Preliminary Groundwater Report Rover 1 Project, Tennant Creek, Northern Territory

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1. Introduction

Castile Resources is undertaking exploration drilling and studies to determine the feasibility of mining at the Rover 1 Project. The site is approximately 63km southwest of Tennant Creek, Northern Territory on EL27372 (see location map Figure 1). The site is within the Tennant Creek Water Control District and approximately 25km south of the Tennant Creek West borefield.

Rover 1 is an iron oxide-copper-gold (IOCG) type deposit, which is hosted in the Palaeoproterozoic Warramunga Formation at depths starting at around 300 m below ground level. The conceptual mine design includes construction of a box cut and decline to access the resource. An indicative site layout has been provided with approximate areas of mineralisation are shown in Figure 2.

The current project area requires a pre-feasibility baseline groundwater study to characterise the underlying hydrogeology. This will partly draw on the comprehensive hydrogeological assessment prepared for the previous Rover 1 exploration target located 2 km the south given the geological similarities between the sites.

Scope of Assessment

The objective of these works is to identify and characterise the hydrogeology of the proposed site and based on this, to design a system to capture data to inform the development of the groundwater model. The model will be used to determine groundwater flow directions, dewatering requirements and aquifer characteristics including spatial and temporal variations, particularly in areas which may be affected by the proposed operations.

The scope of works covered in this report includes:

1. Review of existing groundwater data. Given that the nearest bore to the site is around 800m away (the Rover 1 airstrip bore – now disused), there is no groundwater data onsite. However, given the similar geology at the southern Rover 1 site, this study will draw on the comprehensive hydrogeological assessment data and report undertaken by VDM Consulting (2012).
2. Identification of information gaps – the hydrogeological assessments for the initial Rover 1 site will inform and enable a well targeted program to acquire information on the groundwater conditions at the Rover 1 mining proposal.
3. Develop a groundwater investigation plan including:
    a. Bore network design
    b. Bore drilling and construction design
    c. Other field activities
4. Reporting on findings, providing recommendations.
5. Schedule of cost estimates for all elements of work required.

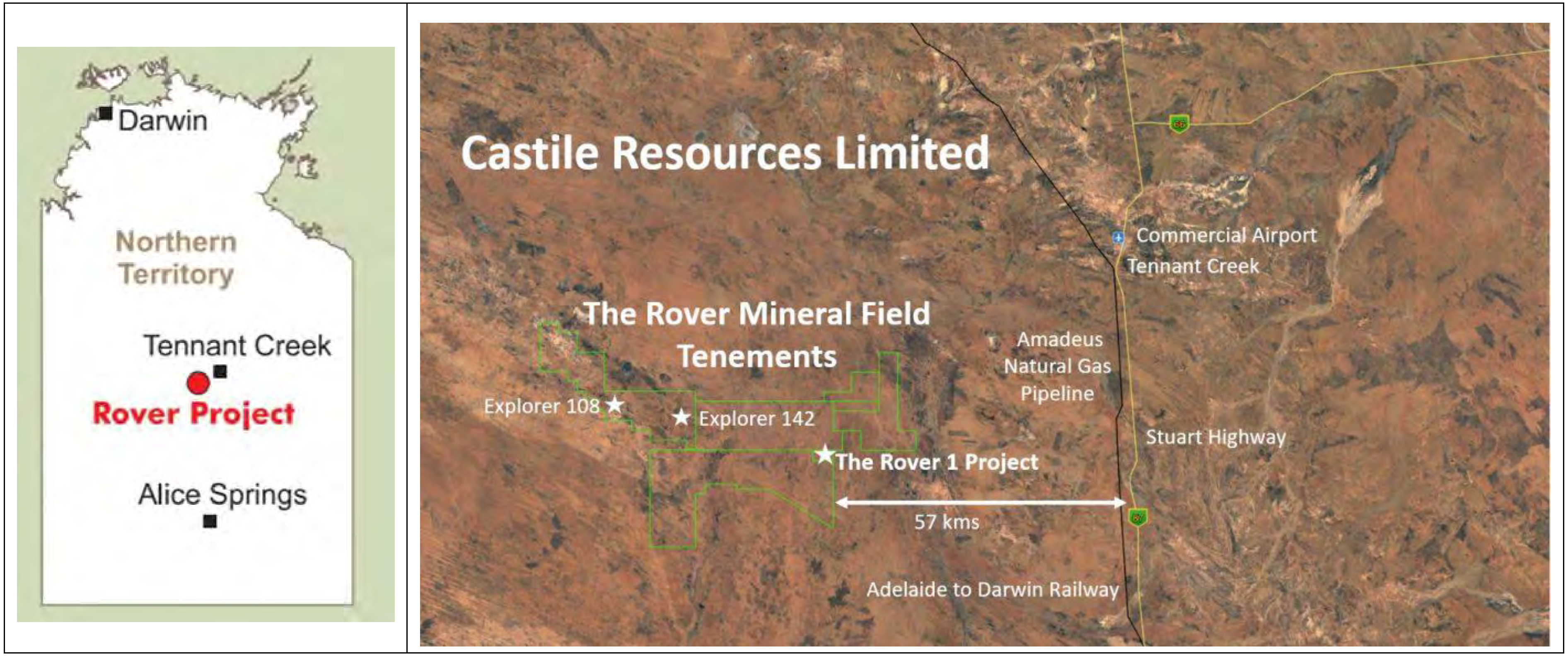

Figure 1 Castile Resources Location of Rover 1

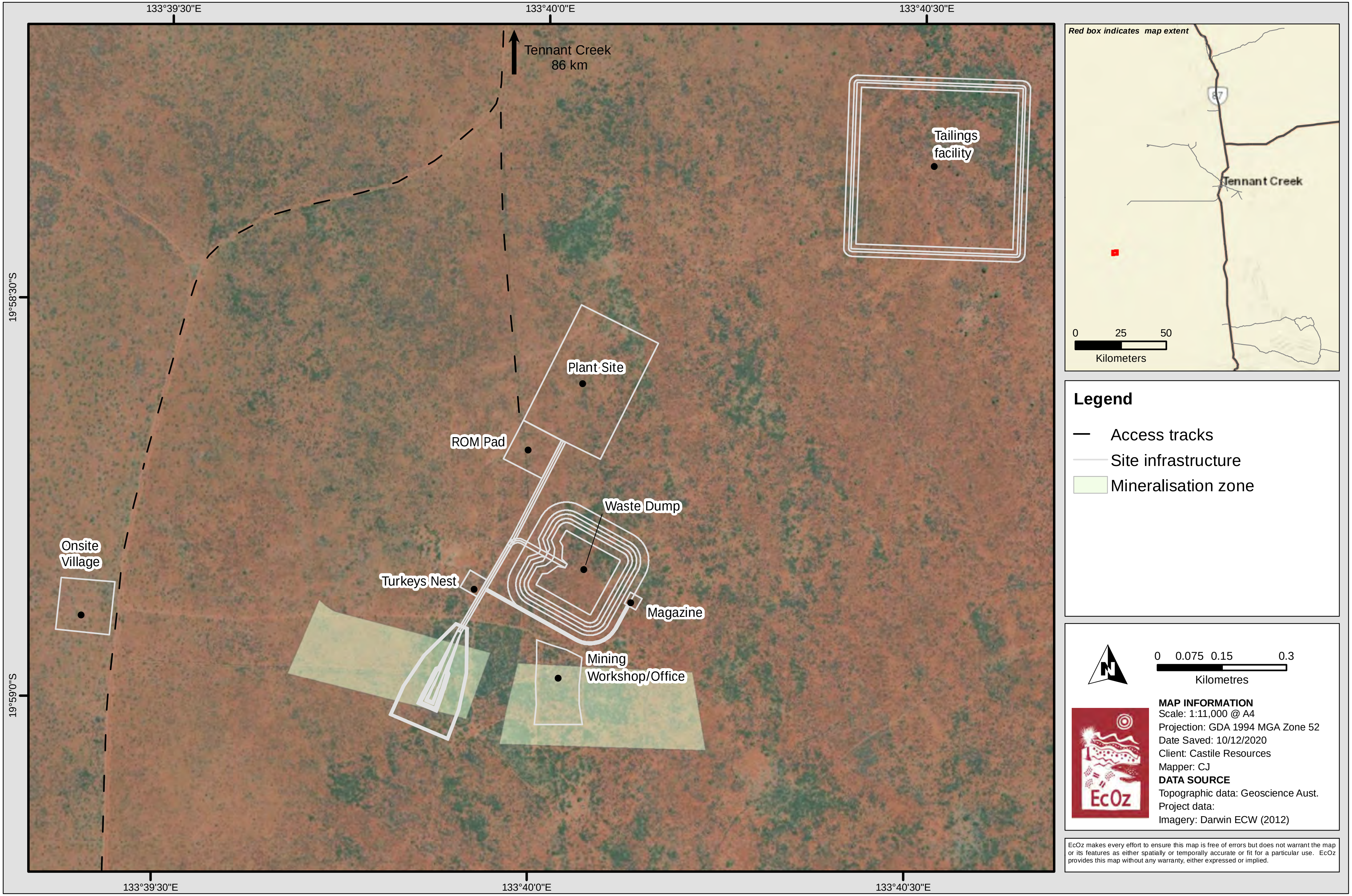

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Figure 2. Rover 1 site layout and approximate areas of mineralisation

2. Previous and Current Work

Recent exploration drilling provides some lithological and stratigraphic information. However, there is no local groundwater data for the new project site. There is an old disused bore drilled for Tennant Creek Station around 800m away that provides little information other than the depth - 102m, yield -1.9 L/s and groundwater salinity EC – 5,150 uS/cm. Otherwise the nearest groundwater data is from 2km south at the previous Rover 1 exploration target.

The Rover 1 site 2 km to the south was subject to a comprehensive hydrogeological investigation in 2012 and produced a conceptual model, a numerical flow model and comprehensive data set. This information can be used to inform the design of groundwater investigations on the new project site given the known stratigraphic similarities between the sites. The 2012 study, based on the drilling of 3 production bores and 6 monitoring bores, provides detailed data on depth of aquifers, hydraulic parameters, groundwater quality, hydro-stratigraphy, recharge estimates etc., and includes groundwater modelling that was used to predict inflows to proposed declines and box cuts.

The authors of the 2012 study (VDM Consulting) described spatial heterogeneity in the basin sedimentary sequences. As such, there may be variations in groundwater conditions between the two sites and therefore in-situ hydrogeological data is required to understand baseline conditions for the new site.

On a broader scale a groundwater exploration study of the Tennant Creek region was completed by Geoscience Australia in 2020 (Macpherson et al, 2020). This work is part of the Southern Stuart Corridor Project, Exploring for the Future program. The objective of this work was to improve understanding of regional groundwater systems and processes and improve water security. Investigation in the area utilised existing geological and geophysical data and information which was applied in the interpretation and integration of Airborne Electromagnetic AEM and ground-based geophysical data, as well as existing and newly acquired hydrochemical data. Relevant to this project is the finding that in the Wiso Basin, lower quality groundwater occurs extensively in the upper 100m of strata, but this may sit above potentially potable water.

The Tennant Creek West borefield, approximately 25 kilometres north has been extensively drilled and investigated (Verhoeven & Knott, 1979, Verhoeven & Russell, 1981). The borefield taps into aquifers in a different formation to that of the new Rover 1 project site and therefore is of limited applicability to this study.

3. Site Description

The project area is within the eastern margin of the Wiso Basin (geological), a large 160 000 km^2 sedimentary basin incorporating the eastern part of the Tanami Desert. The area is of low relief with occasional low rises and broad swales (see Figure 3). The Rover 1 site is generally flat to slightly undulating, ranging in elevation from 290 to 295 mAHD. There is a low gradient elevation decline northward.

The region is located within the hot semi-arid climatic zone (the Koppen-Geiger classification, BOM 2016) characterised by evapotranspiration exceeding rainfall. Mean annual maximum temperature at Tennant Creek is 32^0C. The long-term annual average rainfall for the Tennant Creek station is 401mm, 85% of which occurs over the wet season. Based on a residual mass curve (RMC) of precipitation (a means of examining cumulative departure from the mean), annual average rainfall has increased since 2001. It is understood that large episodic rainfall events, eg >50mm, are required to recharge groundwaters (McPherson, et al., 2020). At Tennant Creek ~9% of all rainfall events are >50mm.

The Rover 1 Project Area is located within the Wiso River Basin (Figure 4). There are several unconnected drainage catchments in this area. Surface drainage is often poorly defined and spatially discontinuous, and trends to the north-west, ultimately draining towards Lake Woods to the north of Tennant Creek. There are no permanent surface water features within or close to the Rover 1 project area. There is a floodout area, draining northward around 10km east of the site. With seasonal rains there may be intermittent small streams and pools.

Figure 3 Relief Image of the Rover 1 Project Area Showing the Wiso Basin (extract from 2015 MMP)

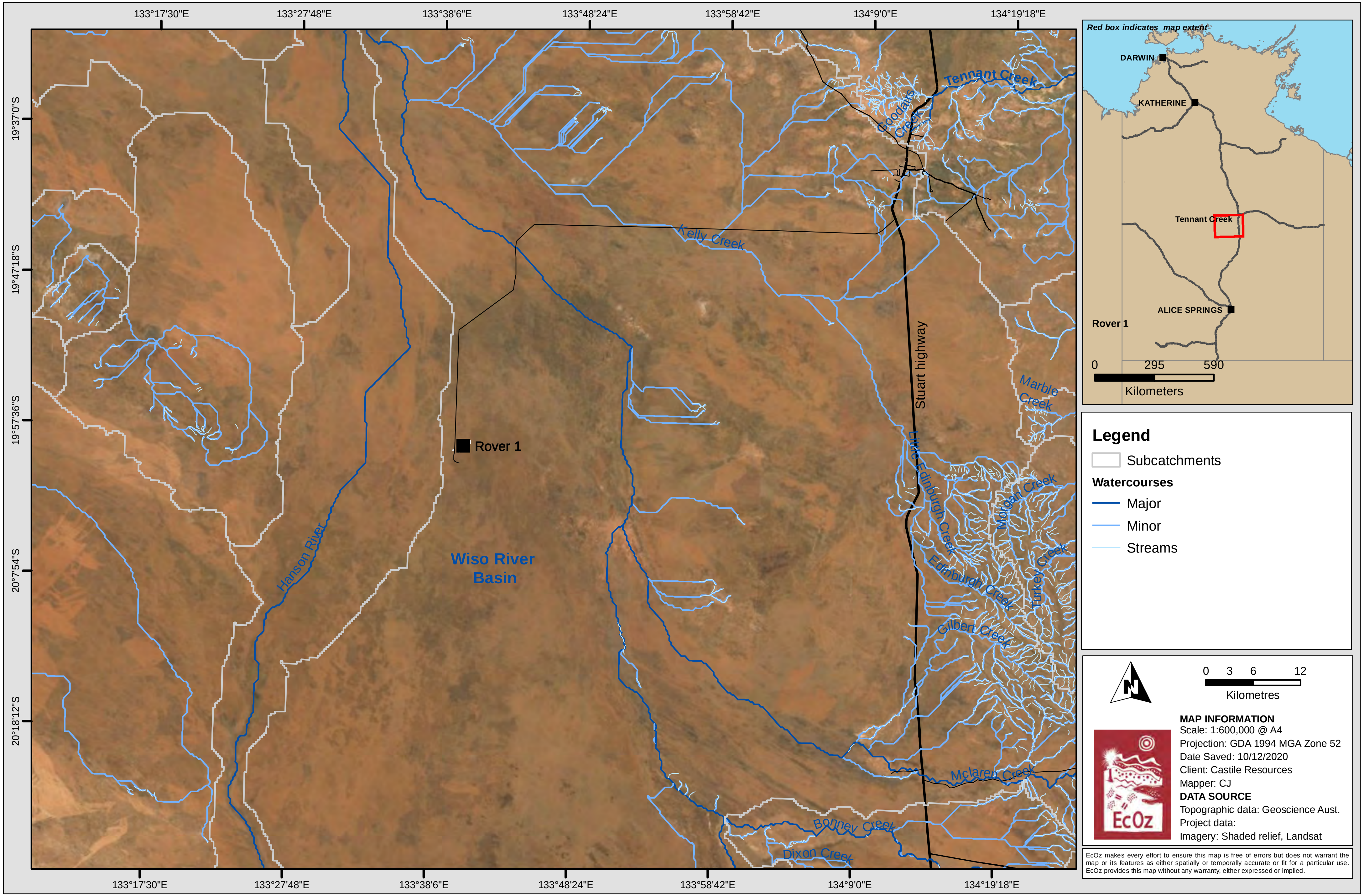

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Figure 4. Regional hydrology

4. Geology

The geology has been described in detail in several reports (Adelaide Resources 2012, VDM/ECOZ 2012, and Castile Resources MMP, 2015). It is summarised as follows:

The entire project area is covered by a thin veneer of Cenozoic sediments such as dune fields and sand plains, which blanket the extensive, flat-lying Wiso Basin sediments. The eastern edge of the Wiso Basin is 20 or so kilometres east of the study site. The Cambrian sediments of the Wiso thicken westward and are approximately 180m thick in the vicinity of the project area (Castile Resources pers.comm). Based on exploration drilling results, the expected stratigraphy of the site is the Hooker Creek Formation conformably overlying the Montejinni Limestone formations consisting of siltstone, dolomitic siltstone, mudstone, sandstone and a basal conglomerate unconformably overlying the basement.

The basement geology consists of the Warramunga Formation with undifferentiated volcanolithic/tuffaceous arenite/wacke ('metagreywacke') and siltstone, shale and argillaceous banded ironstone and slate. The target orebodies are the metalliferous ironstone deposits known as iron oxide-copper-gold IOCG mineral systems. The ironstones occur at depths of 300 m and more at the site.

Geoscience Australia (2020) noted that weathering within the basement, basin and overlying Cenozoic materials is extensive, and appears to be pervasive across all lithologies.

The expected stratigraphy at the site is shown in the following schematic:

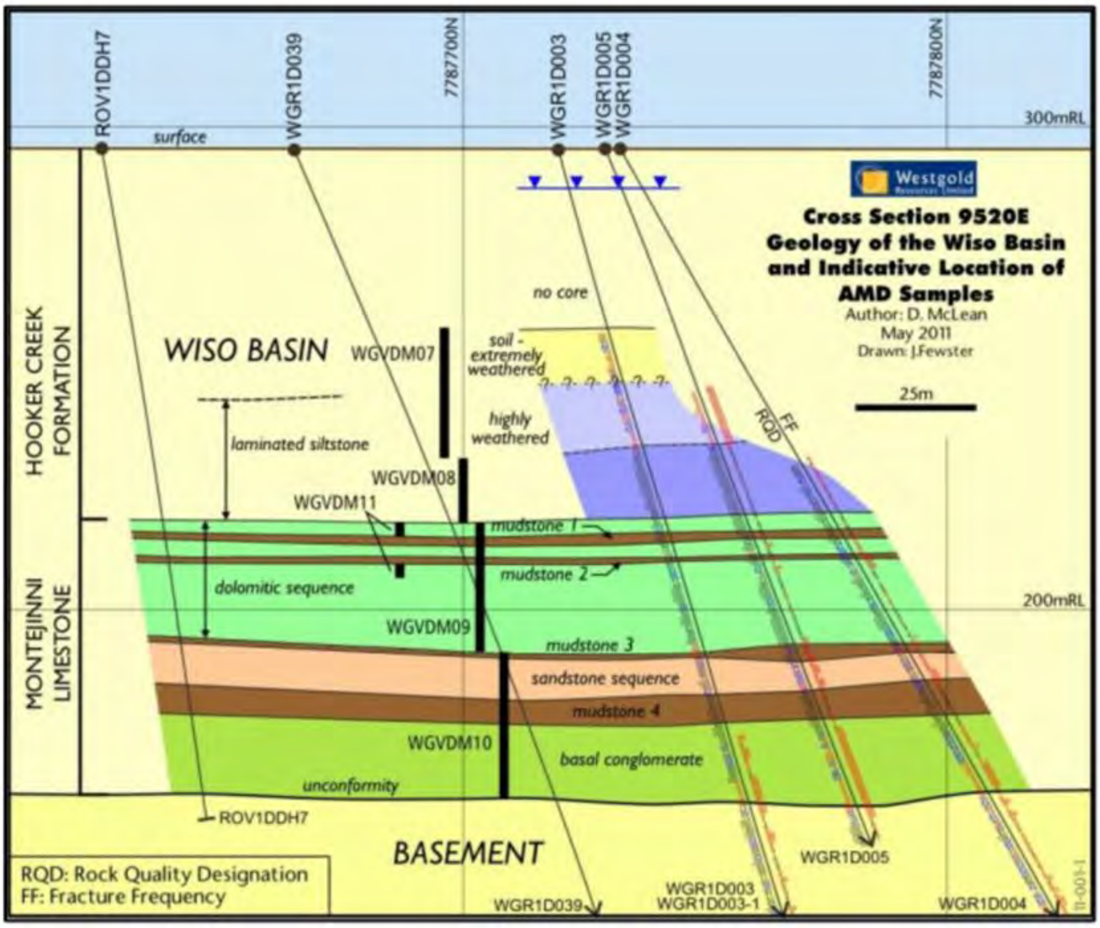

Figure 5 Schematic Stratigraphy at Rover 1 (from VDM Consulting, 2012)

5. Hydrogeology

Current understanding of local hydrogeology is based exclusively on the previous groundwater investigations completed at the first Rover 1 site. Some of these groundwater characteristics are expected to be similar at the new nearby site. However, given the heterogeneity of the sedimentology and associated variations in porosity and therefore hydraulic parameters, (VDM Consulting, 2012), this cannot be assumed, and primary groundwater data acquisition is needed for the Rover 1 site. The existing datasets help in strategic targeting and therefore cost-effectiveness of the data collection effort, and also assist with data analysis and interpretation.

Existing Bores

The closest bore to the new Rover 1 site is approximately 800m southeast, a brackish airstrip bore drilled to 102m with no geological log. Otherwise the nearest bores are those drilled for the first Rover 1 site to the south (Figure 6). A total of seven investigative and environmental monitoring bores to 120m depth were constructed, the details of which are described in the 2012 report.

Hydrostratigraphy

No known aquifers exist within the basement rocks in the area. All known aquifers therefore are limited to the overlying Wiso Basin formations. The conceptual groundwater model described below is for the Rover 1 site and is expected to be similar at the new site 2km to the north.

Rover 1 Hydrogeological Assessment (VDM Consulting, 2012) identified the major aquifers as being between 90-120m below surface in the dolomitic and sandstone sequences of the Montejinni Limestone formation. The water bearing lithologies appear to be porous sandstone bounded and confined by layers of low porosity such as siltstone. The deeper aquifer yields up to 11 L/s. The Montejinni Limestone is also known as a major aquifer in the Tennant Creek West borefield area where permeability is due to solution joints and cavities, (Verhoeven and Knott, 1979).

Minor aquifers (<3 L/s) occur in the shallower strata at less than 60m depth in the dolomitic siltstone of the Hooker Creek Formation. The shallow aquifers are deemed to be unconfined. Analysis of test pumping results indicate the deeper confined aquifer is a leaky system, with some degree of connection to the shallower aquifers.

The hydrostratigraphy is described in Table 1.

Hydraulic parameters

VDM Consulting (2012) presented transmissivity values ranging from low -1m^2/d (siltstone/sandstone Bore DS1-60) and 131 1 m^2/d (siltstone/sandstone with dolomite Bore DS5-90) for the dominant lithologies.

Verhoeven and Russell (1981) noted that the sedimentology in the Tennant Creek West borefield area is spatially heterogenous and the productive aquifers may be limited in lateral extent with limited storage. Hydraulic testing at the new site will be required to determine whether this is the case.

Flow direction, recharge

The hydrogeological studies at the first Rover 1 site show groundwater flowing in a north-easterly direction. The groundwater at the new project site may continue northward although there are some subtle low drainage lines to the east which may influence flow direction towards the lower topography.

Groundwater levels were measured as relatively close to surface at 4.6-8.1 mbgl. Observations over time in monitoring bores at Rover 1 indicates that groundwater level deviates by between 0.45m and

2.24m from the average. Monitored water levels also show a response to high rainfall, with water levels rising around a month following high rainfall i.e. greater than 30mm per rainfall event.

Groundwater Quality

The 2012 hydrogeological investigations found that groundwater quality at the site is poor, particularly in the deeper confining layers. The TDS is between 1,250-2,800 mg/L, with elevated nitrate and fluoride. These parameters exceed drinking water quality guidelines (NHMRC, 2011) and render the water unpotable. It is expected that without any obvious local recharge mechanism (such as a creekline) the water quality at the new project site will be similarly brackish.

Table 1 Hydrostratigraphy Rover 1 (from VDM Consulting 2012)

Geology	Depth (m)	Lithological description(*)
Wiso Basin	0 - 15	Localised aquitard systems among the regolith overlying to the ferruginous pisolites and extremely weathered sandstone with significant siltstones and minor dolomites.
	15 – 60	Extremely weathered rock comprising sandstone, siltstone and minor dolomite, dominated by secondary porosity and permeability. Whilst porosity may be moderate to high, drainage appears low. Vertical and horizontal permeabilities are calculated be low but these would vary where sandy and clay horizons prevail. This system underlies localised lenses of alluvial sands and therefore this is locally interconnected with the overlying aquitard systems.
	60 – 80	Laminated siltstone with minor sandstone and dolomite, highly weathered (decompose to a silt clay) at the top and weathered to slightly unweathered rock below 70m. Progressive downward change from slightly weathered to slightly weathered fractured rock with porosity and permeability along bedding planes with negligible cross cutting. Under natural conditions, these are effectively closed with little weathering. Although pump test data indicate overlying aquifer system may be locally leaking downwards, the siltstone at the lowest of this sequence can be regarded as a confining layer.
	80 – 104	Laminated siltstone with dolomite and dolomitic sandstone with several interbedded mudstones. Fracture porosities and permeability are enhanced in zones where vughs occur within the lithologies. The interbedded fresher siltstones and mudstones with very low vertical and horizontal permeabilities are relatively thin (less than 2m) and hence on regional scale may not act as confining layers.
	104 – 113	Sequences of siltstone, sandstone and minor mudstone and conglomerate with high porosity and moderate permeability where cement has been weathered out; confined aquifers with a relatively low storage coefficient. **Note:** Previous information reported that in some exploration holes i.e. WGR1D048 there was no dissolution of the rock matrix. The basal conglomerate may store locally large quantities of groundwater.
	113 – 120	Fine interlayering of siltstones and mudstones fresh rocks extends to depth having very low porosities and permeability and acts as a confining layer.
	120 – 132	The same as between 104m to 113m.
Basement Rocks	below 132	Basement rocks below the Wiso Basin have generally RQDs of 0 across 3m to 10m. These rocks have no or very little iron staining and decomposition. No known aquifers exist within the basement rocks. Joints are closed and do not exhibit any form of alteration which may store and/or convey groundwater.

(*) Lithological description attained during the drilling program was adapted to descriptions recorded during various exploration activities.

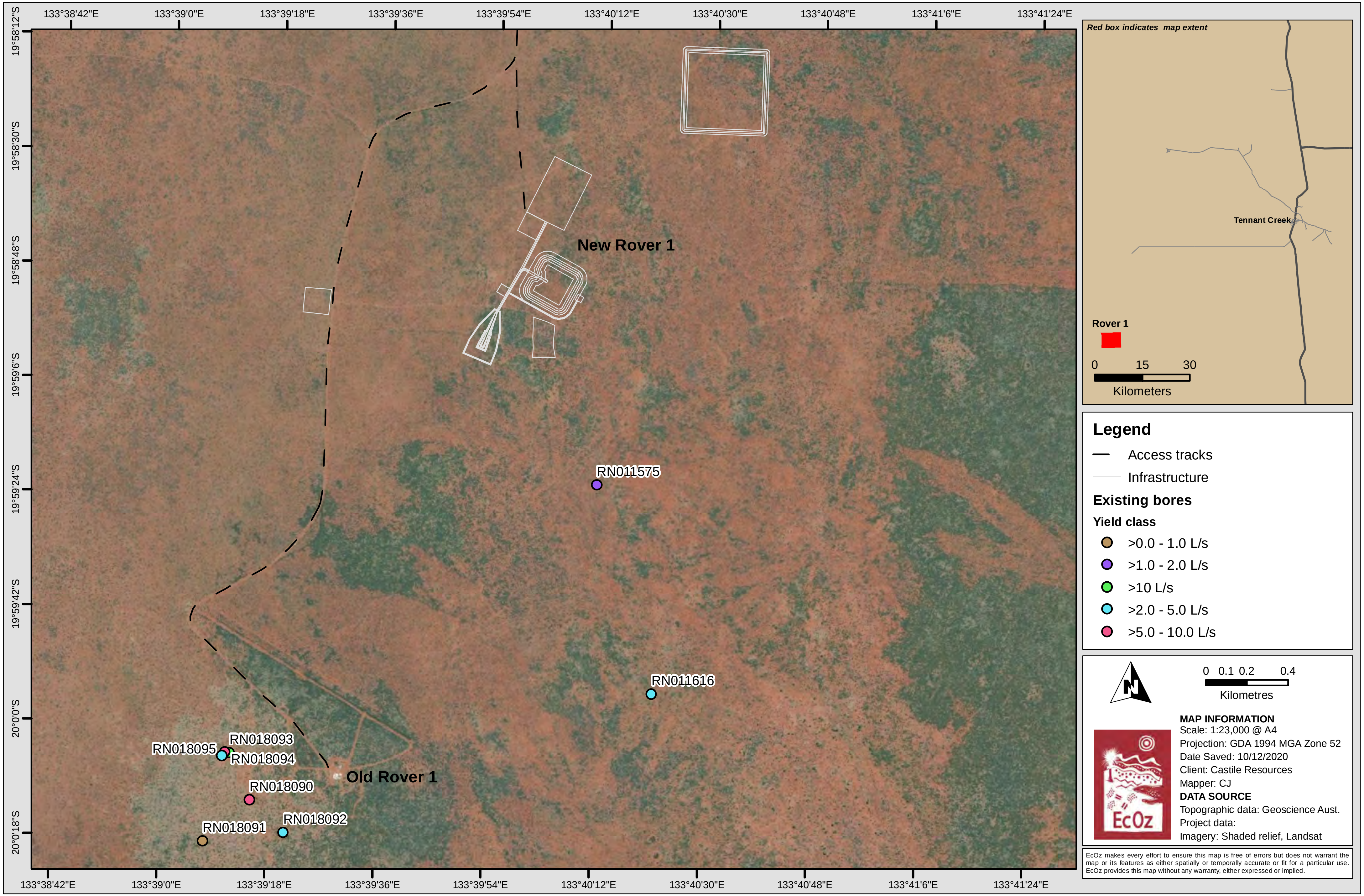

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Figure 6. Existing bores within vicinity of Rover 1

6. Groundwater and Environmental Receptors

There are no known groundwater users near the project site. The nearest bore is an old unused, salty airstrip bore approximately 800m southeast of the site.

Given the inferred north-east groundwater flow path, it could be argued that a long-term receptor could be the Tennant Creek West borefield, a possibility that should be included as a scenario when modelling.

The Groundwater Dependent Ecosystems Atlas (Bureau of Meteorology, 2019) was used to check if there are any ecosystems that rely on groundwater nearby (GDE's). There was no data available for central NT, but being in the arid zone, and with essentially no riparian vegetation nearby, there is no expectation of either aquatic or terrestrial GDE's in the area.

7. Information Gaps

At present there is no information on groundwater at the new Rover 1 site. The groundwater investigations undertaken at the original Rover 1 exploration target provide relevant information about the geological and hydrogeological conditions that occur in the area, summarised as a series of porous rock aquifers hosted in over 100m of Wiso Basin sedimentary formations. Similar conditions can be expected at the current Rover 1 project area but cannot be assumed.

The main conceptual model of the Wiso Basin sedimentary formations overlying the basement will be similar given the extensive basin formations. However, key hydrogeological determinants such as primary and secondary porosity/water bearing and transmitting capacity of rock can vary spatially not only due to lithology, but also according to the degree of weathering, fracturing, jointing, development of dissolution cavities etc. which can vary substantially over short distances. Therefore, groundwater must be investigated at the new site via a drilling and bore construction program.

8. Groundwater Investigation Plan

Bores must be strategically located to capture spatial variation and consider proposed infrastructure and potential groundwater receptors.

Bore network design

There are several considerations for bore network design. There are no groundwater users or groundwater dependent ecosystems nearby, but the Tennant Creek West Borefield may be a more distant receptor which will require location of monitoring bores downgradient of the mine.

Onsite, bores will be located both upgradient and downgradient of facilities to monitor potential water quality impacts, and to provide a reasonable spread across the site especially in and around proposed facilities.

Bores will also be located to provide crucial hydraulic parameter data where dewatering may be required. Investigation bores should be drilled to intersect the main void features including the proposed decline and box cut to characterise the groundwater conditions therein and to determine the dewatering requirements.

It is recommended that a groundwater drilling investigation is undertaken at the site including:

- The drilling of investigation bore holes and installation of a series of investigation and monitoring bores screened separately in the shallow and deep aquifers as outlined in Table 2.

- Hydraulic testing of select bores – particularly bores in proposed void areas and slug tests for lower yielding or small diameter casing bores.
- A groundwater sampling and water level monitoring program, with sampling and measuring bimonthly to start with to establish a data set from which to set up an initial groundwater model.

Figure 7 shows the proposed bore locations.

Table 2 Recommended drilling locations and investigation activities at New Rover 1 Site

Site Name	Easting	Northing	Site Type	No. Bores	Nominal Depth (m)	Rationale
RB1	*361704*	*7791148*	*Monitoring*	*2 piezos – deep/ shallow*	*50m/180m or basement contact*	*Estimated downgradient of proposed tailings dam site for monitoring water quality changes long-term and establish groundwater conditions proximal to tails dam.*
RB2	*360236*	*7789710*	*Testing*	*1 x 150mm cased bore (or larger if yields are high)*	*300m*	*Presumed decline site. An investigation bore here is needed to test the local hydraulic properties down to the orebody for determination of dewatering requirements.*
RB3	*360562*	*7790322*	*Monitoring*	*2 piezos – deep/ shallow*	*50m/180m or basement contact*	*Near ROM Pad. Testing for groundwater and monitoring impacts in proximity to ROM Pad. Also can be used to detect any water quality changes north and down-gradient of the WRD.*
RB4	*360650*	*7789938*	*Testing/monitoring*	*1 x 150mm cased bore (or larger if yields are high)*	*180m or basement contact*	*Baseline above the mineralised area and also adjacent to, (and presumed upgradient of), the waste rock dump to monitor for potentially acid forming material (PAF).*
RB5	*361301*	*7791559*	*Monitoring*	*2 x piezos deep/ shallow*	*50m/180m or basement contact*	*Downgradient from site.*
RB6	*359991*	*7789975*	*Monitoring/investigation*	*2 x piezos deep/ shallow*	*50m/180m or basement contact*	*Western background bore (and future camp production bore ?).*
RB7	*360558*	*7789544*	*Monitoring*	*2 x piezos deep/ shallow*	*50m/180m or basement contact*	*A data point in the southeast corner of the site and also expected upgradient from operations if estimated northward groundwater flow direction is correct.*
RB8	*360770*	*7790184*	*Monitoring*	*2 x piezos deep/ shallow*	*50m/180m or basement contact*	*Downgradient and adjacent to the northeast corner of the waste rock dump to monitor for potentially acid forming material (PAF) or seepage.*

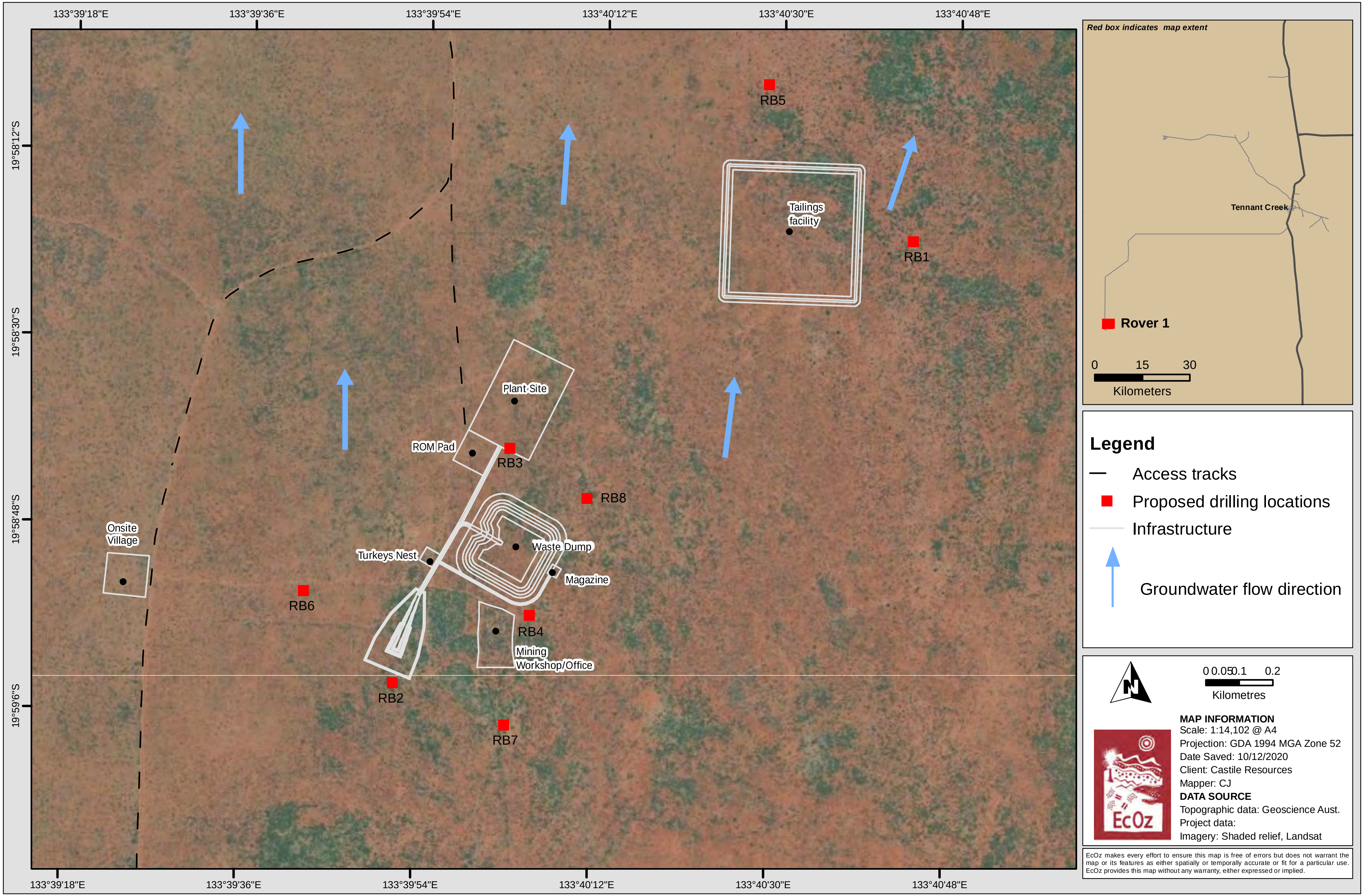

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Figure 7. Recommended bore drill site locations based on groundwater flow directions

Bore design

Bore drilling program should be undertaken by a Northern Territory licenced and registered driller in accordance with the national *Minimum Bore Construction Guidelines* V3 (NUDLC, 2011). As the area is in a Water Control District, a bore permit will be required to drill bores.

A 150mm (or 200mm hole if 150mm casing is to be used) pilot hole should be first drilled using air rotary method to total depth (in this case one bore to the orebody depth of an expected 300m and the rest to basement at around 180 mbgl). This will provide the required detailed downhole water intersection data. Water intersections, flow rates, salinity, pH observations should be made for each water intersection or at the end of each rod once water has been intersected. Should a clear upper and lower aquifer be identified, a second shallow hole to capture the upper aquifer only should be drilled where twin piezometers are required as per Table 2. Twin piezometers could be drilled adjacent to each other rather than 'nested' for ease of drilling and construction and clearly identified at the surface as either shallow or deep.

Bores that are dry should be backfilled. Bores with seepage can still be constructed as monitoring bores.

Bore construction will start with the standard 6 m collar grouted in to surface at a diameter to accommodate the drill bit and proposed casing. The formation is expected to be consolidated and therefore no gravel pack is required in the annulus.

A minimum of 100mm PN12 casing should be used and 150mm PN12 casing where yields are > than 2 L/s. 100mm casing provides more function with low extra cost as a submersible pump &/or downhole geophysics tools, can be inserted for sampling and test pumping if required.

At the end of construction, bore should be airlifted for a minimum of 1 hour to clean out the bore and develop the aquifer. A sample for lab analysis should be collected at the end of airlifting.

A secure, fireproof surface casing with lockable lid should be installed at the surface on a cement slab as specified in the *Minimum Bore Construction Guidelines V3.* Water levels of all bores should be recorded at the end of construction.

Test Pumping Program

Standard test pumping should be undertaken at bore sites R2, R4 to determine hydraulic characteristics in the areas which most likely to require any dewatering. Test should include a 3x 100min step test followed by a 12-24-hour constant rate test using whatever observation bores are around. Salinity should be measured throughout the testing.

As an alternative to the more expensive and time-consuming pumping tests, the remaining bores could be subject to a slug test. This method involves either adding or removing a measured quantity of water from a well rapidly and measuring the rate of water level recovery (either rising- or falling-head). The advantage of this method is that it is relatively low-cost, takes little time with negligible water removed from the aquifer. The disadvantages, and why a pumping test is better, is that it measures hydraulic conditions in a limited area at the screened part of the well and is significantly affected by gravel packing in the annulus. Where water level recovery is either slow or rapid, a pressure transducer logger downhole should be used to capture data more effectively.

Field activities

A bimonthly groundwater quality and level monitoring program must be initiated as soon as possible to capture enough spatial and temporal data for an initial groundwater flow model. Thenceforth, sampling frequency could be increased to quarterly and eventually biannually to capture seasonal variation and provide enough data for a Class 2 groundwater model.

Existing bores at the first Rover 1 site to the south can be included in the data collection network and a logger in RN011575 might be worth considering if it is still serviceable.

New bores must be surveyed at a consistent reference point (such as the top of the surface installation) to enable potentiometric surface to be mapped accurately and groundwater flow directions to be understood. All levels should be reduced to metres Australian Height Datum (mAHD).

9. Conclusions and Recommendations

Based on the findings of the nearby Rover 1 hydrogeological assessment, aquifers are expected to be confined to the Wiso Basin sedimentary formations overlying the mineralised basement expected to be at around 100m depth at Rover 1 site. Site specific conditions must be confirmed by a drilling and testing program as spatial variations in lithology and hydraulic parameters can occur in these heterogeneous systems.

A proposed drilling and testing program will provide definitive hydrogeological baseline data to not only address the requirements of approvals process but provide data to inform design of dewatering programs and water supply if and as required.

The proposed drilling program consists of drilling 2 central 150mm bores, which will be subject to test pumping, and 6 twin shallow/deep piezometers in strategically located positions. The details are included in this report in section 8: the groundwater investigation plan.

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