CALIDUS
RESOURCES LIMITED

Surface Water Monitoring Procedure

CRL-ENV-PRO-020-19

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CRL-ENV-PRO-020 -19
2 October 2019

Rev	Revision Details	Prepared	Reviewed	Authorised	Date
1	Internal Review	P. Brennan - Calidus	K.George – Rapallo	Paul Brennan - Calidus	29 August 2019
2	Rev0	K.George	P. Brennan	Paul Brennan	9 September 2019

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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 surface water management procedure has been prepared as part of the environmental management of Calidus Resources Limited's Warrawoona Gold Project (WGP).

1.1 Purpose

The purpose of this procedure is to identify surface water management and monitoring procedures to minimise the impact on surface water dependent systems to be retained from disturbance. 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 surface water management at the WGP include:

- Potential impacts to surface water quality associated with the placement of infrastructure;
- Potential impacts to surface water quality associated with leaching of metalliferous drainage from temporary or permanent mine void water bodies, open pit mining void walls, tailing storage facilities and waste dumps (including arsenic waste containment); during operations and following closure;
- Altered hydrologic water balance associated with the creation of mining voids;
- Permanent modifications to existing catchments and associated impacts to flow paths and inundation areas of surface water streamflows;
- Impacts to surface water quality associated with hydrocarbon and chemical spills.

Section 3 provides the management actions proposed to manage these potential environmental risks at the WGP.

1.4 Definitions

Term	Definition
ANCOLD	2017 Guidelines for Design of Dams and Appurtenant Structures for Earthquake. Australian National Committee on Large Dams.
Annual Exceedance Probability (AEP)	The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year
Average Recurrence Interval (ARI)	The average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration. It is implicit in this definition that the periods between exceedances are generally random
Australian Rainfall and Runoff (ARR)	National guideline document, data and software suite that can be used for the estimation of design flood characteristics in Australia
Channel	An artificial or constructed waterway designed to convey water
Discharge	Volume of liquid flowing through a cross-section in a unit time
DMIRS	Department Mining, Industry Regulation and Safety
Ephemeral	Something which lasts for a short time. Typically used to describe rivers, lakes and wetlands that are intermittently dry
Floodplain	Flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding
Probable Maximum Flood (PMF)	The PMF is the largest flood that conceivably occur at a particular location, usually estimated from probable maximum precipitation (PMP) and coupled with the worst flood producing catchment conditions
Probable Maximum Precipitation (PMP)	The theoretically greatest depth of precipitation for a given duration under modern meteorological conditions for a given size storm area at a particular location at a particular time of the year with no allowance made for long term climatic trends
Rainfall	The total liquid product of precipitation or condensation from the atmosphere as received and measured in a rain gauge
Surface Runoff	Water from precipitation or other sources that flows over the land surface. Surface runoff is the fraction of precipitation that does not infiltrate at the land surface and may be retained at the surface or result in overland flow toward depressions, streams and other surface water bodies
Total Suspended Solids (TSS)	The sum of all particulate material suspended in water. Usually expressed in term of milligrams per litre (mg/L). It can be measured by filtering and comparing the filter weight before and after filtration
Nickel Arsenic Zone (NAZ)	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 exploration, the Exploration Manager will be accountable for ensuring the requirements of the procedure are met.

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.
Senior Environmental Advisor	Implement and maintain the Surface Water Management Procedure Review the Surface Water Management Procedures Annual Audit of Compliance. Organised the review and update, of this surface water management procedure annually Deliver monitoring/reporting data to the appropriate regulatory authority
Warrawoona Environmental Advisor	Implement monitoring programs. Maintain monitoring records. Implement and deliver awareness training programs to personnel, contactors and visitors.
Construction and Operation Managers	Endorse implementation of the surface water management procedures by Project personnel and contractors.
All personnel, contractors and visitors	Participate in awareness training prior to commencing duties. Implement Surface Water Management Procedures 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 Brockman Creek reports to the Talga River about 35km to the north of the site, which continues for some further 20km before also discharging into the Coongan River. The Coongan River reports to the De Gray River about 100km north of the WGP which continues in a north-westerly direction for approximately 80km before ultimately discharging into the Indian Ocean at Poissonnier Point north-east of Port Hedland.

The WGP and the Brockman Hay Cutting/Sandy/Camel Creek system and Brockman Creek are located centrally within DWER Coongan River Catchment (area = 7,080km^2) which itself is situated within the larger De Gray River Basin (area = 56,800km^2).

Although located within the Pilbara Surface Water Area, inspection of the DWER Spatial database indicated that neither of the creek systems within the vicinity of the WGP intersects any proclaimed Surface Water Management Area of Irrigation Area. Inspection of the 1:250,000 scale topographical mapping indicates that there are no permanent pools within the Brockman Hay Cutting/Sandy/Camel Creek system or Brockman Creek catchments.

While there is a sparsity of flow gauging data across the region, the Coongan River and both creek systems in the vicinity of the WGP are typical of rivers in the Pilbara that they are both ephemeral and only carry runoff following significant rainfall events. Typically over three quarters of the annual streamflow occurs during January, February and March with local rivers usually drying up around July or August.

3.1 Baseline Modelling/Sampling

Initial baseline modelling for surface water hydrology has been conducted as part of the surface water impact assessment to obtain a representative baseline dataset of the site hydrology.

The key findings of the modelling are as follows:

- There are several relatively minor ephemeral watercourses and drainage lines that cross the WGP site on the south side of the Warrawoona ridge which align in northeast to southwest direction, the most significant of which are Brockman Hay Cutting Creek and Sandy Creek;
- Given that the majority of the proposed mining areas are situated within the Warrawoona Ridge with some 80m relief and in the headwaters of both the Brockman Hay Cutting Creek and Sandy Creek, the catchment areas upstream of the proposed project facilities are very limited and impacts on the hydrological regime downstream are expected to be minimal;
- A preliminary quantitative assessment of potential impacts indicates that run off from approximately 2.3% and 0.2% of the Brockman Hay Cutting Creek and Sandy Creek areas will be lost to downstream catchments. The combined area is in the order of 1.43km^2 which represents 0.02% of the total Coongan River catchment. Post mining runoff volumes that will report downstream from Brockman Hay Cutting Creek and Sandy

Creek catchment areas is estimated to be 97.7% and 98.8% of the pre-mining volume respectively for the same event.

Monitoring Parameters and methods are detailed in Section 5.

Refer to GRM (2019) for the full hydrological description for the project.

4 Surface Water Management

The Warrawoona Gold Project will have a negative water balance and will harvest runoff as part of process water requirements. WGP is located at the top of the catchment where surface water flows are lowest. Post mining runoff volumes that will report downstream from Brockman Hay Cutting Creek and Sandy Creek catchment areas is estimated to be 97.7% and 98.8% of the pre-mining volume respectively for the same event.

Source controls will be deployed within pits, waste rock dumps, topsoil stockpiles, ROM, TSF and access and haul roads in order to improve runoff quality. Runoff from such facilities will be directed to sedimentation traps, sumps and ponds.

4.1 Process Plant Area

Runoff within wet processing areas will be collected within bunded areas and returned to the process plant.

4.2 Mine Services/Workshops Area

The Mine Services/Workshop Area will include surface water runoff and wash down water drainage and recovery systems. Surface water runoff and wash-down water will be captured in open drains which report to sedimentation ponds for temporary storage and monitoring prior to reuse. Drains in areas potentially impacted by hydrocarbons will first report to an oil water separator.

4.3 Hazardous Materials Storage Areas

All chemical, oil and other hazardous material storage areas within the processing plant or mine services/workshops area will be enclosed within bunds with the relevant codes and standards. Water collected within bunds will be assessed and if suitable will report to water management/sedimentation Ponds for recycling back to the plant. Oily water will be disposed at the site bioremediation facility (where present) or taken off-site by a licenced controlled waste carrier.

Refer to CRL-ENV-PRO-004-19 for the Hydrocarbon Procedure and CRL-ENV-PRO-005-19 Hydrocarbon (and Chemical) Spill Management Procedure

4.4 Waste Rock Dumps

All waste rock dump tops and upper surfaces will be back-graded and/or edge bunding used to ensure positive drainage and to prevent runoff from reporting over dump crests and eroding dump slopes. Intermediate benches on dumps will be back-graded to break up long slope lengths.

During operations the Klondyke Waste Rock Dump will be contoured so that water shed reports to the TSF to allow for water recovery through the reclaim pond. At closure water will report to the open pit.

The Copenhagen Waste Rock dump will constructed so that the pit can be backfilled at closure.

A Metalliferous Drainage Management Plan was been prepared to specify metalliferous drainage identification, segregation, encapsulation and and monitoring procedures for waste rock streams containing the NiAs rich material (CRL-ENV-PLN-005-19 – Metalliferous Drainage Plan)

4.5 Tailings Storage Facility

The proposed TSF at the WGP is a valley type facility whereby a cross valley containment embankment approximately 17 m high and 250 m long will be constructed across the alignment of an ephemeral drainage line (Brockman Hay Cutting Creek). The tailings impoundment within the valley is approximately 750 m wide and 2.3 km long with an area of approximately 140 ha. Tailings will be discharged down valley from an elevated location approximately 1.5 km to the north west of the proposed processing plant.

The facility catchment is approximately 5.8 km^2 which comprises the tailings storage area, the natural catchment on the valley sides and part of the proposed waste dump area.

The cross-valley embankment will be constructed in two stages. Stage 1 will provide storage for approximately 3 years and the Stage 2 embankment will be commissioned in Year 4.

Based on a determined risk classification of Category 1 (DMIRS) [1] and 'Significant' (ANCOLD) [2], the embankment has been sized to provide storage capacity for tailings and excess storm water in accordance with the relevant guidelines. Provision has been made for storage of 1:10 AEP excess wet season runoff and 1:100 AEP, 72-hour storm runoff together with contingency freeboard allowances. Each construction stage will also incorporate an emergency spillway cut through competent rock. The Stage 2 spillway is sized to pass PMF storm events, satisfying post closure water management requirements.

A normal operating pond: a "nominal" operating pond depth of 0.8 m has been assigned to the TSF (based on water balance assessment of median pond volume) with total freeboard: a minimum of 1.0 m.

CN_{FREE} and CN_{WAD} levels will be monitored in the processing plant to provide information relevant to process control and cyanide destruction.

CN_{WAD} samples will be taken of the cyanide destruct feed, discharge streams and the reclaim pond.

The TSF is addressed further in the Cyanide Monitoring Procedure (CRL-ENV-PRO-019-19).

4.5.1 TSF Reclaim Water

TSF reclaim water is pumped straight from decant to thickener and then overflow reports to process water tank.

4.5.2 Diversions

All practical steps will be taken to divert runoff from undisturbed areas around all proposed mine facilities to minimise potential lowering of water quality. Diversion channels around mining areas will be designed for the 1:100 AEP event of for the 1:10 AEP event for diversions around less sensitive facilities. Flow velocities along all diversion channels will be limited to minimise erosion and the generation of sediment.

4.5.3 Closure

Surface water management at Closure will include the diversion of runoff from undisturbed areas around rehabilitated mining areas, while maximising runoff from disturbed catchment areas that can be directed in-pit. All waste rock dump tops and upper surfaces will be graded in order to promote infiltration where possible. An engineered spillway will be constructed on the abutment of the TSF embankment and will be designed to safely pass the peak of the PMF event.

4.6 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

5.1 Water Quality

A set of preliminary monitoring parameters have been selected to provide broad coverage of different mining related impacts and it is anticipated that monitoring procedures will be refined over the life of the mine and into closure to focus on runoff areas from the final landforms and monitoring of pit voids.

Monitoring will utilises baseline/ambient water quality as the guidelines for trigger values and will be applied at surface water monitoring points specified in The monitoring will utilise baseline/ambient water quality as the guidelines for trigger values. Where these trigger values are exceeded an investigation will be undertaken and remedial action initiated.

Table 2.

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.

Field Analysis

Field Analysis will comprise field instrument measurement of physicochemical properties (EC, pH, DO, temperature and salinity). Field measurements are be taken as per the Department of Water – Field Sampling Guideline: A guideline for field Sampling for surface water quality monitoring programs (DoW 2009).

Laboratory Analysis

The following general groups of water quality parameters will be measured at surface water monitoring sites,:

- major cations;
- major anions;
- nutrients (Camp WWTP sampling areas);
- metals and metalloids; and
- Total and WAD Cyanide (TSF sampling areas– as per Cyanide Monitoring Procedure (CRL-ENV-PRO-019-19) and
- hydrocarbons (process plant only).

Water sampling to be conducted as per:

- AS/NZS 5667.1: 1998 Water Quality Sampling – Guidance on the design of sampling programs, sampling techniques and preservation and handling of samples.
- Department of Water – Field Sampling Guideline: A guideline for field Sampling for surface water quality monitoring programs.
- Laboratory analysis to occur at an appropriate NATA accredited laboratory.

5.2 Surface Water Flow

Two data loggers will be installed on the project to monitor surface water flow.

Datalogger 1 will be located downstream of the TSF on Brockman Hay Cutting Creek. The purpose of datalogger 2 will be to monitor potential impacts of the proposed TSF to the surface flows of Brockman Cutting Creek.

Datalogger 2 will be further downstream at convergence of the Brockman Hay Cutting Creek and Sandy Creek The purpose of datalogger 2 will be to monitor potential impacts of the proposed TSF to the surface flows of Brockman Cutting Creek where it flows into the larger Sandy Creek.

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 plan.

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

5.2.1 Surface Water Quality

Creek line Drainage

As there are no permanent pools on the project area drainage line surface water quality monitoring will be taken oportunistically after flow events (defined as visual streamflow across a floodway or down a drainage system).

Infrastructure Area Drainage

Pit Water

During operation surface water and groundwater entering the pit area(s) will be collected within an in-pit sump system. The water quality within pit sumps will be field monitored for suspended solids, pH and EC on a regular basis prior to being recycled back to the plant via the reclaim pond. The reclaim pond will be regularly monitored for arsenic. suspended solids, pH and EC

At closure water will report to the open pit. Open pit water quality monitoring will be addressed in the Closure Plan.

Waste Rock Dumps

During operations the Klondyke Waste Rock Dump will be contoured so that water shed reports to the TSF to allow for water recovery.

Monitoring of NAZ waste is addressed further in the described in the Metalliferous Drainage Management Procedure.

Tailings Storage Facility

Run-off from disturbed and undisturbed catchment areas upstream of the TSF will report to the decant. Excess decant water is pumped from the decant to thickener and overflow reports to process water tank.

CN_{FREE} and CN_{WAD} levels will be monitored in the processing plant to provide information relevant to process control and cyanide destruction.

CN_{WAD} samples will be taken of the cyanide destruct feed and discharge streams and the decant pond.

The TSF is addressed further in the Cyanide Monitoring Procedure (CRL-ENV-PRO-019-19) .

Waste Water Treatment Plant

Monitoring of the surface water quality at the Wastewater Treatment Plant will occur as per Wastewater (WWTP) Management Plan CRL-ENV-PLN-002-19).

5.3 Sampling Summary

A summary of the monitoring programme is found in Table 2. The monitoring will utilise baseline/ambient water quality as the guidelines for trigger values. Where these trigger values are exceeded an investigation will be undertaken and remedial action initiated.

Table 2: Summary of surface water monitoring points for the Warrawoona Gold Project.

Area / Aspect	Location	Parameter	Collection Method	Frequency	Comment
Rainfall	Upper Reaches of catchments	Rainfall	Gauge	Event based	
Sedimentation basins, wash down facilities, hydrocarbon storage areas	Process Plant	Surface water quality	Field measurement using calibrated instrument and laboratory analysis (for hydrocarbons in treated water)	As required based on weekly inspection	Refer to Hydrocarbon Management Procedure (CRL-ENV-PRO-004-19)
TSF	Surface water flows Brockman Hay Cutting Creek close to TSF [1] Brockman Hay Cutting Creek at convergence into Sandy Creek	Surface water quality and flow	Data logger - Field measurement using calibrated instrument Laboratory analysis (metals and metalloids including As)	Event Based (data logger) Event based (water quality)	Refer to TSF and Cyanide Monitoring Procedure (CRL-ENV-PRO-019-19)

Area / Aspect	Location	Parameter	Collection Method	Frequency	Comment
TSF	Decant	Surface water quality	Field measurement using calibrated instrument and laboratory analysis (metals and metalloids including As)	Daily (Field measurement) and Quarterly (Laboratory Analysis)	Refer to TSF and Cyanide Monitoring Procedure (CRL-ENV-PRO-019-19)
TSF	Any leachate or seepage accessible	Surface water quality	Field measurement using calibrated instrument and laboratory analysis Field measurement using calibrated instrument and laboratory analysis (metals and metalloids including As)	Flow Event or seepage event based Field measurement and Quarterly Laboratory Analysis)	Refer to TSF and Cyanide Monitoring Procedure (CRL-ENV-PRO-019-19)
Drainage Infrastructure	Roads and culverts, diversion drains, sediment control infrastructure	Structural integrity, debris accumulation	Field Assessment	Flow event based	
Camp	WWTP on-site irrigation area	Flow rate Surface water quality	Field Assessment, Field measurement using calibrated instrument and laboratory analysis	Continuously (flowrate) Quarterly	Refer to WWTP Management Plan (CRL-ENV-PLN-002-19).
Pit	In Pit Sumps	Surface water quality	Field measurement using calibrated instrument and laboratory analysis (metals and metalloids including As)	Daily (Field measurement) and Quarterly (metals and metalloids)	Refer Metalliferous Drainage Procedure (CRL-ENV-PRO-022-19).
Drainage Lines	Development Envelope	Surface water quality	Field measurement using calibrated instrument and laboratory analysis (metals and metalloids including As)	Flow event based Field measurement and Quarterly Laboratory Analysis)	

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-004-19 Hydrocarbon Management Procedure

CRL-ENV-PRO-019-19 TSF and Cyanide Monitoring Procedure

CRL-ENV-PRO-022 -19 Metalliferous Drainage Management Procedure

CRL-ENV-PLN-002-19 Wastewater (WWTP) Management Plan

CRL-ENV-PRO-005-19 Hydrocarbon (and Chemical) Spill Management Procedure

CRL-ENV-PLN-006-19 Significant Species Management Plan

8 References

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