Geohydrological Impact Assessment - Calvinia Abattoir, Northern Cape.

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GEOHYDROLOGICAL AND SPATIAL SOLUTIONS INTERNATIONAL (PTY) LTD
GEOSS

21 August 2017

EXECUTIVE SUMMARY

Enviro Africa appointed GEOSS to complete a geohydrological impact assessment of Calvinia Abattoir in the town of Calvinia, Northern Cape Province. The abattoir is seeking to increase its production from 600 to 1000 sheep on site. Therefore it is required that a geohydrological assessment of the immediate area surrounding the abattoir be carried out.

The bedrock underlying the Abattoir comprises of the Tierberg formation. The Tierberg Shale consists of grey shales. The dolerite intrusions (Jurassic age) are subdivided into dykes and sills within Calvinia. Dykes are vertical or near vertical dolerite intrusions and sills are horizontal or near horizontal dolerite intrusions. The depth of the lower sills underlying Calvinia abattoir are unknown. The site is located on a fractured aquifer with a yield potential of 0.5 – 2 L/s. The regional groundwater quality has been classified as moderate with an Electrical conductivity of 70 – 300 mS/m.

Calvinia receives approximately 216 mm of rainfall per year and because it receives most of its rainfall during winter it has a Mediterranean climate. It receives the lowest rainfall in January and the highest in June. The monthly distribution of average daily maximum temperatures shows that the hottest time of the year in the area is during the months of January and February. The region is the coldest during June and July.

Calvinia Abattoir encloses and stores all effluent water on site which is then transferred via pipeline to the Waste Water Treatment Works. The groundwater is treated on site with chlorine to disinfect. It is highly unlikely that if the abattoir expands it production from 600 to 1000 sheep, that there will be any impact on groundwater quality or groundwater users in the area surrounding the site.

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ABBREVIATIONS

m	metres
mamsl	metres above mean sea level
mbch	metres below collar height
mbgl	metres below ground level
mS/m	milliSiemens per meter
mg/l	milligrams per litre
WGS84	Since the 1st January 1999, the official co-ordinate system for South Africa is based on the World Geodetic System 1984 ellipsoid, commonly known as WGS84, with the ITRF91 (epoch 1994.0) co-ordinates of the Hartebeesthoek Radio Astronomy Telescope used as the origin of this system. This new system is known as the Hartebeesthoek94 Datum.

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)].

Fractured aquifer: This is an aquifer setting in which the groundwater occurs within fine fractures within a hard rock matrix. It is also known as a secondary aquifer.

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 Geohydrological Impact Assessment - Calvinia Abattoir, Northern Cape. GEOSS Report Number: 2017/08-25. GEOSS - Geohydrological & Spatial Solutions International (Pty) Ltd. Stellenbosch, South Africa.

Cover photo:

Site overlaid onto Google Earth image

Reviewed by:

J Conrad 23 August 2017

GEOSS project number:

2017_03-2015.

1. INTRODUCTION

Enviro Africa appointed GEOSS (Geohydrological & Spatial Solutions International (Pty) Ltd) to complete a geohydrological impact assessment of Calvinia Abattoir in the town of Calvinia, Northern Cape Province. The abattoir is seeking to increase its production from 600 to 1000 sheep on site. Therefore it is required that a geohydrological assessment of the immediate area surrounding the abattoir be carried out.

A site visit was completed and the findings regarding groundwater use, vulnerability and importance are documented in this report.

2. SCOPE OF WORKS AND METHODOLOGY

The project scope of works was to complete a Geohydrological Impact Assessment of the Abattoir Site in the town of Calvinia stating if there are groundwater issues and how they should be managed.

The site is relatively small and therefore the geohydrological assessment was based on existing geohydrological information and a hydrocensus in the vicinity of the abattoir. As Calvinia depends on groundwater as a source of water and has been subject to geohydrological investigations previously, it was expected sufficient information was available and sourced so that site specific borehole drilling and testing was considered not to be necessary.

As much existing geohydrological information as possible, including information from existing reports and the National Groundwater Archive (NGA), was obtained. After analysing the gathered data and aerial photographs, a site visit was undertaken to assess conditions on the ground and conduct a hydrocensus within 1 km of the abattoir. The data was then analysed in terms of the nature and extent of groundwater resources, the degree and position of existing groundwater users and the threat posed by the landfill.

3. BACKGROUND INFORMATION

Calvinia is a small town in the Northern Cape province of South Africa, located 380 km north-east of Cape Town in the Namakwa District (**Map 1, Appendix A**).

Calvinia receives approximately 216 mm of rainfall per year and because it receives most of its rainfall during winter it has a Mediterranean climate. It receives the lowest rainfall in January and the highest in June. The monthly distribution of average daily maximum temperatures shows that the hottest time of the year in the area is during the months of January and February. The region is the coldest during June and July. The implication of the highest rainfall occurring during the winter time of the year is that more of the rainfall will become groundwater recharge due to the lower evaporation rates.

Figure 1 and **Figure 2** show the long term monthly rainfall and temperature distribution respectively.

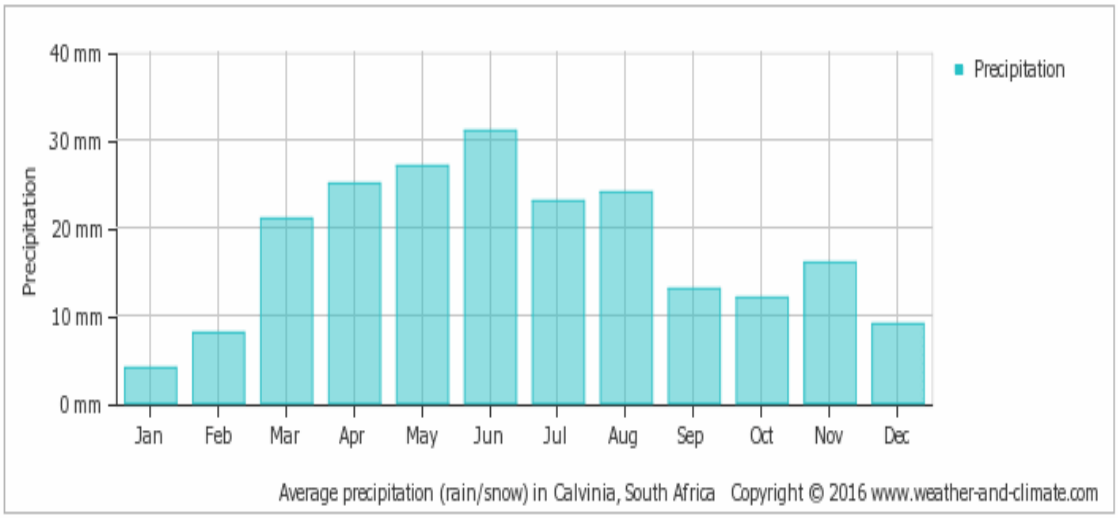


Figure 1: Average monthly rainfall Calvinia (www.weather-and-climate.com)

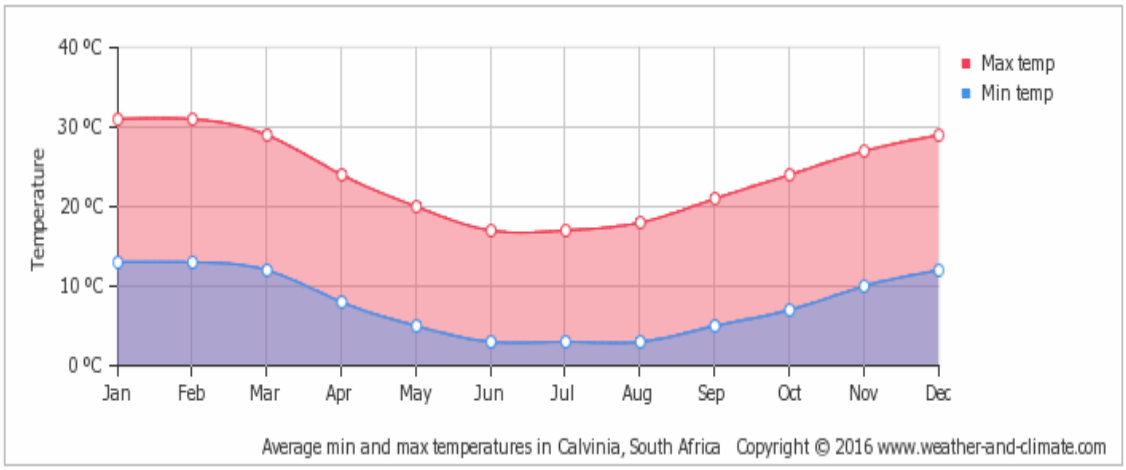


Figure 2: Average monthly temperature for Calvinia (www.weather-and-climate.com)

4. SITE GEOLOGY AND GEOHYDROLOGY

4.1 Geology

The Geological Survey of South Africa (now the Council for Geoscience (CGS)) has mapped the geology at 1:250 000 scale (3118, Calvinia). The geological setting is shown in **Map 2** (**Appendix A**) and the main geology of the area is listed in **Table 1**.

Table 1: Geological setting summary.

Code	Lithology	Formation	Group
J-d	Fine grained dolerite	Dolerite (J-d)	*Post Karoo
Pt	Thin laminated, dark-brown to grey shales	Tierberg (Pt)	Ecca

The bedrock underlying the Abattoir comprises of the Tierberg formation (Shale). (**Map 2**, **Appendix A**). The Tierberg Shale consists of grey shales, with a lower contact of 920 – 930 mamsl, and is therefore only evident in the mountainous areas around Calvinia. The upper contact is not present in the investigation area and has been mostly eroded. The dips of the sedimentary formations are generally to the east south east, but are practically zero in the study area. The dolerite intrusions (Jurassic age) are subdivided into dykes and sills within Calvinia, dykes are vertical or near vertical dolerite intrusions and sills are horizontal or near horizontal dolerite intrusions, and dolerite intrusions of. The depth of the lower sills underlying Calvinia abattoir are unknown.

4.2 Geohydrology

The regional aquifer directly underlying the abattoir is classified by the Department of Water Affairs and Forestry (DWAF 2002; now Department Water and Sanitation (DWS)) as fractured aquifer with an average borehole yield of only 0.5 – 2 L/s (**Map 3, Appendix A**).

Based on the DWAF (1998) classification the regional groundwater quality, as indicated by electrical conductivity (EC) is "moderate". The EC of the area ranges from 70 – 300 mS/m (**Map 4, Appendix A**).

The national scale groundwater vulnerability map, which was developed according to the DRASTIC methodology (DWAF, 2005), classifies the area as having a "medium" vulnerability to surface based contaminants (**Map 6**, **Appendix A**). Thus with this rating and the geological nature of the setting of the site there is a very low risk of groundwater contamination in this area.

The DRASTIC method takes into account the following factors:

D	=	depth to groundwater	(5)
R	=	recharge	(4)
A	=	aquifer media	(3)
S	=	soil type	(2)
T	=	topography	(1)
I	=	impact of the vadose zone	(5)
C	=	conductivity (hydraulic)	(3)

The number indicated in parenthesis at the end of each factor description is the weighting or relative importance at that factor.

5. FIELD PROCEDURE

As the geohydrological information mentioned above is of a very regional scale it is important to verify this information, if possible, in the field. A site visit was completed on 19th July 2017 by Mr C. Peek of GEOSS.

There were Three NGA boreholes within the one kilometre search radius surrounding the Abattoir site. None of the NGA sites could be located during the field visit as they do not exist or have been destroyed.

Five additional boreholes were located in and within the 1 km search area. The boreholes are used for domestic purposes and livestock. The borehole details are provided in **Table 2** Site photographs are presented in **Appendix B**.

Table 2: Calvinia Abattoir hydrocensus borehole details

Parameter	***Description***	
Borehole Number	BH_CA_P1 (GEOSS)	Production Borehole
Co-ordinates	31.46840 S 19.75577 E 975 mamsl	
Borehole Depth (mbgl)	?	
WL (mbgl)	Covered by base plate	
Comments	• Low yield 1000 L/hr • Water pumped into collection JoJo Tanks and used for cleaning • Equipped with pump	

Parameter	***Description***	
Borehole Number	BH_CA1(GEOSS)	Abandoned Borehole
Co-ordinates	31.468661S 19.754416E 973 mamsl	
Borehole Depth (mbgl)	?	
WL (mbgl)	7.15	
Quality	EC: 365 mS/m TDS: 2229 mg/L pH: 7	
Comments	• Not in use • Assumed to be an old windpump	

Parameter	***Description***	
Borehole Number	BH_CA_P2 (GEOSS)	Newly drilled (2017)
Co-ordinates	31.46868 S 19.75409 E 973 mamsl	
Borehole Depth (mbgl)	?	
WL (mbgl)	Covered by base plate	
Comments	• Equipped with pump but now power supply present. • Reported as very low yielding according to property owner • Drilled in Shale	

Parameter	***Description***	
Borehole Number	BH_CA2 (GEOSS)	Production Borehole
Co-ordinates	31.46862 S 19.75409 E 968 mamsl	
Borehole Depth (mbgl)	?	
WL (mbgl)	Borehole is buried underground	
Quality	EC: 365 mS/m TDS: 2336 mg/L pH: 7.5	
Comments	• Borehole is used for cleaning the factory floors • Drinking water for livestock • Waste water is channelled into drains which feed a storage tank • Waste water is pumped to WWTW	

Parameter	***Description***	
Borehole Number	BH_CA_WP1 (GEOSS)	Windpump
Co-ordinates	31.46855 S 19.75067 E 973 mamsl	
Borehole Depth (mbgl)	?	
WL (mbgl)	Covered by base plate	
Comments	• Water is piped to collection JoJo tanks, same as BH_CA_P1 • Sample not collected as main source could not be collected before been mixed into collection tanks	

Parameter	***Description***	
Borehole Number	BH_CA3 (GEOSS)	Production borehole
Co-ordinates	31.471073 S 19.10253 E 972 mamsl	
Borehole Depth (mbgl)	?	
WL (mbgl)	Borehole is buried underground	
Quality	EC: 486.3 mS/m TDS: 3112 mg/L pH: 7	
Comments	• Main production borehole • Used to clean surface on site • Used to clean animal carcass • Waste water is channelled into drains which feed a storage tank • Waste water is pumped to WWTW	

The site was inspected for any potential risks that may lead to groundwater contamination. Groundwater was found to be used to clean off carcasses, the groundwater is chlorinated on site to disinfect. Groundwater was also found to be used to clean out the holding pens. The holding pens and washing zones are within cement bunding walls. The effluent water is channelled into a storage tank where it is transferred to a Waste Water Treatment Works.

Animal remains that are unusable are disposed of on site. The remains are buried in shallow pits and lime is applied to help with the decomposition process.

6. RESULTS AND ANALYSES

Prior to the site visit, all relevant data was obtained from the Department of Water Affairs National Groundwater Archive (NGA). The borehole positions were plotted and there are no NGA sites within 1 km of the landfill site. During the site visit only one hydrocensus site was located. The borehole is however destroyed and no longer in use.

However it is important to take groundwater into consideration as the regional area is classified as a fractured aquifer with a typical borehole range of 0.5 – 2 L/s. In addition, the town is dependent on groundwater.

Groundwater samples were collected and submitted for inorganic chemical analysis to a SANAS accredited laboratory (Bemlab) in the Western Cape. The certificate of analysis for all the samples is presented in **Appendix B**.

The chemistry results obtained have been classified according to the SANS241-1: 2015 standards for domestic water. **Table 3** enables an evaluation of the water quality with regards to the various limits. **Table 4** presents the water chemistry analysis results, colour coded according to the SANS241-1: 2015 drinking water assessment standards.

Table 3: Classification table for specific limits

Acute Health
Aesthetic
Chronic health
Operational
Acceptable

Table 4: Production borehole results classified according the SANS241-1:2015

Analyses	BH-CA1	BH-CA2	BH-CA3	SANS 241-1:2015
pH (at 25 °C)	7	7,5	7	≥5 - ≤9.7 Operational
Conductivity (mS/m) (at 25 °C)	348,3	365	486,3	≤170 Aesthetic
Total Dissolved Solids (mg/l)	2229	2336	3112	≤1200 Aesthetic
Sodium (mg/l as Na)	289,4	269,6	595,1	≤200 Aesthetic
Potassium (mg/l as K)	1,6	1,6	4,3	N/A
Magnesium (mg/l as Mg)	86,8	95,2	82,3	N/A
Calcium (mg/l as Ca)	263,4	276,6	242,2	N/A
Chloride (mg/l as Cl)	770	758,4	1440	≤300 Aesthetic
Sulphate (mg/l as SO4)	225	272	266	≤250 Aesthetic ≤500 Acute Health
Nitrate Nitrogen (mg/l as N)	8,7	9,2	<0,36	≤11 Acute Health
Ammonia Nitrogen (mg/l as N)	<0,28	<0,28	1,87	≤1.5 Aesthetic
Total Alkalinity (mg/l as CaCO3)	606	513	136	N/A
Fluoride (mg/l as F)	0,8	0,7	1,4	≤1.5 Chronic Health
Manganese (mg/l as Mn)	<0,03	<0,03	0,37	≤0.1 Aesthetic ≤0.4 Chronic Health
Iron (mg/l as Fe)	0,2	0,1	0,2	≤0.3 Aesthetic ≤2 Chronic Health
Copper (mg/l as Cu)	<0,02	<0,02	<0,02	≤2 Chronic Health
Zinc (mg/l as Zn)	0,11	<0,03	<0,03	≤5 Aesthetic

The chemistry results obtained have been classified according to the DWAF (1998) standards for domestic water. **Table 5** enables an evaluation of the water quality with regards to the various parameters measured (DWAF, 1998). **Table 6** presents the water chemistry analysis results colour coded according to the DWAF drinking water assessment standards.

Table 5: Classification table for the surface water and groundwater results (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.

Table 6: Classified production borehole results

Sample Marked :	BH-CA1	BH-CA2	BH-CA3	DWA (1998) Drinking Water Assessment Guide				
				Class 0	Class I	Class II	Class III	Class IV
pH	7	7,5	7	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)	348,3	365	486,3	<70	70-150	150-370	370-520	>520
	mg/L							
Total Dissolved Solids	2229	2336	3112	<450	450-1000	1000-2400	2400-3400	>3400
Sodium (as Na)	289,4	269,6	595,1	<100	100-200	200-400	400-1000	>1000
Potassium (as K)	1,6	1,6	4,3	<25	25-50	50-100	100-500	>500
Magnesium (as Mg)	86,8	95,2	82,3	<70	70-100	100-200	200-400	>400
Calcium (as Ca)	263,4	276,6	242,2	<80	80-150	150-300	>300	
Chloride (as Cl)	770	758,4	1440	<100	100-200	200-600	600-1200	>1200
Sulphate (as SO4)	225	272	266	<200	200-400	400-600	600-1000	>1000
Nitrate& Nitrite (as N)	8,71	9,23	<0,36	<6	6.0-10	10.0-20	20-40	>40
Fluoride (as F)	0,8	0,7	1,4	<0.7	0.7-1.0	1.0-1.5	1.5-3.5	>3.5
Manganese (as Mn)	<0,03	<0,03	0,37	<0.1	0.1-0.4	0.4-4	4.0-10.0	>10
Iron (as Fe)	0,2	0,1	0,2	<0.5	0.5-1.0	1.0-5.0	5.0-10.0	>10
Copper (as Cu)	<0,02	<0,02	<0,02	<1	1-1.3	1.3-2	2.0-15	>15
Zinc (as Zn)	0,11	<0,03	<0,03	<20	>20			

From the chemical results presented in **Table 4 and Table 6** it is clear that the groundwater from the boreholes is poor quality in terms of dissolved mineral concentrations (very high dissolved mineral concentration). **It is not recommended to use the groundwater for direct human consumption without prior treatment.**

A number of chemical diagrams have been plotted for the proposed production borehole groundwater samples and these are useful for chemical characterisation of the water. The chemistry of the sample has been plotted on a tri-linear diagram known as a Piper diagram (**Figure 3**). This diagram indicates the distribution of cations and anions in separate triangles and then a combination of the chemistry in the central diamond. Water with similar chemical signatures will plot in close proximity to one another on the diagram.

From **Figure 3** (central diamond) the production borehole groundwater samples are classified as having a sodium – chloride (BH-CA3) and calcium - chloride hydrofacies.

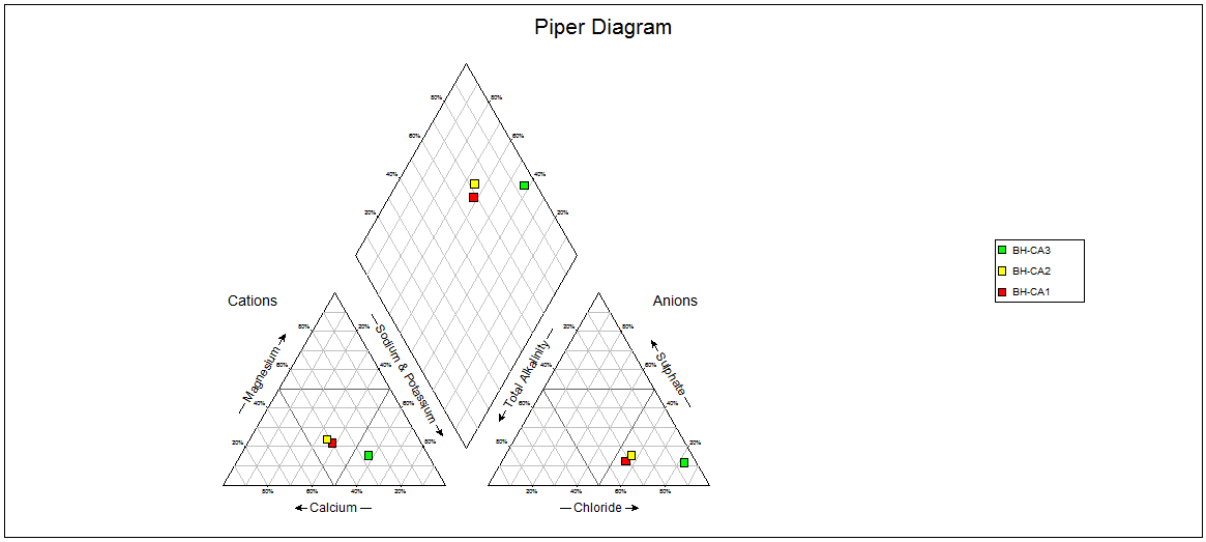


Figure 3: Piper diagram of the production borehole groundwater samples

The Stiff diagram is a graphical representation of the relative concentrations of the cations (positive ions) and anions (negative ions). This diagram shows concentrations of cations and anions relative to each other (not as a percentage as with Piper) and direct reference can be made to specific salts in the water. The Stiff diagram for the samples from the production boreholes are shown in **Figure 4**. From the shape of the Stiff diagram the major ions present in the water can be compared. It is clear that the groundwater samples collected are dominated by Na+K/Ca and Cl and that the groundwater has a high dissolved mineral concentration.

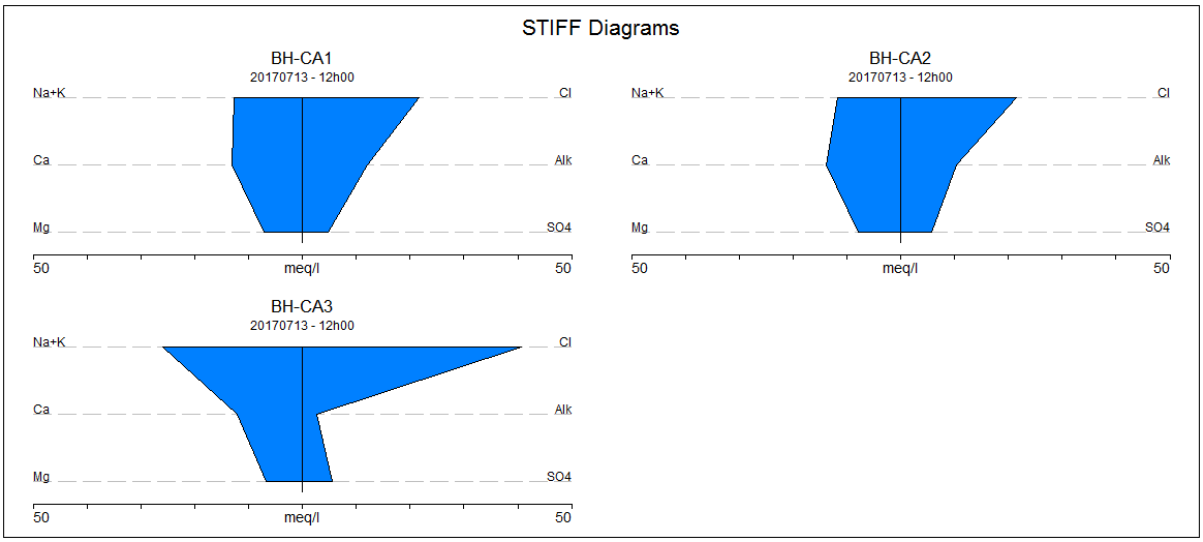


Figure 4: Stiff diagram of the production borehole groundwater samples

Microbiological samples were collected for three boreholes. In terms of the microbiological analysis the groundwater had no detectable E.coli and low counts of total coliform bacteria. The total bacteria count is elevated and above the recommended limit. It is not uncommon for groundwater to have natural bacteria present. It can be concluded that the source of the bacteria is not likely to be from any faecal contamination due to the low total coliform bacteria count and the groundwater had no detectable E.coli.

7. DISCUSSION

7.1 Assumptions

No new boreholes were drilled as part of this study, so existing boreholes and maps were used to obtain an understanding of the groundwater in the area. The geological conditions on site were assessed and they are heterogeneous across the study area. The Calvinia Abattoir Site is situated on rocks from the Ecca Group which is generally known to be associated with poor groundwater conditions in terms of yield and quality.

Although the groundwater occurs in a fractured aquifer setting, it is assumed that within this fracture network the groundwater depths and quality are relatively homogeneous at the study site. It is assumed there is no groundwater contribution to surface water flows.

7.2 Gaps in knowledge

As this study did not include the drilling of new boreholes and pumping test on existing borehole, the groundwater conditions and aquifer characteristics exactly at the site are not known. The exact depth to groundwater and quality is not known beneath and immediately adjacent to the site as the production borehole was covered and no water level could be obtained. However, these issue do not prevent the reaching of a sound recommendation.

7.3 Current geohydrological conditions

The nature of the geology and the relatively low rainfall and recharge rates; result in it being highly unlikely that any surface-based contamination will reach the groundwater.

The national groundwater vulnerability index indicates that the area has a "medium" vulnerability to surface based contaminants. Thus with this rating and the geological nature of the setting of the site there is a very low risk of groundwater contamination in this area.

The results obtained are meaningful and enable the reaching of a high confidence recommendation with regard to the potential impact of the landfill on the groundwater of the area.

8. CONCLUSION

The Calvinia abattoir upgrade will not have any impact in the groundwater resources in the area and it will not impact on the groundwater quality of the production borehole on site or neighbouring farms. A high level of confidence is associated with this conclusion.

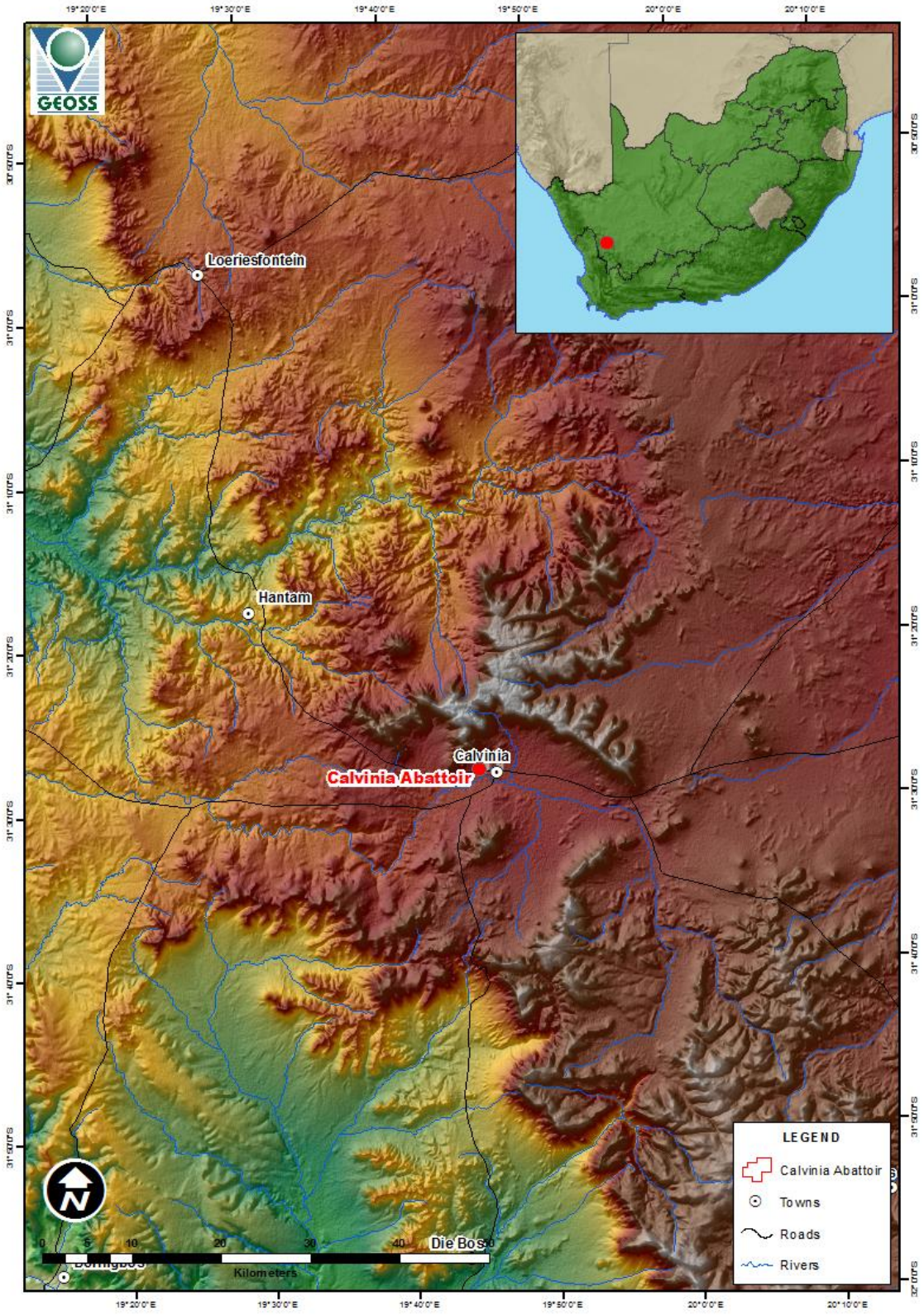
9. REFERENCES

DWAF, 1998. Quality of domestic water supplies, Volume 1: Assessment guide. Department of Water Affairs and Forestry, Department of Health, Water Research Commission, 1998.

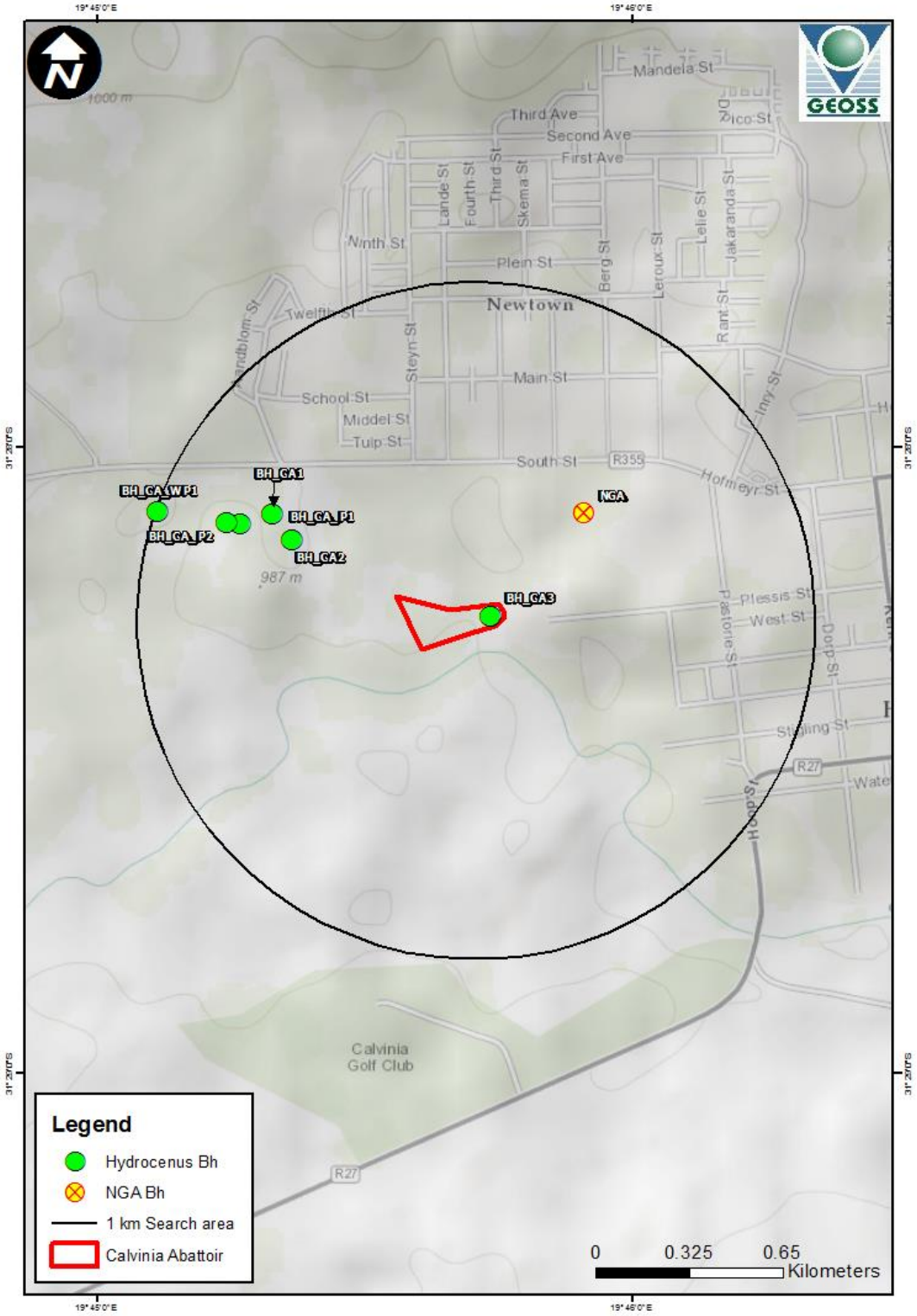
DWAF, 2005. Groundwater Resource Assessment – Phase II (GRAII). Department of Water Affairs and Forestry. Pretoria.

National Water Act, 1998. The National Water Act, No 36. Department of Water Affair and Forestry. Pretoria.

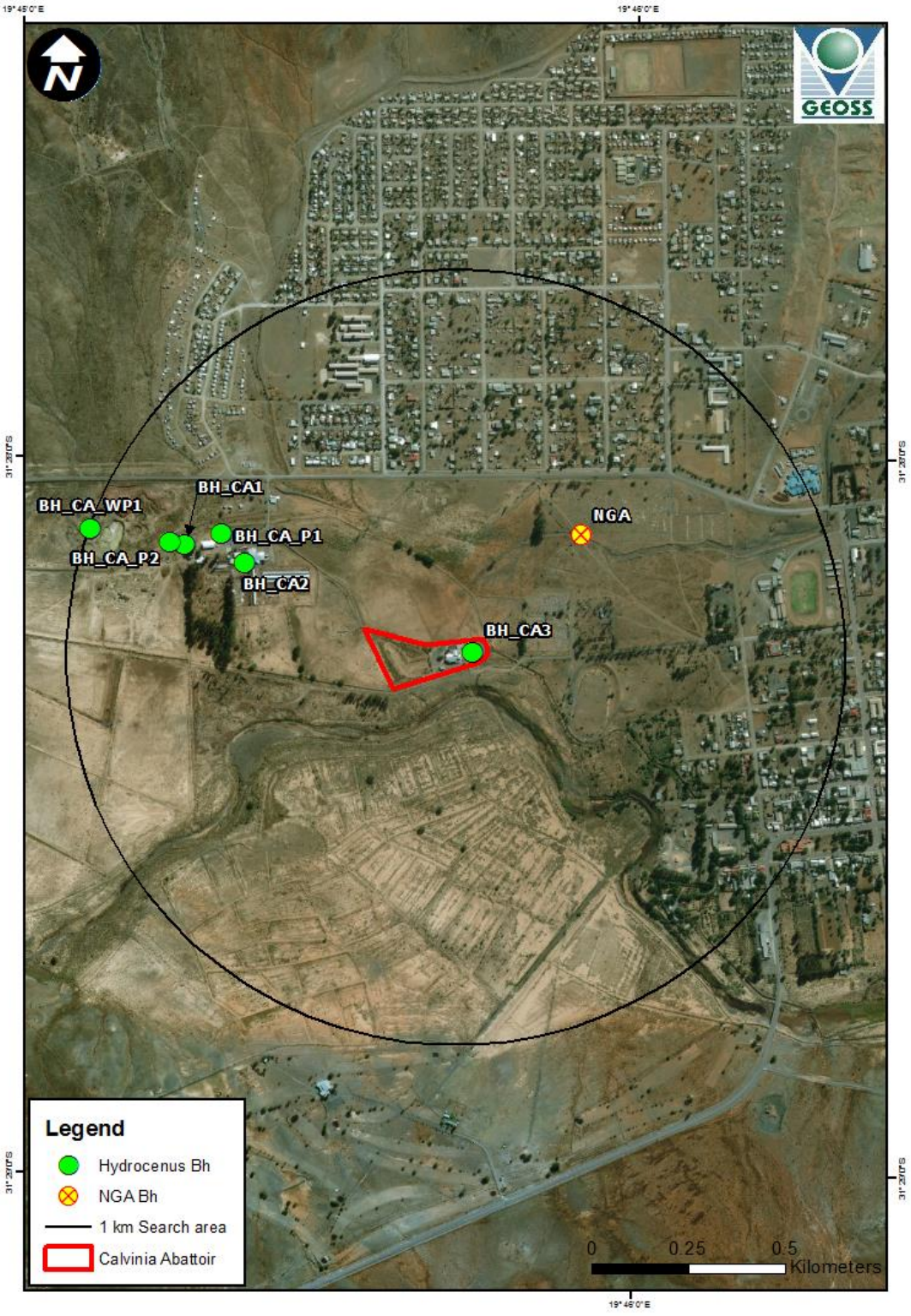
APPENDIX A: MAPS



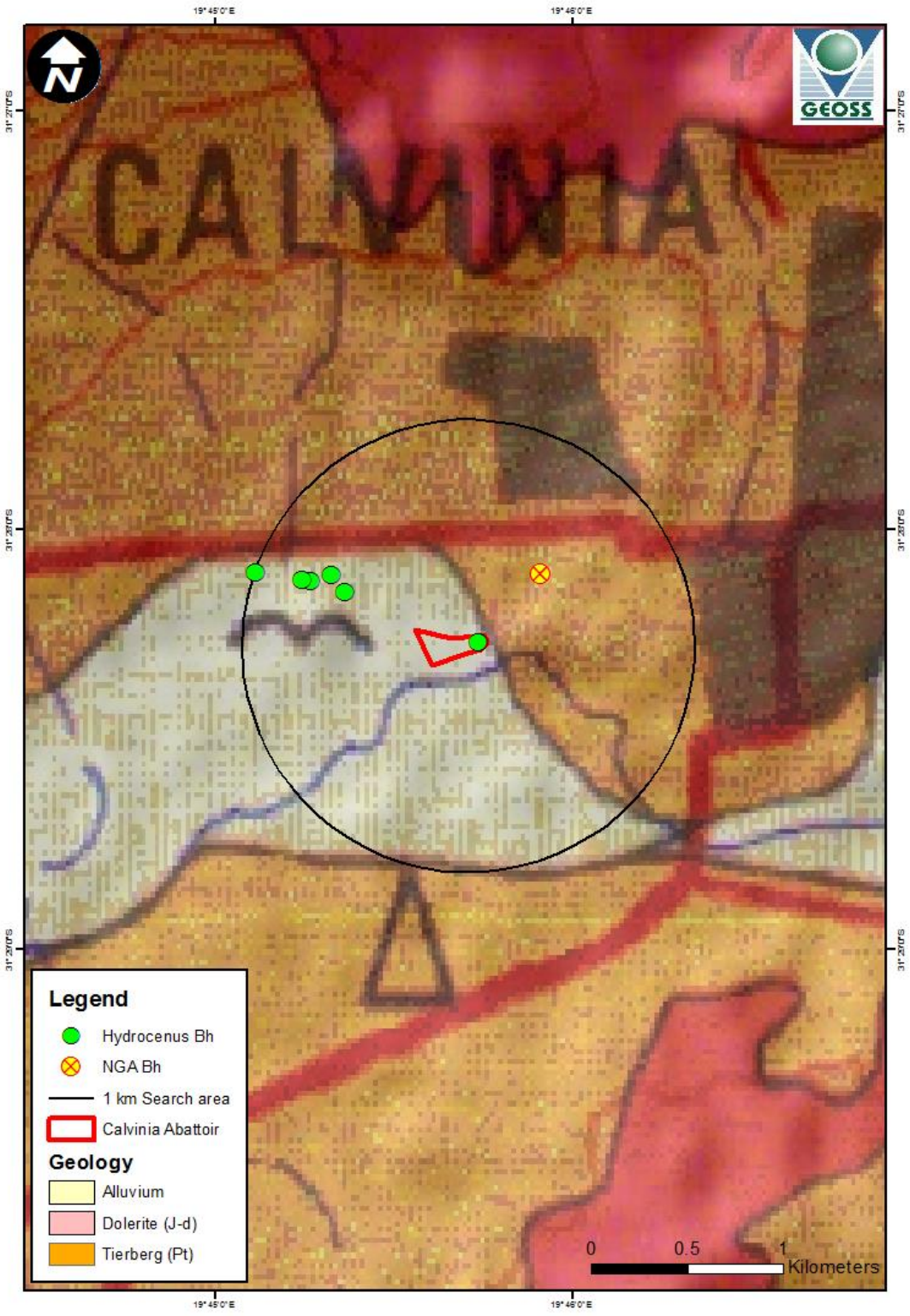
Map 1: Location of the study area (Calvinia Abattoir) within a regional setting



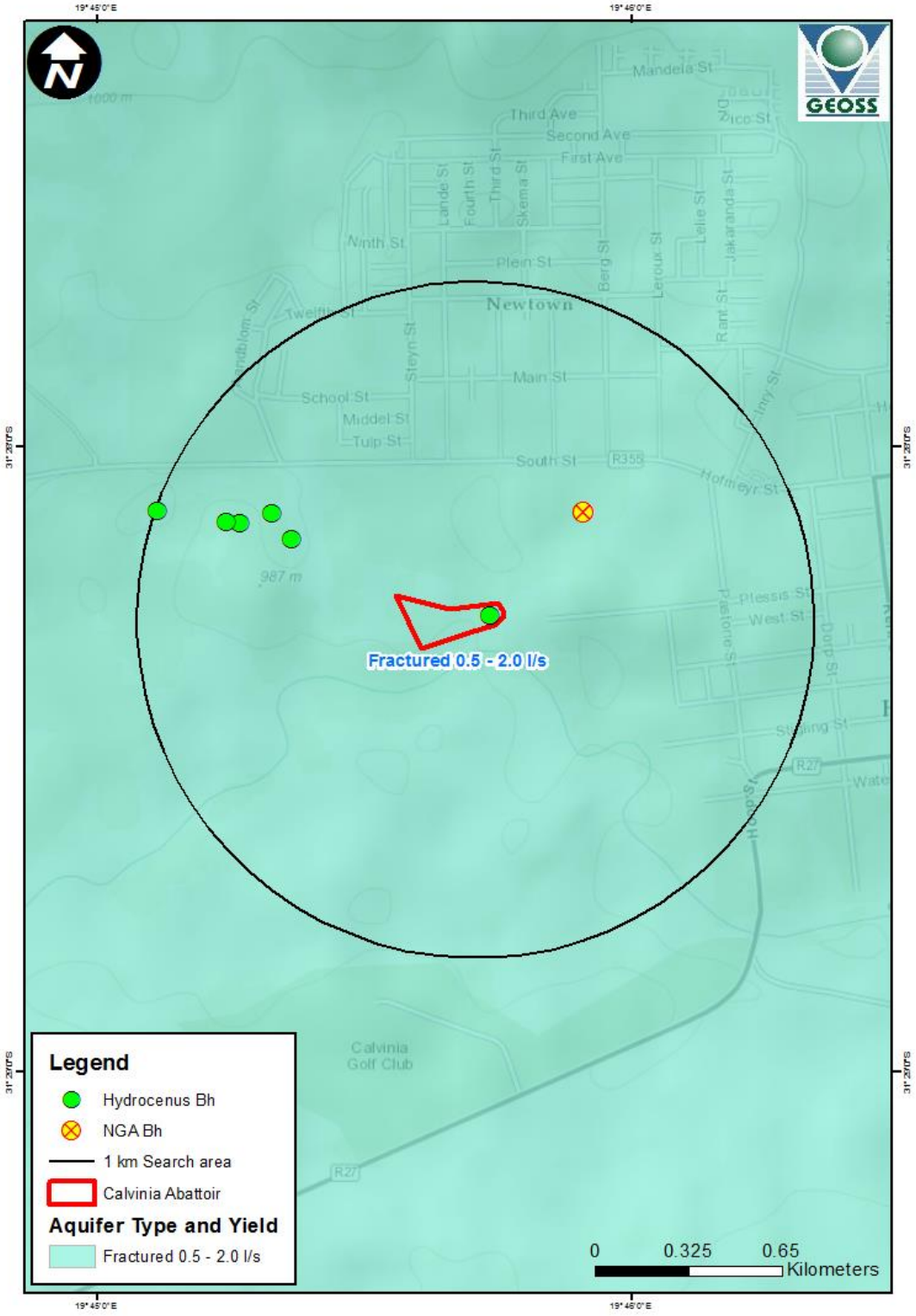
Map 2: Calvinia Abattoir with hydrocensus boreholes superimposed on a topocadastral map.



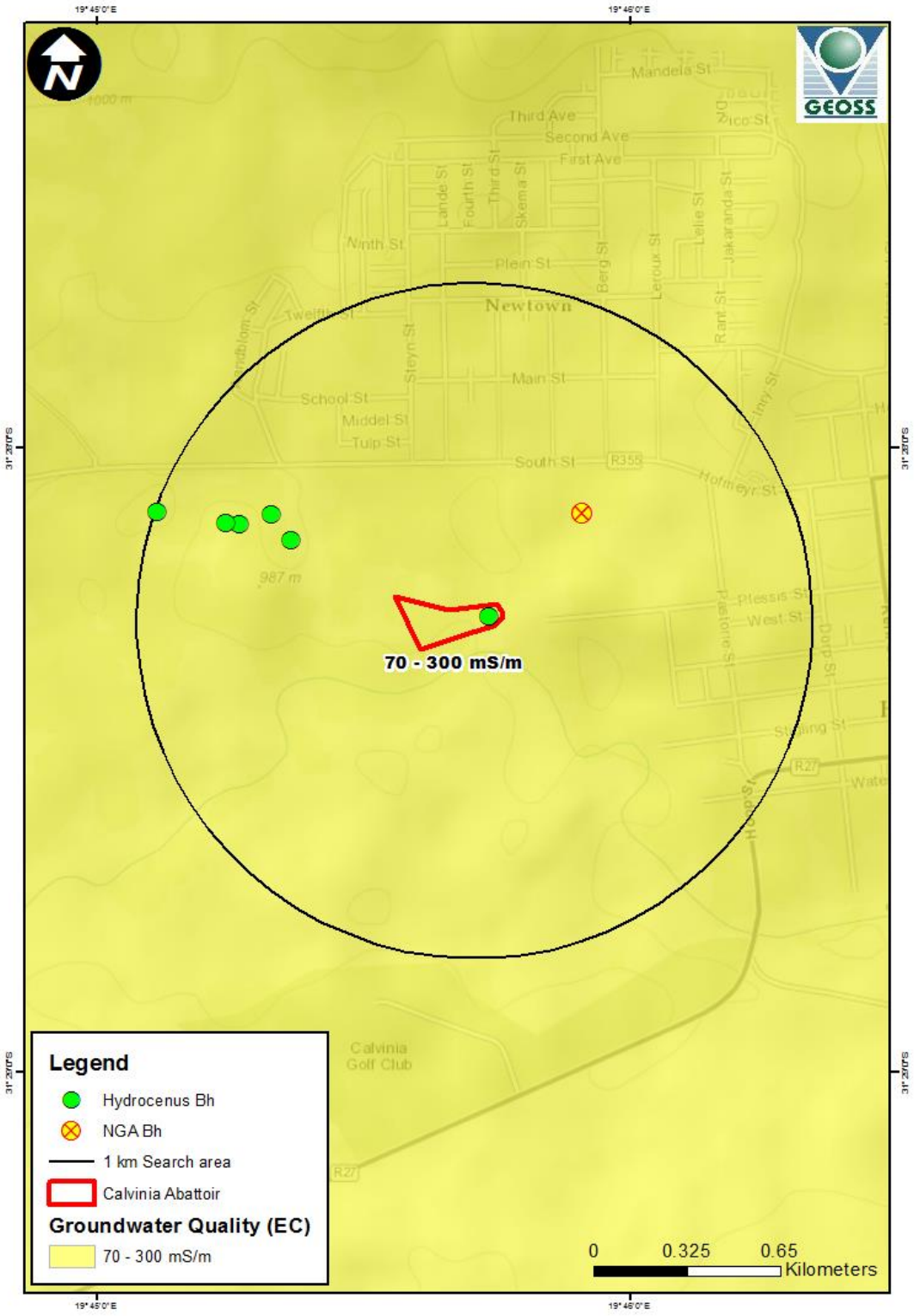
Map 3: Calvinia Abattoir with hydrocensus boreholes superimposed on an aerial photograph of the area.



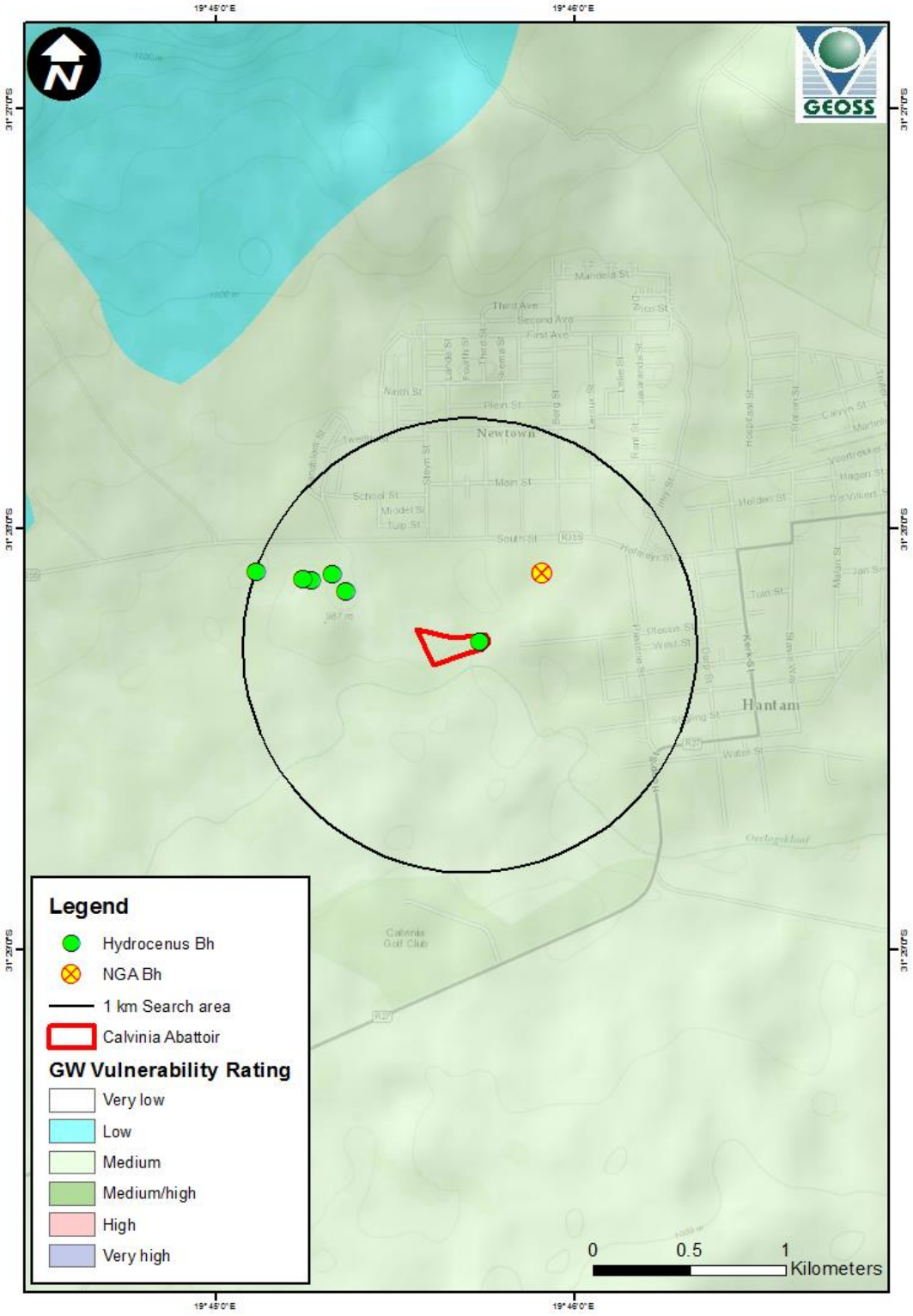
Map 4: Geological setting of the Calvinia Abattoir (Council for Geoscience 1: 250 000 Geological Sheet, 3118 Calvinia)



Map 5: Aquifer type and yield of the region with hydrocensus boreholes (Department of Water Affairs and Forestry 1: 500 000 Hydrogeological map sheets, 3117 Calvinia)



Map 6: Groundwater quality of the region, as indicated by EC, with hydrocensus boreholes (Department of Water Affairs and Forestry 1: 500 000 Hydrogeological map sheets, 3117 Calvinia)



Map 7: Regional groundwater vulnerability (calculated according to the DRASTIC methodology) and boreholes (DWAF, 2005).

APPENDIX B: PHOTO GALLERY

Photo 1: BH_CA_P1

Photo 2: BH_CA1

Photo 3: BH_CA_P2

Photo 4: BH_CA_WP1

Photo 5: BH_CA2, Buried underground

Photo 6: Collection JoJo tanks

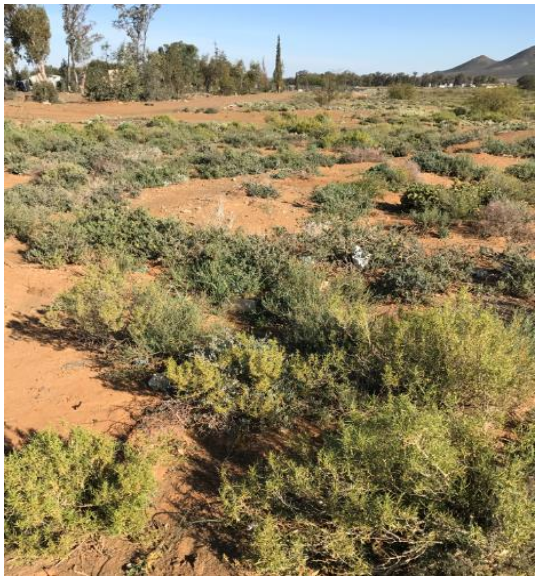


Photo 7: NGA site, no borehole

Photo 8: BH_CA3, Buried underground and sampled at tap.

APPENDIX C: GROUNDWATER QUALITY RESULTS

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Vat Reg. Nr. 4200161414

CERTIFICATE OF ANALYSES

Report Nr.: **WT010443.DOC**

Julian Conrad
GEOSS (Pty) Ltd
Unit 19, Technostell Building
9 Quantum Street, Technopark
Stellenbosch
7600

Date received: **17-07-2017**
Order nr.: **2015**

Sampled by client

Water Analyses Report

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	CO_3^{2-} mg/l	HCO_3^- 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	*F mg/l
BH-CA1	10443	7.0	348.3	289.4	1.6	263.4	86.8	0.2	770.0		459.2	225	0.33	<0.03	<0.02	0.11	0.02	<0.28	8.71	0.8
BH-CA2	10444	7.5	365.0	269.6	1.6	276.6	95.2	0.1	758.4		353.7	272	0.26	<0.03	<0.02	<0.03	0.01	<0.28	9.23	0.7
BH-CA3	10445	7.0	486.3	595.1	4.3	242.2	82.3	0.2	1440.0		166.0	266	0.76	0.37	<0.02	<0.03	<0.01	1.87	<0.36	1.4

Origin	Lab. Nr.	*TDS mg/l	Alkalinity mg/l	Date Sampled	Temperature at reception (°C)	Date Analysed
BH-CA1	10443	2229.0	606.00	13/07/2017	13.3	18/07/2017
BH-CA2	10444	2336.0	513.00	13/07/2017	13.7	18/07/2017
BH-CA3	10445	3112.0	136.00	13/07/2017	13.5	18/07/2017

**** = Not SANAS Accredited***

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.

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

CO_3^{2-} analysis only applicable in case of pH > 7.5.

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)

21-07-2017
Date reported

————END OF REPORT————

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Vat Reg. Nr. 4200161414

CERTIFICATE OF ANALYSES

Report Nr.: **WT010327.DOC**

Julian Conrad
GEOSS (Pty) Ltd
Unit 19, Technostell Building
9 Quantum Street, Technopark
Stellenbosch
7600

Date received: **13-07-2017**
Order nr.: **#2015**

Sampled by client

Water Analyses Report

Origin	Lab. Nr.	Total Bacteria cfu/1ml	Total Coliforms cfu/100 ml	E. coli cfu/100ml	Faecal Coliforms cfu/100ml	Date Tested	Date Sampled	Temperature at reception (°C)
BH_CA1	10327	1810	1076	<10	<10	13/07/17	12/07/2017	13.3
BH_CA2	10328	180	<10	<10	<10	13/07/17	12/07/2017	13.9
BH_CA3	10329	69	63	<10	<10	13/07/17	12/07/2017	12.7

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.

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Refer to website for uncertainty of measurement and referenced methods.

Sample condition: Water sample temperatures were higher than 10°C.

Less than 200ml of the sample was received by Bemlab

Dr. Pieter Raath
General Manager

Lauren Taylor
Technical Signatory(Microbiology)

18-07-2017
Date reported

————END OF REPORT————

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