Volume 2

A31 - Groundwater Monitoring Plan

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Environmental Impact Statement - February 2

Multicom Resources Ltd

Saint Elmo Vanadium Project

Groundwater Monitoring Plan

October 2019 – Rev1

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1 Introduction

Multicom Resources Ltd (Multicom) is planning to develop the Saint Elmo Vanadium Project (SEVP) (the Project) for the purposes of mining and processing vanadium. The Project involves the sequential shallow open-cut strip mining of panels along the north-south axis of Mining Lease Application (MLA) 100162, a greenfield site. Once the ore is removed, the panel will be back filled with overburden material, then contoured and sheeted with topsoil and subsequently revegetated.

MLA100162 is located approximately 25 kilometres (km) east of Julia Creek, north western Queensland.

The document constitutes the groundwater monitoring plan for the SEVP.

The groundwater monitoring framework adopted by the SEVP is based on the principle of adaptive management. Adaptive management is a structured, iterative process of decision making with a focus on reducing uncertainty over time via systems monitoring. Should monitoring results indicate a change in risk profile, the adequacy of monitoring can be reviewed to assist in the management of that risk. Accordingly, this plan will be reviewed within five (5) years of the commencement of monitoring.

The primary objectives of this groundwater monitoring plan are to:

- Establish a monitoring regime that is considered appropriate for the intended mining activities in both geographical spread and duration;
- Establish baseline groundwater conditions prior to potential impacts occurring;
- Enable detection of potential groundwater impacts associated with mining and processing activities; and
- Provide a process for the response to potential impacts resulting from project activities.

2 Conceptual Hydrogeological Model

A conceptual hydrogeological model is a succinct, simplified understanding of a groundwater system. It provides a basis-of-design to ensure that the monitoring program is appropriate for the potential risks associated with the Project.

The Project intends to extract vanadium-rich ore from the Toolebuc Formation of the Great Artesian Basin (GAB) to an average depth of 20m, and to a maximum depth of 40m below ground.

Investigative drilling and the installation of five (5) groundwater monitoring bores across the mine footprint did not identify the presence of groundwater in the target formation. Regional studies identify that the water table may be within 10-15m of surface in the southwest of the Project area, thus the potential exists for limited pit inflows during mining. Water quality monitoring to date indicates that the groundwater in the Toolebuc Formation is saline and several heavy metals concentrations have exceeded the adopted guideline values (ANZECC 2000 trigger values for livestock drinking water). The groundwater flow direction in the water table aquifer is expected to be from east to west.

The Wallumbilla Formation is approximately 200m thick in the vicinity of the Project. The Hooray Sandstone (and lateral equivalents) aquifer underlies the Wallumbilla Formation at a depth of approximately 220m below ground. Despite significant pressure declines, the Hooray Sandstone is artesian across much of the region.

The water chemistry indicates hydraulic separation of the Hooray Sandstone from the shallow Wallumbilla Formation. Notwithstanding the very thick aquitard material providing a significant barrier, the upward hydraulic gradient limits the ability of potential contaminants from the mining process to enter the Hooray Sandstone. The Project will not utilise GAB water.

The potential impacts associated with the Project include:

- Drawdown of the water table aquifer due to the extraction of water directly associated with the ore. Due to the low hydraulic conductivity of the ore-bearing material, the maximum extent of drawdown was estimated in the range of 1,500-2,000m after 30 years of continuous pit inflows (Epic, 2019);
- Impacts to groundwater quality due to the leaching of contaminants associated with replacement of overburden and waste materials into the mine void. Epic (2019) indicates that contaminant migration will be extremely slow, with contaminants only reaching 10m beyond the pit boundary after 75 years (conservative case); and
- Impacts to groundwater quality due to seepage from facilities associated with ore processing and waste management. Key areas of the mine infrastructure area and their associated chemicals are summarized in Table 1.

There are no mapped terrestrial GDEs, areas of natural surface water-groundwater interaction, or human users of the water table aquifer within the distances predicted to be potentially impacted by the SEVP.

Table 1 Potential chemicals of concern ad indicator parameters

Potential Chemicals of Concern	Indicator Parameter(s)
Metals	Metals/metalloids (vanadium, aluminium)
Diesel Lubricants	Total petroleum hydrocarbons
Sulphuric acid Caustic soda Ammonium sulphate Aluminium sulphate Sodium sulphate Floatation Reagent Alamine 336[1]	Major cations and anions (sodium, sulphate) Metals (aluminium) pH

1 a water insoluble amine (BASF, 2015)

3 Groundwater Monitoring

The primary purpose of the groundwater monitoring program is to detect potential impacts associated with mining and processing activities. This section describes where, when and how data will be collected and reported.

3.1. Monitoring Locations and Timing of Commencement

Table 2 summarises the locations of proposed monitoring bores based on the conceptual hydrogeological model associated with the Project. The locations of proposed monitoring bores are shown on Figure 1. Final locations will be subject to final mine design and infrastructure layouts.

New monitoring bores associated with ore extraction will be installed in two phases:

- Phase 1: Prior to the commencement of mining activities; and
- Phase 2: During the 5th year of mining activities.

This timing will enable the establishment of baseline conditions prior to the advancement of mining activities to a bore's proximity. New bores are located outside of the pit shell to ensure they are not destroyed by mining and can provide data for the duration of the Project. The existing bores (installed prior to the preparation of the EIS) will continue to be monitored until they are mined through.

Additional bores will be installed prior to the commissioning of the processing plant, fuel and chemical storage areas as well as the Tailings Storage Facility (refer **Figure 1**).

Table 2 Groundwater monitoring locations and required timing

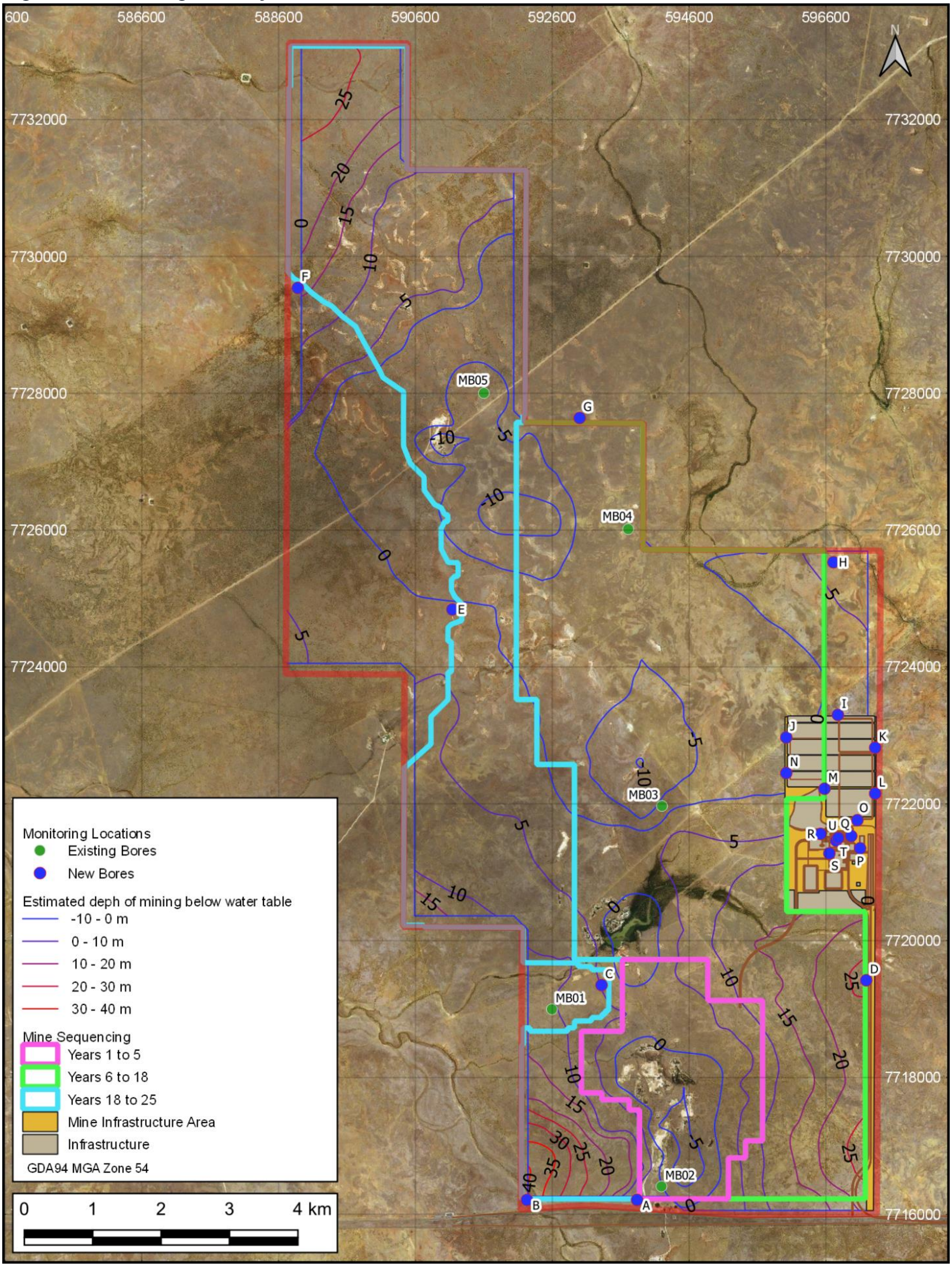
Bore ID	Easting*	Northing*	Location on Site		Justification	Required by	Anticipated Depth (m)
			Mining	Mine Infrastructure Area (Processing)			
MB01	592595	7718997	✓	-	Existing bore – establish baseline conditions for EIS	Existing	Existing (17)
MB02	594196	7716407	✓	-			Existing (16)
MB03	594203	7721968	✓	-			Existing (20)
MB04	593710	7726015	✓	-			Existing (18.8)
MB05	591600	7728004	✓	-			Existing (18)
A	593840	7716210	✓	-	Replacement of MB02 with bore intersecting the watertable. Early confirmation of understanding of potential impacts.	Phase 1	25
B	592230	7716210	✓	-	Area in which mining below the watertable is deepest, therefore area of greatest potential impacts	Phase 1	55
C	593320	7719350	✓	-	Replacement of MB01 with bore intersecting the watertable. Early confirmation of understanding of potential impacts.	Phase 1	23
D	597190	7719420	✓	-	Site coverage on eastern boundary in area of expected shallow water table.	Phase 1	46
E	591140	7724840	✓	-	Site coverage on western boudary	Phase 2	25
F	588880	7729540	✓	-	Site coverage in north of mining area. Larger mining depth below water table	Phase 2	42
G	593000	7727640	✓	-	Site coverage on northern boundary. Replacement for MB04 and MB05 with a bore intersecting the water table.	Phase 2	25
H	596710	7725530	✓	-	Site coverage on northerneastern boundary	Phase 2	33

Bore ID	Easting*	Northing*	Location on Site		Justification	Required by	Anticipated Depth (m)
			Mining	Mine Infrastructure Area (Processing)			
I	596775	7723300		✓	Seepage from evaporation pond	Prior to commissioning	26
J	596020	7722970		✓	Seepage from evaporation pond and TSF	Prior to commissioning	26
K	597320	7722820		✓	Seepage from TSF	Prior to commissioning	26
L	597320	7722150		✓	Seepage from TSF	Prior to commissioning	26
M	596580	7722220		✓	Seepage from TSF and raw water dam	Prior to commissioning	26
N	596020	7722450		✓	Seepage from TSF	Prior to commissioning	26
O	597060	7721760		✓	Seepage from TSF	Prior to commissioning	26
P	597100	7721350		✓	Leakage from fuel storage	Prior to commissioning	25
Q	596970	7721530		✓	Seepage from waste storage facility	Prior to commissioning	26
R	596520	7721560		✓	Seepage from beneficiation process	Prior to commissioning	25
S	596650	7721275		✓	Leakage/seepage from chemical stores	Prior to commissioning	25
T	596750	7721460		✓	Seepage from leaching process	Prior to commissioning	25

Bore ID	Easting*	Northing*	Location on Site		Justification	Required by	Anticipated Depth (m)
			Mining	Mine Infrastructure Area (Processing)			
U	596780	7721500		✓	Seepage from leaching process	Prior to commissioning	25

* MGA Zone 54. Coordinates of proposed bores approximate only.

Figure 1 Monitoring bore layout



3.2. Monitoring Bore Construction

Bores will be drilled and constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia, Edition 3 (NUDLC, 2012) by an appropriately licensed driller (Class 1 – single aquifer).

Bore depths will be based on the following considerations:

- **Bores associated with mining and pit backfill** - the bores will be drilled at a depth 5m deeper than the anticipated maximum mining depth. The screen and gravel pack will extend to 1m below the depth of the first water strike, which will allow monitoring of both water level responses and potential chemical changes due to void backfilling.

- **Bores associated with processing facilities** – bores will be installed in the shallower of either:
    - The top of the Wallumbilla Formation; or
    - 5m below the first water strike.

  This will allow monitoring of the first undisturbed perching layer, or the groundwater that potential contaminants have the potential to reach. Screened intervals will intersect the water strike depth or the shale-coquina interface.

Bores will be drilled with rotary air techniques to ensure that water strikes can be observed.

All bores will be constructed with minimum PN12 50mm uPVC with a 3m machine-slotted screen and gravel pack above the screen. A bentonite seal will be emplaced above the gravel pack and a cement seal from surface to 5m below ground. Bores will be developed until free of sediment either via airlifting or bailing.

3.3. Water Level Monitoring

Water levels will be measured monthly for the first 12 months following the installation of the bore, and quarterly thereafter.

Water levels will be measured with an electronic water level meter (dipmeter) to an accuracy of 1cm.

Automatic water level sensors with data loggers will be installed in bores for monitoring of potential drawdown from pit inflows. Automatic sensors will not be installed in the four dry bores (MB01, MB02, MB04, MB05).

3.4. Water Quality Monitoring

Water quality samples will be collected from every bore on a quarterly basis for the first two years to establish baseline conditions and to develop a sufficiently large dataset to enable the development of site-specific water quality triggers. Following the development of the baseline dataset, the frequency of water quality analysis may be reduced to half-yearly (after Sundaram et al., 2009). More frequent monitoring (e.g. monthly) is not considered justified due to the low permeability of the formations and hence potential for contaminant transport. Furthermore, water level monitoring during the EIS showed that water levels did not fully recover between monthly sampling events and will therefore be unduly affected by a higher frequency of sampling.

Due to the low hydraulic conductivity of the Toolebuc Formation, groundwater samples will be collected by purging the bore and then sampling from within the screened interval with a point source bailer. A minimum of three screened interval (including gravel pack) volumes will be purged prior to sample collection, unless the bore is purged dry. If the latter occurs, a sample will be collected as soon as practicable after the inflow into the bore provides sufficient volume for the required analysis. Non-dedicated equipment will be decontaminated between bores.

Samples will be:

- Collected in new, laboratory supplied sample containers, with appropriate preservatives;
- Stored in a chilled esky or refrigerator prior to delivery to the laboratory;
- Submitted under Chain-of-Custody protocols; and
- Submitted to a laboratory accredited with the National Association of Testing Authorities (NATA) for the analyses to be conducted.

Field water quality (electrical conductivity (EC), pH and temperature) will be measured in-situ at the time of sample collection using a calibrated portable water quality meter. Samples for dissolved analysis will be field filtered using disposable 0.45µm filters.

The suite of laboratory analysis is based on the chemicals that will be used on site and their indicator parameters (Table 1). The analytical suite will include:

- **Physiochemical parameters** – EC, pH, total dissolved solids;
- **Major anions and cations** – bicarbonate, carbonate, chloride, sulphate, sodium, potassium, magnesium, calcium;
- **Dissolved metals/metalloids** - aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, uranium, vanadium, zinc;
- **Total petroleum hydrocarbons** – TPH C6-C36, benzene, toluene, ethylbenzene and xylenes.

For quality assurance purposes, one field duplicate sample will be collected per sampling event and will be submitted for the full suite of laboratory analyses.

3.5. Visual Inspections

Tailings storage facilities, water management ponds and other infrastructure designed to hold liquids will be visually inspected for signs of leaks or seepage, and will include routine visual inspections that include (after DELWP, 2015) evidence for:

- New seepage areas or wet areas around the perimeter of the facility;
- Cracks, sinkholes or areas of subsidence; or
- New or noticeably green vegetation (relative to surrounds).

Visual inspections will be undertaken monthly for the life of the Project.

4 Data Management, Assessment and Reporting

4.1. Data Management

Data collected as part of this groundwater monitoring program will be stored in the Project's environmental database.

4.2. Response triggers

Water level response triggers for mining related monitoring bores (see Table 2) will be 40m below ground, i.e. the equivalent of the maximum anticipated mining depth used in the EIS (Epic, 2019).

In the processing areas, a water level rise of 0.5m between monitoring events will trigger an investigation as this rate of rise is considered rapid and likely to be indicative of a leak or seepage.

Site-specific water quality response triggers will be developed following the collection of sufficient baseline water quality data. The development of groundwater quality triggers and limits will follow the process outlined in DSITI (2017) and will require the analysis of eight (8) samples. The site-specific triggers will therefore be developed after the first two years of water quality monitoring.

In the interim, the ANZECC (2000) livestock guidelines will be adopted. It was recognised in the EIS (Epic, 2019) that the background water quality was unsuitable for beef cattle, which is the primary land use in the region.

4.3. Exceedance investigation and response process

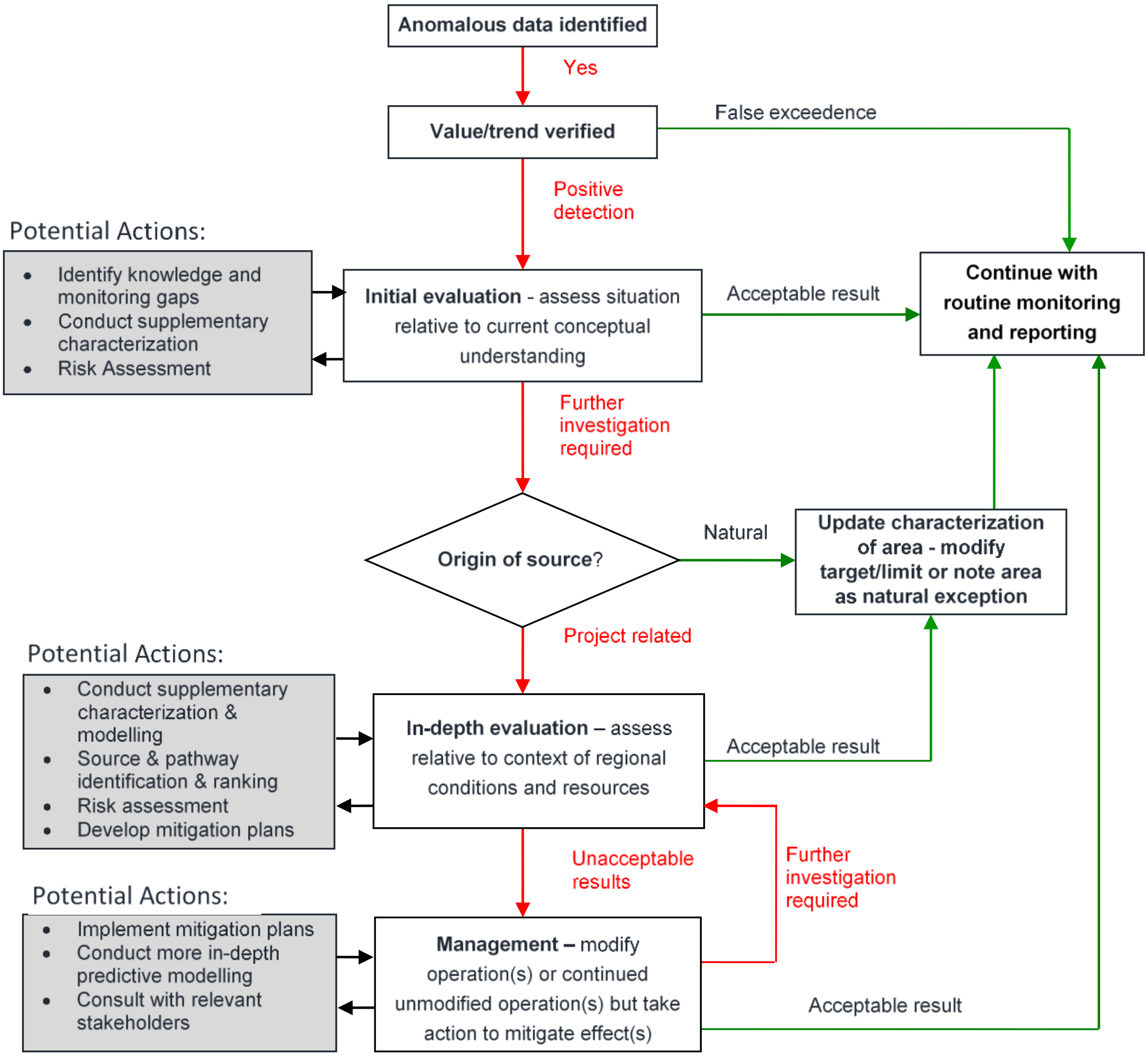
Should monitoring data fall outside of the expected range, response actions will follow the framework shown in Figure 2. The administering authority, the Department of Environment and Science (DES), will be notified of exceedances within the required timeframes, as identified in the Environmental Authority.

4.4. Reporting

An annual report will be produced to present and assess results of the groundwater monitoring program. The report will include:

- The current monitoring locations and scope. Any changes since the previous year (e.g. bores destroyed, replaced, and new bores) will be identified;
- Presentation and discussion of water level data, including:
  - A comparison with triggers;
  - Trend analysis;
- Presentation of water quality monitoring results, including:
  - A comparison of water quality results with triggers;
  - Discussion of any changes in water quality;
  - Tabulation of field and laboratory chemical data from the reporting period;
  - Discussion of quality assurance findings; and
- Investigation and response actions completed since the previous report.

Figure 2 Trigger exceedance investigation and response framework



5 References

ANZECC & ARMCANZ (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1: The Guidelines. Australian and New Zealand Conservation Council, Agriculture Resource Management Council of Australia and New Zealand (ANZECC & ARMCANZ). Commonwealth of Australia, Canberra

BASF (2015 Alamine 336 Solvent Extraction Reagent. Technical Information TI/EVH 0141 e. BASF Global Mining Solutions. September 2015.

DSITI (2017). Using monitoring data to assess groundwater quality and potential environmental impacts. Version 1. Department of Science, Information Technology and Innovation (DSITI), Queensland Government, Brisbane.

DELWP (2015) Dam Safety Surveillance. Templates for very low, low consequence category dams. The State of Victoria Department of Environment, Land, Water and Planning.

Epic (2019) Saint Elmo Vanadium Project – Water. Environmental Impact Statement for the Saint Elmo Vanadium Project. Prepared for Multicom Resources by Epic Environmental.

NUDLC (2012) Minimum Construction Requirements for Water Bores in Australia, Edition 3. National Uniform Drillers Licensing Committee, February 2012.

Sundaram, B., Feitz, A., Caritat, P. de, Plazinska, A., Brodie, R., Coram, J. and Ransley, T., (2009) Groundwater Sampling and Analysis – A Field Guide. Geoscience Australia, Record 2009/27 95 pp.