



Peer Review of the Surface Water Management Plan for the Jervois Base Metal Project

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Project manager:	Mike Ferguson (Gauge Industrial & Environmental Pty Ltd)			
Author(s):	Mike Ferguson (BAppSc Hon, MEnvMan)			
Client:	Nitro Solutions Pty Ltd			
Client contact(s):	Xuanyu Yang			
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1. Scope

Gauge Industrial and Environmental Pty Ltd was engaged by Nitro Solutions Pty Ltd to provide a peer review of the draft Surface Water Monitoring Program (draft SWMP), proposed for the Jervois Base Metal deposit in the Northern Territory, according to the requirements of the Northern Territory Environmental Protection Agency (NT EPA) which required the following:

“Provide a peer reviewed monitoring program capable of monitoring direct and indirect impacts of the Proposal on surface water quality at the mine site during operation and after closure. Pre-mining baseline data should establish impacts from historic mining and natural background conditions...”

As part of the supplementary Environmental Impact Statement (EIS) for the project, Nitro Solutions (on behalf of KGL) engaged the consultancy WRM Water and Environment Pty Ltd (WRM) to produce a draft SWMP (WRM, 1 July 2019), which is the subject of this peer review, completed by the author, possessing the qualifications and experience listed in Table 1 (Appendix A).

2. Introduction

Project: KGL Resources Pty Ltd (KGL) proposes to develop the Jervois Base Metal Project, a copper mine (also containing silver, gold, lead and zinc) in the Northern Territory, 270 km northeast of Alice Springs. Open cut and underground mining will extract ore for onsite processing to a copper and lead/zinc concentrate (CloudGMS, 2018) before truck and rail transportation to Darwin and/or Adelaide, over a 12 to 15-year mine life. The project is located in an area with historic mining disturbance dating back to 1929. A copper mine operated between 1963 to 1977, and mining disturbances include tailings storage dams, waste rock dumps, open cut pits, prospecting trenches, processing plant equipment and ore stockpiles (WRM, 2019).

Catchment & Climate: The project is located adjacent to Unca Creek, a tributary of Arthur Creek in the upper catchment of the Hay River basin, which flows to the south east to the Simpson Desert and eventually Lake Eyre. Other streams in the Hay River basin include the Plenty River, Marshall River and Arthur Creek. The climate is arid, with evaporation rates 8.4 times the annual rainfall (227mm) which mainly occurs in summer. Subsequently the local streams are highly ephemeral, mostly dry channels. Jervois Dam, located on Unca Creek, is the largest (279 ML capacity) and most permanent surface water body in the Jervois region (WRM, 2019). The catchment is sparsely populated with landuse being mainly rural (grazing). Soils on the hills are shallow and stony, with sandy or clayey loams in the extensive undulating plains.

Aquatic flora and fauna: The landscape, flora and fauna report for the project (Low Ecological, 2018) found no records of aquatic fauna in the NT Fauna Atlas within 20km of the project zone, although they do expect fish and aquatic invertebrates will inhabit the area following good rainfall, as burrows of freshwater land crabs have been found previously in nearby Arthur Creek. No aquatic fauna however was found at the project site by Low Ecological in fields surveys between 2012 and 2018.

Riparian trees common to the area (for example *Eucalyptus cameldulensis*) are known to be dependent on shallow groundwater (Low Ecological, 2019).

Surface Water quality: Surface waters upstream of the historical mine workings in Unca Creek and Jervois Dam are slightly acidic to neutral (pH 6.7-6.9) with low salinity and suspended solids, and with total metals generally below detection (except total iron and aluminium). Downstream however, the suspended solids and metals increase significantly, a trend also seen in the relatively undisturbed southern Unca Creek tributary. The higher concentrations may be due to sample sites being in the mineralised zone of the project area, and in flatter terrain where waterborne particles accumulate.

Groundwater: CloudGMS (2018) found groundwater was present in local aquifers within fractures and jointing in base rock, and the shallow alluvial deposits along active drainage lines, although on the mining lease these deposits have limited thickness (<10m) and are unlikely to form permanent aquifers. Registered bores in the area have been used for stock water and historical mining activity, with water quality registered as slightly brackish (typically 2000 to 4000 $\mu\text{S}/\text{cm}$) (CloudGMS, 2018) although suitably fresh for stock water (beef cattle) (ANZECC, 2000). The stygofauna community of the area's bore fields was assessed as having low environmental value based on the limited occurrence of taxa, and the salinity of the water is only potentially suitable for stygofauna.

Water Quality Values and Objectives:

The draft SWMP proposes the following Environmental Values (EVs) for the project, according to NWQMS (1998) and ANZECC & ARMCANZ (2000) guidelines:

- Aquatic ecosystems;
- Primary industries including stock watering, irrigation and general water uses;
- Recreation and aesthetics; and
- Cultural and spiritual values.

The ANZECC & ARMCANZ (2000) Water Quality Objectives (WQO) for slightly to moderately disturbed aquatic ecosystems (slightly to moderately disturbed) were proposed, as being the most conservative (stringent) of the EVs.

3. Review of Surface Water Monitoring Program

The draft Surface Water Monitoring Program (draft SWMP) (WRM, 2019) was reviewed by the author and found to be well researched, structured and composed, with some changes recommended.

The draft SWMP appropriately considered the Environmental Values in the project area, and took a conservative, precautionary approach in applying Water Quality Objectives (WQOs).

Sampling sites include both water storages and streams relevant for determining pre-mining conditions and which will remain relevant during operations and post-closure. The stream monitoring includes four (4) upstream background sites and four (4) downstream receiving water sites. These sites include both major streams on the project site, namely Unca Creek and the relatively undisturbed southern Unca Creek Tributary.

The proposed water quality testing includes a broad suite of physio-chemical parameters and metals for comparison with Australian guidelines. The proposed testing is quarterly and daily during significant runoff events. The test suite includes: pH, Electrical Conductivity (EC), total dissolved solids, turbidity, dissolved oxygen, sulfate and nitrate and filtered metals (Al, As, Cd, Cu, Fe, Pb, Mg, Mn, Hg, Ni and Zn).

The recommended or suggested changes to the draft SWMP, and reasoning, are as follows:

1. Total metals included in the water quality test suite for storages and streams

The current program includes filtered metals and metalloids. This is appropriate for the proposed WQOs based on ecosystem guidelines and values; however, total metals are appropriate for the other EVs.

According to ANZECC (2000), for metals and metalloids, the dissolved fraction is applicable to ecosystem guidelines, whereas the total metals fraction applies to other uses (stock watering, irrigation, household use and drinking water supply). Therefore, for metals, two WQOs can be applied; one for ecosystems (dissolved metals) and one for the most stringent guideline for the other uses (total metals). The ANZECC 2000 guidelines for stock watering are based on total metals, principally because the mode of exposure is via ingestion (whereby total metals suspended in water are potentially solubilised by digestion (acidic), and guidelines are derived from animal feed studies of total metals in the diet). Irrigation guidelines consider the total metal loading in irrigation water.

As the project progresses, total metals will become an important consideration in determining impacts and to make comparison with previous and concurrent land use impacts, particularly for the primary industry values (stock watering, irrigation, general use). Total metals are a function of suspended solids in the water column, which are likely to increase downstream of mining and in low lands in general. Without total metals data these impacts cannot be quantified and compared to guidelines.

2. Additional metals to include

Additional metals for which there are Australian guidelines applicable to the EVs of the area should be included to confirm their current level of significance, and if they increase over the life of the project, particularly after the addition of extracted groundwater and processed/concentrated minerals to the project site.

Suggest the following are included: boron, chromium, cobalt, molybdenum, selenium, silver, uranium, and vanadium.

3. Total Hardness included in the test suite

Hardness ameliorates the toxicity of certain metals and ANZECC (2000) provide algorithms to calculate modified guideline values for certain metals (Cd, Cr, Cu, Ni and Zn). Hardness would not be necessary as a licence condition analyte; however, the project will benefit from knowing the total hardness when reviewing potential water quality impacts.

4. Total Petroleum Hydrocarbons (TPH C6-C9, C10-C36) included in the test suite

Hydrocarbons are stored and used on mines, including this project. Routine monitoring of water storages and streams will help confirm hydrocarbons are being adequately contained at the mine. It is recommended silica gel clean-up is used on any samples registering significant THP concentrations, in order to differentiate from natural materials and those derived from petroleum.

5. EC, pH and turbidity tested in the field

The draft WQMP mentions using a hand held probe to do basic testing in the field. It is recommended pH is tested in the field, as transportation will be well outside of the recommended holding time of 6 hours, and in practice, laboratory pH can differ significantly from field readings if stored for too long. EC and turbidity are also recommended to be done in the field. All can be tested using simple, handheld instruments or a single multiprobe instrument. Also including these parameters (or at least EC) on the laboratory testing suite will provide a back-up of results and a point of reference if there is doubt over the identity of a sample.

6. Neighbouring, reference stream (outside of the immediate project area) be included.

The inclusion of water quality monitoring at a neighbouring stream outside of the immediate project area is suggested for reference purposes. The purpose is to quantify the changes in water quality that occur in the area due to factors unrelated to the project. For example, due to other land uses such as grazing and natural events (e.g. floods), and confirmation of natural geological effects and differences in suspended solids (and therefore total metals) between up-gradient and low land sampling points. An up-gradient and a low land sample point on a neighbouring stream is a suggested inclusion if feasible, particularly if it has similar geology and hydrology. The inclusion of the relatively undisturbed Unca Creek Tributary may already fulfil this role.

4. References

ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

AS/NZS 5667.1:1998 *Water quality – Sampling – Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples*. Standards Australia.

CloudGMS (2018) *Jervois Base Metals Project Mine Site Groundwater Investigation*. Draft Version 0.1. Prepared for KGL Resources. CloudGMS Pty Ltd.

Low Ecological (2018) *Jervois Base Metals Project, EL 25429, Landscape, Flora and Fauna Report. September 2017 and May 2018*. For KGL Resources. Low Ecological Services P/L. July 2018.

Low Ecological (2019) *Jervois Base Metals Project, EL 25429, Landscape, Flora and Fauna Report. Supplement Report*. For KGL Resources. Low Ecological Services P/L. May 2019.

NWQMS (1998) ***National Water Quality Management Strategy: Water quality and monitoring guidelines***. Department of Environment. Australian Government.

WRM (2019) ***Jervois Base Metal Project, Draft Surface Water Monitoring Program***. KGL Resources Pty Ltd. WRM Water & Environment Pty Ltd. 1 July 2019. Document 1348-01-H.

Appendix A – Qualifications and Experience of Peer Reviewer

Table 1 – Peer Experience and Qualifications Relevant to this Project – Mike Ferguson

Qualifications	Experience (relevant to the project, in mining specifically, within the past 10 years)
Bachelor Applied Science (Hons) (Chem/Micro) (Queensland University of Technology)	Designed surface water monitoring programs for EIS baseline studies for new mines and for operational mines.
Masters Environmental Management (University of Queensland)	
Hydrography Certificate (Canberra Institute of Technology & Australian Hydrographers Association)	Designed, conducted and reported 35+ annual REMP (Receiving Environment Monitoring Program) assessments (surface water, sediments, bio-indicators) for mines, including recommended changes to surface water discharge licence conditions.
Groundwater Modelling Certificate (Sustainable Resources Industry Training – Dr Noel Merrick)	Conducted 30+ surface water discharge exceedance investigations for mining, including groundwater investigations related to surface water.
Lead Environmental Auditor - ISO14000 series (SAI & RABQSA)	Reviewed Water Management Plans for mines.
AUSRIVAS certificate (University of Canberra)	Installed and maintained surface water monitoring stations.
Certificate II – Water Sampling (Australian Agricultural College)	Conducted extensive surface water sampling for mining projects.
Member of Environmental Institute of Australia and New Zealand (EIANZ)	