Metalliferous Drainage Management Procedure

CRL-ENV-PRO-022-19

+61 8 6245 2050 info@calidus.com.au
Suite 12, 11 Ventor Ave West Perth WA 6005 AUSTRALIA
calidus.com.au

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CRL-ENV-PRO-022-19
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1	Internal Review	Rory Haymont - Trajectory	Kate George – Rapallo	Paul Brennan - Calidus	17 September 2019
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Calidus Resources Limited
ACN 006 640 553
PO Box 1240
West Perth WA 6872
Australia 6005
+61 8 6245 2050
info@calidus.com.au
https://www.calidus.com.au/

This document has been prepared based on assumptions as reported throughout and upon information and data supplied by others.

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1 Introduction

The Metalliferous Drainage Management Procedure has been prepared as part of the environmental approval documentation for the assessment of Calidus Resources Limited's (Calidus) Warrawoona Gold Project (WGP) .

1.1 Purpose

The purpose of this Management Procedure is to specify metalliferous drainage identification, segregation, encapsulation and monitoring procedures to minimise the impact on surface water values. It is intended to be used as part of an overall framework to plan works and mitigate the environmental risks associated with the WGP.

1.2 Scope

This procedure applies to all Calidus controlled sites and their activities, employees, contractors and visitors, and is subject to the requirements of the Calidus Health, Safety and Environment (HSE) Standards and applicable environmental legislation.

1.3 Context

The environmental risks associated with metalliferous drainage management at the WGP include:

- Potential impacts to surface water quality associated with leaching of metalliferous drainage from temporary or permanent mine waste storage facilities during operations and following closure;
- Potential impacts to revegetation due to metals toxicity;
- Potential impacts due to introduction of metals into the food chain via revegetation.

Section 4 provides the management actions proposed to manage these potential environmental risks at the WGP.

1.4 Definitions

Term	Definition
WRD	Waste Rock Dump
pXRF	Portable X-ray fluorescence analysers
NAF	Non-Acid Forming
Nickel Arsenic Zone (NAZ)	The zone of NiAs-rich waste rock that leaches soluble Nickle and Arsenic.

2 Responsibilities

All Calidus employees and contractors are required to comply with the requirements of this procedure.

Accountability for fulfilling the requirements of this procedure is dependent on the stage of Project development (exploration, construction, operations, decommissioning).

During construction stages, whether activities are undertaken by an external service provider or internal Calidus personnel, the Project Manager / Registered Manager will be accountable for ensuring the requirements of this procedure are met.

During operational, decommissioning and closure stages, the General Manager (Registered Manager) will be accountable for ensuring the requirements of this procedure are met.

Table 1: Responsibilities

Role	Responsibility
Exploration Manager/ Project Manager / Registered Manager/ General Manager	Accountable for ensuring the requirements of the procedure are met dependent on the stage of project development.
Mining Department Supervisor	Implement and maintain the Metalliferous Drainage Management Procedure and associated Standard Operating Procedures Review the Metalliferous Drainage Management Procedure and associated Standard Operating Procedures Annual Audit of Compliance Organise the review and update of this Metalliferous Drainage Management Procedure annually Implement monitoring programs Maintain monitoring records Deliver monitoring/reporting data to the Environmental Department Implement and deliver awareness training programs to personnel, contactors and visitors
Warrawoona Environmental Advisor	Implement and deliver awareness training programs to personnel, contactors and visitors

Role	Responsibility
	Deliver monitoring/reporting data to the appropriate regulatory authority
Construction and Operation Managers	Endorse implementation of the Metalliferous Drainage Management Procedure by Project personnel and contractors
All personnel, contractors and visitors	Participate in awareness training prior to commencing duties Metalliferous Drainage Management Procedure in daily activities, where relevant

3 Background

The WGP is located along the Warrawoona Ridge which forms the local surface water divide with the Brockman Hay Cutting/Sandy/Camel Creek system located to the south of the ridge and the Brockman Creek to the north. The Brockman Hay Cutting/Sandy/Camel Creek reports directly to the Coongan River, approximately 20km west of the WGP.

The combined catchment area is in the order of 1.43km^2 which represents 0.02% of the total Coongan River catchment.

There are no permanent pools within the Brockman Hay Cutting/Sandy/Camel Creek system or Brockman Creek catchments and the creeks directly below the proposed minesite are ephemeral in nature.

A geochemistry study and analysis of the Klondyke and associated deposits of waste material containing Ni values greater than 1,000ppm combined with As values over 100ppm has been identified as having the potential to cause adverse environmental effects (GCA, 2019).

3.1 Baseline Modelling/Sampling

3.1.1 Characterisation and Classification

Consistent with the DMIRS Draft Guidelines on Materials Characterisation, geochemical Characterisation was undertaken for all waste rock types at WGP. The lithotypes were not found to be acid generating, however neutral drainage of NiAs-rich waste rock was identified and static and kinetic testing confirmed that soluble Nickle and Arsenic have the potential to be leached from the waste rock.

The characterisation program involved the selection of 209 waste rock samples for static testing from which a representative subset of 62 samples, both waste rock and ore, were selected for a second phase of testing and analysis including kinetic testing on some lithotypes.

The pervasive carbonate-alterations which is strong to very strong with negligible sulphate results in all lithologies being classified as Non-Acid Forming (NAF).

One lithological unit, the Nickel Arsenic Zone (NAZ), was identified through the testing program to have the potential to produce neutral mine drainage. These findings were further refined with multi week humidity cell testing. The leachates underwent multi element analysis which indicated a range of metals enrichments with Nickle and Arsenic identified as constituents of concern.

The recommended segregation criteria to segregate NAZ-waste was that where both Total-As ≥ 100 mg/kg, and Total-Ni ≥ 1,000 mg/kg these materials should be segregated for encapsulation.

With respect to Tailings, these classify as NAF and have modest Arsenic elevations, Secondary Fe/Ca-arsenates formed during weathering should constrain tailings-pore-fluid-As concentrations to within the sub-mg/L range.

3.1.2 Modelling and Prediction

A Nickel Arsenic NAZ-waste block model has been developed by Calidus for the entire Klondyke deposit based upon geochemical analysis of RC and diamond drillholes. This provides 3D spatial

locations the location of the NAZ-waste within the mine plan and is shown below as red in plan view, Figure 1.

A handheld portable X-ray fluorescence analyser (pXRF) has been used as a screening tool to identify rock volumes with elevated Ni and As contents. The results are stored as 3D block model attributes, allowing for deposit-wide prediction of adverse material to be continuously calibrated.

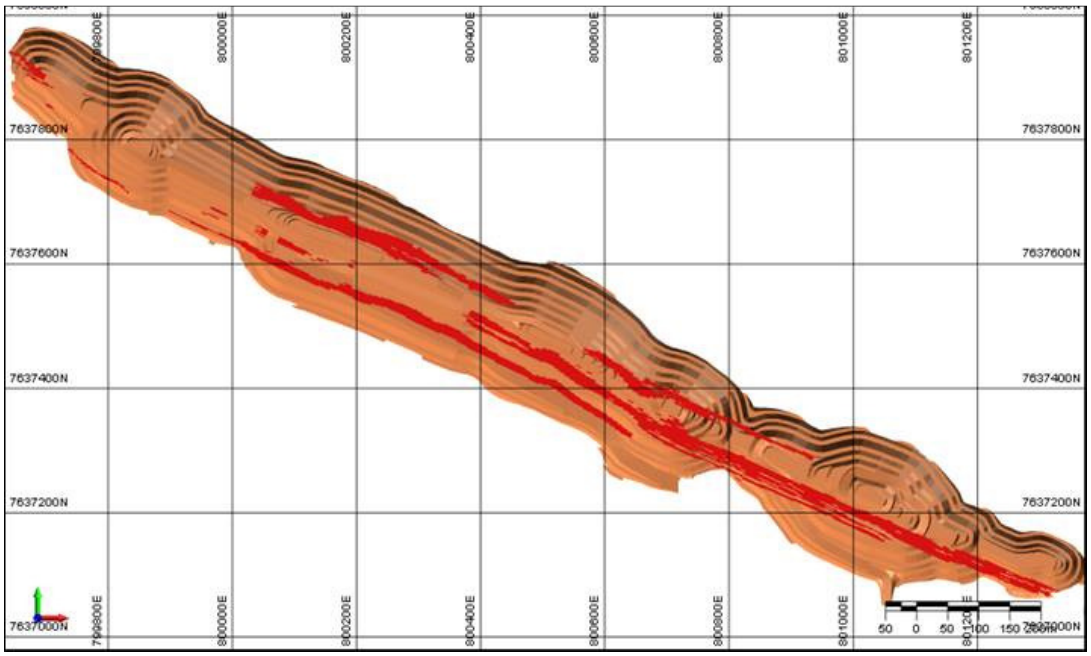

Figure 1 - NAZ-waste model locations in Klondyke Open Pit (Red)

The waste block model currently predicts the occurrence of NAZ. Approximately 8-10% of the total waste rock has been classified as NAZ-waste rock. The NAZ waste block model will be continuously refined as outlined below

4 Waste Rock Metalliferous Drainage Management

Source controls will be deployed waste rock such that it is effectively encapsulated.

4.1 Identification and Segregation

During mining, the NAZ-waste model will be updated on a regular basis from close-spaced grade control drilling programmes from within the pit (approximately 6m x 6m grid with samples collected each metre downhole), or using samples from blast hole rigs if coverage over the waste zones is not sufficient from the grade control drilling.

The NAZ-waste model will be incorporated in “flitch plans” which outline the respective mining blocks on each bench within the pit showing location and mineral concentration variability.

Where a mining block is predicted to contain NAZ-waste, geological technicians (“ore spotters”) will be used on the pit floor utilising pXRF machines to verify the 3D data which will be uploaded to the excavator using GPS. This will ensure that additional waste material is not sent to the

NAZ-waste encapsulation cell(s) and these are maintained for NAZ-waste only. Utilisation of the pXRF field-based tool will allow for geological staff to characterise waste materials ensuring a high degree of confidence to waste management.

4.2 Storage and Encapsulation

4.2.1 Encapsulation Methodology

The Management of NAZ-waste rich material will occur either via:

- back fill into an existing pit over which an infiltration limiting, water shedding earthen cover will be constructed; and/or
- encapsulation within an impermeable synthetic liner.

The majority of the NAZ-waste will be backfilled into the St George pit which will be completed in advance of the Klondyke Pit. St George consists of two shallow above water table pits and preliminary waste characterisation indicates that the St George waste rock is low in NAZ-waste.

A minor volume of material from the remaining pits may require encapsulation within Waste Rock Dumps (WRD). Where minor occurrences of NAZ-waste are identified in any pit (as per the process outlined above), they will be managed in with one of the two methodologies outlined above and described below.

4.2.2 Encapsulation Specifications In-Pit Storage

For the in-pit storage methodology, NAZ-waste will be backfilled into the St George open pit, and is likely to be comingled with benign material. The NAZ-waste will be placed to a depth not more than 2m below the pits lowest point in the landscape.

Benign waste rock, of the highest fines content available on the site will be placed over the open pit in two paddock dumped layers, each layer being compacted with a heavy dozer.

More waste will be placed until there is a minimum one-degree grade away from the centroid of the pit such that it is a free draining landform. Local plant root depths are generally <4m, however only shallow rooted species will be seeded in this location.

4.2.3 Storage with a Synthetic Liner

Where encapsulation within a WRD is required, a traffic compacted layer will be prepared on the WRD surface not less than 2m from the contact with natural ground. A synthetic liner will be laid on the base and with dumping, will be progressively joined up the walls until the target plan volume has been achieved.

The liner will be extended over the NAZ-waste cell and the entire cell sealed for permanent encapsulation. The cell will not come within 4m of the top surface and 5m of any side surface.

As an alternative to the synthetic liner being laid on the base, discussion with DMIRS has identified the potential use of the benign tails as a material to be used. Tails could also be used on the top of the liner as a cushion prior to covering with durable waste rock.

4.3 QA/QC

A Standard Operating Procedure for NAZ-waste rock management will include the specifications for storage and the frequency of quality controls. The controls will include:

- Depth measurement compacted layer (minimum 2m);
- Total depth of cover layer (minimum 4m);
- Water shedding grade of cover (Minimum 1 degree);
- Depth of WRD storage Cell from natural ground (minimum 2m);
- Integrity of synthetic liner welds and surfaces (no failed welds or tears);
- It will be assigned to the Mining Department supervisor to carry out and record these checks on a weekly basis;
- Survey of the volume of NAZ-waste storage in the St George Pit and WRD Encapsulation Cells to reconcile plan versus actual storage. This will occur monthly or sooner if required.

4.4 Adaptive Management

Calidus will implement adaptive management practices to learn from the implementation of mitigation measures, monitoring and evaluation against management targets, to more effectively meet the objectives for surface water management.

The monitoring program will be adaptive, dependent on flow events and the quality and quantity of data collected with innovations in monitoring techniques and methodologies incorporated into program design over time.

5 Monitoring

The objective of this metalliferous drainage management procedure is to ensure that this material will not leach into the environment. Calidus is instigating procedures for both surface and groundwater monitoring (CRL-ENV-PRO-021-19 Surface Water Monitoring Procedure and CRL-ENV-PRO-021-19 Ground water Monitoring Procedures).

This monitoring utilises baseline/ambient water quality as the guidelines for trigger values and will be applied at groundwater and surface water monitoring points specified in the monitoring procedure.

Where these trigger values are exceeded an investigation will be undertaken and remedial action initiated if required.

6 Reporting

Monitoring reports will be provided to the State and Commonwealth Governments as annual reporting requirements.

6.1 Annual Review

An Annual Monitoring Report will be developed with the results of the monitoring programs across the WGP. This report will outline the monitoring data captured during the reporting period and the analysis required to report compliance against management targets and conditioned environmental objectives.

6.2 Annual Environment Monitoring Report

An Annual Environmental Monitoring Report (AEMR) will be submitted in accordance with the relevant licence conditions once the WGP is approved and a licence is issued.

7 Related Documentation:

CRL-ENV-PRO-021-19 Surface Water Monitoring Procedure

CRL-ENV-PRO-021-19 Ground water Management Procedure

8 References

GCA (2019) Warrawoona Project: Geochemical Characterisation of Tailings-Slurry Sample and Implications for Tailings Management

GCA (2019) Warrawoona Project: Characterisation of Mine-Waste & Ore Samples (Klondyke and Copenhagen Pits) –Implications for Mining-Stream Management

Groundwater Resource Management (2019). Hydro-Meteorological and Surface Water Management Study Warrawoona Gold Project Pre-Feasibility Study