GROUNDWATER STUDY

Glass Bottle Manufacturing Plant - Vereeniging

Prepared for: The South African Breweries (Pty) Limited (SAB)

SLR Environmental Consulting (Namibia)(Pty)Ltd

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EXECUTIVE SUMMARY

The South African Breweries (Pty) Limited (SAB) is proposing to develop and operate a glass bottle manufacturing plant on Portion 238 (a portion of Portion 149) of the Farm Leeuwkuil 596 IQ. The site is located within the Emfuleni Local Municipality in Vereeniging, Gauteng Province.

In order for the proposed glass bottle manufacturing plant to go ahead, SAB must obtain environmental authorisation, a waste management licence and an atmospheric emissions licence. A Scoping and Environmental Impact Assessment (S&EIA) process, in terms EIA Regulations 2014, is required to inform an environmental authorisation and a waste management licence decision from the Gauteng Department of Agriculture and Rural Development.

The groundwater investigation, supporting the S&EIA process, was carried out based on the following scope of work:

- Desktop assessment of hydrogeological information available for the site;
- Drilling of two monitoring boreholes for aquifer characterisation;
- Pumping tests to determine aquifer parameters;
- Groundwater sampling and quality analysis; and data interpretation and reporting.

The two monitoring boreholes Bh3 and Bh4 were drilled to 50m and 45m depths and intersected quartzite and shale of the Vryheid Formation of the Ecca Group (Karoo). The underlying dolomite of the Malmani Subgroup was not intersected. Test pumping of the two monitoring boreholes confirmed the moderate aquifer potential of the Vryheid Formation sediments.

Both boreholes are moderately yielding with Bh3 and Bh4 being pump tested at 2.6m^3/h and 3.0m^3/h, respectively. In addition, the up to 15 m thick Tertiary alluvial cover, comprising gravel and clay, forms a low permeable layer protecting the Karoo aquifer from pollution.

The water quality results of the groundwater samples from borehole Bh3 and Bh4 were compared to the relevant water quality guidelines and the results indicate the following: Water quality parameters assessed were within the SANS 241:2015 water quality guidelines expect for Al and Fe, which exceeded the operational and aesthetic limits respectively. Nitrate concentration in Bh4 was equal to the SANS 241:2015 acute health water quality guideline at which level it poses an immediate, unacceptable health risk.

The above findings confirm the classification of the Isanti project area by Conrad et al. 1999, as an area underlain by a moderately-yielding aquifer system of variable water quality. The area is classified as 'least vulnerable area' that is only vulnerable to conservative pollutants in the long term when continuously discharged or leached; according to the classification, the aquifer at the Isanti project site also has 'low' susceptibility.

The risk of groundwater contamination was deemed to be medium when left unmanaged and low when the following recommended management practices were applied:

- the boreholes drilled during the current investigation be monitored on a regular basis to establish the groundwater quality upstream (Bh3) and downstream (Bh4) of the site;
- Plant effluent to be treated on site to meet appropriate discharge standards prior to being pumped to the municipal Waste Water Treatment Works located south of the site;
- Engineered containment of process areas, sewage treatment plants, vehicle maintenance areas, and fuel and oil storage areas; Spill containment and clean-up kits available at each of these facilities;
- Storage and handling of potential contaminant sources to be restricted to designated areas; and
- Regular and effective training of employees who handle these potential contaminants.

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ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Description
EIA	Environmental Impact Assessment
GDARD	Gauteng Department of Agriculture and Rural Development
NEMA	National Environmental Management Act, 1998
SACNASP	South African Council for Natural Scientific Professions
SDT	Step Drawdown Test
SANS	South African National Standards
SAB	South African Breweries (Pty) Limited
DWS	Department of Water and Sanitation (formerly DWA)
CDT	Constant Discharge Rate Test
mbgl	meters below ground level
SLR	SLR Consulting (South Africa) (Pty) Ltd
S&EIA	Scoping and Environmental Impact Assessment
NEMA	National Environmental Management Act, 1998
NEM:WA	National Environmental Management Waste Act, 2008

1. INTRODUCTION

The South African Breweries (Pty) Limited (SAB), with majority (>51%) Black owned partner(s), is proposing to develop and operate a glass bottle manufacturing plant on Portion 238 (a portion of Portion 149) of the Farm Leeuwkuil 596 IQ. The property is owned by SAB and borders Lager Avenue, the R59 and R28 roads. The site is located within the Emfuleni Local Municipality in Vereeniging, Gauteng Province. Refer to Figure 1-3 for the local setting of the project.

In order for the proposed glass bottle manufacturing plant to go ahead, SAB must obtain environmental authorisation, a waste management licence and an atmospheric emissions licence. A Scoping and Environmental Impact Assessment (S&EIA) process, in terms EIA Regulations 2014, is required to inform an environmental authorisation and a waste management licence decision from the Gauteng Department of Agriculture and Rural Development in terms of section 24(5) of the National Environmental Management Act (NEMA) (No. 107 of 1998) and the National Environmental Management Waste Act (NEMWA) (No. 59 of 2008) respectively.

SLR Consulting (South Africa) (Pty) Ltd (SLR), an independent firm of environmental consultants, has been appointed to manage the S&EIA process and conduct the public participation process in support of this application. SLR appointed a hydrogeologist to undertake a groundwater study for the project.

This report details the technical specialist groundwater study to support the S&EIA for the construction and operation of the proposed facility.

1.1 PROJECT DESCRIPTION

SAB utilizes a large volume of glass bottles for the beer they produce and distribute. SAB, with a majority (>51%) Black owned partner(s), is intending to enter the glass bottle manufacturing industry in order to transform its glass bottle procurement spend, while at the same time providing a unique opportunity for new Black economic entrant(s). The annual production target would be approximately 290 000 tons of glass bottles.

The proposed glass bottle manufacturing plant would produce green and amber coloured bottles. The facility would comprise a batch plant, main manufacturing building and warehouse. The conceptual process flow diagram of the proposed project is illustrated in

Figure 1-1 below.

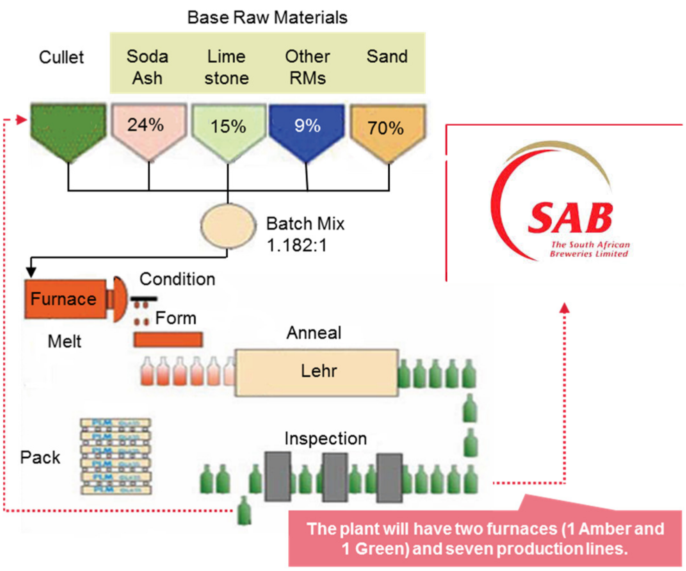

Figure 1-1: Conceptual Process

1.1.1 BATCH PLANT

The batch plant building would have a footprint of approximately 2 100 m^2 and would be used to receive, store and mix the various raw materials required in glass manufacture. The key raw materials are sand, soda ash and limestone, with a number of other raw materials also required. These would be delivered by truck. The raw materials are stored in a variety of silos, hoppers and bunds, before being mixed according to specific recipes for each glass product. Once mixed, the raw material batches would be conveyed across to the main manufacturing building.

1.1.2 MAIN MANUFACTURING BUILDING

The main manufacturing building (see Figure 1-2 below) would comprise a single large covered hall, approximately 45 000 m^2 in extent. The building consists of three areas (named the Furnace, Hot End and Cold End areas) in which, the glass is melted, formed into bottles and inspected for quality and defects.

Figure 1-2: Proposed Main Manufacturing Building

Furnaces

The two furnaces at the proposed plant would utilise natural gas or Liquid Petroleum Gas (LPG) as a heat source. The facility would have a green glass furnace with the capacity to melt 390 metric tons per day (mtpd). This furnace would feed to three bottle manufacturing lines. The amber glass furnace, with a capacity to melt 530 mtpd, would feed to four bottle manufacturing lines. In the furnace the raw materials would be melted into glass at temperatures of up to 1 530°C and degassed. Emissions from the furnaces would be cleaned in order to comply with the minimum emissions standards and released via a stack.

Hot end

In the Hot End the molten glass would be channelled to a series of glass forming machines that cool and meter the glass before using mechanical and pneumatic means to create the specific glass containers. The bottles would be hot end coated to enhance surface resistance and cooled in an annealing oven in a controlled manner, so as to avoid internal stresses.

Cold End

At the Cold End the bottles would be further coated and then subject to inspection for defects by high precision equipment that measure capacity, dimensions, impact, pressure resistance and other tests. Bottles that do not meet specifications would be crushed and conveyed back to the furnaces where the cullet is re-used in the raw material mix. Completed bottles would be packaged by automated palletizers and moved to the warehouse for storage and distribution.

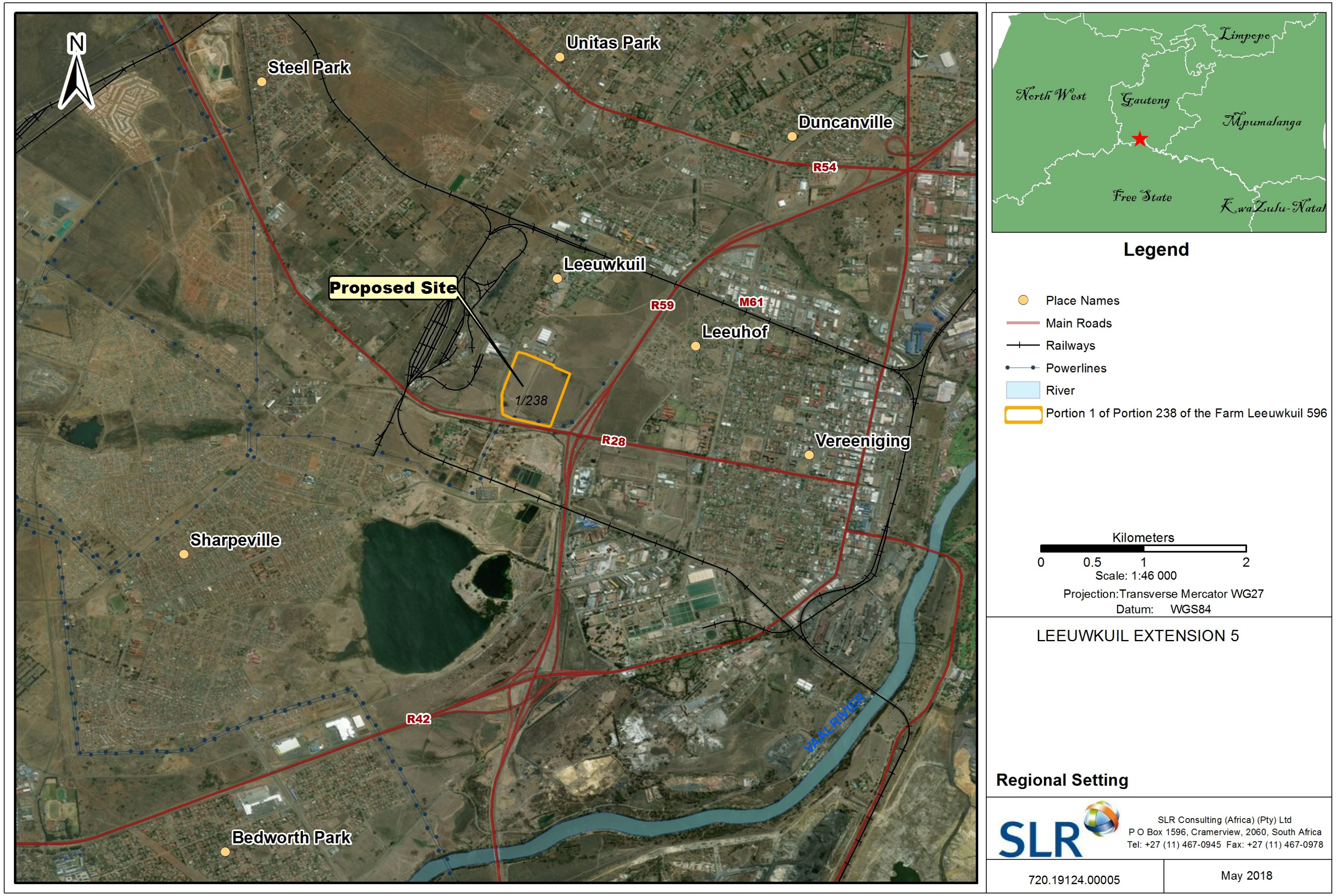

Figure 1-3: Local Setting

1.1.3 WAREHOUSE

The warehouse building would have an area of approximately 40 000 m^2. Storage of the bottles would be in plastic wrapped, bulk pallets up to three pallets high. Pallets would be mobilized using single or dual fork lifts and loaded onto trucks for distribution to customers. A further 40 000 m^2 will be developed adjacent to the warehouse. This concreted area will be utilised for vehicle parking and configuration, pallet stockpiling and other such activities.

General and hazardous waste would be temporarily stored in designated areas and disposed of at an off-site waste disposal facility by a third-party contractor.

1.1.4 SUPPORT SERVICES

Support services associated with the proposed project would include an office building, canteen and gate house. The facility would also have a gas station to regulate gas supply, a diesel fuel oil storage facility for back-up furnace fuel, diesel generators for emergency electricity supply and emergency water storage.

1.2 DETAILS OF SPECIALIST

Gwendal Madec of SLR Environmental Consulting (Namibia) (Proprietary) Limited prepared this groundwater study report. The report review was done by Arnold Bittner. Both are professional scientists registered with the South African Council for Natural Scientific Professions. The details of the report authors are provided in Table 1-1 below. Curriculum Vitae are provided in Appendix A.

Table 1-1: Details of Report Authors

Details	Project manager, author	Reviewer
Name	Gwendal Madec	Arnold Bittner
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Key qualifications	MSc Geology	MSc Geology
Experience	17 Years	26 Years
Professional registration	SACNASP, Pr.Sci.Nat; Registration No. 400225/10	SACNASP, Pr.Sci.Nat; Registration No. 400072/99

1.3 DECLARATION

I, Gwendal Madec hereby declare that I am an independent consultant, who has no interest or personal gains in this proposed project whatsoever, except receiving fair payment for rendering an independent professional service.

1.4 ENVIRONMENTAL LEGISLATION

This report has been compiled in compliance with the requirements specified in Appendix 6 of the Environmental Impact Assessment Regulations (R982 of 2014, as amended) published in terms of the NEMA, as outlined in Table 1-2 below.

Table 1-2: NEMA report requirements

REQUIREMENT 1.(1) A specialist report must contain:	REFERENCE IN THIS REPORT
(a) details of- (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Section 1
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Section 1
(c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 2
(cA) an indication of the quality and age of base data used for the specialist report;	Section 4
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 4
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 4
(f) Details of an assessment of the specific identified sensitivities of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	n/a
(g) an identification of any areas to be avoided, including buffers;	n/a
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	n/a
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5 and 6
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 7
(k) any mitigation measures for inclusion in the EMPr;	Section 7
(I) any conditions for inclusion in the environmental authorisation;	Section 7
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 8
(n) a reasoned opinion- (i) as to whether the proposed activity or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; And (ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 9
(o) a description of any consultation process that was undertaken during the	n/a

REQUIREMENT 1.(1) A specialist report must contain:	REFERENCE IN THIS REPORT
course of preparing the specialist report;	
(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	n/a
(q) any other information requested by the competent authority.	n/a

2. SCOPE OF WORK

The objective of the groundwater study was to address some of the requirements for the S&EIA for the proposed project. SLR has undertaken the following work as part of this assessment:

- Determine the aquifer characteristics on site;
- Construct future groundwater monitoring points; and
- Determine the risks to groundwater that may be associated with the proposed project.

The scope of work undertaken to complete the objectives include the following:

- Desktop assessment of hydrogeological information available for the site;
- Drilling of two (2) boreholes for aquifer characterisation and to serve as future groundwater monitoring points;
- Pumping tests (step drawdown tests and constant discharge rate tests) to determine aquifer parameters;
- Groundwater sampling and quality analysis; and
- Data interpretation and reporting.

3. PHYSIOLOGY

3.1 GEOGRAPHICAL SETTING

3.1.1 Topography and drainage

The proposed project area is located between 1460 – 1440 m amsl, which generally slopes to the south-east. The site and surrounding areas feature a network of man-made drainage channels / drainage features to manage storm water and prevent localised ponding and flooding.

3.1.2 Climate

The town of Vereeniging is situated in a warm temperature summer-rainfall region, with very dry winters and frequent frosts. Vereeniging receives approximately 559 mm of rainfall per annum and has a mean annual evaporation of 1259 mm. Most of the rainfalls occur during the summer months, October to March (peaking in December/January) and the lowest in the month of May to September. The average monthly midday temperatures for Vereeniging range from 17 °C in June to 27.6 °C in January.

3.2 GEOLOGY OF THE VEREENIGING AREA

3.2.1 Regional geology

The northern part of South Africa and particularly the greater Gauteng Province is geologically defined by the Transvaal Supergroup as illustrated in the following figure (Figure 3-1) and is an end Archean-earliest Proterozoic platform succession developed on the Kaapvaal Craton, spanning the approximate period of 2.65-2.05 Ga.

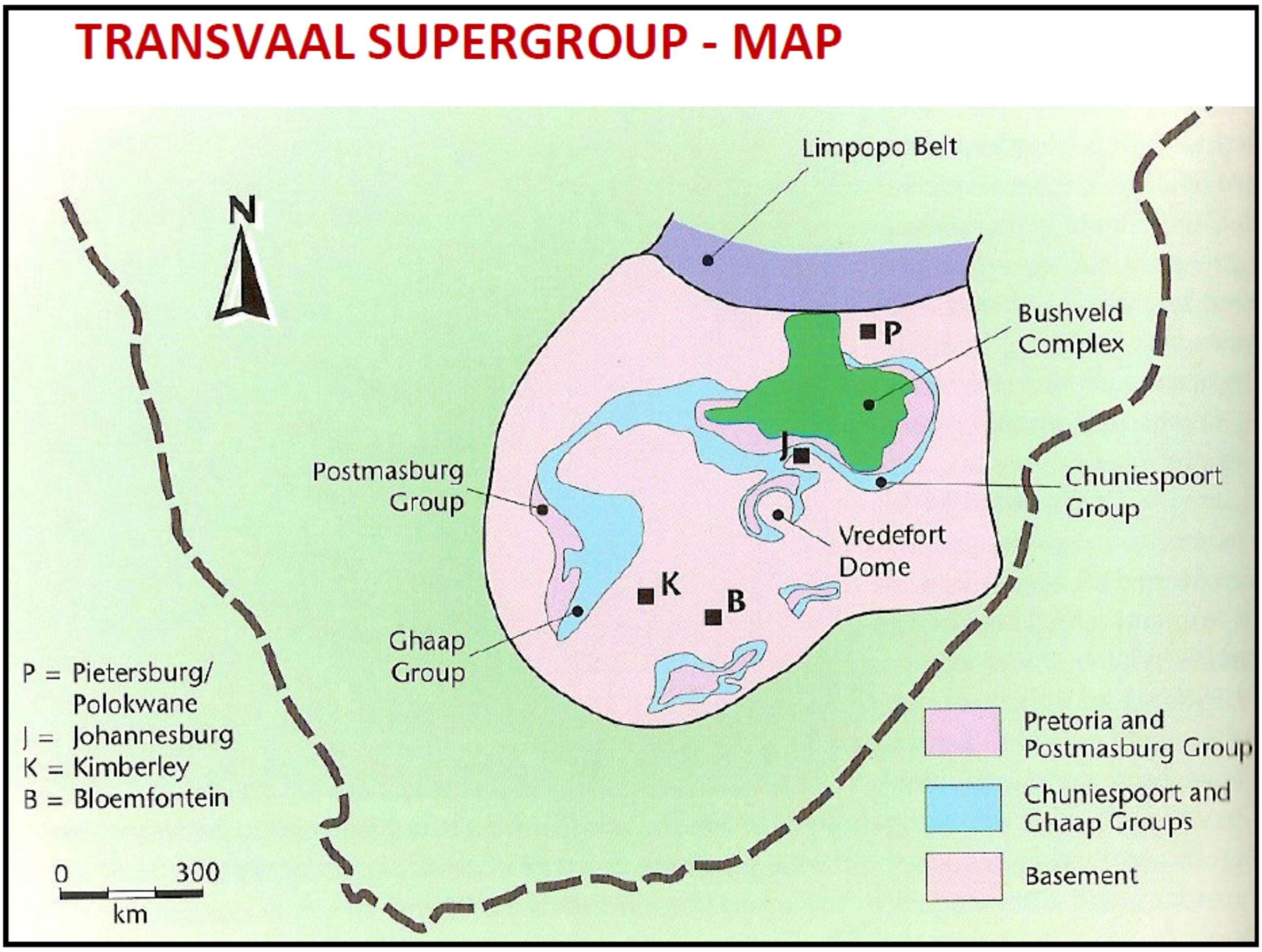

Figure 3-1: Geological setting of northern South Africa (After “Geological Processes and Materials”, University of Pretoria, 2014)

The Archean Kaapvaal Craton hosts three structural basins which are forming part of the late Archean to early Proterozoic Transvaal Supergroup. The Neoarchean-Palaeo-proterozoic eon is synonymous with large scale tectonic, magmatic, crustal, eustatic and depositional controls which resulted in distinctive volcano-sedimentary successions preserved worldwide, of which the Transvaal basin is great remainder.

There are up to 14 formations forming the Pretoria Group sediments, the upper section of the Transvaal Basin, which overlies unconformably the dolomite/iron formation sequence of the lower Chuniespoort Group (Figure 3-2).

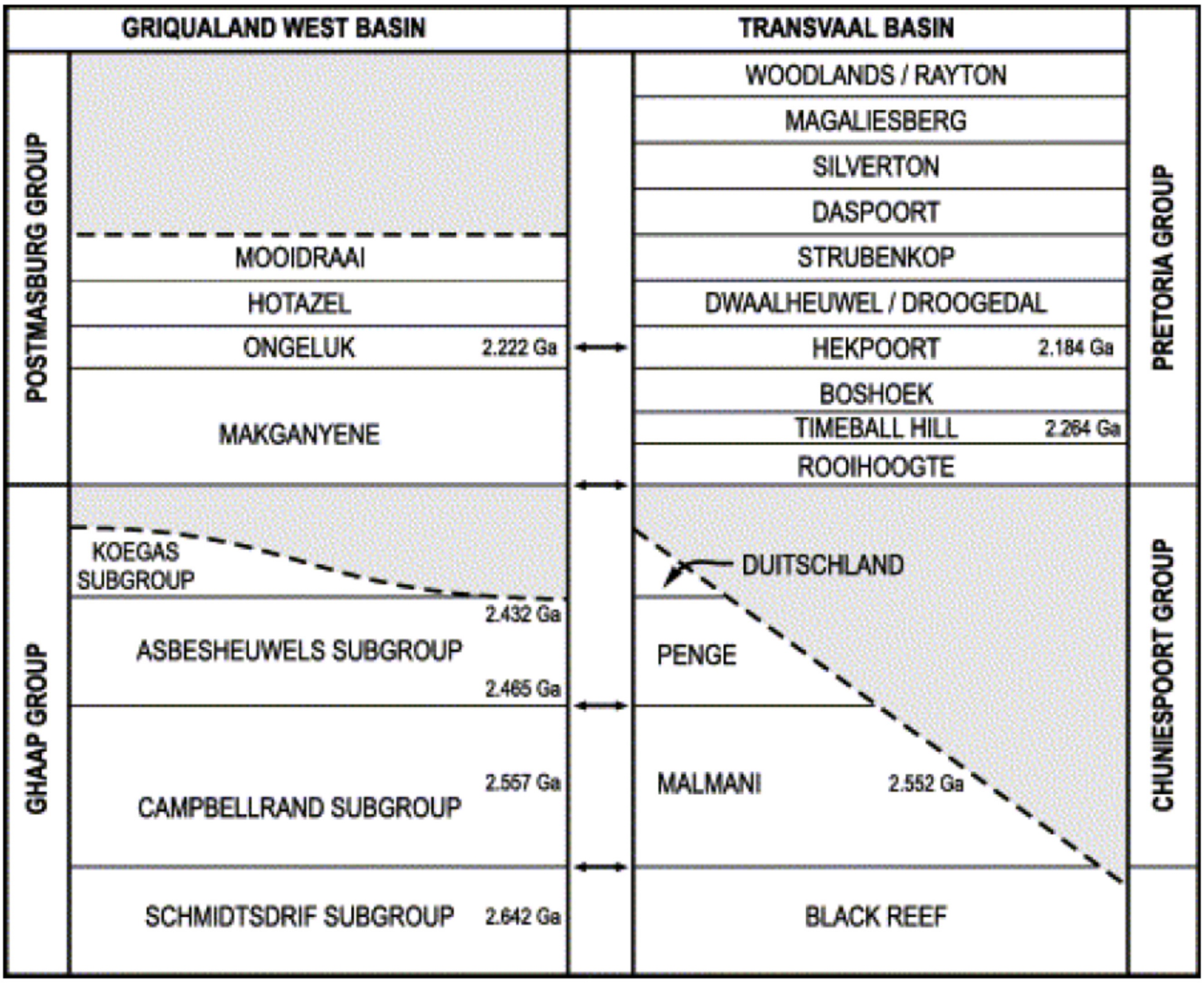

Figure 3-2: Stratigraphy of the Transvaal Supergroup (In "Deconstructing the Transvaal Supergroup, South Africa: implications for Palaeo-proterozoic palaeo-climate models"; J. Moore, H. Tsikos & S. Polteau; Pretoria Geology)

3.2.2 Local geology

The area under study is defined by the Vryheid Formation of the Ecca Group (Karoo Supergroup), which overlies unconformably the rocks of the Transvaal Supergroup as described earlier (see Figure 3-3).

The Ecca Group is an early Permian marine filled system whereby the formations of the late Ecca Group are shallow marine facies followed by fluvial sedimentation. According to Nyathi (2014), the Vryheid Formation is a facies of the Rippon Formation which consists of massive greywackes, arenites, mudstone and carboniferous shale. We assume that the latest was encountered during the drilling of the boreholes.

The underlying dolomite of the Malmani Subgroup was not intersected by the two boreholes. Our accuracy is limited to these two boreholes and at this stage it would be pre-empted to assume what the ground is made of on a wider scale. Figure 3-4 illustrates the regional geological settings featuring the drilled boreholes.

TIME PERIOD	PROXIMAL FACIES (SW)			DISTAL FACIES(NE)
Middle Jurassic, volcanics	DRAKENSBERG GROUP			
Late Triassic–Early Jurassic	STORMBERG GROUP		Clarens Fm	
			Elliot Fm	
			Molteno Fm	
Late Permian-Middle Triassic	BEAUFORT GROUP	Tarkastad Subgroup		
		Burgersdorp Fm		Driekopppen Fm
		Kartberg Fm		Verykerskop Fm
		Adelaide Subgroup		
		Tekloof Fm (W)	Balfour Fm (C)	Normandien Fm (N)
		Abrahamskraal Fm (W)	Koonap / Middleton Fms (C)	
Permian	ECCA GROUP	Fort Brown Fm		Volkrust Fm
		Rippon / Collingham Fms		Vryheid fm
		Whitehill Fm		Pietermaritzburg Fm
		Prince Albert Fm		
Late Carboniferous-late Permian	DWYKA GROUP			

Figure 3-3 Formations of the Karoo Supergroup (Nyathi, 2014)

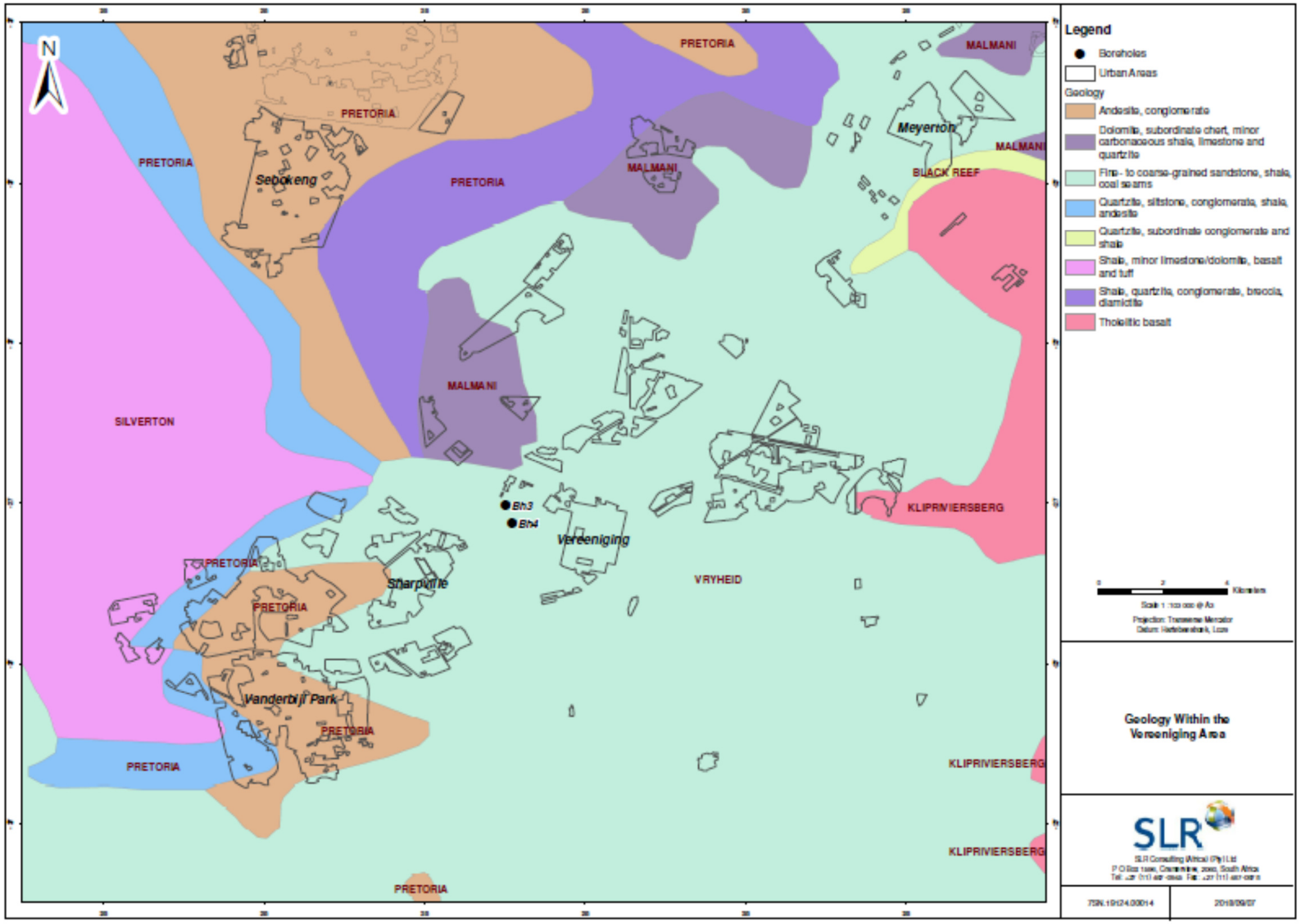

Figure 3-4 Location of the two monitoring boreholes (Bh3 & Bh4) in Vryheid Formation shale (light blue), possibly underlain by Malmani Subgroup dolomite (maroon)

4. GROUNDWATER INVESTIGATION

4.1 DESKTOP STUDY

Existing information on the hydrogeology of the site and surrounds was limited to a geophysical and geological investigation that was conducted by Van Niekerk, Kleyn and Edwards (VKE) (1979) during which seven boreholes were drilled. The positions of the boreholes are shown in Figure 4-1. The following geological profile was delineated by VKE based on the gravity and drilling work:

- The geology of the site under investigation comprises shale; sandstone; coal and mudstone of the Ecca Group which is part of the Karoo Supergroup. The Karoo sediments, across the site, are underlain by dolomites of the Malmani Sub-group of the Chuniespoort Group, Transvaal Supergroup.
- Dolomite is not expected to occur within 40 meters below ground level (mbgl) across the Isanti site 2.
- The Karoo Sediments overlying the dolomites are expected to average a thickness of 30 m across the site, based on an interpretation of the gravity survey and the profile logged at borehole R7;
- Groundwater was encountered at 10.5 mbgl.

It should be noted that dolomite was encountered in an area on the adjacent site to the north (Erf 188), centred at borehole I37, where dolomites occur at a depth of 15 mbgl. It is believed this most likely represents a pinnacle and confirms the potential variability in the site conditions, which need to be verified with a detailed dolomite stability investigation. It is also acknowledged the VKE report of 1979 has a limitation in the geotechnical information, where many of the boreholes were not drilled deep enough to verify dolomite bedrock and groundwater levels.

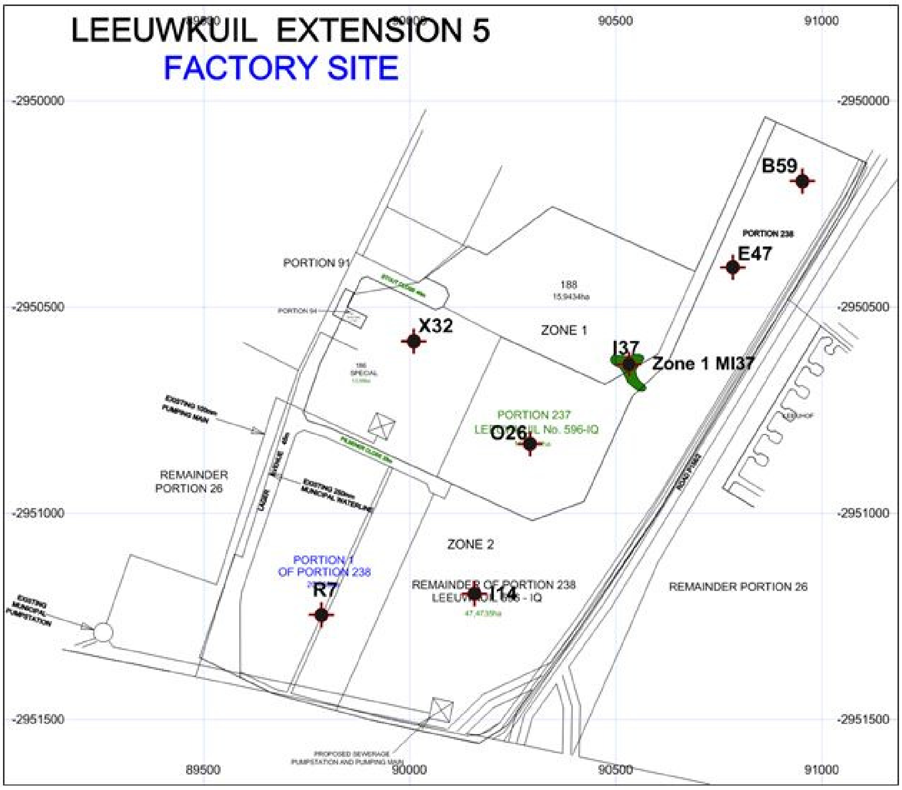

Figure 4-1: VKE PERCUSSION BOREHOLE POSITIONS

SLR consulting conducted a dolomite stability investigation for the Isanti Portion 238 and Ext 238 during June 2018. The investigation entailed a gravity survey, rotary and percussion drilling. The investigation and assessment was conducted in accordance to the SANS 1936 Part 1 and Part 2.

Seventeen percussion boreholes were drilled to depth of 60 m and 120 m bgl. In addition, eight rotary core boreholes drilled for the detailed geotechnical investigation was included to this report.

Dolomite bedrock was encountered in five of the 17 boreholes from depths ranging from 36m to 106m bgl.

The dolomite bedrock is overlain by glacial deposits from the Dwyka Formation and ranges from tillite, varve-like sandstone/siltstone mudstones and carbonaceous siltstone. From the chip logging it was noted that the mudstones which occur between the carbonaceous siltstone, slightly reacts to hydrochloric acids. This indicates that there may be a calcareous component in the tillite.

No dolomite residuum was encountered in the boreholes and may have been eroded due to plucking and abrasion from glacial erosion over time.

The site is located within the Lower Klipriver South Dolomite compartment and groundwater drawdown of 18m was monitored from the year 1986 to 2009 in one of the boreholes close to the Klipriver and Vaalriver intersection. This may be due to an opencast coal mine that is located south of the Vaalriver.

It was determined that there is a low risk of any sinkhole formation and slow to medium risk of subsidence depending on how the water ingress will influence the blanketing horizon, should the site be dewatered.

4.2 DRILLING AND SITING OF BOREHOLES

Two (2) boreholes, i.e. Bh3 and Bh4, were drilled for this study during April 2018, to depths of 50 m and 45 m, respectively. The main purpose of the drilling was to assess the aquifer characteristics through pumping tests and to provide long-term groundwater monitoring boreholes. The boreholes were sited with the following considerations:

- Location of proposed new infrastructure; and
- Monitoring of upstream and downstream water quality.

The locations of the drilled boreholes are presented in Figure 4-2.

Bennett Drilling undertook the drilling. The air percussion drilling method was used for both boreholes. The boreholes were drilled using a THOR drill rig with a 204 mm diameter drill bit. The SLR employee onsite logged the samples and the logs helped to identify the depths at which the screened sections of pipe work (i.e. casing) should be placed based on the geology as well as the water strikes. Water strikes were encountered in Bh3 at 30-31 m and Bh4 at 19 m below ground level.

The groundwater boreholes were completed with 165mm heavy-duty PVC casing pipes. Slotted (slot size = 1 mm) heavy duty PVC casing were installed at reported water strikes and presumed water inflow zones. The remainder of the borehole was completed with solid heavy duty PVC casing. Solid steel casing was installed for the first 10 metres to prevent collapse of shallow unstable ground (clay and gravel of Tertiary age) and protruded 0.5 m above the ground. A gravel pack, using suitable 2-3 mm filter gravel, was installed in the annular space between the casing and the borehole wall to screen the slotted casing extending just above the solid casing.

After the borehole installation had been completed, the borehole was cleaned by blowing compressed air for 1 hour before the casing was installed.

Table 4-1 provides details of the completed two boreholes. Borehole logs are presented in Appendix B.

Figure 4-2 Location of monitoring boreholes BH3 and BH4, west of Vereeniging

Table 4-1: Borehole information

BH ID	Locality	Latitude	Longitude	RWL [m]	Water strike (mbgl)	Borehole Depth [m]
BH3	Vereeniging	-26.66548	27.90156	3.97	30-31	50
BH4	Vereeniging	-26.67023	27.90343	3.30	19	45

4.3 AQUIFER TESTING

Hydraulic tests were performed on both boreholes once the drilling and installation of the boreholes had been completed. VSA Leboa Consulting (Pty) Limited, conducted the pumping tests. The objective of the tests was to determine the borehole yield and hydraulic properties (transmissivity) of the underlying aquifer(s).

4.3.1 Step Drawdown Test (SDT)

Three step drawdown tests were conducted on both boreholes to determine a suitable pumping rate for the constant-rate pumping test. Each step test lasted an hour each at a different pumping rate whilst the water levels in the pumped borehole were monitored.

4.3.2 Constant Discharge Rate Test

From the results obtained by the SDT, a sustainable pumping rate to be applied during the Constant-Discharge Test (CDT) was selected. A pumping rate of 2.6m^3/h was applied to Bh3 and 3m^3/h for Bh4. The CDT was carried out over a period of 12 hours pumping followed by 12 hours recovery after pumping stopped. During the SDT and CDT water levels were recorded on predetermined time intervals.

At the end of the twelve (12) hour CDT period, the pump was shut down and the recovery of the groundwater levels monitored. The groundwater level within the pumped borehole was allowed to recover and measured at pre-determined times. Although the drawdown seemed to stabilize in Bh3, the end of the CDT was not reaching a steady state. In Bh4 the drawdown seemed to have reached a steady state after 7hrs of pumping and the recovery was very good, thus readings were stopped before 12hrs.

A water sample was collected for analysis during the final hour of the CDT.

The test pumping results were analysed using the TPA software (Appendix C). The details of the test pumping and the results are summarised in Table 4-2.

Table 4-2: Test Pumping results

BH ID	Test type	Rest water level [mbgl]	Pump inlet depth [mbgl]	Discharge rate [m^3/h]	Duration [h]		Maximum drawdown [m]	Water Level Recovery [%]	Transmissivity [m^2/d]
					Abstraction	Recovery			
BH3	SDT	3.78	45	0.97; 1.4; 2.60; 3.9	4	3	8.36	n/a	
	CDT	3.97	45	2.6	12	12	12.21	96	5
BH4	SDT	3.34	42	0.9; 1.6; 2.9	3	3	11.24	n/a	
	CDT	3.30	42	3	12	8	26.20	100	17

The two drilled boreholes intercepted the same type of formation and their Transmissivity (T) is of the same magnitude (Bh3: T=5m^2/day; Bh4: T=17 m^2/day), representing a moderately yielding fractured aquifer. The boreholes are low yielding and the nature of the underlying rock formation as well as the subsurface clay rich formation are a good protection to potential groundwater contamination.

4.4 SAMPLING AND CHEMICAL ANALYSIS

Groundwater samples were collected from both of the newly drilled boreholes during the pumping tests. The samples were submitted to Waterlab (Pty) in Pretoria, South Africa for analysis. The results were compared to the following water quality standards (Table 4-3):

- South African National Standards (SANS) 241 (2015) water quality standards (SANS 241 (2015)); and
- Department of Water Affairs (DWAF) Target Water Quality Range Livestock watering (1996).

The analytical certificates are attached in Appendix D. The results indicate the following:

- Aluminium exceeded the SANS operational water quality guideline which indicates that the water quality may have an effect on the efficient operation if the groundwater is used in the plant process;
- Iron exceeded the SANS aesthetic water quality guideline. The aesthetic guideline value gives an indication of concentrations at which the water will be tainted in respect to taste, odour and colour, it does not pose an unacceptable health risk when this value is exceeded; and
- Nitrate (NO_3) concentration in BH4 was equal to the SANS 241:2015 acute health water quality guideline at which level it poses an immediate, unacceptable health risk.

Table 4-3: Analytical data for water samples collected at Isanti

Determinant	Ag	Al	As	Au	B	BA	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Dy	Er	Eu	Fe	Ga	Gd	Ge	Hf
Unit	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SANS 241:2015 Operational	N/A	0.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SANS 241:2015 Aesthetic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.3	N/A	N/A	N/A	N/A
SANS 241:2015 Acute Heath	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SANS 241:2015 Chronic Health	N/A	N/A	0.01	N/A	2.4	0.7	N/A	N/A	N/A	0.003	N/A	N/A	0.05	N/A	2	N/A	N/A	N/A	2	N/A	N/A	N/A	N/A
DWAF TWQG	N/A	5	1	N/A	5	N/A	N/A	N/A	1000	0.01	N/A	1	1	N/A	0.5	N/A	N/A	N/A	10	N/A	N/A	N/A	N/A
BH3	0.017	1.67	< 0.010	< 0.010	0.086	0.107	< 0.010	< 0.010	33	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.649	0.015	< 0.010	< 0.010	< 0.010
BH4	< 0.010	1.833	< 0.010	< 0.010	0.025	0.090	< 0.010	< 0.010	83	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	1.261	0.012	< 0.010	< 0.010	< 0.010

Determinant	Hg	Ho	In	Ir	K	La	Li	Lu	Mg	Mn	Mo	Na	Nb	Nd	Ni	Os	P	Pb	Pd	Pr	Pt	Rb	Rh
Unit	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/L
SANS 241:2015 Operational	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SANS 241:2015 Aesthetic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.1	N/A	200	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SANS 241:2015 Acute Heath	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SANS 241:2015 Chronic Health	0.006	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.4	N/A	N/A	N/A	N/A	0.07	N/A	N/A	0.01	N/A	N/A	N/A	N/A	N/A
DWAF TWQG	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	500	10	0.01	2000	N/A	N/A	1	N/A	N/A	0.1	N/A	N/A	N/A	N/A	N/A
BH3	< 0.010	< 0.010	< 0.010	< 0.010	1.9	< 0.010	< 0.010	< 0.010	28	0.025	< 0.010	59	< 0.010	< 0.010	< 0.010	0.011	0.053	< 0.010	< 0.010	< 0.010	< 0.010	0.014	< 0.010
BH4	< 0.010	< 0.010	< 0.010	< 0.010	2.3	< 0.010	0.011	< 0.010	65	0.065	< 0.010	61	< 0.010	< 0.010	< 0.010	< 0.010	0.069	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010

Determinant	Ru	Sb	Sc	Se	Si	Sm	Sn	Sr	Ta	Tb	Te	Th	Ti	Tl	Tm	U	V	W	Y	Yb	Zn	Zr
Unit	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SANS 241:2015 Operational	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SANS 241:2015 Aesthetic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	N/A
SANS 241:2015 Acute Heath	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SANS 241:2015 Chronic Health	N/A	0.02	N/A	0.04	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.03	N/A	N/A	N/A	N/A	N/A	N/A
DWAF TWQG	N/A	N/A	N/A	0.05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	N/A	N/A	20	N/A
BH3	< 0.010	< 0.010	< 0.010	< 0.010	14.5	< 0.010	< 0.010	0.381	< 0.010	< 0.010	< 0.010	< 0.010	0.098	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.361	< 0.010
BH4	< 0.010	< 0.010	< 0.010	0.021	18.9	< 0.010	< 0.010	0.358	< 0.010	< 0.010	< 0.010	< 0.010	0.137	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.442	< 0.010

Determinant	pH	EC	TDS	Turbidity	Total Alk	P-Alk	HCO_3^-	Total Hardness as $CaCO_3$ *	Ca hardness as $CaCO_3$ *	Mg Hardness as $CaCO_3$ *	Langelier Index	Ryznar Index	Corrosivity Ratio *	Cl	SO_4	F	NO_3 as N	NO_2 as N	DOC as C *
Unit	pH Unit	mS/m	mg/l	N.T,U	mg/l	mg/L	mg/l	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l		mg/L
SANS 241:2015 Operational	5 - 9.7	N/A	N/A	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A
SANS 241:2015 Aesthetic	N/A	170	1200	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	300	250	N/A	N/A	NA	N/A
SANS 241:2015 Acute Heath	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	500	N/A	11	0.9	N/A
SANS 241:2015 Chronic Health	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.5	N/A	NA	N/A
DWAF TWQG	N/A	N/A	1000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1500	1000	2	22	NA	NA
BH3	7.7	57.9	344	33	292	<5	356	188	82	106	0.2	7.4	0.2	22	24	0.4	0.2	<0.05	<1.0
BH4	7.7	113	680	115	308	<5	375	475	221	254	0.5	6.6	0.9	104	131	0.3	11	<0.05	<1.0

5. AQUIFER CHARACTERISATION

5.1 AQUIFER VULNERABILITY

The Aquifer Vulnerability Map of South Africa (Conrad et al. 1999c) indicates the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer. Based on the map, the project area is a 'least vulnerable area' that is only vulnerable to conservative pollutants in the long term when continuously discharged or leached.

5.2 AQUIFER CLASSIFICATION

In terms of the Aquifer Classification Map of South Africa (Conrad *et al*, 1999), the project area is classified as a minor aquifer region, which implies a moderately-yielding aquifer system of variable water quality.

5.3 AQUIFER SUSCEPTIBILITY

The Aquifer Susceptibility Map of South Africa (Conrad *et al*, 1999b), indicates the qualitative measure of the relative ease with which a groundwater body can be potentially contaminated by anthropogenic activities and includes both aquifer vulnerability and the relative importance of the aquifer in terms of its classification. Based on the aquifer susceptibility matrix (Table 5-1), the aquifer at the project site has 'low' susceptibility.

Table 5-1: Aquifer Susceptibility Matrix

		AQUIFER CLASSIFICATION		
VULNERABILITY		Poor	Minor	Major
	Least	1 Low	**2** **Low**	3 Medium
	Moderate	2 Low	4 Medium	6 High
		3 Medium	6 High	9 High

5.4 GROUNDWATER USERS

Groundwater users were determined by exporting data from the National Groundwater Archive (NGA). The NGA is a web enabled database system that allows capturing, viewing, modifying and extraction of groundwater related data. Information extracted for drainage region C22F and NGA boreholes within a 3 km radius of the project site are shown in Figure 5-1.

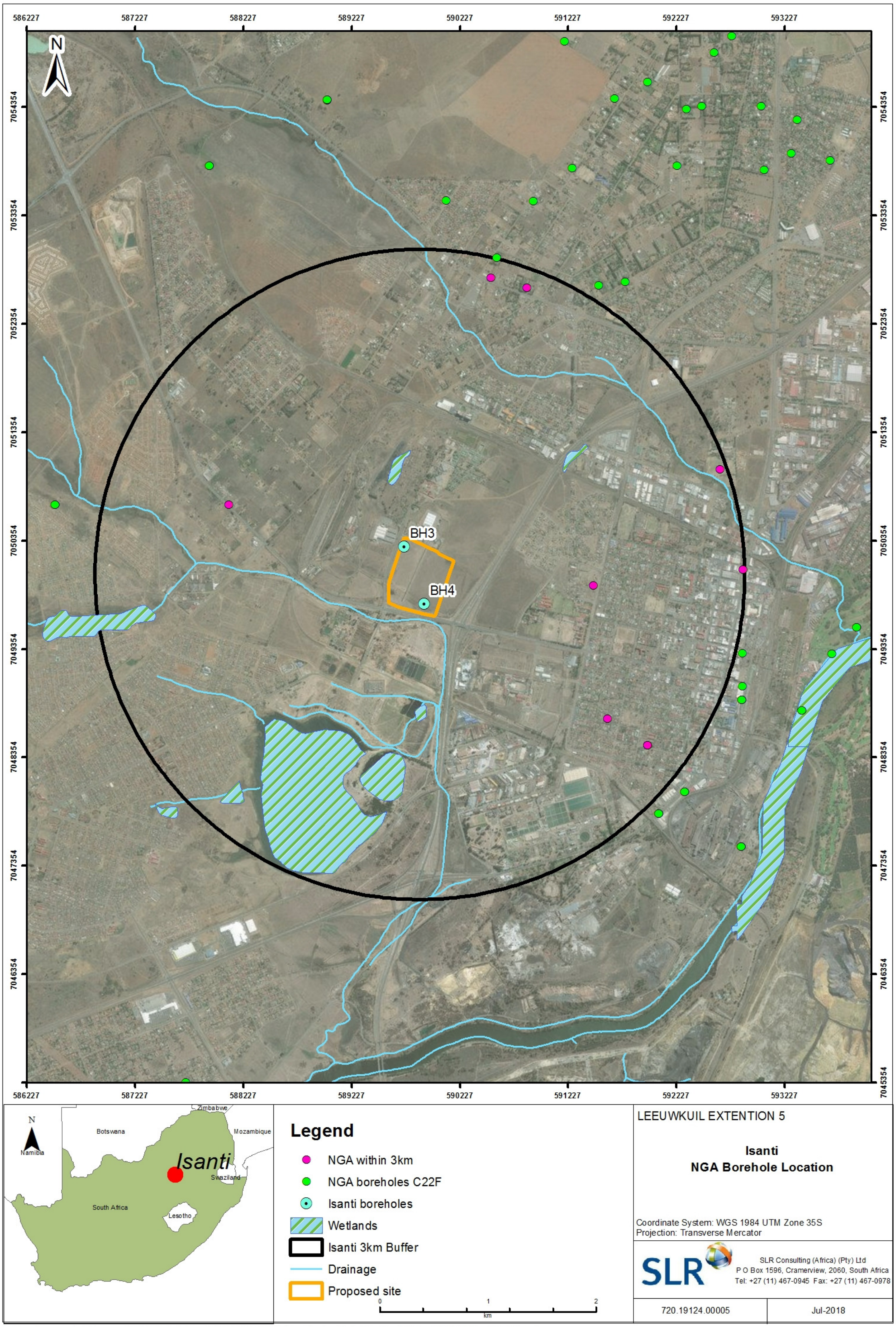

Figure 5-1: Groundwater users in drainage region C22F listed in the National Groundwater Archive

6. HYDROGEOLOGICAL CONCEPTUAL UNDERSTANDING

A conceptual site model (CSM) can be defined as a "representation of a real system" (Fetter, 2001). In terms of hydrogeology, it sets out the "Source-Pathway-Receptor" linkages for a site and can be used as a tool to assist with the assessment of impacts and the management of potential sources of pollution.

A **Source** is defined as a potential source of contamination, for example at an industrial site this can include chemical and raw material storage areas, process water ponds, fuel tanks, etc.

A **Pathway** is the 'route' in which the 'source' takes to reach a given 'receptor'. With regards to hydrogeology, this may include the unsaturated zone and groundwater etc.

A **Receptor** is something that should the 'source' reach, some form of negative impact would occur. With regards to hydrogeology, this could be boreholes on nearby properties gaining rivers (rivers that receive base flow from groundwater) etc.

In the case of the proposed glass bottle manufacturing plant, contamination sources could potentially include the raw materials, products and other input substances. The primary raw materials for the operation are sand, soda ash and limestone, with a number of other raw materials also required. These would be delivered by truck and stored in a variety of silos, hoppers and bunds. All material handling and storage facilities will be located on concreted surfaces. The main production areas are housed under roof in the manufacturing building. The facility would also have a gas station to regulate natural gas supply, a diesel fuel oil storage facility as a back-up furnace fuel, diesel storage to supply generators for emergency electricity supply and emergency water storage. The facility will generate and treat sewerage. All facilities for the storage of dangerous goods will be located above ground and within an engineered bund. In most cases the potential sources are isolated. The identified potential sources of groundwater contamination would be leakages from the designed containment facilities, spillages from transport and handling of dangerous goods outside of designed containment facilities.

The primary pathway for groundwater contamination consists of surface water flow, infiltrating through the unsaturated zone and ultimately in to the fractured aquifer.

While there are a number of neighbouring land users adjacent to the site (i.e. Wise Owl Pre-school, a Telkom facility, a Department of Roads and Transport facility, a Department of Correctional Services facility, informal residences and livestock kraals and the Leeuhof suburb) there is no record of any of these parties making use of groundwater.

7. RISK ASSESSMENT

Based on the review of available data and site visit, a potential environmental impact that the proposed project could have on the groundwater resource is contamination of the groundwater resource. The risk assessment methodology is outlined in Table 7-1. This methodology was used to assess the potential risk of groundwater contamination under a managed (**Error! Reference source not found.**) and unmanaged (Table 7-3) scenario.

Table 7-1: Risk assessment methodology

PART A: DEFINITIONS AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.
	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	**VL**	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	**VL**	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

PART B: DETERMINING CONSEQUENCE							
			EXTENT				
			A part of the site/property	Whole site	Beyond the site, affecting neighbours	Local area, extending far beyond site.	Regional/ National
			VL	L	M	H	VH
			INTENSITY = VL				
DURATION	Very long	VH	Low	Low	Medium	Medium	High
	Long term	H	Low	Low	Low	Medium	Medium
	Medium term	M	Very Low	Low	Low	Low	Medium
	Short term	L	Very low	Very Low	Low	Low	Low
	Very short	VL	Very low	Very Low	Very Low	Low	Low
			INTENSITY = L				
DURATION	Very long	VH	Medium	Medium	Medium	High	High
	Long term	H	Low	Medium	Medium	Medium	High
	Medium term	M	Low	Low	Medium	Medium	Medium
	Short term	L	Low	Low	Low	Medium	Medium
	Very short	VL	Very low	Low	Low	Low	Medium
			INTENSITY = M				
DURATION	Very long	VH	Medium	High	High	High	Very High
	Long term	H	Medium	Medium	Medium	High	High
	Medium term	M	Medium	Medium	Medium	High	High
	Short term	L	Low	Medium	Medium	Medium	High
	Very short	VL	Low	Low	Low	Medium	Medium
			INTENSITY = H				
DURATION	Very long	VH	High	High	High	Very High	Very High
	Long term	H	Medium	High	High	High	Very High
	Medium term	M	Medium	Medium	High	High	High
	Short term	L	Medium	Medium	Medium	High	High
	Very short	VL	Low	Medium	Medium	Medium	High
			INTENSITY = VH				
DURATION	Very long	VH	High	High	Very High	Very High	Very High
	Long term	H	High	High	High	Very High	Very High
	Medium term	M	Medium	High	High	High	Very High
	Short term	L	Medium	Medium	High	High	High
	Very short	VL	Low	Medium	Medium	High	High
			VL	L	M	H	VH
			A part of the site/property	Whole site	Beyond the site, affecting neighbours	Local area, extending far beyond site.	Regional/ National
			EXTENT				

PART C: DETERMINING SIGNIFICANCE							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**VH**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Probable	**H**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Possible/ frequent	**M**	**Very Low**	**Very Low**	**Low**	**Medium**	**High**
	Conceivable	**L**	**Insignificant**	**Very Low**	**Low**	**Medium**	**High**
	Unlikely/ improbable	**VL**	**Insignificant**	**Insignificant**	**Very Low**	**Low**	**Medium**
			VL	**L**	**M**	**H**	**VH**
			CONSEQUENCE				

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely to be required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.

Table 7-2: Potential groundwater Impact in the unmanaged scenario

ISSUE	POTENTIAL GROUNDWATER IMPACT IN THE UNMANAGED SCENARIO	
Leakage/seepage of sewage, oil or fuel from handling and storage facilities or dirty surface water runoff contaminates the groundwater and has a negative impact on aquifer quality and thus groundwater users	**Intensity:** Sewage, oil or fuel from handling and storage facilities would potentially leak into groundwater. The impact on groundwater quality locally will be moderate. Targets, limits and thresholds of concern are expected to be regularly exceeded.	**Intensity: M**
	Extent: Impact would be the whole site, i.e. in the larger area around the bottle manufacturing plant.	**Extent: L**
	Duration: Long-term, between 10 and 20 years but likely to cease at the end of the operational life of the activity	**Duration: H**
	Consequence: Medium in the unmitigated case	**Consequence: M**
	Probability: The probability of exposure to impacts is rated as high	**Probability: H**
	Significance: The significance in the unmitigated case is therefore rated as medium. Mitigation will be required	**Significance: M**

Table 7-3: Potential groundwater Impact in the managed scenario

ISSUE	POTENTIAL GROUNDWATER IMPACT IN THE MANAGED SCENARIO	
Seepage of process fluids, sewage systems, oil or fuel from storage facilities contaminates the groundwater and has a negative impact on the aquifer	**Recommended mitigation measures and processes:** • Monitoring of boreholes Bh3 and Bh4 on a quarterly basis as described in Section 8 • Plant effluent to be treated on site to meet appropriate discharge standards prior to being pumped to the municipal Waste Water Treatment Works located south of the site; • Engineered containment of process areas, sewage treatment plants, vehicle maintenance areas, and fuel and oil storage areas; • Storage and handling of potential contaminant sources to be restricted to designated areas; • The processing plant be located on a concreted surface; • Storage and handling of potential contaminant sources to be restricted to designated areas; • Spill containment and clean-up kits available at each of these facilities; • All vehicles carrying dangerous goods to carry fuel and oil spill kits, with staff trained in the use of spill kits; • Regular and effective training of employees who handle these potential contaminants.	
	Intensity: Mitigation measures permit only minor changes or disturbances	**Intensity: L**
	Extent: Impact would be reduced to a part of the site/property	**Extent: VL**
	Duration: Medium-term, between 5 and 10 years but likely to cease at the end of operation	**Duration: M**
	Consequence: Low in the mitigated case	**Consequence: Low**
	Probability: The probability of exposure to negative impacts is rated as conceivable	**Probability: L**
	Significance: The significance in the mitigated case is rated very low in the managed scenario	**Significance: Very Low**

8. GROUNDWATER MONITORING SYSTEM

In order to assess potential impacts of the project on the surrounding water resources, water quality monitoring is required. The measurement of environmental parameters (groundwater levels, surface and ground-, water quality) allows the early detection of any potential ground water contamination.

Quarterly monitoring of surface water and the boreholes drilled during the current drilling campaign is recommended. Parameters as indicated in Table 8-1 should be monitored during quarterly monitoring events.

Table 8-1: Recommended analytical suite

Groundwater
pH
Electrical Conductivity (EC)
Total Dissolved Solids (TDS)
Alkalinity as $CaCO_3$
Bicarbonate as HCO_3
Carbonate as CO_3
Chloride (Cl)
Fluoride (F)
Sulphate (SO_4)
Nitrate as N (NO_3)
Nitrite as N (NO_2)
Free and Saline Ammonia as N*(NH_3)
Potassium (K)
Calcium (Ca)
Manganese (Mn)
Sodium (Na)
ICP- scan for trace metals (dissolved concentrations)
Hydrocarbons

9. CONCLUSIONS AND RECOMMENDATIONS

The objective of this study was to:

- Determine the aquifer characteristics on site:
    - The two drilled boreholes intercepted the same type of formation and their Transmissivity (T) is of the same magnitude, representing a moderately yielding fractured aquifer;
    - Water quality parameters exceeded the SANS 241:2015 operational and aesthetic limits for Al and Fe respectively. The NO_3 concentration in Bh4 was equal to the SANS 241:2015 acute health limit;
    - The aquifer has a low vulnerability and classifies as a minor aquifer with a resulting low susceptibility to contamination;
- Construct future groundwater monitoring points
    - Two boreholes, one upstream and one downstream of the proposed glass bottle manufacturing plant were installed and equipped;
- Determine the risks to groundwater that may be associated with the proposed project:
    - A potential risk to the groundwater resource is contamination from seepage emanating from facilities introduced on the property. The risk of groundwater contamination was deemed to be medium when left unmanaged and low when recommended management practices were applied.

SLR recommends the following:

- Monitoring of boreholes Bh3 and Bh4 on a quarterly basis as described in Section 8;
    - Plant effluent to be treated on site to meet appropriate discharge standards prior to being pumped to the municipal Waste Water Treatment Works located south of the site;
    - Engineered containment of process areas, sewage treatment plants, vehicle maintenance areas, and fuel and oil storage areas;
    - Spill containment and clean-up kits available at each of these facilities;
    - Storage and handling of potential contaminant sources to be restricted to designated areas;
    - All vehicles carrying dangerous goods to carry fuel and oil spill kits, with staff trained in the use of spill kits;
    - The processing plant be located on a concreted surface; and
    - Regular and effective training of employees who handle these potential contaminants.

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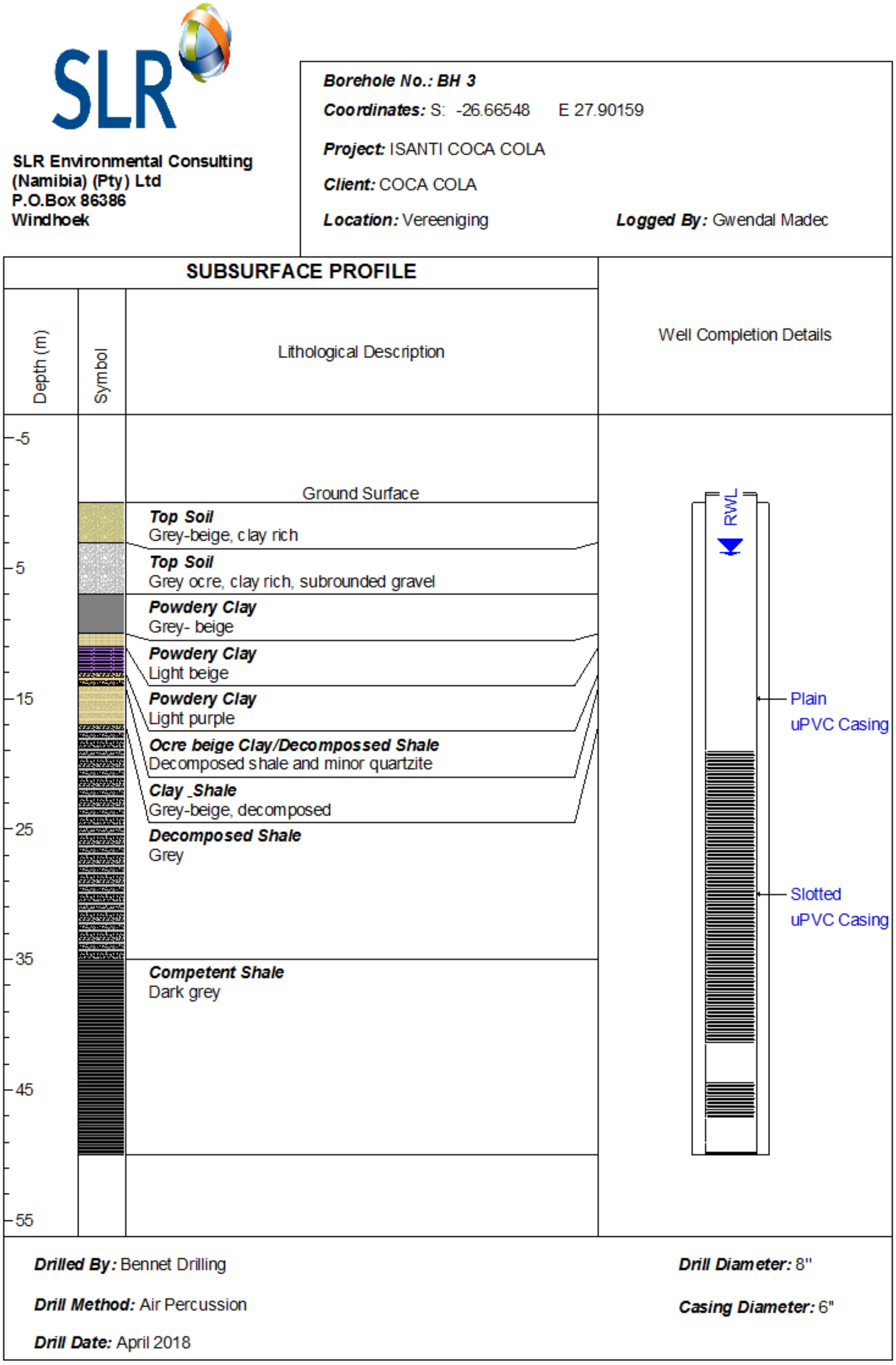
APPENDIX A: CURRICULUM VITAE

Separate files

APPENDIX B: BOREHOLE LOGS



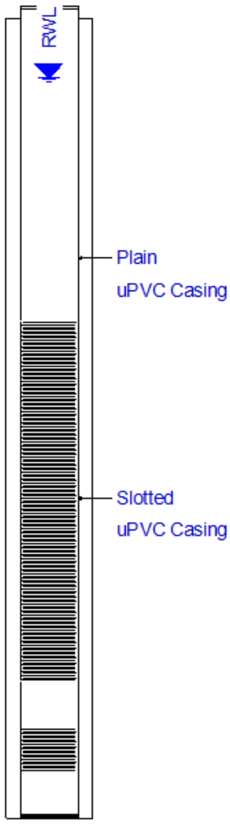
SLR Environmental Consulting (Namibia) (Pty) Ltd
P.O.Box 86386
Windhoek

Borehole No.: BH 4
Coordinates: S: -26.67023 E 27.90343
Project: ISANTI COCA COLA
Client: COCA COLA
Location: Vereeniging ***Logged By:*** Gwendal Madec

SUBSURFACE PROFILE

Depth (m)	Symbol	Lithological Description
-5		Ground Surface
		Top Soil Grey-beige, clay rich matrix with calcrete speckles
5		***Silty Clay*** Beige
		Silty Clay/Decomposed quartz Light grey-beige
15		
		Shale Dark grey, fractured with Fe staining
		Competent Shale Dark grey
25		
35		
45		

Well Completion Details

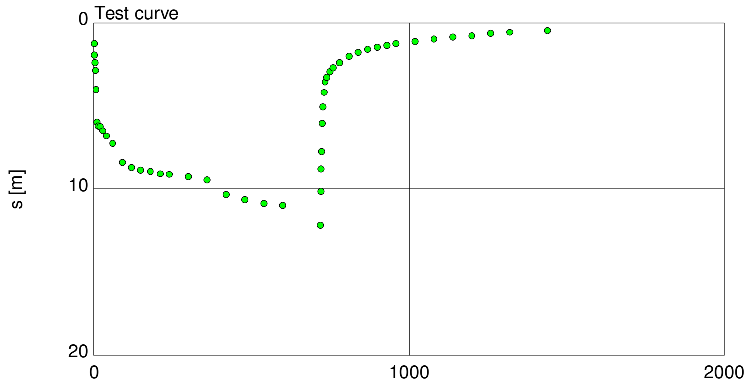


Drilled By: Bennet Drilling
Drill Method: Air Percussion
Drill Date: April 2018
Drill Diameter: 8"
Casing Diameter: 6"

APPENDIX C: PUMP TEST RESULTS

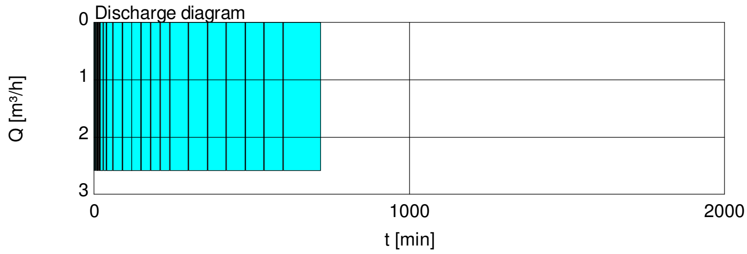
Test pumping analysis

Pumped well BH3



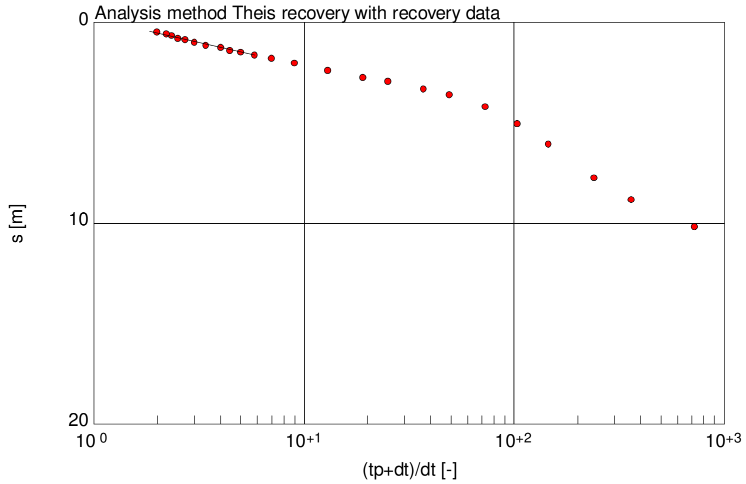
Borehole, well & aquifer

Drilled:	April 2018
Latitude:	
Longitude:	
Elevation:	
Depth:	50 [m]
Stick up:	0.50 [m]
Bh. radius:	0.102 [m]
Casing radius:	0.084 [m]
RWL:	3.97 [m]
max.drawdown:	12.21 [m]
Aq.type:	
Aq.thickness:	
Stratigraphy:	Vryheid Group
Lithology:	sandstone + shale



Test running

Start:	27/06/2018 07:39:04
Dis.dur.:	720 [min]
Av.dis.:	2.6 [m³/h]
Max.dis.:	2.6 [m³/h]
Min.dis.:	2.6 [m³/h]
Total dis.:	31.2 [m³]
Crew:	VSA Leboa
Supervisior:	G Madec



Results

Match parameter:

Q:	2.6 [m³/h]
b:	2.41 [m]
tcorr:	720 [min]
to:	1.23 [-]

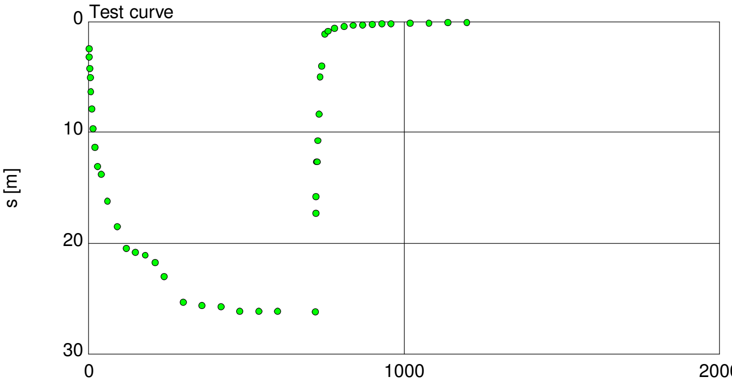
Aquifer parameter:

T:	4.74 [m²/d]
k:	4.74 [m/d]

Date 2018/06/27 prepared by A Bittner Annex 3.1

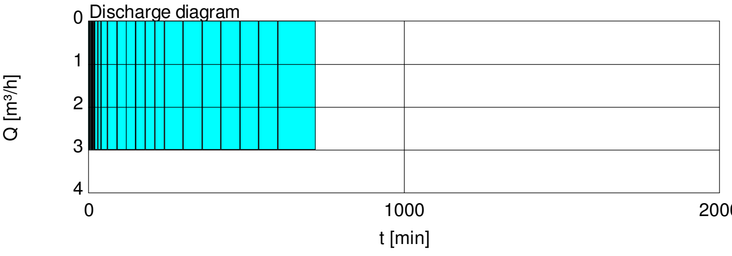
Test pumping analysis

Pumped well BH4



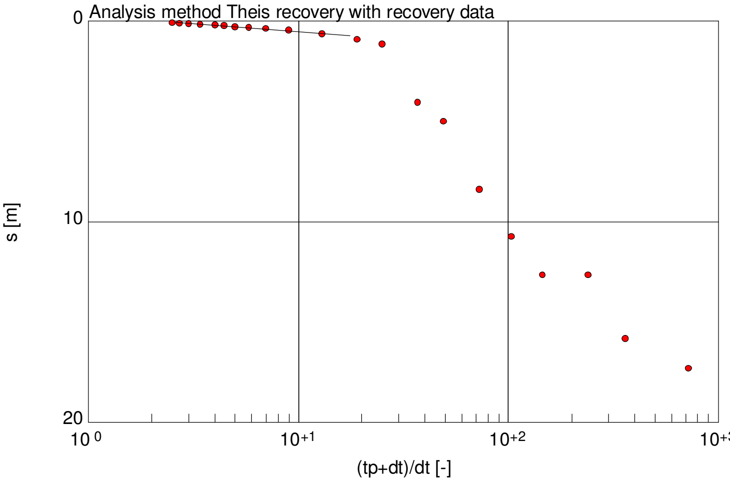
Borehole, well & aquifer

Drilled:	April 2018
Latitude:	
Longitude:	
Elevation:	
Depth:	45 [m]
Stick up:	0.50 [m]
Bh. radius:	0.102 [m]
Casing radius:	0.084 [m]
RWL:	3.30 [m]
max.drawdown:	26.20 [m]
Aq.type:	
Aq.thickness:	
Stratigraphy:	Vryheid Group
Lithology:	sandstone + shale



Test running

Start:	17/05/2018 11:08:30
Dis.dur.:	720 [min]
Av.dis.:	3 [m³/h]
Max.dis.:	3 [m³/h]
Min.dis.:	3 [m³/h]
Total dis.:	36 [m³]
Crew:	VSA Leboa
Supervisior:	G Madec



Results

Match parameter:

Q:	3 [m³/h]
b:	0.784 [m]
tcorr:	720 [min]
to:	2.17 [-]

Aquifer parameter:

T:	16.8 [m²/d]
k:	16.8 [m/d]

Date 2018/06/27	prepared by A Bittner	Annex 4.1

APPENDIX D: ANALYTICAL CERTIFICATES

WATERLAB (Pty) Ltd
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sanas Testing Laboratory
T0391

CERTIFICATE OF ANALYSES
GENERAL WATER QUALITY PARAMETERS

Date received: 2018 - 04 - 26 **Date completed:** 2018 - 05 – 14
Project number: 139 **Report number: 74128** **Order number: SA 0299**

Client name: SLR Environmental Consulting - Namibia **Contact person: Mr. G. Madec**
Address: P.O. Box 86386 Windhoek **e-mail: gmadec@slrconsulting.com**
Telephone: 00 264 61 231 287 **Facsimile: -** **Mobile: -**

Analyses in mg/ℓ (Unless specified otherwise)	Method Identification	Sample Identification: Isanti	
		BH3	BH4
Sample Number		29234	29235
pH – Value at 25°C *	WLAB065	7.7	7.7
Electrical Conductivity in mS/m at 25°C	WLAB002	57.9	113
Total Dissolved Solids (Calculated) *	WLAB003	344	680
Turbidity in N.T.U	WLAB005	33	115
Total Alkalinity as $CaCO_3$	WLAB007	292	308
P-Alkalinity as $CaCO_3$ *	WLAB023	<5	<5
Bicarbonate as HCO_3 *	WLAB023	356	375
Total Hardness as $CaCO_3$ *	WLAB051	188	475
Calcium Hardness as $CaCO_3$ *	WLAB051	82	221
Magnesium Hardness as $CaCO_3$ *	WLAB051	106	254
Langelier Index at 25°C *	WLAB053	0.2	0.5
Ryznar Index at 25°C *	WLAB053	7.4	6.6
Corrosivity Ratio *	WLAB054	0.2	0.9
Chloride as Cl	WLAB046	22	104
Sulphate as SO_4	WLAB046	24	131
Fluoride as F	WLAB014	0.4	0.3
Nitrate as N	WLAB046	0.2	11
Nitrite as N	WLAB046	<0.05	<0.05
Dissolved Organic Carbon as C *	WLAB060	<1.0	<1.0
ICP-MS Scan (Dissolved) *	WLAB050	See Attached Report: 74128-A	
% Balancing *	---	96.8	98.3

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

WATERLAB (PTY) LTD

CERTIFICATE OF ANALYSIS

Project Number	**: 139**	**Date Received:**	2018/04/26
Client	**: SLR Consulting**		
Report Number	**: 74128-A**	**Date Completed:**	2018/05/14

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)
BH3	29234	0.017	1.67	< 0.010	< 0.010	0.086	0.107	< 0.010	< 0.010	33	< 0.010	< 0.010	< 0.010
BH4	29235	< 0.010	1.83	< 0.010	< 0.010	0.025	0.090	< 0.010	< 0.010	83	< 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)
BH3	29234	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.649	0.015	< 0.010	< 0.010	< 0.010	< 0.010
BH4	29235	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	1.26	0.012	< 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)
BH3	29234	< 0.010	< 0.010	< 0.010	1.9	< 0.010	< 0.010	< 0.010	28	0.025	< 0.010	59	< 0.010
BH4	29235	< 0.010	< 0.010	< 0.010	2.3	< 0.010	0.011	< 0.010	65	0.065	< 0.010	61	< 0.010

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