



**GEOHYDROLOGICAL INVESTIGATION STUDY FOR THE DEVELOPMENT OF
ACACIA VILLAS LOCATED IN MIDRAND WITHIN CITY OF JOHANNESBURG
METROPOLITAN MUNICIPALITY OF GAUTENG PROVINCE IN SOUTH AFRICA.**

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PREPARED BY:

ARIYS CONSULTING (PTY) LTD

Oxford Office Park, Unit 30 First Floor Right,
3 Bauhina Street, Highveld Techno Park,
Centurion, 0157 | South Africa

PREPARED FOR



SELAHLE CONSULTANCY AND PROJECTS (PTY) LTD

546 16th Road,
Constantia Park Block 2, 1st Floor,
Randjespark, 1682 | South Africa

Reg. No. 2018/072435/07 | PI No. 730004979

Oxford Office Park, Unit 30 First Floor Right,
3 Bauhina Street, Highveld Techno Park,
Centurion, 0157
Phone: 068 497 6579

Title: Geohydrological Investigation study for the development of Acacia Villas located in Midrand within City of Johannesburg Metropolitan Municipality of Gauteng Province in South Africa.

Prepared for: Selahle Consultancy and Projects (Pty) Ltd
546 16th Road,
Constantia Park Block 2, 1st Floor,
Randjespark, 1682

Contact Person: Miss. Sinnah Mhlongo
Office: +27 79 614 8298

Prepared by: Ariys Consulting (Pty) Ltd
Oxford Office Park, Unit 30 First Floor Right,
3 Bauhina Street, Highveld Techno Park,
Centurion, 0157

Contact Person: Mr Fhatani Makhuvha
Mobile: +27 68 497 6579

Project No.: AC-HG-01/04Revised
Project Team: FL Makhuvha, Hydrogeologist (Pri.Nat.Sci./MGSSA/GWD)

Site Coordinates: Lat: -25.958655°S, Long: 28.090008°E
Location: Acacia Villas Luxury Residential Rentals, Gauteng Province
Date: 26 June 2026

Report Approved:



Fhatani Lenon Makhuvha *Pr.Nat.Sci/GWD*
Hydrogeologist

EXECUTIVE SUMMARY

Ariys Consulting (Pty) Ltd has been appointed by Selahle Consultancy and Projects (Pty) Ltd to conduct a Geohydrological Investigation study for the development of Acacia Villas located in Midrand within City of Johannesburg Metropolitan Municipality of Gauteng Province in South Africa.

The report is a requirement of the Environmental Impact Assessment (EIA) for development of Acacia Villas and supports the Water Use Licence Application (WULA) for groundwater abstraction under Section 21(a) of the National Water Act (Act 36 of 1998).

The field investigation was conducted on the 16th of November 2024.

The site is underlain by the lithological unit of Johannesburg Dome that form part of Transvaal Supergroup. The site is underlain by gneiss, granite-gneiss, amphibolite and granite in places.

Based on the aquifer classification map (Parsons and Conrad, 1998) the aquifer underlying the site is regarded a “**minor aquifer**” with regional yields ranging between 0.5-2.0l/s.

The site is situated in the **Crocodile (West) and Marico water Management and falls within A21C** Quaternary catchment.

The vulnerability, or the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer is classified as low. Measures need to be taken to ensure appropriate drainage facilities are constructed to prevent the abovementioned issues.

Two (2) boreholes were identified from the NGA data all within a 5-kilometre radius from the of the investigated site. Groundwater level range is between 6.05 mbgl and 22 86mbgl. The water levels were recorded between 1972 and 1997. The site is therefore underlain by a very shallow groundwater table.

Acacia Villas is a residential development comprising 100 residential units, a clubhouse, security facilities, and small swimming pools. The development proposes the use of two on-site boreholes identified during a hydro-census. These boreholes are expected to provide a combined abstraction rate of 122.4 m³/day, which exceeds the estimated total daily water demand of 90 m³/day. The projected demand consists of 80 m³/day for residential use and 10 m³/day for irrigation and fire suppression/hydrant requirements. The higher abstraction rate is requested to accommodate fluctuations in residential water consumption, irrigation demand, and system efficiency.

During Hydrocensus two (2) boreholes and stream were visited within a 5km radius of the investigated site. Observations regarding the borehole location, construction, water level and status and current usage was noted.

Aquifer testing Results

The test borehole depth is between 40mbgl (BH02) and 45mbgl (BH01)

The static water was measured between 3.20mbgl (BH01) and 3.96mbgl (BH02)

For sustainable operation, the recommended abstraction rate for BH-01 is set at 1.80 l/s for 10 hours per day, which results in an estimated daily yield of 64800 L/day. Alternatively, it can support a maximum abstraction rate of 2.00 l/s for a shorter duration of 6 hours per day. For BH-02 is set at 1.60 l/s for 10 hours per day, which results in an estimated daily yield of 57600 L/day. Alternatively, it can support a maximum abstraction rate of 2.00 l/s for a shorter duration of 6 hours per day

Water quality Results

Ground water and surface water quality results indicated that all analysed constituents were below SANS 241:2015 standard limits and DWAF Water Quality Guidelines (Livestock Watering) Target Quality Range except for Turbidity (NTU), E coli, T coli, Manganese (Mn) and Iron (Fe).

Ground water and surface water results indicated that the water from these sources is not suitable for human consumption. Filtration method is recommended before any human consumption.

Groundwater Risk Assessment: Groundwater level and quality has a low to medium possible risk impact.

- **Preconstruction:**
- Based on NGA data the site is characterised by shallow groundwater level and wetland that is susceptible to contamination inflow especially in heavy rainfall events. Groundwater Monitoring boreholes should be installed upstream and downstream of the site to monitor groundwater quality.
- The shallow groundwater system more susceptible to contamination inflow during construction. Spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately enter the groundwater system.
 - Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations for storage of construction material to prevent any infiltration of contaminated waste into groundwater system.
- Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff.
 - Vegetation removal must be as minimum as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible.
- **During construction:**
 - During the construction phase, surface water may be diverted for dry working conditions. The natural surface water flow will be affected. The design and implementation of the temporary stream diversion should consider the environmental impacts. To reduce the impact on aquatic habitats, various structures must be installed to mimic and protect existing stream environment.
- The shallow groundwater system more susceptible to contamination inflow during construction. Spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately enter the groundwater system.

- Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations and Environmental Management Programme) for storage of construction material to prevent any infiltration of contaminated waste into groundwater system.
- Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during pre-construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff.
 - Vegetation removal must be as minimum as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible.
- Material from construction flowing into surface water bodies and upstream outbursts and overflow, which may pose a threat and risk to surface water quality.
 - Surface water quality monitoring plan must be implemented to monitor quality and ensure no contamination occurs within the site.
- Continuous groundwater and surface water monitoring is recommending upstream and downstream of the site to monitor quality and water level.
- **After construction (people residing within the investigated site):**
 - In the event the residents rely on groundwater for domestic use, unmonitored abstraction of groundwater is likely to impact negatively on the groundwater table
 - Aquifer testing should be conducted to establish suitable yields on the borehole to prevent excessive pumping and to regulate critical water levels.
 - Domestic wastewater is rich in nitrogen and phosphorus which may pose a threat and risk to groundwater system. The water table in the area is very shallow, this may result in untreated effluent escaping into groundwater
 - Groundwater quality monitoring should be conducted on a quarterly basis to ensure no contamination occurs within the site. The integrity of the domestic wastewater structures must be regularly inspected to prevent against infiltration of domestic wastewater into groundwater system.
- Re-vegetation
 - re-vegetation activities are encouraged during reduce rainfall impact, reduce surface water velocities, enhance infiltration, trap sediments.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	II
1 INTRODUCTION	1
1.1 SCOPE OF WORK	1
2 DESKTOP STUDIES	1
2.1 SITE LOCATION	1
2.2 TOPOGRAPHY AND DRAINAGE.....	1
2.3 CLIMATE	2
2.4 GEOLOGY	2
2.5 HYDROGEOLOGY.....	5
2.6 AQUIFER VULNERABILITY	8
2.7 GROUNDWATER QUALITY MANAGEMENT	9
3 NATIONAL GROUNDWATER ARCHIVE DATA	12
3.1 NGA DATA	12
3.1 GROUNDWATER FLOW DIRECTION	15
4 HYDROCENSUS.....	16
5 AQUIFER TESTING.....	20
5.1 AQUIFER TESTING RESULTS.....	20
5.2 BOREHOLE EQUIPPING RECOMMENDATIONS	25
6 GROUNDWATER AND SURFACE WATER QUALITY ANALYSIS	26
6.1 GROUNDWATER AND SURFACE WATER QUALITY RESULTS.....	26
7 GROUNDWATER RESERVE DETERMINATION	28
7.1 UNIT OF ANALYSIS DELINEATION (PROJECT SITE-ACACIA VILLAS).....	28
7.2 WATER DEMAND (PROJECT SITE)	28
7.3 SCALE OF ABSTRACTION CALCULATIONS	29
7.4 POTENTIAL GROUNDWATER ABSTRACTION IMPACT ON EXISTING SURROUNDING USERS...	30
8 CONCEPTUAL SITE MODEL AND RISK ASSESSMENT	31
9 RISK IMPACT ASSESSMENT	34
9.1 RISK RATING CRITERIA.....	34
9.1.1 RISK RATING CRITERIA.....	34
9.1.2 SIGNIFICANCE OF THE IMPACT	36
10 CONCLUSION	40
11 RECOMMENDATIONS.....	43

11.1.1 GROUNDWATER MONITORING PROGRAMME	43
11.1.2 SAMPLING GUIDELINES.....	43
12 REFERENCES	43

List of Tables

Table 2-1: Aquifer Classification Scheme (Parsons, 1995; Parsons And Conrad, 1998).....	7
Table 2-2: Ratings For The Aquifer System Management And Second Variable Classification (Parsons, 1995)	8
Table 2-3: Ratings For The Site- Aquifer Classification And Second Variable Classifications	9
Table 2-4: Gqm Index For The Site.....	10
Table 3-1: Nga Data Summary	14
Table 4-1 Hydrocensus Boreholes	17
Table 4-2 Hydrocensus Photo Log.....	18
Table 5-1 Fc Method – Basic Solution Estimation Of Sustainable Yield- Bh 1).....	23
Table 5-2 Fc Method – Basic Solution Estimation Of Sustainable Yield -Bh 2.....	24
Table 5-3 Summary Of Borehole Recommendations.....	25
Table 6-1: Summary Of Water Quality Analysis.....	27
Table 7-1 Residential Annual Average Daily Demand (Per-Capita Water Consumption Guidelines For South Africa) (Dhs, 2019).....	28
Table 8-1 Conceptual Site Model	32
Table 9-1scaling Risk.....	35
Table 9-2 Significant Colour Code	36
Table 9-3: Risk Rating.....	37

List of Figures

Figure 2-1: Site Location Map	3
Figure 2-2 Geology Map	4
Figure 2-3 Hydrogeology Map.....	6
Figure 2-4 Aquifer Vulnerability Map Of South Africa	11
Figure 3-1: Nga Data Borehole Locations.....	13
Figure 3-2: Gw Vs Topographical Elevation	15
Figure 4-1 Hydrocensus Map.....	19
Figure 5-1 Pump Testing Data Graphs- Bh 1.....	21
Figure 5-2 Pump Testing Data Graphs- Bh 2.....	22
Figure 12-1 Borehole 1 Raw Data.....	51
Figure 12-2 Borehole 2 Raw Data.....	52

List of Appendices

- Appendix A: Laboratory Results
- Appendix B: Borehole Raw Data

1 INTRODUCTION

Ariys Consulting (Pty) Ltd has been appointed by Selahle Consultancy and Projects (Pty) Ltd to conduct a Geohydrological Investigation study for the development of Acacia Villas located in Midrand within City of Johannesburg Metropolitan Municipality of Gauteng Province in South Africa.

The report is a requirement of the Environmental Impact Assessment (EIA) for development of Acacia Villas.

1.1 SCOPE OF WORK

The purpose of the Hydrogeological Impact Assessment is to assess the current and future impacts on the hydrogeological regime of the area due to the site activities. This includes:

- Desktop study to review all available information.
- Hydrogeological study that will consist of Hydro census investigation to update current groundwater quality and levels within a 5km radius.
- Water quality analyses.
- Risk rating for the prediction of the environmental impact of the development on the hydrogeological regime of the area. This includes the description of possible negative impacts during the operation of the development.
- Hydrogeological report which will include recommendations on findings gathered during the study.

2 DESKTOP STUDIES

2.1 SITE LOCATION

The site is located in within the jurisdiction of Johannesburg Metropolitan Municipality of Gauteng Province in South Africa. The geographical coordinates of the site are -25.958655°S, 28.090008°E. It is situated approximately 36km north of Johannesburg Central Business District. The site can be accessed via Mimosa Road and Acacia Road. Refer to Figure 2-1 for locality map of the project area.

2.2 TOPOGRAPHY AND DRAINAGE

The site is situated at maximum elevation of 1512m, exhibits varied topography in relation to surrounding points. The terrain slopes downward to the south by approximately -23m, rises upward to the east by +5m, and slopes downward to the west by approxiamtely-8m. This suggests an undulating or sloping topography rather than a flat one. Water drainage is likely to occur towards lower elevations, such as south and east, while the western and northern directions may experience water runoff moving away.

2.3 CLIMATE

In Midrand, the climatic conditions are categorized as mild and moderate. In Midrand, the quantity of rainfall during summers surpasses that of winters. According to Köppen and Geiger, this climate is classified as Cwb. The mean yearly temperature recorded in Midrand is 16.6 °C as per the available data. Annually, approximately 678 mm of precipitation descends. The month of maximum warmth in a year is January. The average temperature during this period reaches up to 20.4 °C making it the hottest time of the year. On average, the month of July is considered to be the coldest time of year with temperatures averaging at around 10.3 °C.

2.4 GEOLOGY

According to 1:250 000 2528 Pretoria Geological Map, the site is underlain by the lithological unit of Johannesburg Dome that form part of Transvaal Supergroup as seen in the geology map provided in Figure 2-2. The site is underlain by gneiss, granite-gneiss, amphibolite and granite in places.

The Johannesburg Dome is a 50-km-wide inlier of Archean rocks located in the centre of the Kaapvaal Craton and surrounded by outward-dipping Archean to Paleoproterozoic volcano-sedimentary rocks of the Witwatersrand, Ventersdorp and Transvaal Supergroup.

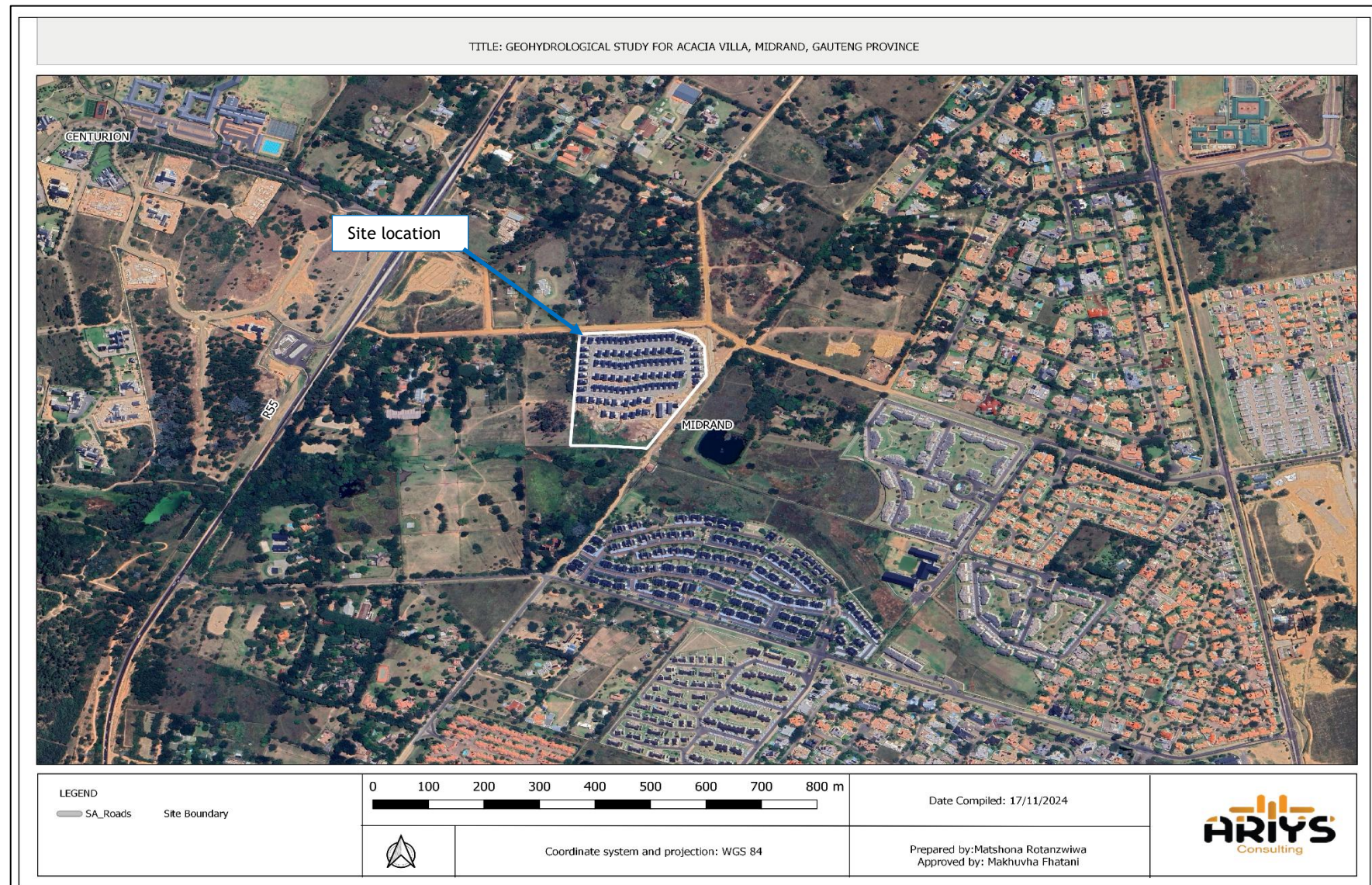


FIGURE 2-1: SITE LOCATION MAP

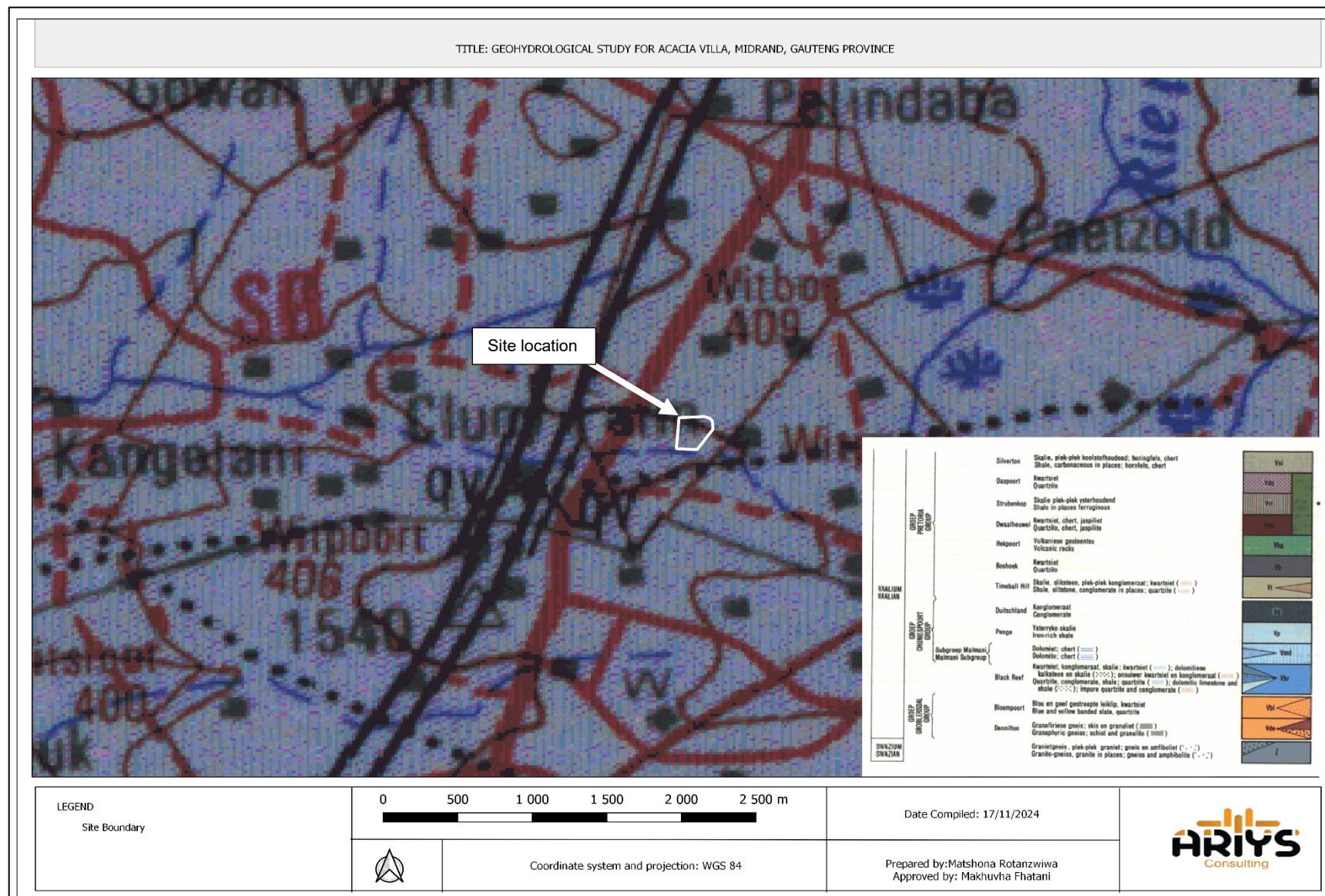


FIGURE 2-2 GEOLOGY MAP

2.5 HYDROGEOLOGY

The study area is situated in the **Crocodile (West) and Marico** Water Management Area and falls within **A21C** Quaternary catchment. As Per the 1:500 000 **2528 Pretoria** Hydrogeological Map Series sheet the underlying geological formations within ‘fractured’ aquifers. Potential groundwater yields of between **0.5 L/s and 20.0 L/s** are associated with ‘fractured’ aquifers. The primary porosity of the rocks provides the storage capacity with limited groundwater movement, while secondary features such as fractures, faults, bedding planes and dolerite intrusions enhance the groundwater flow. Based on the aquifer classification map (Parsons and Conrad, 1998) the aquifer underlying the site is regarded a “**minor aquifer**”. Hydrogeological map is seen in Figure 2-3.

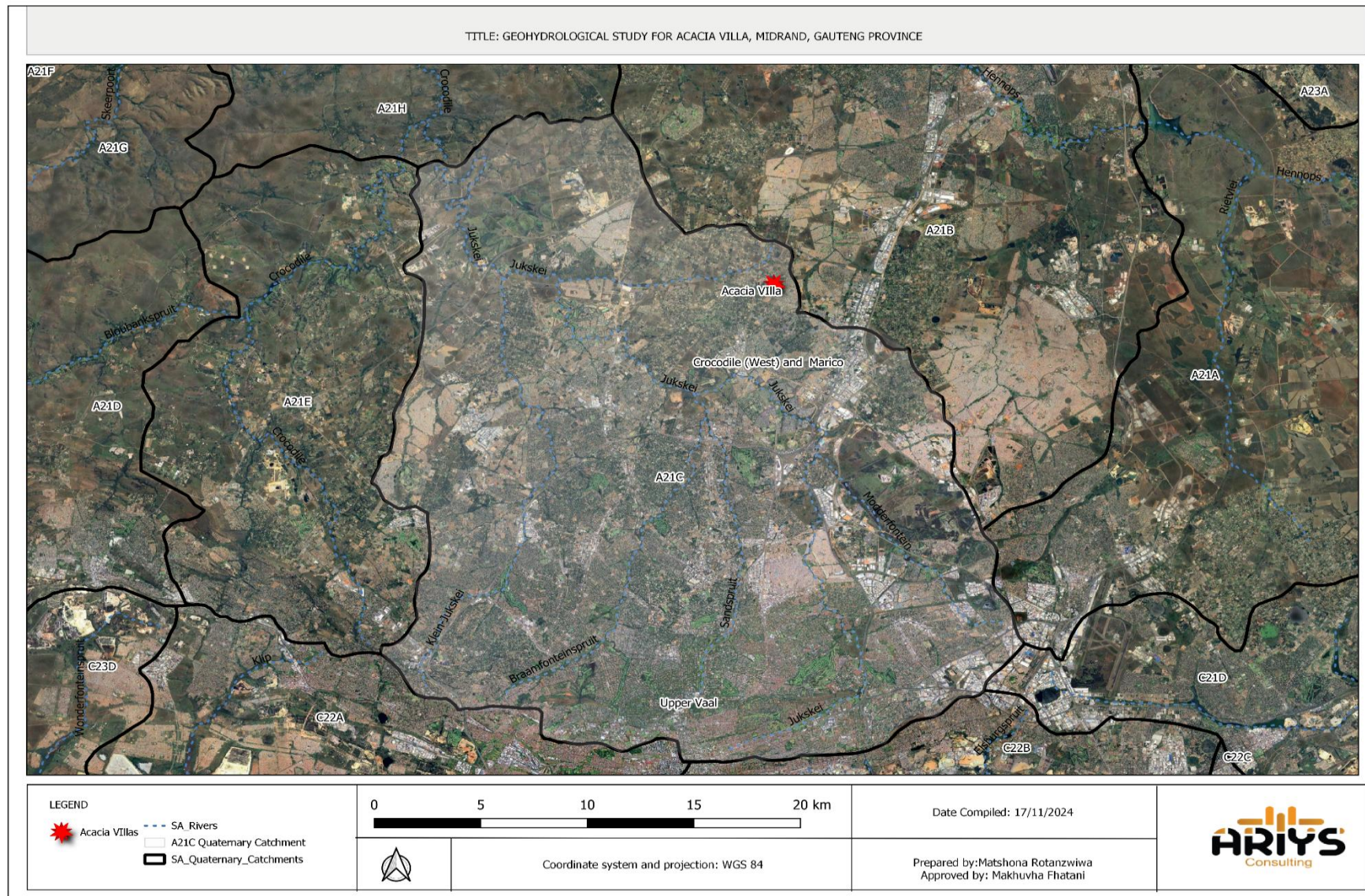


FIGURE 2-3 HYDROGEOLOGY MAP

2.5.1 Aquifer Classification

Based on the aquifer classification map (Parsons and Conrad, 1998) the aquifer underlying the study is regarded a “minor aquifer”. A summary of the classification scheme is provided in Table 2-1.

Table 2-1: AQUIFER CLASSIFICATION SCHEME (PARSONS, 1995; PARSONS AND CONRAD, 1998)

Aquifer System	Defined by Parsons (1995)	Defined by DWAF Min Requirements (1998)
Sole Source Aquifer	An aquifer which is used to supply 50% or more of domestic water for a given area, and for which there are no reasonably available alternative sources should the aquifer be impacted upon or depleted. 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	High permeable formations usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good (<150 mS/m).	High yielding aquifer (5-20 L/s) of acceptable water quality.
Minor Aquifer	These can be fractured or potentially fractured rocks, which do not have a high primary permeability or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large quantities of water, they are important both for local supplies and in supplying baseflow 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 permeability that are generally regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer as unusable. However, groundwater flow through such rocks, although imperceptible, does take place, and need to be considered when assessing the 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.	An aquifer designated as such by the Minister of Water Affairs, after due process.

2.6 AQUIFER VULNERABILITY

Aquifer vulnerability is defined as the intrinsic characteristics that determine the aquifer's sensitivity to the adverse effects resulting from the imposed pollutant (Per Lynch et al). The following factors influence groundwater vulnerability:

- **Depth to groundwater:** Indicates the distance and time required for pollutants to move through the unsaturated zone to the aquifer.
- **Recharge:** The primary source of groundwater is precipitation, which aids the movement of a pollutant to the aquifer.
- **Aquifer media:** The rock matrices and fractures which serve as water bearing units.
- **Soil media:** The soil media (consisting of the upper portion of the vadose zone) affects the rate at which the pollutants migrate to groundwater.
- **Topography:** Indicates whether pollutants will run off or remain on the surface allowing for infiltration to groundwater to occur.
- **Impact of the vadose zone:** The part of the geological profile beneath the earth's surface and above the first principal water-bearing aquifer. The vadose zone can retard the progress of the contaminants.

The Groundwater Decision Tool (GDT) was used to quantify the vulnerability of the aquifer underlying the site. The depth to groundwater below the site was estimated from water levels measured obtained from NGA database inferred to be 14.46 mbgl.

The aquifer system is classified as a minor aquifer. The local population is dependent on groundwater. Furthermore, the area is characterised by several surface water features which can be used if necessary. The aquifer is also important for supplying base flow to the rivers and streams.

To achieve the Aquifer System Management and Second Variable Classifications, as well as the Groundwater Quality Management Index, the waiting and rating approach has been adopted for the site as per South African Aquifer Systems Management Classification (Parson, 1995). Variable classification considers the three (3) generic classes (High, Medium, and Low) (TABLE 2-3). The aquifer vulnerability is determined using the Aquifer Vulnerability Map of South Africa. The vulnerability map indicates the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer. The two ratings (Aquifer System Management and Aquifer Vulnerability) are then multiplied to yield a groundwater management decision index.

TABLE 2-2: RATINGS FOR THE AQUIFER SYSTEM MANAGEMENT AND SECOND VARIABLE CLASSIFICATION (PARSONS, 1995)

Aquifer System Management Classification		Second Variable Classification	
Class	Points	Class	Points
Sole Source Aquifer System	6	High	3

Aquifer System Management Classification		Second Variable Classification	
Class	Points	Class	Points
Major Aquifer System	4	Medium	2
Minor Aquifer System	2	Low	1
Non-aquifer system	0		
Special Aquifer System	0-6		

TABLE 2-3: RATINGS FOR THE SITE- AQUIFER CLASSIFICATION AND SECOND VARIABLE CLASSIFICATIONS

Aquifer Systems Management		
Class	Points	Site
Sole Source Aquifer System	6	2
Major Aquifer System	4	
Minor Aquifer System	2	
Non-aquifer system	0	
Special Aquifer System	0-6	
Vulnerability Classification (weathering/ fracturing)		
Class	Points	Site
• High	3	2
• Medium	2	
• Low	1	

2.7 GROUNDWATER QUALITY MANAGEMENT

As part of the aquifer classification, a Groundwater Quality Management (GQM) Index is used to define the level of groundwater protection required. The GQM Index is obtained by multiplying the rating of the aquifer system management and the aquifer vulnerability. The GQM index for the site is presented in TABLE 2-4.

The vulnerability, or the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer is classified as **medium** (TABLE 2-3). However, it should be noted that due to the near surface perched coupled with shallow groundwater level on site, during heavy rainfall events the site is Kiely to experience raised water levels that may lead to water pooling on site and increases the likelihood of groundwater contamination onsite. Measures need to be taken to ensure appropriate drainage facilities are constructed to prevent the abovementioned issues. The prevailing in-situ conditions thus render the groundwater system as highly vulnerable to contamination due to anthropogenic activities.

TABLE 2-4: GQM INDEX FOR THE SITE

GQM Index	Level of Protection	Study area
<1	Limited	4
1-3.	Low level	
3-6.	Medium Level	
6-10.	High Level	
>10	Strictly non-degradation	

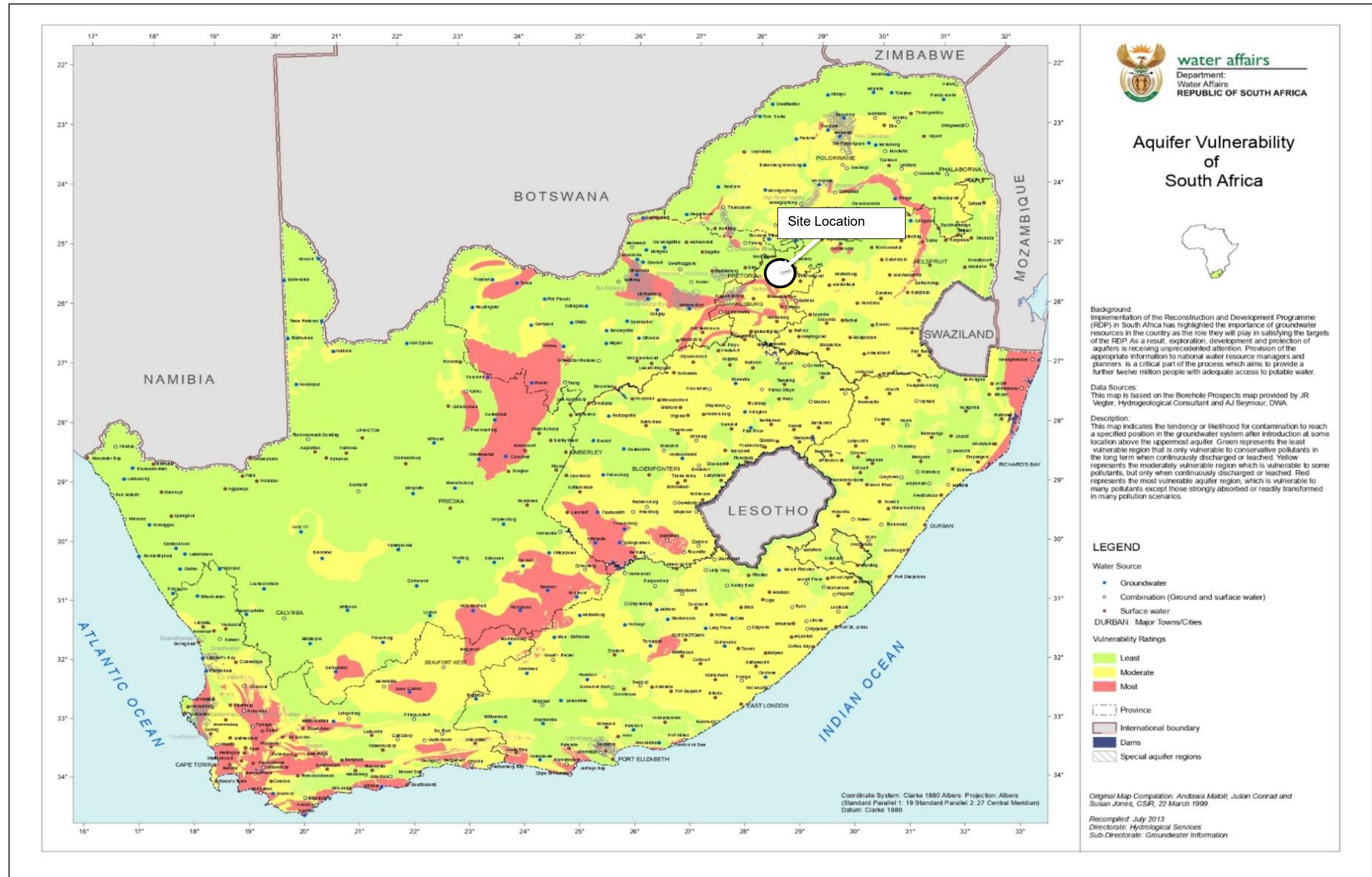


FIGURE 2-4 AQUIFER VULNERABILITY MAP OF SOUTH AFRICA

3 NATIONAL GROUNDWATER ARCHIVE DATA

3.1 NGA DATA

National Groundwater Archives (NGA) is a web enabled database system that allows capturing, viewing, modifying and extraction of groundwater related data by registered users. NGA was used to gather information on existing boreholes within a 5km radius of the site to understand the spatial status of groundwater flow regime. For each borehole identified on NGA, the parameters including location, groundwater level, water strike and elevation where possible were noted.

A total of Two (2) boreholes were identified from the NGA data. The parameters including location, groundwater level, and elevation where possible were noted. The following could be concluded based on the obtained data:

- Groundwater level range is between 6.05mbgl and 22.86mbgl. The water levels were recorded between 1997 and 1972.
- All boreholes identified are located south of the site. With no boreholes located within a 2km radius of the site.
- The site is therefore underlain by a very shallow groundwater table.

Data collected from the NGA database can be outdated and some borehole attributes could have changed over the years, or the borehole has since been destroyed. It is important to note that this information only serves as a baseline to understand the groundwater regime. The table below (Table 3-1) summarizes the NGA data obtained within a 5km radius of the site. Figure 3-1 shows the locations of the boreholes with groundwater levels obtained from the NGA data.

TITLE: GEOHYDROLOGICAL STUDY FOR ACACIA VILLA, MIDRAND, GAUTENG PROVINCE



LEGEND

Acacia Villas Acacia Villas
NGA Boreholes
SA_Roads

0 500 1 000 1 500 2 000 2 500 m



Coordinate system and projection: WGS 84

Date Compiled: 17/11/2024

Prepared by: Matshona Rotanzwiwa
Approved by: Makhuvha Fhatani

FIGURE 3-1: NGA DATA BOREHOLE LOCATIONS

TABLE 3-1: NGA DATA SUMMARY

BH ID	latitude	Longitude	Farm name	Lithology	Water strike	Water Level (m)	Elev - mams	WL_mamsl
2528CC00258	-25,99311	28,11721	WATERVAL GED. MIDRAND SMUTSSTRAAT	Quartzite & Granite	-	6,05	1554	1547,95
2528CC00251	-25,97561	28,08387	WITPOORT	Quartzite & Granite	48,77	22,86	1520	1497,14
Average						14,455	1537	1522,545

3.1 GROUNDWATER FLOW DIRECTION

Groundwater elevation and Flow Regime based on groundwater level measurements obtained from NGA data was used to create groundwater flow directions. In general, the water table mimics the topography, and groundwater flow is from areas of higher lying ground.

A moderate correlation between the measured head and topography can be seen in Figure 3-2 ($R^2 = 0.8864$, i.e., approximately 89% of observed groundwater level variations can be explained by variations in land surface elevation and it can be assumed that the water table slightly mimics the surface topography but is somewhat higher or somewhat lower in places.

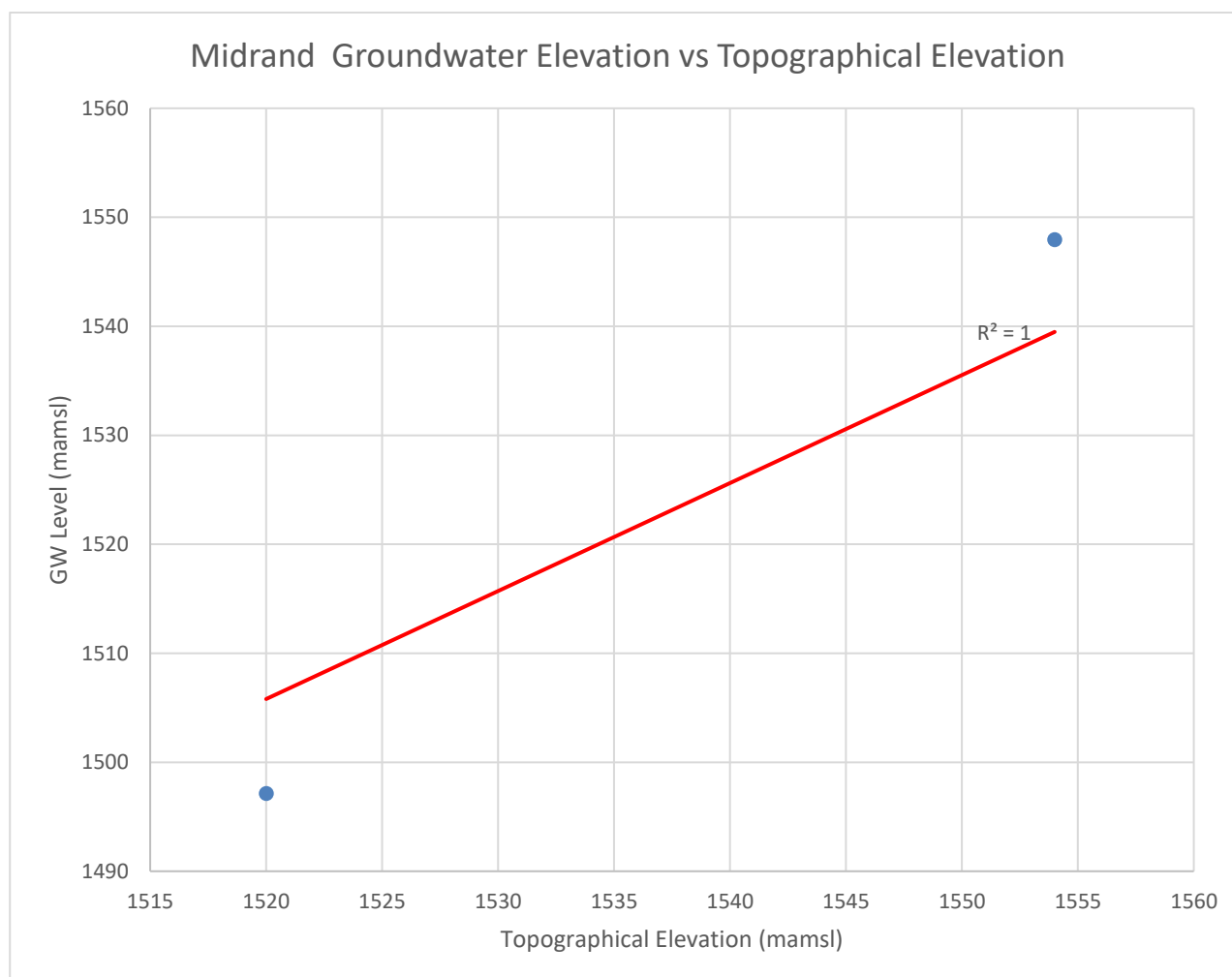


FIGURE 3-2: GW VS TOPOGRAPHICAL ELEVATION

4 HYDROCENSUS

Ariys Consulting undertook the hydrocensus investigation on the 16th of November 2024. A total number of two (2) boreholes and one (1) stream were identified during the hydrocensus investigation. Details of the boreholes and stream are presented in Table 4-1, Table 4-2 and Figure 4-1.

For each borehole identified, parameters including the location, elevation, groundwater level, water quality, and groundwater usage were recorded. Groundwater samples were collected for water quality analyses and submitted to Sanas accredited Laboratory Aquatico in Centurion.

- Boreholes are located within the Acacia Villa.
- Groundwater Level were measured between BH1 (5,78) and Blue Hills X105 (6,20)
- Borehole depths were measured between BH1 (20,00) and Blue Hills X105 (20,78)
- Borehole are quipped and used as domestic boreholes.

TABLE 4-1 HYDROCENSUS BOREHOLES

Borehole ID	Co-ordinates		Elevation (mams)	Water Level(m)	Water Level (mamsl)	Depth	Usage	Colour	Borehole conditions	Water sample collected	Field Measurement
	Latitude	Longitude									
BH1	-25,95951	28,09025	1492	5,78	1486,22	20,00	Domestic	Colourless	Good	Yes	pH=6,88 EC=515 mS/m TDS=266mg/l
Blue Hills X105	-25.959537°	28.089728° °	1491	6,20	1484,8	20,78	Domestic	Colourless	Good	Yes	pH=7,20 EC=575mS/m TDS=320 mg/l
SW1	-25.959786°	28.090101°	1493	-	1493	0,5m	Stream	Brown	-	Yes	pH=7,88 EC=221mS/m TDS=409 mg/l

TABLE 4-2 HYDROCENSUS PHOTO LOG

PhotoLog	
	
Plate1: BH1	Plate 2: SW1 Stream

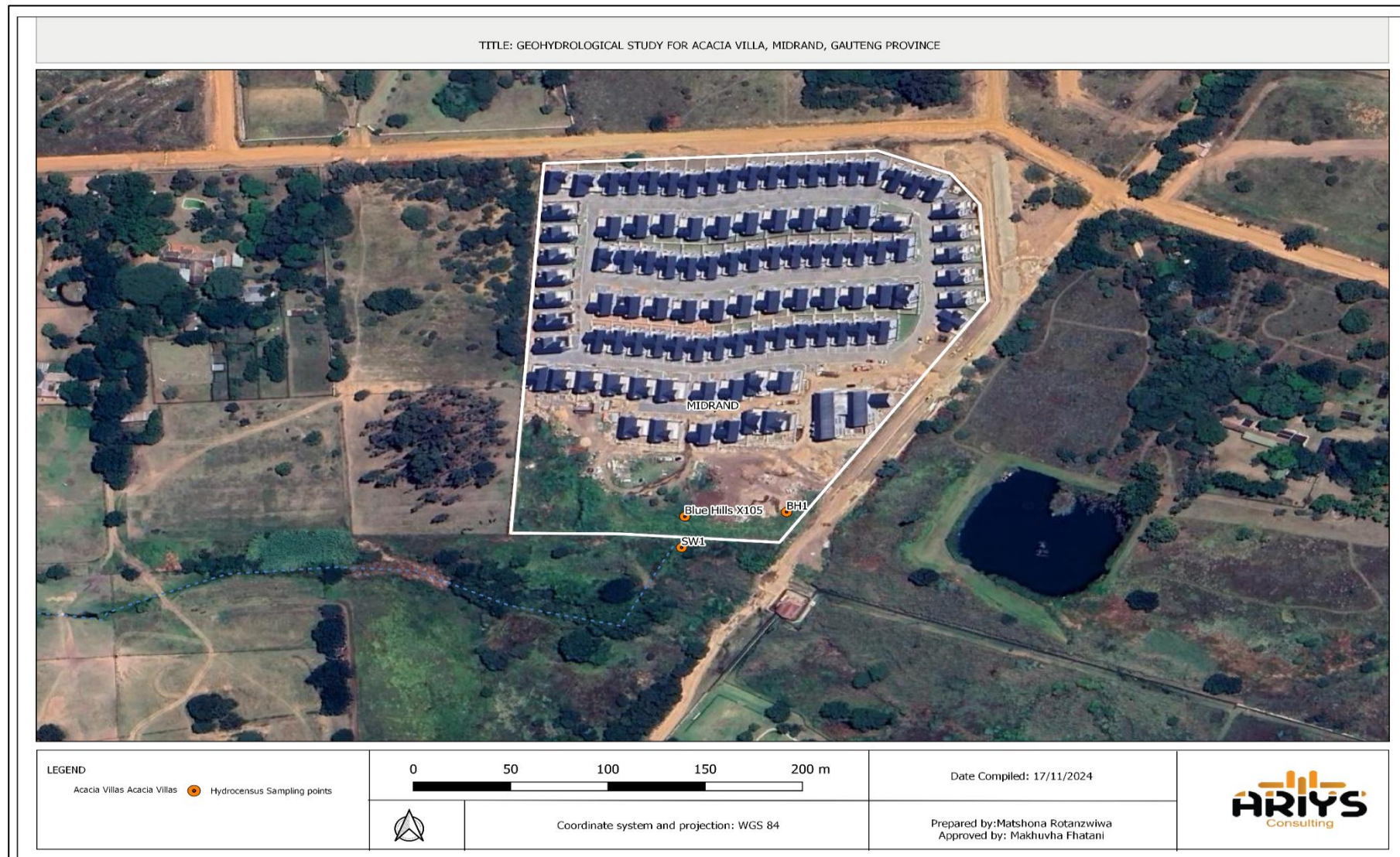


FIGURE 4-1 HYDROCENSUS MAP

5 AQUIFER TESTING

Aquifer tests were conducted in November 2024 by Mshandukani (Pty) Ltd in accordance with the National Standard (SANS 10299, Part 4 - Test Pumping of Water Boreholes). The Department of Water and Sanitation recommends that a 24-hour constant discharge test be conducted where the estimated groundwater abstraction requirements for a proposed activity are less than 150,000 m³/annum.

A 24-hour Constant Discharge Test (CDT) was performed on the two boreholes at average abstraction rates determined during preliminary calibration tests. Following the completion of pumping, groundwater recovery was monitored to ensure that at least 98% recovery to the initial static water level was achieved.

The constant discharge test data were analysed using the Cooper-Jacob (CJ) method and the Basic Flow Characteristic (FC) method to estimate the long-term sustainable yields of the boreholes. Detailed results and data sheets are provided in Appendix A: Borehole Yield Testing Data Sheets.

5.1 AQUIFER TESTING RESULTS

Borehole Number (BH 1)

Borehole (BH 1) located at S25.959599° E28.089758°, four by one hour step tests were conducted at 0.35, 1.40, 2.70 and 4.78 l/sec respectively resulting in a cumulative final drawdown of 34.28 m after 210 mins of step pumping. Recovery after the step tests is at 98.05 % after 90 mins of observation. A 24 hour constant rate test was conducted at 2.50 l/sec resulting in a final drawdown of 30.27 m. Recovery after constant test is at 99.20 % after 120 mins of observation. Specific capacity after 2 hrs of pumping is calculated = 0.22 l/sec.m⁻¹ and transmissivity 2.46 m³/day/m.

Borehole Number (BH 2)

Borehole BH 1 located at S25.959517° E28.090261°, four by one hour step tests were conducted at 0.35, 1.10, 2.00 and 3.75 l/sec respectively resulting in a cumulative final drawdown of 32.90 m after 187 mins of step pumping. Recovery after the step tests is at 99.24 % after 60 mins of observation. A 24 hour constant rate test was conducted at 2.00 l/sec resulting in a final drawdown of 29.04 m. Recovery after constant test is at 98.79 % after 90 mins of observation. Specific capacity after 2 hrs of pumping is calculated = 0.16 l/sec.m⁻¹ and transmissivity 2.93 m²/day.

Borehole yield testing data is shown in appendix B.

Refer to Borehole yield testing data graphs shown Figure 5-1 and Figure 5-2.

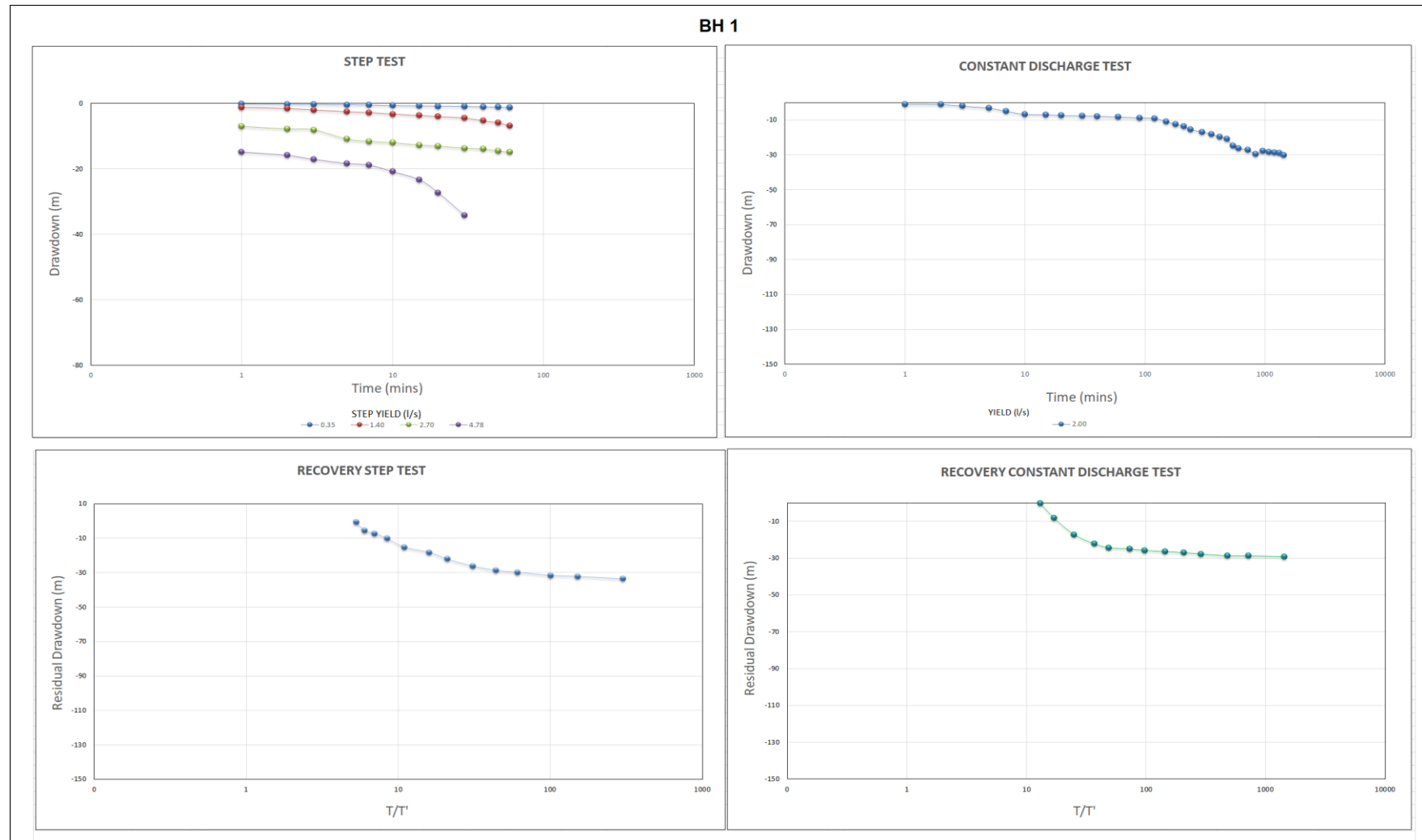


FIGURE 5-1 PUMP TESTING DATA GRAPHS- BH 1

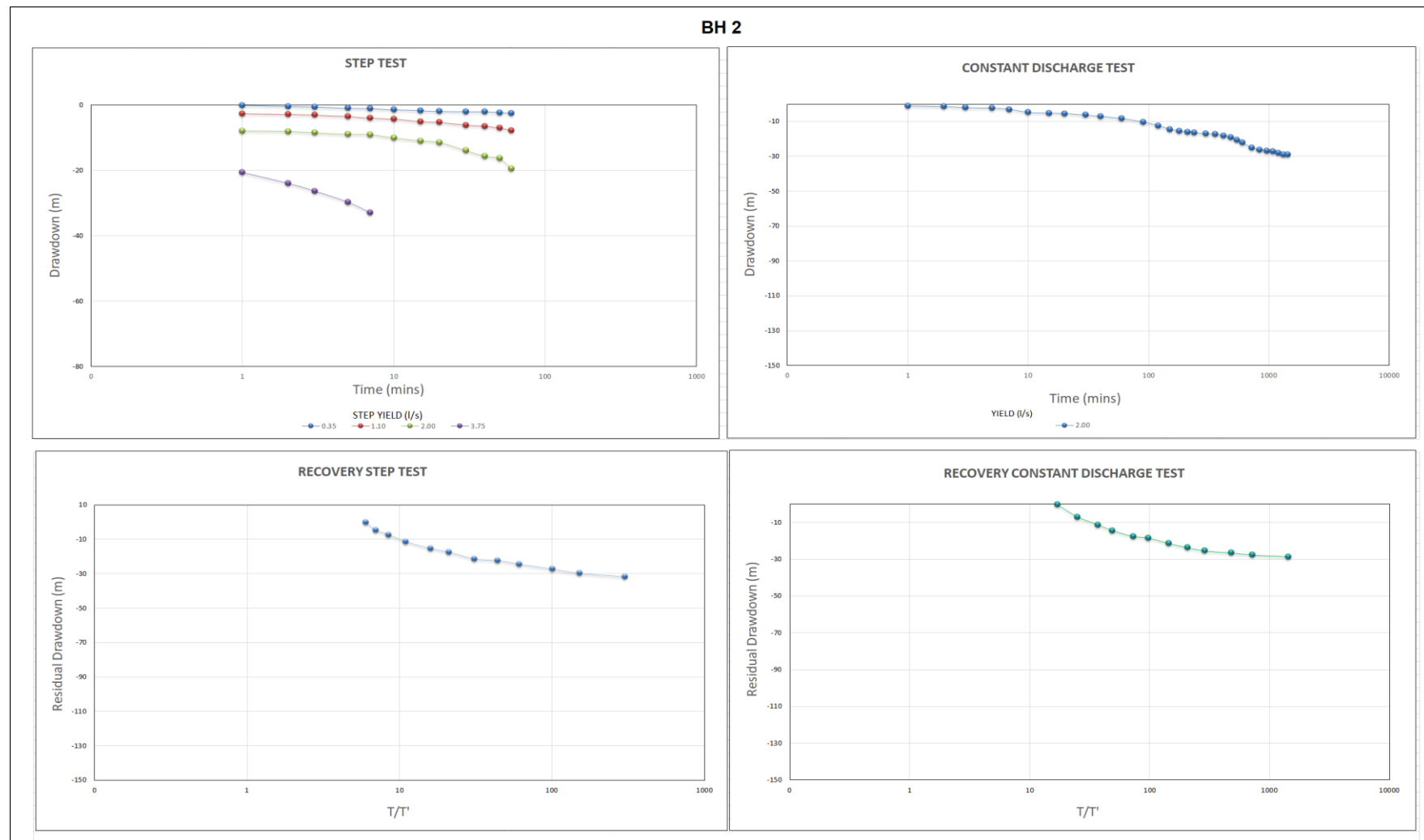


FIGURE 5-2 PUMP TESTING DATA GRAPHS- BH 2

TABLE 5-1 FC METHOD – BASIC SOLUTION ESTIMATION OF SUSTAINABLE YIELD- BH 1)

FC-METHOD : Estimation of the sustainable yield of a borehole				
BH 1		Main	Deriv	Inflection point method
Extrapolation time in years = (enter)	4	2102400	Extrapol.time in minutes	
Effective borehole radius (r_e) = (enter)	59.67	59.67	Est. r_e	From r(e) sheet
Q (l/s) from pumping test =	2.5	5.74E-05	S-late	Change r_e
s_a (available drawdown), σ_s = (enter)	100.0	1.5	Sigma_s from risk	Down
Annual effective recharge (mm) =	42.43	142.43	$s_{\text{available working drawdown(m)}}$	
t(end) and s(end) of pumping test =	1440	30.27	End time and drawdown of test	
Average maximum derivative = (enter)	36.9	36.9	Estimate of average of max deriv	
Average second derivative = (enter)	0.0	0.0	Estimate of average second deriv	
Derivative at radial flow period = (enter)	5.27	5.27	Read from derivative graph	
T and S estimates from derivatives (To obtain correct S-value, use program RPTSOLV)		T-early [m^2/d] = 7.51 T-late [m^2/d] = 1.07 S-late = 2.27E-03	Aqui. thick (m) = 41.22 Est. S-late = 2.27E-03 S-estimate could be wrong	
BASIC SOLUTION				
(Using derivatives + subjective information about boundaries) (No values of T and S are necessary)		Maximum influence of boundaries at long time		
	No boundaries	1 no-flow	2 no-flow	Closed no-flow
sWell (Extrapol.time) =	146.81	263.59	380.37	730.71
Q_sust (l/s) =	2.43	1.35	0.94	0.49
	Best case			Worst case
Average Q_sust (l/s) =	1.11			
with standard deviation =	0.83			
(If no information exists about boundaries skip advanced solution and go to final recommendation)				
ADVANCED SOLUTION				
(Using derivatives+ knowledge on boundaries and other boreholes) (Late T-and S-values a priori + distance to boundary)				
T-late [m^2/d] = (enter)	1.07			
S-late = (enter)	1.00E-03			
1. BOUNDARY INFORMATION (choose a or b)		(Code =9999 = dummy value if not applicable)		
(a) Barrier (no-flow) boundaries		Closed Square	Single Barrier	Intersect. 90°
Bound. distance a[meter] : (enter)	9999	9999	9999	9999
Bound. distance b[meter] : (enter)			9999	9999
$s_{\text{Bound(t = Extrapol.time) [m] =}}$	0.00	0.00	0.00	#NUM!
(b) Fix head boundary + no-flow		Closed Fix	Single Fix	90°Fix+no-flow
Bound. distance to fix head a[meter] : (enter)	9999	9999	9999	9999
Bound. distance to no-flow b[meter] : (enter)			9999	9999
$s_{\text{Bound(t = Extrapol.time) [m] =}}$	0.00	0.00	0.00	0.00
2. INFLUENCE OF OTHER BOREHOLES		Q (l/s)	r (m)	u_r
BH1				0.00E+00
BH2				0.00E+00
$s_{\text{(influence of BH1,BH2) =}}$	0.00	0.00		5.69E-04
SOLUTION INCLUDING BOUNDS AND BH's				
Fix head + No-flow : Q_sust (l/s) =	9999.00	9999.00	9999.00	9999.00
No-flow : Q_sust (l/s) =	9999.00	9999.00	9999.00	9999.00
Enter selected Q for risk analysis = (enter)	1.80		Sigma_s = 0.000	Up Risk
(Go to Risk sheet and perform risk analysis from which sigma_s will be estimated : only for barrier boundaries)				
FINAL RECOMMENDED ABSTRACTION RATE				
Abstraction rate (l/s) for 10 hr/d = (enter)	1.80			
Total amount of water allowed to be abstracted per day (m^3) =	65			
COMMENTS				
Q_sust with 68% safety =		1.10 l/sec		
Q_sust with 95% safety =		1.70 l/sec		

TABLE 5-2 FC METHOD – BASIC SOLUTION ESTIMATION OF SUSTAINABLE YIELD -BH 2

FC-METHOD : Estimation of the sustainable yield of a borehole				
BH 2		Main	Deriv	Inflection point method
Extrapolation time in years = (enter)	4	2102400	Extrapol.time in minutes	
Effective borehole radius (r_e) = (enter)	48.96	48.96	Est. r_e	From r(e) sheet
Q (l/s) from pumping test =	2	7.18E-05	S-late	Change r_e
s_a (available drawdown), sigma_s = (enter)	100.0	1.5	Sigma_s from risk	Down
Annual effective recharge (mm) =	42.43	142.43	$s_{\text{available}}$ working drawdown(m)	
t(end) and s(end) of pumping test =	1440	29.04	End time and drawdown of test	
Average maximum derivative = (enter)	29.5	29.5	Estimate of average of max deriv	
Average second derivative = (enter)	0.0	0.0	Estimate of average second deriv	
Derivative at radial flow period = (enter)	6.94	6.94	Read from derivative graph	
T and S estimates from derivatives (To obtain correct S-value, use program RPTSOLV)	T-early[m ² /d] =	4.56	Aqui. thick (m)	41.22
	T-late [m ² /d] =	1.07	Est. S-late =	2.27E-03
	S-late =	2.27E-03	S-estimate could be wrong	
BASIC SOLUTION				
(Using derivatives + subjective information about boundaries) (No values of T and S are necessary)		Maximum influence of boundaries at long time		
sWell (Extrapol.time) =	No boundaries	1 no-flow	2 no-flow	Closed no-flow
	122.44	215.83	309.22	589.39
Q_sust (l/s) =	2.33	1.32	0.92	0.48
	Best case	Worst case		
Average Q_sust (l/s) =	1.08			
with standard deviation=	0.79			
(If no information exists about boundaries skip advanced solution and go to final recommendation)				
ADVANCED SOLUTION				
(Using derivatives+ knowledge on boundaries and other boreholes)				
(Late T-and S-values a priori + distance to boundary)				
T-late [m ² /d] = (enter)	1.07			
S-late = (enter)	1.00E-03			
1. BOUNDARY INFORMATION (choose a or b)				
(Code =9999 = dummy value if not applicable)				
(a) Barrier (no-flow) boundaries	Closed Square	Single Barrier	Intersect. 90°	2 Parallel Barriers
Bound. distance a[meter] : (enter)	9999	9999	9999	9999
Bound. distance b[meter] : (enter)			9999	9999
$s_{\text{Bound}}(t = \text{Extrapol.time})$ [m] =	0.00	0.00	0.00	#NUM!
(b) Fix head boundary + no-flow	Closed Fix	Single Fix	90°Fix+no-flow	// Fix+no-flow
Bound. distance to fix head a[meter] : (enter)	9999	9999	9999	9999
Bound. distance to no-flow b[meter] : (enter)			9999	9999
$s_{\text{Bound}}(t = \text{Extrapol.time})$ [m] =	0.00	0.00	0.00	0.00
2. INFLUENCE OF OTHER BOREHOLES				
	Q (l/s)	r (m)	u r	W(u,r)
BH1			0.00E+00	#NUM!
BH2			0.00E+00	#NUM!
$s_{\text{(influence of BH1,BH2)}}$ =	0.00	0.00	3.83E-04	7.29
SOLUTION INCLUDING BOUNDS AND BH's				
Fix head + No-flow : Q_sust (l/s) =	9999.00	9999.00	9999.00	9999.00
No-flow : Q_sust (l/s) =	9999.00	9999.00	9999.00	9999.00
Enter selected Q for risk analysis = (enter) →		Sigma_s =	0.000	Up Risk
(Go to Risk sheet and perform risk analysis from which sigma_s will be estimated : only for barrier boundaries)				
FINAL RECOMMENDED ABSTRACTION RATE				
Abstraction rate (l/s) for 10 hr/d = (enter)	1.60			
Total amount of water allowed to be abstracted per day (m ³) =	58			
COMMENTS				
Q_sust with 68% safety = 1.20 l/sec				
Q_sust with 95% safety = 1.6 l/sec				

5.2 BOREHOLE EQUIPPING RECOMMENDATIONS

The recommendations for equipping the two boreholes tested at the project site are detailed in Table 5. These recommendations are based on the pump test analysis methods applied, namely the FC-Method (including the Basic solution, Cooper-Jacob approximation, and FC Non-linear method). Final equipping recommendations and suggested borehole yield are derived from these methods, as well as the geo-hydrologist's geological interpretation and conceptualization of the yield dataset.

TABLE 5-3 SUMMARY OF BOREHOLE RECOMMENDATIONS

Parameter	BH 01	BH 02
Borehole ID	BH 01	BH 02
Borehole Status	Existing Production Borehole	Existing Production Borehole
Coordinates	S 25.722558, E 27.597543	S 25.722603, E 27.596561
Total Depth	45 m	40 m
Static Water Level (SWL)	3.20 mbgl (as of 13/11/2024)	3.96 mbgl (as of 13/11/2024)
Recommended Abstraction Rate	1.80 l/s at 10 hours per day	1.60 l/s at 10 hours per day
Maximum Abstraction Rate	2.00 l/s at 6 hours per day	2.00 l/s at 6 hours per day
Estimated Daily Yield	64 800 L/day	57 600 L/day
Proposed Pump Installation Depth	42 mbgl	38 mbgl
Critical Drawdown Level	41 mbgl	37 mbgl

Total abstraction per day will be at 122 400 liters per day i.e 122.4 m³/day this will easily meet the expected demand of 90m³/day of the project site.

6 GROUNDWATER AND SURFACE WATER QUALITY ANALYSIS

Groundwater and surface water samples were collected and submitted to an accredited laboratory for water quality analyses. Concentrations have been compared to the following water quality standard:

- **South African National Standards (SANS) 241 (2015)**

The SANS 241: 2015 specifies limits in terms of four categories:

- **Acute Health** - poses an immediate unacceptable health risk if present at concentrations exceeding the numerical limits specified.
- **Aesthetic** - does not pose an unacceptable health risk if present at concentrations exceeding the numerical limits specified, but will taint water with respect to taste, odour, and colour.
- **Chronic Health** - poses an unacceptable health risk if ingested over an extended period if present at concentrations exceeding the numerical limits specified.
- **Operational** - is essential for assessing the efficient operation of treatment systems and risks to infrastructure.

6.1 GROUNDWATER AND SURFACE WATER QUALITY RESULTS

Ground water and surface water quality results indicated that all analysed constituents were recorded below SANS 241:2015 standard limits except for Turbidity (NTU), E coli, T coli, Iron (Fe) and Manganese (Mn). Refer to Table 6-1 and Appendix A.

- Turbidity (NTU) has been recorded above SANS 241:2015 of 1 NTU for Operational Health in BH1 (2.39 NTU, and further recorded above SANS 241:2015 of 5 NTU for Aesthetic Health in Blue Hill X105 (31 NTU) and Sw1 (44.2 NTU).
- Manganese (Mn) has been recorded above SANS 241:2015 of 0.1 mg/l for Aesthetic Health in Blue hill X105 (0.329 mg/l)
- Iron (Fe) has been recorded above SANS 241:2015 of 0.3 mg/l for Aesthetic Health in Blue hill X105 (0.236 mg/l)
- E coli has been recorded above SANS 241:2015 of 1 CFU/100ml for Acute Health in BH1 (300CFU/100ml) and SW1 (6 CFU/100ml)
- T coli has been recorded above SANS 241:2015 of 10 CFU/100ml for Operational Health in BH1 (1400CFU/100ml) and SW1 (900 CFU/100ml).

Ground water and surface water results indicated that the water from these sources is not suitable for human consumption. Filtration method is recommended before any human consumption.

TABLE 6-1: SUMMARY OF WATER QUALITY ANALYSIS

SANS 241-1:2015 Ed. 2 :						
Operational Health						
Aesthetic Health						
Acute Health						
Chronic Health						
Date Sampled:				BH1	Blue Hills X105	SW1
Physical Determinants	Unit	Risk	General / Standard Limit	Borehole water	Borehole water	Stream
pH - Value @ 25 °C	pH Units	Operational	≥5 to ≤ 9.7	7,92	7,4	7,51
Electrical Conductivity in mS/m @ 25 °C	mS/m	Aesthetic	≤170	50,7	53,4	22
Total Dissolved Solids @ 180 °C	mg/l	Aesthetic	≤1200	366	340	139
Turbidity in N.T.U	mg/l	Operational	≤1	2,39	31	44,2
	mg/l	Aesthetic	≤5			
Total Alkalinity as CaCO ₃	mg/l	---	---	234	236	82,6
Chloride as Cl	mg/l	Aesthetic	≤300	18,6	17	5,52
Sulphate as SO ₄	NTU	Acute health	≤500	18,4	23	21,5
		Aesthetic	≤250			
Fluoride as F	mg/l	Chronic health	≤1.5	0,567	0,3	0,386
Nitrate as N	-	Acute health	≤11	0,194	0,2	0,194
E. coli (MPN/100 mℓ)	mg/l	Acute health	Not detected	300	<1	6
T. coli (MPN/100 mℓ)	mg/l	Operational health	10	1400		900
Sodium as Na	mg/l	Aesthetic	≤200	51,6	41	11,6
Potassium as K	mg/l	---	---	1,91	0,5	6,01
Calcium as Ca	mg/l	---	---	48,7	51	28,2
Magnesium as Mg	mg/l	---	---	14,7	15	3,8
Aluminium as Al (µg/ℓ)	mg/l	Operational	≤0,3	0,002	0,24	0,287
Cadmium as Cd (µg/ℓ)	mg/l	Chronic health	≤0,03	0,002	0,001	0,002
Total Chromium as Cr (µg/ℓ)	mg/l	Chronic health	≤0,05	0,003	0,025	0,003
Copper as Cu (µg/ℓ)	mg/l	Chronic health	≤2	0,002	0,001	0,002
Iron as Fe (µg/ℓ)		Chronic health	≤ 2	0,001	0,236	0,108
		Aesthetic	≤0,3			
Lead as Pb (µg/ℓ)	mg/l	Chronic health	≤0,01	0,004	0,006	0,004
Manganese as Mn (µg/ℓ)		Chronic health	≤0,4	0,03	0,329	0,001
	mg/l	Aesthetic	≤0,1			
Nickel as Ni (µg/ℓ)	mg/l	Chronic health	≤0,07	0,002	0,025	0,002
Zinc as Zn	mg/l	Aesthetic	≤5	0,002	0,0025	0,002

7 GROUNDWATER RESERVE DETERMINATION

Groundwater Reserve can be defined as the quantity and quality of water required to supply basic human needs with water from a resource, while protecting the aquatic ecosystem to secure sustainable development and use of a water resource. To calculate the groundwater component of the reserve, the following needs to be considered:

7.1 UNIT OF ANALYSIS DELINEATION (PROJECT SITE-ACACIA VILLAS)

Acacia Villas covers an area of 5.7305 hectares (57 305 square meters), which is designated for groundwater recharge and storage. Discussed below is the calculated values of annual Recharge (m3) and Available Water in Aquifer Storage (m3): Recharge = 42.43 mm (0.04243 m) & Storativity = 0.0090 according to GRA II results for quaternary catchment A21C and Sami. K (2015) Groundwater module: Verification studies, default parameters and calibration guide.

7.2 WATER DEMAND (PROJECT SITE)

According to the GRDM Database (DWS, 2013), the basic human needs (BHN) Reserve provides for the essential needs of individuals served by the water resource in question and includes water for drinking, food preparation and for personal hygiene. A life-line amount of 25 litres per person per day is used as a standard.

This study will take into account the conversely, other water use not vital to health and hygiene, but may be considered necessary for maintaining a relatively higher standard of living. These include irrigation and water for car washing or pools. The Department of Water Affairs (DWA) (2009) and later also the DHS (2019) provided guidelines for per-capita water consumption for different settlement categories in South Africa. Consumption values range from 25 to 400 ℓ/c/d for a residential household. The DHS (2019) presented a useful table with per-capita water use for different types of water supply, refer Table 7-1.

TABLE 7-1 RESIDENTIAL ANNUAL AVERAGE DAILY DEMAND (PER-CAPITA WATER CONSUMPTION GUIDELINES FOR SOUTH AFRICA) (DHS, 2019)

Land use		Persons per unit	Typical annual average daily demand* (ℓ/c/d)	Annual average daily demand range* (ℓ/c/d)
Standpipe		5	25	10-40
Yard connection	With dry sanitation	5	50	40-60
	With low-flow sanitation	5	60	50-70
	With full-flush sanitation	5	70	60-80
House connection	Low-income housing	5	90	60-120
	Residential	5	230	120-400
	Group/cluster housing	3-5	120	130-120
	Flats	1-4	150	250-110

* Per-capita calculated on persons per unit

The expected residential population at Acacia Villas (Project Site) is 400 residents, based on an average of 4 occupants per unit for the 100 developed units, along with 10 employees, resulting in a total population of 410 people. As the land use is classified under Group/Cluster housing, the average daily water demand for the project has been calculated as follows:

The residential water use for the Acacia Villas project, using the Flats housing development type of the site the per capita daily water consumption (in litres per person per day).

The average water use of 200 litres per person per day, which is a typical value for luxury flat residential developments.

- Total population = 400 people (400 permanent residents at full capacity)
- Per capita daily water use = 200 litres/person/day

Total Residential daily water use = 400 people $\times$ 200 liters/person/day = 80 000 liters/day or 80 (m³/day).

The irrigation water daily demand for the Acacia Villas project for the lawns covering a combined area of less than hectare (2,000 square meters) of land within the premises

- Water requirement: 5 mm of water per day, which equals 5 liters per square meter per day for the lawns (According to standard agriculture lawn irrigation demand)
- Total water requirement: 2,000 m² $\times$ 5 liters/m² = 10,000 liters per day.

Thus, the irrigation demand for all the lawns covering a hactor is 10 000 liters/day or 10 (m³/day).

Total daily water demand = 80 m³/day (residential) + 10 m³/day (irrigation) = 90 m³/day. (Note that this demand can be higher or less depending on individual resident's water use and effectiveness of irrigation system thus the proposed abstraction of 122.4 m³/day is applied for to cover for the fluctuations in individual water uses.

7.3 SCALE OF ABSTRACTION CALCULATIONS

DWS categorizes the water use license applications in three (3) categories based on the amount of recharge to groundwater that is used by the applicant in relation to the specified property:

- Category A: Small scale abstraction (<60% recharge on property)
- Category B: Medium scale abstraction (60-100% recharge on property)
- Category C: Large scale abstraction (>100% recharge on property)

The area is Categorised as Category A Small scale abstraction (<60% recharge on property) based on the abstraction formulas given by DWS

Scale abstraction calculations area as follows:

The calculations for groundwater recharge: (Quaternary Catchment)

$$\begin{aligned}\text{Average Recharge (m}^3\text{)} &= \text{Area (m}^2\text{)} \times \text{Recharge (m)} \\ &= 761\,000\,000\text{ m}^2 \times 0.04243\text{ m} \\ &= \underline{32\,289\,230\text{ m}^3/\text{a}}\end{aligned}$$

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

$$\begin{aligned}\text{Available Water in Aquifer Storage (m}^3\text{)} &= (\text{Area (m}^2\text{)} \times \text{Drawdown (m)} \times \text{Storativity}) \\ &= 57\,305\text{ m}^2 \times 48.52\text{ m} \times 0.0090 \\ &= \underline{25\,023.95\text{ m}^3/\text{a}}\end{aligned}$$

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

Sustainable Quaternary aquifer yield: (Quaternary Catchment)

$$\begin{aligned}\text{Average sustainable yield (m}^3/\text{day)} &= (\text{Average recharge (m}^3\text{)} \times 60\%) / 365\text{ days} \\ &= (32\,289\,230\text{ m}^3 \times 0.6) / 365 \\ &= \underline{53\,078.19\text{ m}^3/\text{day}}\end{aligned}$$

Please note that these calculations do not include inflows from neighbouring Quaternary Catchments or current water usage at the project site, surrounding facilities, and villages. Additionally, fractured or fault-associated aquifers may extend beyond their primary catchment zones and often yield higher volumes than primary aquifers as in this case of Acacia Villas as shown by the high borehole yields and transmissivity indicative of open flowing aquifer.

7.4 POTENTIAL GROUNDWATER ABSTRACTION IMPACT ON EXISTING SURROUNDING USERS

Groundwater abstraction yield estimates, based on the FC and Cooper-Jacob methods, are conservative. Consequently, groundwater drawdown is anticipated to range between 5-10 meters under the recommended duty cycles. No significant impact on groundwater levels is expected in the immediate vicinity of the project site. However, it is recommended that a numerical groundwater model be developed to assess potential long-term impacts on groundwater levels and aquifer storage.

8 CONCEPTUAL SITE MODEL AND RISK ASSESSMENT

The site has been zoned as residential area. As part of the evaluation of the site, the environmental risk has been assessed using the potential Source - Pathway - Receptor model of potential contamination. The site assessment includes identification of the potential sources, pathways, and receptors within the context of possible contamination, i.e., a situation where the source(s), pathway(s) and receptor(s) are all present at a site and therefore a real (as opposed to a perceived) risk of potential impact exists

TABLE 8-1 CONCEPTUAL SITE MODEL

CONCEPTUAL SITE MODEL				
Overview	The land use is zoned as an Acacia Villas residential area. The neighbouring properties comprise residential and commercial properties The groundwater flow direction inferred from the NGA data in south easterly direction.			
Sources	The study area will consist of domestic waste and minor construction waste which is the main source of contamination. - Domestic and Construction waste: Domestic sludge containing organic substances, soaps, hydrocarbons, and high pH maybe found due to the waste found on site. - Petrol: MTBE and Benzene concentration may be detected in surface and groundwater due to tracks on site. - Diesel: Hydrocarbons of the paraffinic and naphthenic concentration may be detected in surface and groundwater due to tracks on site. - Dust pollution: Pollution caused by movement of vehicles. The airlifted pollution can infiltrate into the groundwater during rain events.			
	Pathway	Description		Risk
	Groundwater infiltration	Onsite	Infiltration of contaminated water into the ground	Medium
		Offsite	Via shallow groundwater and vertical migration through low to medium permeable shallow soils	Medium
	Vehicle movement	Surface	Spillage of oils from heavy vehicles contaminating surface water and soil and creating dust and noise	Low
	Receptor	Location		
	Onsite employees	Workers that are based at Acacia Villas.		

CONCEPTUAL SITE MODEL		
	Onsite residents	Residents that are based at Acacia Villas
	Offsite residents	Relatively modern residential properties located 5km around the study area
	Commercial users	Businesses located in a 5km radius from the site
	Groundwater	Nearest groundwater sources providing water to the residential and commercial areas
	Surface waters	The Stream is located 1km southeast of the site (downstream)
Pollutant linkages	Receptor	Location
Groundwater: Source concentration is not likely exceeding impact criteria for the impact to water resources.		
OVERALL ASSESSMENT	Low to Medium	

9 RISK IMPACT ASSESSMENT

Impacts from the proposed development construction activities on Acacia Villa, Midrand were evaluated and include:

- Impacts on groundwater levels, flow patterns and volumes;
- Impacts on groundwater qualities; and
- Impacts on surface water qualities.

During the risk assessment, the risk to the groundwater levels and quality were evaluated. Each of the identified risks was then rated (Table 9-3).

9.1 RISK RATING CRITERIA

This section contains a summary and a motivation of the potential interactions and impacts which may be associated with the project activities, specifically related to the hydrogeological specialist field. The identified potential impacts are summarised as follows:

- Groundwater level
- Groundwater Quality

9.1.1 RISK RATING CRITERIA

The impacts were rated and ranked based on the system as described below:

- **Magnitude:** is a measure of the degree of change in a measurement or analysis (e.g., the area of pasture, or the concentration of a metal in water compared to the water quality guideline value for the metal), and was classified as none/negligible, low, moderate or high. The categorization of the impact magnitude may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment) pertinent to each of the discipline areas and key questions analysed. The specialist study must attempt to quantify the magnitude and outline the rationale used. Appropriate, widely recognized standards were to be used as a measure of the level of impact.
- **Scale/Geographic extent** refers to the area that could be affected by the impact and was classified as site, local, regional, national, or international.
- **Duration:** refers to the length of time over which an environmental impact may occur i.e. transient (less than 1 year), short-term (1 to 5 years), medium term (5 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project), or permanent.
- **Probability of occurrence** is a description of the probability of the impact occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40% to 60% chance), highly probable (most likely, 60% to 90% chance) or definite (impact will occur).

Table 9-1Scaling Risk

Status of Impact	
The impacts are assessed as either having a:	
Negative effect (i.e. at a `cost' to the environment),	
Positive effect (i.e. a `benefit' to the environment),	
Neutral effect on the environment.	
Extent of the impact	Duration of the impact
(1) Site (site only),	1) Immediate (<1 year),
(2) Local (site boundary and immediate surrounds),	(2) Short term (1-5 years),
(3) Regional,	(3) Medium term (5-15 years),
(4) National,	(4) Long term (ceases after the operational life span of the project),
(5) International.	(5) Permanent.
Magnitude of the Impact	Probability of Occurrence
(0) None,	The likelihood of the impact actually occurring is indicated as either:
(2) Minor,	(0) None (the impact will not occur),
(4) Low,	(1) Improbable (probability very low due to design or experience),
(6) Moderate (environmental functions altered but continue),	(2) Low probability (unlikely to occur),
(8) High (environmental functions temporarily cease),	(3) Medium probability (distinct probability that the impact will occur),
(10) Very high / unsure (environmental functions permanently cease.	(4) High probability (most likely to occur),
	(5) Definite.

9.1.2 SIGNIFICANCE OF THE IMPACT

Based on the information contained in the points above, the potential impacts are assigned a significance rating (S). This rating is formulated by adding the sum of the numbers assigned to extent (E), duration (D) and magnitude (M) and multiplying this sum by the probability (P) of the impact.

$$S = (E + D + M) \times P$$

The significance ratings are given below

(<30) low (i.e. where this impact would not have a direct influence on the decision to develop in the area), (30-60) medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated), (>60) high (i.e. where the impact must have an influence on the decision process to develop in the area).

Table 9-2 Significant colour code

Significance	Environmental Significance Points	Colour Code
High	>60	H
Medium	30 to 60	M
Low	<30	L

TABLE 9-3: RISK RATING

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	AREA APPLICABLE	CORRECTIVE MEASURE	IMPACT RATING CRITERIA						RECOMMENDED MITIGATION MEASURES
				Nature	Extent	Duration	Magnitude	Probability	SIGNIFICANCE	
Pre-Construction										
Hydrological yield	Vegetation removal to clear area for construction	Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during pre-construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff.	Yes	Negative	2	1	6	4	36	Vegetation removal must be as minimum as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible. ion of water seepage in construction site, drainage system will need to be installed to redirect water away from construction site.
Groundwater quality	Hydrocarbons leakage	Based on NGA and hydrocensus data the site is characterised by shallow groundwater levels, thus hazardous waste such as grease and oil from operational HDV and LDV can impact the groundwater quality in events of spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately the groundwater system especially during rainfall events.	yes	Negative	1	2	5	3	24	Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations for storage of construction material to prevent any infiltration of contaminated waste into groundwater system. Vehicle found with a leak to be removed from site immediately.

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	AREA APPLICABLE	CORRECTIVE MEASURE	IMPACT RATING CRITERIA						RECOMMENDED MITIGATION MEASURES
				Nature	Extent	Duration	Magnitude	Probability	SIGNIFICANCE	
Construction										
Diversion surface water for dry working conditions on site.	Construction of housing	During the construction phase, surface water may be diverted for dry working conditions. The natural surface water flow will be affected.	Yes	Negative	3	1	3	3	21	The design and implementation of the temporary stream diversion should consider the environmental impacts. To reduce the impact on aquatic habitants, various structures must be installed to mimic and protect existing stream environment.
Groundwater quality	Construction of housing	Shallow groundwater systems are susceptible to contamination inflow during construction. Spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately the groundwater system especially during rainfall events.	Yes	Negative	2	2	6	4	40	Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations for storage of construction material to prevent any infiltration of contaminated waste into groundwater system. Groundwater Monitoring boreholes should be installed upstream, midpoint and downstream of the site to monitor quality and water level.
Surface water quality	Construction of sewer pipeline	Material from construction flowing into surface water bodies and upstream outbursts and overflow, which may pose a threat and risk to surface water quality.	yes	Negative	2	2	6	4	40	Surface water quality monitoring plan must be implemented to monitor quality and ensure no contamination occurs within the site.
Increase in hydrological yield	Construction of a housing	Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff.	Yes	Negative	1	2	5	3	24	Vegetation removal must be as minimum as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible.

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	AREA APPLICABLE	CORRECTIVE MEASURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION						RECOMMENDED MITIGATION MEASURES	
				Nature	Extent	Duration	Magnitude	Probability	SIGNIFICANCE		
OPERATIONAL- PEOPLE RESIDING IN THE HOUSES											
Groundwater Level	Abstraction of Groundwater	In the event the residents relies on groundwater for domestic use, unmonitored abstraction of groundwater is likely to impact negatively on the groundwater table	Yes	Negative	1	1	6	3	24	boreholes must be pumped and recovered according to the prescribed borehole management recommendations. Boreholes to be installed with automatic switch that will go off when the groundwater level is below recommended critical level.	
Groundwater quality	Infiltration of domestic wastewater	Domestic wastewater is rich in nitrogen and phosphorus which may pose a threat and risk to groundwater system. The water table in the area is very shallow, this may result in untreated effluent escaping into groundwater	Yes	Negative	1	1	4	3	18	Maintenance plan must include groundwater quality monitoring should be conducted on a quarterly basis to ensure no contamination occurs within the site. Management plan must include inspection of the integrity of the domestic wastewater structures to prevent against infiltration of domestic wastewater into groundwater system.	
Hydrological yield	Re-vegetation	Vegetation acts as buffer zones and protect soil surface and limit soil erosion.	Yes	Positive	1	2	3	4	24	re-vegetation activities are encouraged during reduce rainfall impact, reduce surface water velocities, enhance infiltration, trap sediments	

10 CONCLUSION

Based on the desktop studies, field investigation and assessment of data collected, the following conclusions are made:

- The site is underlain by the lithological unit of Johannesburg Dome that form part of Transvaal Supergroup. The site is underlain by gneiss, granite-gneiss, amphibolite and granite in places.
- Based on the aquifer classification map (Parsons and Conrad, 1998) the aquifer underlying the site is regarded a “**minor aquifer**” with regional yields ranging between 0.5-2.0l/s.
- The site is situated in the **Crocodile (West) and Marico water Management and falls within A21C** Quaternary catchment.
- The vulnerability, or the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer is classified as low. Measures need to be taken to ensure appropriate drainage facilities are constructed to prevent the abovementioned issues.
- Two (2) boreholes were identified from the NGA data all within a 5-kilometre radius from the of the investigated site. Groundwater level range is between 6.05 mbgl and 22 86mbgl. The water levels were recorded between 1997 and 1972. The site is therefore underlain by a very shallow groundwater table.
- During Hydrocensus two (2) boreholes and stream were visited within a 5km radius of the investigated site. Observations regarding the borehole location, construction, water level and status and current usage was noted.
- Acacia Villas is a residential development comprising 100 residential units, a clubhouse, security facilities, and small swimming pools. The development proposes the use of two on-site boreholes identified during a hydro-census. These boreholes are expected to provide a combined abstraction rate of 122.4 m³/day, which exceeds the estimated total daily water demand of 90 m³/day. The projected demand consists of 80 m³/day for residential use and 10 m³/day for irrigation and fire suppression/hydrant requirements. The higher abstraction rate is requested to accommodate fluctuations in residential water consumption, irrigation demand, and system efficiency.

- **Aquifer testing Results**

- The test borehole depth is between 40mbgl (BH02) and 45mbgl (BH01)
- The static water was measured between 3.20mbgl (BH01) and 3.96mbgl (BH02)
- For sustainable operation, the recommended abstraction rate for BH-01 is set at 1.80 l/s for 10 hours per day, which results in an estimated daily yield of 64800 L/day. Alternatively, it can support a maximum abstraction rate of 2.00 l/s for a shorter duration of 6 hours per day. For BH-02 is set at 1.60 l/s for 10 hours per day, which results in an estimated daily yield of 57600 L/day. Alternatively, it can support a maximum abstraction rate of 2.00 l/s for a shorter duration of 6 hours per day

- **Water Quality Results**

- Ground water and surface water quality results indicated that all analysed constituents were below SANS 241:2015 standard limits and DWAF Water Quality Guidelines (Livestock Watering) Target Quality Range except for Turbidity (NTU), E coli, T coli, Manganese (Mn) and Iron (Fe).

- Ground water and surface water results indicated that the water from these sources is not suitable for human consumption. Filtration method is recommended before any human consumption.

- **Groundwater Risk Assessment:** Groundwater level and quality has a low to medium possible risk impact.

- **Preconstruction:**

- Based on NGA data the site is characterised by shallow groundwater level and wetland that is susceptible to contamination inflow especially in heavy rainfall events. Groundwater Monitoring boreholes should be installed upstream and downstream of the site to monitor groundwater quality.
- The shallow groundwater system more susceptible to contamination inflow during construction. Spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately enter the groundwater system. - Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations for storage of construction material to prevent any infiltration of contaminated waste into groundwater system.
- Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff. - Vegetation removal must be as minimum as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible.

- **During construction:**

- During the construction phase, surface water may be diverted for dry working conditions. The natural surface water flow will be affected. The design and implementation of the temporary stream diversion should consider the environmental impacts. To reduce the impact on aquatic habitats, various structures must be installed to mimic and protect existing stream environment.
- The shallow groundwater system more susceptible to contamination inflow during construction. Spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately enter the groundwater system. - Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations and Environmental Management Programme) for storage of construction material to prevent any infiltration of contaminated waste into groundwater system.
- Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during pre-construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff. - Vegetation removal must be as minimum as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible.
- Material from construction flowing into surface water bodies and upstream outbursts and overflow, which may pose a threat and risk to surface water quality. - Surface water quality monitoring plan must be implemented to monitor quality and ensure no contamination occurs within the site.
- Continuous groundwater and surface water monitoring is recommending upstream and downstream of the site to monitor quality and water level.
- **After construction (people residing within the investigated site):**
- In the event the residents rely on groundwater for domestic use, unmonitored abstraction of groundwater is likely to impact negatively on the groundwater table- Aquifer testing should be conducted to establish suitable yields on the borehole to prevent excessive pumping and to regulate critical water levels.
- Domestic wastewater is rich in nitrogen and phosphorus which may pose a threat and risk to groundwater system. The water table in the area is very shallow, this may result in untreated effluent escaping into groundwater- Groundwater quality monitoring should be conducted on a quarterly basis to ensure no contamination occurs within the site. The integrity of the domestic wastewater structures must be regularly inspected to prevent against infiltration of domestic wastewater into groundwater system.
- Re-vegetation - re-vegetation activities are encouraged during reduce rainfall impact, reduce surface water velocities, enhance infiltration, trap sediments.

11 RECOMMENDATIONS

The following recommendation are to be considered:

11.1.1 GROUNDWATER MONITORING PROGRAMME

Groundwater level and quality are required to be continuously monitored to be able to trace and measure possible contaminants that may emanate from the proposed activities and rising of the groundwater levels that may emanate due to recharge of the aquifer.

During groundwater monitoring programme the following information must be recorded as per the Standard Operations Procedure (SOP) for sampling and monitoring groundwater:

- Static water level, prior to sampling.
- Site conditions and Pictures
- Purging volumes and purging time
- Borehole conditions
- In-situ field parameters
- Sampling volumes and preservation methods

11.1.2 SAMPLING GUIDELINES

- The sampling and sample preservation will be undertaken according to the following guidelines:
- “Groundwater sampling: a comprehensive guide for sampling methods”, compiled by John M Weaver for the Water Research Commission (WRC Report TT 56/92).
- SABS ISO 5667-11: 1993 Guidance on sampling of groundwater
- SABS ISO 5667-1: 1980 Guidance on the design of sampling programs
- SABS ISO 5667-2: 1991 Guidance on sampling techniques
- SABS ISO 5667-3: 1994 Guidance on the preservation and handling of samples

12 REFERENCES

- The Groundwater Resources of the Republic of South Africa Map.
- The Hydrogeological Map Series of the Republic of South Africa.
- The 1:250 000,2528 Pretoria Geological Map-sheet.
- Satellite images, provided by Google Earth.
- Parsons, RP and Conrad, J. (1998). Explanatory Notes for the Aquifer Classification Map of South Africa. Water Research Commission Report No KV 116/98.

APPENDICES

APPENDIX A: LABORATORY RESULTS



Test Report

Page 1 of 2

Client: Ariys Consulting

Address: Oxford Office Park, 30 Bauhinia Street, Highveld Techno Park, Centurion 016

Report no: 202708

Project: Acacia Villas Project

Date of report: 26 November 2024

Date accepted: 18 November 2024

Date completed: 25 November 2024

Date received: 18 November 2024

Lab no:						163747
Date sampled:						16-Nov-24
Aquatico sampled:						No
Sample type:				Uncertainty of measurement %	SANS 241-1:2015	Water
Locality description:						BH01
Analyses		Unit	Method			
A	AQL pH @ 25°C	pH	ALM 20	2.33	5 - 9.7	7.92
A	AQL Electrical conductivity (EC) @ 25°C	mS/m	ALM 20	4.92	< 170	50.7
A	AQL Total dissolved solids (TDS)	mg/l	ALM 26		< 1200	366
A	AQL Total Alkalinity	mg CaCO ₃ /l	ALM 01	6.06		234
A	AQL Chloride (Cl)	mg/l	ALM 02	7.57	< 300	18.6
A	AQL Sulphate (SO ₄)	mg/l	ALM 03	8.45	< 500	18.4
A	AQL Nitrate (NO ₃) as N	mg/l	ALM 06	9.46	< 11	<0.194
A	AQL Total oxidised nitrogen as N	mg/l	ALM 06	9.46		<0.194
A	AQL Ammonium (NH ₄) as N	mg/l	ALM 05	8.46	< 1.5	0.067
A	AQL Fluoride (F)	mg/l	ALM 08	9.76	< 1.5	0.567
A	AQL Calcium (Ca)	mg/l	ALM 30	7.65		48.7
A	AQL Magnesium (Mg)	mg/l	ALM 30	7.65		14.7
A	AQL Sodium (Na)	mg/l	ALM 30	6.94	< 200	51.6
A	AQL Potassium (K)	mg/l	ALM 30	10.47		1.91
A	AQL Aluminium (Al)	mg/l	ALM 31	7.08	< 0.3	<0.002
A	AQL Iron (Fe)	mg/l	ALM 31	7.16	< 0.3	<0.004
A	AQL Manganese (Mn)	mg/l	ALM 31	6.34	< 0.1	0.030
A	AQL Chromium (Cr)	mg/l	ALM 31	6.88	< 0.05	<0.003
A	AQL Copper (Cu)	mg/l	ALM 31	5.15	< 2	<0.002
A	AQL Nickel (Ni)	mg/l	ALM 31	6.45	< 0.07	<0.002
A	AQL Zinc (Zn)	mg/l	ALM 31	6.65	< 5	<0.002
A	AQL Cadmium (Cd)	mg/l	ALM 31	7.19	< 0.003	<0.002
A	AQL Lead (Pb)	mg/l	ALM 31	7.09	< 0.01	<0.004
A	AQL E.coli	CFU/100ml	ALM 40	7.74	0	300
A	AQL Total coliform	CFU/100ml	ALM 40	7.76	< 10	1400

A = Accredited N = Non accredited Sub = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine ATR = Alternative test report ; Results relate only to the items received and tested ; Results reported against the limit of detection; Results marked "Non SANAS Accredited" in this report are not included in the SANAS Schedule of Accreditation for this laboratory; Uncertainty of measurement available on request for all methods included in the SANAS Schedule of Accreditation; The report shall not be reproduced except in full without approval of the laboratory

M. Swanepoel
Technical Signatory

AQL 89 Regency Drive, R21 Corporate Park, Centurion, South Africa
AQK 28 Karoo ave, Kathu, Northern Cape, South Africa

Tel: +27 12 450 3800
Tel: +27 53 880 0208

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A AQL Turbidity	NTU	ALM 21	5.9	< 1		2.39
A AQL Total hardness	mg CaCO ₃ /l	ALM 26				182
A AQL Total organic carbon (TOC)	mg/l	ALM 63	6.46	< 10		6.57
A AQL Langelier Saturation Index	LSI	ALM 26				0.02

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AQK 28 Karoo ave, Kathu, Northern Cape, South Africa

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 Reg. No.: 1983/00016507 V.A.T. No.: 4130107801
 23B De Havilland Crescent P.O. Box 283, Perseus Park, 0020
 Perseus Techno Park Tel: +2712 - 349 - 1066
 Meiring Naudé Drive Fax: +2786 - 654 - 2570
 Pretoria e-mail: admin@waterlab.co.za



CERTIFICATE OF ANALYSES

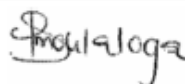
GENERAL WATER QUALITY PARAMETERS

Date received: 2022-07-14 Date completed: 2022-08-03
 Project number: 1000 Report number: 111856 Order number:
 Client name: Mshandukani Holdings Contact person: R. Shandukani
 Address: P.O Box 357, Celtis Ridge, e-mail: rendani@mshandukani.co.za
 Telephone: 012 656 0236 Facsimile: Mobile: 072 382 7279

Analyses in mg/l (Unless specified otherwise)	UOM %	Method ID	Risk	SANS 241 : 2015 Limits	Sample Identification	
					Blue Hills X 105	
Sample Number					167435	
Date/Time Sampled					N/A	
pH - Value @ 25 °C	A	7.7	WLAB066	Operational	≥5 to ≤ 9.7	7.4
Electrical Conductivity in mS/m @ 25°C	A	7.0	WLAB066	Aesthetic	≤170	63.4
Total Dissolved Solids @ 180°C	A	6.6	WLAB027	Aesthetic	≤1200	340
Colour in PtCo Units	A	---	WLAB006	Aesthetic	≤15	2
Turbidity in N.T.U	A	7.6	WLAB006	Operational/Aest	≤1 / ≤6	31 +
Total Alkalinity as CaCO ₃	A	10	WLAB007	---	---	236
Langelier Index at 25°C	A	---	WLAB063	---	---	-0.1
Chloride as Cl	A	8.0	WLAB046	Aesthetic	≤300	17
Sulphate as SO ₄	A	8.4	WLAB046	Acute health/Aest	≤500 / ≤250	23
Fluoride as F	N	---	WLAB014	Chronic health	≤1.5	0.3
Nitrate as N	A	4.8	WLAB046	Acute health	≤11	0.2
Nitrite as N	A	3.0	WLAB046	Acute health	≤0.9	<0.06
Combined Nitrate & Nitrite	A	---	WLAB046	Acute health	≤1	<0.1
Silica as SiO ₂	N	---	WLAB046	---	---	64
Total Organic Carbon as C	A	---	WLAB060	Chronic health	≤10	1.4
E. coli (MPN/100 ml)	A	6.0	WLAB021	Acute health	Not detected	<1
Free and Saline Ammonia as N	A	10	WLAB046	Aesthetic	≤1.5	<0.1
Sodium as Na	A	8.3	WLAB015	Aesthetic	≤200	41
Potassium as K	A	7.9	WLAB015	---	---	<0.5
Calcium as Ca	A	9.5	WLAB015	---	---	61
Magnesium as Mg	A	9.5	WLAB015	---	---	15
Aluminium as Al (µg/l)	A	8.1	WLAB015	Operational	≤300	244
Antimony as Sb (µg/l)	A	9.4	WLAB060	Chronic health	≤20	<1
Arsenic as As (µg/l)	A	9.6	WLAB060	Chronic health	≤10	<1
Barium as Ba (µg/l)	A	9.4	WLAB015	Chronic health	≤700	33
Boron as B (µg/l)	A	9.7	WLAB015	Chronic health	≤2400	<25
Cadmium as Cd (µg/l)	A	8.5	WLAB015	Chronic health	≤3	<1



A. van de Wetering - Chemical Technical Signatory



D.O. Mohlala - Microbiological Technical Signatory

A = Accredited N = Not Accredited S = Subcontracted UoM = Uncertainty Of Measurement L = Lower Limit exceeded U = Upper Limit exceeded
 Tests marked "Not SANAS Accredited" in this report are not included in the SANAS Scope of Accreditation for this Laboratory.
 Results marked "Subcontracted Test" in this report are not included in the SANAS Scope of Accreditation for this Laboratory.

Sample condition acceptable unless specified on the report.

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Bacteriological parameters analysed on: 2022-07-14

Page 1 of 2



WATERLAB (Pty) Ltd

Reg. No.: 1983000165/07 V.A.T. No.: 4130107891

23B De Havilland Crescent
Perseus Techno Park
Meiring Naudé Drive
Pretoria

P.O. Box 283, Perseus Park, 0020
Tel: +2712 - 349 - 1066
Fax: +2786 - 654 - 2570
e-mail: admin@waterlab.co.za



T0391

CERTIFICATE OF ANALYSES

GENERAL WATER QUALITY PARAMETERS

Date received: 2022-07-14

Project number: 1000

Report number: 111856

Date completed: 2022-08-03

Order number:

Client name: Mshandukani Holdings

Address: P.O Box 357, Celtis Ridge,

Telephone: 012 656 0236

Facsimile:

Contact person: R. Shandukani

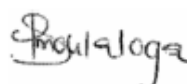
e-mail: rendani@mshandukani.co.za

Mobile: 072 382 7279

Analyses in mg/l (Unless specified otherwise)	UOM %	Method ID	Risk	SANS 241 : 2015 Limits	Sample Identification
					Blue Hills X 105
Sample Number					167435
Date/Time Sampled					N/A
Total Chromium as Cr (µg/l)	A	7.8	WLAB016	Chronic health	≤50
Copper as Cu (µg/l)	A	7.7	WLAB016	Chronic health	≤2000
Iron as Fe (µg/l)	A	8.1	WLAB016	Chronic health/Aest	≤ 2000 / ≤300
Lead as Pb (µg/l)	A	9.7	WLAB016	Chronic health	≤10
Manganese as Mn (µg/l)	A	8.3	WLAB016	Chronic health/Aest	≤ 400 / ≤100
Mercury as Hg (µg/l)	A	16	WLAB047	Chronic health	≤5
Nickel as Ni (µg/l)	A	7.7	WLAB016	Chronic health	≤70
Selenium as Se (µg/l)	A	9.4	WLAB060	Chronic health	≤40
Uranium as U (µg/l)	A	8.5	WLAB060	Chronic health	≤ 30
Zinc as Zn	A	8.0	WLAB016	Aesthetic	≤5
% Balancing	N	---	---	---	98.7



A. van de Wetering - Chemical Technical Signatory



D.O. Mohlala - Microbiological Technical Signatory

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Sample condition acceptable unless specified on the report.

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Bacteriological parameters analysed on: 2022-07-14

Page 2 of 2

APPENDIX B: BOREHOLE PUMP TESTING DATA

DATA sheet: Enter general info and data of constant rate pumping test and recovery (optional)												
Country:	South Africa		Main		Geology:	Granite						
Region:	Gauteng				Depth of BH:	45						
Owner:	Acacia Villas		Diagnostic Plots	Derivative	Water strikes:	N/A						
X-coord:	28.09		Sust_Q		Date of Test:	13/11/2024						
Y-coord:	-25.96				Contractor:	Mshandukani Holdings						
CONSTANT RATE TEST DATA : enter values in cells which are coloured light yellow												
Borehole:		BH 1								Other info:		
Distance from Rest WL to main water strike (m) =			37	S _{max} =	30.27	Recom. AD =	33.5					
Q (l/s)=		1.75	Recovery data					T (m ² /d) : Logan eq.				
t (min)	s (m)	avg s'	avg s"	avg T	avg S	Time t'	Res s	t/t'	WI rise	s'	Rec_T	6.1
1.00	1.01					1	29.35	1441	0.92			
2.00	1.16					2	28.8	721	1.47	1.26		
3.00	2.06	5.40	0.70			3	28.78	481	1.49	2.59		
5.00	3.19	7.06	0.42	3.61	3.42E-06	5	27.8	289	2.47	4.68	7.4	
7.00	5.03	7.88	-0.18	3.05	3.45E-06	7	27.05	206.7	3.22	4.34	6.5	
10.00	6.79	6.32	-1.02	3.93	3.45E-06	10	26.49	145	3.78	3.75	6.5	
15.00	6.91	3.79	-1.28	6.99	3.45E-06	15	25.81	97	4.46	4.75	6.3	
20.00	7.46	2.49	-0.87	14.16	3.45E-06	20	25.04	73	5.23	4.75	4.7	
30.00	7.68	2.03	-0.17	13.78	3.45E-06	30	24.36	49	5.91	8.88	2.8	
40.00	7.81	2.19	0.41	12.98	3.45E-06	40	22.26	37	8.01	23.94	1.4	
60.00	8.35	2.79	0.99	11.30	3.45E-06	60	17.25	25	13.02	39.47	0.7	
90.00	8.79	4.54	1.77	6.66	3.45E-06	90	8.36	17	21.91	56.11	0.6	
120.00	9.05	8.44	2.19	3.01	1.71E-05	120	0.24	13	30.03	38.97	1.9	
150.00	10.81	14.57	1.88	1.76	2.99E-05	150		10.6	30.27	1.40	#DIV/0!	
180.00	12.58	19.31	0.89	1.30	3.53E-05	180		9	30.27	0.00	#DIV/0!	
210.00	13.69	20.62	0.06	1.29	3.62E-05	210		7.857	30.27	0.00	#DIV/0!	
240.00	15.57	19.64	-0.29	1.29	3.62E-05	240		7	30.27	0.00	#DIV/0!	
300.00	16.81	18.64	0.22	1.29	3.62E-05	300		5.8	30.27	0.00	#DIV/0!	
360.00	18.25	21.04	1.24	1.29	3.62E-05	360		5	30.27	0.00	#DIV/0!	
420.00	19.69	27.16	1.86	1.00	4.61E-05	420		4.429	30.27	0.00	#DIV/0!	
480.00	20.8	35.97	1.06	0.70	5.57E-05	480		4	30.27	0.00	#DIV/0!	
540.00	24.81	36.90	-0.96	0.65	5.74E-05	540		3.667	30.27	0.00	#DIV/0!	
600.00	26.27	27.35	-3.12	0.65	5.74E-05	600		3.4	30.27	0.00	#DIV/0!	
720.00	27.27	14.18	-6.10	0.65	5.74E-05	720		3	30.27	0.00	#DIV/0!	
840.00	29.58	4.31	-6.56	0.65	5.74E-05	840		2.714	30.27	0.00	#NUM!	
960.00	27.79	2.11	-0.99	0.65	5.74E-05	960		2.5	30.27	0.00	#DIV/0!	
1080.00	28.25	2.70	#NUM!	0.65	5.74E-05	1080		2.333	30.27	0.00	#DIV/0!	
1200.00	28.79	#NUM!	#NUM!	0.65	5.74E-05	1200		2.2	30.27	0.00	#DIV/0!	
1320.00	29.02	#NUM!	#NUM!	0.65	5.74E-05	1320		2.091	30.27	0.00	#DIV/0!	
1440.00	30.27	#NUM!	#NUM!	0.65	5.74E-05	1440		2	30.27	#DIV/0!	#DIV/0!	
		#NUM!	#NUM!	0.65	5.74E-05			#####	#####	#DIV/0!	#DIV/0!	

FIGURE 12-1 BOREHOLE 1 RAW DATA

DATA sheet: Enter general info and data of constant rate pumping test and recovery (optional)													
Country:	South Africa		Main		Geology:	Granite							
Region:	Gauteng				Depth of BH:	40							
Owner:	Acacia Villas		Diagnostic Plots	Derivative	Water strikes:	N/A							
X-coord:	28.09		Sust_Q		Date of Test:	13/11/2024							
Y-coord:	-25.96				Contractor:	Mshandukani Holdings							
CONSTANT RATE TEST DATA : enter values in cells which are coloured light yellow													
Borehole:		BH 2										Other info:	
Distance from Rest WL to main water strike (m) =			35	S _{max} =	29.04	Recom. AD =	31.9						
Q (l/s)=		2		Recovery data								T (m²/d) : Logan eq.	
t (min)	s (m)	avg s'	avg s"	avg T	avg S	Time t'	Res s	t/t'	WL rise	s'	Rec_T	7.3	
1.00	1.02					1	28.6	1441	0.44				
2.00	1.4					2	27.6	721	1.44	4.30			
3.00	2.03	3.24	0.44			3	26.49	481	2.55	5.50			
5.00	2.27	3.62	0.54	8.90	4.65E-06	5	25.4	289	3.64	7.61	3.8		
7.00	3	4.89	0.49	5.69	5.72E-06	7	23.6	206.7	5.44	13.30	2.7		
10.00	4.73	5.36	-0.04	5.33	5.94E-06	10	21.4	145	7.64	15.74	2.3		
15.00	5.15	4.76	-0.24	6.77	5.94E-06	15	18.4	97	10.64	12.91	2.3		
20.00	5.4	4.49	0.13	8.12	5.94E-06	20	17.6	73	11.44	13.61	2.1		
30.00	6.25	5.19	0.64	6.35	5.94E-06	30	14.4	49	14.64	20.84	1.7		
40.00	7.04	7.00	0.84	4.39	9.47E-06	40	11.27	37	17.77	24.42	1.3		
60.00	8.29	9.63	0.81	3.31	1.32E-05	60	7.04	25	22	31.01	1.2		
90.00	10.3	12.72	0.67	2.43	1.89E-05	90	0.35	17	28.69	24.34	2.9		
120.00	12.3	15.30	0.25	1.91	2.40E-05	120		13	29.04	1.64	#NUM!		
150.00	14.4	15.38	-0.62	1.90	2.46E-05	150		10.6	29.04	0.00	#NUM!		
180.00	15.4	12.54	-1.67	1.90	2.46E-05	180		9	29.04	0.00	#DIV/0!		
210.00	16.05	8.99	-1.85	1.90	2.46E-05	210		7.857	29.04	0.00	#DIV/0!		
240.00	16.48	6.86	-1.06	1.90	2.46E-05	240		7	29.04	0.00	#DIV/0!		
300.00	17.03	6.56	0.67	1.90	2.46E-05	300		5.8	29.04	0.00	#DIV/0!		
360.00	17.29	8.60	2.25	1.90	2.46E-05	360		5	29.04	0.00	#DIV/0!		
420.00	18.03	13.46	3.09	1.90	2.46E-05	420		4.429	29.04	0.00	#DIV/0!		
480.00	18.93	21.06	2.76	1.40	5.71E-05	480		4	29.04	0.00	#DIV/0!		
540.00	20.6	27.70	1.41	1.05	7.18E-05	540		3.667	29.04	0.00	#DIV/0!		
600.00	22.15	29.51	-0.15	1.01	7.18E-05	600		3.4	29.04	0.00	#DIV/0!		
720.00	25	25.03	-1.63	1.01	7.18E-05	720		3	29.04	0.00	#DIV/0!		
840.00	26.25	18.03	-2.01	1.01	7.18E-05	840		2.714	29.04	0.00	#DIV/0!		
960.00	26.93	13.93	-1.18	1.01	7.18E-05	960		2.5	29.04	0.00	#DIV/0!		
1080.00	27.15	12.87	#NUM!	1.01	7.18E-05	1080		2.333	29.04	0.00	#DIV/0!		
1200.00	28	#NUM!	#NUM!	1.01	7.18E-05	1200		2.2	29.04	0.00	#DIV/0!		
1320.00	28.83	#NUM!	#NUM!	1.01	7.18E-05	1320		2.091	29.04	0.00	#DIV/0!		
1440.00	29.04	#NUM!	#NUM!	1.01	7.18E-05	1440		2	29.04	#DIV/0!	#DIV/0!		
		#NUM!	#NUM!	1.01	7.18E-05			####	####	#DIV/0!	#DIV/0!		

FIGURE 12-2 BOREHOLE 2 RAW DATA