water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

A GEOHYDROLOGICAL REPORT FOR

4 U2 DO FARM

POLOKWANE LOCAL MUNICIPALITY

CAPRICORN DISTRICT MUNICIPALITY,

LIMPOPO PROVINCE

NOVEMBER 2023

COMPILED BY

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1. Introduction

Geohydrological, borehole drilling and yield testing investigations were carried out on one new borehole located at 4 U2 DO Farm. The farm is located in Moletjie under Polokwane Local Municipality within the Capricorn District Municipality of the Limpopo province.

The farm is located approximately 26 km northwest of Polokwane Town. The size of the farm is 100 hectares and the intended area for irrigation is 4 hectares. The project site is located in quaternary catchment A71E (a map showing the Quaternary catchment areas is attached on Appendix 2).

Project locality details are as indicated below:

4 U2 DO Farm: S 23.711140° E 29.289537°

(I.e. Coordinates are denoted as decimal degrees using WGS 84 datum).

Map 1: Locality map of the tested boreholes, 4 U2 DO Farm project site.

2. Geographical Setting

2.1 Topography

The Limpopo province is characterised by its contrasting landscapes. The topographical map for Polokwane shows a topographically diverse area. The study area's topography consists largely of undulating terrain between ranges of hills and mountains. The northward flowing tributaries of the Limpopo River have incised deep gorges through the hills and mountain ranges that are visible as erosional remnants. The lowest point is located in the north at approximately 1204 m above sea level (m asl). The nearest villages are located on the southwest and southern side of the project site. The project site is elevated to an average of 1208 m asl.

2.2 Climate

The study area within the A71E quaternary catchment is subtropical semi-arid, tempered by altitude, with mild, dry winters (during which it can get cold at night) and hot, sunny summers (during which thunderstorms can break out).

The area is located in the north of the South African Republic, at approximately 1,300 meters above sea level, in the Limpopo province (https://www.climatestotravel.com).

The average temperature of the coldest month (July) is 13.1 °C, that of the warmest month (January) is of 23.4 °C. Precipitation amounts to 560 millimeters per year. It ranges from 4 mm in the driest months (July, August, September) to 110 mm in the wettest month (November). On average there are about 3070 sunshine hours per year in the area (https://www.climatestotravel.com/climate/south-africa/polokwane).

Figure 1 on the next page represents monthly rainfall as per the Climates to travel climate chart-Polokwane.

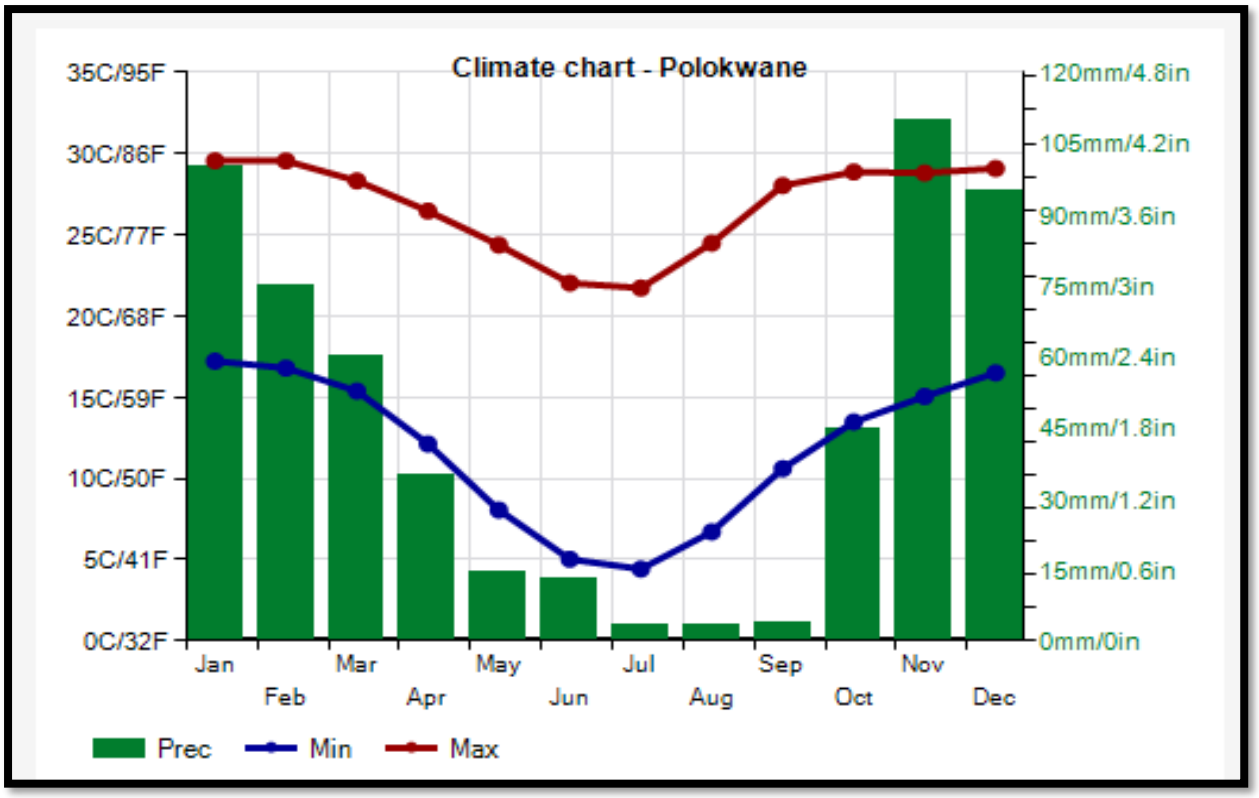
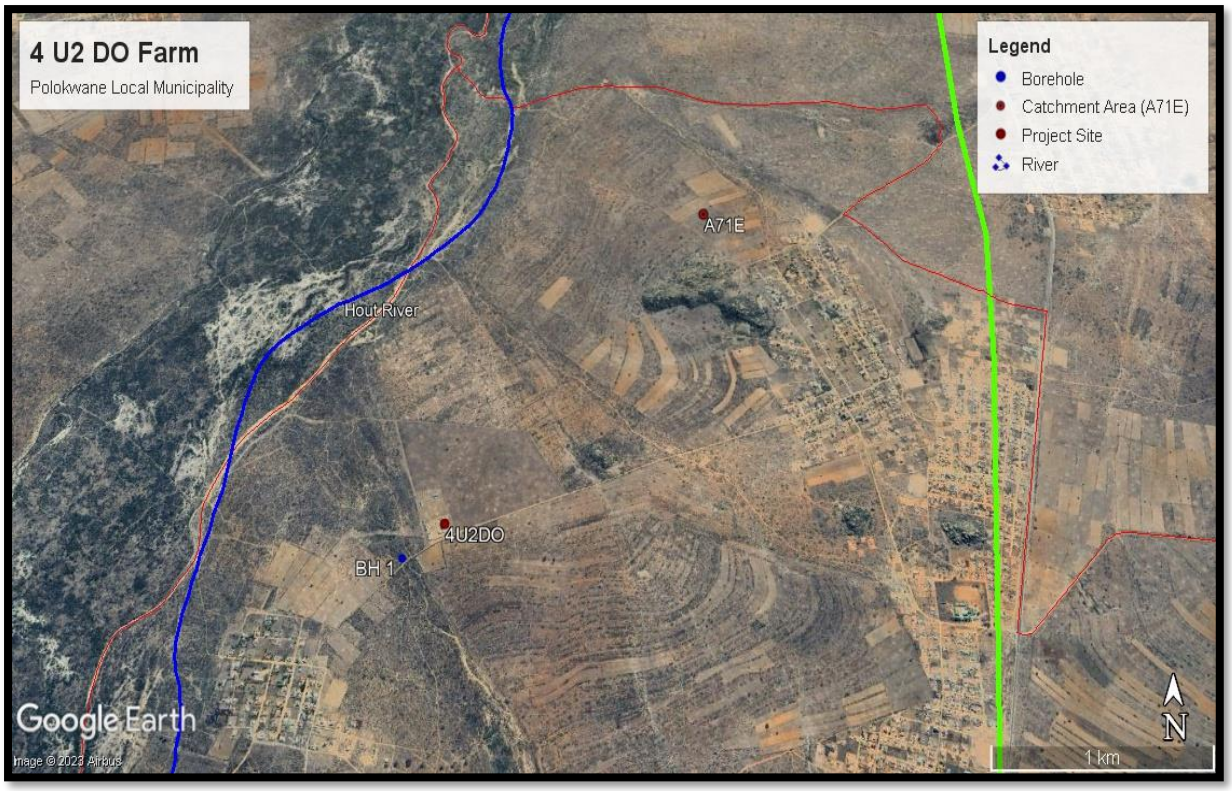


Figure 1: Average monthly rainfall and minimum and maximum temperature for the PLM (Climate Chart- Polokwane) [Altitude: 1300 m above sea level].

2.3 River Systems and Drainage

The project site is located close to the Hout river, a tributary of the sand river. The Hout River starts on the eastern side of the Waterberg and flows in a Northeast direction. Its course is dammed at the Mathala Dam, also known as Houtriver Dam, the only significant dam in the whole Sand River basin. It continues flowing northeast until it reaches the southern flank of the Soutpansberg when it bends towards the northeast at the feet of the mountains right before meeting the left bank of the Sand River not far from the Waterpoort gorge.

The Diep River meets the right bank of the Sand River northeast of Polokwane town. The Mulaudzi River, also known as "Blood River", joins the Sand River from the left just north of Polokwane. The Seshego dam is a small dam on the Mulaudzi River. The Brak River is an intermittent stream flowing between the Blouberg and the Soutpansberg, joining the left bank of the Sand River about 35 kilometres) from the Limpopo River.



Map 2: A map showing the river system in the area of Polokwane Local Municipality

3. Scope of Work

The Geo-hydrological consultant was tasked with providing the following listed information and activities. These include:

- Collate all borehole data, geological and hydrogeological information.
- Drilling, Test pumping and supervision of one new borehole at the project site.
- Analyse water chemistry to determine potability.
- Provide management and equipping recommendations.
- Provide any specific pollution hazard protection and groundwater monitoring requirements and
- To compile a Hydrogeological report on the work done.

4. Methodology

4.1 Desk Study

A remote sensing technique used was the interpretation of Google Earth™ satellite imagery. The objective of the interpretation was to identify details of water-related features (e.g. erosion gullies, embankment, etc.), features where water could collect during rainy seasons, water supply sources and sources of water pollution in the area.

4.2 Hydro-census

A site visit was conducted on the 6th of November 2023 and the borehole shown on Map 1 as BH 1 was identified and assessed before yield testing was conducted.

4.3 Geophysical Survey and Results

No geophysical surveys were conducted, borehole drilling was done on a site provided by the client.

4.4 Drilling and Siting of Boreholes

Borehole drilling has been completed using standard air rotary percussion drilling.

Borehole 1 (BH 1) located at S 23.712666 E 29.287592 intersected overburden, brownish medium grained top soil from surface to 3 m bgl. Light grey, medium grained, and highly weathered granite rock to 14 m bgl. Light grey, medium grained, and highly fractured granite rock to 28 m bgl. Light grey, medium grained, fractured granite rock to 40 m bgl. Whitish, medium grained, fractured gneiss rock to 55 m bgl. Further drilling intersected whitish, medium grained, slightly fractured gneiss rock to a final depth of 60 m bgl. Groundwater was intersected at 17 and 45 m bgl. Blow yield = 1.50 l/sec.

Borehole construction data is shown in Appendix 1.

4.5 Pump Testing

4.5.1 Results

At borehole 1 (BH 1) located at S 23.712666° E 29.287592°, three by one hour step tests were conducted at 0.60, 1.32 and 3.50 ℓ/sec respectively resulting in a cumulative final drawdown of 48.25 m after 160 minutes of pumping. Recovery after the step tests is at 99.61 % after 90 mins of observation. A 24-hour constant rate test was conducted at 1.50 ℓ/sec resulting in a

final drawdown of 24.00 m. Recovery is at 97.63 % after 60 mins of observation. Specific capacity is calculated = 0.13 ℓ/sec per m and transmissivity = 3.08 m^3/day.

Table 1: Pump testing results.

PROJECT		4 U2 DO FARM			DATE		06/11/2023							
BOREHOLE No			BH 1		AVAIL. DRAWDOWN		49,64	m				BOREHOLE COORDINATES		
BOREHOLE DEPTH			60 m		PUMP DEPTH		57,5	m				LAT	S 23,712666	
STATIC WATER LEVEL			7,86 m		PUMP TYPE		MONO BP 16 H					LONG	E 29,287592	
		STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6	T/T'		RECOVERY		CD	T/T'	RECOVERY
AVERAGE YIELD (l/s)		0,54	1,32	3,50						1,74		1,50		
TIME(hrs)	TIME(min)								Time		Time			
-1	1,00	-0,77	-4,97	-9,59				161,00	1	-44,30	1,00	-1,56	1441,00	-20,59
	2,00	-1,40	-5,41	-12,01				81,00	2	-39,98	2,00	-2,92	721,00	-17,22
	3,00	-1,86	-5,76	-14,28				54,33	3	-35,35	3,00	-4,15	481,00	-14,77
	5,00	-2,30	-6,17	-17,77				33,00	5	-30,79	5,00	-5,03	289,00	-11,58
	7,00	-2,59	-6,86	-21,28				23,86	7	-26,25	7,00	-5,30	206,71	-8,87
	10,00	-2,90	-7,4	-24,74				17,00	10	-21,46	10,00	-6,35	145,00	-6,53
	15,00	-3,08	-7,63	-30,25				11,67	15	-16,04	15,00	-7,00	97,00	-5,06
	20,00	-3,32	-7,92	-35,82				9,00	20	-10,54	20,00	-7,61	73,00	-3,40
	30,00	-3,59	-8,2	-43,81				6,33	30	-8,17	30,00	-8,52	49,00	-2,27
	40,00	-3,83	-8,42	-48,25				5,00	40	-5,60	40,00	-9,19	37,00	-1,38
	50,00	-4,00	-8,51					4,20	50	-2,96	60,00	-10,10	25,00	-0,57
	60,00	-4,24	-8,66					3,67	60	-1,62	90,00	-10,77	17,00	
	70,00							3,29	90	-0,19	120,00	-11,54	13,00	
	80,00		Recovery Steps		99,61	%		3,00	120		150,00	-12,30	10,60	
	90,00							2,78	150		180,00	-12,93	9,00	
	120,00							2,33	180		210,00	-14,29	7,86	
0,5	150,00							2,07	210		240,00	-15,25	7,00	
	180,00							1,89	240		300,00	-16,22	5,80	
	210,00							1,76	300		360,00	-17,10	5,00	
4	240,00							1,67	360		420,00	-17,86	4,43	
	270,00							1,59	420		480,00	-18,33	4,00	
	300,00							1,53	480		540,00	-18,96	3,67	
	330,00							1,48	540		600,00	-19,71	3,40	
	360,00							1,44	600		720,00	-20,76	3,00	
	390,00							1,41	720		840,00	-21,32	2,71	
											960,00	-21,97	2,50	
											1080,00	-22,40	2,33	
											1200,00	-23,19	2,20	
											1320,00	-23,63	2,09	
											1440,00	-24,00	2,00	

4.5.2 Borehole Equipping Recommendations

Borehole ID	**BH 1**
Borehole Co-ordinates	S 23.712666° E 29.287592°
Borehole depth	60.00 m
Diameter	165 mm ID
Static water level	7.86 m (06/11/2023)
Rec. Pumping rate	1.10 ℓ/sec at 24 hrs/day
Max. Pumping rate	1.50 ℓ/sec at 18 hrs/day
Daily abstraction	95.04 m^3/day (@ 24 hr duty cycle)
Rec. Pump Installation depth	55 m bgl

The borehole has been successfully pump tested and can yield a total approximate of **95.04 KL/ day in a 24-hr pumping cycle**. It should however be noted that water level

monitoring on a bi-annual basis is also required to determine the sustainability of long-term abstraction at the recommended production borehole.

4.6 Groundwater recharge, yield & storage calculations

The 4 U2 DO Farm has a surface area of 100 hectares. Discussed below is the calculated values of Available Recharge (m^3/day) and Available Water in Aquifer Storage (m^3):

The calculations for groundwater recharge (Quaternary Catchment):

Average Recharge (m^3) = Area (m^2) X Recharge (m)

= 893 000 000 m^2 X 0.00714 m

= <u>6 376 020 m^3</u>

The calculations for available water in aquifer storage (Project Site):

Available Water in Aquifer Storage (m^3) = (Area (m^2) X Drawdown (m) X Storativity

= 1 000 000 m^2 X 39.52 m X 0.0060

= <u>237 120 m^3</u>

Storativity & aquifer thickness / drawdown estimates as per Sami. K (2015) Groundwater module: Verification studies, default parameters and calibration guide.

Sustainable aquifer yield:

Average sustainable yield (m^3/day) = (Average recharge (m^3) X 60 %)/ 365 days

= (6 376 020 m^3 X 0.6)/ 365

= <u>10 481.13 m^3/day</u>

NB: The calculations do not take into account water flowing in from other Quaternary Catchments and current water usage on the farm and surrounding farms and communities.

4.7 Groundwater availability assessment

4 U2 DO Farm is located in Quaternary catchment A71E. Below is a discussion of the geohydrological characteristic of the catchment.

The Quaternary catchment data is listed in Table 2. The average static water level is 22.98 m; an average weathered thickness of 34.08 m; average fractured aquifer thickness of 123.42 m;

the calculated aquifer thickness of 157.50 m. Boreholes are to be drilled to a minimum depth of 35 - 50 m to intersect the weathered zone and 180 - 200 m to intersect the fractured zones.

Table 2: Statistics of quaternary catchment A71E.

Quaternary Catchment A71E	
Surface Area (km²)	893
Mean Annual Precipitation (mm)	421
Average Groundwater level (m bgl)	22.98
Recharge (mm/annum)	7.14
Weathered zone (m)	34.08
Fractured zone (m)	123.42
Aquifer Thickness (m)	157.50
Aquifer Storativity	0.0060
Aquifer Thickness_WRSM/Pitman Model_ (m)	39.52

5. Prevailing Groundwater Conditions

5.1 Geological Setting

The potential of groundwater varies significantly throughout the study area and is determined mainly by the specific lithologies underlying each terrain. Higher groundwater potential (yield and storage) is found in unconsolidated sand and gravel deposits associated with the Hout river drainage systems which in turn provides enhanced recharge potential towards the deeper lying fractured aquifers. In the igneous rocks of the Moletsi granite formation, higher groundwater potential is associated with dolerite contact zones and lineaments. The groundwater potential in the igneous and underlying associated metamorphic rocks is generally determined by rock type, discontinuities due to compositional differences, lineaments, topography and the grade of metamorphism. Rocks subjected to higher grade of metamorphism typically display a resistance to weathering of fractures. The depth to groundwater is generally greater in the sandstones than in the metamorphic rocks. This may be controlled by contrasting depth of fracturing and weathering in the two terrains and have a bearing on the pollution potential.

5.1.1. Regional Geology

The local municipal area is dominated by lithostratigaphical units in the crystalline complex, namely the Goudplaats-Hout River Gneiss with granite intrusions of the Moletsi Granite formation. These Palaeoarcheaen gneissic bodies range from homogenous to strongly layered, leucocratic felsic to mafic minerals (Anhaeusser, 1992).

The Goudplaats-Hout River Gneiss Suite ranges in age from 3600 to 3200 Ma and comprise of a wide range of granitoid gneisses. The gneisses are massive to layered, leucocratic to dark grey and vary in grain-size from fine-grained to pegmatoidal.

The area is underlain by homogenous, light grey, medium-grained biotite gneiss (syenogranitic in composition) with occasional distinct leucocratic bands resulting from local incipient anatexis. Younger granitic intrusions into but not forming part of the GHRG include the Duivelskloof Leucogranite, Shamriri Granite, Turfloop Granite, Matok Granite, Moletsi Granite, Matlala Granite, Utrecht Granite and Mashashane Suite (Robb et al. 2006).

5.1.2. Local Geology

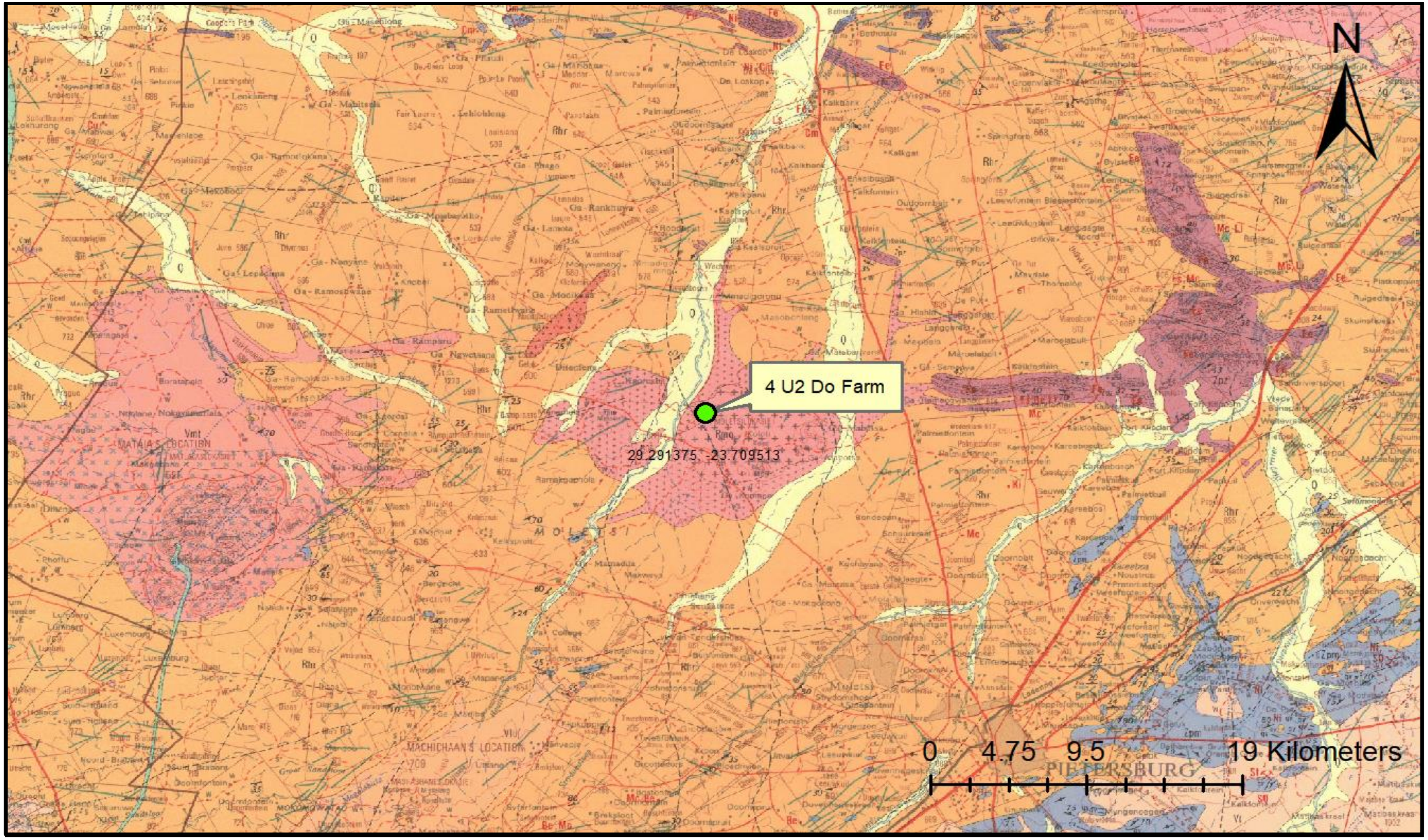
According to the 1: 250 000 scale geological sheet 2328 Pietersburg map and field observations, the geology of the study area is dominated by granites of the Moletsi Granite formation that are underlain by the Goudplaats-Hout River Gneiss.

The Moletsi Granite, located east of the Matlala batholith comprises of three phases (Brandl, 1985, 1986, and unpubl. data). A coarse-grained, pinkish to pinkish grey rock occurs in the core of the formation, which is surrounded by an apparently younger, grey to pinkish grey, coarse grained to porphyritic variety. Biotite, which occurs in clusters, is the only mafic constituent. Both rock types are monzogranitic in composition. A minor, early phase is represented by medium- to fine-grained, dark-grey, tonalitic granite that occurs at the margin of the batholith as well as in the form of large rafts within the other two phases. In places, narrow, north-trending dykes of grey monzogranite and pink, leucocratic granite cut the intrusion. All phases of the Moletsi Granite are metaluminous and plot along the boundary of the calc-alkaline and tholeiitic fields. Similar to the Matlala Granite, several prominent off shoots extend from the main granite formation in a northerly direction.

The contact zones are usually fractured however, and along with any other faults, fractures (lineaments) and significant weathering result in preferential parent rock dissolution and the

development of groundwater flow paths in the area, hence the zones and fractured zones are normally the primary target for borehole drilling in the area.

Local geology is further depicted in Map 3 below.



Map 3: The geological map of the project site and surrounding areas

Table 3: legend to the geological map on the previous page and a brief explanation.

Main Geology	Description
Q	Quaternary deposit (soil, sand, alluvium; calcrete; scree
Rmo	Porhyritic granite
Rhr	Leucocratic migmatite gneiss
	Diabase dyke

5.2 Soils and Vegetation

The study area lies within the Savanna biome vegetation which is the largest biome in Southern Africa. It is characterized by a grassy ground layer and a distinct upper layer of woody plants (trees and shrubs). The environmental factors delimiting the biome are complex and include altitude, rainfall, geology and soil types, with rainfall being the major delimiting factor. Fire and grazing also keep the grassy layer dominant. The most recent classification of the area by Mucina & Rutherford shows that the site is classified as Polokwane Plateau Bushveld. The vegetation units of the site vary between open woodland to denser woodland associated with outcrops.

The dominant soils on the study site are deep, red apedal soils of the Hutton soil form on the slightly undulating plains, while the shallower soils in between the deeper soils represent gravelly Glenrosa or very rocky Mispah soils.

5.3 Hydrogeology

The presence of groundwater depends upon the hydrological characteristics of the underlying aquifer. The most prominent rock in the area is gneiss as discussed on the previous section.

Aquifers are developed within the weathered overburden and fractured bedrock of these igneous rocks of the Moletsi Granite formation. These granite rocks are characterized by very low primary porosity (contain virtually no water), and almost all groundwater movement and storage take place through fractures, faults, weathered zones and other secondary features that enhance the aquifer potential locally.

5.3.1 Unsaturated Zone

This is the zone between the land surface and water table which may include the capillary fringe (The area just above the water table in which water is held in the soil by surface tension). Water in this zone is generally under less atmospheric pressure, and the voids may

contain air and water. This zone usually occurs within the weathered subsurface. For catchment area A71E the unsaturated zone has an average thickness of 34.08 m.

5.3.2 Saturated Zone

The area below the water table where all open spaces are filled with water under pressure equal to or greater than that of the atmosphere. For catchment area A71E the saturated zone occurs within the fractured subsurface and has an average general thickness of 123.42 m.

5.3.3 Hydraulic Conductivity

It is defined as the volume of water that will move through a porous medium in unit time under a unit hydraulic gradient through a unit area measured at perpendicular to the flow direction. It should not be confused with permeability.

The hydraulic conductivity in this area with a local geology of granites (Fractured crystalline rocks) as the parent rock ranges between 8×10^{-9} to 3×10^{-4} m/sec (Glenn M. Duffield, President, HydroSOLVE, Inc.).

5.4 Borehole Data

The Department of Water and Sanitation established a database called the Groundwater Resource Information Project (GRIP) to record borehole information throughout the Limpopo province. The GRIP database shows at least 394 boreholes located within the quaternary catchment A71E (i.e data such as borehole depth, water level, daily abstraction, etc.). The quaternary catchment excel datasheet can be submitted to the client upon request.

5.5 Groundwater Levels

The static water level averages 22.98 meters below ground level and changes at an average of 2 meters annually (i.e according to the Department of Water and Sanitation Quaternary Catchment data for A71E).

5.6 Groundwater Potential Contaminants

The farm intends to grow citrus fruits such as oranges and other soft citruses depending on their favourable season. Like most commercial farming projects, farmers use fertilizers to provide trees with essential nutrients to increase yield and growth. For example, citrus plants grow in soils that are rich in potassium.

This specific farm intends to use a combination of synthetic NPK (Nitrogen, Phosphorus and Potassium) based fertilizers and composted manure to meet the nutritional needs of the plantations. However, because these fertilizers are applied directly onto the soils and not in plant tissues there is high likelihood that these chemicals will seep into the soil and into the groundwater resources.

5.7 Groundwater Quality

Water samples for the borehole were collected using standard sampling procedures and taken to an accredited laboratory for water quality analysis. Samples were analysed for Calcium, Chloride, Electrical conductivity, Magnesium, Nitrate –Nitrogen, pH, Fluoride, Potassium, Sodium, Sulphate, Manganese Iron, Total dissolved solids @ 180^{o}C and Total Hardness in mg $CaCO_3$.

The Department of Water Affairs and Forestry developed a water quality classification system in 1996 in association with the Department of Health. This classification was revised in 1998 i.e The Department of Water Affairs and Forestry, and Health, and the Water Research Commission, 1998 (Quality of domestic water supplies Volume 1: Assessment Guide. Second Edition).

Table 4 below shows a summary of the various water classes, and the possible effects of drinking water of poor quality.

Table 4: Classification of water for domestic utilisation

Class 0	Ideal water quality	**Drinking health**: No effects, suitable for many generations
		Drinking aesthetic: Water is pleasing
		Food preparation: No effects
		Bathing: No effects
		Laundry: No effects
Class 1	Good water quality	**Drinking health**: Suitable for lifetime use. Rare instances of sub-clinical effects.
		Drinking aesthetic: Some aesthetic effects may be apparent.
		Food preparation: Suitable for lifetime use
		Bathing: Minor effects on bathing or on bath fixtures
		Laundry: Minor effects on laundry or fixtures
Class 2	Marginal water quality	**Drinking health**: May be used without health effects by the majority of indivuduals of all ages, but may cause effects in some individuals in sensitive groups . Some effects possible after lifetime use.
		Drinking aesthetic: Poor taste and appearance are noticeable
		Food preparation: May be used without health or aesthetic effects by the majority of individuals
		Bathing: Slight effects on bathing or on bath fixtures
		Laundry: Slight effects on laundry or on fixtures.
Class 3	Poor water quality	**Drinking health**: Poses a risk of chronic health effects, especially in babies, children and the elderly .
		Drinking aesthetic: Bad taste and appearance may lead to rejection of the water.
		Food preparation: Poses a risk of chronic health effects, especially in children and elderly.
		Bathing: Significant effects on bathing or on bath fixtures
		Laundry: Significant effects on laundry or on fixtures.
Class 4	Unacceptable water quality	**Drinking health**: Severe acute health effects, even with short term use.
		Drinking aesthetic: Taste and appearance will lead to rejection of the water.
		Food preparation: Severe acute health effects, even with short term use.
		Bathing: Serious effects on bathing or on fixtures
		Laundry: Serious effects on laundry or on fixtures.

Laboratory water analysis results for the tested borehole are shown below in Table 5 on the next page.

Table 5: Water quality results

ANALYSES	UNIT	4U2DO FARM	CLASSIFICATION				
			Class 0	Class 1	Class 2	Class 3	Class 4
		BH 1 {sample date 07/11/2023}	Ideal Quality	Good Quality	Marginal Quality	Poor Quality	Unacceptable Quality
pH @25ºC	pH value	7,43	5.5 - 9.5	4.5 - 10	4 - 10.5	3 - 11	< 3 - 11
Conductivity	mS/m	95	< 70	70 - 150	150 - 370	370 - 520	> 520
Total Dissolved Solids	mg/l	589	< 450	450 - 1000	1000 - 2400	2400 - 3400	> 3400
Turbidity	NTU	0,56	0 - 0.5	0.5 - 1	1 - 5	5 - 10	> 10
Total Alkalinity as CaCO3	mg/l	280	-	-	-	-	-
Fluoride as F	mg/l	1,9	< 0.7	0.7 - 1	1 - 1.5	1.5 - 3.5	> 3.5
Sulphate as SO4	mg/l	17,83	< 200	200 - 400	400 - 600	600 - 1000	> 1000
Nitrate as N	mg/l	8,25	< 6	6 - 10	10 - 20	20 - 40	> 40
Chloride as Cl	mg/l	80,29	< 100	100 - 200	200 - 600	600 - 1200	> 1200
Ammonia as N	mg/l	0,05	≤ 1,5			-	-
Nitrite as N	mg/l	0,01	≤ 0,09			-	-
Total Hardness	$CaCo_3$	213	< 100	100 - 200	200 - 300	300 - 600	> 600
Calcium Hardness		110,5					
Magnesium Hardness		102,5					
Potassium as K	mg/l	4,54	< 25	25 - 50	50 - 100	100 - 500	> 500
Calcium as Ca	mg/l	44,2	< 80	80 - 150	150 - 300	> 300	
Magnesium as Mg	mg/l	25	< 70	70 - 100	100 - 200	200 - 400	> 400
Sodium as Na	mg/l	104	< 100	100 - 200	200 - 400	400 - 1000	> 1000
Zinc as Zn	mg/l	0,11	<3	3-5'	5-10'	10-20'	>20
Iron as Fe	mg/l	0,03	< .5	.5 - 1	1 - 5	5 - 10	> 10
Manganese as Mn	mg/l	ND	<0,1	0,1-0,4	0,4-4	4-10'	>10
Copper as Cu	mg/l	ND	<1	1-1,3	1,3-2	2-15'	>15
Chemical Water Classification		**CLASS III**					

Comment: - According to the ***"Quality of Domestic Water Supplies – Volume I – Assessment Guide."***- Dept Water Affairs and Forestry; Dept of Health; and WRC the water samples are classified as:- CLASS III

BH 1: Chemical => CLASS 3: - *(Poor Water Quality) Fluoride: 1.5- 3.5 mg/l and Total Hardness (Marginal): 200-300 $CaCo_3$, for drinking water standards, however groundwater from this borehole is considered suitable for agricultural use.*

5.8 Water Demand

Water from the borehole will be utilised for irrigation purposes of a citrus plantation.

According to the Department of Agriculture and rural Development [http://www.kzndard.gov.za/images/Documents/Horticulture/Veg_prod/water_requirements_irrigation.pdf] accessed 8 November 2023, total irrigation of a citrus enterprise such as this requires about 8 000 000 ℓ (8 000 m^3) of water per annum for each hectare worked. This quantity will be lower in cool, moist areas, especially under drip irrigation, and appreciably higher in hot, dry areas, where less efficient flood irrigation is practised.

The intended plan is to irrigate 4 Ha: As such total annual demand = 8 000 m^3 X 4

= 32 000 m^3 / annum

i.e this translates to a water demand = 87,67 m^3/day *(Please note this water demand will be lower if drip irrigation or other less intensive methods are used).*

6. Aquifer Characterisation

6.1 Groundwater Vulnerability

Nitrogen, potassium, phosphorus fertilizer and pesticides, used extensively in agriculture to enhance crop growth, lingers in soil and leaches into groundwater resources for long periods of time.

6.2 Aquifer Classification

The area has low and erratic rainfall; hence groundwater is the only dependable source of water for many users in this area away from the Limpopo River.

7. Conclusions and Recommendations

7.1 Conclusions

Geological mapping and subsequent analysis of the 1: 250 000 scale geological map sheet No. 2328 Pietersburg has indicated that the underlying geology is mainly composed of granites. Granites have low to moderate groundwater potential.

The recommended borehole located at the farm can be utilised for water supply as recommended in section 4.5.2. Pump test data is indicated in Table 1 and Appendix 2.

7.2 Recommendations

7.2.1 Management and Monitoring

Recommendations are as detailed below:

- Borehole 1 (BH 1) located at S 23.712666° E 29.287592° has a recommended yield of 1.10 ℓ/sec at 24 hrs/day. A daily maximum abstraction of 95.04 m^3/day is thus recommended. Pump installation depth recommended at 55 m bgl (meters below ground level).
- Borehole 1 (BH 1) has an estimated total yield of 34 689.60 m^3/annum or 95.04 KL/day.

- Groundwater levels should be monitored bi-annually in order to evaluate the sustainability of supply.
- Laboratory water quality results collected from the farm suggests that groundwater at the tested borehole is Class 3 due to elevated Fluoride..
- Groundwater investigations have been concluded and the borehole can be equipped as recommended in section 4.5.2 [Equipping recommendations].
- Potential sources of pollution i.e. cattle kraals, cemeteries, pit latrines etc., should be located at least 100 m away from all production boreholes.

8. References

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9. Appendices

Appendix 1: Borehole drilling log.

BOREHOLE LOG

BH 1

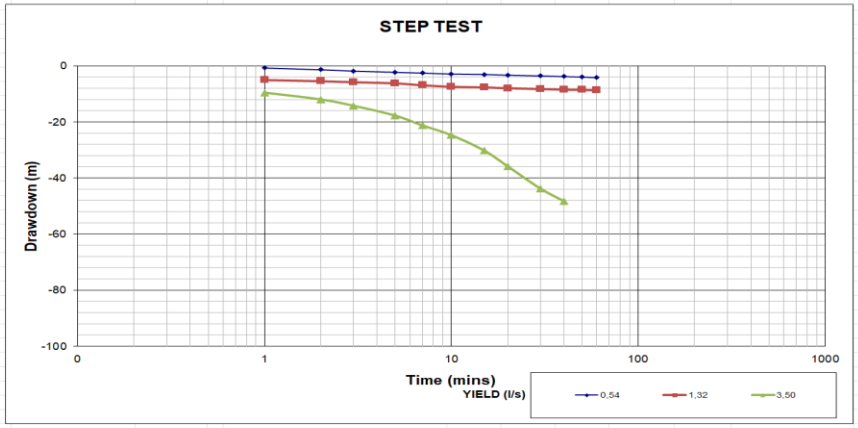
BOREHOLE DRILLING RECORD

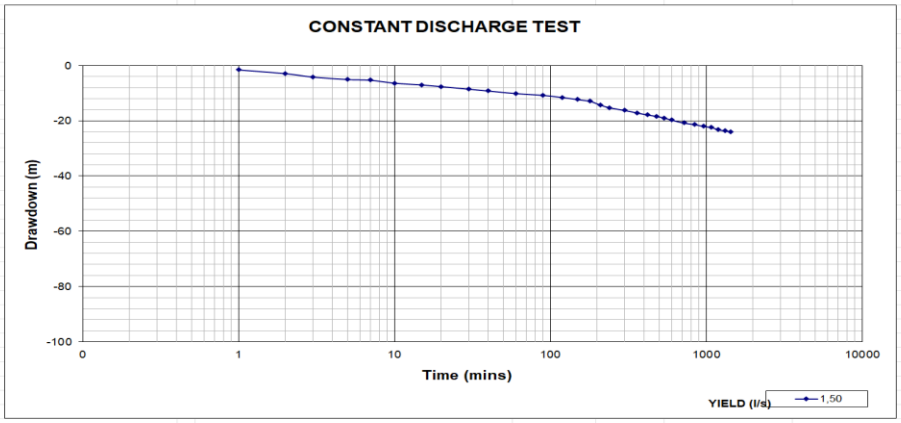
CLIENT :	4 U2 DO (PTY) LTD		
PROJECT :	4 U2 DO FARM GROUND WATER SUPPLY	**BOREHOLE NO :**	BH 1
SITE :	4 U2 DO FARM	**WATER TABLE :**	7,86 m bgl
LOG :		**ELEVATION :**	
DRILLER :	MTH DRILLING CO.	**SOUTH :**	23,712666
DATE DRILLED :	14/11/2023	**EAST:**	29,287592

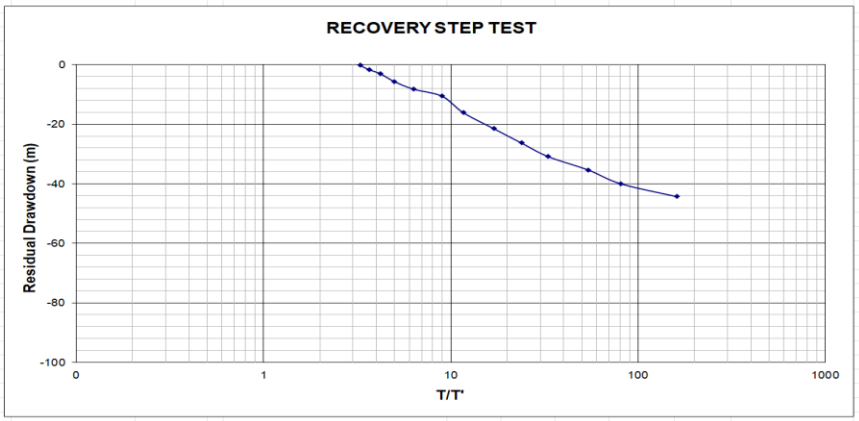
BOREHOLE CONSTRUCTION	PENETRATION RATE (Mins / m)	STRIKES (mbgl)	S W L (mbgl)	DEPTH	PROFILE	LITHOLOGICAL DESCRIPTION
BOREHOLE CAP				0		
Solid 165 mm steel casing			SWL 7,86 m	10		Overburden, brownish medium grained top soil
						Light grey, medium grained, highly weathered granite rock
		Water strike 17 m		20		Light grey, medium grained, highly fractured granite rock
Drilling 165mm				30		Light grey, medium grained, fractured granite rock
				40		
		Water strike 45 m				Whitish, medium grained, fractured gneiss rock
Drilling 165mm				50		
						Whitish, medium grained, slightly fractured gneiss rock
60 m E.O.H				60		Blowyield= 1,50 l/sec

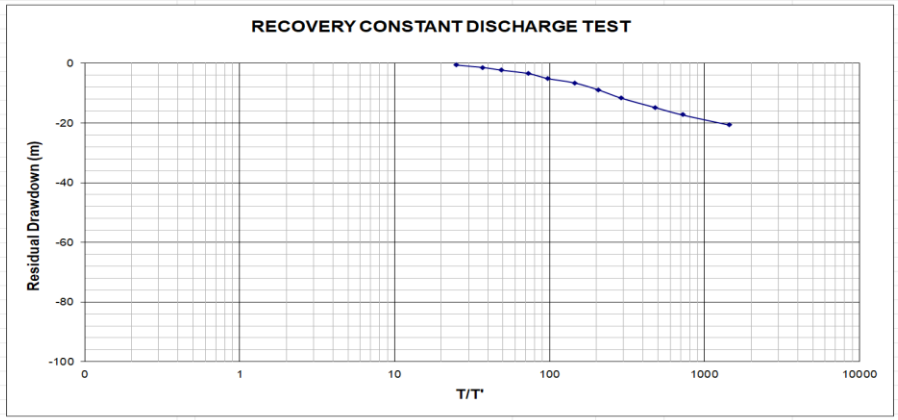
Appendix 2: Pump testing (plotted) data of boreholes at 4 U2 DO Farm

4 U2 DO FARM **BOREHOLE NO : BH 1**









BOREHOLE DATA		RECOMMENDATIONS					INTERPRETATION GENERAL COMMENTS		HYDRAULIC PARAMETERS			EXISTING PUMPING EQUIPMENT
DEPTH :	60 m	PUMPING RATE	gal/hr	m^3/hr	l/s	hrs/day	GEOLOGY :	Granite	T (STEP 1) :	3,35	m^3/day/m	MOTOR :
S W L :	7,86 m	MAXIMUM :			1,50	18,00	AQUIFER TYPE :	Fractured	T (RECOVERY STEPS) :	0,92	m^3/day/m	PUMP :
STRIKE :	m	RECOMMENDED :		3,96	1,10	24,00	DRILL TARGET :	N/A	T (CONSTANT DISCHARGE) :	3,08	m^3/day/m	COLUMN SIZE :
TEST PUMP TYPE :	Mono	MAX ABSTRACTION PER DAY :			95,04	m^3/day	RECOVERY :	97,63 %	T (RECOVERY CONSTANT DISCHARGE) :	1,72	m^3/day/m	No of COLUMNS:
PUMP DEPTH :	57,5 m	PUMP SETTING (m bgl) :				55	WATER QUALITY :	Class 3	STORAGE COEFFICIENT :	n/a		OUTLET SIZE :
DATE TESTED :	06/11/2023	CRITICAL WATER LEVEL (m bgl) :				45	PROBLEM SPECIES	Fluoride	SPECIFIC CAPACITY (after 2 hrs pumping) :	0,13	l/s per m	CONDITION :

Appendix 3: Catchment Areas