Cedarberg Aqua – Natural Mineral Water Annual geohydrological audit (2017)

REPORT:	***SUBMITTED BY:***
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03 May 2017

EXECUTIVE SUMMARY

Cedarberg Aqua is a bottled water company which obtains its water supply from a single borehole (KSV1). Following on from an assessment in 2008, 2010, 2012, 2014, 2015 and 2016, GEOSS was requested to complete another assessment in April 2017. The borehole is drilled into the Nardouw Sub-group quartzitic sandstones on the eastern limb of the Citrusdal syncline. The water bearing fractures are about 100 m below the ground level and the borehole is 180 m deep. The geological formations dip to the west and there are no contamination sources up-gradient of the borehole. The groundwater recharge is into the pristine geological formations in the mountains to the east of the borehole and the Nardouw Sub-group aquifer is confined.

The groundwater has a low pH (laboratory pH = 4.3 @ 25°C) and a low Total Dissolved Solids content (TDS = 120.0 mg/L). Of all the parameters analysed none were above the maximum permissible limits for bottled water. There is no microbiological contamination in the borehole water. There has been essentially no change in the water quality from the 2008, 2010, 2012, 2014, 2015 and 2016 measurements. Even though the past year has been very dry, the chemical composition of the water has remained unchanged.

Due to the following factors:

- the favourable geological setting
- the great depth from which the water is abstracted
- the groundwater recharge flow paths direction
- the borehole having steel casing in the upper zone
- the borehole being well sealed, and
- the very good quality of the groundwater with no signs of contamination whatsoever,

This groundwater is completely acceptable for bottling purposes.

The borehole water is "ideal" water, most suitable for bottling purposes and suitable for lifetime use.

The current groundwater and borehole protection measures in place are adequate.

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ABBREVIATIONS

EC	Electrical Conductivity
L/hr	litres per hour
L/s	litres per second
m	metres
m^3/hour	cubic meters per hour
mamsl	metres above mean sea level
mbch	metres below collar height
mbgl	metres below ground level
mg/L	milligrams per litre
mS/m	milliSiemens per meter
mV	millivolts
nm	not measured
TDS	Total Dissolved Solids
WGS84	Since 1st January 1999, the official co-ordinate system for South Africa is Based on the World Geodetic System 1984 ellipsoid, commonly known as WGS84.

GLOSSARY OF TERMS

Aquifer: a geological formation, which has structures or textures that hold water or permit appreciable water movement through them [from National Water Act (Act No. 36 of 1998)].

Borehole: includes a well, excavation, or any other artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer [from National Water Act (Act No. 36 of 1998)].

Confined aquifer: Groundwater below a layer of solid rock or clay is said to be in a confined aquifer. The rock or clay is called a confining layer. A borehole that goes through a confining layer is known as an artesian well. The groundwater in confined aquifers is usually under pressure. This pressure causes water in an artesian well to rise above the aquifer level. If the pressure causes the water to rise above ground level, the well overflows and is called a flowing artesian well.

Groundwater: water found in the subsurface in the saturated zone below the water table or piezometric surface i.e. the water table marks the upper surface of groundwater systems.

Suggested reference for this report:

GEOSS (2017). Cedarberg Aqua – Geohydrological Review 2017. GEOSS Report Number: 2017/04-23. GEOSS - Geohydrological & Spatial Solutions International (Pty) Ltd. Stellenbosch, South Africa

Cover photo:

Photo of the Cedarberg Aqua road sign.

GEOSS project number:

2010_03-593.

1. INTRODUCTION

This report reviews the results of recent sampling of the borehole which supplies groundwater to the company Cedarberg Aqua. For the sake of completeness, some information from previous GEOSS reports (2008, 2010, 2012, 2014, 2015 and 2016) is also included.

Cedarberg Aqua is a bottled water company located on the farm Klein Swartvlei (KSV) situated approximately 10 km south of Citrusdal (**Map 1**, **Appendix A**). Cedarberg Aqua obtains its water for bottling from a borehole (KSV1). A vulnerability assessment was completed previously by GEOSS (2008) on the groundwater from the borehole, the borehole itself and the source. The details of borehole KSV1 are provided in **Table 1**.

Table 1. Borehole details (KSV1)

Parameter	Value
Latitude (WGS84)	-32.682753° S
Longitude (WGS84)	19.059483° E
Elevation (mamsl)	256
Collar height (m)	0.1
Borehole depth (m)	180
Pump depth (mbgl)	170
Pump Type	18 kW super D T25/18
Steel casing diameter (inches)	8" (203 cm)
Riser Pipe	75 mm Boreline
Depth of water bearing fractures (m)	~100
Rest water level (mbgl)	~60
Recommended max. abstraction rate (L/s)	4.1
Recommended max. abstraction rate (m^3/hr)	14.76

2. TERMS OF REFERENCE

The project Terms of Reference were to complete field measurements of the borehole water chemistry, collect samples for macro-chemical and microbiological analysis and reassess the vulnerability of the source and borehole to contamination.

3. SITE VISIT

A site visit was completed on 12 April 2017, which included a visual assessment of the site and collection of a borehole water sample. Old infrastructure surround the borehole has been removed and a new stainless steel housing unit with baseplate has been installed. The groundwater sample was collected from the sample tap connected to the borehole. The laboratory analysis certificates are included in **Appendix B**. Photos of the site are included in **Appendix C**.

No problems have been reported with the borehole water level being drawn down too deep (i.e. to the pump inlet), not even during the peak summer abstraction period. This past year has been particularly dry. The sampling was carried out on a particularly hot day.

Two samples were collected for chemical analysis and microbiological analysis by Bemlab (Somerset West). Bemlab is a SANAS accredited laboratory. The latter sample was collected in a sterilised container and collected a week after the chemical sample (to ensure it could reach the laboratory within 24 hours. The samples were kept cool in transit and submitted the following day for analysis.

In the recent past there has been no change in the land use activities in the vicinity of the borehole. The borehole consists of an outer steel casing and an inner casing. The inner casing is sealed with a cover plate thus preventing surface based contamination (i.e. the inflow of surface based run-off or the possibility of a small creature/animal from falling into the borehole). No sources of potential contamination were identified proximal to the borehole. The general setting of the borehole is shown on an aerial photo map in **Map 2 (Appendix A**).

4. RESULTS AND ANALYSES

The chemical results obtained from Bemlab (Somerset West) are included in **Appendix B. Table 2** provides a colour classification according to the SANS241-1 (2015) guidelines. **Table 3** lists the results as well as the SANS 241-1 (2015) standards and SANBWA (2010) guidelines.

Table 2: Classification table for specific limits (SANS241-1, 2015)

Acute Health
Aesthetic
Chronic health
Operational
Acceptable

Table 3: Chemical analysis of the borehole water and SANS241-1 (2015) and SANBWA (2010) guidelines

Borehole	KSV1 (04 May 2010)	KSV1 (14 Feb 2012)	KSV1 (14 Jan 2014)	KSV1 (12 Mar 2015)	KSV1 (14 Jan 2015)	KSV1 (2 Mar 2016)	KSV1 (12 Apr 2017)	SANS 241 (2015)	SANBWA (2010)
					Abbott	Bemlab			
Alkalinity - $CaCO_3$ (mg/L)	2.51	0.00	0.000	-	<11.0	1.0	0.000	N/A	No limit
Aluminium - Al (mg/L)	0.068	-	-	-	0.139	0.108	0.086	≤0.300 Operational	0.20

Antimony - Sb (mg/L)	0.000	-	-	-	<0.01	-	<0.002	≤0.020 Chronic Health	0.01
Arsenic - As (mg/L)	0.006	-	-	-	<0.003	0.003	<0.005	≤0.01 Chronic Health	0.05
Barium - Ba (mg/L)	0.04	-	-	-	0.03	-	-	N/A	-
Bicarbonate - HCO_3 (mg/L)	7.66	7.60	0.00	13.40	-	-	-	N/A	-
Boron - B (mg/L)	0.492	0.03	0.11	0.10	<0.10	0.71	<0.08	N/A	-
Cadmium - Cd (mg/L)	0.001	-	-	-	<0.001	0.00	<0.003	≤0.003 Chronic Health	0.005
Calcium - Ca (mg/L)	1.19	1.3	0.95	0.32	0.51	0.67	0.7	N/A	No limit
Chloride - Cl (mg/L)	48.46	43.3	17.62	44.80	56.7	42.00	45	≤300 Aesthetic	250
Chromium - Cr (mg/L)	0.01	-	-	-	-	0.022	<0.027	N/A	0.10
Copper - Cu (mg/L)	0.023	0.01	0.013	0.006	<0.006	0.03	<0.02	≤2.000 Chronic Health	1.00
Cyanide - CN (mg/L)	0.00	-	-	-	-	0.005	0.002	≤0.200 Acute Health	0.20
Dissolved Organic Carbon (mg/L)	2	-	-	-	-	-	-	N/A	-
EC (mS/m)	17.78	14	14	17	16.3	18.3	18.8	≤170 Aesthetic	No limit
Fluoride - F (mg/L)	0.00	0.0	0.000	0.000	0.08	0.24	0	≤1.5 Chronic Health	5.00
Iron - Fe (mg/L)	0.033	0.01	0.03	0.024	0.024	**0.667**	0.1	≤0.300 Aesthetic ≤2.000 Chronic Health	-
Lead - Pb (mg/L)	0.004	0.00	-	-	0.008	0.00	<0.007	≤0.01 Chronic Health	0.05
Magnesium - Mg (mg/L)	2.77	3.1	3.23	2.50	2.9	2.66	2.8	N/A	No limit
Manganese - Mn (mg/L)	0.01	0.00	0.007	0.019	<0.0.19	0.004	<0.03	≤0.100 Aesthetic ≤0.4400 Chronic Health	0.10

Mercury - Hg (mg/L)	0.00	-	-	-	-	0	<0.003	≤0.006 Chronic Health	0.002
Molybdenum - Mo (mg/L)	0.00	-	-	-	<0.001		-	N/A	-
Nickel - Ni (mg/L)	0.002	-	0.639	-	0.002	0.00	0.008	≤0.070 Chronic Health	0.15
Nitrate plus nitrite - N (mg/L)	0.92	1.08	0.266	0.720	0.79	0.67	0.79	≤11 Acute Health	-
pH	5	5.0	4.4	5.1	**4.8**	**4.4**	**4.3**	≥5 - ≤9.7 Operational	-
Potassium - K (mg/L)	0.63	4.0	1.63	0.99	1.0	0.82	1.6	N/A	-
Selenium - Se (mg/L)	0.013	-	-	-	-	0.001	0.033	≤ 0.040 Chronic Health	0.02
Sodium - Na (mg/L)	28.25	18.5	26.31	23.00	22.9	19.39	20.4	≤200 Aesthetic	No limit
Sulphate - SO_4 (mg/L)	2.68	5	7.38	2.00	<0.28	1.83	3	≤250 Aesthetic ≤500 Acute Health	250
Total Dissolved Solids - TDS (mg/L)	132.7	136	92	111	98	117	120	≤1200 Aesthetic	No limit
Zinc - Zn (mg/L)	0.073	0.00	0.014	0.005	0.006	0.12	<0.03	≤5 Aesthetic	-

The microbiological results from Bemlab are listed in **Table 4** and are also included in **Appendix B**.

Table 5 also compares the borehole water from KSV1 to DWAF drinking water standards, colour coded according to **Table 6**.

Table 4. Microbiological analysis of the borehole water (CFU/100ml)

Borehole	KSV1 (14 Feb 2012)	KSV1 (14 Jan 2014)	KSV1 (14 Feb 2014)	KSV1 (13 Mar 2014)	KSV1 (08 Apr 2014)	KSV1 (12 Mar 2015)	KSV1 (02 Mar 2016)	KSV1 (28 Apr 2017)	SANS 1657 (2007)	SANBWA (2010)
Heterotrophic plate count	73	341	nm	6	1	220	4	No growth	-	<100
Total Coliforms	1	64	No growth	No growth	No growth	<1	No growth	No Growth	Absent in 100 mL	Absent in 100 ml
Escherichia coli	No growth	No growth	nm	No growth	No growth	<1	No growth	No Growth	Absent in 100 mL	Absent in 100 ml
Faecal Coliforms	No growth	No growth	nm	nm	nm	<1	No growth	nm	Absent in 100 mL	Absent in 100 ml

Table 5: Chemical analysis of the borehole water (KSV1) (DWAF, 1998)

Parameters :	**KSV1 (12 Apr 2017)**	**DWAF (1998) Drinking Water Assessment Guide**				
		Class 0	**Class I**	**Class II**	**Class III**	**Class IV**
pH (lab)	4.3	5-9.5	4.5-5 & 9.5-10	4-4.5 & 10-10.5	3-4 & 10.5-11	< 3 &>11
Conductivity (mS/m)	18.8	<70	70-150	150-370	370-520	>520
Total bacteria (/ 1 ml)	0	< 5 000 - **SANS 241**				
Coliforms (/ 100 ml)	0	0	0 - 10	10 - 100	100 – 1000	> 1 000
E. Coli (/ 100 ml)	0	Absent / 100 ml - **SANS 241**				
		mg/l	mg/l	mg/l	mg/l	mg/l
Calcium (as Ca)	0.7	0-80	80-150	150-300	>300	
Magnesium (as Mg)	2.8	<30-70	70-100	100-200	200-400	>400
Sodium (as Na)	20.4	<100	100-200	200-400	400-1000	>1000
Potassium (as K)	1.6	<25	25-50	50-100	100-500	>500
Zinc (as Zn)	<0.03	<3-20	>20	Noticeable taste	Astringent taste	Repulsive taste
Chloride (as Cl)	45.0	<100	100-200	200-600	600-1200	>1200
Sulphate (as SO_4)	3	<100-200	200-400	400-600	600-1000	>1000
Total Dissolved Solids	120	<450	450-1000	1000-2400	2400-3400	>3400
Nitrate (as N)	0.79	<6	6-10	10-20	20-40	>40
Iron (as Fe)	0.1	<0.01-0.5	0.5-1.0	1.0-5.0	5.0-10.0	>10
Manganese (as Mn)	<0.03	<0.05-0.1	0.1-0.4	0.4-4	4.0-10.0	>10
Copper (as Cu)	<0.02	0-1	1-1.3	1.3-2	2-15	>15
Phosphorous (as P)	<0.01	-	-	-	-	-

Table 6: Colour coded classification table taken from DWAF (1998).

Blue	**(Class 0)**	**Ideal water quality** - suitable for lifetime use.
Green	**(Class I)**	**Good water quality** - suitable for use, rare instances of negative effects.
Yellow	**(Class II)**	**Marginal water quality** - conditionally acceptable. Negative effects may occur.
Red	**(Class III)**	**Poor water quality** - unsuitable for use without treatment. Chronic effects may occur.
Purple	**(Class IV)**	**Dangerous water quality** - totally unsuitable for use. Acute effects may occur.

5. DISCUSSION

The geological setting of the borehole means that there is essentially no risk of surface based contamination to the groundwater in the vicinity of the borehole. The borehole setting is presented in **Map 3** (**Appendix A**). The borehole is drilled into the quartzitic sandstones of the Nardouw Sub-group (C1Q2) on the eastern limb of the Citrusdal syncline. The geological formations dip to the west and the water-bearing fractures were intersected at a depth of 100 mbgl. The Nardouw Sub-group is the upper portion of the Table Mountain Group, and the fractured nature of this aquifer reduces the possible risk of contamination to the borehole.

The setting is well suited for good quality groundwater, as is evident in the chemistry results. The groundwater has a low "total dissolved solids" content. The pH is low (laboratory pH = 4.3) which is acidic and typical of the Nardouw Sub-group sandstones. No parameters are above maximum limits and no microbiological contamination was detected. The dissolved iron concentration is low and well within recommended limits.

6. RECOMMENDATIONS

Due to the remote location of the site and the normally safe nature of the area it is not deemed a prerequisite to "house" the borehole. The security fencing around the borehole is currently being upgraded. The borehole itself is secured in a small stainless steel housing which is kept locked.

The groundwater abstracted at Cedarberg Aqua is an excellent source of water and ideally suited for bottled water purposes.

For bottled labelling purposes the old values and latest values are included in **Table 7**.

Table 7: Bottle labelling – mineral content (mg/L)

Parameter	2016 - Bottle label content	2017 – Proposed bottle label content
Calcium as Ca	0.67	0.7
Magnesium as Mg	2.66	2.8
Sodium as Na	19.39	20.4
Potassium as K	0.82	1.6
Chloride as Cl	42.0	45.0
Sulphate as SO_4	1.83	3.0
Alkalinity as $CaCO_3$	1.0	0.0
Nitrate as N	0.67	0.79
Fluoride as F	0.24	0.0
TDS	117	120
pH	5.6	4.3

7. CONCLUSION

The Cedarburg Aqua borehole is drilled into a high yielding and good quality aquifer which has a very low contamination risk potential. The borehole itself is closed off from surface water inflow and is in a natural setting. This is deemed as adequate protection. The good quality groundwater and its low contamination risk potential are clearly reflected in the water chemistry. Although the water has a low pH this is not a negative characteristic of bottled water and all other parameters, including microbiological content, are within acceptable limits. Therefore the borehole and associated groundwater used by Cedarberg Aqua is approved for use as bottled water.

8. REFERENCES

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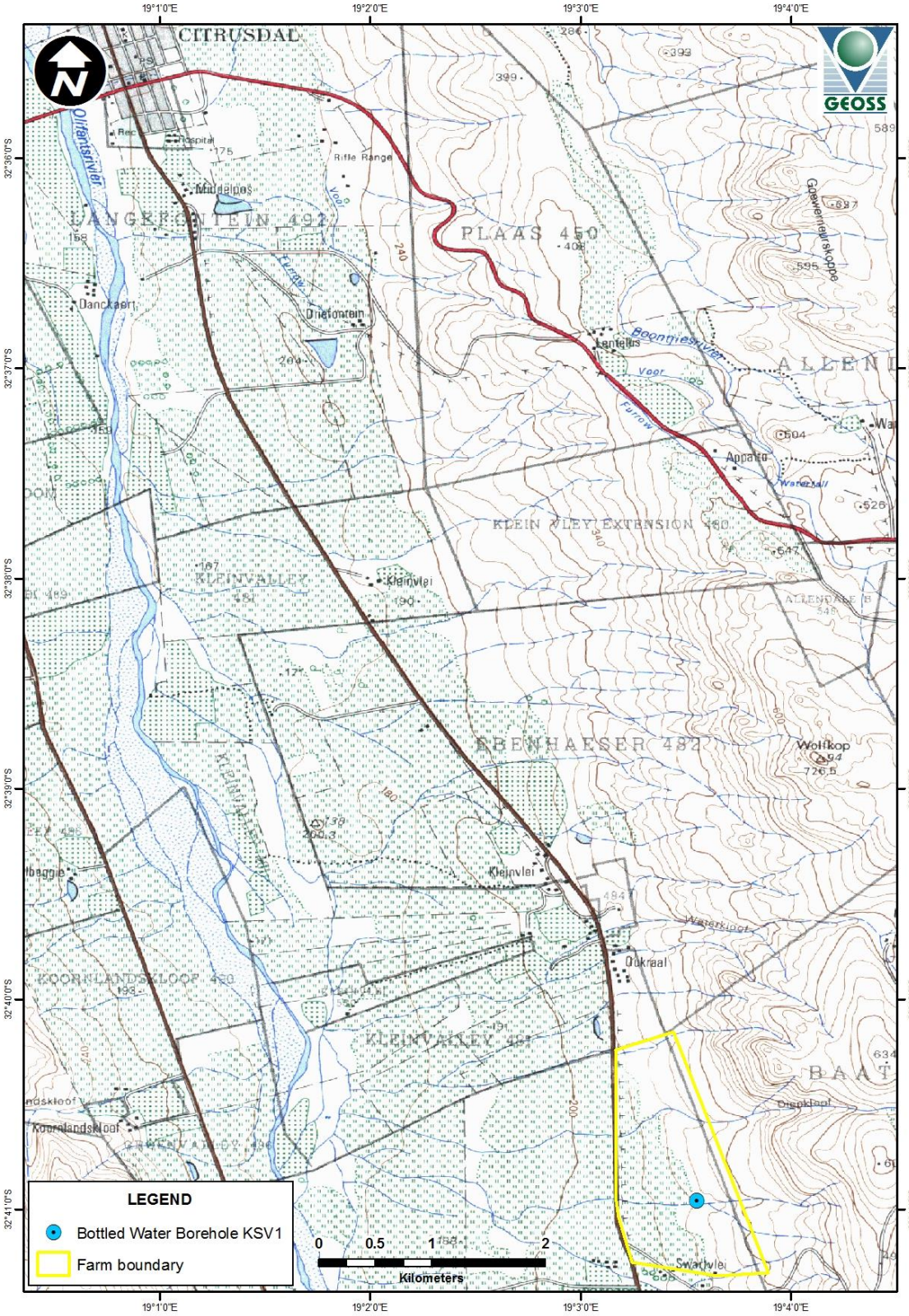
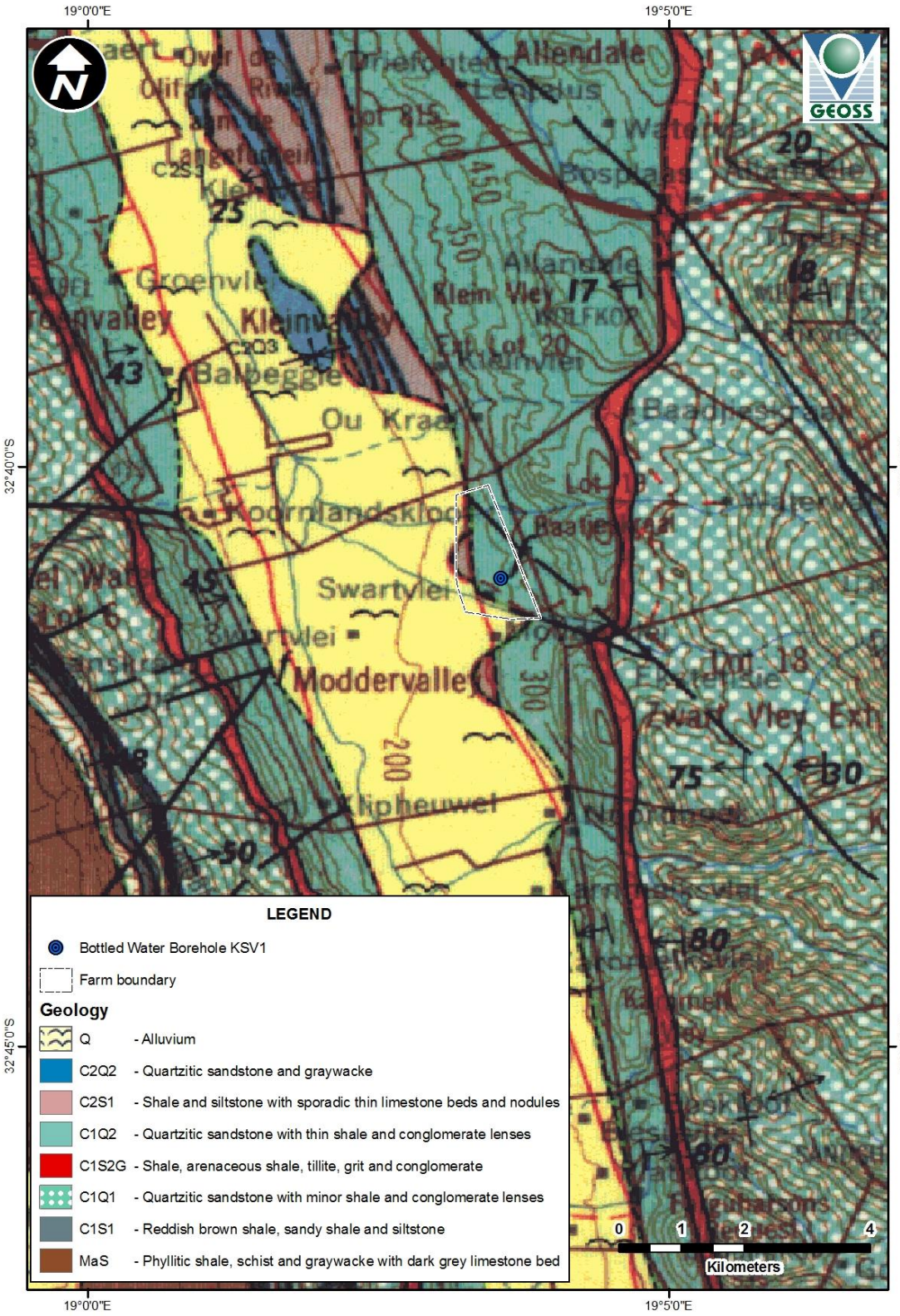
9. APPENDIX A: MAPS



Map 1: Topographical setting of the Cedarberg Aqua borehole (KSV1)

Map 2: Aerial photo of the borehole (KSV1) position.



Map 3 Geological setting of the Cedarberg Aqua borehole (KSV1)

10. APPENDIX B: LABORATORY RESULTS (BEMLAB)

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CERTIFICATE OF ANALYSES

Report Nr.: **WT005659.DOC**

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Date received: **18-04-2017**
Order nr.: **#593/F**

Sampled by client

Water Analyses Report

SANS241

Origin	Lab. Nr.	pH @ 25°C	EC @ 25°C mS/m	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Fe mg/l	Cl mg/l	SO_4 mg/l	B mg/l	Mn mg/l	Cu mg/l	Zn mg/l	P mg/l	NH_4-N mg/l	NO_3-N mg/l	*NO_2-N mg/l	*F mg/l
BH1	5659	4.3	18.8	20.4	1.6	0.7	2.8	0.1	45.0	3	<0.08	<0.03	<0.02	<0.03	<0.01	<0.28	0.79	0.05	0.0
Norm		≥5.0-≤9.7	≤170.0	≤200.0				≤2.0	≤300.0	≤500	≤2.40	≤0.40	≤2.00	≤5.00		≤1.50	≤11.00	≤0.90	≤1.5

Origin	Lab. Nr.	*TDS mg/l	Alkalinity mg/l	Al µg/l	As µg/l	Ba µg/l	Cd µg/l	Co µg/l	Cr µg/l	*Hg µg/l	Ni µg/l	Pb µg/l	Sb µg/l	Se µg/l	*U µg/l	V µg/l	*CN µg/l	Date Sampled	Temperature at reception (°C)
BH1	5659	120.0	<11.49	86.10	<5	70.0	<3.1	3.5	<27	<3.1	8.4	<7	<2	33.6	<13.8	<0.13	2.0	12/04/2017	12.9
Norm		≤1200.0		≤300.00	≤10.0	≤700.0	≤3.0		≤50.0	≤6.0	≤70.0	≤10.0	≤20.0	≤40.0	≤30.0		≤200.0		

Origin	Lab. Nr.	*Colour mg/l Pt	*Turbidity NTU	*TOC mg/l	*Cl_2 (Free) mg/l	Date Analysed
BH1	5659	<1	0.00	4.00	0.23	19/04/2017
Norm		≤15	≤5	≤10.00	≤5.00	

**** = Not SANAS Accredited***

Norms according to SANS 241-1:2015.

Statement: The reported results may be applied only to samples received. Any recommendations included with this report are based on the assumption that the samples were representative of the source from which they were taken.

Notes:

To ensure sample integrity, samples are stored only for seven days after release of the report. Thereafter it is disposed of and a fresh sample will be required if additional analyses are requested.

Results marked with "**Not SANAS Accredited**" in this report are not included in the SANAS Schedule of Accreditation for this laboratory. These results relate to the items tested.

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Opinions and interpretations expressed herein are outside the scope of SANAS accreditation.
Refer to website for uncertainty of measurement and referenced methods.
Sample condition: Samples received in good condition.

Dr. Pieter Raath
General Manager

Sandisiwe Mbula
Technical Signatory(Water chemistry)

21-04-2017
Date reported

————END OF REPORT————

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CERTIFICATE OF ANALYSES

Report Nr.: **WT005719.DOC**

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Date received: **19-04-2017**
Order nr.: **593/F**

Sampled by client

Water Analyses Report

Origin	Lab. Nr.	Total Bacteria cfu/1ml	Total Coliforms cfu/100 ml	E. coli cfu/100ml	Date Tested	Date Sampled	Temperature at reception (°C)
BH1	5719	<1	<1	<1	19/04/2017	18/04/2017	9.8

Statement: The reported results may be applied only to samples received. Any recommendations included with this report are based on the assumption that the samples were representative of the source from which they were taken.

Notes:

To ensure sample integrity, samples are stored only for seven days after release of the report. Thereafter it is disposed of and a fresh sample will be required if additional analyses are requested.

This test report shall not be reproduced except in full, without written approval of the laboratory.

Refer to website for uncertainty of measurement and referenced methods.

Sample condition: Samples received in good condition.

Dr. Pieter Raath
General Manager

Lauren Taylor
Technical Signatory(Microbiology)

21-04-2017
Date reported

————END OF REPORT————

11. APPENDIX C: PHOTO GALLERY

Photo 1: Regional setting up-gradient of the borehole

Photo 2: Secure stainless steel box surrounding the production borehole.

Photo 3: Stainless steel box, which is kept locked and secured on a concrete floor, preventing anything from falling or flowing into the production borehole. Note the sampling tap.

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