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TALE ENVIRO CONSULTING (PTY) LTD

SUSTAINABILITY IS THE KEY TO ENVIRONMENT

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MANINI HOLDINGS (PTY) LTD

GEOHYDROLOGICAL REPORT OF PORTION 18 AND 19 OF THE FARM SCHERP ARABIE 743 KS, MARBLE HALL IN LIMPOPO PROVINCE.

SEPTEMBER 2022

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It should, accordingly, not be assumed that all possible and applicable observations and/or measures are included in this report as this assessment report represents a sample of assessable parameters.

As a subsequent event, should additional information become available, Tale Enviro Consulting reserves the right to amend its observations and executive summary.

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EXECUTIVE SUMMARY

Introduction	Tale Enviro Consulting (Pty) Ltd was appointed to conduct geohydrological assessment for on portion 18 and 19 of the farm Scherp Arabie 743 KS, Marble Hall by Manini Holdings (Pty) Ltd.
Site Description	Investigated site IS situated north of the town Marble Hall, Thembelihle Ephraim Mogale Local Municipality under Sekhukhune District Municipality, within the Limpopo province of South Africa. Farm is located 10km north of Marble Hall. The project is located under Olifants Water Management Area within B31J quaternary catchment. The Olifants Water Management Area is located on the northeastern part of the Republic of South Africa and includes portions of the following provinces: the eastern part of Gauteng, the northern part of Mpumalanga Province and the south-eastern part of the Northern Province. The large urban centres in the WMA are Witbank and Middelburg, while towns of significance include Bronkhorstspruit, Groblersdal, Lydenburg, Belfast, Phalaborwa and Lebowakgomo. The Olifants River catchment area constitutes the WMA. The average temperatures show moderate fluctuation with average summer temperature 23°C, with a maximum of 28°C and a minimum of 18°C. In winter the average is 13, 5°C with a maximum of 20°C and a minimum of 7°C as measured at the Sekhukhune Land Weather Station. The south-western part of Marble Hall is underlain by the acid and intermediate intrusive rocks of the Waterberg Group, as well as small areas of mafic and ultramafic formations. The western portion is underlain by extensive Karoo Supergroup formations, principally basalts of the Lebombo Group and Clarens Formation sandstones, with smaller areas of Ecca Group shales, siltstones and mudstones. The central and eastern portions are underlain by a variety of rocks of the Bushveld igneous Complex. The most important of these are the Lebowa Granite suite, with outcrops of the Rashoop Granophyre Suite, followed by rocks of the Rustenburg Layered Suite further to the north and east. Much of the northern part of the area is underlain by rocks of the Transvaal Sequence, with the

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	silicified sandstones and quartzites of the Black Reef Quartzite Formation being very prominent, together with Chuniespoort dolomites and Pretoria group shales, hornfels and quartzites.
Hydro-census	On August 17, 2022, a site examination (hydrocensus) was carried out. All pertinent onsite visual, chemical, and geological observations were made during this site visit. ❖ A hydrocensus was conducted in a 2 km radius surrounding the proposed development site. The aim of this census was to; ❖ Map geological structures via visual and geophysical analysis. ❖ Determine local urban and rural groundwater dependencies and related influences on local groundwater quality and quantity. ❖ Chemical sampling of surface water (if applicable) and groundwater to determine current local groundwater quality.
Aquifer pump test	This kind of test entails figuring out how quickly geological formations around the borehole actually flow into it. By drawing water out of the ground at the precise pace at which it is supplied, it is accomplished. The only water that is ultimately extracted is the water that comes into the borehole from the aquifer. If this rate of abstraction is quantified, it indicates the rate at which water exits the borehole from the aquifer, or the aquifer's real yield. **BOREHOLE BH1** The recorded borehole data for BH1 Borehole depth: 51.5 mbgl Water level: 6.1 mbgl Abstraction rate: 10 l/s Duration: 12h **BOREHOLE BH2** The recorded borehole data for BH1 Borehole depth: 30.1 mbgl Water level: 7 mbgl Abstraction rate: 29 l/s Duration: 12h **BOREHOLE BH3**

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	The recorded borehole data for BH1 Borehole depth: 36.1 mbgl Water level: 5.5 mbgl Abstraction rate: 23 l/s Duration: 12h According to results of all tested borehole (BH1, BH2 and BH3) may produce an abstraction yield of 0.12 l/s for 24 hours each day. However, it is strongly advised that the boreholes be used in a sustainable cycle of 12 hours pumping and 12 hours rest. All three boreholes are thus projected to have a 12 hour per day sustainable abstraction output of 0.17 l/s. At the recommended cycles, this amounts to 220 320 liters of groundwater withdrawal every month.
Conclusion	❖ The project is situated in a region with limited aquifer systems and low producing boreholes projected. The predicted range for groundwater quality is 70–150 mS/m. It can be expected that the aquifer has a low susceptibility for pollution given that the study region is situated inside a minor aquifer system. ❖ During a hydrocensus, a total of 6 usable boreholes were counted. Groundwater dependence was noted in the neighborhood surrounding the analysed location; however, it was limited to domestic and agricultural irrigation
Recommendations	❖ Use soil management techniques to prevent moving water from eroding the margin of an irrigated field, such as creating grassed waterways and vegetative buffers. ❖ To change the seasonal water use patterns in relation to the precipitation patterns, use more varied crop rotations. ❖ Usage optimum management methods for irrigation to safeguard water quality and increase water use effectiveness. ❖ Improve the rate, form, and positioning of when you apply fertilizer, manure, and pesticides. ❖ Implement landscaping techniques, such as buffer strips, biofilters, controlled drainage systems, etc., to offer a potential means of catching sediment, nutrients, pathogens, and pesticides before they are delivered into streams or rivers

GLOSSARY GEOHYDROLOGICAL TERMS AND ACRONYMS

Geohydrological terms	Definitions
Confined Aquifer	A confined aquifer is bounded above and below by an aquiclude. In a confined aquifer, the pressure of the water is usually higher than that of the atmosphere, so that if a borehole taps the aquifer, the water in it stands above the top of the aquifer, or even above the ground surface. We then often speak of a free-flowing or artesian borehole.
Shear Zone	A shear zone is a structural discontinuity surface in the Earth's crust and upper mantle which forms as a response to inhomogeneous deformation partitioning strain into planar or curviplanar high-strain zones.
Sedimentary rock	A type of rock that formed by sedimentation material on the earth surface or in water bodies
Metasedimentary Rock	A sedimentary rock that appears to have been altered by metamorphism.
Intrusive rock	Rock that formed due to the cooling of magma that forced its way into fractures and cavities of other rock types without reaching the surface.
Fault (Brittle Shear)	A planar fracture or discontinuity in a volume of rock, across which there has been significant displacement along the fractures as a result of earth movement
Argillaceous rock	A type of sedimentary rock that contains a substantial amount of clay or clay-like compounds
Vulnerability	The likelihood for contamination to reach a specified position in a groundwater system after introduction at some location above the uppermost aquifer.
Recharge	Groundwater recharge, also known as deep drainage or deep percolation, is a hydrologic process in which water travels downward from the surface to the earth. This process often takes place in the vadose zone under plant roots and is frequently described as a flux to the water table surface. Rainwater and/or reclaimed water are channelled to the subsurface for recharge, which occurs both naturally and anthropologically.
Unconfined Aquifer	An unconfined aquifer, often known as a water table aquifer, is defined by an aquiclude below but not by any confining layer

	above it. Its top limit is the water table, which is free to rise and decrease.
Transmissivity (KD or T)	Transmissivity is calculated as the product of average hydraulic conductivity K and saturated aquifer thickness D. As a result, transmissivity is defined as the rate of flow under a unit hydraulic gradient through a unit width cross-section of the aquifer over its whole saturated thickness.
Sustainable Yield	Aquifer test pumping yield computed by a trained hydrogeologist. The yield is the recommended abstraction rate and pumping schedule for ongoing use.
Susceptibility	A qualitative estimate of the ease with which anthropogenic activity can possibly contaminate a groundwater body.
Storativity Ratio	The storativity ratio is a characteristic that governs the flow from aquifer matrix blocks into the fractures of a double porosity restricted fractured aquifer.
Storativity (S)	The volume of water released from storage per unit surface area of the aquifer per unit decline in the component of hydraulic head normal to that surface is the storativity of a saturated confined aquifer of thickness D.
Specific Yield (Sy)	The specific yield is the volume of water released from storage by an unconfined aquifer per unit surface area or aquifer per unit decrease in the water table. Specific yield values vary from 0.01 to 0.3 and are substantially greater than limited aquifer storativities.
Porosity	A rock's porosity is its ability to hold pores or cavities. Primary porosity, which exists when the rock is formed, is distinguished from secondary porosity, which occurs later as a result of solution or fracturing in cemented rocks and hard rocks.
Leaky Aquifer	A leaky aquifer, also known as a semi-confined aquifer, is an aquifer with upper and lower aquitards, or one aquitard and the other an aquiclude. Water can freely flow uphill or downwards through the aquitards. If a leaky aquifer is in hydrological equilibrium, the water level in a borehole tapped into it may be the same as the water table.
Hydraulic Conductivity (K)	Darcy's Law uses hydraulic conductivity as the proportionality constant. It is defined as the volume of water that will pass through a porous medium in a unit time under a unit hydraulic

	gradient through a unit area measured perpendicular to the flow direction.
Diffusivity (KD/S)	The hydraulic diffusivity of a saturated aquifer is the ratio of its transmissivity and storativity. It influences the spread of a hydraulic head in the aquifer. Diffusivity has a length/time dimension.
Borehole census	A field survey that collects all important information on groundwater. Yields, drilling equipment, groundwater levels, casing height/diameter, co-ordinates, potential pollution issues, pictures, and so on are often included.
Aquitards	An aquitard is a geological unit that is permeable enough to convey considerable amounts of water when viewed over broad and long periods of time, but its permeability is insufficient to warrant the placement of production boreholes in it. Aquitards are often clays, loams, and shales.
Aquiclude	An aquiclude is a geological block that is impervious to water and does not convey it at all. Aquiclude is typically composed of dense, unfractured igneous or metamorphic rocks.

DOCUMENT INFORMATION

Title	**Hydrogeological Report September 2022**
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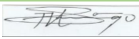
Signature	
Client	Manini Holdings (Pty) Ltd
Date last printed	2022/09/05 11:51:59
Date last saved	2022/09/05 11:51:59
Comments	The report has been compiled as per the client's requirements.
Keywords	Groundwater report and environmental site investigation
Revision Number	01
Status	Final
Issue Date	2022/09/05 11:51:59

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1. INTRODUCTION

Tale Enviro Consulting (Pty) Ltd was appointed to conduct geohydrological assessment for on portion 18 and 19 of the farm Scherp Arabie 743 KS, Marble Hall by Manini Holdings (Pty) Ltd.

The Department of Water and Sanitation has requested a hydrogeological report that includes the following as part of a water usage permission:

- A hydro-census consists of gathering the following information: borehole coordinates, water levels, borehole purpose, abstraction volumes, and borehole depth.
- The sites' groundwater aquifer descriptions
- Borehole pump tests are performed on-site.
- The potential impact of agricultural operations on the groundwater regime in the area.
- Maps of groundwater elevation that include groundwater flow directions
- The volume of water to be extracted from the borehole.
- To develop a conceptual model of the area, aerial photography, topography, geology, geohydrology, and aeromagnetic interpretation were used.
- The current state of groundwater quality.
- Put together a geohydrological report.

2. LIMITATIONS

The statements, opinions, and conclusions contained in this report are based solely upon the services rendered by Tale Enviro Consulting (Pty) Ltd as described in this report, the scope of work as established for the report, and in accordance with our proposal. In performing these services and preparing the report, Tale Enviro Consulting (Pty) Ltd relied upon the information provided by others, including public agencies, whose information is not guaranteed by Tale Enviro Consulting (Pty) Ltd. No indications were found during our investigations that information contained in this report as provided to Tale Enviro Consulting (Pty) Ltd, was false.

This report is based on conditions encountered and the information reviewed at the time of the site investigations. Tale Enviro Consulting (Pty) Ltd disclaims responsibility for any changes that may have occurred after this time or any error in the analytical results received from the laboratory. This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

3. METHODOLOGY

The following emphasis areas were necessary to analyse the geohydrological conditions:

- Environmental baseline conditions are described in detail.
- Determination of the area's baseline (status quo) geohydrology, including a desktop assessment of groundwater conditions and pertinent environmental elements.
- Recommendations for a groundwater management framework and monitoring program to aid in the creation of rehabilitation measures based on physical, hydraulic, and hydro-geochemical data

3.1. Desk Study

To obtain all essential environmental information, including topographical, hydrological, and geohydrological data, a desk study was done. Material/information was also acquired from past relevant research in the area, as well as data released in the public domain.

The National Aquifer Classification System created by Parsons is the aquifer classification system used to classify South African aquifers (1995). This method is adaptable and can be linked to secondary classes such as a vulnerability or usage classification. According to Parsons, aquifer classification is a very important planning technique that may be used to assist groundwater management.

3.1.1. Aquifer Classification

The South African Aquifer System Management Classification is divided into five major categories, which are mentioned below and specified in Table 6:

- Sole Source Aquifer System
- Major Aquifer System
- Minor Aquifer System
- Non-Aquifer System
- Special Aquifer System

Table 3-1: Aquifer classification scheme (Parsons, 1995)

Aquifer system	Defined by Parsons (1995)	Defined by DWA minimum requirements (DWAF, 1998)
Sole source aquifer	An aquifer that is used to supply 50% or more of domestic water for a given area, and for which there are no reasonable alternative sources should the aquifer become depleted or impacted upon. Aquifer yields and natural water quality are immaterial.	An aquifer, which is used to supply 50% or more of urban domestic water for a given area for which there are no reasonably available alternative sources should this aquifer be impacted upon or depleted.
Major aquifer	Highly permeable formations, usually with a known or probable presence of significant fracturing. They may	High yielding aquifer (5-20 l/s) of acceptable water quality

	be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good	
Minor aquifer	These can be fractured or potentially fractured rocks that do not have a high primary hydraulic conductivity, or other formations of variable hydraulic conductivity. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large quantities of water, they are both important for local supplies and in supplying base flow for rivers.	Moderately yielding aquifer (1-5 l/s) of acceptable quality or high yielding aquifer (5-20 l/s) of poor-quality water
Non-aquifer	These are formations with negligible hydraulic conductivity that are generally regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer unusable. However, groundwater flow through such rocks does occur, although imperceptible, and needs to be considered when assessing risk associated with persistent pollutants.	Insignificantly yielding aquifer (< 1 l/s) of good quality water or moderately yielding aquifer (1-5 l/s) of poor quality or aquifer which will never be utilised for water supply, and which will not contaminate other aquifers.
Special aquifer	An aquifer designated as such by the Minister of Water Affairs, after due process.	

3.1.2. Aquifer Vulnerability

Due to its low annual average precipitation of 460 mm, which is significantly below the world average of 860 mm, groundwater plays an essential role in supplying water to many regions of Southern Africa. The quality of South Africa's groundwater resources has thus garnered substantial focus and attention on the necessity for a proactive strategy to protecting these sources from contamination (Lynch et al., 1994). Groundwater protection must be prioritized based on an aquifer's vulnerability to pollution. This can be accomplished in two ways: I through pollution risk assessments and ii) through aquifer vulnerability evaluations. Aquifer vulnerability considers the characteristics of the aquifer itself or parts of the aquifer in terms of their sensitivity to being adversely affected by a contaminant should it be released, whereas pollution risk assessments consider the characteristics of a specific pollutant, including source and loading.

The concept of the DRASTIC model created for the United States (Aller et al., 1987) is well suited for developing a groundwater vulnerability evaluation for South African aquifers. The DRASTIC assesses an aquifer's inherent vulnerability (IV) by taking into account characteristics such as depth to the water table, natural recharge rates, aquifer media, soil media, topographic aspect, impact of vadose zone media, and hydraulic conductivity. Different ratings are assigned to each factor, which are then added together with the appropriate constant weights to yield a numerical number that quantifies the vulnerability:

DRASTIC Index (IV) = *DrDw + RrRw+ ArAw + SrSw + TrTw + IrIw + CrCw*

Where *D, R, A, S, T, I,* and *C* are the parameters, r is the rating value, and w the constant weight assigned to each parameter (Lynch et al, 1994). The scores associated with the vulnerability of South African aquifers are shown in **Error! Reference source not found.**.

Table 3-2: South African National Groundwater Vulnerability Index to Pollution (Lynch et al, 1994)

Score	Vulnerability
50-87	Least susceptible
87 - 109	Moderate susceptible
109 - 226	Most susceptible

3.2. Quality Assurance and Quality Control Program

A quality assurance and quality control (QA/QC) procedure was used to determine whether the sampling and analytical results were reliable in accordance with industry standards. The QA/QC program was divided into two parts (described below), one completed by the laboratory and the other as part of Tale Enviro routine field procedures.

3.2.1. Laboratory QA/QC Program

Regan Laboratory analyse groundwater samples. The South African National Association of Standards has accredited the laboratory (SANAS). Calibrations, blanks, duplicates, and/or verification are all part of the internal quality method for batch samples.

To preserve sample integrity, every time-sensitive analysis is performed promptly (where preservation is not possible). The results are also compared with separate tests components/elements of overlap, such as the GRO ranges seen in TPH ranges. For trend analysis, all verifications are imported into control charts.

Laboratory equipment is calibrated and/or validated according to a maintenance schedule. The laboratory's quality manager and SANAS both audit the quality system.

3.2.2. Field QA/QC Program

Tale Enviro takes blind duplicate groundwater samples to ensure the reliability of laboratory tests and field sampling. At least one groundwater blind duplicate was collected and sent to the laboratory for BTEXN, MTBE, and TAME analyses.

The relative percent difference (RPD2) is calculated as a measure of QA/QC based on the findings of the duplicate analysis. Because analytical error increases towards the method detection limit (MDL), the RPD is generally not calculated till the concentrations of both the original and duplicate samples exceed five times the MDL. If the RPD for a sample and its duplicate do not fulfil Tale Enviro's RPD standards for the parameters tested, an explanation is required to qualify the value discrepancy.

To confirm that QA/QC guidelines were followed, trip blanks were submitted to the laboratory for the same analysis and computation procedure. Each cooler box received one trip blank.

Tale Enviro employs a data quality evaluation program that considers both duplicate and trip blank data when assessing the trustworthiness of field data.

4. SITE BACKGROUND INFORMATION

4.1. Location

Investigated site IS situated north of the town Marble Hall, Thembelihle Ephraim Mogale Local Municipality under Sekhukhune District Municipality, within the Limpopo province of South Africa. Farm is located 10km north of Marble Hall.

The location of investigated site relative to Marble Hall town is shown in Figure 4-1.

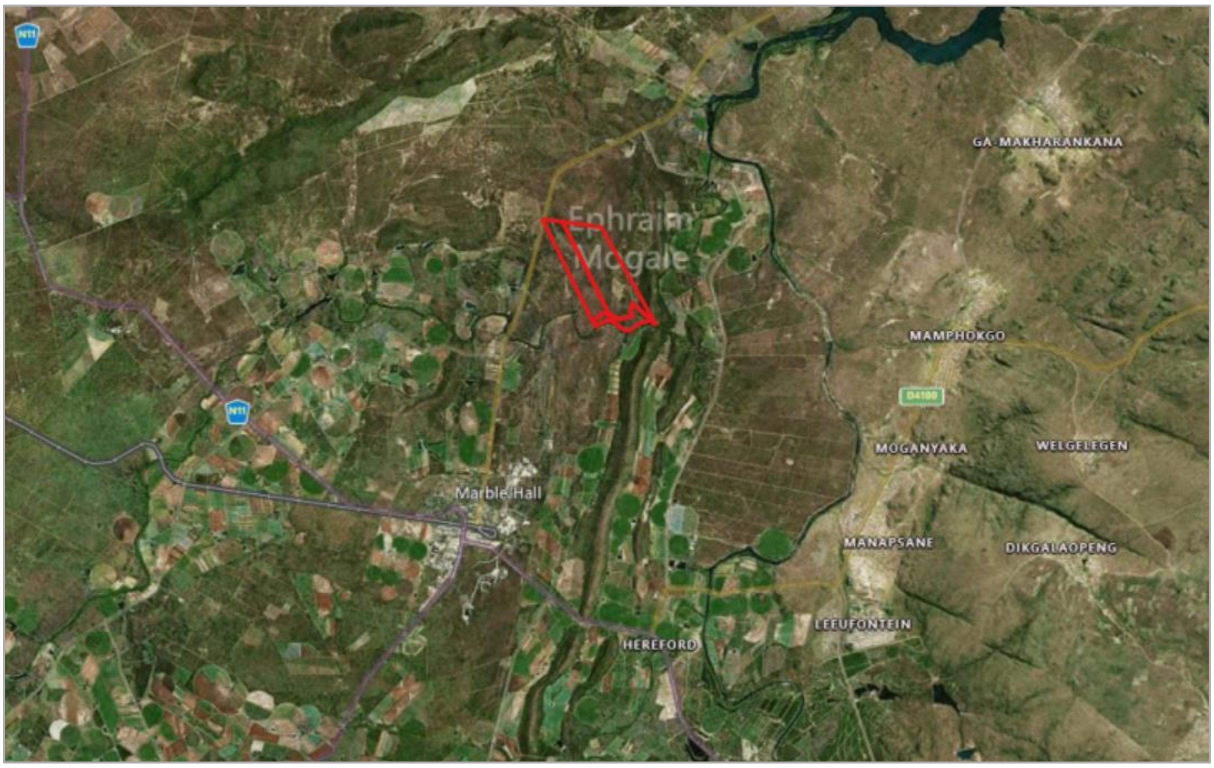


Figure 4-1: Locality Map

4.2. Water Management Area (WMA)

The project is located under Olifants Water Management Area within B31J quaternary catchment as shown in Figure 4-2. The Olifants Water Management Area is located on the northeastern part of the Republic of South Africa and includes portions of the following provinces: the eastern part of Gauteng, the northern part of Mpumalanga Province and the south-eastern part of the Northern Province. The large urban centers in the WMA are Witbank and Middelburg, while towns of significance include Bronkhorstspruit, Groblersdal, Lydenburg, Belfast, Phalaborwa and Lebowakgomo. The Olifants River catchment area constitutes the WMA.

The main stem of the Olifants River originates in the far southern, Highveld region of the WMA. In this Upper Region (secondary catchment area B10) the altitude in the south is in the order of 1 700 m and in the vicinity of Middelburg 1 500 m.

The Middle Olifants River section is taken from the Elands River confluence to the Olifants River at Bewaarkloof, where the river flows northeast between the Springbokvlakte and the Nebo Plateau (around Jane Furse).

The altitude in the catchment is 1 000 m in the Springbokvlakte and east of the river, about 1 500 m on the plateau.

The major portion of the Springbokvlakte is a local endoreic area, as shown in Figure 2.1.3. The endoreic area boundaries were taken from Midgley et al (1994). However, all the figures show rivers draining this area. The GIS River coverage used in the figures was obtained from DWAF but inspection of 1:250 000 maps does not show continuous rivers draining quaternary catchments B31J, B51E and part of B31E. The river coverage should be improved in these catchments.

The Olifants River flows generally eastwards from Lebowakgoma, in deep valleys west of the Escarpment and exiting onto the Lowveld at quaternary catchment boundary B71G/H. In the Lowveld region the altitude is at about 400 m (to 250 m in the Kruger National Park).

The major rivers contributing to the Olifants River are the following:

- The Rietspruit, the Steenkoolspruit and the Viskuile that confluences to form the main stem of the Olifants River south of Witbank. The Klein Olifants River is to the east of the tributaries above and joins the river northwest of Middelburg.
- The Wilge and Koffiespruit Rivers drains the area to the west of the main stem and join the Olifants River north of Witbank.
- The Moses and Elands Rivers drain the western part of the region south of the endoreic Springbokvlakte and the Elands River confluences with the Olifants River upstream of Arabie Dam.
- The Steelpoort River, and its tributaries the Dwars and Spekboom Rivers, drains a large area in the east, rising near Belfast and Lydenburg.
- The Blyde and Klaserie Rivers originates east of the Steelpoort River on the western mountainous area of the Escarpment. The Blyde River has its confluence with the Olifants River in the Lowveld region.
- The Ga-Selati River flows north of the main stream, in the Lowveld region, and originates on the eastern face of the Escarpment.

- ❖ The last tributary, and by far the largest, is the Letaba River which joins the Olifants River virtually on the Mozambican border.

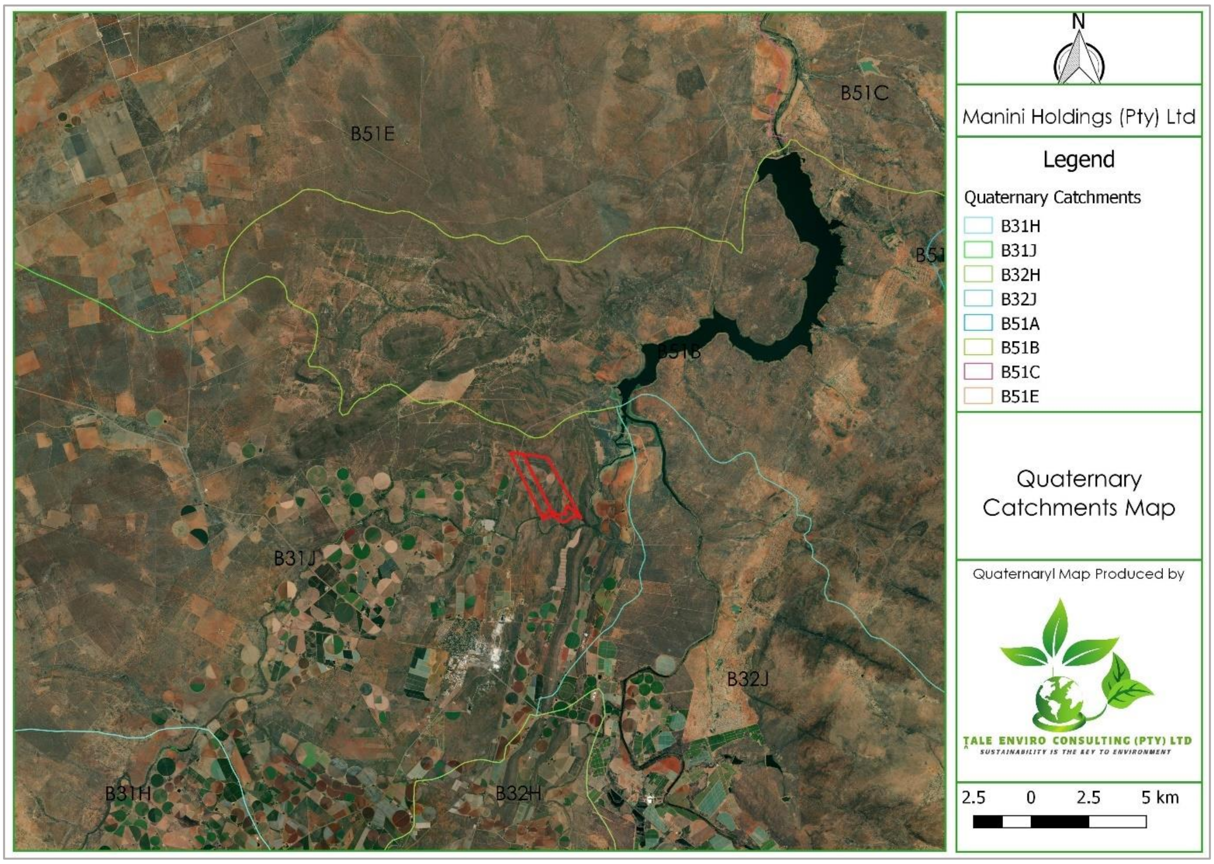


Figure 4-2: Quaternary Catchment Map

4.3. Climate

The average temperatures show moderate fluctuation with average summer temperature 23°C, with a maximum of 28°C and a minimum of 18°C. In winter the average is 13, 5°C with a maximum of 20°C and a minimum of 7°C as measured at the Sekhukhune Land Weather Station.

4.4. Topography and Drainage

To the south-west of the municipal area the Olifants River is located on an open floodplain area and to the north the river is located in a valley surrounded by the Strydpoort Mountains (parallel hills and lowlands). Strips of erosion can be found in the valleys alongside most of the perennial and nonperennial rivers.

The region is generally characterised by an extremely broken topography, bounded in the north by rugged mountainous terrain (Button, 1973) which is underlain by intensely deformed volcano-sedimentary sequences of the Wolkberg Group and dolomites and banded iron-formation of the Chuniespoort Group, and to the south by argillaceous and arenaceous rocks of the Pretoria Group. The altitude varies from 780 m above mean sea level (mamsl) along the Olifants River to approximately 2 300 mamsl at the top of escarpment. The topography of the region closely follows the geological variations.

The Olifants River flows through the study area in an easterly direction, from west through the escarpment (Figure 1), before flowing out towards the Lowveld and across the border into Mozambique, with the Steelpoort and Blyde Rivers being the major tributaries. Numerous ephemeral streams join the Olifants River, but other notable perennial tributaries include the Blyde, Mohlapitsi and Ohrigstad Rivers.

4.5. Geological Setting

4.5.1. Regional Geology

The south-western part of Marble Hall is underlain by the acid and intermediate intrusive rocks of the Waterberg Group, as well as small areas of mafic and ultramafic formations. The western portion is underlain by extensive Karoo Supergroup formations, principally basalts of the Lebombo Group and Clarens Formation sandstones, with smaller areas of Ecca Group shales, siltstones and mudstones. The central and eastern portions are underlain by a variety of rocks of the Bushveld igneous Complex. The most important of these are the Lebowa Granite suite, with outcrops of the Rashoop Granophyre Suite, followed by rocks of the Rustenburg Layered Suite further to the north and east. Much of the northern part of the area is underlain by rocks of the Transvaal Sequence, with the silicified sandstones and quartzites of the Black Reef Quartzite Formation being very prominent, together with Chuniespoort dolomites and Pretoria group shales, hornfels and quartzites.

According to Soils occurring in the Marble Hall can be divided into the following groups: In the west: Shallow to moderately deep sandy-clay loam soils on flat and undulating terrain overlying rocks of the Ecca Group, principally shales and silicified sandstones; In the east: Deep, black, blocky vertisols of the Springbok Flats; Moderate to deep sandy loam soils lining long stretches of the Olifants River valley in its middle reaches.

Most of the soils are suitable for commercial agriculture when sufficient water is available. Virtually all of the areas with suitable soils, particularly the area downstream of the Loskop and Flag Boshielo dams, are contained within the jurisdiction of formal irrigation boards or Government Water Control Areas. Further away from the main river channels, land use is given over to small- and medium-scale livestock farming operations. A relatively wide variety of crops are produced on the irrigated and rain-fed areas, primarily maize, wheat, sorghum, cotton, tobacco, Lucerne, potatoes, vegetables, table grapes, sunflowers, and soya bean.

4.5.2. Local Geology

The Paleoproterozoic Duitschland Formation lies stratigraphically beneath the Timeball Hill Formation, which contains the only unequivocal glacial unit of this era in the Transvaal Basin, South Africa. Lithologic evidence in Paleoproterozoic successions of North America, however, indicates the existence of three discrete and potentially global ice ages within this 300 my interval. Carbonates of the Duitschland Formation are significantly enriched in 13C up to +10.1 permil in the upper part of the succession above a notable sequence boundary. In contrast, the lower part of this unit contains carbonates with consistently negative δ13C values. Trace and major element compositions of these carbonates as well as carbon-isotopic compositions of coexisting organic matter support a primary origin for the markedly positive carbon isotope anomaly. The stratigraphic constraints indicate that 13C-enriched carbonates were deposited prior to Paleoproterozoic glaciation in southern Africa, similar to carbonates stratigraphically beneath Neoproterozoic glacial diamictites worldwide. Also mirroring the Neoproterozoic record are strongly negative δ13C values in cap carbonates atop glacial diamictites in Paleoproterozoic strata of Wyoming and Ontario. The litho- and chemostratigraphic constraints indicate that the interval of negative carbon isotope values in well-preserved carbonates of the lower Duitschland Formation may reflect a second Paleoproterozoic ice age in the Transvaal succession. This interpretation is further supported by recently discovered bullet-shaped clasts with striations in diamictite from the basal part of the succession. Thus, the emerging temporal pattern of carbon isotope variations and glaciation in the Paleoproterozoic has a close analogue to Neoproterozoic events, suggesting a coupling of climatic and biogeochemical changes at both ends of the eon.

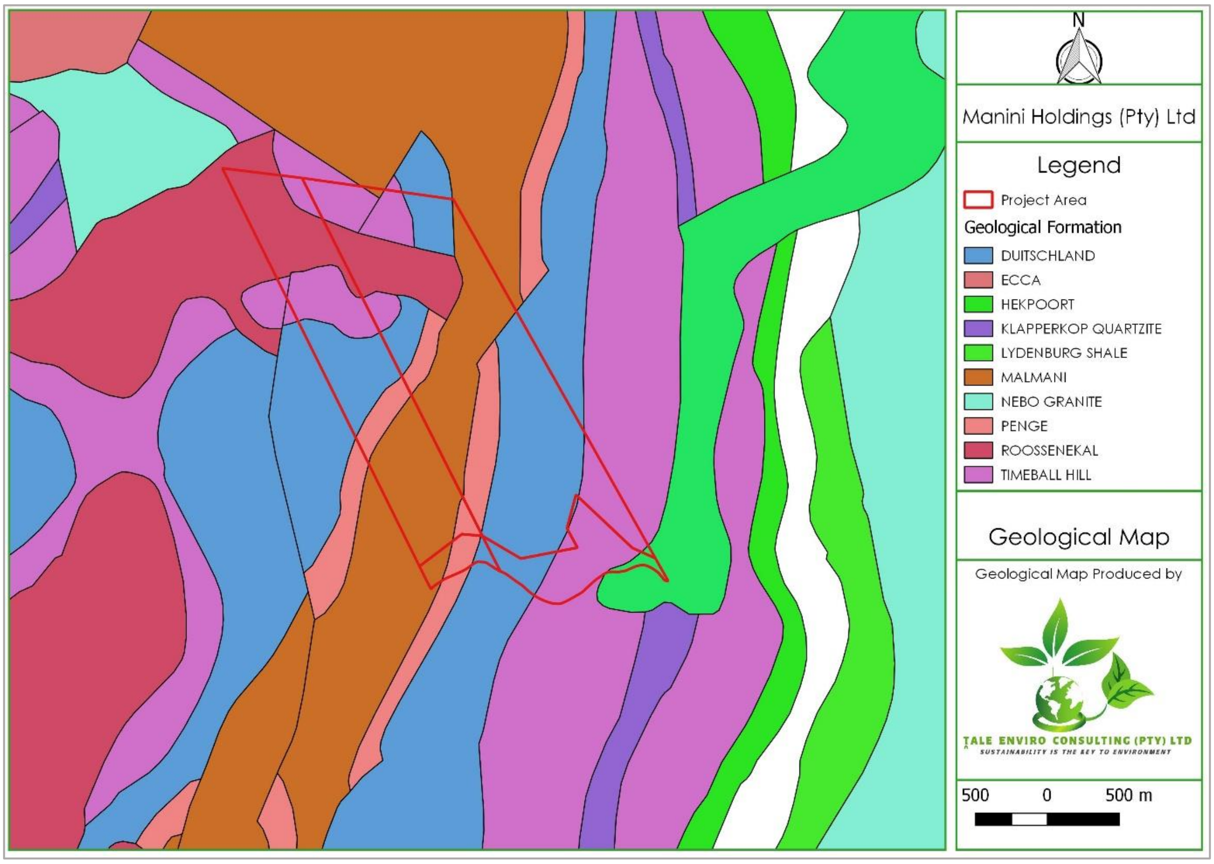


Figure 4-3: Local Geology

4.6. Hydrogeological Setting

The project area is underlain predominantly by strata of the Chuniespoort and Pretoria groups of the Transvaal Supergroup. Rocks of the Halfway House Granites, Ventersdorp Supergroup and Witwatersrand Supergroup underlie minor sections of the area.

The Chuniespoort Group consists of the lower Malmani subgroup (stromatolitic dolomite with chert interbeds) and the upper Penge (banded iron formations) and Duitschland (mixed clastic and carbonate rocks) Formations, which are absent in the study area. Based on the occurrence of interbedded cherts and shales, the variety of stromatolite structures present and the low-angle unconformities the dolomites of the Malmani Subgroup are subdivided into the Oaktree, Monte Christo, Lyttleton, Eccles and Frisco Formations (Button, 1973; SACS, 1980). Karstification has been more active in the chert-rich Eccles and Monte Christo Formations, resulting in good water bearing and storage characteristics (Bredenkamp et al., 1986). An important characteristic of the regional karst aquifer of the Malmani dolomite is its subdivision into 'compartments' isolated hydrogeologically from each other by impervious sub-vertical dykes of dolerite and syenite or by silicified faults.

The entire Transvaal Supergroup originated between 2658±1 Ma and 2224±21 Ma (Eriksson et al., 2001) with the carbonate sequence being deposited over between 2643 and 2520 Ma (Obbes, 2000). The strata dip at angles up to 20° toward the centrally located Bushveld intrusives (Eriksson et al., 1995) in the NW of the study area.

The dolomitic formations generate little surface run-off, suggesting relatively high recharge and predominance of underground water flow, which eventually drains to springs typically associated with dykes, faults or formation contacts.

5. HYDROCENSUS

On August 17, 2022, a site examination (hydrocensus) was carried out. All pertinent onsite visual, chemical, and geological observations were made during this site visit.

- A hydrocensus was conducted in a 2 km radius surrounding the proposed development site. The aim of this census was to;
- Map geological structures via visual and geophysical analysis.
- Determine local urban and rural groundwater dependencies and related influences to local groundwater quality and quantity.
- Chemical sampling of surface water (if applicable) and groundwater to determine current local groundwater quality.

5.1. Recorded Boreholes

During the site investigation, a total of 6 boreholes were recorded within a 2 km radius. Recorded boreholes are expected to reveal local groundwater chemical qualities as well as

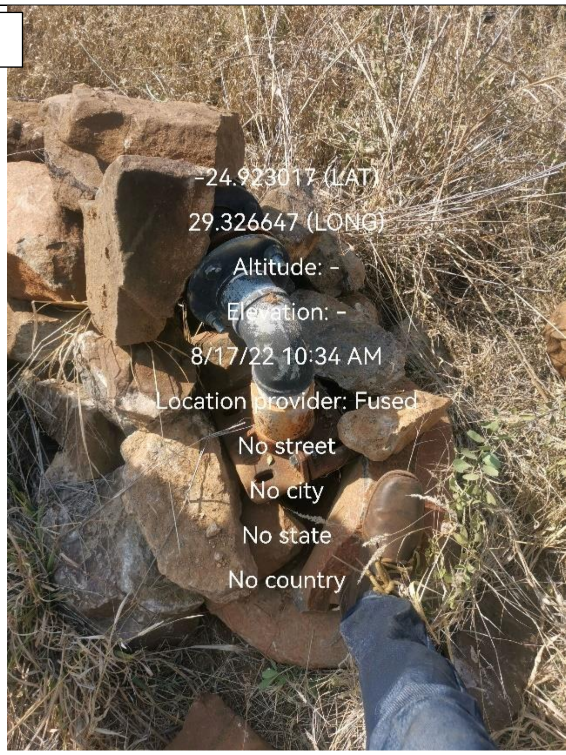
associable groundwater levels and flow directions. The local area surrounding the investigated site was recorded to have a groundwater dependency for crop irrigation and domestic use.

The deepest recorded borehole depth drilled was recorded at 90mgl with the majority of boreholes in use. No specific water devining techniques were used prior to drilling as a general local area was intersected multiple times. It is expected that boreholes BH1-BH3 are directly interlinked within the same aquifer.

Table 5-1: Hydro-census properties

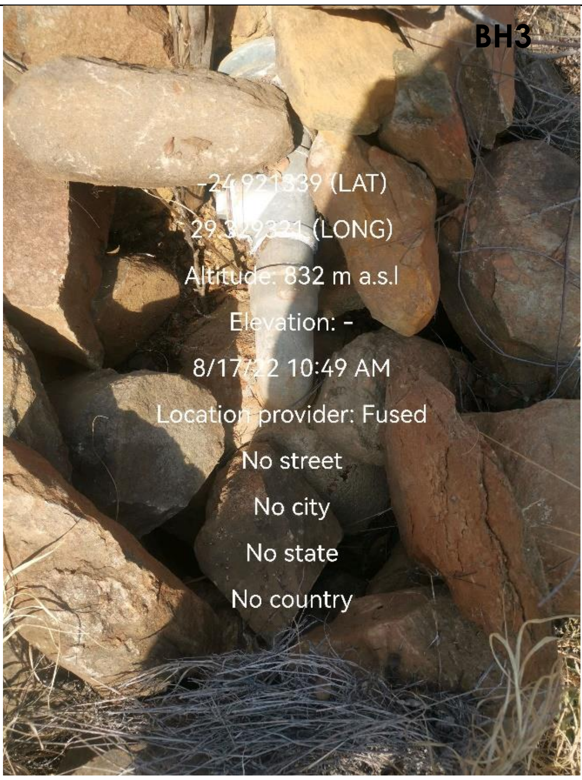
Borehole ID	Latitude	Longitude	Elevation (mamsl)	Water Level (mbgl)	Borehole Depth (m)	Water use	Owner
BH1	-24.923017	29.326647	833	6.1m	51.5m	Irrigation	Thabo
BH2	-24.921578	29.329211	833	7m	30.1m	Irrigation	Thabo
BH3	-24.921339	29.329321	832	5.5m	36.1m	Irrigation	Thabo
BH4	-24.907029	29.323172	869	-	90m	-	Thabo
BH5	-24.905602	29.321767	863	-	50m	Domestic	Thabo
BH6	-24.905204	29.321114	863	-	50m	-	Thabo
Tank	-24.906906	29.323334	869	-	-	Domestic	Thabo
Mini Dam	-24.921915	29.329872	833	-	-	Irrigation	Thabo

BH1

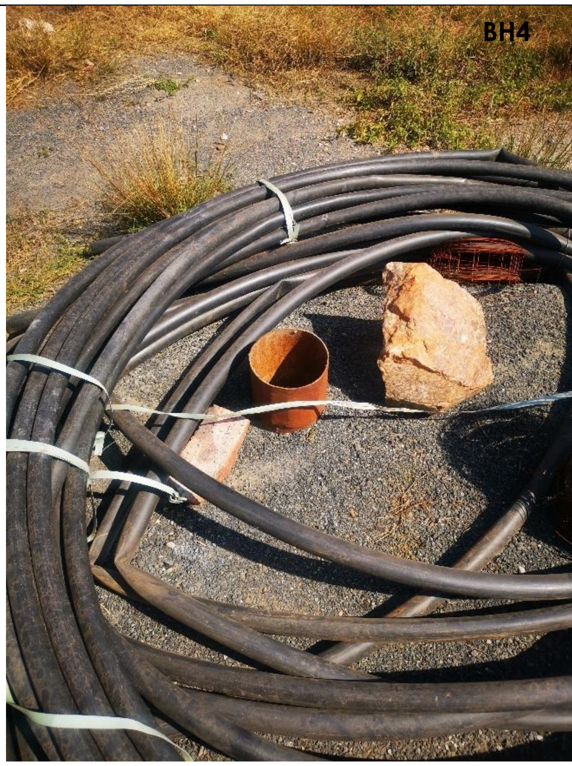


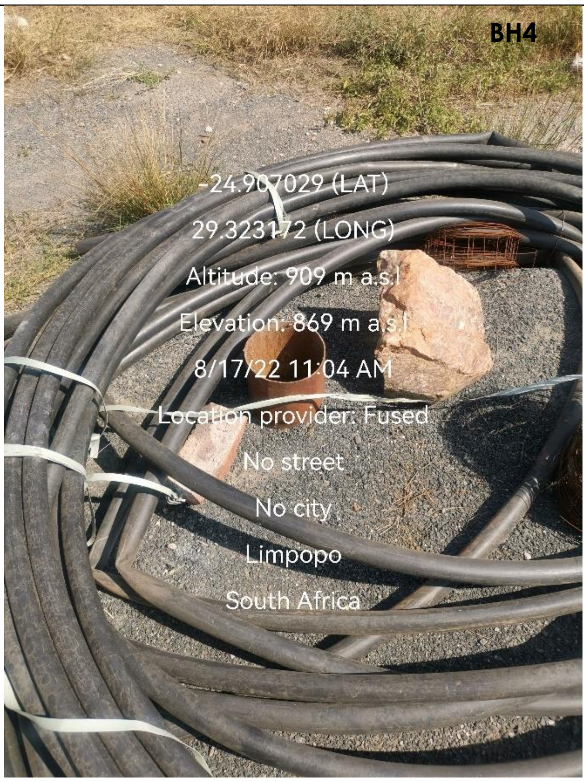
BH2


-24.921578 (LAT)
29.329211 (LONG)
Altitude: 837 m a.s.l
Elevation: 833 m a.s.l
8/17/22 10:39 AM
Location provider: Fused
No street
No city
No state
No country


BH3
-24.921339 (LAT)
29.329321 (LONG)
Altitude: 832 m a.s.l
Elevation: -
8/17/22 10:49 AM
Location provider: Fused
No street
No city
No state
No country


Tank



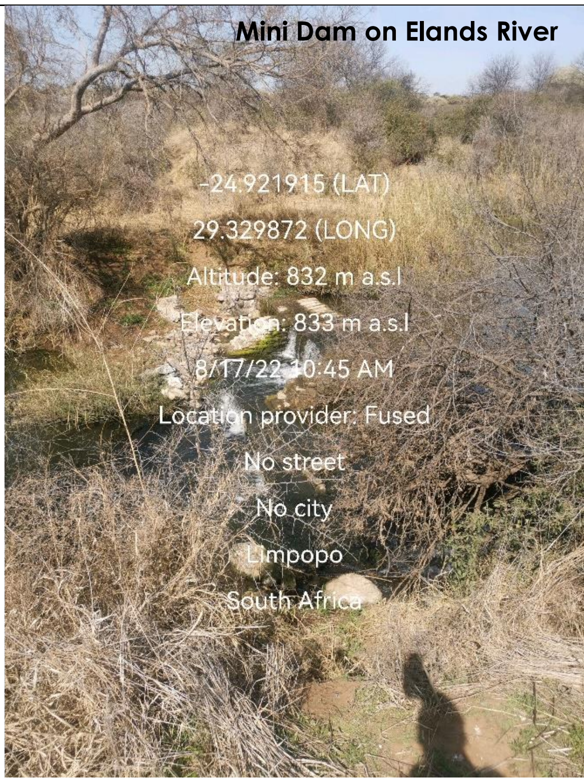


: Tale Enviro Consulting (Pty) Ltd. : 0767 676 4348/081 533 5281. : anthony@taleenviroconsulting.co.za


BH5
-24.905602 (LAT)
29.321767 (LONG)
Altitude: 860 m a.s.l
Elevation: 863 m a.s.l
8/17/22 11:10 AM
Location provider: Fused
No street
No city
No state
No country


BH6


BH6
-24.905208 (LAT)
29.321081 (LONG)
Altitude: 859 m a.s.l
Elevation: 863 m a.s.l
8/17/22 11:15 AM
Location provider: Fused
No street
No city
Limpopo
South Africa


Mini Dam on Elands River
-24.921915 (LAT)
29.329872 (LONG)
Altitude: 832 m a.s.l
Elevation: 833 m a.s.l
8/17/22 10:45 AM
Location provider: Fused
No street
No city
Limpopo
South Africa

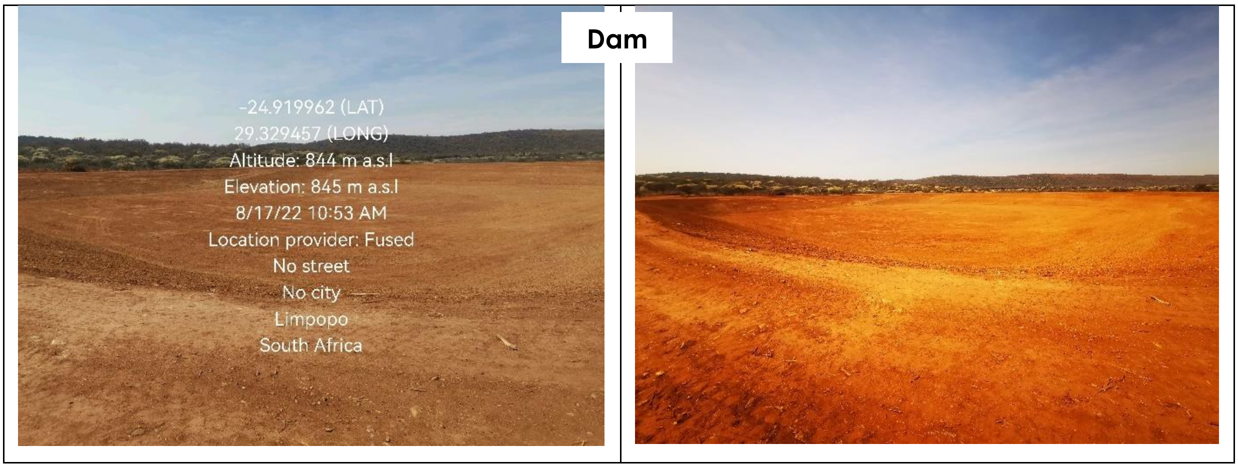


Figure 5-1: Hydro-census

5.2. Water Quality Analysis

Groundwater samples were collected from three boreholes as part of this investigation and taken to an accredited laboratory for examination. These boreholes were collected during site phase to verify that the chemistries analyzed are reflective of pure aquifer conditions (purged borehole) and are not impacted by potential borehole contamination.

Tables below contains a summary of the analysis' findings. The results were then compared to water quality criteria; all parameters examined were within class 1 (recommended levels) of the drinking water quality guidelines. Thus, meaning the groundwater within the farm is of good quality.

Table 5-2: Water Quality Results (Next Borehole)

Analysis Results mg/l		SANS Standards -241: 2015 Drinking WaterStandard Limits	Next Borehole
Total Dissolved Solids	LPM 2	≤ 1 200	1120
Nitrate & Nitrite as N	LPM 76K		<0.1
Nitrate NO_3 as N	LPM 76K	≤ 11	<0.1
Nitrite NO_2 as N	LPM 76K	≤ 0.9	<0.1
Chloride as Cl	LPM 76K	≤ 300	282.0
Total Alkalinity as $CaCO_3$	LPM 11		329
Fluoride as F	LPM 76K	≤ 1.5	0.63
Sulphate as SO_4	LPM 76K	Acute Health ≤ 500 - Aesthetic ≤ 250	187
Total Hardness as $CaCO_3$	LPM 85		600
Calcium Hardness as $CaCO_3$	LPM 85		292
Magnesium Hardness as $CaCO_3$	LPM 85		308
Calcium as Ca	LPM 15		117
Magnesium as Mg	LPM 15		74.8
Sodium as Na	LPM 15	≤ 200	106
Potassium as K	LPM 15		5.28
Iron as Fe	LPM 15	Chronic Health ≤ 2.0 - Aesthetic ≤ 0.3	0.09
Manganese as Mn	LPM 15	Chronic Health ≤ 0.4 - Aesthetic ≤ 0.1	<0.01
Conductivity at 25° C (mS/m)	LPM 51	≤ 170	169
pH Value at 25° C (pH units)	LPM 51	≥ 5.0 to ≤ 9.7	7.91
pHs at 21° Celsius	LPM 85		6.97
Langelier Saturation Index	LPM 85		0.94
Turbidity (NTU)	LPM 23	Operational ≤ 1.0 - Aesthetic ≤ 5.0	0.46
Aluminium as Al	LPM 15	≤ 0.30	0.03

Table 5-3: Water Quality Results (No.1 Borehole)

Analysis Results mg/l		SANS Standards -241: 2015 Drinking WaterStandard Limits	No.1 Borehole
Total Dissolved Solids	LPM 2	≤ 1 200	658
Nitrate & Nitrite as N	LPM 76K		<0.1
Nitrate NO_3 as N	LPM 76K	≤ 11	<0.1
Nitrite NO_2 as N	LPM 76K	≤ 0.9	<0.1
Chloride as Cl	LPM 76K	≤ 300	248
Total Alkalinity as $CaCO_3$	LPM 11		148
Fluoride as F	LPM 76K	≤ 1.5	0.85
Sulphate as SO_4	LPM 76K	Acute Health ≤ 500 - Aesthetic ≤ 250	52.4
Total Hardness as $CaCO_3$	LPM 85		249
Calcium Hardness as $CaCO_3$	LPM 85		95
Magnesium Hardness as $CaCO_3$	LPM 85		154
Calcium as Ca	LPM 15		37.9
Magnesium as Mg	LPM 15		37.5
Sodium as Na	LPM 15	≤ 200	109
Potassium as K	LPM 15		4.97
Iron as Fe	LPM 15	Chronic Health ≤ 2.0 - Aesthetic ≤ 0.3	0.14
Manganese as Mn	LPM 15	Chronic Health ≤ 0.4 - Aesthetic ≤ 0.1	0.04
Conductivity at 25° C (mS/m)	LPM 51	≤ 170	112
pH Value at 25 ° C (pH units)	LPM 51	≥ 5.0 to ≤ 9.7	7.97
pHs at 21° Celsius	LPM 85		7.74
Langelier Saturation Index	LPM 85		0.23
Turbidity (NTU)	LPM 23	Operational ≤ 1.0 - Aesthetic ≤ 5.0	1.83
Aluminium as Al	LPM 15	≤ 0.30	0.04

Table 5-4: Water Quality Results (No.3 Borehole)

Analysis Results mg/l		SANS Standards -241: 2015 Drinking WaterStandard Limits	No.3 Borehole
Total Dissolved Solids	LPM 2	≤ 1 200	1100
Nitrate & Nitrite as N	LPM 76K		0.43
Nitrate NO_3 as N	LPM 76K	≤ 11	0.43
Nitrite NO_2 as N	LPM 76K	≤ 0.9	<0.1
Chloride as Cl	LPM 76K	≤ 300	189
Total Alkalinity as $CaCO_3$	LPM 11		406
Fluoride as F	LPM 76K	≤ 1.5	0.72
Sulphate as SO_4	LPM 76K	Acute Health ≤ 500 - Aesthetic ≤ 250	169
Total Hardness as $CaCO_3$	LPM 85		604
Calcium Hardness as $CaCO_3$	LPM 85		305
Magnesium Hardness as $CaCO_3$	LPM 85		299
Calcium as Ca	LPM 15		122
Magnesium as Mg	LPM 15		72.6
Sodium as Na	LPM 15	≤ 200	87.5
Potassium as K	LPM 15		3.29
Iron as Fe	LPM 15	Chronic Health ≤ 2.0 - Aesthetic ≤ 0.3	0.02
Manganese as Mn	LPM 15	Chronic Health ≤ 0.4 - Aesthetic ≤ 0.1	0.09
Conductivity at 25° C (mS/m)	LPM 51	≤ 170	150
pH Value at 25° C (pH units)	LPM 51	≥ 5.0 to ≤ 9.7	7.32
pHs at 21° Celsius	LPM 85		6.86
Langelier Saturation Index	LPM 85		0.46
Turbidity (NTU)	LPM 23	Operational ≤ 1.0 - Aesthetic ≤ 5.0	3.00
Aluminium as Al	LPM 15	≤ 0.30	0.03

6. AQUIFER PUMP TEST AND ABSTRACTION SCALE

As part of this study, three (3) boreholes (BH1, BH2 and BH3) were selected to undergo aquifer pump testing.

6.1. Calibration Test

This kind of test entails figuring out how quickly geological formations around the borehole actually flow into it. By drawing water out of the ground at the precise pace at which it is supplied, it is accomplished. The only water that is ultimately extracted is the water that comes into the borehole from the aquifer. If this rate of abstraction is quantified, it indicates the rate at which water exits the borehole from the aquifer, or the aquifer's real yield.

6.2. Constant Rate Discharge Test

The recovery test findings are used to establish the aquifer characteristics, as well as to gauge how quickly the water level recovers and whether the storativity values differ in different parts of the aquifer (Driscoll, 1986). According to the project geohydrologist's specifications, a calibration test, step drawdown test, constant discharge test, or both must come before the recovery test. (SANS 10299-4).

The constant discharge test is used to determine:

- Determine the hydrological properties of an aquifer, such as transmissivity and storativity,
- Compile a conceptual model of the hydraulic scenario of the aquifer, such as the presence of impermeable or recharge barriers.

The test entails monitoring the borehole drawdown while keeping the abstraction rate constant during the test. Kruseman and De Ridder describe the various approaches used to analyze the data acquired from constant discharge experiments (1991). The information and level of reliability required may determine the time of the constant rate test (Weaver, 1993).

The type of test and its duration must be chosen to meet the needed level of reliability, which is determined by the water user's reliance on the borehole(s) and the repercussions (typically financial) of borehole failure (SANS 10299-4).

6.3. Recovery Test

The recovery test findings are used to establish the aquifer parameters, as well as how quickly the water level returns and whether the storativity values change throughout the aquifer (Driscoll, 1986). The recovery test is performed following a calibration test, step drawdown test, or constant discharge test (or both), as specified by the project hydrogeologist. (SANS 10299-4).

It can also indicate the aquifer's extent or the extent and connectiveness of fractures. Switch off the pump at the completion of the pumping test (continuous discharge test or step-drawdown test (or both)) and immediately begin collecting residual drawdown data at the required time intervals until,

- The water level recovers to less than 5% of the total drawdown during the constant discharge test,
- at least three consecutive readings are identical, or
- a time equal to the entire time required for the constant discharge test has elapsed.

It may be preferable to monitor recovery water levels for at least the same duration as the constant discharge test in order to determine whether the aquifer was significantly dewatered during the constant discharge test and to accurately apply the recovery test data for estimating sustainable borehole yields.

6.4. Borehole BH1

The recorded borehole data for BH1

Borehole depth: 51.5 mbgl

Water level: 6.1 mbgl

Abstraction rate: 10 l/s

Duration: 12h

6.5. Borehole BH2

The recorded borehole data for BH1

Borehole depth: 30.1 mbgl

Water level: 7 mbgl

Abstraction rate: 29 l/s

Duration: 12h

6.6. Borehole BH3

The recorded borehole data for BH1

Borehole depth: 36.1 mbgl

Water level: 5.5 mbgl

Abstraction rate: 23 l/s

Duration: 12h

7. GROUNDWATER BALANCE

An Intermediate Groundwater Reserve Determination was conducted for the study area in order to establish the impact on the groundwater reserve as a result of the existing and proposed groundwater abstraction activities.

The Groundwater Reserve Determination takes the following elements into account:

- Effective recharge from rainfall and specific geological circumstances;
- Sub-catchment basic human needs;
- Groundwater input to surface water (baseflow);
- Existing and prospective abstraction; and
- Surplus reserve

The calculations were based on data from the WRC 90 Water Resources of South Africa 2012 Study (WR2012) and the Groundwater Resource Assessment Ver. 2 (GRAII) datasets.

7.1. Quaternary Catchment

Data from important hydrogeological databases, including the Groundwater Resource Directed Measures (GRDM), were collected from the Department of Water and Sanitation. The project area is located within quaternary catchment W51D, as shown in.

Table 7-1: Summarised Quaternary Catchment Information.

Quaternary Catchment	Total Area (km^2)	Recharge (mm/a)	Rainfall (mm/a	Baseflow (mm/a)
B31J	459	64.02 mm (7.3 %)	552	9.94

7.2. Sub-Catchment Delineation

A sub-catchment was delineated with QGIS. The delineated sub-catchment is indicated in Figure 7-1. The total sub-catchment area is in the order of 1.4 km^2

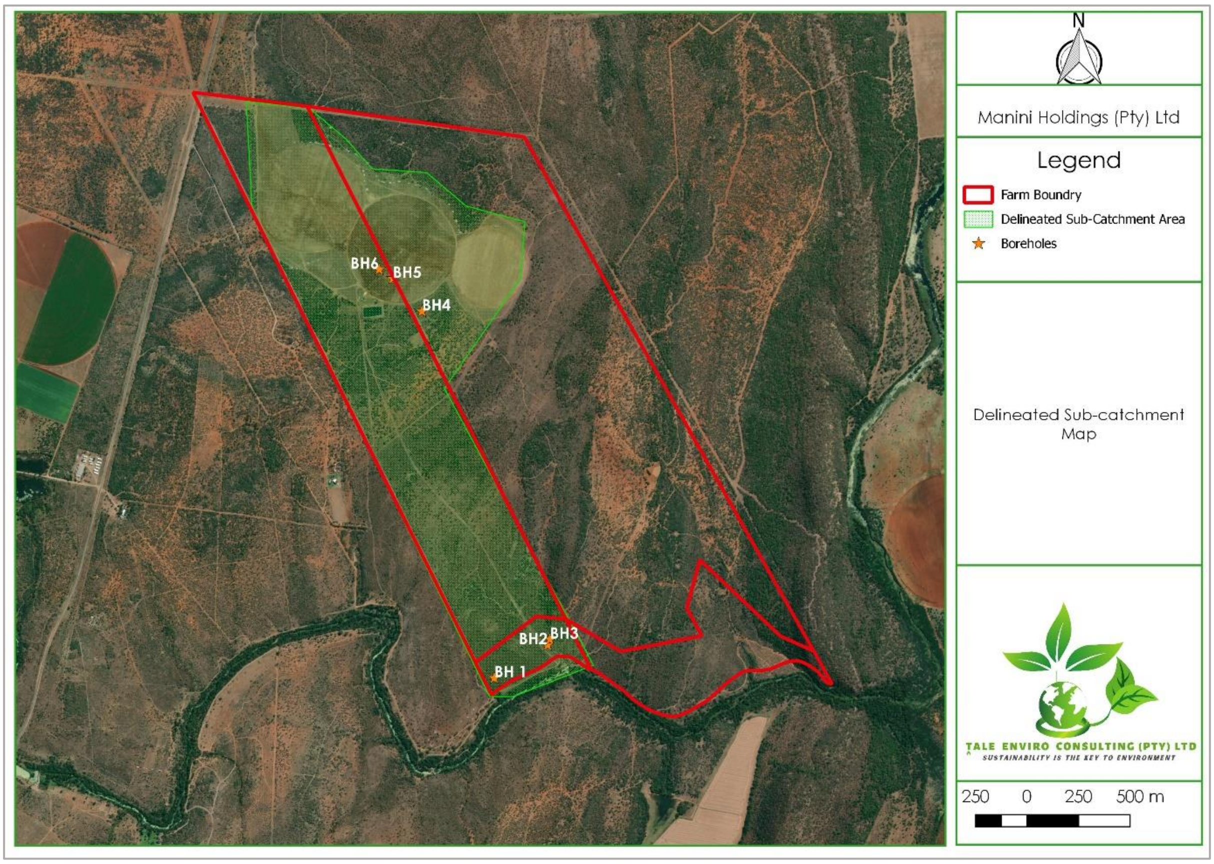


Figure 7-1: Delineated Sub-Catchment

7.3. Groundwater Usage

The irrigation uses 1 369 m³ of water from boreholes each day on average, which corresponds to around 500 000 m³ every year (1 369x 365 days). Groundwater is for irrigation.

The following scenario is assessed in the water balance:

- Abstracting 1 369 m³ per day, which is the average water use per day;

7.4. Groundwater Balance

Table 7-2 summarizes the groundwater balance and thus reserve determination on a sub-catchment scale.

Based on an average water use of 1369 m³/day, the impact on the groundwater reserve can be considered low. Long-term pumping increases the dewatering impact, yet there is still a surplus of groundwater accessible. As a result, the total influence on aquifer safe yield can be judged low to relatively low for all four situations.

Table 7-2: Groundwater Balance Summary

Overview	Calculation

▪ Based on the literature, recharge in the order of 7.65% is assumed for the study area (41.1 mm/a)
▪ The water balance did not include artificial recharge from irrigation activities.
▪ It is assumed that there are no protective groundwater areas.
▪ The Basic Human Needs (BHN) are set by the Water Services Act, 1997 (Act No. 108 of 1997) (WSA) at 25 l per person per day. Groundwater is used for irrigation and staff.
    ▪ There are 17 people working at the farm meaning there are 17 users of groundwater for drinking. This equates to approx. 425 l/day for drinking purposes.
▪ Existing water use is estimated to be 1 369 m³/day.
▪ Baseflow is the low flow in a river during dry or fair weather, however it does not always contribute to groundwater.
▪ Baseflow comprises both delayed interflow and groundwater discharge. The estimated average baseflow is:
▪ 1.4 km² = 9.94 mm/a
▪ Proposed water:
  ▪ 1 369 m³
	GWavailable = (Re) - (BHN + BF)
	
	Where:
	Gwavailable = Available groundwater for use
	Re = Effective recharge to aquifer
	BF = Baseflow to surface water streams
	BHN = Basic Human Needs
	
	Calculations:
	Re (sub catchment) = 1.4 km² x 41.2 mm/a = 57 680 000 m³/a (158 027.6m³/day)
	
	BHN = 1 m³/day
	
	BF = 9.94 mm x 1.4 km² = 13 916 000 m³/a = 38 126 m³/day)
	
	Gwavailable = (57 680 000 - [1+ 38 126]) m³ = + 57 679 960 m³/day

7.5. Scale of Existing Abstraction

According to the "Requirements for Water Use License Application: Groundwater Abstraction [S21(a)]" of the Department of Water and Sanitation (DWS), the license application must be considered in terms of three different categories. Category A, B, and C each have a list of information required for the license application that should be supplied to the DWS by the applicant. The following are the categories:

Small-scale abstractions (<60% recharge) Category A

Medium-scale abstractions (60-100% recharge) Category B

Large-scale abstractions (>100% of recharge) Category C

Size of sub-catchment = 1 400 000 m²

Recharge = 158 027.6 m³/d

Total use volume = BHN (1 m³/d) + Baseflow (38 126 m³/d) + Existing Use (1369 m³/d)

= 39 496 m^3/d

Scale of abstractions = (Total Use/Recharge) ×100

= (39 496 / 158 027.6) ×100

= 25%

As a result, small-scale abstraction (<60% recharge on sub-catchment) will occur, which is classed as **Category A** abstraction.

8. HYDROLOGICAL IMPACT ASSESSMENT AND RISK ASSESSMENT

A variety of elements must be evaluated in order to quantify the risk of a proposed development on the local groundwater regime. The main approaches for measuring groundwater vulnerability include SINTACS, GOD, SEEPAGE, the AVI rating system, ISIS, EPIK, and DRASTIC. In this study, the "DRASTIC" method of analysis will be employed for risk assessment.

The DRASTIC Index (DI) is a model for analysing a specific area's pollution potential, and its name is an acronym created from the seven parameters required for its application. They are as follows:

- Depth to water table
- Recharge (net)
- Aquifer media
- Soil media
- Topography
- Impact of the vadose zone
- Conductivity (Hydraulic)

The classification ratings for these groundwater vulnerability parameters are shown in Table 8-2.

Conductivity classification ratings are given in Table 8-1.

Table 8-1: Ratings for Hydraulic conductivity of different aquifer types

Slope	Hydraulic Conductivity	Rate
Dolomite	1x10ˆ4 – 1x10ˆ2	10
Integranular	1x10ˆ2 – 1x10ˆ1	6
Fractured	1x10ˆ1 – 1x10ˆ-5	3
Fractured and weathered	1x10ˆ1 – 1x10ˆ-1	1

Table 8-2: Ratings assigned to groundwater vulnerability parameters (Lynch et al., 1994)

Depth to groundwater (D_R)		**Net Recharge (R_R)**	
Range (m)	**Rating**	**Range (mm)**	**Rating**
0 – 5	10	0 – 5	1
5 – 15	7	5 – 10	3
15 – 30	3	10 – 50	6
> 30	1	50 – 100	8
		> 100	9

Aquifer Media (A_R)		**Soil Media (S_R)**	
Range	**Rating**	**Range**	**Rating**
Dolomite	10	Sand	8 – 10
Intergranular	8	Shrinking and/or aggregated clay	7 - 8
Fractured	6	Loamy sand	6 - 7
Fractured and weathered	3	Sandy loam	5 - 6
Topography (T_R)		Sandy clay loam and loam	4 - 5
Range (% slope)	**Rating**	Silty clay loam, sandy clay and silty loam	3 - 4
0 – 2	10	Clay loam and silty clay	2 – 3
2 – 6	9		
6 – 12	5		
12 – 18	3		
> 18	1		

Impact of the vadose zone (I_R)	
Range	**Rating**
Gneiss,Namaqua metamorphic rocks	3
Ventersdorp, Pretoria, Griqualand West, Malmesbury, Van Rhynsdorp, Uitenhage, Bokkeveld, Basalt, Waterberg, Soutspansberg, Karoo (northern), Bushveld, Olifantshoek	4
Karoo (southern)	5
Table Mountain, Witteberg, Granite, Natal, Witwatersrand, Rooiberg, Greenstone, Dominion, Jozini	6
Dolomite	9
Beach sands and Kalahari	10

An equation will be used for the pollution potential (DRASTIC Index) as is given below:

DRASTIC Index (DI) = DrDw + RrRW + ArAw + SrSw + TrTw + IrIw + CrCw

Where, r is the rating for the area evaluated and

w is the importance weight of the parameter (normally from 1 to 5) – refer to

Table 8-3: Description of parameter weights used when assessing groundwater vulnerability

Weight	Significance	Description
1	Least	Negligible contribution in factors that have an impact on an aquifer
2	Less	Little effect in enhancement or reduction of vulnerability
3	Moderate	Medium effect
4	More	Consideration in the assessment process AND is crucial due to its properties in relation to aquifer vulnerability>
5	Most	Has the most important properties that could affect aquifer vulnerability.

The weights assigned to these parameters were as follows:

Parameter	Weight
Depth to groundwater (D_w)	5
Recharge (R_w)	4
Soil Media (S_w)	3
Soil Media (Sw)	2
Topography (Tw)	1
Impact of Vadose zone (I_w)	5
Hydraulic Conductivity (C_w)	3

Total DI groundwater vulnerability values will be classified using the values shown below.

- Insignificant (3-5)
- Very low (15-20)
- Low (20-25)
- Moderate (25-30)
- High (30-45)
- Very High (45-60)
- Extreme (60-110)

8.1. Site Analysis

8.1.1. Depth to Groundwater

Local groundwater levels gathered in the local vicinity of the project area were calculated to be 6.1 mbgl.

The depth to groundwater vulnerability importance rating is calculated at 0.2 with a weight of 5 based on information acquired during the site assessment.

8.1.2. Net Recharge

The study area is located in the quaternary catchment B31J. This location has an estimated groundwater recharge rate of 2.6 mm/a. As a result, the net recharge vulnerability significance rating is estimated to be 0.01 with a weight of 4.

8.1.3. Aquifer Media

The study region is projected to be underlain by homogeneous intergranular geology, based on geological data. As a result, an aquifer media vulnerability importance rating of 2.1 with a weight of 3 is estimated.

8.1.4. Hydraulic Conductivity

The hydraulic conductivity of the project area is thought to be closely related to the Malmani and Duitschland formation. This sort of aquifer is projected to have a vulnerability importance rating of one with a weight of three.

8.1.5. Conclusion

The following DRASTIC Index (DI) pollution potential equation can be compiled.

$$\text{DRASTIC Index (DI)} = DrDw + RrRW + ArAw + SrSw + TrTw + IrIw + CrCw$$

$$\text{DRASTIC Index (DI)} = (0,2)(5) + (0.1)(4) + (2.2)(3) + (0,48)(2) + (0.37)(1) + (0.4)(5) + (1)(3)$$

$$\text{DRASTIC Index (DI)} = 13.3$$

The calculated DRASTIC Index (DI) suggests that the project area exhibit a susceptibility and vulnerability rating ranging of **INSIGNIFICANT.**

8.2. Potential Geohydrological Impacts and Mitigation Measures

Risk assessment requires understanding the genesis of a danger, the likelihood that the hazard will occur, and the repercussions if it does occur.

Key assumptions made:

- Saturated hydraulic conductivities are correlated with aquifer rock values in the literature.
- The risk/impact analysis takes a worst-case scenario approach.
- Groundwater resembles topography.
- The risk/impact evaluation for the site is based on the topography, groundwater flow direction, groundwater levels, geology, geophysical data, and aquifer system features.

Table 8-4: Potential geohydrological impacts and mitigation measures

Geohydrological Impact	**Potential Impact**	**Environmental Significance of Impact**							**Mitigation Measure Proposed**
		M	**D**	**S**	**P**	**Total**	**Status**	**SP**	
Aquifer dewatering	Over pumping of boreholes could promote the formation of algae (iron-related microorganisms), blocking the pump components; and	2	1	1	2	8	-	L	Water levels monitoring on a regular basis.
	If substantial amounts of water are withdrawn from the area without any recharge (i.e., during dry months), the risk of dewatering the aquifer and shutting fractures is high. Because fractures may collapse, long-term borehole utilization will be reduced.	2	1	1	2	8	-	L	If substantial amounts of water are withdrawn from the area without any recharge (i.e., during dry months), the risk of dewatering the aquifer and shutting fractures is high. Because fractures may collapse, long-term borehole utilization will be reduced.
Boreholes for Groundwater Abstraction - Primary Groundwater Receivers	Pesticides and other sprayed chemicals on crops could impact groundwater quality.	4	2	1	2	23	-	L	Monitoring of water quality and visual inspections
Perennial River Elands is the primary surface water receiver.	Water quality degradation at the Elands River (perennial stream) and non-perennial downstream of the farm.	5	2	1	2	48	-	M	Monitoring of water quality and visual inspections

Where S = scale of magnitude, D = duration of activity, S = Scale of activity, P = Probability of occurrence, (-) = negative impact type, SP = Significance Points / Potential Impact,

L : Low (negative) >-30

M : Medium (negative) -30 to -60

H : High (negative) <-60

9. GROUNDWATER MONITORING SYSTEM

9.1. Groundwater monitoring system

Groundwater management options for this type of project are restricted, and the emphasis is on contamination prevention rather than treatment. Early detection of contamination is critical for efficiently reacting to and managing any potential sources of pollution. This will aid in determining potential future implications of agricultural operations on groundwater habitats. The groundwater monitoring for this project should be conducted quarterly.

9.2. System response monitoring network

9.2.1. Water Level

To detect any changes or trends in groundwater flow direction, groundwater levels must be recorded quarterly using an electrical contact tape or pressure transducer. Contamination from the pesticides as well as other agricultural chemicals can contaminate the underlying aquifers.

Proposed monitoring boreholes should be established to monitor for changes in groundwater level and quality near crops field.

9.2.2. Sampling Method and Preservation

- Most sampling exercises necessitate the use of one-litre plastic bottles with a plastic cap and no lining within the cap. If organic ingredients are to be examined, glass bottles are necessary. The borehole name, date of sampling, water level depth, and sampler's name should be properly labelled on sample bottles.
- Prior to obtaining the sample, water levels (mbgl) should be determined with a dip meter. To assure sampling of the aquifer rather than stagnant water in the casing, each borehole to be sampled should be purged with a submersible pump or, in the case of a small diameter borehole, a clean disposable polyethylene bailer. Until the electrical conductivity value stabilizes, at least three borehole volumes of water should be evacuated either purging or continual water quality monitoring. To remove clay suspensions from metal samples, they must be filtered in the field.
- In the field, samples should be kept cool in a cooler box and kept cool before being submitted to the laboratory; and

- ❖ The pH and EC meter used for field measurements should be calibrated daily using standard solutions obtained from the instrument supplier.

9.2.3. Sampling Locations

The main objectives in positioning the monitoring boreholes are for:

- ❖ Monitoring of groundwater migrating away from the crops field area and
- ❖ Monitoring the lowering of the water table and the radius of influence.

9.2.4. Data Management

Good hydrogeological judgments in any project necessitate good information derived from raw data. The ability to generate good, relevant, and timely information is essential for achieving qualified long-term and short-term strategies. To reduce groundwater contamination, it is vital to use all relevant groundwater data.

During the course of this inquiry, an excel-based database was used, and it is advised that database be used and regularly updated to maintain it as new data becomes available. Monitoring results should be recorded in an electronic database as soon as they are available, allowing for:

- ❖ Data presentation in tabular format
- ❖ Time-series graphs with comparison abilities
- ❖ Graphical presentation of statistics
- ❖ Presentation of data, statistics and performance on diagrams and maps and
- ❖ Comparison and compliance to legal and best practice water quality standards.

9.2.5. Monitoring points, monitoring frequency and chemistry analyses

Table 9-1 summarizes the proposed (current and new points) monitoring points and monitoring frequencies. The proposed laboratory analysis parameters have been added to the last column.

Table 9-1: Monitoring points, monitoring frequency and laboratory analyses

Borehole ID	Latitude	Longitude	Site Type	Frequency	Field	Lab
BH1	-24.923017	29.326647	Groundwater	Quarterly and Monthly	Monthly inspections of all boreholes. Water levels in actively pumping boreholes should be measured regularly (monthly), while other boreholes should be measured quarterly. Quarterly sampling of all boreholes.	pH, EC, HCO3, Ca, Mg, Na, K, F, Cl, SO_4, NH_3, PO_4
BH2	-24.921578	29.329211	Groundwater			
BH3	-24.921339	29.329321	Groundwater			
BH4	-24.907029	29.323172	Groundwater			
BH5	-24.905602	29.321767	Groundwater			
BH6	-24.905204	29.321114	Groundwater			
Upstream	-24.92365	29.32647	Surface Water	Bi-Monthly (Every 2nd Month)	All surface water sites are inspected monthly. Water quality is sampled bimonthly.	Constituents within the WUL or General Authorisation Limits (Government Gazette No. 20526, 8 October 1999) - General Wastewater Limits
Instream Dam	-24.921915	29.329872	Surface Water			
Down Stream	-24.92348	29.34287	Surface Water			

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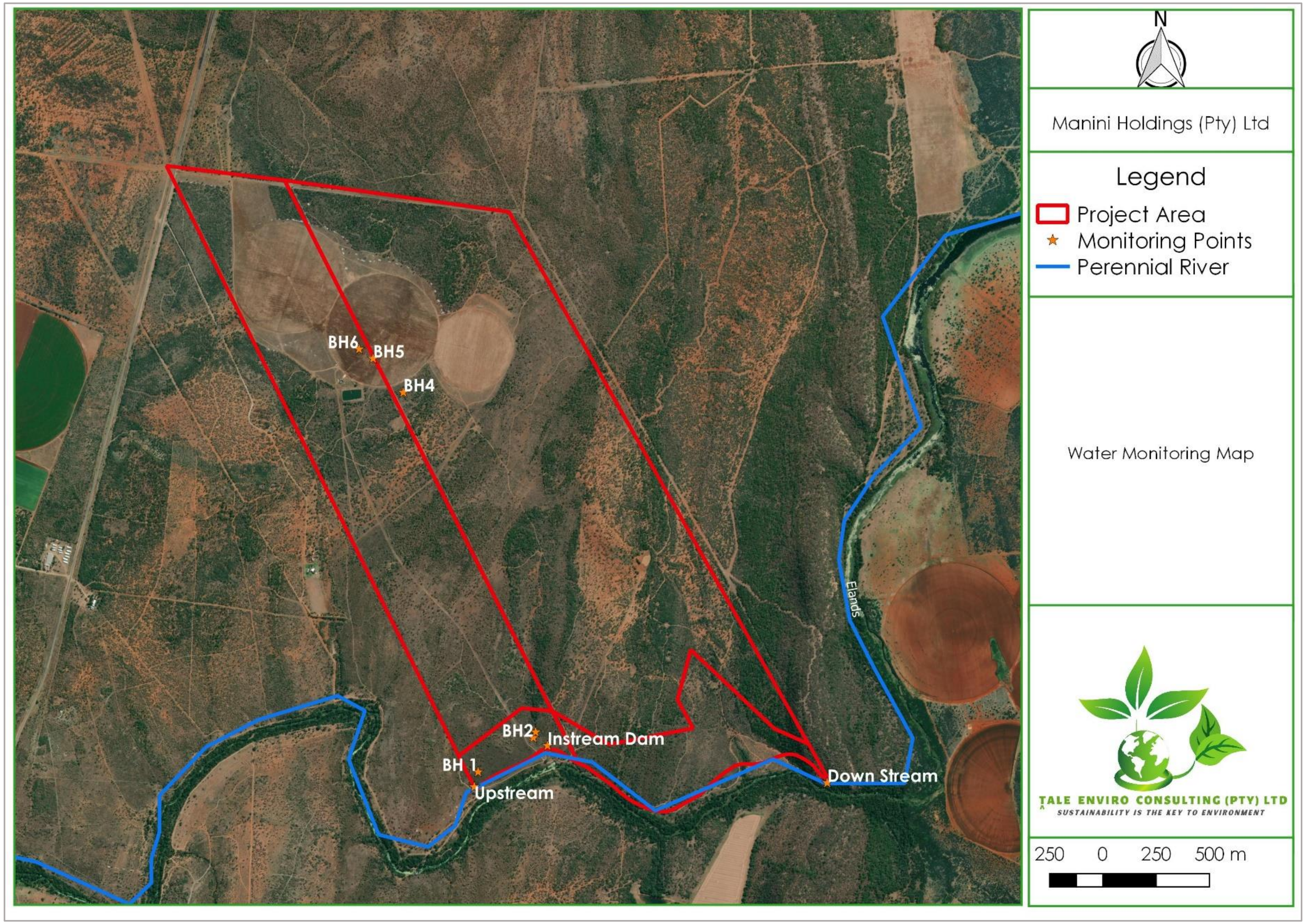


Figure 9-1: Proposed Monitoring Points

10. OVERALL CONCLUSION AND RECOMMENDATIONS

The likelihood of groundwater pollution is inversely correlated with the activity's type. The outcomes of a thorough desktop and site inquiry could be summarized as follows:

10.1. Conclusion

- The project is situated in a region with limited aquifer systems and low producing boreholes projected. The predicted range for groundwater quality is 70–150 mS/m. It can be expected that the aquifer has a low susceptibility for pollution given that the study region is situated inside a minor aquifer system.
- During a hydrocensus, a total of 6 usable boreholes were counted. Groundwater dependence was noted in the neighborhood surrounding the analysed location; however, it was limited to domestic and agricultural irrigation.

10.2. Recommendations

Based on geohydrological data, the planned agricultural development may only be taken into consideration if the following recommendations are taken into consideration:

- Use soil management techniques to prevent moving water from eroding the margin of an irrigated field, such as creating grassed waterways and vegetative buffers.
- To change the seasonal water use patterns in relation to the precipitation patterns, use more varied crop rotations.
- Usage optimum management methods for irrigation to safeguard water quality and increase water use effectiveness.
- Improve the rate, form, and positioning of when you apply fertilizer, manure, and pesticides.
- Implement landscaping techniques, such as buffer strips, biofilters, controlled drainage systems, etc., to offer a potential means of catching sediment, nutrients, pathogens, and pesticides before they are delivered into streams or rivers

BIBLIOGRAPHY

Kate Robey (2014) A Feasibility Study of In-situ Iron Removal in the Atlantis Primary Aquifer, Western Cape Province, South Africa.

Water Resources Maps (2005)

Peel, M. C.; Finlayson, B. L.; McMahon, T. A. (March 1, 2007). "Updated world map of the Koppen-Geiger climate classification

APPENDIX 1: SITE PICTURES

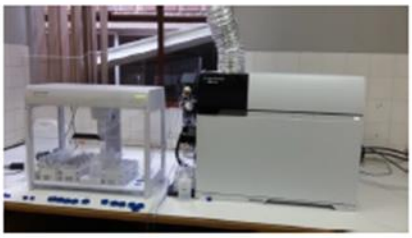
APPENDIX 1: REGEN WATERS INSTRUMENTATION DESCRIPTION

sanas Testing Laboratory T0156

REGEN WATERS
LABORATORY • LABORATORIUM

4 Woltemade Street
P.O. Box 8328
WITBANK 1035
Tel.: 013-690-1487
Fax: 013-656-5050
E-mail: regenlab@mweb.co.za

Regen Waters Instrumentation Description

Instrument	Disruption	Photo
Agilent 5110 ICP-OES	This state of the art instrument is very sensitive and used for metal analysis. Regen Waters has two Agilent 5110 ICPs in operation to prevent delays due to downtime.	
Agilent ICP/MS	This instrument is used for metal analysis. Because of the mass spectrometer as detector the ICP/MS is a very sensitive instrument that can detect very low concentrations which makes it ideal for rare metal analysis.	

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Instrument	Disruption	Photo
Agilent GC/MS with headspace and Gerstel MPS auto-samplers	This instrument is used for organic analysis (example THM, VOC, Phenols, Diesel Range Organics, PAH etc). The auto-samplers make it possible for this instrument to perform Headspace, Liquid, SPME and SBSE analysis.	
Thermo Scientific Discrete analysers	These instruments are used for nutrient analysis (Chloride, Fluoride, Nitrate, Nitrite, Ammonia, Otrho-Phosphate). Each instrument has the capability of performing up to 1600 analysis per day. They can perform automatic dilutions for over range samples thus eliminating the need for later dilutions and completing entire analysis sets in one segment.	 

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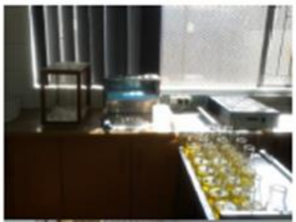
Instrument	Disruption	Photo
Chemical Oxygen Demand(COD) open and Closed reflux analysis	Regen Waters uses two different setups for COD analysis, open and closed reflux analysis. Chemical oxygen demand (COD) tests are commonly used to indirectly measure the amount of organic compounds in water.	 
Turbidity	Regen Waters uses an automated Mantech system and a HACH 2100 meter for the analysis of turbidity. The automated system with a 122 space auto-sampler tray allows Regen Waters to analyse the samples as they are received by the laboratory. The Mantech system has an intellirinse setup, that rinses until the system reaches a low turbidity.	 

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Instrument	Disruption	Photo
Sievers TOC/DOC analyser	This fully automated system is equipped with an ICR unit to remove the inorganic carbon that cause erratic and error prone TOC readings. Dissolved organic carbon (DOC) is defined as the organic matter that is able to pass through a filter (filters generally range in size between 0.7 and 0.22 um). Total organic carbon (TOC) is the amount of carbon bound in an organic compound and is often used as a non-specific indicator of water quality or cleanliness of pharmaceutical manufacturing equipment.	 
Mettler Acidity Titrator	This automated system is used to determine the acidity of a sample by titration with sodium hydroxide solutions.	

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Instrument	Disruption	Photo
Mantech Acidity and Alkalinity Titrator	This automated system has the ability to determine acidity and alkalinity of water samples. Different titrants are used depending on the analysis and the sample is titrated to a specific end point. The system measures the volume of sample required for analysis and then adds the correct solution until the desired pH has been obtained.	
Orion pH and Conductivity meter	Automated pH and conductivity system with automated calibration before each set of samples and quality control samples during the set. The system has 3 rinse stations to prevent contamination.	
Mantech pH and Conductivity Meter	Automated pH and conductivity system with automated calibration before each set of samples and quality control samples during the set. The system has an intellirinse setup, which will prevent analysis to continue if the system is not contaminant free.	

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Instrument	Disruption	Photo
Microbiological analysis	Regen Waters is SANAS accredited for Total Coliform, Faecal Coliform, E.Coli and Heterotrophic Plate Count analysis. These analysis form part of the SANS 241 drinking water standard bacteriological analysis. Regen Waters can perform quantitative Legionella analysis.	    

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Instrument	Disruption	Photo
General Lab Equipment	• Microwave Digestor • Hamilton automated µl pipetting system. • Balances • Ovens, desiccators • 550°C oven for volatile analysis.	

- Incubators, ovens, balances and electronic thermometers used at Regen Waters Laboratory are calibrated on a yearly basis by a SANAS accredited institute. Daily quality control charts are maintained to monitor performance.
- Quality Control samples are analysed periodically during analysis to ensure that the system/ instruments are still performing accurately. Quality Control charts are kept to monitor limits and to prevent bias problems.
- Regen Waters performs validation that correlate with SANAS strict guidelines, which ensures accuracy and method performance.
- Regen Waters participates in proficiency testing schemes as an external check. Regen Waters participate in the SABS, NLA and ERA a Waters company proficiency testing schemes.
- Yearly internal audits are performed where all methods are reviewed and personnel competency evaluated. As a SANAS accredited laboratory Regen Waters undergoes external audits by SANAS personnel every 18 months.
- Grade A volumetric glassware are used in the laboratory where applicable. The glassware is verified on a regular basis to ensure its accuracy.
- Regen Waters stays up to date with the latest technology and optimizes methods on a regular basis.

APPENDIX 2: REGEN ACCRIDATION CERTIFICATE

sanas
South African National Accreditation System

CERTIFICATE OF ACCREDITATION

In terms of section 22(2) (b) of the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act, 2006 (Act 19 of 2006), read with sections 23(1), (2) and (3) of the said Act, I hereby certify that:-

REGEN WATERS LABORATORY (PTY) LTD

Co. Reg. No.: 2018/379064/07

Facility Accreditation Number: **T0156**

is a South African National Accreditation System accredited facility provided that all conditions and requirements are complied with

This certificate is valid as per the scope as stated in the accompanying schedule of accreditation, Annexure "A", bearing the above accreditation number for

CHEMICAL AND MICROBIOLOGICAL ANALYSIS

The facility is accredited in accordance with the recognised International Standard

ISO/IEC 17025:2005

The accreditation demonstrates technical competency for a defined scope and the operation of a quality management system

While this certificate remains valid, the Accredited Facility named above is authorised to use the relevant accreditation symbol to issue facility reports and/or certificates

Mr R Josias
Chief Executive Officer

Effective Date: 01 October 2018
Certificate Expires: 30 September 2023

ANNEXURE A

SCHEDULE OF ACCREDITATION

Facility Number: **T0156**

Permanent Address of Laboratory:
Regen Waters Laboratory (Pty) Ltd
4 Woltemade Street
Witbank
1035

Technical Signatories:
Mr PLG Uys (All Methods)
Ms A Kohrs (All Methods)
Ms M Wilding (M67)
Ms M Minnie (M76)

Postal Address:
P O Box 8328
Witbank
1035

Nominated Representative:
Ms A Kohrs

Tel: (013) 690-1487
Fax: (013) 656-5050
E-mail: regenlab@mweb.co.za

Issue No.: 14
Date of Issue: 26 September 2018
Expiry Date: 30 September 2023

Material or Products Tested	Type of Tests / Properties Measured, Range of Measurement	Standard Specifications, Techniques / Equipment Used
CHEMICAL		
Water: Domestic, Sewage, Surface, Borehole, Industrial & Environmental	Determination of total Alkalinity by Titration using H_2SO_4	Method No.11
	Determination of metals by ICP: Sodium as Na, Potassium as K, Iron as Fe, Cobalt as Co, Magnesium as Mg, Aluminium as Al, Cadmium as Cd, Chromium as Cr, Calcium as Ca, Copper as Cu, Nickel as Ni, Lead as Pb, Selenium as Se, Boron as B, Silicon as Si, Vanadium as V, Zinc as Zn, Mercury as Hg, Strontium as Sr, Molybdenum as Mo, Beryllium as Be, Arsenic as As, Thallium as Tl, Lithium as Li, Silver as Ag, Bismuth as Bi, Titanium as Ti, Antimony as Sb , Manganese as Mn and Barium as Ba	Method No.15
	Determination of pH in water sample	Method No.51
	Determination of Electrical Conductivity	Method No.51
	Determination of Total Dissolved Solids	Method No.2
	Determination of Suspended Solids	Method No.1
	Determination of Hexavalent Chromium	Method No.12

Facility Number: T0156

Water, Domestic, Sewage, Surface, Borehole, Industrial & Environmental	Determination of Oxygen Absorbed	Method No.25
	Determination of Chemical Oxygen demand (open reflux)	Method No.6
	Determination of Turbidity	Method No.23
	Determination of Acidity	Method No.35
	Determination of settleable Solids (technique accreditation)	Method No.3
	Total Hardness (Calculation)	Method No.85
	Calcium Hardness (Calculation)	
	Magnesium Hardness (Calculation)	
	Langelier Saturation Index (calculation)	
	Sodium Adsorption Ratio	
	Alkalinity Relationships (Calculation)	
	pHs @ 21°C	
Water: Borehole, Drinking, Sewage, Industrial, Surface & Environmental	Determination of metals by ICP-MS: Aluminium as Al, Cobalt as Co, Cadmium as Cd, Chromium as Cr, Copper as Cu, Nickel as Ni, Lead as Pb, Selenium as Se, Boron as B, Barium as Ba, Vanadium as V, Zinc as Zn, Mercury as Hg, Strontium as Sr, Molybdenum as Mo, Beryllium as Be, Arsenic as As, Thallium as Tl, Lithium as Li, Silver as Ag, Bismuth as Bi, Titanium as Ti, Antimony as Sb, Manganese as Mn, Iron as Fe and Uranium (238) as U	Method No.67
	Determination by Aquakem/Konelab of:	Method No.76
	Nitrate+Nitrite	
	Nitrite	
	Fluoride	
	Chloride	
	Ammonia	
	Sulphate	
	Ortho-Phosphate	
	Determination of Total and Dissolved Organic Carbon concentrations by used of the Sievers analyzer	Method No.68
	Determination of pH, Alkalinity and Acidity by Automated Mantech System	Method No.81
	Determination of pH, Conductivity and Turbidity by Automated Mantech System	Method No.82

Page 2 of 3

Facility Number: T0156

Water: Borehole, Drinking, Sewage, Industrial, Surface & Environmental	Determination Chemical Oxygen Demand using Closed Reflux, Titrimetric methods	Method No.83
Settleable Particulate Matter	Determination of the quantity of Settleable Particulate matter (to estimate the dustfall deposition rate)	Method No.42
MICROBIOLOGY		
Water: Domestic, Sewage, Surface & Borehole	Heterotrophic Plate Counts	SANS 5221
	Total Coliform Counts	
	Faecal Coliform Counts	
Water: Borehole, Domestic, Sewage & Surface	*Escherischia* coli	Colilert
	Total Coliform Counts	

Original Date of Accreditation: 01 October 2003

ISSUED BY THE SOUTH AFRICAN NATIONAL ACCREDITATION SYSTEM

Accreditation Manager

: Tale Enviro Consulting (Pty) Ltd. : 0767 676 4348/081 533 5281. : anthony@taleenviroconsulting.co.za

APPENDIX 4: WATER QUALITY RESULTS CERTIFICATES

sanas Testing Laboratory T0156

CK. 89/14418/23

REGEN WATERS

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BREDELL AGRIC VERSPREIDERS t/a
LAEVELD AGROCHEM MARBLE HALL

P.O. Box 625 , MABRBLE HALL, 0450

CERTIFICATE OF ANALYSIS

Attention :	A. Bredell
Email :	mhinfo@laeveld.co.za
Date received :	16-Mar-2022
Date reported :	22-Mar-2022
Dates analysed :	16-Mar-2022 to 22-Mar-2022
Our Ref :	LAE / 213 - 215 / C / 03 / 22
Quantity Analysed :	3
Lab No:	C 213
Order No: 13848	MANINI HOLDINGS

Analysis Results mg/l		SANS Standards -241: 2015 Drinking Water Standard Limits	Next Borehole
Total Dissolved Solids	LPM 2	≤ 1 200	1120
Nitrate & Nitrite as N	LPM 76K		<0.1
Nitrate NO_3 as N	LPM 76K	≤ 11	<0.1
Nitrite NO_2 as N	LPM 76K	≤ 0.9	<0.1
Chloride as Cl	LPM 76K	≤ 300	282.0
Total Alkalinity as $CaCO_3$	LPM 11		329
Fluoride as F	LPM 76K	≤ 1.5	0.63
Sulphate as SO_4	LPM 76K	Acute Health ≤ 500 - Aesthetic ≤ 250	187
Total Hardness as $CaCO_3$	LPM 85		600
Calcium Hardness as $CaCO_3$	LPM 85		292
Magnesium Hardness as $CaCO_3$	LPM 85		308
Calcium as Ca	LPM 15		117
Magnesium as Mg	LPM 15		74.8
Sodium as Na	LPM 15	≤ 200	106
Potassium as K	LPM 15		5.28
Iron as Fe	LPM 15	Chronic Health ≤ 2.0 - Aesthetic ≤ 0.3	0.09
Manganese as Mn	LPM 15	Chronic Health ≤ 0.4 - Aesthetic ≤ 0.1	<0.01
Conductivity at 25° C (mS/m)	LPM 51	≤ 170	169
pH Value at 25 ° C (pH units)	LPM 51	≥ 5.0 to ≤ 9.7	7.91
pHs at 21° Celsius	LPM 85		6.97
Langelier Saturation Index	LPM 85		0.94
Turbidity (NTU)	LPM 23	Operational ≤ 1.0 - Aesthetic ≤ 5.0	0.46
Aluminium as Al	LPM 15	≤ 0.30	0.03

All heavy metal analyses have been performed on filtered samples. Tests marked with an asterisk * are not SANAS accredited. These results are related only to the items tested. These results must be read in conjunction with the Uncertainty of Measurement list as provided by Regen Waters Laboratory

QUALITY CONTROL CHECKS	
Cation Balance	16.75
Anion Balance	18.45
% Difference	-4.9
Measured TDS	1120
Calculated TDS	973
Limits	1.2
Calc TDS / E.C.	0.6

P.L.G. UYS / A. KOHRS
Technical Signatory
Electronic Signature

: Tale Enviro Consulting (Pty) Ltd. : 0767 676 4348/081 533 5281. : anthony@taleenviroconsulting.co.za

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CK. 89/14418/23
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BREDELL AGRIC VERSPREIDERS t/a
LAEVELD AGROCHEM MARBLE HALL

P.O. Box 625 , MABRBLE HALL, 0450

CERTIFICATE OF ANALYSIS

Attention :	A. Bredell
Email :	mhinfo@laeveld.co.za
Date received :	16-Mar-2022
Date reported :	22-Mar-2022
Dates analysed :	16-Mar-2022 to 22-Mar-2022
Our Ref :	LAE / 213 - 215 / C / 03 / 22
Quantity Analysed :	3
Lab No:	C 214
Order No:	13848

Analysis Results mg/l		SANS Standards -241: 2015 Drinking Water Standard Limits	MANINI HOLDINGS No.1 Borehole
Total Dissolved Solids	LPM 2	≤ 1 200	658
Nitrate & Nitrite as N	LPM 76K		<0.1
Nitrate NO_3 as N	LPM 76K	≤ 11	<0.1
Nitrite NO_2 as N	LPM 76K	≤ 0.9	<0.1
Chloride as Cl	LPM 76K	≤ 300	248
Total Alkalinity as $CaCO_3$	LPM 11		148
Fluoride as F	LPM 76K	≤ 1.5	0.85
Sulphate as SO_4	LPM 76K	Acute Health ≤ 500 - Aesthetic ≤ 250	52.4
Total Hardness as $CaCO_3$	LPM 85		249
Calcium Hardness as $CaCO_3$	LPM 85		95
Magnesium Hardness as $CaCO_3$	LPM 85		154
Calcium as Ca	LPM 15		37.9
Magnesium as Mg	LPM 15		37.5
Sodium as Na	LPM 15	≤ 200	109
Potassium as K	LPM 15		4.97
Iron as Fe	LPM 15	Chronic Health ≤ 2.0 - Aesthetic ≤ 0.3	0.14
Manganese as Mn	LPM 15	Chronic Health ≤ 0.4 - Aesthetic ≤ 0.1	0.04
Conductivity at 25° C (mS/m)	LPM 51	≤ 170	112
pH Value at 25 ° C (pH units)	LPM 51	≥ 5.0 to ≤ 9.7	7.97
pHs at 21° Celsius	LPM 85		7.74
Langelier Saturation Index	LPM 85		0.23
Turbidity (NTU)	LPM 23	Operational ≤ 1.0 - Aesthetic ≤ 5.0	1.83
Aluminium as Al	LPM 15	≤ 0.30	0.04

All heavy metal analyses have been performed on filtered samples. Tests marked with an asterisk * are not SANAS accredited. These results are related only to the items tested. These results must be read in conjunction with the Uncertainty of Measurement list as provided by Regen Waters Laboratory

QUALITY CONTROL CHECKS	
Cation Balance	9.86
Anion Balance	6.38
% Difference	-4.9
Measured TDS	658
Calculated TDS	581
Limits	1.1
Calc TDS / E.C.	0.5

P.L.G. UYS / A. KOHRS
Technical Signatory

CK. 89/14418/23

REGEN WATERS

LABORATORY • LABORATORIUM

sanas Testing Laboratory T0156

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BREDELL AGRIC VERSPREIDERS t/a
LAEVELD AGROCHEM MARBLE HALL

P.O. Box 625 , MABRBLE HALL, 0450

CERTIFICATE OF ANALYSIS

Attention :	A. Bredell
Email :	mhinfo@laeveld.co.za
Date received :	16-Mar-2022
Date reported :	22-Mar-2022
Dates analysed :	16-Mar-2022 to 22-Mar-2022
Our Ref :	LAE / 213 - 215 / C / 03 / 22
Quantity Analysed :	3

Lab No: C 215

Order No: 13848

Analysis Results mg/l		SANS Standards -241: 2015 Drinking Water Standard Limits	MANINI HOLDINGS No.3 Borehole
Total Dissolved Solids	LPM 2	≤ 1 200	1100
Nitrate & Nitrite as N	LPM 76K		0.43
Nitrate NO_3 as N	LPM 76K	≤ 11	0.43
Nitrite NO_2 as N	LPM 76K	≤ 0.9	<0.1
Chloride as Cl	LPM 76K	≤ 300	189
Total Alkalinity as $CaCO_3$	LPM 11		406
Fluoride as F	LPM 76K	≤ 1.5	0.72
Sulphate as SO_4	LPM 76K	Acute Health ≤ 500 - Aesthetic ≤ 250	169
Total Hardness as $CaCO_3$	LPM 85		604
Calcium Hardness as $CaCO_3$	LPM 85		305
Magnesium Hardness as $CaCO_3$	LPM 85		299
Calcium as Ca	LPM 15		122
Magnesium as Mg	LPM 15		72.6
Sodium as Na	LPM 15	≤ 200	87.5
Potassium as K	LPM 15		3.29
Iron as Fe	LPM 15	Chronic Health ≤ 2.0 - Aesthetic ≤ 0.3	0.02
Manganese as Mn	LPM 15	Chronic Health ≤ 0.4 - Aesthetic ≤ 0.1	0.09
Conductivity at 25° C (mS/m)	LPM 51	≤ 170	150
pH Value at 25 ° C (pH units)	LPM 51	≥ 5.0 to ≤ 9.7	7.32
pHs at 21° Celsius	LPM 85		6.86
Langelier Saturation Index	LPM 85		0.46
Turbidity (NTU)	LPM 23	Operational ≤ 1.0 - Aesthetic ≤ 5.0	3.00
Aluminium as Al	LPM 15	≤ 0.30	0.03

All heavy metal analyses have been performed on filtered samples. Tests marked with an asterisk * are not SANAS accredited. These results are related only to the items tested. These results must be read in conjunction with the Uncertainty of Measurement list as provided by Regen Waters Laboratory

QUALITY CONTROL CHECKS	
Cation Balance	15.96
Anion Balance	6.38
% Difference	-4.9
Measured TDS	1100
Calculated TDS	894
Limits	1.2
Calc TDS / E.C.	0.6

P.L.G. UYS / A. KOHRS
Technical Signatory
Electronic Signature