PRISM ENVIRONMENTAL MANAGEMENT SERVICES

Baseline Geohydrological Assessment for Motor Dealership on Portion 59 and 168 of the Farm Bultfontein 533-JQ

Project Number: Delh.2020.035-8

WATER SYSTEMS MODELLING

Contact: +2782 497 9088
info@delta-h.co.za
www.delta-h.co.za
PO Box 11465
Sliver Lakes
0054
Pretoria, South Africa

September 2020

PRISM ENVIRONMENTAL MANAGEMENT SERVICES

Baseline Geohydrological Assessment for Motor Dealership on Portion 59 and 168 of the Farm Bultfontein 533-JQ

Delh.2020.035-8

Document Information

Report Version	Draft
Reference/order Number	Delh.2020.035-8
Author(s)	TG Rossouw
Document Reviewer	M Holland
Client Contact	Vanessa Stipple
Date	September 2020

Dr Martin Holland (Pr.Sci.Nat)
PRINCIPAL HYDROGEOLOGIST

Table of Contents

1. Introduction ... 1
1.1. Background ... 1
1.2. Scope of Work ... 1
1.3. Data Sources and Deficiencies ... 2
2. General Setting ... 2
2.1. Climate ... 2
3. Methodology ... 4
3.1. Desk study ... 4
3.2. Hydrocensus ... 4
3.3. Geophysical survey and results ... 4
3.4. Drilling and siting of boreholes ... 4
3.5. Aquifer testing ... 4
3.6. Sampling and chemical analysis ... 4
3.7. Groundwater recharge calculations ... 4
3.8. Groundwater modelling ... 4
3.9. Groundwater availability assessment ... 4
4. Prevailing groundwater conditions ... 5
4.1. Geology ... 5
4.2. Hydrogeology ... 5
4.3. Hydrocensus ... 7
4.3.1. Geo-sites and observations ... 7
4.3.2. Groundwater levels ... 7
4.3.3. Groundwater quality ... 7
4.3.4. Hydrochemical Facies ... 10
5. Hydraulic Test / Pump Test ... 11
5.1. Calculated Yield ... 12
6. Aquifer Characterisation ... 13
6.1. Groundwater Vulnerability ... 13
6.2. Aquifer Classification ... 13
6.3. Aquifer Protection Classification ... 14
7. Source-Pathway-Receptor risk assessment ... 16
8. Conclusions and Recommendations ... 17
9. References ... 19
APPENDIX ... 20
Appendix A – Hydrocensus Photos ... 20
Appendix B – Laboratory Certificates ... 25
Appendix C – Pump Test Assessment ... 26

List of Figures and Tables

Figure 2.1: Locality map of Motor Dealership. 3
Figure 4.1: Geology map of Motor Dealership. 6
Figure 4.2: Spatial distribution of the geo-sites collected during the hydrocensus for Motor Dealership........ 9
Figure 4.3: Piper diagram of the geo-sites........ 11
Figure 5.1: Drawdown extent for the current estimated pumping rate........ 13
Figure 6.1: Groundwater vulnerability map for the Motor Dealership. 15

Table 2-1: Summary of information for the quaternary catchment (GRAII; DWAF 1996)........ 2
Table 4-1: Summary of the geo-sites (boreholes) obtained during the hydrocensus data. 8
Table 4.2: Summary of the water quality (in mg/l) for the geo-site samples collected during the hydrocensus........ 10
Table 5.1: Pumping test summary. 11
Table 5.2: Transmissivity (in m^2/d) estimates based on tests conducted........ 12
Table 5.3: Summary of yield rates for dewatering 12
Table 6.1: Aquifer classification scheme after Parsons and Conrad (1998). 14
Table 6.2: Groundwater Quality Management (GQM) Classification System. 14
Table 6.3: GQM index for the project area........ 14
Table 8.1: List of groundwater monitoring parameter. 17

1. INTRODUCTION

1.1. BACKGROUND

Delta H (Delta-H Water System Modelling PTY Ltd) has been appointed by Prism Environmental Management Services to conduct a baseline geohydrological specialist study for the proposed Motor Dealership on Portion 59 and 168 on the farm Bultfontein 533-JQ near Lanseria Airport. The facility will use an existing borehole on site (Portion 168) to supplement municipal water supply.

The Geohydrology Report forms part of the procedural requirements for Environmental Impact Assessments and Water Use Licence Applications and Appeals according to the Government Notice R. 267 (Government Gazette No. 40713, 27/03/2017) pertaining to the National Water Act, 1998 (Act No. 36 of 1998) and assess potential impacts of the Project on the ambient groundwater environment.

1.2. SCOPE OF WORK

The scope of work of the groundwater study are sub-divided into the following tasks:

Data Collection and Review.
All available national/regional scale as well as local geological and hydrogeological information will be collated and assessed. Furthermore, the national aquifer vulnerability (DRASTIC) and aquifer classification will be assessed for the site as well. Groundwater vulnerability gives an indication of how susceptible an aquifer is to contamination. Aquifer vulnerability is used to represent the intrinsic characteristics that determine the sensitivity of various parts of an aquifer to being adversely affected by a contaminant load imposed from surface.

Hydrocensus
This dataset will be augmented with a hydrocensus to establish the quality and quantity of the groundwater resource (including the measurement of groundwater levels) as well as actual utilisation thereof. The hydrocensus will give focus on a 2 km radius, where after a larger radius of up to 5 km will be incorporated should limited data be collected in the 2 km radius. Selected. Allowance has been made for 6 water samples for major ions and trace elements. The water quality will be comparted to relevant national and international water quality guidelines and standards, e.g. SANS 241 (2015) and DWAF (2006).

Pumping Test
The pumping test will entail the following:

1. A step drawdown test (SDT) during which the borehole should be pumped at a constant discharge rate for 30 minutes for each step, thereafter the steps should be repeated at progressively higher discharge rates. During the SDT the drawdown over time should be recorded for the borehole being tested. After the test has stopped, the residual drawdown should be measured until ~95% recovery of the water level has been reached.
2. During the constant discharge test (CDT) the borehole is pumped 4 hours at a constant rate (based on data from the SDT) and the drawdown over time in at least the pumping borehole recorded. Discharge measurements must be taken at regular time intervals (at least once every hour) to ensure that the constant discharge rate is maintained throughout the test period. During the CDT the aquifer needs to be stressed sufficiently to identify boundary effects that may impact on long-term aquifer utilization.
3. The recovery period follows directly after pump shut down at the end of the CDT. The residual drawdown over time (water level recovery) is measured in the production and potential observation boreholes until a 95% recovery (of the initial water level) is reached.

Impact assessment and reporting

The impact assessment will be based on the baseline assessment. The Impact assessment will be based on the Regulation 3 h(vi) of Appendix 2 of R.9831 (2014), under the NEMA2 (1998), which requires an assessment of the nature (status), consequences (magnitude), extent, duration, probability and significance of the identified potential environmental impacts of the proposed activities.

1.3. Data Sources and Deficiencies

Numerous data sources were obtained to investigate and conceptualise the groundwater conditions and to make recommendations for groundwater management. The development of the hydrogeological concepts was based on the following information and data made available to the consulting team or gathered as part of the groundwater investigation: Geological information based on the 1:250 000 scale geology map.

- National hydrogeological map of South Africa, 1:500 000 scale hydrogeology map.
- Digital Elevation Model (DEM) based on a 30m x 30 m grid, Advanced Spaceborn Thermal Emission and Reflection Radiometer (ASTRA) data.
- Groundwater levels and quality data from the hydrocensus.
- Pump test data from the onsite borehole.

2. GENERAL SETTING

The Motor Dealership is located on the Farm Bultfontein 533-JQ, Lanseria, Gauteng, approximately 3.5km north of the N14 next to R512. The area is characterised by a flat sloping topography with some hill sides. The project area falls on the boundary within the quaternary catchment A21E with the Crocodile River tributary, within the Crocodile (West) and Marico Water Management Area. The summary of readily available hydrological data for the catchment is provided in Table 2-1.

Table 2-1: Summary of information for the quaternary catchment (GRAII; DWAF 1996).

Quaternary catchment	Area (km^2)	Mean Annual Precipitation (mm/a)	Mean Annual Runoff (mm/a)	Mean Annual Baseflow (mm/a)	Mean Annual Recharge	
					mm/a	% of MAP
A21E	289.8	706	55	26	43.05	6.1

2.1. Climate

The study area falls within the summer rainfall region, with a Highveld climate of warm to hot summers and cold, dry winters. The Mean Annual Precipitation (MAP) according to the GRA II by the Department of Water and Sanitation is approximately 706 mm/a for quaternary catchment A21E (Table 2-1) and occurs mostly in the summer months.

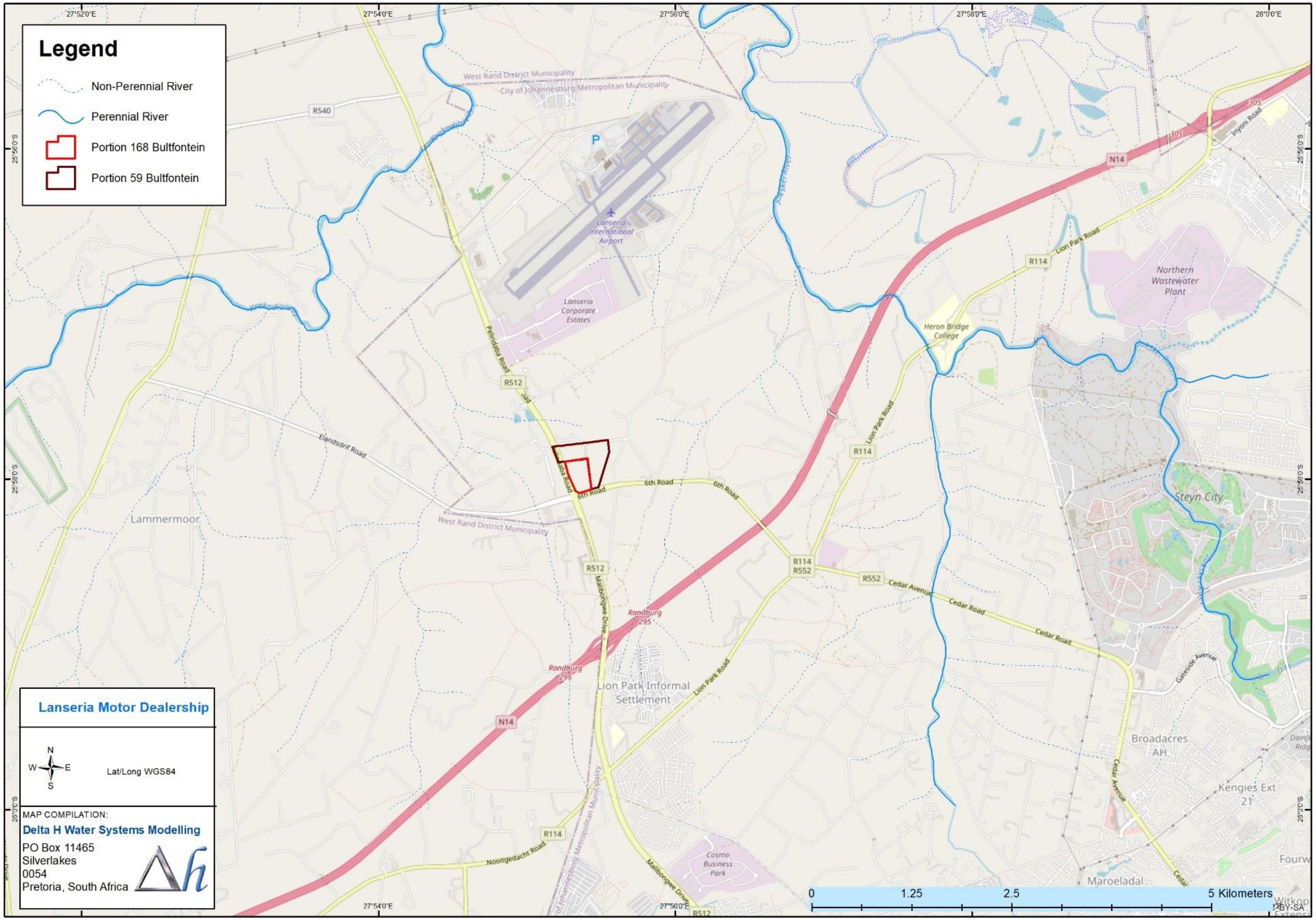


Figure 2.1: Locality map of Motor Dealership.

3. METHODOLOGY

3.1. DESK STUDY

The desk study entailed a review of the available groundwater related information and studies in the area of the Motor Dealership project.

3.2. HYDROCENSUS

The hydrocensus was conducted to obtain baseline groundwater conditions including third party groundwater users, groundwater levels and quality.

3.3. GEOPHYSICAL SURVEY AND RESULTS

No geophysical surveys were done as part of this study.

3.4. DRILLING AND SITING OF BOREHOLES

No new boreholes were drilled as part of this study

3.5. AQUIFER TESTING

A short term (2.5 hours) pump test was conducted on site following a recovery response measurement up to 95% of the original water level.

3.6. SAMPLING AND CHEMICAL ANALYSIS

Six groundwater samples were retrieved or analysed as part of hydrocensus. The chemical analysis includes pH, Electrical conductivity, Total Dissolved Solids, Turbidity, major ions and ICP scan for trace elements.

3.7. GROUNDWATER RECHARGE CALCULATIONS

The groundwater recharge rate at site is based on the GRAII data held by DWS. No independent measurements of recharge and seepage rates for the coal stockpiles, pollution control dam or geology were obtained.

3.8. GROUNDWATER MODELLING

No three dimensional (3D) numerical groundwater flow and transport modelling was conducted for this baseline study.

3.9. GROUNDWATER AVAILABILITY ASSESSMENT

No groundwater availability assessment was done as part of this study.

4. PREVAILING GROUNDWATER CONDITIONS

4.1. GEOLOGY

The area is characterised by granites and gneiss rock types, typical of the basement rock formation. The term basement rock applies to any hard, crystalline or recrystallised, igneous or metamorphic rock associated with Precambrian Age, including ancient Archaean cratonic rocks (granites, gneisses, greenstones), metamorphic rocks associated with mobile belts (usually deformed and of Proterozoic age) and anorogenic intrusions of variable age (Arcworth 1987; Jones 1985; Wright and Burgess 1992; Key 1992). Granite, from a geological point-of-view, can be considered any intrusive or hypabyssal, felsic, igneous, or metamorphic rock composed of predominantly quartz and feldspar (orthoclase and plagioclase). Igneous granites (granites or granitoid rocks) typically comprise alkali feldspar granite, granite, granodiorite and tonalite. Granitic weathering shows typical weathering patterns associated with saprolite, laterite, fissures followed by fresh basement (Dippenaar et al, 2009).

This fractured-weathered layer is generally characterized by a fracture density that decreases with depth, and which can be related to cooling stresses in the magma, subsequent tectonic activity (Houston and Lewis, 1988) or litho-static decompression processes (Wright, 1992). The horizon of fracturing between the fresh rock and the regolith frequently has a higher permeability, depending on several factors including the nature of the fracturing and the presence of clay in the fractures. Fresh basement (un-weathered) is permeable only locally where deep tectonic fractures are present.

4.2. HYDROGEOLOGY

Based on the conceptual hydrogeological understanding of the site, the following hydro-stratigraphic zones are differentiated within the model area:

1. **Shallow alluvial and weathered basement aquifer**
2. **Fractured basement aquifer**

Weathered basement aquifer

The weathered zone of the basement rock hosts the unconfined or semi-confined shallow weathered basement aquifer or hydro-stratigraphic zone. Due to direct rainfall recharge and dynamic groundwater flow through the unconfined aquifer in weathered basement rock, the water quality is generally good, but in the absence of an overlying confining layer also vulnerable to pollution. Localised perched aquifers, formed from secondary mineralised clay layers and ferri-crete layers, may occur. Water intersections in the weathered aquifer are mostly above or at the interface to fresh bedrock (basement), where less permeable layers of weathering products and capillary forces limit the vertical percolation of water and promote lateral water movement.

Fractured basement aquifer

The fractured basement aquifer consists of mostly granites and gneiss. Groundwater flow is governed by secondary porosities like faults, fractures, joints, bedding planes or other geological contacts, while the rock matrix itself is considered impermeable. Geological structures are generally better developed in competent rocks like granites and gneiss. Not all secondary structures are water bearing due to e.g. compressional forces by the neo-tectonic stress field overburden closing the apertures. The fractured basement aquifer is considered a confined aquifer.

Fractured basement aquifers have typically a low hydraulic conductivity, but are known to be highly heterogeneous with yields ranging from 0.5L/s to even higher yield than 10L/s. Higher yields are typically associated with higher hydraulic conductivities along fracture zones associated with faults and shear zones and at contact zones with intrusive rocks. Depending on the residence time of the water in the aquifer, groundwater quality can be poor.

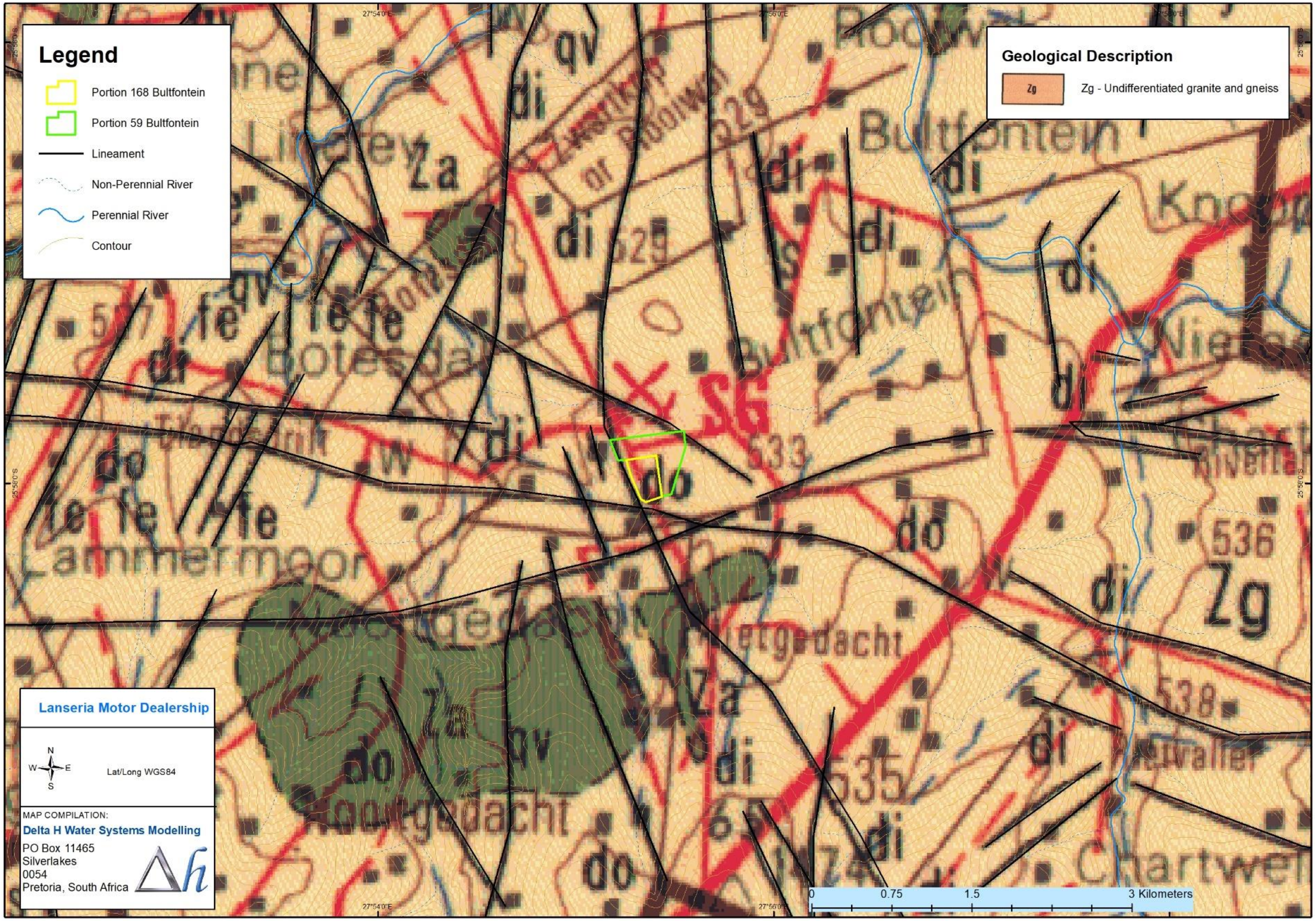


Figure 4.1: Geology map of Motor Dealership.

4.3. HYDROCENSUS

The aim of the groundwater census was to describe the water occurrences in qualitative and quantitative terms. A hydrocensus forms part of a quantitative approach to determine baseline water conditions. The hydrocensus was conducted in the vicinity of the Motor Dealership on the 20th and 24th of August 2020. The hydrocensus reported on borehole location, status, depth, water level, distribution, use and ownership. A total of six (6) groundwater samples were collected and submitted to an accredited laboratory, Waterlab (Pty) Ltd. Photos of geo-sites visited is shown in Appendix A.

4.3.1. Geo-sites and observations

A total of 19 boreholes were identified during the hydrocensus. One borehole is located on the Motor Dealership property, i.e. LBH1 covered by a man-hole steel cover and is currently in use. Some areas, i.e. private residents, and estates as well as the Lanseria Airport, were not visited due to either not access allowed or not obtaining contact information to arrange a visit/meeting.

Majority of the boreholes identified during the hydrocensus is currently equipped and being used mostly for domestic use. A bulk water supply line from Rand Water is located along the R512. Industrial sites located along the R512 make use of the bilk water supply line, however, private residents and small business make use of groundwater. It should be noted limited access could be obtained due to Health and Safety measured put in place during the SARS-Cov2 (COVID-19) Level 2 lock down.

4.3.2. Groundwater levels

Four (4) groundwater levels obtained from the hydrocensus in the area. The groundwater level ranges from 22.7 metre below ground level [m bgl] to 29.3 m bgl with an average groundwater level of 26 m bgl. The groundwater levels measured at the Motor Dealership is 29.28 mbgl. It is expected that the general groundwater flow is mostly west with localised flow towards river systems or depression areas. Geo-spatial illustration of the boreholes from the hydrocensus is presented in Figure 4.2.

4.3.3. Groundwater quality

The groundwater qualities are shown in Table 4.2 for the hydrocensus geo-sites (chemical elements below the detection limit are excluded from the table). Water samples were collected at six (6) geo-sites during the hydrocensus. The concentrations of selected constituents of groundwater samples were compared against the following standards / target values:

- SANS (241-1 2015) South African National Standards for Drinking Water.
- South African Water Quality Guidelines for Drinking Water (DWAF 1996).

Based on the results the groundwater quality at the project site is characterised by neutral pH conditions with elevated nitrate concentrations. The boreholes located at and around d the project site exceed the target values for nitrate (except borehole LBH3).

The current groundwater baseline quality indicates average water quality with elevated nitrate concentrations in the area. The nitrate concentrations below 10mg/l could be from naturally occurring sources in the plutonic rocks, however concentrations above this can be attributed to organic fertilization from animal farms, such as the poultry farm, historical agricultural practices, septic tanks and leaking sewage systems.

Table 4-1: Summary of the geo-sites (boreholes) obtained during the hydrocensus data.

Name	Latitude	Longitude	Elevation [mamsl]	Status	Casing Material	Equipped	Water Level [m]	Sampled	Notes
LBH1	-25.96482	27.92334	1369	In Use	Steel	Submersible Pump	29.28	Yes	To be used for WULA
LBH10	-25.95483	27.91149	1361	In Use	Steel	Submersible Pump		No	No access was granted d to visit the borehole on site
LBH11	-25.96918	27.92756	1379	In Use	Steel	Submersible Pump	28.99	Yes	Farm uses approx. 125 000L/day
LBH12	-25.96956	27.92893	1379	In Use	Steel	Submersible Pump		No	No access for water level measurement, locked
LBH13	-25.96962	27.92865	1382	In Use	Steel	Submersible Pump		No	No access for water level measurement, locked
LBH14	-25.96990	27.92691	1389	In Use	Steel	Submersible Pump		No	No access for water level measurement, locked
LBH15	-25.95959	27.92266	1381	In Use	-	-		No	No access for water level measurement, locked
LBH16	-25.97480	27.92209	1394	In Use	Steel	Submersible Pump		No	No access for water level measurement, locked. Pump water to 4x 10 000L YoYo tanks
LBH17	-25.95053	27.93388	1373	Not in use	Steel	-	22.68	No	Pump to 10 000L YoYo tank
LBH18	-25.95113	27.93370	1373	In Use	Steel	Submersible Pump		Yes	No access for water level measurement, locked
LBH19	-25.95099	27.93431	1372	In Use	Steel	Submersible Pump		No	No access for water level measurement, locked
LBH2	-25.96620	27.93061	1365	In Use	-	-		No	No access was granted d to visit the borehole on site
LBH3	-25.96164	27.92632	1380	In Use	Steel	Submersible Pump	23.13	Yes	
LBH4	-25.97450	27.91690	1385	In Use	Steel	Submersible Pump		Yes	No access for water level measurement, locked
LBH5	-25.97439	27.91710	1384	In Use	Steel	Submersible Pump		No	No access for water level measurement, locked
LBH6	-25.97052	27.92231	1388	In Use	Steel	Submersible Pump		Yes	No access for water level measurement, locked. Pump water to 3x 10 000L YoYo tanks
LBH7	-25.96821	27.92115	1374	In Use	Steel	Submersible Pump		No	No access for water level measurement, locked. Use approx. 10 000L per day
LBH8	-25.95860	27.92262	1388	In Use	-	-		No	No access for water level measurement, locked
LBH9	-25.95609	27.90872	1337	In Use	Steel	Submersible Pump		No	No access for water level measurement

Figure 4.2: Spatial distribution of the geo-sites collected during the hydrocensus for Motor Dealership.

4.3.4. Hydrochemical Facies

As water flows through an aquifer it adopts a diagnostic chemical composition because of the interaction with the lithologic framework. The term hydrochemical facies refer to bodies of groundwater, within an aquifer, that differ in their chemical composition. The facies are a function of the lithology, solution kinetics and flow patterns of the aquifer (Back, 1960 and 1966 as cited in Fetter, 2001) and can assist in determining whether water has been impacted by anthropogenic activities.

Hydrochemical facies are classified based on the dominant ions. The hydrochemical facies for the water samples are characterised by Na+K-HCO_3-NO_3 water facies and presented graphically as a piper diagram in Figure 4.3.

The dominance of sodium plus potassium in most samples could indicate dissolution of sodium rich sedimentary rock unit, as found in the area, i.e. plutonic rocks. The data show that most samples show a mixed anion facies between the bicarbonate to nitrate anions which indicate younger groundwater, less mineralised but with some anthropogenic impacts on the natural groundwater.

Table 4.2: Summary of the water quality (in mg/l) for the geo-site samples collected during the hydrocensus.

Name	DWA SAWQTV Drinking Water	SANS 241-1: 2015	LBH1*	LBH3	LBH4	LBH6	LBH12	LBH18
Sample ID			102958	102959	102960	102961	102962	102963
pH	06-Sep	5-9.7	7.1	7.3	6.8	7.1	7.2	7.1
Electrical Conductivity mS/m	70	170	40.9	43.6	33.4	51.3	48.4	43.2
Total Dissolved Solids	450	1200	290	332	294	430	350	316
Turbidity in N.T.U	1	1	21	0	0	0	0	0.6
Total Alkalinity as $CaCO_3$	NS	NS	100	124	84	100	100	112
Chloride as Cl	100	300	28	24	22	27	36	34
Sulphate as SO_4	200	500	42	54	19	33	39	27
Fluoride as F	1	1.5	0.2	0.2	0.2	0.3	0.2	<0.2
Nitrate as N	6	11	7.1	3.3	9	23	16	9.1
Ortho Phosphate as P			<0.1	0.1	0.1	0.1	0.1	0.1
Free & Saline Ammonia as N	NS	NS	0.2	0.2	0.3	0.2	0.1	0.2
Ca (mg/L)	32	-	22.3	33.8	23	41.2	29.5	43.9
Mg (mg/L)	30	-	11.9	18.7	12.4	20.1	25	10.9
Na (mg/L)	100	200	37.78	26.88	23.7	29.23	25.47	22.72
K (mg/L)	50	-	2.6	2.8	3.5	1.8	2.8	2.8

* - borehole to be used by Motor Dealership to supplement municipal water.

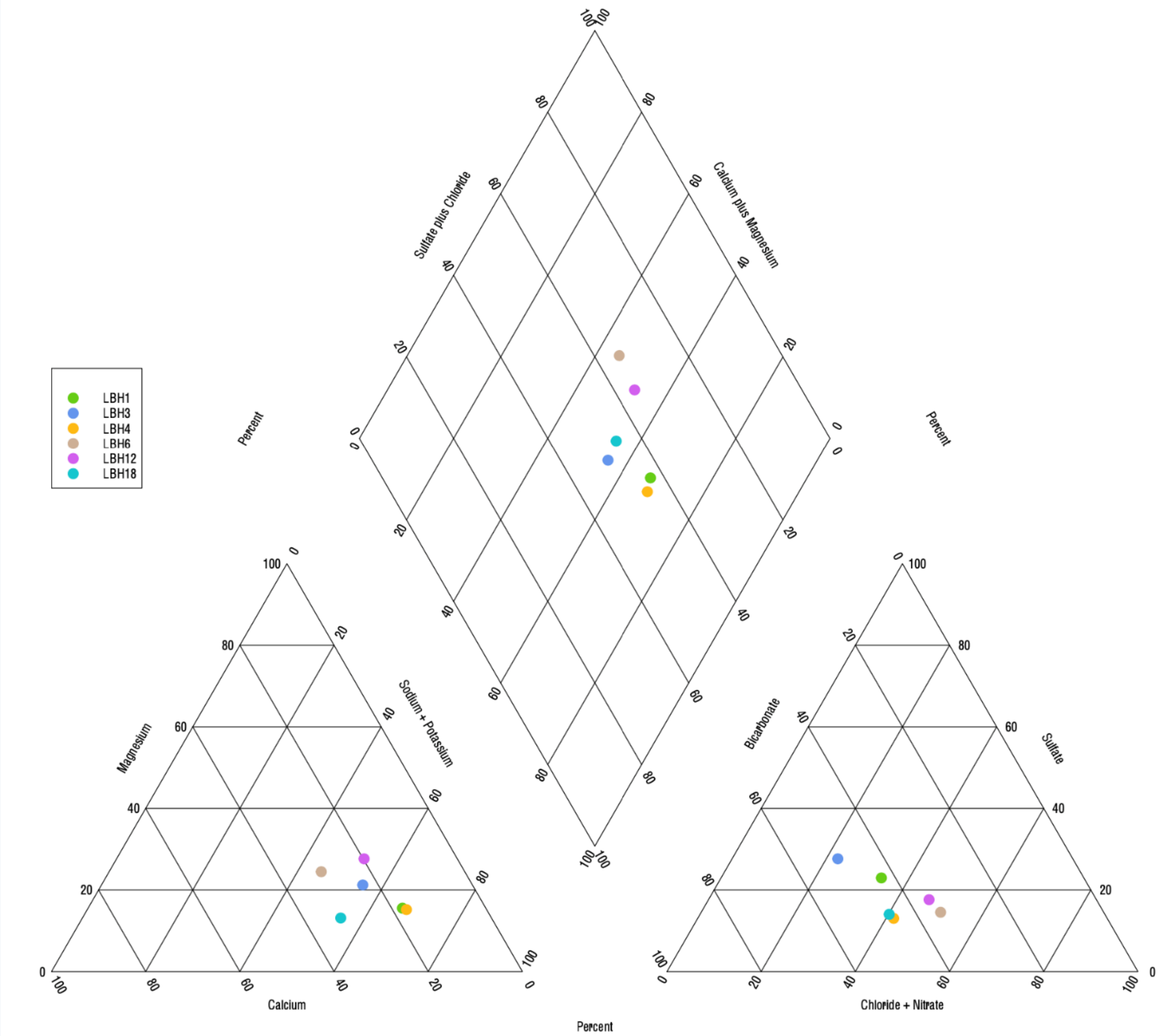


Figure 4.3: Piper diagram of the geo-sites.

5. HYDRAULIC TEST / PUMP TEST

The existing boreholes on site was used to conduct a short-term pumping test to determine the aquifer characteristics/parameters and propose a recommended abstraction yield. The pump test consisted of three, 30min step tests with recovery following a 2.5-hour (135min) pump test with recovery up to 95% of the rest water level. The aquifer parameter estimates are therefore based on drawdown and recovery data from the step drawdown (SDT) and constant discharge test (CDT). The summary of the pumping test is provided in Table 5.1.

Table 5.1: Pumping test summary.

Name	Water Level (mbgl)	Available Drawdown (m)	Step Drawdown Test	Constant Discharge Rate (l/s)	CDT Duration (min)	Final Drawdown (m)
LBH1	16.61	55.52	Step 1: 0.14L/s Step2: 0.28L/s Step 3: 0.56L/s	0..42	135.00	12.58

The following process was followed for estimating aquifer parameters based on the pumping test data.

1) Develop a conceptual understanding of the geological setting of the test.
2) Create the diagnostic plots from pumping test data and define the flow regime.
3) Choose the appropriate analytical solution (e.g. Theis, 1935; Cooper and Jacob, 1946; Hantush and Jacob 1955; Neuman, 1974; Moench, 1997) and determine the aquifer and well parameters from the curve fitting of the drawdown (and derivative) and/or the recovery data.
4) The recovery of a pumped aquifer can be interpreted in the same way as the drawdown by using diagnostic plots. Through a simple transformation of the time variable, Agarwal (1980) devised a procedure that uses solutions developed for drawdown analysis (i.e. the Theis type-curve) to analyse recovery data.

A summary of the borehole parameters and determined Transmissivity values is given in Table 5.2. Selected diagnostic plots with fitted data are shown in Appendix B.

Table 5.2: Transmissivity (in m^2/d) estimates based on tests conducted.

Name	Aquifer properties								*T-value*	*S-value*
	Cooper-Jacob (late)		Papadopulos-Cooper		Theis (Step Test)		Agarwal (Recovery)		Average	Average
	T-value	*S-value*	*T-value*	*S-value*	*T-value*	*S-value*	*T-value*	*S-value*		
LBH1	1.248	3.0E-03	1.85	3.0E-04	4.357	5.7E-06	1.469	1.0E-03	2.23	1.08E-03

5.1. Calculated Yield

Borehole yields (defined as the yield that can be maintained over a short-term (2-year) period with water levels above a specified level), were calculated using Van Tonder et al. (2002) that developed the Flow Characteristic Excel Spreadsheet (FC Method). The FC method addresses the long-term assurance of water supply from a borehole based on available drawdown figures, hydraulic boundaries, and abstraction rates, but does not define the resource yield. A summary of the borehole estimated yield and drawdown is given in Table 5.3. Current groundwater use (from the borehole) at the Motor Dealership is estimated to be less than 0.02 L/s (or 52 560 L/month). The borehole potential exceeds the current abstraction rate.

Table 5.3: Summary of yield rates for dewatering

Name	Recommended Yield (l/s)	Note/Comment	
LBH1	0.3	24 hours	Based on the drawdown derivative plot the aquifer shows a good fracture network. Available working drawdown was set to 10 m.
	0.45	12 hours	

Based on the Cooper-Jacob's (1946) approximation of Theis equation (Theis, 1935) the drawdown with distance for a given time can be determined based on the following equation:

$$s = \frac{2.3Q}{4\pi T}\log\left(\frac{2.25Tt}{r^2 S}\right)$$

Where s is drawdown [L], *Q* is pumping rate [L3/T], *T* is transmissivity [L^2/T], *r* is radial distance from pumping well to observation well [L], *S* is storativity [-] and *t* is elapsed time since start of pumping.

Transmissivity values obtained from the pumping test is 2.3 m^2/d. The aim of the borehole would be to supply 55 000 L of water per month (or around 1 800 L/d). Assuming a pumping period of 12 hours per day an observed drawdown extent (of less than 0.1 m) is limited to 80 m (Figure 5.1).

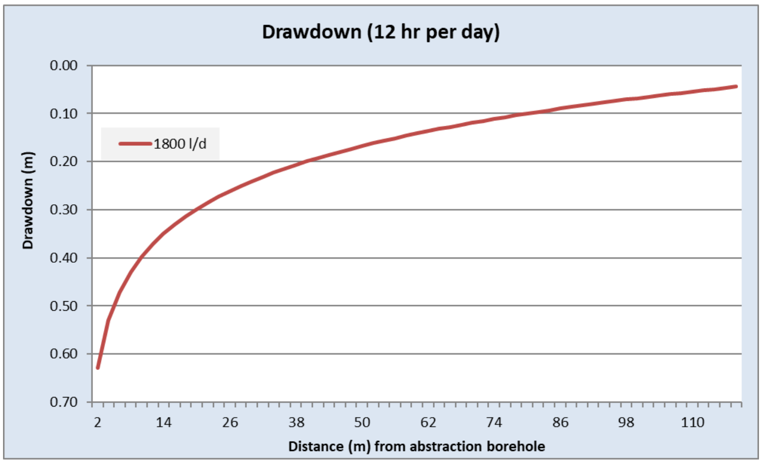


Figure 5.1: Drawdown extent for the current estimated pumping rate.

6. AQUIFER CHARACTERISATION

6.1. GROUNDWATER VULNERABILITY

Groundwater vulnerability gives an indication of how susceptible an aquifer is to contamination. Aquifer vulnerability is used to represent the intrinsic characteristics that determine the sensitivity of various parts of an aquifer to being adversely affected by a contaminant load imposed from surface. Figure 6.1 shows the national groundwater vulnerability ratings underlying the project area, indicating 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 method is based on the DRASTIC method which includes the following parameters: Depth to water table; Recharge (net); Aquifer media; Soil media; Topography; Impact of the vadose (unsaturated) zone; conductivity (hydraulic).

Based on the national results, the aquifer underlying the project area has a medium vulnerability rating.

However, it must be kept in mind that the compilation of groundwater vulnerability map, which rely on the intrinsic natural properties of an area and aquifer, are not very meaningful in the context of the historically undermined project area. The natural aquifer properties in the project area are extensively altered by the existence of open underground mine voids, land subsidence due to shallow undermining, neighbouring mining activities, mine residue deposits and acid rock drainage. The maps should therefore only be seen in regional context.

6.2. AQUIFER CLASSIFICATION

According to the Hydrogeological Map (1:500 000) series, the regional hydrogeology is characterized as an 'intergranular and fractured aquifer' with a typical potential yield of 0.5 – 2.0 litres per second. A micro-fractured matrix in the fractured Basement aquifers provides the storage capacity with limited groundwater movements, while secondary features such as fractures / faults and bedding planes enhance the groundwater flow. Based on the aquifer classification map (Parsons and Conrad, 1998), the aquifer system underlying the project area is regarded a "minor aquifer".

A summary of the classification scheme is provided in Table 6.1. In this classification system, it is important to note that the concepts of Minor and Poor Aquifers are relative and that yield is not quantified. Within any specific area, all classes of aquifers should therefore, in theory, be present.

Table 6.1: Aquifer classification scheme after Parsons and Conrad (1998).

Aquifer	Description
Sole source aquifer	An aquifer 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 region	High-yielding aquifer of acceptable quality water.
Minor aquifer region	Moderately yielding aquifer of acceptable quality or high yielding aquifer of poor-quality water.
Poor aquifer region	Insignificantly yielding aquifer of good quality or moderately yielding aquifer of poor quality, or aquifer that will never be utilised for water supply and that will not contaminate other aquifers.
Special aquifer region	An aquifer designated as such by the Minister of Water

6.3. AQUIFER PROTECTION CLASSIFICATION

As part of the aquifer classification, a Groundwater Quality Management (GQM) Index is used to define the level of groundwater protection required (Parsons 1995). The point scoring system and classification of the site-specific project area are presented in Table 6.2.

Table 6.2: Groundwater Quality Management (GQM) Classification System.

Aquifer System Management Classification		
Class	Points	**Project area**
Sole Source Aquifer System: Major Aquifer System: Minor Aquifer System: Non-Aquifer System: Special Aquifer System:	6 4 2 0 0 – 6	**2**
Aquifer Vulnerability Classification		
Class	Points	**Project area**
High: Medium: Low:	3 2 1	**2**

The recommended level of groundwater protection based on the Groundwater Quality Management Classification is calculated as follows: GQM Index = Aquifer System Management x Aquifer Vulnerability = 2 x 2 = 4

A Groundwater Quality Management Index of 4 was estimated for the project area from the ratings for the Aquifer System Management Classification (Table 6.3). According to this estimate, a medium-level groundwater protection is required for the intergranular and fractured aquifer. Reasonable groundwater protection measures are recommended to ensure that no cumulative pollution affects the aquifer, even in the long term. DWS's water quality management objectives are to protect human health and the environment. Therefore, the significance of this aquifer classification is that if any potential risk exists, measures must be taken to limit the risk to the environment, which in this case is the protection of the underlying aquifer.

Table 6.3: GQM index for the project area.

Index	Level of Protection	Project area
<1 1 - 3 3 - 6 6 - 10 >10	Limited Low Level Medium Level High Level Strictly Non-Degradation	**4**

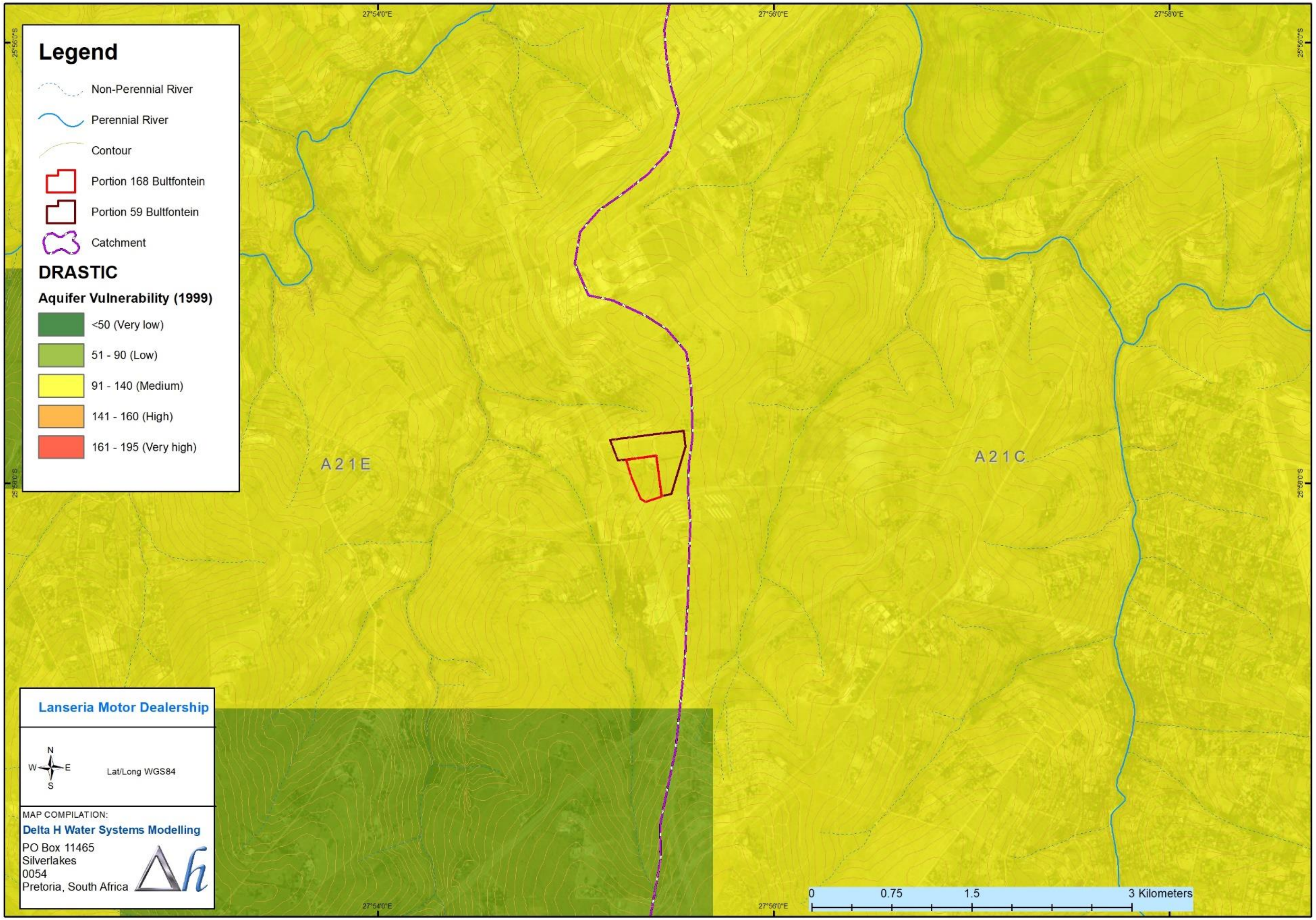


Figure 6.1: Groundwater vulnerability map for the Motor Dealership.

7. SOURCE-PATHWAY-RECEPTOR RISK ASSESSMENT

The desktop level source-pathway-receptor analysis aims to infer water related risk based on:

- Sources which affects the quality and quantity of water
- Pathways through which contaminants are transported
- Receptors being water users and the receiving environment.

Sources influencing the hydrogeological conditions include the neighbouring properties and their daily operations, groundwater abstraction, seepage of polluted water from the poultry farm, leaking or broken sewage systems and septic tanks.

Pathways of contaminant transport are mostly though groundwater flow, surface runoff and shallow interflow. The exact mode of contaminant transport will depend on contaminants of concern.

Shallow interflow, perched water and waterlogged land may possibly result in water influencing development and development impacting on the shallow movement of water, especially during development of the saturated conditions on site.

In summary, the potential groundwater impacts on site are:

- Insignificant w.r.t the shallow weathered and fractured aquifers of the Swazian age rocks/ basement aquifer system,
- Unlikely to impact third party groundwater users, should a 12-hour pump schedule be followed, and
- based on the expected drawdown extent not likely to impact on groundwater contribution to baseflow.

8. CONCLUSIONS AND RECOMMENDATIONS

Delta-H conducted a groundwater study for supporting document to the Water Use License (WUL) application for the Motor Dealership on Portion 59 and 168 on the farm Bultfontein 533-JQ near Lanseria Airport. In support of the WUL application the groundwater study included a desktop assessment, hydro-census, including groundwater sampling, and risk-based assessment.

According to the Hydrogeological Map (1:500 000) series, the regional hydrogeology is characterized as a minor 'intergranular and fractured aquifer' with a typical potential yield of 0.5 to 2.0 litres per second with a medium vulnerability rating. The groundwater levels observed range from 22 m to 30 m, with an average water level of 26 m, suggesting that most of the boreholes measure interaction of the weathered and intact rock formation with water levels within the upper weathered/fractured aquifer.

A total of six (6) groundwater samples were collected during the hydrocensus to determine the current baseline water quality at the project site. The groundwater samples indicate anthropogenic impacted groundwater with nitrate.

The following recommendations are given regarding the monitoring protocol for the project site:

- The recommended abstraction rate for the borehole on site is 0.45 L/s, based on a pump schedule of 12 hours. However, the current abstraction rate is less than 0.02 L/s (or or 52 560 L/month) and the drawdown extent (of less than 0.1 m) will be limited to 80 m.

Potential groundwater related impacts are expected to be insignificant w.r.t the shallow weathered and fractured aquifers of the aquifer, unlikely to impact third party groundwater users and unlikely to impact groundwater contribution to baseflow.

The existing borehole on site should be monitored for water levels and qualities. The following monitoring frequencies are recommended:

  - Water levels: Monthly
  - Water qualities: Quarterly

- A list of groundwater parameters to be monitored is given in Table 8.1.

Table 8.1: List of groundwater monitoring parameter.

Description	Parameter	Comments
Potential heads	Static groundwater levels	Measured in metres below ground level (mbgl) and converted into metres above mean seal level (mamsl). Collar elevations of the boreholes need to be considered.
Physico-chemical parameter, field	pH, Electrical Conductivity (EC), Temperature, Redox-Potential (mV), colour and smell (if any)	Parameters to be measured during sampling in the field, should stabilize before sample is retrieved
Physico-chemical parameter, laboratory	pH, Electrical Conductivity (EC), Temperature, Redox-Potential (mV)	To assess deviations from field measurements
Major elements	Ca, Mg, Na, K, Total Alkalinity, SO_4, NO_3, Cl, Total Dissolved Solids (TDS)	
Trace elements	Al, As, B, Ba, Cr, Cu, F, Fe, Mn, Mo, Ni, Pb	Samples to be filtered and acidified on-site.

- The boreholes should be purged (replacing approximately three times the stagnant water within the borehole) until the physic-chemical parameters stabilize and are determined.
    - Suitable sample containers should be utilised for the sample collection, i.e. plastic or glass containers for major elements and plastic or boron-glass containers for minor and trace elements.
- Sample collection including determined physic-chemical parameter should be documented in a sample protocol for each site and signed off by the sampling personnel as part of the chain of custody.
- The samples should be delivered to an accredited laboratory as soon as possible for analysis of the above parameters.

9. REFERENCES

Arcworth, R. I. (1987). The development of crystalline basement aquifers in a tropical environment. Quarterly Journal of Engineering Geology 20:265-272.

Dippenaar, M. A., van Rooy, J. L., and Witthüser, K. T. (2009). Groundwater occurrence in basement aquifers in Limpopo Province, South Africa: model-setting- scenario approach. Environmental Earth Science. 59:459-464.

[DWAF] Department of Water Affairs and Forestry (2008). BPG G4 Impact Prediction. Department of Water Affairs and Forestry series: Best Practice Guidelines for the Protection of Water Resources in the South African Mining Industry. Department of Water Affairs and Forestry (DWAF), December 2008.

Houston, J.F.T. and Lewis, R.T. (1988). The Victoria Province drought relief project, II. Borehole yield relationships. Ground Water, 26(4): 418-426.

Jones, M. J. (1985). The weathering zone aquifers of the Basement Complex areas of Africa. Quarterly Journal of Engineering Geology 18:35-46.

Parsons, R.P. (1995). A South African aquifer system management classification; WRC Report No. 77/95, Water Research Commission, Pretoria.

Parsons and Conrad, J.E. (1998). Explanatory notes for the aquifer classification map of South Africa; WRC Report No. 116/98, Water Research Commission, Pretoria.

Vegter, J.R. (1995). An explanation of a set of National Groundwater Maps. Water Research Commission. Report No TT 74/95.

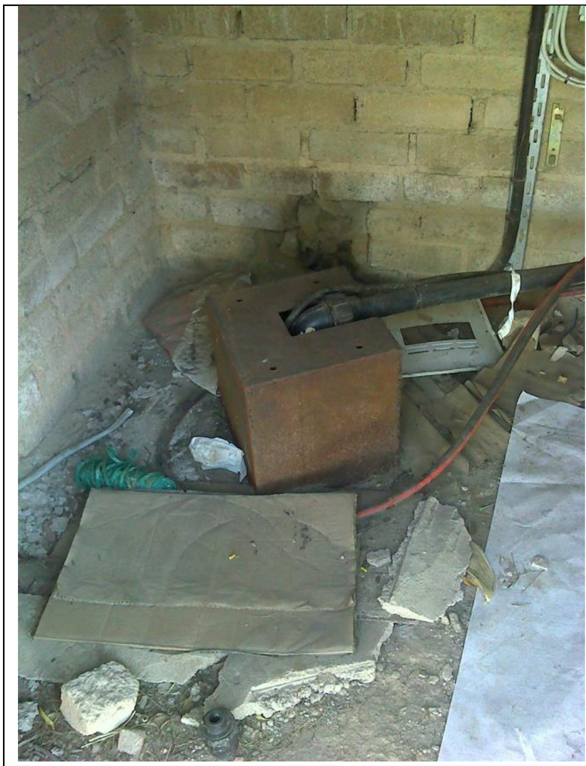
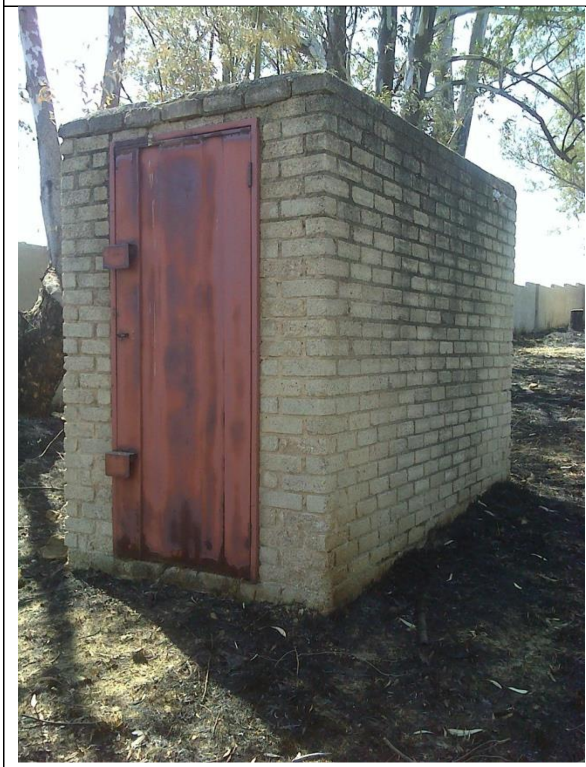
Wright, E.P. (1992). The hydrogeology of crystalline basement aquifers in Africa. In: Wright, E.P. and Burgess, W.G. (eds.) Hydrogeology of Crystalline Basement Aquifers in Africa. Geological Society Special Publication No 66. Geological Society, London.

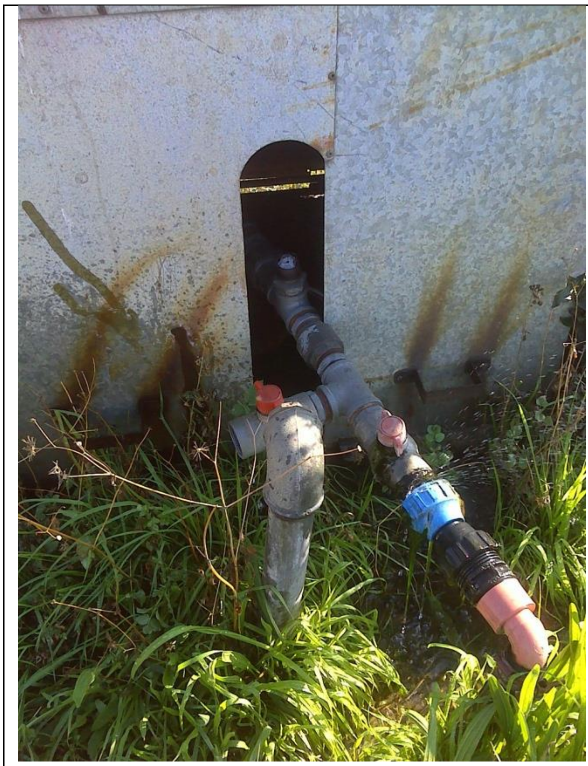
Wright, E. P. and Burgess, W. G. (eds.) (1992). The hydrogeology of crystalline basement aquifers in Africa. Geological Society Special Publication No 66. Geological Society. London.

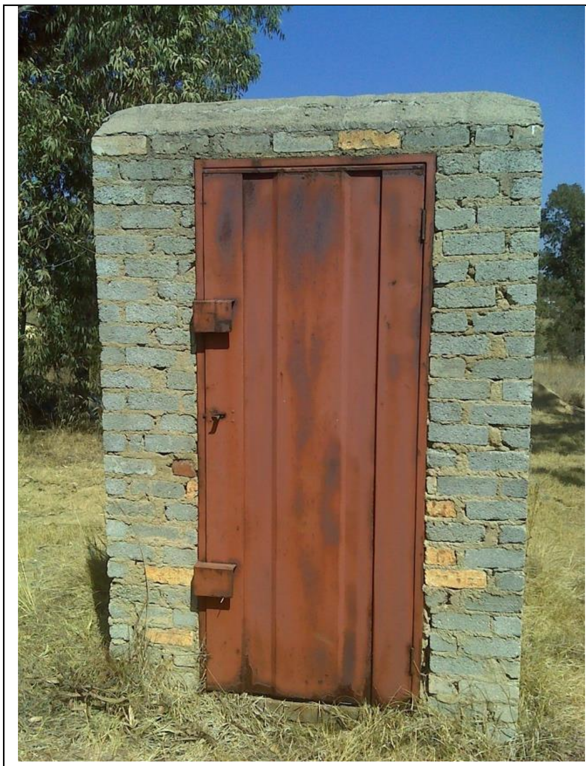
APPENDIX

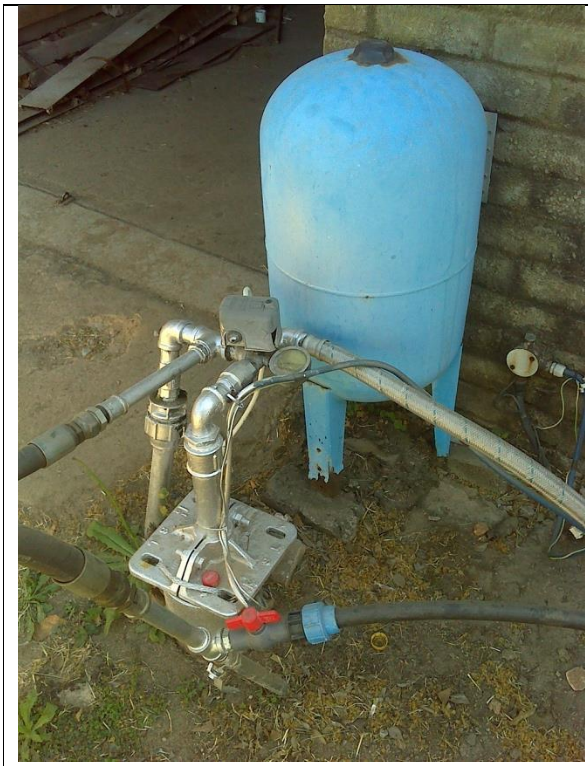
Appendix A – Hydrocensus Photos

	
LBH1	LBH3
	
LBH4	LBH5

	
LBH6	LBH7
	
LBH8	LBH9

	
LBH11	LBH12
	
LBH13	LBH14

	
LBH15	LBH16
	
LBH17	LBH18

	none
LBH19	

APPENDIX B – LABORATORY CERTIFICATES

WATERLAB (Pty) Ltd
Reg. No.: 1983/009165/07 V.A.T. No.: 4130107891
23B De Havilland Crescent
Persequor Techno Park
Meiring Naudé Drive
Pretoria
P.O. Box 283
Persequor Park, 0020
Tel: +2712 – 349 – 1066
Fax: +2712 – 349 – 2064
e-mail: admin@waterlab.co.za

sanas Testing Laboratory
T0391

CERTIFICATE OF ANALYSES
GENERAL WATER QUALITY PARAMETERS

Date received: 2020 - 08 – 27
Date completed: 2020 - 09 – 04
Project number: 1000 **Report number: 93968**
Order number: Dehl.2020.035-8_Lanseria

Client name: Delta h Water Systems
Contact person: Dr. M. Holland
Address: P.O. Box 11465 Silver Lakes 0054
e-mail: martin@delta-h.co.za
Telephone: 082 497 9088 **Facsimile: -**
Mobile: 082 497 9088

Analyses in mg/ℓ (Unless specified otherwise)	**Method Identification**	**Sample Identification**		
		LBH1	**LBH3**	**LBH4**
Sample Number		102958	102959	102960
pH – Value at 25°C	WLAB065	7.1	7.3	6.8
Electrical Conductivity in mS/m at 25°C	WLAB002	40.9	43.6	33.4
Total Dissolved Solids at 180°C	WLAB003	290	332	294
Turbidity in N.T.U	WLAB005	21	0.2	0.1
Total Alkalinity as $CaCO_3$	WLAB007	100	124	84
Chloride as Cl	WLAB046	28	24	22
Sulphate as SO_4	WLAB046	42	54	19
Fluoride as F	WLAB014	0.2	0.2	0.2
Nitrate as N	WLAB046	7.1	3.3	9.0
Ortho Phosphate as P	WLAB046	<0.1	0.1	0.1
Free & Saline Ammonia as N	WLAB046	0.2	0.2	0.3
Semi Quantitative ICP Scan (Dissolved) *	WLAB050	See Attached Report: 93968-A		
% Balancing *	---	95.5	99.9	99.0

E. Nkabinde

Technical Signatory

WATERLAB (Pty) Ltd

Reg. No.: 1983/009165/07 V.A.T. No.: 4130107891

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

P.O. Box 283
Persequor Park, 0020
Tel: +2712 – 349 – 1066
Fax: +2712 – 349 – 2064
e-mail: admin@waterlab.co.za

T0391

CERTIFICATE OF ANALYSES
GENERAL WATER QUALITY PARAMETERS

Date received: 2020 - 08 – 27 **Date completed:** 2020 - 09 – 04

Project number: 1000 **Report number: 93968** **Order number: Dehl.2020.035-8_Lanseria**

Client name: Delta h Water Systems **Contact person: Dr. M. Holland**

Address: P.O. Box 11465 Silver Lakes 0054 **e-mail: martin@delta-h.co.za**

Telephone: 082 497 9088 **Facsimile: -** **Mobile: 082 497 9088**

Analyses in mg/ℓ (Unless specified otherwise)	**Method Identification**	**Sample Identification**		
		LBH6	**LBH12**	**LBH18**
Sample Number		102961	102962	102963
pH – Value at 25°C	WLAB065	7.1	7.2	7.1
Electrical Conductivity in mS/m at 25°C	WLAB002	51.3	48.4	43.2
Total Dissolved Solids at 180°C	WLAB003	430	350	316
Turbidity in N.T.U	WLAB005	0.1	0.1	0.6
Total Alkalinity as $CaCO_3$	WLAB007	100	100	112
Chloride as Cl	WLAB046	27	36	34
Sulphate as SO_4	WLAB046	33	39	27
Fluoride as F	WLAB014	0.3	0.2	<0.2
Nitrate as N	WLAB046	23	16	9.1
Ortho Phosphate as P	WLAB046	0.1	0.1	0.1
Free & Saline Ammonia as N	WLAB046	0.2	0.1	0.2
Semi Quantitative ICP Scan (Dissolved) *	WLAB050	See Attached Report: 93968-A		
% Balancing *	---	99.0	96.7	97.3

*** = Not SANAS Accredited**
Tests marked "Not SANAS Accredited" in this report are not included in the SANAS Schedule of Accreditation for this Laboratory.

E. Nkabinde

Technical Signatory

WATERLAB (PTY) LTD

CERTIFICATE OF ANALYSIS

Project Number : **1000**
Client : **Delta H Water Systems**
Report Number : **93968-A**

Sample Origin	Sample ID	Ag (mg/L)	Al (mg/L)	As (mg/L)	Au (mg/L)	B (mg/L)	Ba (mg/L)	Be (mg/L)	Bi (mg/L)	Ca (mg/L)	Cd (mg/L)	Ce (mg/L)	Co (mg/L)
LBH1	102958	< 0.010	< 0.100	< 0.010	< 0.010	< 0.010	0.030	< 0.010	< 0.010	22	< 0.010	< 0.010	< 0.010
LBH3	102959	< 0.010	< 0.100	< 0.010	< 0.010	< 0.010	0.018	< 0.010	< 0.010	34	< 0.010	< 0.010	< 0.010
LBH4	102960	< 0.010	< 0.100	< 0.010	< 0.010	< 0.010	0.039	< 0.010	< 0.010	23	< 0.010	< 0.010	< 0.010
LBH6	102961	< 0.010	< 0.100	< 0.010	< 0.010	< 0.010	0.027	< 0.010	< 0.010	41	< 0.010	< 0.010	< 0.010
LBH12	102962	< 0.010	< 0.100	< 0.010	< 0.010	< 0.010	0.026	< 0.010	< 0.010	29	< 0.010	< 0.010	< 0.010
LBH18	102963	< 0.010	< 0.100	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	44	< 0.010	< 0.010	< 0.010

Sample Origin	Sample ID	Cr (mg/L)	Cs (mg/L)	Cu (mg/L)	Dy (mg/L)	Er (mg/L)	Eu (mg/L)	Fe (mg/L)	Ga (mg/L)	Gd (mg/L)	Ge (mg/L)	Hf (mg/L)	Hg (mg/L)
LBH1	102958	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.025	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH3	102959	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.025	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH4	102960	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.025	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH6	102961	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.025	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH12	102962	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.025	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH18	102963	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.025	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010

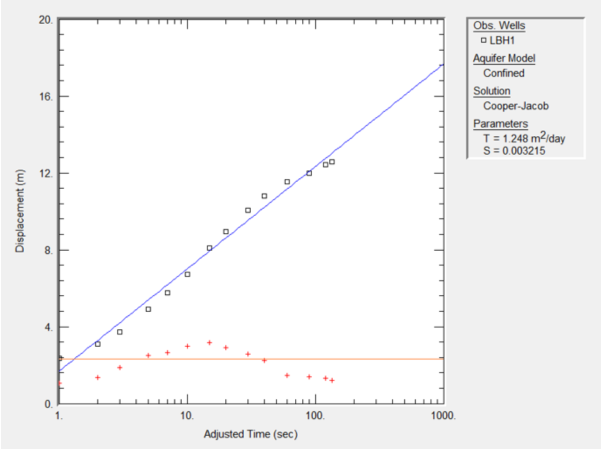
Sample Origin	Sample ID	Ho (mg/L)	In (mg/L)	Ir (mg/L)	K (mg/L)	La (mg/L)	Li (mg/L)	Lu (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	Na (mg/L)	Nb (mg/L)
LBH1	102958	< 0.010	< 0.010	< 0.010	2.6	< 0.010	0.027	< 0.010	12	< 0.025	< 0.010	38	< 0.010
LBH3	102959	< 0.010	< 0.010	< 0.010	2.8	< 0.010	0.016	< 0.010	19	< 0.025	< 0.010	27	< 0.010
LBH4	102960	< 0.010	< 0.010	< 0.010	3.5	< 0.010	0.014	< 0.010	12	< 0.025	< 0.010	24	< 0.010
LBH6	102961	< 0.010	< 0.010	< 0.010	1.8	< 0.010	0.011	< 0.010	20	< 0.025	< 0.010	29	< 0.010
LBH12	102962	< 0.010	< 0.010	< 0.010	2.8	< 0.010	0.012	< 0.010	25	< 0.025	< 0.010	25	< 0.010
LBH18	102963	< 0.010	< 0.010	< 0.010	2.8	< 0.010	0.018	< 0.010	11	< 0.025	< 0.010	23	< 0.010

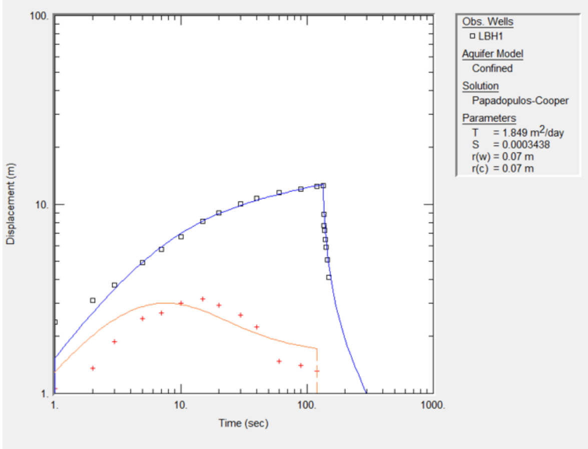
Sample Origin	Sample ID	Nd (mg/L)	Ni (mg/L)	Os (mg/L)	P (mg/L)	Pb (mg/L)	Pd (mg/L)	Pr (mg/L)	Pt (mg/L)	Rb (mg/L)	Rh (mg/L)	Ru (mg/L)	Sb (mg/L)
LBH1	102958	< 0.010	< 0.010	< 0.010	0.111	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH3	102959	< 0.010	< 0.010	< 0.010	0.231	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH4	102960	< 0.010	< 0.010	< 0.010	0.139	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH6	102961	< 0.010	< 0.010	< 0.010	0.223	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH12	102962	< 0.010	< 0.010	< 0.010	0.423	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH18	102963	< 0.010	< 0.010	< 0.010	0.191	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010

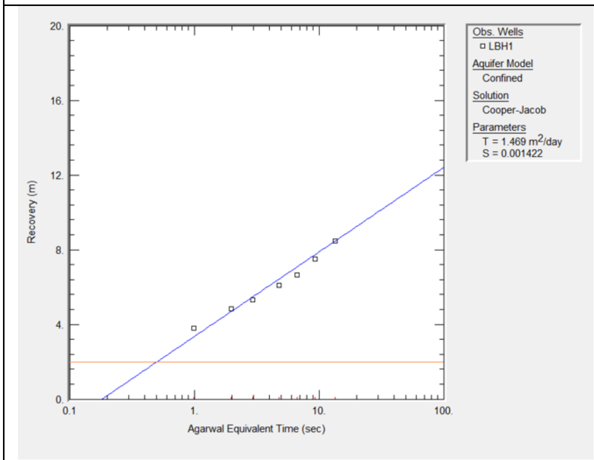
Sample Origin	Sample ID	Sc (mg/L)	Se (mg/L)	Si (mg/L)	Sm (mg/L)	Sn (mg/L)	Sr (mg/L)	Ta (mg/L)	Tb (mg/L)	Te (mg/L)	Th (mg/L)	Ti (mg/L)	Tl (mg/L)
LBH1	102958	< 0.010	< 0.010	21	< 0.010	< 0.010	0.109	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH3	102959	< 0.010	< 0.010	25	< 0.010	< 0.010	0.113	< 0.010	< 0.010	< 0.010	< 0.010	0.011	< 0.010
LBH4	102960	< 0.010	< 0.010	28	< 0.010	< 0.010	0.101	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH6	102961	< 0.010	< 0.010	35	< 0.010	< 0.010	0.104	< 0.010	< 0.010	< 0.010	< 0.010	0.018	< 0.010
LBH12	102962	< 0.010	< 0.010	27	< 0.010	< 0.010	0.108	< 0.010	< 0.010	< 0.010	< 0.010	0.010	< 0.010
LBH18	102963	< 0.010	< 0.010	24	< 0.010	< 0.010	0.087	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010

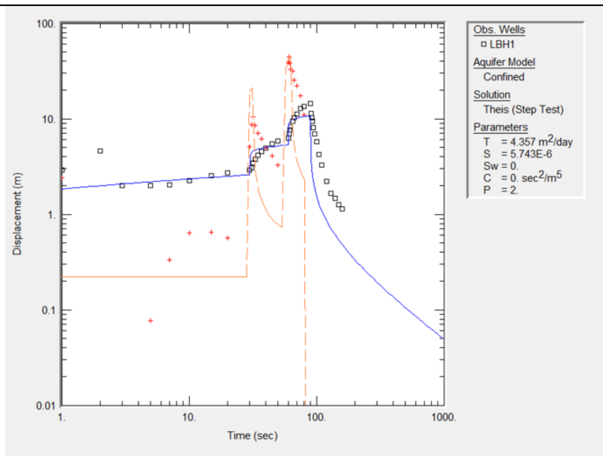
Sample Origin	Sample ID	Tm (mg/L)	U (mg/L)	V (mg/L)	W (mg/L)	Y (mg/L)	Yb (mg/L)	Zn (mg/L)	Zr (mg/L)
LBH1	102958	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.011	< 0.010
LBH3	102959	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH4	102960	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.014	< 0.010
LBH6	102961	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH12	102962	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
LBH18	102963	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.028	< 0.010

APPENDIX C – PUMP TEST ASSESSMENT









Clearwater pumps
www.clearwaterpumps.co.za
email: louis@clearwaterpumps.com
66 Jurg Avenue, Hennopspark
Centurion, 0157
26 Phyllite Ave, Swartkops, 0157
+27 82 857 9488 or +27 82 955 3050
VAT no: 45602657755
Reg no: 2012/090319/07

Borehole Test Record

Project Information

Project Name: Halfway Toyota

Client: Delta-H Water Systems Modelling (Pty) Ltd

Borehole Information

Borehole Number: BH01

Coordinate: S 25.96480 E 27.92336

Newly Drilled Borehole [ ] Existing Borehole [x]

Borehole Depth: 72.13 mbcl Collar Height: -0.38 m

Casing: [x] Steel [ ] U-PVC Diameter: 165 mm

Main Water Strike: m Blow Yield: L/h

Static Water Level: 16.61 mbcl

Photo

Existing Equipment

Borehole Equipped ? Yes [x] No [ ] Operational ? Yes

Type of Pump: Submersible Make & Model: Vortex ST10-10 (0.55kW)

Installation Depth: 69 m Riser Pipe: 32mm HDPE

Testing Information

Date Test Started: 27-Aug-20 Type of Test: 3 x 30min Steps & 2hr Constant Discharge

Test Pump: Submersible VANSAN 412-26 (5.5KW) Installation Depth: 69.00 m

Operator: Ruan Campher Water level recording: Manual [x] Logger [ ]

Observation Boreholes ? Yes [ ] No [X] Nr of Observation BH's: BH's

BH nr: Coord: S E Dist. to pump BH: m

BH nr: Coord: S E Dist. to pump BH: m

BH nr: Coord: S E Dist. to pump BH: m

Sample Collection: Inorganic [x] Micro [x] None [ ] Date & Time 27 Aug (14:00)

COMMENTS:

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE NO: BH01 **COORDINATES:** **S** 25.96480 **E** 27.92336

BOREHOLE DEPTH (mbcl):	72.13	WATER LEVEL (mbcl):	16.61
COLLAR HEIGHT (magl):	-0.38	DEPTH OF PUMP (m):	69.00
		AVAILABLE DRAWDOWN (m):	52.39

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1:			500	l/h	DISCHARGE RATE 2:			1000	l/h	DISCHARGE RATE 3:			2000	l/h
DATE:	27-Aug-20	TIME:		10:45	DATE:	27-Aug-20	TIME:		11:15	DATE:	27-Aug-20	TIME:		11:45
Time	Drawdown	Yield	Time	Recovery	Time	Drawdown	Yield	Time	Recovery	Time	Drawdown	Yield	Time	Recovery
min	m	l/h	min	m	min	m	l/h	min	m	min	m	l/h	min	m
1	2.89	500	**1**		**1**	3.08	1000	**1**		**1**	6.98	2000	**1**	11.42
2	4.57	500	**2**	0.14	**2**	3.45	1000	**2**	0.28	**2**	7.73	2000	**2**	10.30
3	1.98	500	**3**		**3**	3.73	1000	**3**		**3**	8.22	2000	**3**	9.45
5	2.01	500	**5**		**5**	4.17	1000	**5**		**5**	9.35	2000	**5**	8.09
7	2.04	500	**7**		**7**	4.54	1000	**7**		**7**	10.19	2000	**7**	6.92
10	2.25	500	**10**		**10**	4.96	1000	**10**		**10**	11.14	2000	**10**	5.74
15	2.53	500	**15**		**15**	5.47	1000	**15**		**15**	12.70	2000	**15**	4.22
20	2.71	500	**20**		**20**	5.88	1000	**20**		**20**	13.50	2000	**20**	3.26
30	2.90	500	**30**		**30**	6.28	1000	**30**		**30**	14.52	2000	**30**	2.20
40			**40**		**40**			**40**		**40**			**40**	1.65
50			**50**		**50**			**50**		**50**			**50**	1.47
60			**60**		**60**			**60**		**60**			**60**	1.26
70			**70**		**70**			**70**		**70**			**70**	1.14
80			**80**		**80**			**80**		**80**			**80**	
90			**90**		**90**			**90**		**90**			**90**	
100			**100**		**100**			**100**		**100**			**100**	
110			**110**		**110**			**110**		**110**			**110**	
120			**120**		**120**			**120**		**120**			**120**	
pH			**150**		**pH**			**150**		**pH**			**150**	
TEMP		°C	**180**		**TEMP**		°C	**180**		**TEMP**		°C	**180**	
EC		mS/m	**210**		**EC**		mS/m	**210**		**EC**		mS/m	**210**	

DISCHARGE RATE 4:				l/h	DISCHARGE RATE 5:				l/h	DISCHARGE RATE 6:				l/h
DATE:		TIME:			DATE:		TIME:			DATE:		TIME:		
Time	Drawdown	Yield	Time	Recovery	Time	Drawdown	Yield	Time	Recovery	Time	Drawdown	Yield	Time	Recovery
min	m	l/h	min	m	min	m	l/h	min	m	min	m	l/h	min	m
1			**1**		**1**			**1**		**1**			**1**	
2			**2**		**2**			**2**		**2**			**2**	
3			**3**		**3**			**3**		**3**			**3**	
5			**5**		**5**			**5**		**5**			**5**	
7			**7**		**7**			**7**		**7**			**7**	
10			**10**		**10**			**10**		**10**			**10**	
15			**15**		**15**			**15**		**15**			**15**	
20			**20**		**20**			**20**		**20**			**20**	
30			**30**		**30**			**30**		**30**			**30**	
40			**40**		**40**			**40**		**40**			**40**	
50			**50**		**50**			**50**		**50**			**50**	
60			**60**		**60**			**60**		**60**			**60**	
70			**70**		**70**			**70**		**70**			**70**	
80			**80**		**80**			**80**		**80**			**80**	
90			**90**		**90**			**90**		**90**			**90**	
100			**100**		**100**			**100**		**100**			**100**	
110			**110**		**110**			**110**		**110**			**110**	
120			**120**		**120**			**120**		**120**			**120**	
pH			**150**		**pH**			**150**		**pH**			**150**	
TEMP		°C	**180**		**TEMP**		°C	**180**		**TEMP**		°C	**180**	
EC		mS/m	**210**		**EC**		mS/m	**210**		**EC**		mS/m	**210**	
			240					**240**					**240**	
			300					**300**					**300**	
			360					**360**					**360**	

COMMENTS:

CONSTANT DISCHARGE TEST

BOREHOLE NO: BH01 **COORDINATES:** **S** 25.96480 **E** 27.92336

BOREHOLE DEPTH (mbcl):	72.13	WATER LEVEL (mbcl):	17.75
COLLAR HEIGHT (magl):	-0.38	DEPTH OF PUMP (m):	69.00
		AVAILABLE DRAWDOWN (m):	51.25

TEST STARTED				**TEST COMPLETED**	
DATE:	27-Aug-20	TIME:	13:30	DATE:	TIME:

DISCHARGE BOREHOLE					OBSERVATION BH1			OBSERVATION BH2			OBSERVATION BH3		
					NR:			NR:			NR:		
					Distance(m):			Distance(m):			Distance(m):		
Time	Drawdown	Yield	Time	Recovery	Time	Drawdown	Recovery	Time	Drawdown	Recovery	Time	Drawdown	Recovery
min	m	l/h	min	m	min	m	m	min	m	m	min	m	m
1	2.37	1500	**1**	8.80	**1**			**1**			**1**		
2	3.10	1500	**2**	7.73	**2**			**2**			**2**		
3	3.72	1500	**3**	7.28	**3**			**3**			**3**		
5	4.89	1500	**5**	6.49	**5**			**5**			**5**		
7	5.77	1500	**7**	5.94	**7**			**7**			**7**		
10	6.74	1500	**10**	5.07	**10**	0.42		**10**			**10**		
15	8.08	1500	**15**	4.10	**15**			**15**			**15**		
20	8.96	1500			**20**			**20**			**20**		
30	10.06	1500			**30**			**30**			**30**		
40	10.78	1500			**40**			**40**			**40**		
60	11.53	1500			**60**			**60**			**60**		
90	11.98	1500			**90**			**90**			**90**		
120	12.44	1500			**120**			**120**			**120**		
135	12.58	1500			**150**			**150**			**150**		
					180			**180**			**180**		
					210			**210**			**210**		
					240			**240**			**240**		
					300			**300**			**300**		
					360			**360**			**360**		
					420			**420**			**420**		
					480			**480**			**480**		
					540			**540**			**540**		
					600			**600**			**600**		
					720			**720**			**720**		
					840			**840**			**840**		
					960			**960**			**960**		
					1080			**1080**			**1080**		
					1200			**1200**			**1200**		
					1320			**1320**			**1320**		
					1440			**1440**			**1440**		
					1560			**1560**			**1560**		
					1680			**1680**			**1680**		
					1800			**1800**			**1800**		
					1920			**1920**			**1920**		
					2040			**2040**			**2040**		
					2160			**2160**			**2160**		
					2280			**2280**			**2280**		
					2400			**2400**			**2400**		
					2520			**2520**			**2520**		
					2640			**2640**			**2640**		
					2760			**2760**			**2760**		
					2880			**2880**			**2880**		
					3000			**3000**			**3000**		
					3120			**3120**			**3120**		
					3240			**3240**			**3240**		
					3360			**3360**			**3360**		
					3480			**3480**			**3480**		
					3600			**3600**			**3600**		
					3720			**3720**			**3720**		
					3840			**3840**			**3840**		
					3960			**3960**			**3960**		
					4080			**4080**			**4080**		
					4200			**4200**			**4200**		
					4320			**4320**			**4320**		
						SWL (mbcl)			**SWL (mbcl)**			**SWL (mbcl)**	

COMMENTS: