.2
DM13	18/08/2023	24/09/2023	0.3	0.5	0.8
DM13	24/09/2023	22/10/2023	0.1	0.1	0.2
DM13	22/10/2023	6/12/2023	0.4	0.1	0.5
DM14	13/12/2022	13/01/2023	0.1	0	0.1
DM14	13/01/2023	22/06/2023	2	0.8	2.8
DM14	22/06/2023	21/07/2023	1.2	0.8	2
DM14	21/07/2023	18/08/2023	0.8	0.4	1.2
DM14	18/08/2023	24/09/2023	9.7	0.5	10.2
DM14	24/09/2023	22/10/2023	0.7	0.2	0.9
DM14	22/10/2023	6/12/2023	7.9	0.6	8.5
DM15	13/01/2023	7/02/2023	0.4	0.5	0.9
DM15	7/02/2023	22/06/2023	2.1	2.5	4.6
DM15	22/06/2023	21/07/2023	1.6	2	3.6

Sample Location ID	Sample Date - Start	Sample Date - End	Ash Content	Combustible Matter	Total Insoluble Matter
DM15	21/07/2023	18/08/2023	0.1	0.1	0.2
DM15	18/08/2023	22/10/2023	0.8	1.2	2
DM15	22/10/2023	6/12/2023	0.9	0.6	1.5

Notes: NS – Not Sampled

Results highlighted blue & italic are below the limit of reporting. Such results have been halved for the use in statistical analysis.

wrm
water+environment

Memorandum

Date	12 November 2019	Pages	11
Attention	Jim Barker		
Company	METServe		
Job No.	1547-02-E2		
Subject	Preliminary review of water quality data to derive trigger values suitable for the receiving waters for the Roper Bar Mine		

Dear Jim

Overview

Mining & Energy Technical Services Pty Ltd (METServe) have requested WRM Water and Environment (WRM) to undertake a preliminary review of available receiving waters water quality data at the Roper Bar Mine (RBM). The review is to derive suitable local trigger values for the RBM Environmental Management System (EMS) based on background values in the local waterways and relevant trigger values from the *Australian Guidelines for Water Quality Monitoring and Reporting* (ANZECC & ARMCANZ, 2000).

The review has been undertaken using RBM surface water quality data collected at the following monitoring sites:

- three reference sites upstream of the mine on the following drainage lines:
    - Towns River at the monitoring points RBSW01 and RBSW02; and
    - A tributary of the Maganaryi River at monitoring point RBSW13.
- four receiving waters sites downstream of the mine on the following drainage lines:
    - Towns River at the monitoring points RBSW04, RBSW05 and RBSW14; and
    - Maganaryi River at monitoring point RBSW15.

The proposed local water quality trigger levels for RBM have been derived in accordance with ANZECC & ARMCANZ (2000) guidelines. These guidelines outline the requirements for deriving local water quality trigger levels.

Surface water site specific trigger values

To derive site-specific trigger values, ANZECC & ARMCANZ (2000) states the following:

> *For these Guidelines, data collected after two years of monthly sampling are regarded as sufficient to indicate ecosystem variability and can be used to derive trigger values.*

The guidelines state that a minimum of 24 monthly data points should be collected in a two-year period before they are used to derive site specific guideline values. Of the nine natural surface water sites, the most sampled site in close proximity to the mine (RBSW04) has a maximum total of 10 monthly samples in a two-year period. There is therefore not yet the recommended minimum number of data samples to derive site specific trigger values for the RBM receiving waters. This is because NRR has only recently acquired the RBM and has not been on site long enough to acquire the required number of samples.

In the absence of sufficient data, the ANZECC & ARMCANZ (2000) guidelines recommend the use of default trigger values. The adopted surface water quality indicators relevant to protecting declared beneficial uses including aquatic ecosystems are given in ANZECC & ARMCANZ (2000).

ANZECC & ARMCANZ (2000) Trigger Values

The ANZECC & ARMCANZ (2000) guideline values for physical and chemical stressors in lowland rivers for Tropical Australia are summarised in Table 1. The ANZECC & ARMCANZ (2000) guideline values for metals, metalloids and non-metallic inorganics for different ecosystem protection levels are summarised in Table 2. Table 1 and Table 2 also summarises the ANZECC & ARMCANZ (2000) guideline values for stock drinking water limits.

It is initially proposed to adopt the ANZECC & ARMCANZ (2000) default triggers for physical and chemical stressors and 95% protection for freshwater ecosystems for toxicants unless interim locally derived values or guidelines are considered appropriate based on the below analysis. This will allow RBM time to operate with an interim set of triggers until they collect a suitable amount of monitoring data to develop locally derived triggers.

Table 1 - Default trigger values for physical and chemical stressors (Tropical Australia, Lowland River) (ANZECC & ARMCANZ, 2000)

Parameter	Lowland River Trigger value	Stock Drinking Water Limits
pH	6 - 8	4 - 9
Electrical Conductivity (µS/cm)	250	5,970
Turbidity (NTU)	15	-
Chlorophyll (µg/L)	5	-
Total Phosphorous (µg/L)	10	-
Filterable Reactive Phosphorous (µg/L)	4	-
Total Nitrogen (µg/L)	300	-
Nitrogen Oxide (NOx) (µg/L)	10	-
Ammonium (µg/L)	10	-
Dissolved Oxygen (% saturation)	85 - 120	-

Table 2 - Specific toxicant default trigger values for ecosystem protection in freshwater as well as stock drinking water limits (ANZECC & ARMCANZ, 2000)

Toxicant	Level of aquatic ecosystem protection (% species)[a]				Stock Drinking Water Limits[b]
	99%	95%	90%	80%	
Metals & Metalloids (µg/L)					
Aluminium (pH filtered >6.5)	27	55	80	150	5,000
Arsenic (AS III)	1	24	94	360	500
Arsenic (AS V)	0.8	13	42	140	-
Boron	90	370	680	1,300	-
Cadmium	0.06	0.2	0.4	0.8	10
Chromium	0.01	1.0	6	40	1,000
Copper	1.0	1.4	1.8	2.5	1,000
Lead	1.0	3.4	5.6	9.4	100
Manganese	1,200	1,900	2,500	3,600	10,000
Mercury	0.06	0.6	1.9	5.4	
Nickel	8	11	13	17	1,000
Selenium (Total)	5	11	18	34	34
Silver	0.02	0.05	0.1	0.2	-
Zinc	2.4	8.0	15	31	20,000
Non-Metallic Inorganics (µg/L)					
Ammonia (Total)	320	900	1,430	2,300	-
Chlorine	0.4	3	6	13	-
Cyanide	4	7	11	18	-
Nitrate	17	700	3,400	17,000	-
Hydrogen sulfide	0.5	1.0	1.5	2.6	-
Sulfate[c]	-	-	-	-	1,000
Calcium	-	-	-	-	1,000
Magnesium	-	-	-	-	1,000[d]

[a] Applicable to filtered (dissolved) samples for metals and metalloids

[b] Applicable to total samples for metals and metalloids

[c] Australian Drinking Water Guideline (NHMRC, NRMMC 2011) value is 250 mg/l (aesthetic considerations - taste) and 500 mg/l (purgative effects)

[d] South African proposed upper limit for livestock drinking water (DWAF 1996)

Available data

Natural surface water quality data collected at RBM between December 2010 and August 2019 was provided by NRR for this review. The water quality parameters available for the three reference sites and three receiving waters sites which are relevant to ANZECC & ARMCANZ (2000) trigger levels investigated for this review are as follows:

- Dissolved and total metals -Aluminium (Al), Arsenic (As), Boron (B), Cadmium (Cd), Chromium (Cr), Copper (Cu), Manganese (Mn), Nickel (Ni), Lead (Pb), Selenium (Se), Silver (Ag), and Zinc (Zn);
- Turbidity;
- Electrical Conductivity (EC);

- pH;
- Ammonia;
- Calcium;
- Magnesium;
- Nitrate; and
- Sulphate.

A detailed review of the surface water quality at and in the vicinity of RBM was undertaken by WRM for NRR in a document entitled *Surface water and Groundwater Quality Assessment* (WRM, 2019).

RBSW14 was included in this review although elevated salt concentrations at RBSW14 suggests that salt concentrations in natural surface water are naturally elevated during baseflow conditions. This site is approximately 16.8 km northeast (downstream) of RBM and located within the Limmen National Park and upstream of the Limmen Bight coastal floodplains.

Table 3 and Table 4 show the summary of surface water quality statistics from WRM (2019) for the relevant natural surface water quality parameters investigated in the vicinity of RBM for the Towns River and the Magaranyi River respectively. Note that the blue shaded cells show values below the limit of detection (LOD) and orange shaded cells show values that exceed the ANZECC & ARMCANZ (2000) trigger values.

Due to the limited number of sample points for some parameters, both the 80th percentile and maximum values were considered when deriving the interim local trigger levels, where appropriate.

Table 3 - Towns River Water quality data statistics (2010 to 2019)

Analyte	LOD	ANZECC & ARMCANZ (2000) Trigger Value/Range	Upstream sites				Downstream sites					
			RBSW01		RBSW02		RBSW04		RBSW05		RBSW14	
			80%ile	Max	80%ile	Max	80%ile	Max	80%ile	Max	80%ile	Max
Field parameters												
pH (upper)	-	>8[a] / >9[b]	7.8	8.15	7.8	8.63	7.8	8.68	7.6	8	7.9	8.3
pH (lower)[d]		<6 [a] / <4 [b]	7.0	6.8	7.0	6.0	7.1	5.7	6.7	5.4	7.3	6.5
EC (µS/cm)	-	250[a] / 5,970[b]	70.8	121	211	1,156	188	853	90	230	1,021	18,677
DO (%)	-	85-120[a]	97	108	94	121	93	118	85	96	91	120
Turbidity (NTU)	-	15[a]	109	361	102	800	194	800	81	216	92	1,315
Metals and metalloids												
Aluminium (µg/L)	20	55[a]	2,918	6,540	2,546	28,400	4,400	9,600	932	1,260	732	1,060
Arsenic (AS V) (µg/L)	0.5	13[a]	1	1	1	1	1	2.5	1	1	1	2
Boron (µg/L)	20	370[a]	50	50	80	520	80	100	56	80	80	1,220
Cadmium (µg/L)	0.2	0.2[a]	0.10	0.20	0.20	0.20	0.20	0.20	0.10	0.10	0.20	0.40
Chromium (µg/L)	5	1[a]	1	5	5	20	5	5	1	1	5	5
Copper (µg/L)	10	1.4[a]	2	10	10	10	10	10	1	1	9.8	10
Manganese (µg/L)	5	1,900[a]	11.6	21.0	49	205	24.4	390	10.2	312	12	206
Nickel (µg/L)	2	11[a]	1	2	2	4	2	2	1	1	2.0	2
Lead (µg/L)	1	3.4[a]	1	1	1	2	1	2	1	1	1	1
Selenium (µg/L) (total)	1	11[a]	10	10	2	10	10	10	10	10	10	10
Silver (µg/L)	10	0.05[a]	6.4	10	10	10	10	10	1	1	10	10
Zinc (µg/L)	10	8[a]	6.6	10	10	10	10	10	6.6	30	10	26
Cations, Anions and Nutrients												
Calcium (mg/L)	0.1	1,000[b]	2	2	2	10	2.1	6	1.2	9	54.56	172
Magnesium (mg/L)	0.1	1,000[b]	2	4	3	13.8	3.9	6.7	2.2	10	62.14	406
Sulphate (mg/L)	0.1	250[c]/500[c]/1,000[b]	3	5	3	37.4	3.6	8.8	3.8	6	138	756
Ammonia as N NH3_N (mg/L)	0.005	0.74	0.06	0.11	0.225	1.65	0.165	0.305	0.024	0.11	0.02	0.17
Nitrate NO3 (mg/L)	0.02	0.7[a]	0.02	0.02	0.16	2.5	0.05	0.16	0.038	0.14	0.02	0.09

[a] 95% freshwater ecosystem protection (applicable to filtered (dissolved) samples for metals and metalloids)

[b] stock watering values (applicable to total samples for metals and metalloids)

[c] Australian Drinking Water Guideline (NHMRC, NRMMC 2011) value is 250 mg/l (aesthetic considerations - taste) and 500 mg/l (purgative effects)

[d] Inverse is applied to pH (lower) ie. 80th percentile column corresponds to the 20th percentile value and Maximum column corresponds to minimum value

Table 4 - Magaranyi River Water quality data statistics (2010 to 2019)

Analyte	LOD	ANZECC & ARMCANZ (2000) Trigger Value/ Range	Upstream RBSW13		Downstream RBSW15	
			80%ile	Max	80%ile	Max
Field parameters						
pH (upper)	-	>8[a] / >9[b]	7.6	7.84	7.8	8.51
pH (lower)		<6 [a] / <4 [b]	6.9	5.3	7.1	6.1
EC (µS/cm)	-	250[a] / 5,970[b]	103	314	42	70
DO (%)	-	85-120[a]	97	115	100	110
Turbidity (NTU)	-	15[a]	55	245	95	673
Metals and Metalloids						
Aluminium (µg/L)	20	55[a]	1,388	1,580	952	1,870
Arsenic (AS V) (µg/L)	0.5	13[a]	1	1	1	10
Boron (µg/L)	20	370[a]	48	60	50	100
Cadmium (µg/L)	0.2	0.2[a]	0.20	0.20	0.20	5
Chromium (µg/L)	5	1[a]	5	5	2.6	10
Copper (µg/L)	10	1.4[a]	10	10	4.6	10
Manganese (µg/L)	5	1,900[a]	14.4	85	5	20
Nickel (µg/L)	2	11[a]	2	2	2	10
Lead (µg/L)	1	3.4[a]	1	1	1	10
Selenium (µg/L) (total)	1	11[a]	1	10	10	10
Silver (µg/L)	10	0.05[a]	10	10	4.6	10
Zinc (µg/L)	10	8[a]	10	16	10	19
Cations, Anions and Nutrients						
Calcium (mg/L)	0.1	1,000[b]	2	2.5	1	3
Magnesium (mg/L)	0.1	1,000[b]	2	2.8	2	4
Sulphate (mg/L)	0.1	250[c]/500[c]/1,000[b]	1	1.3	1	11
Ammonia as N NH_3_N (mg/L)	0.005	0.74[d]	0.034	0.085	0.022	0.06
Nitrate NO_3 (mg/L)	0.02	0.7[a]	0.032	0.17	0.03	0.4

[a] 95% freshwater ecosystem protection (applicable to filtered (dissolved) samples for metals and metalloids)

[b] stock watering values (applicable to total samples for metals and metalloids)

[c] Australian Drinking Water Guideline (NHMRC, NRMMC 2011) value is 250 mg/l (aesthetic considerations - taste) and 500 mg/l (purgative effects)

Comparison of local water quality data with ANZECC & ARMCANZ (2000) trigger levels.

pH

Table 3 and Table 4 show the 20th to 80th percentile pH values derived from the RBM natural surface water monitoring sites range from 6.7 to 7.9. Table 3 and Table 4 also show that the minimum to maximum values range from 5.3 to 8.7. The ANZECC & ARMCANZ (2000) default trigger value range for pH is 6 to 8.

The water quality results for pH indicate that adoption of an interim 80th percentile locally derived range of 5.5 to 8.5 would increase the receiving water trigger range for pH, compared to using the ANZECC & ARMCANZ (2000) default trigger range of 6 to 8.

Electrical Conductivity (EC)

Table 3 and Table 4 show the 80th percentile electrical conductivity derived from the RBM natural surface water monitoring sites range from 71 to 201 µS/cm for upstream sites and 42 to 1,021 µS/cm for downstream sites. Table 3 and Table 4 also show that the maximum values range from 70 to 18,677 µS/cm. The ANZECC & ARMCANZ (2000) default trigger value for turbidity is 250 µS/cm.

The water quality results for electrical conductivity indicate that adoption of an interim 80th percentile locally derived level of 1,021 µS/cm would increase the receiving water trigger level for electrical conductivity, compared to using the ANZECC & ARMCANZ (2000) default trigger value of 250 µS/cm.

Turbidity

Table 3 and Table 4 show the 80th percentile turbidity concentration derived from the RBM natural surface water monitoring sites range from 55 to 109 NTU for upstream sites and 81 to 194 NTU for downstream sites. Table 3 and Table 4 also shows that the maximum values range from 216 to 1,315 NTU. The ANZECC & ARMCANZ (2000) default trigger value for turbidity is 15 NTU.

The water quality results for turbidity indicate that adoption of an interim 80th percentile locally derived level of 194 NTU would increase the receiving water trigger level for turbidity, compared to using the ANZECC & ARMCANZ (2000) default trigger value of 15 NTU.

Sulphate

ANZECC & ARMCANZ (2000) does not recommend a sulphate concentration for freshwater aquatic ecosystems.

In the absence of this, it is recommended that the Australian Drinking Water Guidelines (NHMRC, NRMMC 2011) drinking water guideline of 500 mg/L be adopted as the interim Sulphate trigger, which is the receiving waters trigger value adopted for mines in Queensland.

It is noted that a maximum sulphate concentration of 756 mg/L has been measured at RBSW14.

Metals

Table 5 shows the 80th percentile values for aluminium measured both upstream and downstream of the RBM exceed the ANZECC & ARMCANZ (2000) 95% freshwater ecosystem protection trigger levels. Table 5 also shows the maximum values for aluminium, boron, cadmium, chromium and zinc exceed the ANZECC & ARMCANZ (2000) 95% freshwater ecosystem protection trigger levels. The 80th percentile and maximum concentration values for arsenic, copper, manganese, nickel, lead, selenium and silver are either below the limit of detection (LOD) or below the ANZECC & ARMCANZ (2000) 95% protection values.

The available values indicate that five metals shown in Table 5 have recorded higher concentrations in the receiving waters than the values given in ANZECC & ARMCANZ (2000) for 95% freshwater ecosystem protection.

Table 5 indicates that the trigger level for the above five metals could potentially be based on locally derived levels. Therefore, it is recommended that the current suite of metals continue to be monitored until there is a suitable number of samples.

Table 5 - Derived local trigger levels for metals compared with ANZECC & ARMCANZ (2000)

Parameter	ANZECC & ARMCANZ (2000) trigger level **(µg/L)**	Recorded 80th percentile **total (µg/L)**	Recorded Maximum value **(µg/L)**	Site(s) that recorded exceedances
Aluminium	55	932 - 4400	1050 - 28,400	All sites
Boron	370	48 - 80	520 - 1,220	RBSW02 RBSW14
Cadmium	0.2	< LOD (0.2)	< LOD - 5	RBSW14 RBSW15
Chromium	1	< LOD (10)	< LOD - 20	RBSW02 RBSW15
Zinc	8	< LOD (10)	16 - 30	RBSW05 RBSW14 RBSW13 RBSW15

Recommendations

Based on currently available information, the following interim receiving water trigger levels are recommended to be adopted for the RBM during a mine water release event:

- pH - locally derived range of 5.5 to 8.5.
- electrical conductivity - locally derived value of 1,021 µS/cm.
- turbidity - locally derived value of 194 NTU;
- sulphate - NHMRC, NRMMC (2011) drinking water guideline value of 500 mg/l; and
- aluminium, boron, cadmium, chromium, and zinc - locally derived lowest maximum values recorded in the receiving waters monitoring locations listed in Table 5. If the lowest value is exceeded during a release event, it is possible that similar exceedances occur in upstream monitoring locations as

well and this should be confirmed (Ongoing monthly monitoring of the receiving waters is required to confirm these values).

Adopting the interim receiving water quality trigger levels proposed below for the RBM, which are based on local measurements and ANZECC & ARMCANZ (2000) guideline values, will help limit the occurrence of non-compliances due to naturally occurring (non-mine related) events.

It is recommended that the ANZECC & ARMCANZ (2000) values for all other parameters are adopted, until local or regional data is available to derive more site-specific trigger levels. A comparison of the ANZECC & ARMCANZ (2000) trigger levels for receiving waters and those recommended from either locally derived values or guideline values is shown in Table 6 and Table 7.

A review of the RBM groundwater quality data in WRM (2019) found that the water quality in a number of regional groundwater bores exceeded the ANZECC & ARMCANZ (2000) stock water guidelines. Hence, it is recommended that appropriate management measures are implemented to prevent livestock access to water storages that contain groundwater that exceeds the ANZECC & ARMCANZ (2000) stock water trigger levels.

It is also recommended that once the required minimum number of samples are collected, the required suite of parameters to be monitored in mine water storages and the receiving environment is reviewed and refined. The review of RBM water quality data collected to date for mine water dams in WRM (2019) indicated that a number of parameters are well below the ANZECC & ARMCANZ (2000) trigger values and may not have to be monitored.

Table 6 -Trigger limits for physical and chemical stressors in receiving waters

Parameter	(ANZECC & ARMCANZ 2000) lowland River Trigger limit	(ANZECC & ARMCANZ 2000) stock Drinking water lmit	Recommended locally derived interim limit
pH	6 to 8	4 to 9	5.5 to 8.5
Electrical Conductivity (µS/cm)	250	5,970	1,021
Turbidity (NTU)	15	-	194
Chlorophyll (µg/L)	5	-	-
Total Phosphorous (µg/L)	10	-	-
Filterable Reactive Phosphorous (µg/L)	4	-	-
Total Nitrogen (µg/L)	300	-	-
Nitrogen Oxide (NOx) (µg/L)	10	-	-
Ammonium (µg/L)	10	-	-
Dissolved Oxygen (% saturation)	85 to 120	-	-

Table 7 -Trigger values for toxicants in receiving waters

Parameter	ANZECC & ARMCANZ (2000) 95% protection	NHMRC, NRMMC (2011) guideline levels	Recommended locally derived levels	Note
Al (µg/L)	55		1,050	Needs confirmation after collecting the required minimum number of reference site samples
As (µg/L)	13			
B (µg/L)	370		520	Needs confirmation after collecting the required minimum number of reference site samples
Cd(µg/L)	0.2		<0.2	Needs confirmation after collecting the required minimum number of reference site samples
Cr (µg/L)	1		<10	Needs confirmation after collecting the required minimum number of reference site samples
Cu (µg/L)	2			
Fe (µg/L)	300			
Pb (µg/L)	4			
Mn (µg/L)	1,900			
Hg (µg/L)	0.2			
Ni (µg/L)	11			
Se (µg/L)	10			
Ag (µg/L)	1			
Zn (µg/L)	8		16	Needs confirmation after collecting the required minimum number of reference site samples
Ammonia (µg/L)	900			
Nitrate (µg/L)	700			
Sulphate (mg/L)	-	500		As per drinking water guidelines (NHMRC, NRMMC 2011)

I trust this advice is of assistance. Please don’t hesitate to contact me if you would like to discuss the results.

For and on behalf of
WRM Water & Environment Pty Ltd

Julian Orth
Principal Engineer

References:

ANZECC & ARMCANZ (2000)	'*ANZECC (Australian and New Zealand Environment and Conservation Council) and ARMCANZ (Agriculture and Resource Management Council of Australia and New Zealand)* 2000', Australian Guidelines for Water Quality Monitoring and Reporting. National Water Quality Management Strategy Paper No. 7, ANZECC and ARMCANZ, Canberra.
DWAF (1996)	*'South African water quality guidelines'*, 2nd edn, vol 5: Agricultural use: Livestock watering. CSIR Environmental Services, Pretoria.
NHMRC, NRMMC (2011)	*'Australian Drinking Water Guidelines'* Paper 6 National Water Quality Management Strategy. Version 3.5. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.
WRM (2019)	'*Surface water and Groundwater Quality Assessment',* prepared by WRM for NRR, 6 September 2019.

WATER MANAGEMENT PLAN

Nathan River Project

Mining Operations and Bing Bong Loading Facility

TABLE OF CONTENTS

1 INTRODUCTION 4
  1.1 Background 4
  1.2 Purpose and Scope 4
  1.3 Guidelines 4
2 CURRENT CONDITIONS 5
  2.1 NRP Mine 5
    2.1.1 Surface Water 5
    2.1.2 Groundwater 9
  2.2 Bing Bong Loading Facility 11
    2.2.1 Surface water 11
    2.2.2 Groundwater 11
3 PROJECT OVERVIEW 12
  3.1 NRP Mine 12
    3.1.1 NRP Surface Water Management Infrastructure 12
    3.1.2 NRP Groundwater Management Infrastructure 19
  3.2 BBLF 25
    3.2.1 BBLF Surface Water Management Infrastructure 25
    3.2.2 BBLF Groundwater Management Infrastructure 29
  3.3 Water requirements, sources and storages 31
    3.3.1 Mining and Processing 31
    3.3.2 Potable Water Supply 31
    3.3.3 Wastewater discharge 31
4 RISK MANAGEMENT 32
  4.1 Identify hazards and rank risks 32
    4.1.1 NRP Mine risk assessment 32
    4.1.2 BBLF dredging risk assessment 33
    4.1.3 Pandanus drainage line diversion 34
  4.2 Actions and strategies in response to identified risks 36
5 MONITORING 37
  5.1 NRP Monitoring Programs 37
    5.1.1 Surface water quality monitoring program 37
    5.1.2 Groundwater monitoring program 42
    5.1.3 Fluvial Sediment monitoring 46
    5.1.4 Macroinvertebrate monitoring 49
    5.1.5 Pandanus Creek Diversion Monitoring program 52
    5.1.6 Potable water monitoring program 54
  5.2 BBLF Monitoring Programs 56
    5.2.1 BBLF Surface water quality monitoring program 56
    5.2.2 BBLF Groundwater monitoring program 58
    5.2.3 Dredge Monitoring Program 59
  5.3 Sampling method, quality control and assurance 59
    5.3.1 Sampling method 59
    5.3.2 Quality control and assurance 60
6 MANAGEMENT AND REPORTING 61
  6.1 Remedial or corrective management actions 61
    6.1.1 Surface water management plan 61
    6.1.2 Groundwater Management Plan 65
  6.2 Information and Knowledge gaps 67

6.3 Data review and interpretation 67
7 REFERENCES........ 68

Figures

Figure 2-1 Local hydrology and catchments 6
Figure 2-2 SOCS and important wetlands surrounding the NRP 8
Figure 2-3 Potential GDEs at the NRP 10
Figure 3-1 NRP Mine Surface Water Infrastructure 16
Figure 3-2 NRP Water Management System Overview 17
Figure 3-3 NRP Groundwater Bore Locations 23
Figure 3-4 BBLF Surface Water Infrastructure 26
Figure 3-5 BBLF Water Management System Overview 27
Figure 5-1 NRP Surface Water Monitoring Locations 39
Figure 5-2 NRP Groundwater Monitoring Locations 44
Figure 5-3 NRP Fluvial Sediment Monitoring Locations 47
Figure 5-4 NRP Biological Monitoring Locations 50
Figure 5-5 NRP Pandanus Diversion Monitoring Locations 53
Figure 5-6 BBLF Surface Water and Groundwater Monitoring Locations 57

Tables

Table 3-1 NRP Mine surface water management infrastructure 13
Table 3-2 NRP Groundwater bore construction details 19
Table 3-3 BBLF Surface Water Management Infrastructure 25
Table 3-4 BBLF Groundwater Bore Construction Details 29
Table 5-1 NRP Surface Water Monitoring Locations 37
Table 5-2 Surface Water Quality Assessment Guideline Values 41
Table 5-3 NRP Groundwater Monitoring Bores and Monitoring Frequency 42
Table 5-4 Groundwater Quality Assessment Guideline Values 45
Table 5-5 NRP Fluvial Sediment Monitoring Locations 46
Table 5-6 Default Toxicant Guideline Values for Sediment Quality 48
Table 5-7 NRP Biological Monitoring Locations 49
Table 5-8 AUSRIVAS Output and Assessment Criteria 51
Table 5-9 Health and aesthetic guidelines values to be applied to Potable Water 54
Table 5-10 BBLF Surface Water Monitoring Locations 56
Table 5-11 BBLF Groundwater Monitoring Bore Locations 58
Table 6-1 Surface Water Objectives, Targets, Monitoring and Management 62
Table 6-2 Groundwater Objectives, Targets, Monitoring and Management 66

Appendices

Appendix A NRP Water Management Trigger Action Response Plan (TARP) A

1 INTRODUCTION

1.1 Background

NRR Services Pty Ltd (NRR) operates an iron ore mine within the Roper Region of the Northern Territory known as the Nathan River Project (NRP). The NRP is located approximately 530 kilometres (km) southeast of Darwin within the Gulf of Carpentaria and is comprised of three main operation domains: the mine, the haul road and the Bing Bong Loading Facility (BBLF).

1.2 Purpose and Scope

This Water Management Plan (WMP) is required for the NRP to continue its restart of operations as water management is an integral part of managing the NRP and its interaction with the surrounding environment. This WMP has been developed to provide effective water management strategies to facilitate the activities which are planned for the NRP during the 2024-2028 MMP period. This WMP forms part of the wider Environmental Management System (EMS) for the NRP and is considered a working document.

The overarching purpose of this WMP is to:

- Ensure data is collected as per approved monitoring programs to manage water quality and inform operational decisions;
- Minimise the impact on surface and groundwater within and adjacent to the NRP and the BBLF;
- Ensure compliance with regulatory approvals (both Territory and Federal);
- Ensure compliance with NRR's EMS, Environmental Policy and Environmental Management Plans (EMPs);
- Manage risks to surface water and groundwater environmental values within and surrounding operations at the NRP, specifically targeting the following future activities:
    - The Zabeel ultimate pit expansion, Border and Ponting pit constructions;
    - Pandanus drainage line diversion;
    - Waste rock dump expansion and construction; and
    - Other water management infrastructure.

This WMP does not cover the haul road from the NRP mine to the BBLF as there is no current monitoring commitments for this area. This WMP will be reviewed on an annual basis and will be updated should monitoring data reflect issues with the existing monitoring programs, show mitigation measures are not effective or to reflect changes in management policy, regulatory requirements (e.g. updated Waste Discharge Licence (WDL)) and site conditions arising within the preceding year.

1.3 Guidelines

The WMP has been developed with reference to the Department of Industry, Tourism and Trade (DITT), Northern Territory Environmental Protection Authority (NT EPA), Department of Environment, Parks and Water Security (DEPWS) and the Australian and New Zealand Government's (ANZG 2018) guidelines including:

- Mining Management Plan for Mines – Content Guide;
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018);
- Australian Guidelines for Water Quality Monitoring and Reporting (ANZG 2018);
- Australian Drinking Water Guidelines (NHMRC/ARMMC) (2018); and
- Guidelines for Groundwater Protection in Australia (ANZECC/ARMCANZ, 2013).

2 CURRENT CONDITIONS

2.1 NRP Mine

2.1.1 Surface Water

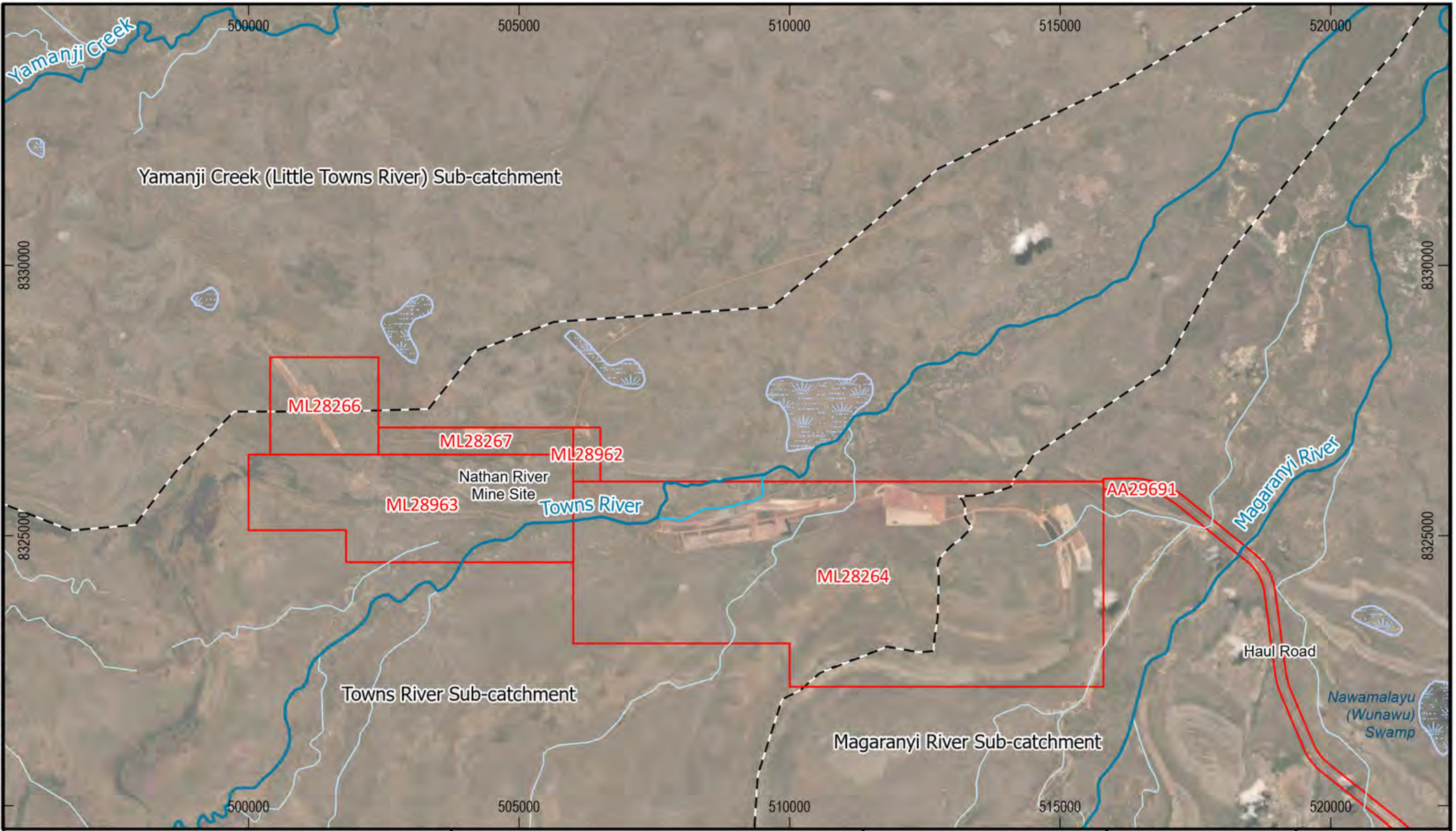
Catchment and drainage

The NRP is located within the middle reaches of the Towns River catchment, which is approximately 5,441 km^2 in extent. The Towns River catchment is comprised of three sub-catchments surrounding the NRP: Yumanji (1,213 km^2), Towns (503 km^2) and Magaranyi (2,068 km^2) sub catchments. All surface waterways in this catchment area are ephemeral and flow only during and shortly after the wet season, generally from November to April. The exception is the tidally influenced sections of the Towns and Magaranyi Rivers downstream of the NRP. The low-lying floodplain in the vicinity of the NRP is wide and flat and contains many non-active channel features including ox-bow lakes and abandoned pools.

Rivers and creeks associated with the NRP mine include:

- **Towns River**: Flows through the mine site from west to north-east, through the Croc crossing and along the Danehill flood protection levee. The Towns River and its tributaries display a highly sinuous and meandering form, which alternates between well-defined channels and braided channel areas;
- **Magaranyi River**: Located east of the site, flowing south to north and joining the Towns River near the NRP haul road crossing. The river does not come into immediate contact with mine infrastructure; and
- **Pandanus Creek**: A tributary to the Magaranyi River which flows east between Zabeel North and south pits. Pandanus Creek has a catchment area of approximately 4.7 km^2.

Figure 2-1 illustrates the location of each waterway and the extents of the associated sub catchments surrounding the NRP.



Legend

🟥 Tenement Boundaries	Streams
Major Drainage	Swamp
Minor Drainage	Catchment Boundary

Source: Commonwealth of Australia (Bureau of Meteorology) 2023, Northern Territory Government (Department of Industry, Tourism and Trade) 2020-2022, Nathan River Resources 2024, METServe 2024, Esri, Earthstar Geographics.

Nathan River Project

NRP Local Hydrology and Catchments

0 1 2 4

Kilometers

Scale: 1:100,000 (A4)

24/06/2024

Datum: GDA2020
Projection: MGA53

FIGURE 2-1

METSERVE
Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\WMP\BM001_NR_WMP_Local_Hydrology_and_Catchments_V2.aprx

Surface water environmental and social values

The NRP borders the Limmen National Park to the east, with the Towns River downstream of the NRP part of this National Park at the confluence with the Magaranyi River. The Limmen National Park was declared on 26 June 2012, gazetted on 16 July 2012 (Government Gazette S35) for the primary objective of protecting the biotic and abiotic environment in this area. The NRP itself is situated within the St Vidgeon Management Area, which was declared as being outside the Limmen National Park on 16 July 2012 (Government Gazette S35).

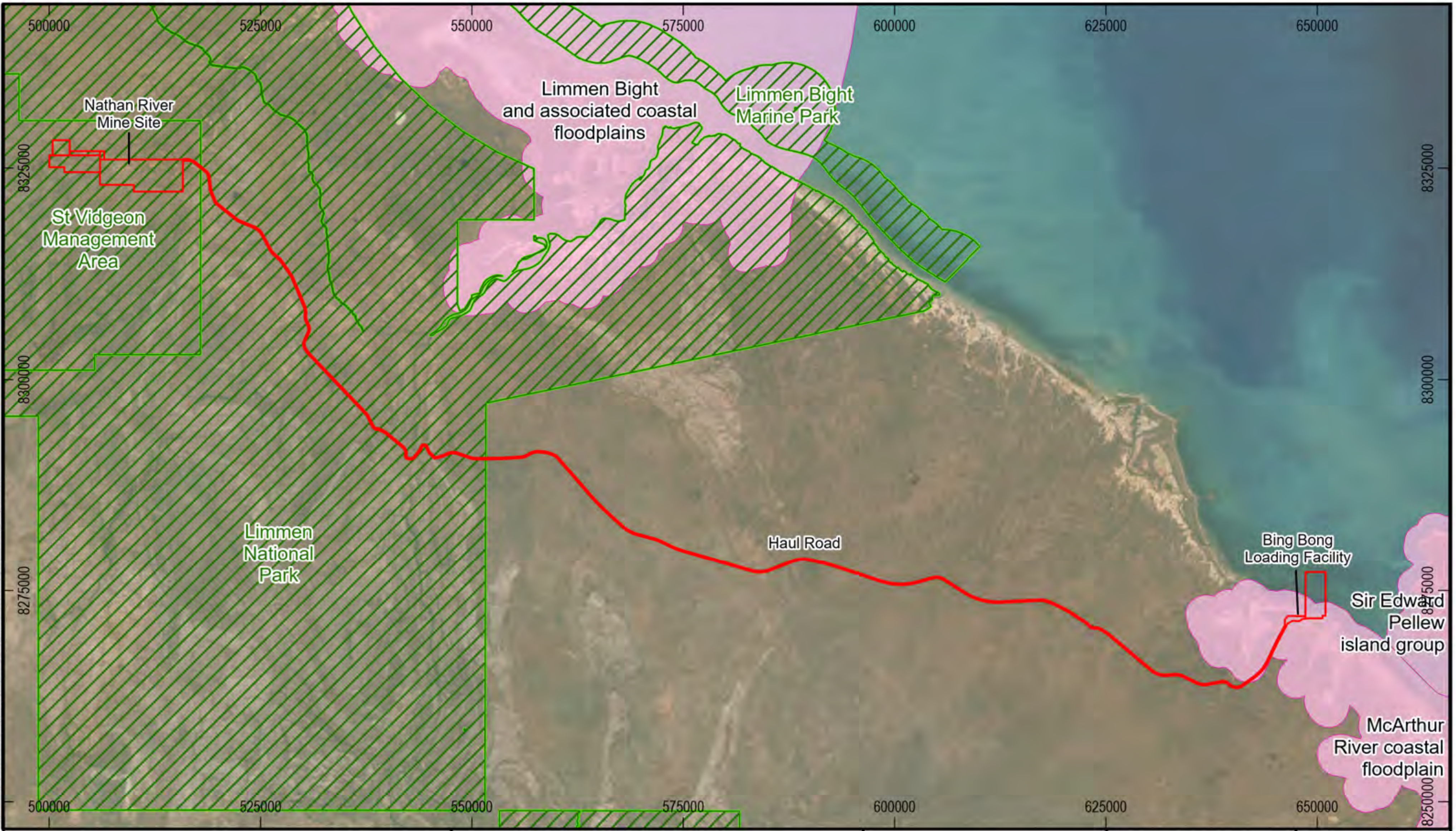
The mouth of the Towns River is included in the Limmen Bight (Port Roper) Tidal Wetlands System, classed as important wetland in the Directory of Important Wetlands of Australia (DIWA). It is described as wetland types A7 – intertidal mud, sand or salt flats, A8 – intertidal marshes (includes saltmarshes, salt meadows, saltings, raised salt marshes, tidal brackish and freshwater mashes), A2 – subtidal aquatic beds (includes kelp beds, seagrasses, tropical marine meadows), A6 – estuarine waters; permanent waters of estuaries and estuarine systems of deltas, and A9 - intertidal forested wetlands (includes mangrove swamps, nipa swamps, tidal freshwater swamp forests).

The criteria for inclusion in the DIWA are:

- It is a good example of a wetland type occurring within a biogeographic region in Australia;
- It is a wetland, which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex;
- It is a wetland, which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail;
- The wetland supports 1% or more of the national populations of any native plant or animal taxa;
- The wetland supports native plant or animal taxa or communities, which are considered endangered or vulnerable at the national level; and
- The wetland is of outstanding historical or cultural significance.

The Limmen Bight and associated coastal floodplains are a declared NT Site of Conservation Significance (SOCS) (#32), identifying it as one of 67 of the most important sites for biodiversity conservation that need further protecting (Harrison et al. 2009). It is classed of International Significance as nesting sites of four species of marine turtle, three significant seabird breeding sites, freshwater wetlands supporting large numbers of water birds and extensive areas of intertidal mud and sand flats that support significant numbers of shorebirds. Eight threatened vertebrate species are reported from the site as well as one vertebrate and ten plant species endemic to the NT.

Figure 2-2 below shows the SOCS and important wetlands downstream of the NRP mine.



Legend

🟥 Tenement Boundaries

▨ NT Parks and Reserves

Sites of Conservation Significance

🟪 International

🟦 National

Source: Geoscience Australia 2006, Northern Territory Government (Department of Industry, Tourism and Trade) 2022, Northern Territory Government (Department of Environment, Parks and Water Security) 2021-2022, Nathan River Resources 2018-2020, METServe 2023, Earthstar Geographics.

Nathan River Project

SOCS and Important Wetlands Surrounding the NRP

0 5 10 20

Kilometers

Scale: 1:640,000 (A4)

18/06/2024

N

Datum: GDA2020
Projection: MGA53

FIGURE 2-2

METSERVE
Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\WMP\BM001_NR_WMP_SOCS_and_important_wetlands_Surrounding_the_NRP.aprx

2.1.2 Groundwater

Groundwater aquifers and flows

A detailed hydrogeological investigation was undertaken for the 2012 EIS which included the drilling of monitoring bores, on which the following information is based (EcOz 2012). The geology of the area is characterised by a sequence of laterised soils overlying thick sequences of weathered interlayered siltstones and sandstones, siltstones and mudstones with minor bands of sandstones. Underlying these is a thin layer of extremely weathered whitish siderite, which in turn overlies the hematitic iron ore body. The iron ore layer is normally interlayered with fine to medium grained sandstones, grey to dark grey siltstones with thin layers of mudstones.

Whilst groundwater levels imitate the local and regional topography and are deeper than 9 m below surface, groundwater level behaviour indicates that the shallow groundwater levels are not hydraulically interconnected with surface waters. Any existing interaction including potential groundwater dependent ecosystems (GDEs) are limited to slow leakage from the Towns and Magaranyi Rivers and a spring west of the Magaranyi River where rain recharges surficial fracture systems. Two defined groundwater systems were described:

- A shallow unconfined aquitard system located at between 25 to 30 m depth among a highly weathered sequence of sandstone interbedded with siltstones; and
- A shallow semi-confined to confined aquifer system among the Sherwin Ironstone Formation (SIF) located between 50 to 60 m below ground level, particularly where the shallow dipping reserves were observed to exist. Deeper systems seem to be a continuity of this aquifer system and water appears to move downwards throughout primary conduits within the coarser SIF.

The RBIOP EIS determined that groundwater levels across the NRP are relatively deep and imitate the local topography. Groundwater levels range from the shallowest of 9.39 m to the deepest of 16.18 m below ground level. The average standing water level (SWL) measured at the 15 monitoring bores ranged from 4.1 m to 15.0 m (data range from 2010 to 2023).

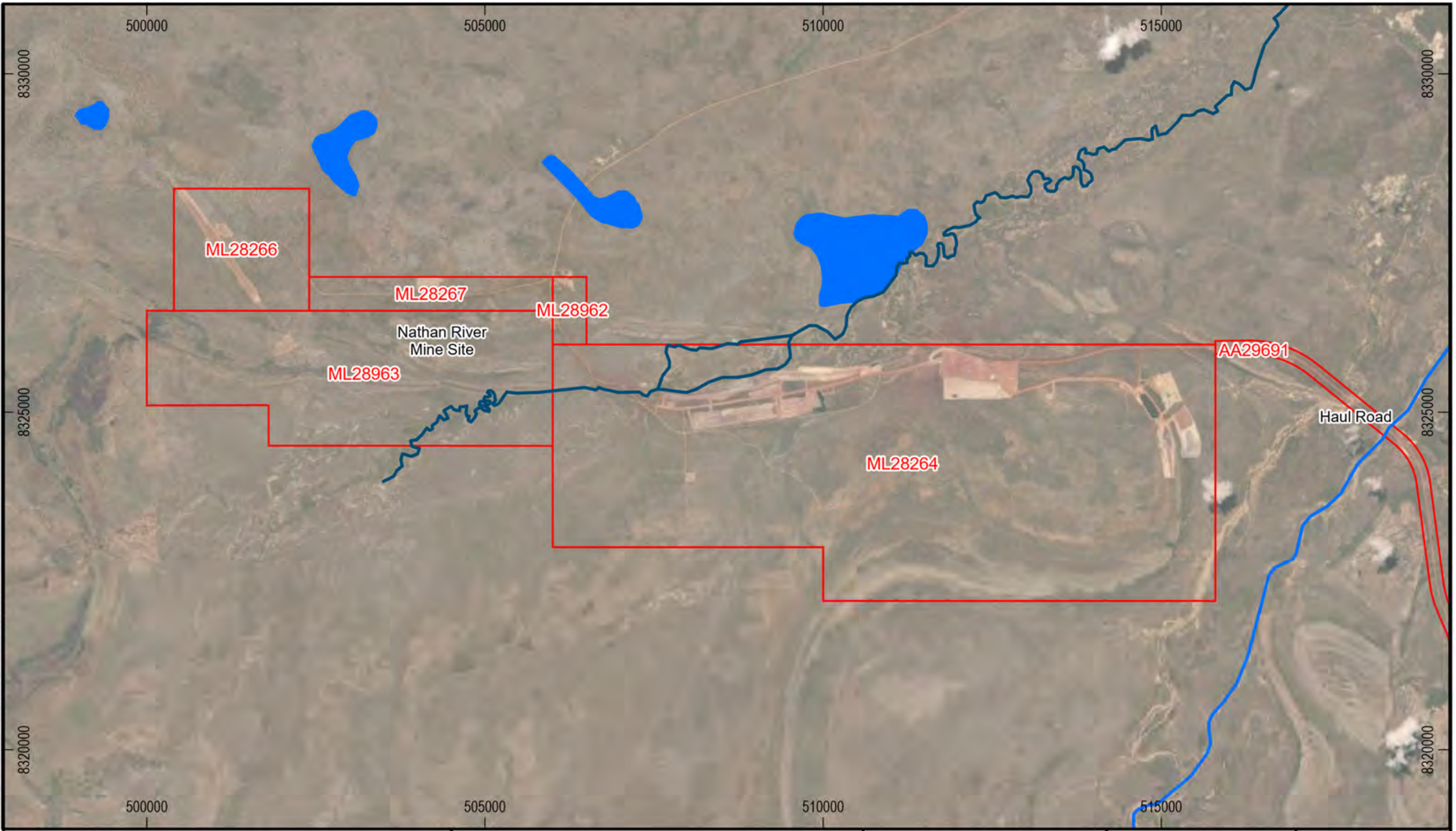
In general, the time-drawdown/falling head curves display decreases in groundwater flows over the short term (EcOz 2012). Recovery of the groundwater level after discharge was incomplete, indicating that systems are dewatered during abstraction with no or little replenishment indicative of minor fractures in a low yielding environment. It is thus likely that bores will not maintain yields and that water influx into open pits will decrease with time.

The hydraulic testing indicates a range of permeabilities of about two orders of magnitude. This is typical of fractured rock aquifers, where the permeability is controlled by a combination of primary porosity from the pore space matrix and secondary porosity resulting from fractures and bedding plains. Aquifer hydraulic parameters in sandstones, siltstones and the hematite iron ore body are low, with transmissivities in the order of 0.1 m^2/day to 4.0 m^2/day. The lower transmissivity pertains to the dominantly ferruginous sandstone materials and the quartzite sandstone interbedded with ferruginous sandstones. The hematite iron ore interbedded with sandstones, mudstones and siltstones have an average transmissivity of 0.4 m^2/d.

Groundwater flows within the NRP footprint are preferentially to the north, north-west, towards the Towns River, with radial flow from the water mound in the sandstone-siltstone ridges located to the south, south-eastern side of the Zabeel mining areas (EcOz 2012).

Groundwater environmental and social values

The NRP is outside the Daly Roper Beetaloo Water control district (WCD) and thus in an area not considered needing improved management of water resources. The GDE Atlas (Bureau of Meteorology) shows one high potential aquatic GDE as a wetland/swamp from national assessment to the northern side of the Towns River on the northwestern side of ML 28264 (**Figure 2-3**). Several small low potential aquatic GDEs are scattered on the southern side of the Towns River within the mining lease. Given the varied water quality from fresh in shallow formations to highly saline in deeper formations, groundwater at the NRP is of limited beneficial use. It may be used for stock watering for certain livestock or used for industrial purposes.



Legend

🟥 Tenement Boundaries

Aquatic GDE

▬ Known GDE - from regional studies

▬ High potential GDE - from national assessment

Source: Northern Territory Government (Department of Environment, Parks and Water Security 2012-2024), Northern Territory Government (Department of Industry, Tourism and Trade) 2022, Nathan River Resources 2024, METServe 2024.

Nathan River Project

Potential GDEs at the NRP

0 0.5 1 2

Kilometers

Scale: 1:80,000 (A4)

24/06/2024

Datum: GDA2020
Projection: MGA53

FIGURE 2-3

Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\WMP\BM001_NR_Potential_GDEs_at_the_NRP.aprx

2.2 Bing Bong Loading Facility

2.2.1 Surface water

Catchments and drainage

The BBLF is within the Rosie Creek Catchment (5,000 km^2) on the dunes and beach ridges adjacent to tidal mud flats along the coastline of the Gulf of Carpentaria. The main drainage lines, Mule Creek to the east and Bing Bong Creek to the north, are not within the BBLF footprint. Rather, the BBLF is within low-lying marshland systems bordering the marine environment. There are no major fresh surface waterbodies in the immediate vicinity of the BBLF, with the closest major systems being Bing Bong Creek ~10 km to the west and Mule Creek to the east approximately ~10 km away. Both Bing Bong and Mule Creeks are mangrove-lined estuaries with relatively small freshwater catchments. The BBLF is considered to be the watershed between these two catchments. Despite this, given the very flat topography and presence of Chenier ridges, it is very difficult to determine the direction of run-off, if any. The presence of sandy soils means it is likely that there will be minimal run-off during the wet season.

Surface water environment and social values

There are no formally nominated water management areas such as water reserves, water control districts, declared or proposed water supply catchment areas, in or near the BBLF. Surface water use in the area is limited to recreational fishermen visiting areas such as Bing Bong and Mule Creeks.

The BBLF is subject to storm surges associated with cyclones given its proximity to the coastline. It falls within the Gulf of Carpentaria 1 in 100-year storm surge zones.

2.2.2 Groundwater

Groundwater aquifers

The BBLF is situated within the Palaeo Mesoproterozoic McArthur Basin. The lithology largely consists of dolostone and sandstone, with minor volcanics and intrusives also present (EcOz 2012). The McArthur Basin is known to host a variety of economic commodities. The area surrounding the BBLF is affected by saline groundwater, which extends inland for a distance of 10 km or more from the coastline where the BBLF infrastructure is located (Zaar 2009). A registered bore (RN 25711) located approximately 4.5 km to the south of the BBLF has a standing water level of 8 m below ground level and yield of 3 L/s (Zaar 2009).

Groundwater level measurements collected by the existing monitoring program indicates an average SWL between 2.0 m and 3.9 meters below ground level (mBGL) for data collected 2018-2023. Groundwater quality data indicates a highly saline groundwater condition with electrical conductivity across the BBLF groundwater monitoring network ranging from 6,500 µS/cm to 110,000 µS/cm.

Groundwater environmental and social values

There are no formally nominated groundwater management areas, in or near the BBLF, nor are there any known existing users.

3 PROJECT OVERVIEW

3.1 NRP Mine

The water management strategy to be implemented during the MMP period at the NRP will focus on managing the surplus water inventory within existing and approved water storages until such time a waste discharge licence is granted facilitating the discharge of water to the receiving environment. Since 2021, the Zabeel South pit has been utilised as the primary water storage at the NRP, storing approximately 950 ML as of June 2024, which has allowed the mining of the Danehill and Zabeel north pits. Given the future mine plans to amalgamate the Zabeel north and south pits during the MMP period, all water currently stored in Zabeel south must be transferred to another water storage at the NRP. NRR intends to utilise RBSP02, Danehill West and the Border pit to store water dewatered from the Zabeel South pit. NRR also intends to hold a waste discharge licence by the 2024-25 wet season to enable the discharge of surplus water inventory to the surrounding watercourses during flood events. To ensure the water management system at the NRP can sufficiently manage water throughout subsequent wet seasons during the MMP period, NRR engaged WRM to revise the existing water balance model.

A revised water balance (WRM 2024) has been completed to reflect the current water inventory and the planned water management strategy for the upcoming MMP period. The water balance model has been used to predict the NRP's water management systems performance over the MMP period, based on 131 different modelled climatic sequences. The water balance assumes a 'discharge' scenario, whereby the NRP does have the ability to discharge mine-affected water off-site under a waste discharge licence (WDL) during the MMP period.

A summary of the water storage operating volumes which will be implemented during the MMP period are presented in **Table 3-1**. Should the NRP water storages be operated within the Maximum Operating Volume (MOV) provided in **Table 3-1**, the intended mining activities at the NRP will not be impacted according to the revised water balance model. Further details on the NRP's water management strategy can be found in the NRP Water Balance Report (WRM 2024).

Short-term water management at the NRP is implemented through the NRP Water Management Trigger Action Response Plan (TARP). This plan explicitly outlines a minimum set of actions which must be enacted in response to exceedance/s of nominated criteria developed using a tiered system as a function of increasing risk. The TARP also aims to assist with the management of the NRP's key water storages throughout operations, including actions with the intent of mitigating the risk of uncontrolled discharges to the receiving environment whilst facilitating mining operations. Further details are provided in **Appendix A**.

3.1.1 NRP Surface Water Management Infrastructure

The NRP's water management infrastructure was initially constructed by the previous operator in 2014. The constructed infrastructure was designed to manage potential mine affected water (MAW) across the NRP and facilitate the movement of clean water through the site based on flood modelling completed during the EIS.

Catchments upstream of all mine infrastructure including open-pits, waste rock dumps (WRD) and run-of-mine (ROM) pads are directed by means of constructed levee banks, diversion bunds and channel drains. These structures were designed to convey the 100-year peak flow rate from upstream external catchments around existing mine infrastructure, and through to existing waterways, thus preventing contact with disturbed areas, excavated material, and ore stockpiles.

Surface water run-off from the ROM pads, WRDs and the open pits, together with any groundwater inflows, are captured by surface water drains and is directed to an appropriate water storage preventing MAW from entering the surrounding environment.

NRP surface water management schematic, capacities and water management infrastructure are summarised in **Table 3-1** with locations of such infrastructure illustrated in **Figure 3-1**. **Figure 3-2** presents a high-level overview of the water management system at the NRP.

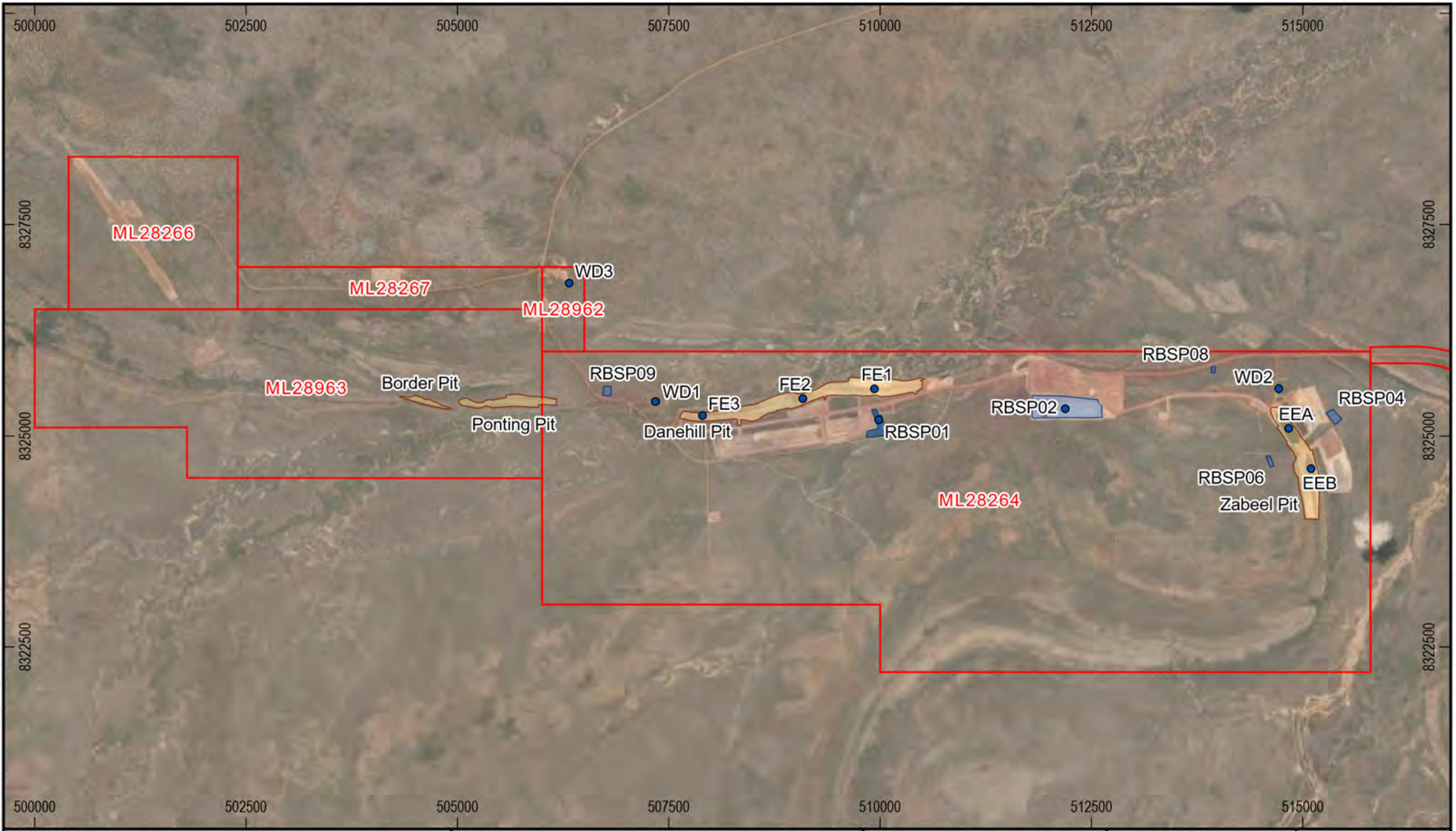
Table 3-1 NRP Mine surface water management infrastructure

Infrastructure type	Infrastructure name	Storage capacity (ML)	Water volume stored (ML) (June-24)	Design details	Purpose
Open-cut pit	Danehill East (FE1)	783	350	See Section 5.4 of MMP	Contains water, currently being dewatered to Zabeel South pit.
	Danehill West (FE2)	982	650		Contains water, currently being dewatered to Zabeel South pit.
	Zabeel North (EEA)	802	0		Production – currently mined. Water is captured by in-floor sumps and pumped to Zabeel South pit.
	Zabeel South (EEB)	1,307	950		Contains water.
	Ponting	NA	NA		Not yet constructed.
	Border	138	NA		Not yet constructed.
Sediment ponds	RBSP01	8.6	8.6	AEP: 1:100 72 hour (540 mm) Capacity: 100% containment of design storm (89,100 m^3) plus 0.5 m for wave run-up. Spillway: 21.2 mAHD Low Level Outlet: 19.0 mAHD Discharge Water Body: RBSP01 is within the flood protection levy and flows back into Danehill Pits.	Located east of Danehill WRD and west of the irrigation area. Captures runoff from WRD and LGO stockpile area. Water is pumped to the irrigation area and used for dust suppression. Has an emergency overflow spillway plus a low-level outlet.
	RBSP02	602	350	AEP: 1:100 72 hour (540 mm)	Located south of the Central ROM, capturing stormwater runoff from the ROM

Infrastructure type	Infrastructure name	Storage capacity (ML)	Water volume stored (ML) (June-24)	Design details	Purpose
				Capacity: 100% containment of design storm (345,700 m^3) plus 0.5 m for wave run-up. Spillway: 21.7 mAHD Low Level Outlet: 20.0 mAHD Discharge Water Body: Drainage to Towns River tributary.	and mine services area. Has an emergency overflow spillway.
	RBSP03	2.4	2.4	AEP: 1:100 72 hour (540 mm) Capacity: 100% containment of design storm (8,600 m^3) plus 0.5 m for wave run-up. Spillway: 16.5 mAHD Low Level Outlet: 14.5 mAHD. Discharge Water Body: Pandanus Creek.	Located east of the Zabeel north WRD. Captures runoff from the WRD. Has an emergency overflow spillway plus a low level outlet. To be decommissioned once Zabeel WRD is expanded.
	RBSP04	8.5 (current) 25 (proposed)	0	AEP: 1:100 72 hour (540 mm) Capacity: 100% containment of design storm (Volume: 8,500 m^3) plus 0.5 m for wave run-up. Spillway: TBA Low Level Outlet: TBA mAHD. Discharge Water Body: Pandanus Creek.	Located northeast of Zabeel South WRD. Captures runoff from the WRD. Has an emergency spillway plus a low-level outlet.
	RBSP06	11.6	NA	TBA	Proposed sediment pond for Pandanus drainage line / Zabeel west WRD.

Infrastructure type	Infrastructure name	Storage capacity (ML)	Water volume stored (ML) (June-24)	Design details	Purpose
	RBSP08	5.4	NA	TBA	Proposed sediment pond capturing surface run-off from proposed Zabeel ROM pad.
	RBSP09	16.4	NA	TBA	Proposed sediment pond capturing surface run-off from proposed Ponting WRD.
Water dam / turkeys nest	WD1	6.7	0	NA	Located west of Danehill pits. Redunant water dams from construction phase now used to collect surface run-off.
	WD2	2.2	0	NA	Located north of Zabeel north pit.
	WD3	1.2	0	NA	Located near mining admin area.
Irrigation / evaporation area	Irrigation / evaporation area	NA	NA	29.1 ha catchment area	Irrigation / evaporation area, refer to Soil and Irrigation management plan.
Waterway	Pandanus drainage line	NA	NA	ARI: 35 minutes at 1:100 AEP. Invert level: 16 mAHD Top of rip rap liner: 18.5 mAHD.	Pandanus drain diversion around the Zabeel mining area.
Levee bank	Danehill levee	NA	NA	AEP: 1:100 year flood level	Flood protection levee diverting non-MAW around Danehill pits.
	Zabeel levee	NA	NA	AEP: 1:100 year Top of clay: 19.0 mAHD Top of rock: 19.3 mAHD	Flood protection levee diverting non-MAW around Zabeel pits.

Infrastructure type	Infrastructure name	Storage capacity (ML)	Water volume stored (ML) (June-24)	Design details	Purpose
	Ponting pit levee 2 (ML2)	NA	NA	NA	Proposed flood protection levee diverting non-MAW around western extent of Ponting Pit.
	Ponting pit levee 2 (ML3)	NA	NA	NA	Proposed flood protection levee diverting non-MAW around eastern extent of Ponting Pit.
	Border pit levee 1 (ML1)	NA	NA	NA	Proposed flood protection levee diverting non-MAW around the western extent of the Border pit.



Legend

🟥 ML Boundary	▨ Pits
● Water Storages	▨ Sediment Ponds and Water Dams

Source: Nathan River Resources 2021-2024, METServe 2024, Maxar.

Nathan River Project

NRP Mine Surface Water Infrastructure

0 0.5 1 2

Kilometers

Scale: 1:64,000 (A4)

25/06/2024

N

Datum: GDA2020
Projection: MGA53

FIGURE 3-1

METSERVE
Mining & Energy Technical Services Pty Ltd

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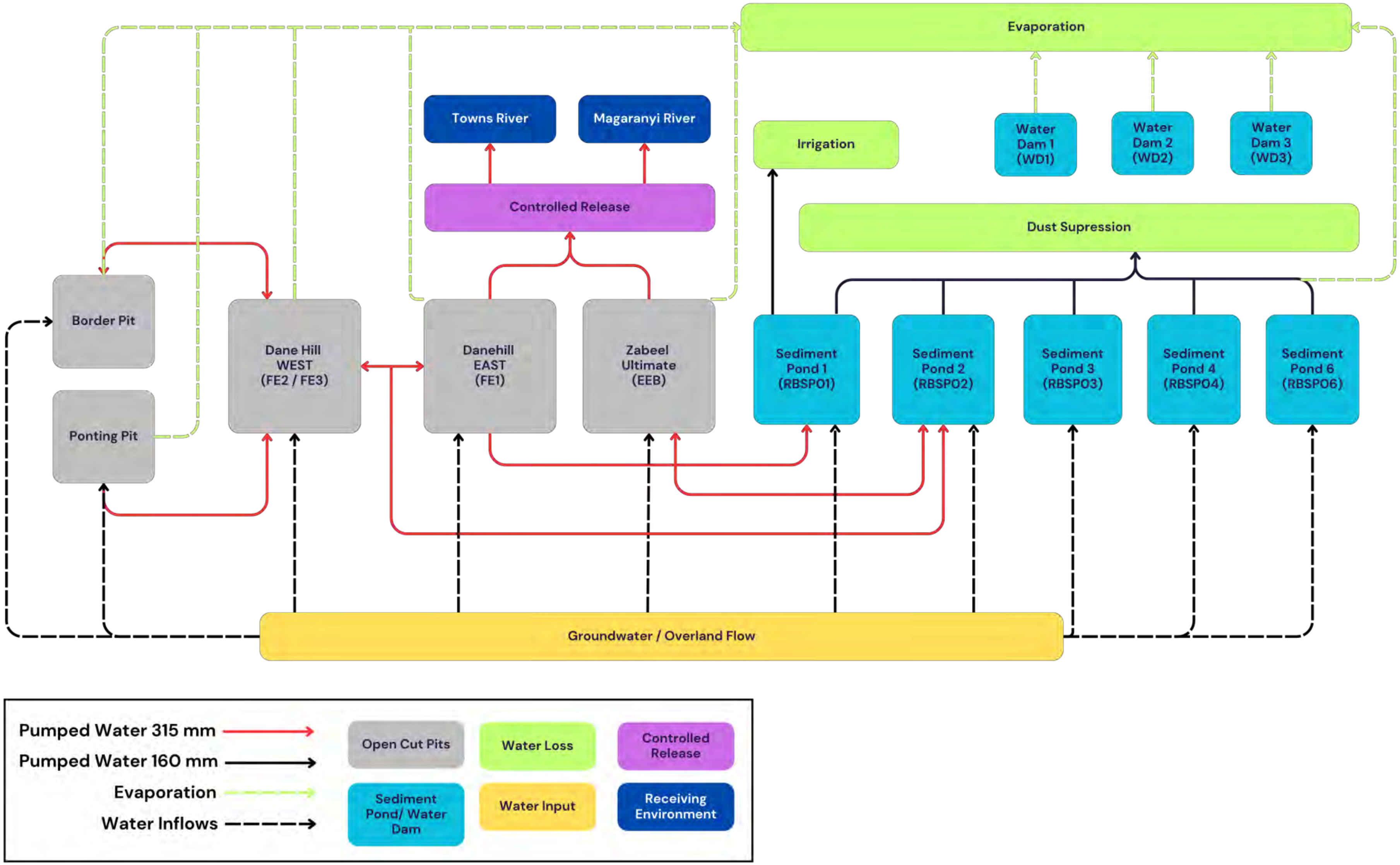


Figure 3-2 NRP Water Management System Overview

Flood prevention

Flood prevention is managed at the NRP mine by the construction of flood protection levees. During 2014, the Danehill and Zabeel flood protection levees were constructed to protect the Danehill and Zabeel mining infrastructure (pits and WRDs) from the upstream catchment of the Towns River and Pandanus Creek. These existing flood levees have been designed to protect against rainfall events with Annual Exceedance Probability (AEP) of up to 1 in 100.

Several flood protection levees will be constructed during the MMP period to provide protection of the Border and Ponting mining areas. Such levees will follow the same design method and will be at least 10 m wide at the crest allowing for vehicle and haulage fleet access.

Erosion and sediment control

The NRP Erosion and Sediment Control Plan (ESCP) has been recently revised to capture the future operational activities for the 2024-2028 period. The revised ESCP details the controls to be implemented across the mining areas aiming to minimise erosion, sedimentation, and prevent contamination of stormwater by directing it around operational areas. This plan has been developed by a Certified Practitioner in Erosion and Sediment Control, and is consistent with the International Erosion Control Association, Best Practice Erosion and Sediment Control (IECA 2008).

The ESCP will undergo annual revisions and will be updated and provided to the DITT should any significant changes to the ESCP occur.

3.1.2 NRP Groundwater Management Infrastructure

The pre-mining hydrogeological investigation undertaken during the EIS included the installation of 11 groundwater monitoring bores (RBGW01 – RBGW11) ranging from 56 to 125 mBGL during 2012.

Additional monitoring bores (MB series) were installed across the NRP during 2013 closer to mining infrastructure such at open-pits, ROM and WRDs. The monitoring bores provide coverage adjacent to infrastructure and the baseline monitoring bores (RBGW series) provide predominantly up-gradient locations and extended coverage. Fifteen ground water bores are monitored for water quality assessment biannually (**Section 5.1**).

A summary of bore construction details available for all NRP monitoring bores are provided in **Table 3-2** and locations shown in **Figure 3-3**. This information has been sourced from the registered bore logs (NR Maps) and RBIOP WRD Draft EIS, Hydrogeological Studies: Bore drilling, Sampling, Testing and Modelling (EcOz 2012b).

The bores were constructed in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (LWBC 2003) and were screened to capture all intersected water strikes (EcOz 2012b).

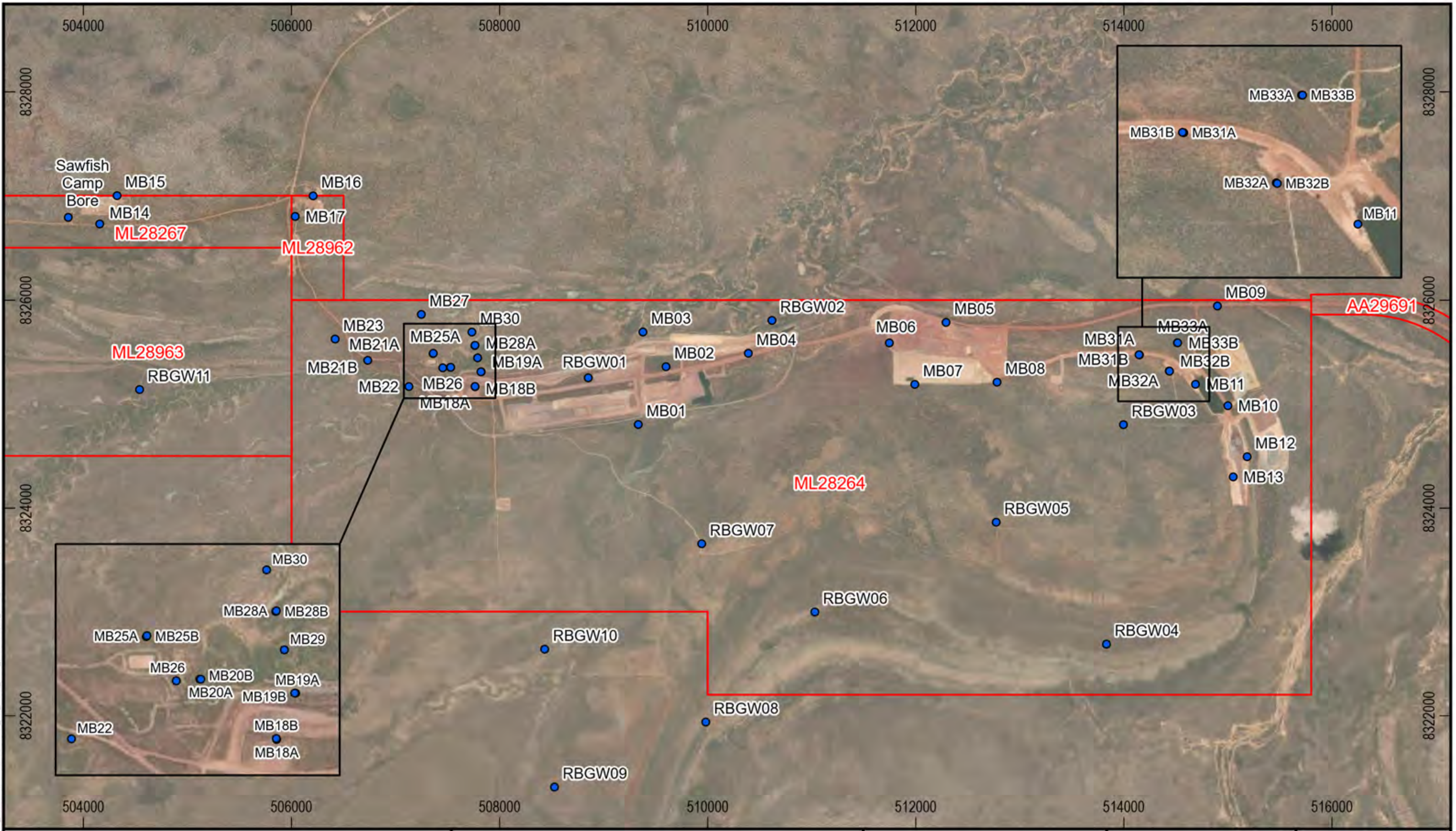
Table 3-2 NRP Groundwater bore construction details

Bore hole ID	RN	Easting (GDA94, Z53)	Northing (GDA94, Z53)	Completion date	Ground elevation (mAHD)	Top of casing (mAHD)	Groundwater level - Dec-23 (mbgl)	Bore depth (mbgl)	Screen interval (mbgl)	Current status	Location domain
RBGW01	038689	508851	8325252	2011	24.3	25.01	5.44	79	49 - 79	Impact. Monitored	Danehill
RBGW02	037464	510617	8325804	2011	23.1	23.80	10.21	102	69 - 102	Impact. Monitored	Danehill
RBGW03	037463	513995	8324801	2011	25.2	25.90	14.04	79	49 - 79	Impact. Monitored	Zabeel
RBGW04	037462	513832	8322687	2011	52.5	53.25	2.44	71.5	59.5 – 71.5	Not monitored	Zabeel
RBGW05	037461	512772	8323863	2011	30.0	30.75	**ND**	87	53 - 87	Background. Monitored	Regional
RBGW06	037389	511029	8322996	2011	55.8	56.62	**ND**	56	44 - 56	Not monitored	Regional
RBGW07	037338	509942	8323656	2011	26.8	27.54	11.59	125	101 - 125	Background. Monitored	Regional
RBGW08	037460	509981	8321938	2011	38.9	39.58	**ND**	56	22 - 56	Not monitored	Regional
RBGW09	037386	508527	8321313	2011	31.8	32.27	**ND**	71.5	59.5 – 71.5	Not monitored	Regional
RBGW10	037387	508433	8322638	2011	26.8	27.26	**ND**	72	53.5 – 71.5	Not monitored	Regional
RBGW11	037466	504539	8325139	2011	27.3	27.96	12.73	71.5	41.5 – 71.5	Background.	Regional
MB01	038321	509332	8324803	2013	20.92	21.49	8.74	36	11.5 – 35.5	Impact. Monitored	Danehill
MB02	038322	509599	8325359	2013	20.10	20.68	4.48	60	12 - 36	Not monitored	Danehill
MB03	038355	509377	8325693	2013	19.64	20.19	11.73	60	18 - 60	Not monitored	Danehill
MB04	038352	510390	8325488	2013	20.53	20.98	**ND**	60	18 - 60	Decommissioned	Danehill
MB05	038323	512290	8325785	2013	23.18	23.98	3.07	36	12 - 36	Impact. Monitored	ROM

Bore hole ID	RN	Easting (GDA94, Z53)	Northing (GDA94, Z53)	Completion date	Ground elevation (mAHD)	Top of casing (mAHD)	Groundwater level - Dec-23 (mbgl)	Bore depth (mbgl)	Screen interval (mbgl)	Current status	Location domain
MB06	038325	511745	8325588	2013	18.33	18.93	1.29	36	12 - 36	Impact. Monitored	ROM
MB07	038324	511990	8325189	2013	20.56	21.16	6.95	36	12 - 36	Impact. monitored	ROM
MB08	038326	512780	8325210	2013	23.25	24.40	**ND**	36	12 - 36	Impact. Monitored	ROM
MB09	038351	514898	8325943	2013	17.48	18.38	5.54	36	12 - 36	Background	Zabeel
MB10	038328	514999	8324984	2013	17.42	17.82	**ND**	90	36 – 90	Decommissioned	Zabeel
MB11	038327	514687	8325190	2013	18.56	19.06	**ND**	72	24 - 72	Decommissioned	Zabeel
MB12	038350	515184	8324493	2013	22.12	22.82	**ND**	72.0	24 - 72	Decommissioned	Zabeel
MB13	038329	515050	8324299	2013	24.37	24.87	**ND**	60.0	18 – 60	Decommissioned	Zabeel
MB14	038353	504156	8326728	2013	41.41	42.06	**ND**	49.0	13 – 49	Not monitored	Sawfish
MB15	038320	504323	8327000	2013	38.13	38.78	**ND**	54.0	18 – 54	Not monitored	Sawfish
MB16	038299	506207	8326998	2013	30.80	31.45	**ND**	44.0	12 – 44	Not monitored	Sawfish
MB17	038354	506035	8326800	2013	28.93	29.58	**ND**	48.0	12 – 48	Not monitored	Sawfish
MB18A	ND	507764	8325166	2013	20.09	20.99	13.51	24.00	12 – 24	Not monitored	Danehill
MB18B	ND	507763	8325169	2013	20.13	21.00	12.95	48.9	30.9 - 48.9	Not monitored	Danehill
MB19A	ND	507823	8325310	2013	19.80	20.70	**ND**	11.9	8.9 - 11.9	Decommissioned	Danehill
MB19B	ND	507820	8325310	2013	19.65	20.45	**ND**	48.9	30.9 - 48.9	Decommissioned	Danehill
MB20A	ND	507526	8325353	2013	20.16	21.01	11.71	17.7	11.7 - 17.7	Not monitored	Danehill
MB20B	ND	507529	8325353	2013	20.14	21.00	14.60	48.9	30.9 - 48.9	Not monitored	Danehill

Bore hole ID	RN	Easting (GDA94, Z53)	Northing (GDA94, Z53)	Completion date	Ground elevation (mAHD)	Top of casing (mAHD)	Groundwater level - Dec-23 (mbgl)	Bore depth (mbgl)	Screen interval (mbgl)	Current status	Location domain
MB21A	ND	506732	8325420	2013	21.48	22.34	Dry	8	5 – 8	Not monitored	Danehill
MB21B	ND	506732	8325420	2013	21.58	22.33	17.44	20	18.5 -20.5	Impact. Monitored	Danehill
MB22	ND	507128	8325168	2013	20.93	21.71	Dry	7.8	6.3 - 7.8	Not monitored	Danehill
MB23	ND	506419	8325625	2013	22.05	22.88	Dry	8.9	5.9 - 8.9	Not monitored	Danehill
MB25A	ND	507360	8325485	2013	20.84	21.74	Dry	6.1	3.1 - 6.1	Not monitored	Danehill
MB25B	ND	507362	8325488	2013	20.84	21.74	16.11	23.0	14 – 23	Not monitored	Danehill
MB26	ND	507453	8325348	2013	20.83	21.61	Dry	7.0	4 – 7	Not monitored	Danehill
MB27	ND	507247	8325862	2013	20.74	21.53	**ND**	7.0	4 – 7	Decommissioned	Danehill
MB28A	ND	507761	8325563	2013	19.66	20.51	Dry	6.9	3.9 - 6.9	Not monitored	Danehill
MB28B	ND	507763	8325565	2013	19.73	20.65	14.86	22.8	13.8 - 22.8	Not monitored	Danehill
MB29	ND	507788	8325444	2013	20.40	21.18	**ND**	7.1	4.1 - 7.1	Decommissioned	Danehill
MB30	ND	507733	8325692	2013	20.47	21.31	**ND**	7	4 – 7	Not monitored	Danehill
MB31A	ND	514149	8325473	2013	23.51	24.32	14.97	21.9	15.9 - 21.9	Not monitored	Zabeel
MB31B	ND	514145	8325474	2013	24.36	25.23	15.64	59.8	41.8 - 59.8	Not monitored	Zabeel
MB32A	ND	514435	8325318	2013	20.99	21.84	11.95	20.0	14 – 20	Not monitored	Zabeel
MB32B	ND	514438	8325316	2013	20.98	21.86	11.99	60.0	42 - 60	Impact. Monitored	Zabeel
MB33A	ND	514513	8325589	2013	24.73	25.63	Dry	11.9	5.9 - 11.9	Not monitored	Zabeel
MB33B	ND	514516	8325589	2013	24.67	25.50	12.42	49.0	37 – 49	Not monitored	Zabeel

Bore hole ID	RN	Easting (GDA94, Z53)	Northing (GDA94, Z53)	Completion date	Ground elevation (mAHD)	Top of casing (mAHD)	Groundwater level - Dec-23 (mbgl)	Bore depth (mbgl)	Screen interval (mbgl)	Current status	Location domain
Sawfish Camp Bore	037658	503854	8326791	2012	43.33	44.2	**ND**	65	53 - 65	Background. Monitored	Sawfish



Legend

● Groundwater Bore Locations

▭ Tenement Boundaries

Source: Northern Territory Government (Department of Industry, Tourism and Trade) 2020-2022, Nathan River Resources 2024, METServe 2024.

Nathan River Project

NRP Groundwater Bore Locations

0 0.5 1 2

Kilometers

Scale: 1:52,000 (A4)

24/06/2024

N

Datum: GDA2020
Projection: MGA53

FIGURE 3-3

METSERVE
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3.2 BBLF

The overarching water management strategy for the BBLF during the MMP is to ensure sufficient water supply for dust suppression demands during the dry season, and the prevention of passive discharges from sediment ponds to the surrounding environment.

3.2.1 BBLF Surface Water Management Infrastructure

Surface water catchments upstream of the BBLF stockyard are diverted by means of open catch drains around the BBLF. Run-off captured within the BBLF stockyard is directed to one of five sediment ponds located around the perimeter of the stockyard area. During periods of high rainfall, the BBLF sediment ponds are designed to allow water to be released via constructed spillways, to the receiving environment. This will most likely occur during the wet season (i.e. between December and April), when rainfall may exceed the capacities of the basins (NRR 2019c). Site water management infrastructure at the BBLF is outlined below in **Table 3-3** and **Figure 3-4**. The water management schematic for BBLF is shown in **Figure 3-5**.

Throughout the dry season, water captured within the BBLF sediment ponds are used for operational dust suppression supply across the BBLF operation. Dust suppression supply along with dry season evaporation often depletes all five BBLF sediment basins by the late dry season. Prior to the wet season, NRR conducts annual maintenance and repairs on the sediment ponds which includes:

- De-silting;
- Re-establishment of inlet drains;
- Repair of spillway; and
- Re-installation of pumping infrastructure.

Throughout the wet season, water is transferred between the five sediment ponds subject to individual capacities. NRR attempts to avoid the passive discharge of water from BBLF sediment ponds by actively managing water volumes. However, if a significant rainfall event was to occur, sediment pond discharges are likely.

Table 3-3 BBLF surface water management infrastructure

Infrastructure type	Infrastructure name	Design details	Location
Sediment pond	BBLF Basin No. 1 (BBSP01)	AEP: 1:50 1 hour (114 mm) Capacity: 5,387 m^3 Runoff Coefficient: 0.9 Discharge Water Body: Marshland	Southwest corner of stockyard perimeter.
	BBLF Basin No. 2 (BBSP02)	AEP: 1:50 1 hour (114 mm) Capacity: 7,080 m^3 Runoff Coefficient: 0.9 Discharge Water Body: Marshland	Southeast corner of stockyard perimeter.
	BBLF Basin No. 3 (BBSP03)	AEP: 1:50 1 hour (114 mm) Capacity: 4,925 m^3 Runoff Coefficient: 0.9 Discharge Water Body: Marshland	Northeast corner of stockyard perimeter.
	BBLF Basin No. 4 (BBSP04)	AEP: 1:50 1 hour (114 mm) Capacity: 3,540 m^3 Discharge Water Body: Marshland	Northwest corner of stockyard perimeter.
	BBLF Basin No. 5 (BBSP05)	AEP: 1:50 1 hour (114 mm) Capacity: 5,430 m^3 Runoff Coefficient: 0.9 Discharge Water Body: Marshland	East of stockyard adjacent to loading wharf.
Dredge Spoil Pond	Dredge Spoil Containment Pond (BBDSCP)	NA – not yet constructed.	West of stockyard
	Old Dredge Spoil Containment Pond (DSCP)	Decommissioned. Catchment run-off reports to BBSP01.	West of stockyard

Legend

🟥	Tenement Boundaries
🟦	Sediment Ponds
🟧	Dredge Spoil Containment Ponds

Source: Northern Territory Government (Department of Industry, Tourism and Trade) 2022, Nathan River Resources 2024, METServe 2024. Imagery - © OpenStreetMap and contributors.

Nathan River Project

BBLF Surface Water Infrastructure

0 50 100 200

Meters

Scale: 1:7,000 (A4)

24/06/2024

N

Datum: GDA2020
Projection: MGA53

FIGURE 3-4

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Mining & Energy Technical Services Pty Ltd

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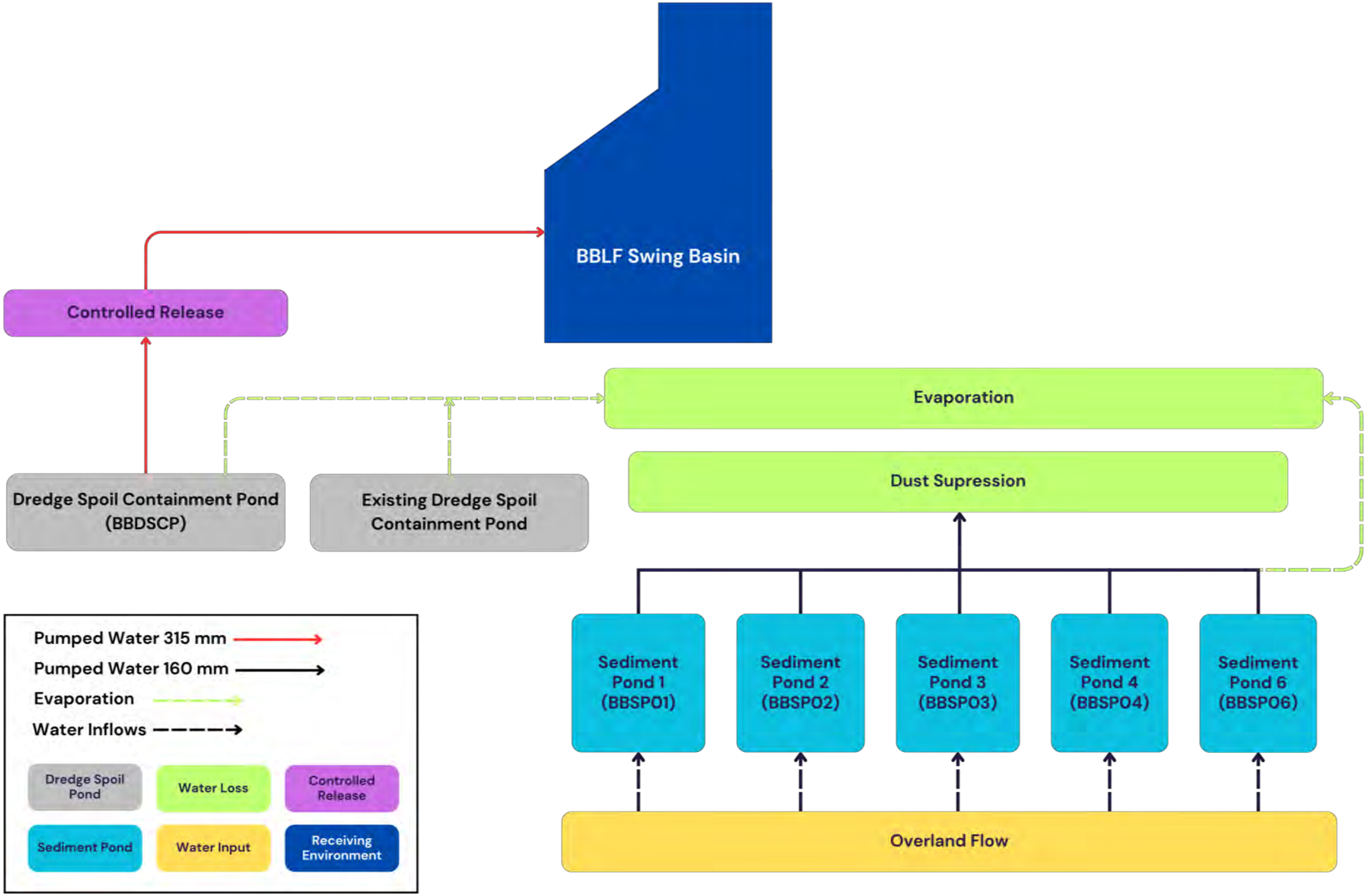

Figure 3-5 BBLF water management system overview

3.2.2 BBLF Groundwater Management Infrastructure

Groundwater monitoring locations have been established to monitor the effectiveness of the management measures in limiting impacts to the local groundwater at the BBLF.

The sediment ponds at BBLF are assumed to potentially discharge excess water to the surrounding area where it is likely to seep into the underlying groundwater. It should be noted that no project and/or waste stockpiles are present at BBLF and the discharge from the basins is considered non-MAW and is not likely to cause environment harm.

BBLF monitoring bores were installed across the BBLF in 2013 during the construction of the BBLF. Monitoring bores have been positioned around the perimeter of the stockyard and sediment dams to primarily monitor potential water quality impacts. Four groundwater bores are monitored for water quality on a biannually basis (**Section 5.2**).

A summary of bore construction details available for all BBLF monitoring bores are provided in **Table 3-4** and locations shown in **Figure 5-6**. This information has been sourced from the registered bore logs (NR Maps) and RBIOP WRD Draft EIS, Hydrogeological Studies: Bore drilling, Sampling, Testing and Modelling (EcOz 2012b).

The bores were constructed in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (LWBC, 2003) and were screened to capture all intersected water strikes (EcOz 2012b).

Table 3-4 BBLF groundwater bore construction details

Bore Hole ID	RN	Easting (GDA94, Z53)	Northing (GDA94, Z53)	Completion date	Ground elevation (mAHD)	Top of Casing (mAHD)	Groundwater level (date) mAHD	Bore depth (m)	Screen interval (mbg*)	Screen interval (mbg*)	Current status	Location description
									From	To		
BBMB01	038430	647877	8271430	12-Sep-13	ND	ND	ND	16	10	16	Impact Monitored	North of discharge monitoring point / South of BBSP01.
BBMB02	038431	647789	8271811	12-Sep-13	ND	ND	ND	18	9	18	Impact Monitored	East of old Dredge spoil containment pond.
BBMB03	038433	648322	8271827	14-Sep-13	ND	ND	ND	10	4	10	Impact Monitored	East of BBSP04.
BBMB04	038432	648293	8271631	13-Sep-13	ND	ND	ND	10	1	10	Impact Monitored	East of BBSP02.

3.3 Water requirements, sources and storages

3.3.1 Mining and Processing

Water balance modelling for the NRP outlines no additional water supplies/sources are required to facilitate mining operation, with the NRP currently operating in a water surplus. Surface water run-off and groundwater inflows captured by the NRP water management system are expected to adequately meet the NRP's water demands for the Life of Mine. Surplus water inventory will be irrigated within designated areas, utilised for dust suppression and during the wet season discharged into the Towns and Magarangyi Rivers under an authorised waste discharge licence.

The following water inputs and outputs have been used to develop the NRP water balance:

Water source (inputs)
- Catchment rainfall;
- Groundwater inflow; and
- Bore water supply.

Water usage (demands)
- Dust suppression

Water losses (outputs)
- Evaporation;
- Seepage;
- Irrigation;
- Controlled discharges to surrounding waterways (Towns or Magaranyi Rivers); and
- Uncontrolled discharges – passive spills from sediment ponds.

A revised NRP water balance has been prepared for the 2024-2028 period. Refer to the NRP Water Balance Report (WRM 2024) for further water balance information.

3.3.2 Potable Water Supply

NRP Mine

Potable water supply at the NRP is sole sourced from groundwater which is treated through a water treatment plant. The potable water treatment plant treats raw water supplied by a groundwater bore (referred to as the Sawfish Camp Bore), treats water using Reverse Osmosis and supplies the Sawfish Camp with its entire potable water supply. Both raw water and treated potable water are stored within water tanks at the treatment plant and are drawn upon when required by the camp's water supply. This treatment plant is serviced regularly by an experienced contractor and potable water is tested on a monthly basis to ensure quality is within the recommended quality guidelines. Current average water use from the Sawfish bore is < 5 ML / year. However, as operations at the NRP continue to expand, groundwater usage will be an estimated 12 ML / year.

Potable water monitoring program is detailed in **Section 5.1.6**.

BBLF

Potable water supply at the BBLF is reliant on potable water and bottled water externally sourced from Borroloola.

3.3.3 Wastewater discharge

NRR has recently applied for a waste discharge licence (WDL) to facilitate the discharge of decant water during the upcoming maintenance dredging program in 2024. This application did not seek for any discharge capabilities for the NRP mine.

NRR intends to submit another application or amend the granted WDL to allow for the controlled discharge of treated MAW from the NRP to the Towns and Magaranyi Rivers. The WMP will be revised and updated once a WDL is granted.

4 RISK MANAGEMENT

4.1 Identify hazards and rank risks

The initial risk assessment for the NRP completed during the 2012 EIS has been reviewed and updated relevant to planned activities for the 2024-2028 period. The full risk assessment can be found in the MMP (NRR 2024).

A summary of the water related risks associated with the NRP Mine and the BBLF, inclusive of the proposed diversion of waterways are discussed further below.

4.1.1 NRP Mine risk assessment

The risk assessment highlighted one high residual risk in relation to water management which includes:

- Natural disasters, cyclones and heavy storms causing engineered structure failures and flooding leading to the release of MAW off lease. This has the potential to impact surface and groundwater quality and aquatic habitat quality.

NRP flood levees have the potential to cause significant environmental harm should the structure collapse due to overtopping and/or engineering failure. The collapse of the Danehill pits levee would be the highest risk and is likely to reduce surface water flows within the Towns River.

Flood protection levees and water storage structures will be inspected each year prior to the onset of the wet season to identify if the structure is fit for purpose. These structures are again inspected after the wet season to identify any issues which may have arisen over the wet season.

Several medium residual risks were also identified which include;

- Open Pit Lakes - Formation of evaporative sinks;
- Open Pit Lakes - Formation of groundwater through flow pit lakes; and
- Leaching of acid mine drainage (AMD) from Low Grade Ore (LGO) stockpiles and PAF waste material at Danehill and Zabeel WRDs.

Groundwater behaviour within Danehill, Ponting and Zabeel mining areas is not fully understood. It is unknown if the pits will create an evaporative sink or a flow through lake and what implications this could have on the surrounding environment. Increased frequency of groundwater level monitoring will be implemented across the NRP in preparation for further hydrogeological investigations. These investigations are expected to commence shortly as part of the Mine Closure Plan.

PAF volumes across all open-cut pits are predicted to be minimal; however, given the presence of PAF remain a medium residual risk as suitable management of the PAF cell is required to mitigate potential impacts.

Two risks are associated with waste rock management which include:

- Inappropriate placement of PAF material causing AMD; and
- Leaching AMD through waste rock, product and LGO at Danehill and Zabeel WRDs and ROM pads.

Three risks are associated with water management infrastructure which include;

- Seepage of retained MAW stored within sediment ponds; and
- Uncontrolled discharge from water storages housing MAW.

To effectively manage the residual medium risks, NRR have undertaken the following management and mitigation measures:

- Ongoing reviews of the WMP and Acid Mine Drainage Management Plan (AMD MP) and implementation of the plans;
- Implementation of the revised water management strategy outlined in the Water Balance Report (WRM 2024);
- Implementing water management strategies such as irrigation and evaporation; and
- Implementation of the environmental monitoring programs.

4.1.2 BBLF dredging risk assessment

Majority of the risks identified at the BBLF are associated with the maintenance dredging program expected to commence late in 2024. Residual risks associated with the maintenance dredging activities are all considered as low as reasonably possible, with mitigation measures coordinated by the Dredging Monitoring and Management Plan (DMMP). Capital dredging of the BBLF transhipment zone was completed in 1995 by MRM and is considered a heavily modified environment. MRM has undertaken numerous annual monitoring programs to monitor and assess the potential impacts over the years. The monitoring has indicated the following:

- A local assemblage of benthic invertebrates and seagrasses with a recorded naturally high resilience to turbid waters due to seasonal cyclone activity (MRM 2005 & ERIAS 2018);
- No presence of seagrasses or significant habitat for motile marine species within the swing basin (ERIAS 2018); and
- Saline tolerant vegetation communities and no recorded incidence of significant vegetation die back (ERIAS 2016 and 2018).

NRR intends to commence a maintenance dredging program at the BBLF which will remove built-up marine sediment from the transhipment channel and swing basin, further facilitating access to these areas of the BBLF. Since the most recent, large-scale dredge program completed in 2012, a significant amount of sediment has built up throughout the swing basin and transhipment channel. The majority of this built-up material that has accumulated in the transhipment zone can be indirectly attributed to the ongoing movements of the vessel *Aburri*, manoeuvring in the swing basin as part of ongoing MRM operations and natural sediment infill processes typical of shallow coastal waters.

This maintenance dredge program will aim to remove an estimated 90,000 m^3 of material from the BBLF transhipment zone over a four-month period. The maintenance dredging program is considered low impact with the implementation of management and mitigation measures. Such measures include:

- Cutter suction dredging (CSD) coupled with onshore spoil disposal and settlement, with licenced decant to provide the lowest impact dredging methodology;
- Dredging during wet season where turbidity levels in the receiving marine environment are already elevated owing to monsoonal activity;
- Soil disposal onshore within designated area only rather than sea disposal reducing marine impacts;
- Dredging within pre-disturbed transhipment zone;
- Preventative maintenance of dredging vessels to reduce impact of hydrocarbon spills;
- Certified poly welding of spoil disposal pipeline to reduce split/leaking pipelines;
- Environmental monitoring providing baseline and early warning to avoid potential impacts; and
- BBLF has minimal tidal range, reducing zone of impact.

An environmental monitoring program has been developed specifically for the dredging program. Further details on risk management, mitigation measures and monitoring programs associated with the dredging program can be found in the NRP Dredging Monitoring and Management Plan (NRR 2024).

4.1.3 Pandanus drainage line diversion

WRM (2021b) used a hydrological (URBS) and hydraulic (TUFLOW) model of the Pandanus Creek catchment to assess the performance of the proposed Pandanus diversion. The following section addresses the potential impacts of the diversion on Pandanus drainage line, mitigation actions, monitoring and review of the diversion.

Management of potential flood impacts

The Zabeel Surface Water Assessment (WRM 2021b) shows peak flood depths and extents for the 1% and 0.1% AEP events respectively. The assessments show the proposed diversion and Zabeel West WRD will prevent inundation of the Zabeel pits from a 0.1% AEP event. The Pandanus drainage line floodwater inundation extends to the toe of the Zabeel North and South waste rock dumps. Hence, diversion bunds generally in the order of up to 1.5 m in height will be installed around the perimeter of the WRDs to prevent floodwaters from coming into contact with waste rock material.

The Zabeel Surface Water Assessment concluded that:

- There is a negligible peak water level impact (i.e. <0.1 m) to the west of the Zabeel mining area;
- There is a negligible impact (i.e. <0.1 m) along Pandanus drainage line downstream of the proposed diversion;
- Flood levels will reduce along the original Pandanus drainage line alignment between the Zabeel north and south WRDs;
- There is an increase in peak water levels of up to 1.1 m at the upstream end of the proposed diversion channel; and
- There is an increase in peak water levels of up to 0.5 m along Reach 6 of the diversion to the north of the Zabeel mining area where it carves through the existing floodplain.

Impact of diversion on regional hydrologic regime

The Pandanus drainage line diversion has been designed as a free draining structure connecting the invert of the existing creek upstream of the Zabeel mining area with the invert of the existing creek downstream of the mining area (WRM 2021b). The diversion will therefore not affect regional surface water hydrology upstream, as all surface flows from the catchment upstream of the diversion would continue to report to Pandanus Creek downstream of the drainage line diversion (WRM 2021b).

As a result of amalgamating the two existing Zabeel pits and the two Zabeel WRDs together, approximately 1.1 km of the Pandanus drainage line would be removed, and a corresponding 30 ha catchment would be removed from the Pandanus drainage line catchment. This is considered small on the scale of Pandanus drainage line, which has a total catchment of approximately 790 ha (WRM 2021b).

The Zabeel Surface Water Assessment (WRM 2021b) shows that changes to peak water levels during a 1% AEP event as a result of the diversion are negligible upstream and downstream of the Zabeel mining area (WRM 2021b, Section 6.4). Furthermore, there would be reductions in peak water levels in the diverted section of the existing Pandanus drainage line. There would be increases in the flood level directly adjacent the proposed diversion and along the proposed diversion.

The design of the diversion and additional dump ensures that during the operational phase of mining, surface flows for events up to and including the 0.1% AEP (1,000 years ARI) would be diverted around the Zabeel Ultimate pit (WRM 2021b).

Local sub-catchment runoff

The existing Pandanus drainage line drains a natural catchment of approximately 470 ha which extends 3 km to the southwest of the Zabeel mining area. Catchment runoff will drain overland to the diversion before discharging back into Pandanus drainage line downstream of the Zabeel pit.

As outlined in the Zabeel Surface Water Assessment (WRM 2021b), approximately 1.1 km of the Pandanus drainage line channel will be removed as a result of the merging of the Zabeel pits. The merging of the pits and the Zabeel west waste rock dump will result in the loss of approximately 30 ha of catchment to the Creek. This is considered small in the context of the Pandanus drainage line total catchment area (approximately 790 ha).

Impact on aquatic health

The residual impact on aquatic health on the receiving Pandanus drainage line is considered low. The existing Pandanus drainage line is stream order one and is not well defined upstream of the Zabeel mining area.

The proposed diversion cuts off the Pandanus upper catchment flows to the west of Zabeel and rediverts the water north around the Zabeel mining area and re-enters downstream Pandanus drainage line to the east of the pit. This area has been previously impacted from mining operations prior to NRR acquiring the NRP.

Aquatic health downstream of the Pandanus diversion will be assessed through the existing macroinvertebrate monitoring program. Additional monitoring locations will be added to the program and will utilise historical data for baseline comparisons.

Erosion and sediment transport

The Pandanus diversion has been designed such that impacts on channel morphology upstream and downstream of the diversion will be limited. The Zabeel Surface Water Assessment describes how the proposed diversion will behave in a hydraulically similar manner to the existing channel (WRM 2021b). The locations at which the diversion connects to the existing watercourses will not be exposed to high velocities, bed stresses or stream powers, and will not result in significant contraction or expansion of flows. Therefore, the potential for morphological impacts upstream and downstream of the diversion is limited.

NRR intends to implement additional surface water monitoring specific to the Pandanus diversion, aiming to identify any morphological impacts that may occur along the diversion, and allow mitigation measures to be implemented where possible. Further information on the additional surface water monitoring is provided in **Section 5**.

There is potential for rill erosion to occur on the diversion banks due to direct rainfall and local catchment flows discharging into the diversion. The potential for erosion on the banks of the diversion will be managed via revegetation of the banks where possible (WRM 2021b). The diversion batter slopes are designed to be 1V:6H which will further reduce the potential to erosion of the diversion banks.

It should be noted that Pandanus drainage line and its tributaries are dynamic systems, so erosion and sediment transport from the creek bed and banks is normal and should be facilitated to maintain a natural balance.

Model review and calibration

The site hydrology and hydraulics models are currently uncalibrated and should be calibrated as soon as possible once sufficient data is available. It is recommended that following a significant flow event in Pandanus drainage line, the site hydrology and hydraulics models are calibrated, and a report prepared outlining:

- The results of the calibration (i.e. comparison of model predictions against recorded water level data and surveyed debris marks);
- The impact of the calibration on the adopted design event discharges in Pandanus Creek; and
- The potential for any change in design discharges to affect the design of the diversion.

The model calibration should be revisited on an annual basis when new data become available.

4.2 Actions and strategies in response to identified risks

The risk assessment has established project risks associated with all operations of the NRP. The control and associated mitigation measures include the following:

- Established, regularly reviewed and implemented EMPs, including;
  - Water Management Plan;
  - AMD Management Plan;
  - Erosion and Sediment Control Plan;
  - Dust Management Plan;
  - Waste Management Plan;
  - Marine Management Program; and
  - Dredging Management and Monitoring Program.
- Groundwater levels to improve understanding of flow conditions across the NRP mine;
- Regular pit water level monitoring (mAHD);
- Surface and groundwater quality monitoring up gradient and down gradient of the mining infrastructure to establish trends and potential management measures;
- Surface water and aquatic habitat monitoring of waterway diversion up and down gradient of the diversion;
- Management and future treatment (where required) of any captured seepage water;
- PAF material managed in accordance with the approved AMD Management Plan; and
- Ongoing aquatic health monitoring.

A series of engineering controls will be included in addition to monitoring programs outlined in this WMP. Engineering controls include civil inspections, pre and post wet season, by a suitably qualified engineer of the Danehill flood levee, sediment ponds (including BBLF sediment ponds) and Pandanus drainage line diversions. The post wet season inspection will stipulate required remediation works and the pre wet season will determine if the works are sufficient for the approaching wet season.

Historical data collection at the NRP has been inconsistent and often have not produced sufficient information to determine risks from mine infrastructure. With the recommencement of operations in November 2022, data collection is now following the WMP approved monitoring programs. All water related monitoring programs are detailed in **Section 5** of this WMP. However, it will take some time to obtain a dataset that allows for a more substantiated risk assessment.

5 MONITORING

NRR implements a comprehensive environmental water monitoring program, which encompasses the monitoring of surface water, groundwater, sediments, and macroinvertebrates. The details of these programs are outlined in the following sections.

5.1 NRP Monitoring Programs

5.1.1 Surface water quality monitoring program

The surface water monitoring program at the NRP consists of 11 natural surface water sites and nine artificial surface water sites. The NRP surface water monitoring programs aims to:

- Detect impacts to surface water quality in waterways and tributaries downstream of operations at the NRP; and
- Inform internal water management strategies at the NRP.

The natural surface water monitoring program consists of sites which fulfill the one of two purposes:

- Reference locations allowing the collection of background data which is removed from any potential influence of NRP operations; and
- Impact locations intended to collect data from the receiving waterways which have the potential to be impacted by NRP operations.

Given the changes to the NRP mine plan, some previous reference sites are now proposed as impact sites. One such site is RBSW02, previously located upstream of all mine operations; however, now will be downstream of the Ponting mining area in the future.

Table 5-1 provides details on each surface water monitoring site at the NRP, with locations presented in **Figure 5-1**.

Table 5-1 NRP Surface Water Monitoring Locations

Monitoring Location	Description	Purpose	Easting (GDA94 Z53)	Northing (GDA94 Z53)	Monitoring Frequency
Natural Surface Waters					
RBSW01	Upstream Towns River	Reference	504457	8325044	Monthly
RBSW02	Croc Crossing, downstream of Ponting mining area on Towns River.	Impact	506970	8325291	
RBSW04	Immediately downstream of Danehill mining area on Towns River.	Impact	509379	8325889	
RBSW08	Downstream of ROM Pad on drainage line before confluence with Towns River.	Impact	511484	8325873	

Monitoring Location	Description	Purpose	Easting (GDA94 Z53)	Northing (GDA94 Z53)	Monitoring Frequency
RBSWDS	Downstream of Danehill mining area and ROM Pad on Towns River.	Impact	511090	8327142	
RBSWPU	Upstream of Zabeel mining area and before Pandanus Creek Diversion.	Impact	514889[1]	8324845[1]	
RBSW09	Downstream of Zabeel mining area.	Impact	515467	8325500	
RBSW13	Situated at Magaranyi River tributary.	Reference	518316	8324677	
RBSW14	Savannah Way Towns River crossing downstream.	Impact	522667	8336830	
RBSW15	Downstream of RBSW09 on Magaranyi River.	Impact	517786	8325162	
RBSW2US	Upstream on creek flowing between Danehill pit and ROM Pad	Reference	509393	8324118	
Artificial Surface Waters					
RBSP01	Danehill WRD sediment pond.	Sediment pond	510025	8325111	Monthly
RBSP02	ROM sediment pond	Sediment pond	511878	8325349	
RBSP03	Zabeel South WRD sediment pond.	Sediment pond	515133	8325541	
FE1	Danehill East Pit	Open pit	509460	8325548	
FE3	Danehill West Pit	Open pit	507786	8325257	
FE4	Ponting Pit	Open pit	505624	8325425	
FE5	Border Pit	Open pit	504715	8325383	
EEA	Zabeel North Pit	Open pit	514785	8325176	
EEB	Zabeel South Pit	Open pit	515087	8324693	

[1] *Monitoring site to be relocated once Pandanus drainage diversion is constructed.*

Legend

Surface Water Monitoring Locations

- ● Artificial Surface Waters
- ● Natural Surface Waters
- Major Drainage
- Minor Drainage
- Streams
- ▭ Tenement Boundaries

Source: Northern Territory Government (Department of Industry, Tourism and Trade) 2020-2022, Nathan River Resources 2024, METServe 2024.

Nathan River Project

NRP Surface Water Monitoring Locations

0 0.5 1 2

Kilometers

Scale: 1:62,000 (A4)

24/06/2024

Datum: GDA2020
Projection: MGA53

FIGURE 5-1

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Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\WMP\BM001_NR_WMP_NRP_Surface_Water_Monitoring_Locations.aprx

Monitoring frequency and parameters

Monitoring of natural and artificial surface water sites will occur on a monthly basis. Natural surface waters are only sampled when flowing conditions at the monitoring site are observed, typically coinciding with the wet season between November and April. One sampling event from a ponded/remnant pool at a monitoring site after flow has ceased is also undertaken. Artificial surface water sites are monitored and sampled on a monthly basis throughout the year subject to the water storage having sufficient water for sampling.

Each surface water monitoring event will collect several in-situ physio-chemical parameters as well as a water quality sample for laboratory analysis. Field parameters will utilise a calibrated multi-parameter water quality probe to collect the in-situ measurements. Field parameters include pH, electrical conductivity (EC), dissolved oxygen (DO), temperature, oxidation reduction potential (ORP) and total dissolved solids (TDS).

Laboratory analysis will include physicals (pH, EC, total suspended solids (TSS) and TDS), major ions (Ca, K, Mg, Na, SO_4 and Cl), alkalinity, nutrients (NH_3, NO_3, total nitrogen (TN), total phosphorus (TP)), filtered and total metals (Al, Sb, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, Se, Ag, Sn, U, and Zn).

Water quality assessment criteria

According to the ANZ Guidelines (2018), sufficient data to calculate local site-specific trigger values (SSTVs) requires a minimum of 24 monthly data points collected over a two-year period. This amount of data is not yet available for the NRP, hence, default guidelines from ANZG 2018 and ANZECC 2000 are used as water quality assessment criteria for natural surface waters only. **Table 5-2** presents the water quality assessment criteria to be implemented at the NRP. Please note that the ANZG (2018), that updated ANZECC (2000) guidelines, state that the guideline concentration for nitrate (700 µg/L) was erroneous with no new value provided. Thus, nitrate was removed from this list (**Table 5-2**). No default guideline value exists for sulfate, hence the health guideline value of 500 mg/l taken from the Australian Drinking Water Guidelines has been applied in **Table 5-2**.

Table 5-2 Surface water quality assessment guideline values

Parameter	Guideline reference	Guideline value
Physical parameters		
pH	ANZECC 2000[1]	6.0 – 8.0
Electrical conductivity (EC)	ANZECC 2000[2]	900 µS/cm
Turbidity	ANZECC 2000[1]	15 NTU
Nutrients and Ions		
Ammonia	ANZG 95 % species protection	0.9 mg/L
Sulphate	ADWG[3]	500 mg/L
Dissolved metals		
Aluminium	ANZG 95 % species protection	55 µg/L
Antimony	ANZG 95 % species protection	9 µg/L
Arsenic	ANZG 95 % species protection	13 µg/L
Boron	ANZG 95 % species protection	940 µg/L
Cadmium	ANZG 95 % species protection	0.2 µg/L
Chromium	ANZG 95 % species protection	3.3 µg/L
Copper	ANZG 95 % species protection	1.4 µg/L
Iron	ANZG 95 % species protection	300 µg/L
Lead	ANZG 95 % species protection	3.4 µg/L
Manganese	ANZG 95 % species protection	1,900 µg/L
Nickel	ANZG 95 % species protection	11 µg/L
Selenium	ANZG 95 % species protection	10 µg/L
Silver	ANZG 95 % species protection	1 µg/L
Tin	ANZG 95 % species protection	11 µg/L
Uranium	ANZG 95 % species protection	0.5 µg/L
Zinc	ANZG 95 % species protection	8 µg/L

1 ANZECC default guideline value for lowland rivers in tropical Australia.

2 ANZECC default guideline value for wetlands in tropical Australia.

3 Australian Drinking Water Guideline

5.1.2 Groundwater monitoring program

The NRP groundwater monitoring program consists of 15 groundwater monitoring bores located across the NRP, which includes the measurement of groundwater levels (manual observations) and groundwater quality (field and laboratory analysis). The monitoring program has been developed with the primary aim to detect and monitor potential mine derived impacts to the surrounding groundwater system at the NRP. The monitoring program includes several reference bores, positioned hydraulically up-gradient from NRP infrastructure, as well as impact bores which are located around infrastructure areas such as pits, WRDs, and processing areas. RBGW series are located within the deeper aquifer around 60 m below ground level and monitor any potential impacts to this aquifer, whereas the MB series monitors the shallower, unconfined aquifer. Impact bores will be compared to the corresponding reference bore of that specific bore series.

Table 5-3 summarises the details for NRP's groundwater monitoring bores, with locations presented in **Figure 5-2**.

MB30 has been removed from the groundwater monitoring program as it has been consistently dry throughout numerous monitoring events. MB25B, located 400 m to the southeast of MB30, has been chosen to replace MB30 on the monitoring program. MB25B is screened in a deeper geological formation than MB30 and contains water throughout the year.

Table 5-3 NRP Groundwater monitoring bores and monitoring frequency

Monitoring Location	Description	Purpose	Easting (GDA94 Z53)	Northing (GDA94 Z53)	Monitoring Frequency	
					SWL	Laboratory
MB01	Southern Danehill WRD monitoring bore	Impact	509332	8324803	Quarterly	Biannual
MB05	Northern ROM Pad monitoring bore.	Impact	512290	8325785		
MB06	Eastern ROM Pad monitoring bore	Impact	511745	8325588		
MB07	Southern ROM Pad monitoring bore.	Impact	511990	8325189		
MB08	South-western ROM Pad monitoring bore.	Impact	512780	8325210		
MB09	Northwest boundary bore, situated to the northwest of mine infrastructure.	Reference	514898	8325943		
MB21B	Western Danehill pit monitoring bore.	Impact	506732	8325420		
MB25B	Northwestern Danehill pit monitoring bore.	Impact	507362	8325488		
MB32B	Northwest of Zabeel pit.	Impact	514438	8325316		
RBGW01	Centrally located to the south of Danehill pit and north of Danehill WRD.	Impact	508848	8325244		
RBGW02	North-eastern Danehill pit monitoring bore.	Impact	510619	8325806		

Monitoring Location	Description	Purpose	Easting (GDA94 Z53)	Northing (GDA94 Z53)	Monitoring Frequency	
					SWL	Laboratory
RBGW03	South-western Zabeel monitoring bore.	Impact	513986	8324813		
RBGW05	Southern boundary bore for Zabeel infrastructure	Reference	512747	8323880		
RBGW07	Southern boundary bore for Danehill infrastructure	Reference	509934	8323667		
RBGW11	Western boundary bore	Reference	504497	8325175		

Legend

● Groundwater Monitoring Locations

☐ Tenement Boundaries

Source: Northern Territory Government (Department of Industry, Tourism and Trade) 2020-2022, Nathan River Resources 2024, METServe 2024.

Nathan River Project

NRP Groundwater Monitoring Locations

0 0.5 1 2

Kilometers

Scale: 1:50,000 (A4)

24/06/2024

Datum: GDA2020
Projection: MGA53

FIGURE 5-2

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Monitoring frequency and parameters

Standing water level measurements will be collected on a quarterly basis at the NRP. NRR also intends to implement an additional monitoring campaign collecting standing water levels from all NRP monitoring bores on a biannual basis pre and post wet season. This additional monitoring campaign aims to target the main recharge event which occurs at the NRP in efforts to collect further data on groundwater level and flow at the NRP.

Water quality sampling will occur on a biannual basis from the bores detailed in **Table 5-3**, focusing on pre and post wet season monitoring events. Both field and laboratory parameters will be collected during each monitoring event. Field parameters will be collected in-situ during sampling and includes pH, electrical conductivity (EC), dissolved oxygen (DO), temperature, oxidation reduction potential (ORP) and total dissolved solids (TDS).

Laboratory measured analytes include physical (pH, EC, total suspended solids (TSS), TDS, turbidity), general chemistry (hardness, major cations Ca, K, Mg, Na, major anions SO_4, Cl), alkalinity, nutrients (NH_3, NO_2, NO_3, total phosphorus TP) as well as total and filtered metals (Al, Sb, As, Ba, Be, B, Cd, Cr, Cu, Fe, Pb, Mn, Mo, Ni, Se, Ag, Sn, U, Zn).

Water quality assessment criteria

Groundwater monitoring data will be assessed against the ANZECC (2000) for stock drinking water outlined in **Table 5-4**. Due to the quality of groundwater within the NRP and surround, stock irrigation is considered to be the only beneficial use for groundwater in this region, hence, stock drinking water guidelines have been chosen as assessment criteria.

Table 5-4 Groundwater quality assessment guideline values

Parameter	Guideline reference	Guideline value
Physical parameters		
Total Dissolved solids (TDS)	Stock drinking water (ANZECC 2000)	4,000 mg/L
Nutrients and Ions		
Calcium	Stock drinking water (ANZECC 2000)	1,000 mg/L
Sulphate	Stock drinking water (ANZECC 2000)	1,000 mg/L
Nitrite	Stock drinking water (ANZECC 2000)	30 mg/L
Nitrate	Stock drinking water (ANZECC 2000)	400 mg/L
Dissolved metals		
Aluminium	Stock drinking water (ANZECC 2000)	5,000 µg/L
Arsenic	Stock drinking water (ANZECC 2000)	500 µg/L
Boron	Stock drinking water (ANZECC 2000)	5,000 µg/L
Cadmium	Stock drinking water (ANZECC 2000)	10 µg/L
Chromium	Stock drinking water (ANZECC 2000)	1,000µg/L
Copper	Stock drinking water (ANZECC 2000) - cattle	1,000 µg/L
Lead	Stock drinking water (ANZECC 2000)	100 µg/L
Nickel	Stock drinking water (ANZECC 2000)	1,000 µg/L
Selenium	Stock drinking water (ANZECC 2000)	20 µg/L
Uranium	Stock drinking water (ANZECC 2000)	200 µg/L
Zinc	Stock drinking water (ANZECC 2000)	20,000 µg/L

5.1.3 Fluvial Sediment monitoring

Fluvial sediments are sediments which have been transported and deposited by rivers or streams, ranging from sand, muds, silts to gravel and large boulders. Sampling of fluvial sediments are typically conducted to identify heavy metal concentrations which have been deposited within a waterway and have the potential to mobilise and cause environmental harm once flow resumes within ephemeral streams. NRR has developed the fluvial sediment monitoring program to allow for the detection and monitoring of potential mine derived impacts to stream sediments surrounding the NRP. The fluvial sediment monitoring program consists of 10 monitoring locations which correspond to the natural surface water sites at the NRP. **Table 5-5** summarises the details of the monitoring program and locations presented in **Figure 5-3**.

Table 5-5 NRP Fluvial Sediment Monitoring Locations

Monitoring Location	Description	Purpose	Easting (GDA94 Z53)	Northing (GDA94 Z53)	Monitoring Frequency
RBSED01	Upstream Towns River	Reference	504457	8325044	Annual
RBSED02	Croc Crossing, downstream of Ponting mining area on Towns River.	Impact	506970	8325291	
RBSED04	Immediately downstream of Danehill mining area on Towns River.	Impact	509379	8325889	
RBSED08	Downstream of ROM Pad on drainage line before confluence with Towns River.	Impact	511484	8325873	
RBSEDDS	Downstream of Danehill mining area and ROM Pad on Towns River.	Impact	511090	8327142	
RBSEDPU	Upstream of Zabeel mining area and before Pandanus Creek Diversion.	Reference	514889	8324845	
RBSED09	Downstream of Zabeel mining area.	Impact	515467	8325500	
RBSED13	Situated at Magaranyi River tributary.	Reference	518316	8324677	
RBSED14	Savannah Way Towns River crossing downstream.	Impact	522667	8336830	
RBSW15	Downstream of RBSW09 on Magaranyi River.	Impact	517786	8325162	
RBSW2US	Upstream on creek flowing between Danehill pit and ROM Pad.	Reference	509393	8324118	

Legend

- ● Fluvial Sediment Monitoring Locations
- Major Drainage
- Minor Drainage
- Streams
- ▭ Tenement Boundaries

Source: Northern Territory Government (Department of Industry, Tourism and Trade) 2020-2022, Nathan River Resources 2024, METServe 2024.

Nathan River Project

NRP Fluvial Sediment Monitoring Locations

0 0.5 1 2

Kilometers

Scale: 1:62,000 (A4)

24/06/2024

Datum: GDA2020
Projection: MGA53

FIGURE 5-3

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Monitoring frequency and parameters

Fluvial sediment monitoring will occur annually coinciding with the end of the wet season during recessional flows. The annual monitoring event will include a collection of a fluvial sediment sample for laboratory analysis. Laboratory analysis will measure physical (pH, EC, moisture), particle size distribution, major ions (Cl, Cn, P) and metals through dilute acid extract for bioavailable fraction <63 um (Al, Sb, As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Ag and Zn).

Fluvial sediment assessment criteria

The precautionary approach of applying Toxicant Default Guideline Value (DVG) for sediment quality (ANZG 2018) has been adopted (i.e. utilising the upper and lower guideline values). The assessment includes fluvial sediment quality in the receiving environment but also physical habitat changes from previous operations (i.e. deposition of fine sediment). A summary of adopted sediment assessment guideline values is provided in **Table 5-6**.

Table 5-6 Default toxicant guideline values for sediment quality

Metals / Metalloids	Units	*DGV-Low	*DGV-High
Antimony	mg/kg	2	25
Arsenic	mg/kg	20	70
Cadmium	mg/kg	1.5	10
Chromium	mg/kg	80	370
Copper	mg/kg	65	270
Lead	mg/kg	50	220
Mercury	mg/kg	0.15	1
Nickel	mg/kg	21	52
Silver	mg/kg	1	3.7
Zinc	mg/kg	200	410

*Sediment Toxicant DGV: Toxicant default guideline values for sediment quality (https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/sediment-quality-toxicants ANZG (2018).

Fluvial sediment samples will be collected in accordance with Simpson & Batley (2016): Sediment Quality Assessment and follow the NEPM schedules B 1 (1999) and B 2 (2011) and Australian Standard AS/NZS5667.12-1999: *Water quality - Sampling, Part 12: Guidance on sampling of bottom sediments*.

5.1.4 Macroinvertebrate monitoring

To detect potential impacts derived from NRP operations on aquatic health, NRR has developed a comprehensive biological monitoring program. The biological monitoring program consists of 13 sites across waterways at the NRP whereby macroinvertebrates are collected, analysed and assessed by a qualified aquatic ecologist. The monitoring program consists of six control sites and seven potential impact sites. Details on the biological monitoring locations are summarised in **Table 5-7** with locations presented on **Figure 5-4**.

Table 5-7 NRP Biological Monitoring Locations

Monitoring Location	Description	Purpose	Easting (GDA94 Z53)	Northing (GDA94 Z53)	Monitoring Frequency
B1	Towns River Upstream Control Site.	Reference	504355	8325016	Annual
B1A	Towns River Upstream Alternate Site.	Reference	505326	8325253	
B2	Croc Crossing, downstream of Ponting mining area on Towns	Impact	507251	8325274	
B3	Immediately downstream of Danehill mining area on Towns River.	Impact	509014	8325536	
B4	Upstream on creek flowing between Danehill pit and ROM	Reference	509391	8324112	
B5	Towns River downstream of levee bank and B3.	Impact	510659	8326722	
B6	Towns River downstream of flood levee.	Impact	511326	8326331	
B7	Towns River downstream of branch confluence.	Impact	511077	8327038	
B8	Downstream of Zabeel mining area.	Impact	515293	8325135	
B9	Pandanus Creek downstream of B8.	Impact	516095	8325304	
B10	Magaranyi River downstream of B9.	Impact	517865	8325285	
B11	Situated at Magaranyi River tributary.	Reference	518309	8324661	
B12	Savannah Way Towns River crossing downstream.	Impact	522720	8336882	

Legend

- 🟢 Biological Monitoring Locations
- Major Drainage
- Minor Drainage
- Streams
- ▭ Tenement Boundaries

Source: Northern Territory Government (Department of Industry, Tourism and Trade) 2020-2022, Nathan River Resources 2024, METServe 2024.

Nathan River Project

NRP Biological Monitoring Locations

0 0.5 1 2

Kilometers

Scale: 1:62,000 (A4)

24/06/2024

N

Datum: GDA2020
Projection: MGA53

FIGURE 5-4

METSERVE
Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\WMP\BM001_NR_WMP_NRP_Biological_Monitoring_Locations.aprx

Monitoring frequency and parameters

Biological monitoring will be undertaken annually during receding wet season recessional flows and include:

- Macroinvertebrate survey - using Northern Territory AUSRIVAS method (Cook & Lloyd 2001);
- Habitat Assessment; and
- In-situ water quality measurements.

An appropriate sample location is selected at each site (i.e. ideal edge habitat, with a 5-10 m accessible stretch, with trailing root matter, from a flowing watercourse but sample area must not be fast flowing)..

The macroinvertebrate identification and data analysis will be undertaken by an AUSRIVAS accredited aquatic ecologist, with the following analysis completed:

- Macroinvertebrate metrics will be calculated (abundance, taxa richness);
- AUSRIVAS modelling will be implemented and OE50 scores and bandings calculated for each site; and
- Multivariate analysis of macroinvertebrate community composition will be completed to understand the differences and similarities between the sites.

Macroinvertebrate assessment criteria

The biological monitoring program will utilise the AUSRIVAS method for assessment criteria. AUSRIVAS is based on the assessment of any site in comparison to reference sites, the information on which is part of the AUSRIVAS software. For the NRP, the NT edge habitat family level model is applicable. AUSRIVAS analysis classifies each sampling sites into a Band from A to D based on the observed versus the expected taxa abundance. These banded criteria used by AUSRIVAS are summarised in **Table 5-8**.

Table 5-8 AUSRIVAS output and assessment

Band	Description	O/E taxa	O/E taxa interpretations
X	MORE BIOLOGICALLY DIVERSE THAN REFERENCE	O/E greater than 90th percentile of reference sites used to create the model.	More families found than expected. Potential biodiversity "hot-spot" or mild organic enrichment. Continuous irrigation flow in a normally intermittent stream.
A	SIMILAR TO REFERENCE	O/E within range of central. 80% of reference sites used to create the model.	Expected number of families within the range found at 80% of the reference sites.
B	SIGNIFICANTLY IMPAIRED	O/E below 10th percentile of reference sites used to create the model. Same width as band A.	Fewer families than expected. Potential impact either on water and/or habitat quality resulting in a loss of families.
C	SEVERELY IMPAIRED	O/E below band B. Same width as band A.	Many fewer families than expected. Loss of families from substantial impairment of expected biota caused by water and/or habitat quality.
D	EXTREMELY IMPAIRED	O/E below band C down to zero.	Few of the expected families and only the hardy, pollution tolerant families remain. Severe impairment.

5.1.5 Pandanus Creek Diversion Monitoring program

A surface water monitoring program for the Pandanus Creek Diversion Channel has been developed and will be implemented prior to construction, and throughout the division's establishment. The monitoring program will focus on monitoring:

- Stream morphology; and
- Water level and discharge.

Stream Morphology

The three nominated stream morphology monitoring points presented in **Figure 5-5** will be monitored as follows:

- Stream cross section surveys will be undertaken:
  - Prior to construction of the diversion; and
  - At least once annually following a significant rainfall event resulting in flows within Pandanus Creek.
- Stream cross section surveys will include the following:
  - Detailed survey of the bed and banks of the creek at each location; and
  - Photographs of the streambed and banks, clearly showing any erosion or deposition of sediment.

The cross-section survey data will be provided to an appropriately qualified and experienced professional with relevant expertise in watercourse diversions for review following the flow event. A review report will be prepared identifying any potential stream morphological issues, and recommending mitigation works or further investigations.

The full length of the diversion will also be inspected and surveyed following construction and after cross section recordings. The diversion survey will include regular cross sections or a full 3D surface survey and photographs at regular intervals or locations where damage has occurred.

Water Level and Discharge

Two level and discharge monitoring points will be implemented along the Pandanus Creek including:

- The Zabeel haul road crossing of the diversion; and
- The northern haul road crossing of the diversion.

Both locations will provide stable cross sections to allow the development of reliable rating curves to estimate discharges in Pandanus Creek, allowing calibration of the site hydrology and hydraulic models. Both locations will have cross sections surveyed on an annual basis and be fitted with continuous water level loggers. Data will be downloaded from the water level loggers following any flow event. Wherever possible, debris or tide marks that remain following a flow event should be surveyed for use in model calibration.

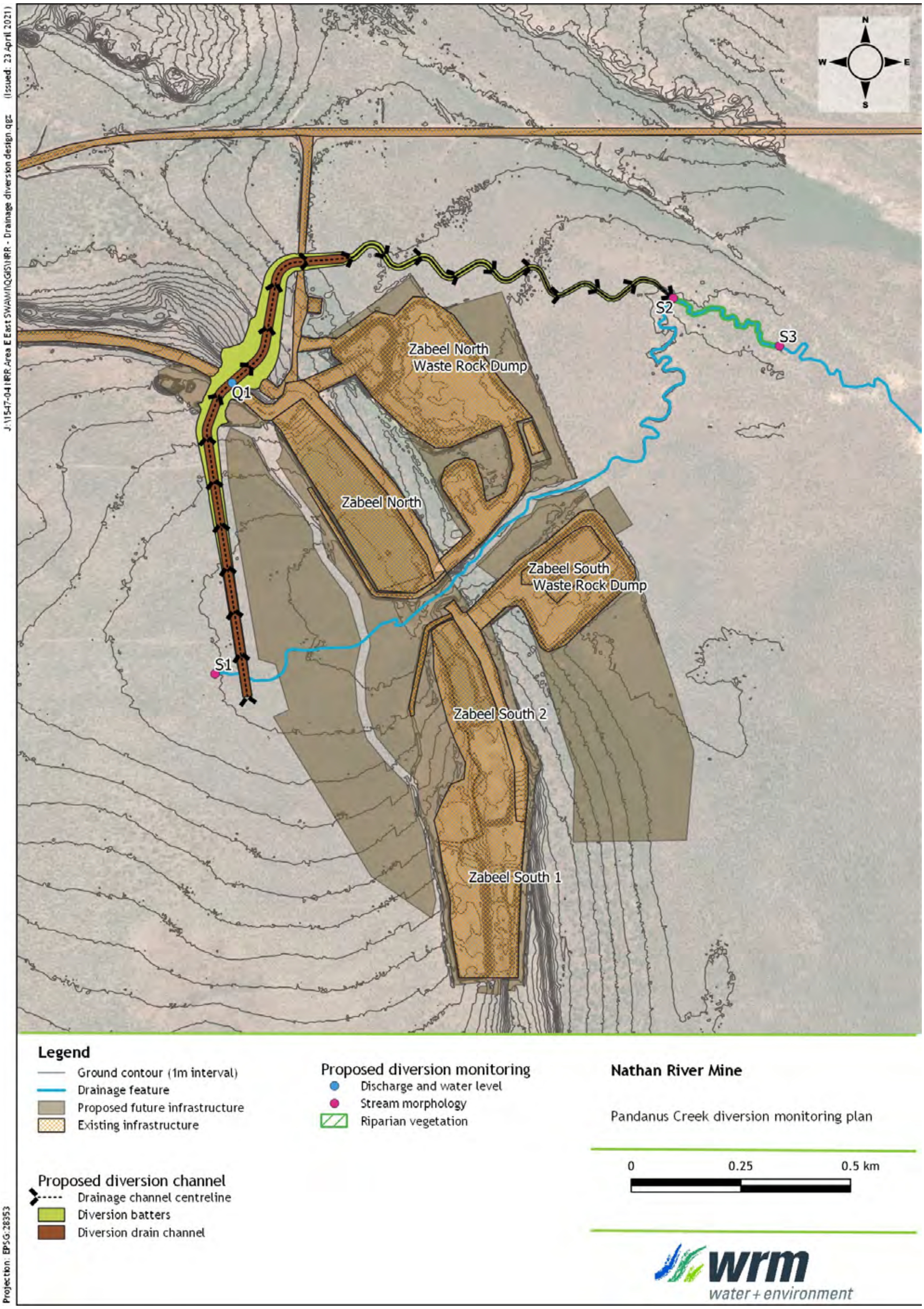


Figure 5-5 - Pandanus Creek diversion monitoring plan

5.1.6 Potable water monitoring program

As outlined in **Section 3.3.2**, the NRP's potable water supply is sole sourced from groundwater which is treated through a water treatment plant. The potable water treatment plant treats raw water supplied by a groundwater bore (referred to as the Sawfish Camp Bore), using Reverse Osmosis and supplies the Sawfish Camp with its entire potable water supply. To ensure potable water is fit for purpose and safe for human consumption, potable water quality at the Sawfish camp is monitored on a monthly basis. Water quality data is compared to the Australian Drinking Water Guidelines (ADWG), summarised in **Table 5-9** below. The ADWGs are comprised of two guideline values, aesthetic (AGV) and health (HGV) guideline values. These are defined by the guidelines as the following:

- a health-based guideline value, which is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption; and
- an aesthetic guideline value, which is the concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer; for example, appearance, taste and odour.

The main sample collection point for potable water monitoring is the Sawfish Camp kitchen as this is closest to the consumer of the potable water in accordance with ADWG 2011.

Table 5-9 Health and aesthetic guideline values to be applied to potable water

Analytes	Unit	Health Guideline Value (HGV)	Aesthetic Guideline Value (AGV)
E.Coli	PASS/FAIL	FAIL	
pH	pH units	ND	6.5 – 8.5
Turbidity	NTU		5
Total Dissolved Solids (TDS)	mg/L		600
Nitrite	mg/L	3	
Nitrate	mg/L	50	
Chloride	mg/L		250
Ammonia	mg/L		0.5
Fluoride	mg/L	1.5	
Hardness (as CaCO3)	mg/L		200
Sodium	mg/L		180
Silica	mg/L		80
Sulfate	mg/L	ND	250
Silver	µg/L	100	
Aluminium	µg/L		200
Boron	µg/L	4,000	
Barium	µg/L	2,000	
Beryllium	µg/L	60	
Cadmium	µg/L	2	
Chromium	µg/L	50	
Copper	µg/L	2,000	1,000
Iron	µg/L	ND	300
Mercury	µg/L	1	
Manganese	µg/L	500	100
Molybdenum	µg/L	50	
Nickel	µg/L	20	
Lead	µg/L	10	
Antimony	µg/L	3	
Selenium	µg/L	10	
Uranium	µg/L	17	
Zinc	µg/L	ND	3,000

ND - Insufficient data to set a guideline value based on health considerations

If a guideline value for a health-based characteristic is exceeded, NRR will undertake immediate action upon the receipt of results to reduce the risk to personnel, and, if necessary, to advise the health authority and consumers of the problem and the action taken. If the characteristic affects only aesthetic water quality, the action may be to advise the community of deterioration in water quality.

NRR will take urgent action if *Escherichia coli* (*E. coli*) is detected in potable water samples. The following actions will occur should *E.coli* be detected:

- Further samples should be collected to confirm the presence of *E. coli* and determine possible sources and distribution. This should include a repeat sample from the point where the nonconforming sample was collected and, as appropriate, an upstream sample (e.g. a service reservoir or system entry point) and a downstream or adjacent sample (e.g. a nearby sampling location);
- An investigation should be initiated immediately to identify the underlying cause(s) of any barrier breaches or unexplained results and put in place corrective actions to prevent future faecal contamination and detection of *E. coli*;
- Further sampling should be undertaken to verify that the corrective actions have been effective; and
- All actions taken in relation to the detection should be documented.

5.2 BBLF Monitoring Programs

5.2.1 BBLF Surface water quality monitoring program

The surface water monitoring program at the BBLF consists of five artificial sediment ponds which capture run-off from the BBLF stockyard and wharf area. The details of each monitoring location are provided in **Table 5-10** and locations shown on **Figure 5-6** below.

Table 5-10 BBLF Surface water monitoring locations

Monitoring Location	Description	Purpose	Easting (GDA94 Z53)	Northing (GDA94 Z53)	Monitoring Frequency
BBSP01	Located south-west of stockyard.	Sediment pond	647940	8271560	Monthly during wet season
BBSP02	Located south of stockyard.	Sediment pond	648163	8271596	
BBSP03	Located north-east of stockyard.	Sediment pond	648114	8271815	
BBSP04	Located north-west of stockyard.	Sediment pond	647985	8271800	
BBSP05	Located adjacent to wharf.	Sediment pond	648700	827174	

Monitoring frequency and parameters

Monitoring frequency of BBLF surface water sites will occur on a monthly basis during the wet season. Sediment ponds at the BBLF typically only hold water during this period and are quickly depleted through supplying dust suppression or evaporated during the dry season.

Each surface water monitoring event will collect several in-situ physio-chemical parameters as well as a water quality sample for laboratory analysis. Field parameters will utilise a calibrated multi-parameter water quality probe to collect the in-situ measurements. Field parameters include pH, electrical conductivity (EC), dissolved oxygen (DO), temperature, oxidation reduction potential (ORP) and total dissolved solids (TDS).

Laboratory analysis will include physicals (pH, EC, total suspended solids (TSS) and TDS), major ions (Ca, K, Mg, Na, SO_4 and Cl), alkalinity, nutrients (NH_3, NO_3, total nitrogen (TN), total phosphorus (TP)), filtered and total metals (Al, Sb, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, Se, Ag, Sn, U, and Zn).

Water quality assessment criteria

Water quality data collected by this monitoring program at the BBLF will be compared to the same water quality criteria as applied at the NRP provided in **Section 5.1.1**. Water quality in BBLF sediment ponds will be monitored for water management purposes only, informing the water management strategy at the BBLF mainly during the wet season.

Legend

- ● Groundwater Bore Locations
- ● Artificial Surface Water Monitoring Locations
- ● WDL Water Monitoring Location
- □ Tenement Boundaries

Source: Northern Territory Government (Department of Industry, Tourism and Trade) 2020-2022, Nathan River Resources 2024, METServe 2024.

Nathan River Project

BBLF Surface Water and Groundwater Bore Locations

0 50 100 150 200 250

Meters

Scale: 1:6,500 (A4)

24/06/2024

N

Datum: GDA2020
Projection: MGA53

FIGURE 5-6

METSERVE
Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\WMP\BM001_NR_WMP_BBLF_Surface_Water_and_Groundwater_Monitoring_Locations.aprx

5.2.2 BBLF Groundwater monitoring program

The BBLF groundwater monitoring program consists of four monitoring bores located around the perimeter of the BBLF stockyard. **Table 5-11** summarises the details of the BBLF groundwater monitoring bores with locations presented in **Figure 5-6** above.

Table 5-11 BBLF groundwater monitoring bores

Monitoring Location	Description	Purpose	Easting (GDA94 Z53)	Northing (GDA94 Z53)	Monitoring Frequency
BBMB01	Southwest stockyard bore	Impact	647877	8271430	Biannual
BBMB02	Northwest of stockyard and material containment bund	Impact	647789	8271811	
BBMB03	Northeast stockyard bore	Impact	648322	8271827	
BBMB04	Southeast stockyard bore	Impact	648293	8271631	

Monitoring frequency and parameters

Standing water level measurements will be collected on a quarterly basis at the BBLF. Water quality sampling will occur on a biannual basis from the bores detailed in **Table 5-11**, focusing on pre and post wet season monitoring events. Both field and laboratory parameters will be collected during each monitoring event. Field parameters will be collected in-situ during sampling and includes pH, electrical conductivity (EC), dissolved oxygen (DO), temperature, oxidation reduction potential (ORP) and total dissolved solids (TDS).

Laboratory measured analytes include physical (pH, EC, total suspended solids (TSS), TDS, turbidity), general chemistry (hardness, major cations Ca, K, Mg, Na, major anions SO_4, Cl), alkalinity, nutrients (NH_3, NO_2, NO_3, total phosphorus TP) as well as total and filtered metals (Al, Sb, As, Ba, Be, B, Cd, Cr, Cu, Fe, Pb, Mn, Mo, Ni, Se, Ag, Sn, U, Zn).

Water quality assessment criteria

Groundwater quality at the BBLF is highly saline due to its proximity to the ocean and its location within marine sediments. Due to the high EC of groundwater, it is considered to have limited beneficial use including stock watering. Despite the elevated EC/TDS, groundwater quality data collected at the BBLF is compared to the ANZECC (2000) stock drinking water guidelines for comparative purposes only. These guideline values are presented in **Table 5-4** in **Section 5.1.1**.

5.2.3 Dredge Monitoring Program

NRR intends to undertake water quality monitoring throughout the maintenance dredging program to ensure the early detection of potentially unacceptable impacts to the receiving environment. The monitoring programs detailed in this section will be conducted prior to, during and post dredging activities. Monitoring of cumulative impacts to the broader marine environment associated with the operation of the BBLF (by both NRR and MRM) will continue to be monitored by MRM through the already implemented, routine monitoring programs. NRR will provide monitoring results to MRM to inform analysis of future monitoring data. Monitoring programs relevant to the maintenance dredging program include:

- Discharge water quality monitoring;
- Dredge plume turbidity monitoring;
- Marine water quality monitoring via diffuse gradient in thins (DGTs); and
- Dredge spoil testing.

These monitoring programs will be supplemented by aerial drone surveys and visual site inspections throughout the dredging program along with the existing monitoring programs already implemented at the BBLF such as groundwater monitoring. Further details on monitoring intended to be implemented during the dredging program can be found in the *BBLF Dredging Monitoring and Management Plan* (NRR 2024).

5.3 Sampling method, quality control and assurance

5.3.1 Sampling method

Water quality monitoring (field parameters and sampling) will be completed by a suitably qualified person and follow the applicable Australian Standard (AS/NZS 5667).

All water quality samples collected as part of the various monitoring programs within this document will be submitted to a NATA accredited laboratory requesting the fastest turn-around time requested for analysis. Given the remote nature of the NRP and BBLF, water quality samples will be dispatched to a laboratory as soon as practical. Samples will be collected and transported in appropriately pre-treated sample bottles supplied by a NATA accredited laboratory. Specific procedures will be developed for each routine monitoring program at the NRP, focusing on a standardised method for each program to ensure consistency between monitoring events. These monitoring procedures can be made available by the NRP HSE Team.

Sample containers will be labelled with a waterproof xylene-free marker pen on the container's label. The monitoring location ID, name of the personnel collecting the sample, time and date will be included on the label. All storage containers will be chilled on ice (4°C) immediately following collection and stored in a refrigerator until delivery to the respective laboratory within parameter holding times. Samples which require freezing will be placed in the freezer at the completion of the day's sampling. Accurate chain of custody forms will be maintained for samples. The form will identify all samples numbers, the respective analyses and limits or reporting (LORs) required for analysis. All samples will be submitted to the laboratory as a single batch to minimise the chance for misplaced or misdirected freight.

Each monitoring event, the sampler will collect and populate the following information:

- Date and time the sample was collected;
- Location which the sample was collected;
- Name of the person who collected the sample;
- Chain of custody form relating to the sample;
- Field measurements and analytical requests relating to the sample; and
- Laboratory quality assurance and quality control documentation.

Chain of custody information will be sent to the respective laboratory with all information collected to be stored on the NRP environmental database for further reference. Once laboratory reports are received, this information will also be stored in the dedicated folder on the NRP database for that specific monitoring events.

5.3.2 Quality control and assurance

Following best practise, duplicate samples will be collected and submitted to the laboratory as 'blind' duplicates. Laboratory analysis results of blind duplicate samples should be similar or identical to the parent sample. Should this not be the case, an investigation into the sample collection and laboratory analysis conducted will be commenced. In addition to blind duplicate samples, blank samples will also be submitted to the laboratory. Blank samples will be filled with de-ionised water under field conditions. Results from blank samples will assist in identifying any contamination during sample collection, transport, and analysis. One blind duplicate will be completed with every 10 samples collected, and one field blank will be collected every laboratory submission, or every 20 samples collected.

Data from duplicate and blank samples will be assessed immediately upon receipt from the laboratory. This will ensure any problems indicated from the quality control program can be investigated as soon as possible by the Environmental Contractor Any reported concentrations of inorganic or organic contaminants in blanks will be investigated immediately. Collection of adequate blank data should indicate if the source of contamination is from sample collection (i.e. container, equipment), sample transport, or the laboratory.

Relative Percent Difference (RPD) between the duplicate sample and the corresponding parent sample will be used to distinguish if there is an acceptable difference between the samples. RPD is calculated using the following equation:

$$\mathrm{RPD}(\%) = \frac{\left|C_o - C_d\right|}{C_o + C_d} \times 200$$

Where Co = Analyte concentration of the original sample

Cd = Analyte concentration of the duplicate sample

A nominal acceptance criterion of 30% RPD for field duplicates will be adopted; however, it is noted that this will not always be achieved, particularly at low analyte concentrations. Should there be > 30% difference between a duplicate and original sample, an investigation into the cause of the sample discrepancy will be commenced.

6 MANAGEMENT AND REPORTING

6.1 Remedial or corrective management actions

In the event that the monitoring programs in **Section 5** identify a potential exceedance of a corresponding guideline value, then an investigation will be triggered including:

- Initial emergency response if required/warranted (eg. water capture and pumping);
- Follow-up testing/investigations to confirm initial findings;
- Investigate cause of said exceedance;
- Reporting to regulatory agencies and other relevant stakeholders if required; and
- Identification and implementation of appropriate corrective actions including additional engineering controls, administrative and technical procedures.

This investigation will be conducted by the NRP HSE Team or a suitably qualified contractor. Corrective actions will be implemented where a non-conformance with a management measure has been determined, or if monitoring indicates an environmental objective or performance criteria is not being achieved. Corrective actions will be designed to manage any further impact and achieve environmental objectives.

6.1.1 Surface water management plan

The operational surface water management strategy for the NRP seeks to:

- Minimise the amount of surface runoff impacted by mining operations by diverting clean water flows around the mining operations;
- Minimise impacts to water quality and quantity on existing downstream water users;
- Provide adequate protection of internal water management infrastructure, including the flood levee, and external surface water values during flood events;
- Minimise the amount of raw water to be imported to site;
- Maximise the recycling of stored water resources within the mine;
- Manage wastewater discharges in accordance with the WDL conditions; and
- Minimise changes to Pandanus Creek hydrology regimes and water quality following diversion works.

Table 6-1 below discusses these surface water management objectives, targets, monitoring and contingency management measures.

Table 6-1 Surface water objectives, targets, monitoring and management

Objective	Target	Monitoring Program or Initiative	Nominal Contingency and Management Measures
Minimise the amount of surface runoff impacted.	Water quality in natural surface receiving waters not to exceed the following nominated trigger values listed in **Table 3-2**. Geotechnical and structural integrity of all flood protection infrastructure is considered to be satisfactory by a suitably qualified engineer.	<u>NRP Mine</u> 20 surface water monitoring locations at the NRP will be monitored at the following frequencies: • Monthly – field sampling and laboratory analysis. • Additional monitoring is to take place in the event of an uncontrolled discharge, and in remnant pools during the dry season. <u>BBLF</u> Five surface water monitoring locations at the BBLF will be monitored at the following frequencies: • Biannual – field sampling and laboratory analysis.	Maintenance of pumps and associated pipe infrastructure. If sediment ponds are likely to overflow, then pumps will be used to discharge to other storages (including pits) with available storage.
Minimise impacts to water quality and quantity on existing downstream water users.			Emergency Response Plan procedures for levee collapse including: • Any work should be stopped and people and equipment removed from the area. • Notification to the Management team. • Appropriately qualified personnel to visually inspect the incident site and immediate area if safe to do so. • Request assistance as required; emergency response, medic, mine engineering (if needed). • Due to potential environmental impact the incident must be reported to the Department of Industry, Tourism and Trade through a Section 29 Notification of Environmental Incident (email to Mineral.Info@nt.gov.au) and the NT EPA Pollution Hotline
Provide adequate protection of internal water management infrastructure, including the flood levees, and external surface water values during flood events.			

Objective	Target	Monitoring Program or Initiative	Nominal Contingency and Management Measures
			(tel. 1800 064 567) through a Section 14 Incident Report Form within 24 hours of the incident occurring. Field inspection by a mining engineer or geotechnical engineer as soon as practicable after the event, including an assessment of potential further impacts, risk assessment, and remedial action/s to prevent any additional failure.
Minimise the amount of raw water to be imported to site and maximise the recycling of stored water resources at both the NRP mine and the BBLF.	No water imported to site. Use and re-use of on-site water for operational requirements with appropriate recycling infrastructure.	Management, diversion and storage of all MAW and non-MAW for use (and re-use) in mining activities in accordance with the WMP and a site water balance that is informed by hydrological data collection and modelling and considers planned site activities.	Refinement of site water management system based on planned site activities, water balance opportunities and evolving understanding of site hydrology.
Manage wastewater discharges in accordance with the WDL conditions.	No water discharged from site, except in accordance with the Waste Discharge Licence (WDL). Re-use and recycle mine water as much as possible.	Management according to site WMP and site water balance.	Any discharge to be managed in accordance with the site WMP and WDL conditions. Response to uncontrolled discharges are covered by the NRP Emergency Management Plan.

Objective	Target	Monitoring Program or Initiative	Nominal Contingency and Management Measures
Minimise changes to Pandanus Creek hydrology regimes and water quality following diversion works.	Minimal erosion and sedimentation impacts to downstream water quality. Water quality downstream of realignment is of similar quality to upstream of the realignment. Stabilised creek banks and revegetation success. Target criteria is provided in the Riparian Revegatation Plan.	Stream morphology monitoring cross-sections to be conducted as a minimum annually following significant rainfall event at three locations within Pandanus Creek S1, S2, S3 (WRM 2021). Riparian vegetation and revegetation monitoring as a minimum annually of realignment banks and immediately downstream section of each diversion outlet. Continuous water level and quality discharge monitoring with loggers at Q1 and Q2 on Pandanus Creek. Monitoring in accordance with **Section 5.1**.	Remediation works to be undertaken following each wet season. Revegetation of impacted area. Increased monitoring if adverse impacts detected.

6.1.2 Groundwater Management Plan

The operational groundwater management strategy for the NRP and the BBLF seeks to:

- Ensure no detrimental impact on the availability and suitability of groundwater;
- Prevent adverse changes to groundwater quality as a direct result of mining activities outside of the NRP footprint; and
- Protect cultural heritage or spiritual values associated with surface water features that are maintained by groundwater.

Table 6-2 discusses these groundwater management objectives, targets, monitoring and contingency management measures.

Table 6-2 Groundwater objectives, targets, monitoring and management

Objective	Target	Monitoring Program or Initiative	Nominal Contingency Management Measures
Ensure no detrimental impact on the availability and suitability of groundwater for stock watering purposes.	Impact groundwater bore's level and quality will be compared to the relevant reference bores. Water quality will also be assessed against ANZECC (2000) Stock Drinking Water guideline values listed in **Table 5-4**.	NRP Mine 15 groundwater monitoring bores that are monitored at the following frequencies: • Standing water level measurements are undertaken on a quarterly basis. • Sampling and laboratory assessment occurs on a biannual basis. BBLF Four groundwater monitoring bores at the BBLF are monitored on the following frequencies: • Standing water level measurements are undertaken on a quarterly basis. • Sampling and laboratory assessment occurs on a biannual basis.	Water management contingencies may include: • Additional engineering controls; • Source control including waste rock and chemical storage methods and infrastructure; • Water capture; • Pumping; and • Supplementary revegetation works. In addition, a review of regional groundwater bore water quality data found that reported water quality exceeded the ANZECC stock water drinking guidelines in a number of bores. Therefore, appropriate management measures will be implemented to prevent livestock access to water storages that contain groundwater that exceeds stock water drinking guideline levels.
Prevent adverse changes to groundwater quality outside the mine footprint as a direct result of the mine's activities.			
Protect cultural heritage or spiritual values associated with surface water features that are maintained by groundwater (groundwater dependent ecosystems)			Additional to the contingencies listed above, water management contingencies may include: • Prevention of stock access to water storages that contain groundwater.

6.2 Information and Knowledge gaps

Across the baseline, operation and care and maintenance periods of the NRP, limited data has been collected for surface water and groundwater. The inconsistency across the previous historical data has made assessing trends and the significance of environmental trends challenging. The ongoing implementation of the monitoring programs outlined in **Section 5** will allow the further collection of data, in turn facilitating further assessment and understanding of the severity of environmental trends.

An assessment of impacted versus reference sites has not been possible as the existing surface water monitoring program only included two true reference sites. Quantitative analysis of impact versus reference is possible with a minimum of three reference sites. NRR intends to add a third reference site on an upstream tributary of the Towns River (RBSW2US) with the aim of improving the qualitative assessment of surface water quality.

Inconsistent collection of groundwater level measurements throughout the NRP's life has made it difficult to develop and produce groundwater flow maps. NRR intends to collect quarterly SWL measurements from bores listed in **Table 5-3** and **5-10**, and intends on collecting SWL measurements biannually from all monitoring bores across the NRP and the BBLF.

6.3 Data review and interpretation

Data collected by monitoring programs outlines in **Section 5** will be reviewed internally upon receipt of results to detect any significant changes in water quality, level and aquatic health which may require immediate action. Further in-depth data interpretation will be completed on an annual basis during the development of the Environmental Mining Report (EMR). Monitoring data and interpretation will be reported to the DITT through the EMR process. Interpretation of data allows for the detection of impacts to the surrounding environment along with the refinement and improvement of existing monitoring programs and mitigation measures.

7 REFERENCES

ANZECC & ARMCANZ (2000), Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia.

Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) (ANZECC guidelines): Guidelines for Fresh and Marine Water Quality.

Australian Drinking Water Guidelines Paper 6, Version 3.6. National Water quality Management Strategy. National Health and Medical Research Council, National Resource Management Ministerial Council (NHMRC, NHMMC) (2011, updated March 2021).

Australian/New Zealand Standard (1998) AN/NZS 5667.10:1998. Water Quality Sampling – Part 10: Guidance on sampling of waste waters, Standards Australia, New South Wales.

Australian/New Zealand Standard (1999) AS/NZS 5667.12-1999. Water quality - Sampling, Part 12: Guidance on sampling of bottom sediments, Standards Australia, New South Wales.

Australian/New Zealand Standard (1998) AS/NZS 5667.1:1998. Water Quality Sampling - Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples, Standards Australia, New South Wales.

Australian/New Zealand Standard (1998) AS/NZS 5667.6:1998. Water Quality Sampling – Part 6: Guidance on sampling of rivers and streams, Standards Australia, New South Wales.

Australian/New Zealand Standard (1998) on Water Quality AS/NZS 5667.11:1998. Water Quality Sampling - Part 11: Guidance on sampling of groundwater, Standards Australia, New South Wales.

Bureau of Meteorology: Groundwater Dependant Ecosystems Atlas.

Department of Natural Resources, Environment, the Arts and Sport (DNRWAS) (2007a), Sites of Conservation Significance Factsheet 33 Sir Edward Pellew Island Group, Northern Territory Government, Darwin.

Department of Natural Resources, Environment, the Arts and Sport (DNRWAS) (2007b), Sites of Conservation Significance Factsheet 34 McArthur River coastal floodplain, Northern Territory Government, Darwin.

Department of Lands, Planning and Environment. Lloyd J, Cook S (2002): Northern Territory AUSRIVAS Sampling and Processing Manual. Natural Resources Division.

EcOz (2012), Roper Bar Iron Ore Project Environmental Impact Statement, prepared for Western Desert Resources.

EcOz (2012a): Roper Bar Iron Ore Project, EIS Chapter 5 Marine Environment, prepared for Western Desert Resources.

EcOz (2012b): Draft EIS – Appendix E: Bore Logs and Construction Details, prepared for Western Desert Resources.

EcOz (2012c): Draft EIS – Appendix E: Groundwater Report. Report to Western Desert Resources Ltd, prepared for Western Desert Resources.

ERIAS Group Pty Ltd (2016), Independent Monitor Environmental Performance Annual Report. 2015-2016. McArthur River Mine, Report to the Minister for Primary Industry and Resources.

ERIAS Group Pty Ltd (2018) Independent Monitor Environmental Performance Annual Report. 2017-2018 McArthur River Mine, Report to the Minister for Primary Industry and Resources.

Government Gazette S35. Available at: https://nt.gov.au/__data/assets/pdf_file/0004/198625/S35-2012.pdf

Harrison, L., McGuire, L., Ward, S., Fisher, A., Pavey, C., Fegan, M., Lynch, B. (2009): Natural Heritage Trust (Australia). Northern Territory Department of Natural Resources, Environment, The Arts And Sport. Biodiversity Conservation Unit.

IECA (2008): International Erosion Control Association, Best Practice Erosion and Sediment Control.

LWBC – Land and Water Biodiversity Committee (2003): Minimum Construction Requirements for Water Bores in Australia V2.

Nathan River Resources (2024), Nathan River Project Dredging Monitoring and Management Plan.

Nathan River Resources (2024), Nathan River Project Mining Management Plan.

Simpson and Batley (2016), Sediment Quality Assessment, A Practical Guide, second edition.

Zaar, U. (2009): Gulf Water Study – Limmen Bight & McArthur Rivers Region. Report 17/2009D, Northern Territory Government.

Appendix A

Water Management Trigger Action Response Plan (TARP)

Water Management
Trigger Action Response Plan (TARP)

Nathan River Project

Mining Operations

TABLE OF CONTENTS

1 INTRODUCTION 3

2 TRIGGER ACTION RESPONSE PLAN 5

2.1 Water Storage Operating Levels 5

2.2 Water Transfers and TARP Volumes 6

3 MONITORING 8

4 REFERENCES 9

Tables

Table 1 Water Level TARP 5
Table 2 Water Storage Operating Levels 5
Table 3 TARP Level Volumes 6

Figures

Figure 1 NRP Mine Surface Water Infrastructure 4

1 INTRODUCTION

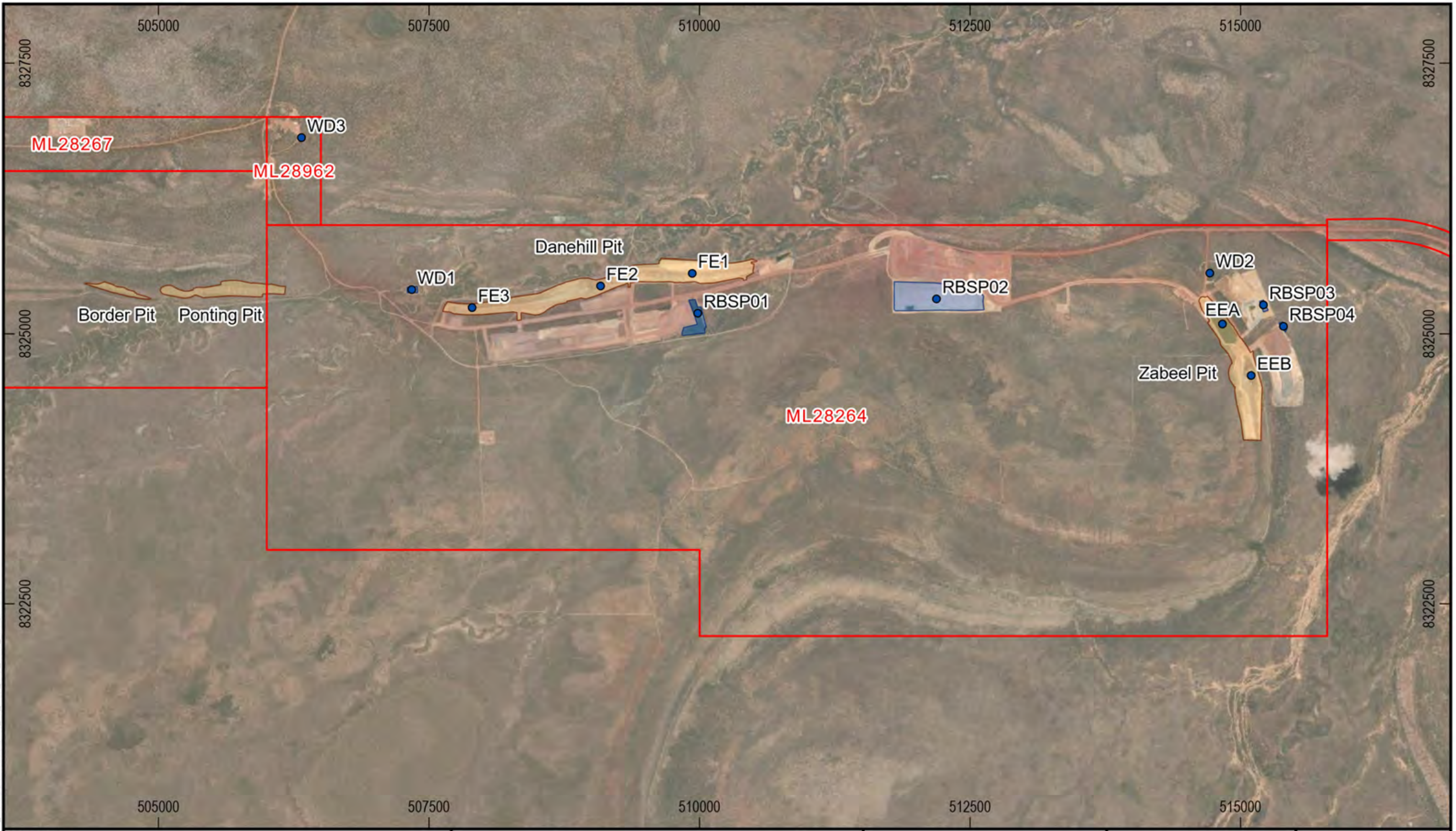
In accordance with the Variation of Authorisation (1062-01) issued for the Nathan River Project (NRP), a Trigger Action Response Plan (TARP) has been developed pertaining to the on-site water management at the NRP. This TARP specifically addresses the water management strategy to be implemented for the Mining Management Plan (MMP) period (July 2024 to July 2028), in accordance with activities outlined in the 2024 MMP.

Since the commencement of Stage 1A operations in November 2023, dewatering of the Danehill East and West pits has commenced, transferring approximately 600 megalitres (ML) of mine-affected water to the unused Zabeel South pit and RBSP02 for temporary storage. By the completion of Stage 1A, expected to be July 2024, the Danehill East pit will be completely dewatered to facilitate the next stage of mining operations as outlined in the Stage 1B MMP amendment.

Throughout Stage 1B, NRR intends to implement a range of measures which will reduce the surplus water inventory currently held within the NRP's water management system. These measures include the additions of evaporative fans and increased dust suppression (e.g. more water carts operating. In addition to this, NRR intends to apply for a new waste discharge licence for the upcoming 2024-2025 wet season which will allow for the controlled release of surplus mine-affected water to the receiving environment should specific conditions be met.

This TARP is an iterative document and focuses on the short-term water management strategy at the NRP, specifically the upcoming 2024-2025 wet season. Stage 1B operations will be commenced by this time and continue over 2024-2025 wet season. Hence, this TARP directly assesses water management for this period, with references to the overarching 2024-2028 MMP period.

NRR's highest priority over the MMP period is water management, avoiding any uncontrolled mine water discharges to the receiving environment. **Figure 1** presents the location of the main water storages at the NRP.



Legend

🟥 ML Boundary

● Water Storages

Proposed Infrastructure

▨ Pits

▨ Sediment Ponds and Water Dams

Source: Nathan River Resources 2021-2024, METServe 2024, Maxar.

Nathan River Project

NRP Water Storages

0 0.5 1 1.5

Kilometers

Scale: 1:50,000 (A4)

20/06/2024

N

Datum: GDA2020
Projection: MGA53

FIGURE 1

METSERVE
Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\BM001 Nathan River\ArcGIS\Project_Files\Projects\MMP\BM001_NR_MMP_NRP_Water_Storages.aprx

2 TRIGGER ACTION RESPONSE PLAN

Trigger Action Response Plans (TARP) are a useful adaptive management tool which assist in managing scenarios that differ from normal conditions. Condition 19 of the Variation of Authorisation 1062-01 outlines the Operator must develop and adhere to the TARPs for the site. A TARP should explicitly outline a minimum set of actions which must be enacted in response to exceedance/s of nominated criteria developed using a tiered system as a function of increasing risk. This TARP aims to assist with the management of the NRP's key water storages throughout operations, including actions with the intent of mitigating the risk of uncontrolled discharges to the receiving environment whilst facilitating mining operations.

This TARP incorporates information from the revised water balance completed for the 2024 MMP (WRM 2024). Four tiered levels are used in this TARP, each with a scenario description and a corresponding action which must be implemented in response. **Table 1** outlines the levels used in this TARP.

NRR does intend on applying for a waste discharge licence (WDL) prior to the 2024-2025 wet season. However, given the WDL has not been issued yet, this TARP conservatively assumes a WDL is not granted for the 2024-2025 wet season. Should this assumption change, the TARP will be updated accordingly.

Table 1 – TARP Level Descriptions and Actions

TARP Level	Description	Action
Level 1	Stored volume is less than Upper Operating Level (UOL).	Pumped inflows can occur at this level.
Level 2	Stored volume is greater than UOL and less than Maximum Operating Volume (MOV).	Early warning – cease pumped inflows from other storages unless otherwise specified in another TARP. Identify potential receiving water storages for pumped outflows should Level 3 be triggered.
Level 3	Stored volume is greater than MOV but less than Full Storage Level (FSL).	Imminent risk – commence pumped outflows immediately to other water storages.
Level 4	Stored volume is greater than FSL.	Uncontrolled discharge of water – undergo monitoring and reporting procedures.

2.1 Water Storage Operating Levels

Table 2 presents the Upper Operating Level (UOL), Maximum Operating Volume (MOV) and Full Storage Level (FSL) for each water storage within the NRP Water Management System. Operating levels for all open-cut pits reflect the water volumes which are required to facilitate mining operations planned for Stage 1B operations. Should any of the pits exceed their corresponding MOVs, mining activities may be impacted.

Table 2 – Water Storage Operating Levels

Levels	Zabeel South	Zabeel North	Danehill East	Danehill West	RBSP01	RBSP02
Upper Operating Level (UOL)	1,183 ML[1]	0 ML	0 ML[1]	771 ML	NA	453 ML
Maximum Operating Volume (MOV)	1,250 ML[1]	0 ML	0 ML[1]	771 ML	94 ML	604 ML
Full Storage Capacity (FSL)	1,307 ML	802 ML [4]	1,300 ML [2]	982 ML	104 ML [3]	762 ML

1 *Level to facilitate mining activities.*
2 *Mining activities to be impacted.*
3 *FSL volume at the point which RBSP01 will overflow to adjacent irrigation area.*
4 *FSL volume at the end of Stage 1A mining operations.*

NRR intends to utilise RBSP02 as a water storage during the MMP period. After meeting the requirements of the authorisation and DITT's acceptance of such documents, RBSP02 was commissioned in April 2024. RBSP02 will receive mine-affected water from either the Danehill pits or Zabeel South during the MMP period with a MOV capacity of approximately 604 ML. Water stored in RBSP02 will be utilised for dust suppression within the processing area on the ROM.

2.2 Water Transfers and TARP Volumes

Dewatering from both Danehill East and West pits has commenced in Stage 1A, transferring mine-affected water to the Zabeel South pit and RBSP02 for temporary storage. Stage 1B mining operations require the Danehill East pit to be dry, whilst continuing to use the Danehill West pit as a key water storage at the NRP. At the completion of saddle mining in Stage 1A, a portion of the saddle separating the two Danehill pits will remain, leaving capacity in the the Danehill West pit to store mine-affected water without impacting mining activities. In order to do this, water volumes in the Danehill West pit must be maintained below the MOV of 771 ML. The implemented MOV allows 3 m freeboard (or an additional ~210 ML) before water from the Danehill West pit overtops the saddle and enters the Danehill East pit. If this was to occur, mining activities in the Danehill East pit would be impacted.

Table 3 presents the TARP levels and the associated water volumes for the key water storages at the NRP over the Stage 1B operating period (July 2024 - October 2025). Certain water storages outlined in **Table 3** have not been assigned level 1 or 2 volume triggers because these storages are not expected to receive pumped inflows during this period (a requirement of the Level 1 and 2 TARP). Only Zabeel South, RBSP01 and RBSP02 are planned to receive pumped inflows, hence have Level 1 and 2 TARP levels assigned in **Table 3**. Zabeel North and both Danehill pits will not receive pumped inflows unless dewatering from another storage is required under this TARP. Level 3 and 4 volume triggers have been assigned to these storages in order to mitigate the risk of uncontrolled discharge should extremely wet conditions occur.

Table 3 – TARP Level Volumes

TARP Level	Zabeel South	Zabeel North	Danehill East	Danehill West	RBSP02
Level 1	< 1,183 ML	NA	NA	NA	< 453 ML
Level 2	1,183 – 1,250 ML	< 1	< 1	< 771	453 – 604 ML
Level 3	1,250 – 1,307 ML	1 – 802 ML	1 – 1,300 ML	771 - 982 ML	604 – 762 ML
Level 4	> 1,307 ML	> 802 ML	> 1,300 ML	> 982 ML	> 762 ML

The water management strategy at the NRP aims to operate all water storages below their corresponding MOV, reducing the risk of uncontrolled discharges to the receiving environment along with facilitating mining operations. In the instance whereby a water storage has triggered TARP Level 3, NRR will commence pumped outflows from the Level 3 storage to another NRP water storage which remains below its MOV (Level 1 or Level 2).

The following water storages, ranked in order of priority, should receive pumped inflows in the event of a storage triggering Level 3:

1. RBSP02;
2. Zabeel South Pit;
3. Zabeel North Pit;
4. Danehill West Pit; and
5. Danehill East Pit.

Once water transfers are underway, transfers will continue until one of the following occurs:

- The source storage water volume returns below its MOV; or
- The receiving storage triggers its UOL.

TARP levels have not been assigned to RBSP01 as it is an active sediment basin by which overflows report to the adjacent irrigation area and the Danehill East pit. Given RBSP01 is used as the main water supply for operational dust suppression with the water volume typically declining, it is not anticipated to overflow to the Danehill East pit.

3 MONITORING

In order to for this TARP to be implement and actioned, water storage volumes informing this TARP must be frequently updated. NRR currently collects weekly water volume surveys across mine water storages, along with additional surveys after large rainfall events. Once updated water volumes are collected, the TARP is reassessed to indicate if a water storage's TARP level has changed. Should a water storage's TARP level change, all operational stakeholders will be inform of the change and the subsequent change in action as per the TARP. MOV indicators (starpickets) will be installed at each water storage allowing for the visual comparison of the water level to the MOV.

Monitoring of water volumes and inspection of all mine water infrastructure will occur frequently throughout the Stage 1B operating period and the 2024-2024 wet season. All water transfers will utilise flow meters to record flow and transfer volumes and will be recorded in a log along with source and destination of each transfer. Along with water transfer record keeping, water storages and associated infrastructure (i.e. pipeline, holding tanks) across the mine will be frequently inspected and maintained to ensure no uncontrolled discharges to the receiving environment. Along with frequent infrastructure inspections, monthly water quality monitoring of mine water storages will continue as outlined in the Water Management Plan (NRR 2024).

4 REFERENCES

Nathan River Resources (2024), NRP Water Management Plan (WMP).

WRM (2024) Nathan River Water Balance Report.