WERDA PROJECT PROSPECTING RIGHT APPLICATION - GROUNDWATER STUDY

HC Van Wyk Diamonds Limited

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Limitations, Reliance and Assumption

This report has been exclusively prepared for the client and the findings presented herein are limited to the scope of work approved by the client upon acceptance of MojaTerre's proposal.

The report is considered current only for a period of 180 days from the site inspection. Investigation findings presented in this report are based on MojaTerre's professional judgment using information available at the time of the assessment. It is assumed that information that MojaTerre sourced from the client during the undertaking of this assessment is accurate, current and representative of the site.

Information presented in this report is not intended as legal advice and MojaTerre makes no guarantees about the conditions of the site.

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List of Abbreviations

BH	Borehole
BIF	Banded Iron Formation
Boscia	Boscia Ecological Consulting
DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
DWS	Department of Water Affairs and Sanitation
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme Report
GN	Government Notice
HVWD	HC van Wyk Diamonds Limited
iLEH	Irene Lea Environmental and Hydrogeology cc
mamsl	metres above mean sea level
MAP	Mean annual precipitation
MPRDA	Minerals and Petroleum Resources Development Act, 2002
NEMA	National Environmental Management Act, 2002
NEM:WA	National Environmental Management: Waste Amendment Act, 2008
NGDB	National Groundwater Database
NNW	North-north-west
NS	Not specified
NWA	National Water Act, 1998
PES	Present Ecological State
SWL	Static Water Level
TDS	Total Dissolved Solids

1 Introduction

1.1 Terms of Reference

MojaTerre (Pty) Ltd (MojaTerre) was appointed by HC Van Wyk Diamonds Limited. (HVWD) to undertake a specialist hydrogeological assessment of a proposed location for a new diamond prospecting project, to be located on the Farm 503 (Werda) near the mining town Lime Acres, which is situated in the Northern Cape Province of South Africa. The requested assessment is required in support of an Environmental Impact Assessment (EIA) to apply for a prospecting permit.

2 Project Background

HVWD is in the process of applying for a prospecting right that includes bulk-sampling activities and trenching for alluvial diamond prospecting. The project is situated on the Remaining Extent of the Farm 503 (Werda) approximately 10km south of the town of Lime Cares, Northern Cape Province, as shown in ***Annex B***.

HVWD submitted a Scoping Report for approval to the DMR under the reference number ***NC30/5/1/1/2/11779 PR***. This report forms part of the EIA phase of the application and is submitted to quantify the impact of the proposed activities on groundwater.

2.1 Project Description

Prospecting with bulk sampling will assist in indicating the grade and quality of diamond resources on Werda. HVWD estimates that the prospecting activities will be completed over a period of five years and will be undertaken in five phases (Boscia, 2015):

- ***Phase 1*** will entail non-invasive activities, including a desktop study and interpretation of aerial photos and satellite images to delineate the alluvial gravels.
- During ***Phase 2***, at least 300 boreholes of ~5m in depth will be drilled. These boreholes will be drilled to the depth of bedrock on a 200 x 200m or a 100 x 50m grid.
- ***Phases 3*** and ***Phase 4*** will entail opencast pitting and trenching using heavy earthmoving equipment. During these activities, vegetated soil and overburden will be stripped and the underlying gravels will be excavated from 0,5 – 5m deep open pits by means of hydraulic shovels and excavators. These prospecting pits will be positioned along the same grid as used during drilling and it is envisaged that 150 pits of a dimension of 2 x 3m; and 20 trenches of 100 x 50m will be excavated. The locations of these pits are not known at present and will be verified after a pre-feasibility study has been completed.
- During ***Phase 5***, continuous analysis and desktop studies will be undertaken to interpret and model the results from the sampling activities. The outcome of this phase may be used to amend the prospecting programme, if necessary.

The project will entail the following activities, as described in the Scoping Report for the application (Boscia, 2015):

- Excavated gravels will be screened, scrubbed, crushed and processed on-site (Boscia, 2015). No processing agents will be used. Oversized material will be stockpiled temporarily for backfilling and rehabilitation. Screened gravel will be de-sanded, sized and treated through a diamond rotary pan plant. Suitable material will then be scanned in an X-Ray machine where after rough diamond product will be removed off-site for further beneficiation.

- Residue from the plant will be pumped onto dewatering screens to remove coarser material. The remaining slimes, consisting of muddy water with minimum solids, will be pumped into an on-site slimes dam. Specifications for the slimes dam are not available at present, but will be developed by engineering consultants. HVWD will apply for a water use license from the DWS for the construction and operation of the slimes dam. This application will form part of the EIA phase of the application.

Table 1 Activities to be Undertaken On-Site

Activity
1. Prospecting for diamond resources, which requires permission in terms of Section 20 (MPRDA), for the removal and disposal of bulk samples of minerals over an area of 2069ha.
2. Possible excavation of soil, sand, shells, shell grit, pebbles or rock over an area of 72ha from a watercourse.
3. Clearance of indigenous vegetation over an area of approximately 150ha.
4. Development of haul roads and continuous lengthening and rehabilitation of haul roads 15m wide with no reserve over an area of approximately 20 000m^2.
5. Development of access roads 6m wide with no reserve over an area of approximately 4000 m^2.
6. Continuous establishment and reclamation of temporary stockpiles because of prospecting activities over an area of approximately 500m^2.
7. Primary processing of diamond gravels at a processing plant over an area of approximately 400 m^2. The plant will be mobile and its position will be linked to the locations of pits and trenches. The final position of the plant will be confirmed once non-invasive prospecting activities have been completed.
8. The development of infrastructure for the storage and handling of fuel in containers with a combined capacity of 80m^3.
9. The establishment of a slimes dam because of prospecting activities. The size of this facility will be confirmed.
10. General site infrastructure including office complexes, workshop facilities, storage facilities, concrete bund walls and diesel depots, ablution facilities, water storage tanks and pipelines.
11. Construction of a reservoir with a capacity of more than 250 m^3 for bulk water supply. The capacity of the reservoir still needs to be confirmed.

The pits and trenches will be backfilled and rehabilitated on a continuous basis during prospecting. No material will be permanently dumped on surface. Washed and screened material will be backfilled into mined out areas. Stripped topsoil will be replaced over backfilled areas. The rehabilitation plan will be presented in more detail during the EIA phase of the project.

2.2 Water Use and Management

As The project falls within the D71B and C92C quaternary catchments of the Lower Vaal Water Management Area, as shown in ***Annex B***. Although catchment C92C geographically forms part of the Lower Vaal Water Management Area, it was transferred to the Lower Orange Water Management Area to allow some farmers to benefit from irrigation schemes. Catchment D71B is allocated a Present Ecological State (PES) B (largely natural), while catchment C92C is a class C (moderately modified).

Rainfall in the area is low, on average 390 mm/a for Lime Acres. The rainy season is from October to March (Boscia, 2015). Droughts are common in the area.

Drinking water will be brought on-site in containers or may be sourced from a local borehole, if groundwater is of suitable quality (Boscia, 2015).

Process water will either be sourced from a suitable borehole or from local service providers (Boscia, 2015).

No pollution control dams will be established, as the gravel processing and treatment is chemical free. Water from the plant will be pumped to the slimes dam, which will also be used as a settling dam (also see ***Section 2.4***).

2.3 Waste Management

General waste will be gathered and stored in dedicated garbage bins, which will be emptied to a registered waste disposal facility in Lime Acres (Boscia, 2015).

The project will be serviced with flush toilets that will drain either into a septic tank or French drain.

An industrial waste disposal facility will be created on-site. This will include designated concrete wash bays and a fenced scrap yard. A temporary workshop and storage facility will be used for repair and maintenance. Hazardous substances, like oil and grease, will be stored at the workshops within proper spill containment. Hazardous waste will be collected by registered service providers and removed off-site for safe disposal. Diesel will be stored in a self-contained diesel depot (also see ***Section 2.4***).

No permanent waste rock dumps will be created, as waste rock will be continuously backfilled into the pits and trenches as prospecting continues.

2.4 Alternatives Considered

The property on which the proposed diamond prospecting activities will be undertaken is determined by the geology. The planned prospecting activities, including excavation of diamondiferous gravels, processing thereof and continual backfilling upon completion of prospecting, are presented as the most suitable method of undertaking the work. The Scoping Report submitted as part of the application indicates that the following alternatives to the project was considered (Boscia, 2015):

- The site infrastructure will be strategically placed and will take environmental sensitivities into consideration. The final site layout will be confirmed based on the outcome of the EIA process.
- Alternative fuel storage options were evaluated, including underground storage and mobile tanks with a metal bund wall. Due to the perceived pollution potential with these options, the most suitable fuel storage option is an above-ground tank with a concrete bund wall. The final location of the fuel storage tanks will be determined by the proximity of site operations, but also on the outcome of the environmental sensitivity analysis to be undertaken as part of the EIA process.
- Alternative water use options were investigated. The project is not situated near perennial rivers and groundwater was therefore identified as the best water source for the operation. Sourcing water from service providers was considered as an alternative. Water will be transferred with plastic pipelines due to their temporary nature and minimal anticipated environmental disturbance. A pipeline route will be designed based on the outcome of a sensitivity analysis to be undertaken during the EIA phase of the project.
- As discussed earlier, a slimes dam will be established at the operations. The location of the slimes dam will take into consideration the historic transformation of the site and existing infrastructure on the property; proximity to the processing plant; and the underlying ore bodies. The slime dam will be designed by a professional engineer to ensure that the capacity and risks associated with the facility is adequately incorporated into the designs.

3 Details of Specialist Hydrogeologist

Irene Lea is a consulting hydrogeologist that has 24 years of experience in the field of hydrogeology. She has a M.Sc. in Hydrogeology from the Institute of Groundwater Studies at the University of the Free State and is a registered Professional Natural Scientist. Her focus includes numerical groundwater flow and contaminant transport modelling, water treatment, mine dewatering, integrated water management strategies, mine rehabilitation and closure, environmental management systems, risk assessments and auditing. She worked in the mining industry for 8 years and has experience of the environmental and water related issues associated with mining. A summarised CV of Irene is presented in ***Annex A***.

3.1 Declaration of Independence

iLEH has no direct or indirect beneficial interest or contingent in HC Van Wyk Diamonds at present or in the past. iLEH will be paid a fee by the Client for completing the assessment in accordance with normal professional consulting practice. Payment of these fees is in no way contingent upon the conclusions or opinions expressed in this report.

4 Scope of work

The project entails the completion of a detailed baseline desktop study and limited fieldwork on the site with the aim to identifying site sensitivities and constraints related to the hydrogeology. The deliverable is the compilation of data in both report and GIS format and to identify and map all relevant environmental sensitivities on-site. The report includes a detailed description of the methodology followed as well as the results and conclusions of the assessment.

5 Date and Season of Site Visit

The site visit included a hydrocensus of private groundwater use within the project area. The hydrocensus was undertaken during October 2016 and represents conditions at the end of the dry season. As such, groundwater level and quality information gathered reflects the impact of low rainfall conditions on the aquifers present.

6 Our Approach

The following activities were completed as part of the study:

- All relevant legislation and guidelines were identified.
- The available dataset was evaluated to plan for the study.
- A hydrocensus was undertaken within a 3km radius around the project area. The purpose of the hydrocensus was to identify private groundwater use within the zone of influence. The information gathered during the hydrocensus forms an important component to the hydrogeological study, as it assists with conceptualising the aquifers present and identifies potential sensitive receptors. The hydrocensus information is used to determine the importance of groundwater use in the sub-catchment in which the proposed project is situated, to establish the ambient groundwater quality and to plan the design of water supply boreholes to be used during the project. Groundwater use and the depth of the SWL were measured in each borehole. Groundwater samples were taken from 6 of the hydrocensus boreholes. The sampling positions were chosen to cover the entire project area. Where possible, boreholes used for domestic supply were sampled. The private boreholes were sampled per the requirements in SABS ISO 5667 series. All samples were submitted to a SANAS accredited laboratory (Waterlab) in Pretoria.

- A baseline geohydrological report was prepared, based on the information gathered. The report focuses on potential sensitivities related to groundwater as well as potential impacts identified and addresses the aquifers present, geological/hydrological features that may be a constraint or fatal flaw during the project.
- The available information was used to identify possible impacts on groundwater.
- The baseline report includes a geohydrological constraints and fatal flaw analysis.
- A hydrogeological sensitivity map was compiled for the project.

7 Baseline Groundwater Description

7.1 Geology

The geological setting for the project is presented in ***Annex B***. Regionally, the rock formations present in the project belong to the Kuruman Member, Asbestos Hills Subgroup, of the Griqualand West Basin of the Transvaal Supergroup (Johnson *et al*, 2006). Diamonds are associated with gravels found in the Daniel Alluvial Channel, as shown. These gravels are thought to be derived from erosion of the Finsch Kimberlite Pipe, which is situated NNW of the project area (Boscia, 2015). The Finsch pipe was emplaced into the Kuruman Member of the Asbestos Hills Formation of the Griqua Group. Considerable erosion of the kimberlite pipe has since taken place and this suggests that rivers downstream of the pipe could have carried diamonds into the surrounding area over time (Boscia, 2015).

The largest portion of the property is overlain by Quaternary deposits, comprising Aeolian sands (Qs) and surface limestone (Ql). The sands are reddish in colour and are interspersed with calcrete and ferricrete. The thickness of the unconsolidated material is not known at present, but is assumed to be 5 m – 10 m deep.

The diamond deposits are mainly associated with the limestone deposits (Boscia, 2015).

The Kuruman Formation (Vak) comprises banded iron formation (BIF) cycles and reaches a thickness of approximately 250m in the Prieska sub-basin. Rocks from this formation outcrop along the western boundary of the project area and form the hills in this area, as indicated on ***Annex B***. The Danielskuil Formation (Vad) outcrops further west and northwest and is generally considered as reworked Kuruman-type BIF (Johnson *et al*, 2006). The formation consists of alternating layers of shales, mudstones, jaspillite and crocodolite. Several marker horizons are present in this formation, including concretions, conglomerate and chert. The geological map suggests that the Asbestos Hills formations dip in a westerly direction in the project area.

A small outcrop of dolomite from the Lime Acres Formation (Vgl), Campbell Rand Subgroup, is present along the western boundary of the property. This formation consists of dolomitic limestone with subordinate coarsely crystalline dolomite, chert and lenses of limestone. These limestones also outcrop to the northeast and east of the project area, as shown in ***Annex B***.

A typical geological cross section is presented in ***Table 2***. The assumed lithological thickness of each unit is presented. The information was inferred from Johnson *et al* (2006).

Table 2 Typical geological cross section

Assumed thickness (m)	Description		
10	Quaternary	Surface limestone	Ql
10		Aeolian sand	Qs
50	Asbestos Hills Subgroup	Danielskuil Fm: Banded iron formation	Vad
250		Kuruman Fm: Banded iron formation	Vak
200	Campbell Rand Subgroup	Lime Acres Fm: Dolomitic limestone	Vgl

7.2 Hydrogeology

7.2.1 Occurrence of Boreholes and Springs

A hydrocensus was completed around the project area with the objective of establishing regional groundwater use patterns and ambient groundwater quality. A total of 25 boreholes were identified and visited during the hydrocensus. The locations of these boreholes are indicated in ***Annex B***.

Thirteen of the boreholes visited during the hydrocensus are currently in use. Groundwater is mainly used for livestock and game watering, but two of the boreholes (HC15 and HC16) are used for domestic supply. The average depth of the boreholes drilled is 60 m, but the drilling depth varies between 26 m and 100m, excluding the hand-dug pit (HC7).

Groundwater is abstracted from all boreholes using windpumps. The rate at which groundwater abstracted is variable. Three of the boreholes on the farm Werda (HC2, HC3 and HC20) have comparatively high reported yields, as indicated in ***Table 3***. It is possible that the higher yielding boreholes are associated with the chert and chert breccia that underlies the surficial limestone and unconsolidated sands.

It is advisable that these abstraction rates are confirmed to ensure that high performance boreholes are identified and protected during prospecting. HVWD have identified groundwater as a possible water resource to the project in the absence of reliable surface water (see ***Section 2.2***). These three boreholes may therefore be considered, but their use will depend on negotiations with the landowners. These boreholes are currently used by Mr. Oosthuizen and Mr. Lombard for livestock watering.

The yields of other boreholes identified during the hydrocensus are below 1 L/s (3600 l/hr).

The depth to groundwater varies between 3 m and 31 m, with an average depth of 22 m, in boreholes visited during the hydrocensus (***Table 3***). The depth to groundwater is affected by the geology as well as by the effects of pumping. Shallower groundwater levels (shallower than 10m) were measured in boreholes west of the project area and is associated with the Danielskuil Formation outcrops, as shown in ***Annex B***. These boreholes are not currently in use. The depth to groundwater in boreholes within the project area is around 30m below surface. Most of these boreholes are currently in use and are fitted with windpumps.

A groundwater flow contour map was generated with the available groundwater level measurements and is presented in ***Annex B***. Groundwater flows in a westerly to north-westerly direction across the project area at a gradient of 0,006 (1:167).

Table 3 **Hydrocensus borehole information**

BH ID	Lat	Long	Diameter (m)	Casing Height (m)	Depth (m)	Fitted Equipment	Static Water Level (mbgl)[1]	Groundwater Use	Extraction Rate (l/s)	Dependants	Land Owner
HC1	28° 26' 54.5"S	23° 28' 28.7"E	0.140	0.50	26.25	None.	Dry	None.	-	-	Jerg Oosthuizen: 0827893201.
HC2	28° 27' 07.0"S	23° 28' 14.9"E	0.140	2.10	47.90	Wind pump.	27.12	Game watering.	10.00	20 Springbucks, 15 Blesbucks, 2 donkeys.	
HC3	28° 28' 17.9"S	23° 28' 14.5"E	0.140	0.33	NATWL	Wind pump.	NATWL.	Livestock watering.	13.33	50 Cattle.	
HC4	28° 27' 55.3"S	23° 28' 28.5"E	0.140	0.45	NATWL	Wind pump.	NATWL.	Livestock watering.	Not known.	70 Cattle.	
HC5	28° 27' 07.3"S	23° 27' 05.0"E	0.180	0.50	>60	None.	28.72	None.	-	-	
HC6	28° 26' 29.1"S	23° 24' 07.2"E	0.180	0.83	>60	None.	3.81	None.	-	-	
HC7^	28° 26' 29.1"S	23° 24' 07.3"E	0.180	0.43	5.69	None.	2.94	None.	-	-	
HC8	28° 26' 28.1"S	23° 24' 02.4"E	0.180	0.00	>60	None.	3.94	None.	-	-	
HC9	28° 26' 31.4"S	23° 24' 02.4"E	0.180	0.00	>60	None.	9.41	None.	-	-	
HC10	28° 26' 29.9"S	23° 24' 08.7"E	0.180	0.30	NATWL	Wind pump.	NATWL.	Livestock watering.	Not known.	Not known.	
HC11	28° 27' 13.9"S	23° 27' 34.7"E	0.180	0.30	NATWL	Wind pump.	NATWL.	Livestock watering.	Not known.	Not known.	
HC12	28° 26' 34.2"S	23° 26' 53.1"E	0.180	0.30	NATWL	Wind pump.	NATWL.	Livestock watering.	Not known.	Not known.	
HC13	28° 27' 07.3"S	23° 27' 26.4"E	0.180	0.30	NATWL	Wind pump.	NATWL.	Livestock watering.	Not known.	Not known.	
HC14	28° 26' 44.7"S	23° 27' 06.2"E	0.165	0.25	37.75	None.	30.12	None.	-	-	
HC15#	28° 25' 17.2"S	23° 28' 11.6"E	0.165	0.25	35.00	Wind pump.	NATWL.	Domestic.	0.20	Farm is approx. 2000ha. 2 people, 20 cattle, 800 sheep & 200 goats.	Rudolph Lombard: 0533133447.
HC16#	28° 25' 56.3"S	23° 28' 50.0"E	0.165	0.25	40.00	Wind pump.	30.00	Domestic & Livestock.	0.04		
HC17#	28° 25' 58.3"S	23° 28' 28.0"E	0.165	0.25	100.00	Wind pump.	30.00	Livestock watering.	0.28		

BH ID	Lat	Long	Diameter (m)	Casing Height (m)	Depth (m)	Fitted Equipment	Static Water Level (mbgl)[1]	Groundwater Use	Extraction Rate (l/s)	Dependants	Land Owner
HC18[#]	28° 25' 53.3"S	23° 26' 55.0"E	0.165	0.25	100.00	Wind pump.	30.00	Livestock watering.	0.83		
HC19[#]	28° 25' 46.3"S	23° 27' 06.0"E	0.165	0.25	100.00	Wind pump.	Dry.	-	-		
HC20	28° 26' 16.9"S	23° 27' 07.7"E	0.165	0.30	80.00	None.	31.47	-	5.56		
HC21[#]	28° 25' 16.5"S	23° 28' 11.9"E	0.165	0.30	40.00	Wind pump.	30	Livestock watering.	0.33		
HC22	28° 27' 50.4"S	23° 27' 46.9"E	0.165	0.50	-	None.	-	-	-	-	Jerg Oosthuizen: 0827893201.
HC23	28° 26' 56.1"S	23° 26' 30.3"E	0.165	0.50	-	None.	-	-	-	-	
HC24	28° 27' 01.8"S	23° 27' 47.2"E	0.165	0.50	-	None.	-	-	-	-	
HC25	28° 27' 04.3"S	23° 27' 39.4"E	0.180	0.62	>60	Wind pump.	30.73	Livestock watering.	-	Not known.	

1 - All wind pump measurements taken whilst pumping.

Good performance refers to no dry conditions since being used.

NATWL - No access to water level.

^ Water pit

Based on owner information and not field measurements.

7.2.2 National Groundwater Database Boreholes

In addition to the hydrocensus, the NGDB was consulted to identify boreholes recorded by the DWS in the region. A total of 47 boreholes were identified within or near the application area, as shown in ***Annex B*** and ***Table 4***. The complete dataset evaluated is presented in ***Annex C***.

The information suggests that regionally, the average depth to groundwater is 28 m, varying between 2 m and 129 m below surface. The depth to water strikes also vary, but is on average 64 m. If HVWD intend to drill boreholes for water supply to the project, these should be a minimum of 100m deep, based on this information.

The average discharge rate from the boreholes in the NGDB is comparable to that recorded during the hydrocensus. The average pumping rate in the database is 1.4 L/s (5040 L/hr), varying between 0.01 L/s – 5 L/s (36 L/hr and 18000 L/hr). The water strikes are associated with dolomite, and quartzite, but also with intrusions like dolerite and diabase.

Table 4 National Groundwater Database Boreholes

BH ID	Latitude	Longitude	SWL (m)	Discharge rate (l/s)	Depth to water strike (m)	Lithology associated with water strike
2823DA00022	-28.50452	23.50223	17.70	0.16	40.20	Dolomite
2823DA00023	-28.50452	23.50224	-	0.88	35.70	Dolomite
2823BC00095	-28.49979	23.52862	35.50	No information		
2823AD00127	-28.48202	23.48972	11.50	0.70	No information	
2823AD00126	-28.48174	23.48972	-	3.70	No information	
2823AD00128	-28.48146	23.48917	17.30	0.70	No information	
2823BC00094	-28.47758	23.51334	14.60	No information		
2823AD00104	-28.47563	23.41028	47.10	No information		
2823AD00118	-28.47119	23.46973	16.10	No information		
2823AD00116	-28.46563	23.44111	15.90	No information		
2823AD00117	-28.46452	23.46278	18.20	No information		
2823AD00105	-28.45979	23.38806	30.40	No information		
2823BC00093	-28.45924	23.52501	No information			
2823BC00090	-28.45424	23.50139	No information			
2823AD00114	-28.45229	23.45751	21.60	No information		
2823AD00112	-28.45174	23.47056	18.20	No information		
2823AD00113	-28.45146	23.46084	21.10	No information		
2823AD00014	-28.45035	23.45834	128.01	0.77	128.01	Quartzite
2823AD00015	-28.45035	23.45834	128.93	1.08	128.93	Quartzite
2823AD00016	-28.45035	23.45834	128.93	1.08	128.93	Quartzite
2823AD00073	-28.45035	23.45834	24.38	1.06	24.38	Diabase
2823AD00074	-28.45035	23.45834	35.05	1.16	42.67	Dolerite
2823AD00111	-28.44868	23.46362	19.05	No information		
2823AD00115	-28.44535	23.45139	19.70	No information		
2823BC00091	-28.44368	23.52668	9.20	No information		
2823AD00009	-28.44257	23.39945	30.48	0.49	41.45	BIF
2823AD00010	-28.44257	23.39945	18.28	0.01	16.45	Dolerite
2823AD00110	-28.44257	23.40001	9.40	No information		
2823AD00108	-28.44118	23.40056	3.80	No information		
2823AD00107	-28.44118	23.40195	3.50	No information		

BH ID	Latitude	Longitude	SWL (m)	Discharge rate (l/s)	Depth to water strike (m)	Lithology associated with water strike
2823AD00106	-28.44118	23.40223	3.40	No information		
2823AD00103	-28.44007	23.40362	3.10	No information		
2823AD00109	-28.43979	23.39361	1.70	No information		
2823AD00129	-28.43979	23.40417	3.90	No information		
2823AD00064	-28.43979	23.40556	19.81	1.32	38.1	Dolomite
2823AD00065	-28.43925	23.40834	No information			
2823AD00067	-28.43924	23.40834	45.72	1.16	70.71	Dolerite
2823AD00121	-28.43285	23.47445	No information			
2823AD00120	-28.4323	23.48056	15.00	No information		
2823AD00122	-28.43146	23.44861	34.70	No information		
2823AD00123	-28.42952	23.45167	No information			
2823BC00092	-28.42341	23.51001	8.20	No information		
2823AD00066	-28.42146	23.41834	30.17	4.99	35.05	Dolomite
2823AD00124	-28.42091	23.46973	19.10	No information		
2823AD00125	-28.42063	23.46973	20.30	No information		
2823AD00075	-28.41702	23.46612	48.76	1.27	103.63	Dolerite
2823AD00119	-28.41646	23.4925	9.10	No information		

7.3 Aquifers Present

Two aquifers were identified from the available information. These include:

- The Quaternary Aeolian, alluvial and surficial limestone deposits present typically form unconsolidated intergranular aquifers. The thickness of these aquifers is expected to vary significantly and could be a thin cover of soil and calcrete in places, but also thicker than 50m where Aeolian sand dunes are present. Where present, the aquifers typically have a higher permeability (1 m/d – 100 m/d) and receive recharge from direct rainfall. As such, it can act as a preferential flow path to groundwater and potential contamination from surface sources associated with the project. The rate of recharge to these aquifers can be high (10 % – 20 % of the MAP) due to the unconsolidated nature of the sediments, but is expected to take place at irregular intervals as rainfall patterns vary in this arid part of South Africa. High rates of evapotranspiration in this region will reduce the volume of water that is available for infiltration to the aquifer. The extent to which the Quaternary deposits are water-bearing is often dependent on the presence of perennial streams. These formations are not often exploited on their own, but generally in conjunction with the underlying fractured rock aquifers. For this reason, the aquifers are considered minor in the project area.
- Weathered and fractured rock aquifers are formed in zones of weathering, fracturing, intense jointing, breciation and shearing in the BIF and dolomite of the Asbestos Hills Subgroups. Dolerite intrusions (dykes and sills) can occur, but there is no evidence of intrusions within the project area. The depth of the water-bearing geological structures in the region varies between 16 m and 129 m below surface (NGDB, ***Table 4***). Groundwater occurs typically in fresh rock at these depths, below the weathered zone, and not in the transition between weathered and fresh rock, as in the case in higher rainfall areas. The permeability of the fractured rock aquifers varies significantly, depending on the nature of fractures. In this region, silicification and chertification of fracture zones can significantly reduce fracture permeability. Typically, permeability can vary between 0,01 m/d and 10 m/d and the aquifers are expected to be highly heterogeneous. Major fault zones can

yield groundwater at high rates. The rate of recharge to the fractured rock aquifer is expected to be lower than that discussed for the primary aquifers above, probably in the region of 1 % – 3 % of the MAP. Farmers and landowners typically target these aquifers for water supply. As groundwater is often the sole source of water available to farmers in the area, the weathered and fractured rock aquifers are classified as minor and they seldom produce large quantities of groundwater and have variable permeability. The aquifers are however important for supply of water locally and supply baseflow to rivers and streams in the area.

- Karst aquifers could be associated with the dolomites of the Lime Acre Formation in the region. The dolomites in the project area are expected to be coarse recrystallized dolomite with interbedded chert. Karst aquifers are characterised by conduits, dolines, caverns and even sinkholes. Such structures can store large volumes of water and often result in intermittent or permanent springs. Although dolomite has a relatively low primary permeability, the development of karstic features due to dissolution of the carbonate rock along faults and fractures, results in a high secondary permeability, which controls the storage and movement of groundwater. Dolomitic karst aquifers typically form high-yielding aquifers and are therefore form important water resources. For this reason, they are classified as major aquifers. These aquifers are vulnerable to pollution due to high associated permeability and rapid groundwater flow rates. Dolomite also has a low capacity to attenuate pollution. The permeability of dolomites is highly variable and can range from 1 m/d – 1000 m/d or even higher, depending on the presence of cavities. The rate of recharge to these aquifers are also expected to be high, typically >20 % of the MAP. Within the project area, only a small dolomitic outcrop is present in the western part of the property (see ***Annex B***).

7.4 Ambient Groundwater Quality

Six groundwater samples were taken during the hydrocensus for chemical analysis. The results of the analyses are presented in ***Table 5*** and in ***Annex D***. The certificates of analyses are provided in ***Annex D***.

The groundwater analyses presented in ***Table 5*** are compared to the SANS 241:2015 Drinking Water Standards. Results indicated that the water quality is generally fit for domestic use. The exceptions are iron and manganese in HC8 and HC9 and ammonia in HC9.

Iron is an abundant element in the BIF formations present in the project area. The elevated iron and manganese concentrations could therefore be a natural occurrence. It could also be because of rusted pipes in the boreholes sampled. Excessive ingestion of iron may result in haemochromatosis. It could also result in the proliferation of iron-oxidising bacteria, which manifests as a slimy coating on the pipes. Elevated iron concentrations can also result in discolouration of water supplies and other aesthetic impacts. Iron concentrations between 1mg/L – 10mg/l may have an impact on the taste of the water and will stain plumbing. It may also result in slight health effects in young children and sensitive individuals.

Elevated manganese concentrations could indicate anaerobic conditions where soluble manganese has been mobilised. The concentrations recorded in H8 and 9 may cause severe staining and taste effects, but is not expected to have negative health effects. This water can be treated with an oxidising process, like the addition of chlorine, to convert soluble manganese to an insoluble oxide, which can be filtered from the water.

Ammonia tends to be elevated where organic decomposition under anaerobic conditions takes place and could be an indication of the impact of agricultural activities on groundwater quality. Ammonia is not toxic to man, but can lead to nitrate formation, which may affect taste and odour in the water. A concentration exceeding 10mg/l is generally thought to be unacceptably high for domestic use and can compromise chlorination of the water.

The groundwater sampled has a neutral to slightly alkaline pH. The total dissolved salts, indicated by the EC and TDS concentrations, are low and comply with drinking water standards. The groundwater sampled is hard and will result in scaling of pipes and plumbing. Hardness is determined by the calcium and magnesium concentrations in the water. Excessive hardness can give rise to scaling and results in an increase in soap required to produce lather when bathing and in household cleaning. The natural hardness of groundwater is influenced by the geology and the presence of soluble calcium and magnesium minerals. The water can be softened by the addition of lime.

Table 5 Ambient Groundwater Quality

Analyses in mg/ℓ	**SANS 241-1:2015 Drinking Water Standard**	**HC2**	**HC3**	**HC8**	**HC9**	**HC15&21**	**HC6**
pH – Value at 25°C	5 - 9,7	7.3	7.3	7.0	7.1	7.1	7.4
Electrical Conductivity in mS/m at 25°C	170	83.6	62.9	36.0	44.0	118	49.8
Total Dissolved Solids at 180°C *	1200	538	356	248	218	810	326
Total Alkalinity as $CaCO_3$	NS	328	264	164	180	320	240
Bicarbonate as HCO_3 *	NS	400	322	200	219	390	293
Chloride as Cl	300	60	40	22	25	99	15
Sulphate as SO_4	250 (aesthetic)	48	28	<2	<2	209	12
Fluoride as F	1,5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nitrate as N	11	7.5	3.0	0.1	0.1	7.5	2.8
Nitrite as N	0,9	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ortho Phosphate as P	NS	<0.1	<0.1	<0.1	0.2	<0.1	<0.1
Total Cyanide as CN [s]	0,2	0.01	0.01	0.01	<0.01	0.01	<0.01
Chemical Oxygen Demand as O_2 (Total)	NS	<10	<10	44	94	<10	<10
Free & Saline Ammonia as N	1,5	0.1	<0.1	1.0	**11**	<0.1	<0.1
Sodium as Na	200	15	18	15	14	41	9
Potassium as K	NS	2.6	2.5	3.4	5.0	3.1	2.6
Calcium as Ca	NS	126	82	31	30	165	65
Magnesium as Mg	NS	28	24	16	15	37	23
Aluminium as Al (Dissolved)	0,3	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Antimony as Sb (Dissolved)*	0,02	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Arsenic as As (Dissolved)*	0,01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Barium as Ba (Dissolved)*	0,7	<0.025	<0.025	0.148	0.177	<0.025	<0.025
Beryllium as Be (Dissolved)*	NS	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Boron as B (Dissolved)*	2,4	0.049	0.029	0.049	0.061	0.050	<0.025
Cadmium as Cd (Dissolved)	0,003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Total Chromium as Cr (Dissolved)	0,05	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Cobalt as Co (Dissolved)	NS	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Copper as Cu (Dissolved)	2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

Analyses in mg/ℓ	**SANS 241-1:2015 Drinking Water Standard**	**HC2**	**HC3**	**HC8**	**HC9**	**HC15&21**	**HC6**
Iron as Fe (Dissolved)	0,3 (aesthetic)	<0.025	<0.025	**6.25**	**3.06**	<0.025	<0.025
Lead as Pb (Dissolved)	0,01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Manganese as Mn (Dissolved)	0,1 (aesthetic)	<0.025	<0.025	**0.718**	**1.68**	<0.025	<0.025
Uranium as U (Dissolved)*	0,03	0.001	0.001	<0.001	<0.001	<0.001	<0.001
Vanadium as V (Dissolved)*	NS	<0.025	<0.025	<0.025	0.025	0.028	<0.025
Zinc as Zn (Dissolved)	NS	0.099	0.065	<0.025	<0.025	0.114	0.058
% Balancing *		97.6	93.8	97.0	99.4	96.6	99.3

The results of the groundwater analyses are presented graphically in a Piper diagram in ***Annex D***. This trilinear diagram is used to plot the equivalent concentrations of several elements to characterise the types of groundwater in the project area. The diagram indicates that the groundwater is calcium-bicarbonate dominant, which is expected in the geological setting.

The groundwater samples plot in an area on the Piper diagram that indicates mixing chemical processes, typically of recently recharged water.

8 Hydrogeological Sensitivities

8.1 Activities that May Impact on Groundwater

8.1.1 Using Groundwater as Water Supply to the Project

Groundwater was identified as the best water resource for the HVWD operation (Boscia, 2015).

If water for the project is to be sourced from boreholes, existing private groundwater use may be negatively affected, as the abstraction of groundwater by HVWD will be in direct competition with existing groundwater users in the area. The processing plant water demand is estimated to be approximately 18 000 L/hr (5 L/s) over an 8-hour shift.

Three of the boreholes identified during the hydrocensus have reported yields higher than the regional average, including HC6, HC8 and HC9. All three boreholes are within the project property, as indicated in ***Annex B*** and could therefore be considered for water supply to the project. HVWD has started negotiations with Mr Oosthuizen, the landowner, regarding the use of the three boreholes on his land. As part of these negotiations, HVWD will undertake to complete pump tests on the boreholes to confirm their sustainable yields.

The reported yields for the three boreholes range between 5 L/s and 10 L/s. If these boreholes are pumped at 8 hours per day, their combined yield is expected to meet the water demand for the plant. Given the reported yield, HVWD could alternate pumping from the three boreholes to ensure that over-abstraction does not occur. The use of these boreholes by HVWD would strictly depend on negotiations with landowners, as mentioned.

Based on the hydrocensus information, groundwater is extracted from the underlying fractured and possibly karst aquifers in these boreholes. These rocks underlie the superficial limestone and unconsolidated sediments indicated on the geological map (***Annex B***). Groundwater levels in these boreholes are shallower than 10 m. It is likely that the surficial limestone formations in the vicinity of the boreholes may be water-bearing, especially after a rainfall event. In this case, the limestones will contribute to the volume of groundwater that is available for abstraction from the underlying fractured rock aquifers and care should be taken not to unnecessarily disturb the formation during diamond prospecting.

A high level assessment of the zone of impact of groundwater abstraction from these boreholes, based on literature based permeabilities, indicates that the borehole capture zones are roughly 3 km around each borehole, as demonstrated in Annex B. The means that groundwater abstracted from the three boreholes may be attracted from aquifers within a 3 km radius around each borehole. It is acknowledged that combined abstraction from the three boreholes will result in interception between the borehole capture zones, but this cumulative impact cannot be assessed with the available dataset. The borehole capture zones may therefore be slightly larger due to the cumulative impact of groundwater abstraction. To counter the effect of interference between the three boreholes during pumping, an abstraction programme during which pumping from the boreholes is alternated is recommended.

Trenching and excavations during diamond prospecting will not extend to the depths of the water-bearing fractures intercepted in the three high-yielding boreholes. Diamond prospecting may however affect the rate of recharge to the fractured rock and possibly karst aquifers, thus affecting groundwater levels and ultimately groundwater availability. The surficial limestones and alluvium are expected to play an important role in the rate of recharge to the underlying aquifers due to their unconsolidated nature and anticipated high permeabilities.

Please note that these calculations are not based on-site-specific aquifer parameters and only a low level of confidence can therefore be assigned to the impact assessment. The calculations do however indicate that groundwater yield within the project property could potentially be negatively affected during prospecting, due to the disturbance of surficial sediments. For this reason, borehole yields reported during the hydrocensus may be reduced during the life of the project. The extent to which this impact will affect borehole yield cannot be estimated with the available dataset and should be confirmed through on-going monitoring in the boreholes identified.

Two of the private boreholes identified during the hydrocensus fall within the 3 km zone around the earmarked abstraction boreholes. One of these, HC10, is used for livestock watering by the landowner. This borehole is ranked as high sensitivity boreholes for the purpose of the impact assessment, as indicated on ***Annex B***. This is due to the fact that potential abstraction of groundwater to supply diamond-prospecting activities may impact on regional groundwater availability as mentioned above. Boreholes that are in use may therefore experience reduced yield as a result. As groundwater is the sole source of water supply to landowner, a negative impact on borehole performance will result in a significant impact and they are therefore highlighted as high sensitivity boreholes.

It is noted that the expected zone of impact as a result of groundwater abstraction for water supply to the diamond prospecting activities is unlikely to extend onto the application area, as shown in ***Annex B***. Other boreholes used for private groundwater abstraction, and not on Mr. Oosthuizen's farm, should therefore not be affected by the proposed groundwater abstraction.

Disturbance of the surficial limestone and the unconsolidated sediments during prospecting may affect the rate of recharge to the underlying fractured rock aquifers. There is a small possibility that this could impact on the yield of boreholes that are currently in use within the application area. For this reason, these boreholes are assigned a high sensitivity, as indicated on ***Annex B***. It is important that no prospecting takes place in the immediate vicinity of such boreholes and that unnecessary surface disturbance is avoided.

Other boreholes present in the project area that are not currently in use are assigned a medium sensitivity from a groundwater perspective due to their presence and potential for use in future.

8.1.2 Contamination of the Shallow Aquifer Systems Because of Surface Activities

The Aeolian sand, surficial limestone and alluvial aquifers present within the project area are vulnerable to surface sources of contamination due to their perceived high expected permeability, unconfined nature and role in the rate of recharge to the underlying fractured rock aquifers. Groundwater contamination may therefore occur because of hydrocarbon (oil and diesel) spills and slimes deposition within the project area. Groundwater contamination may also be associated with sewage spills and leachate generated by or spills from waste management areas. For this reason, these sediments are considered a medium sensitivity and should be protected during diamond prospecting. It is acknowledged that the sediments will be destroyed during trenching and excavations, but they should be protected in the plant area and where hazardous material (like diesel) is stored and in areas where vehicles are serviced and maintained.

The outcrop of dolomite to the west of the project area is designated as a high sensitivity area from a groundwater perspective. This is because the dolomitic aquifer is considered a major aquifer and that it is vulnerable to groundwater contamination, as discussed above. This area should therefore be avoided during prospecting.

8.2 Residual Impacts

If groundwater will be abstracted for use during prospecting, pumping will cease at the end of the project. This will result in a recovery of groundwater levels and a reduction in the residual impacts associated with groundwater abstraction. The rate at which groundwater levels would recover once pumping ceases is expected to be quick, probably within a few days. This must however be confirmed through groundwater monitoring during the decommissioning phase of the project.

To ensure that the long-term residual impacts on groundwater levels and quality is minimised, it is important that the trenches and excavations are rehabilitated in an efficient manner during prospecting. This must entail backfilling and shaping of areas where prospecting has been completed.

All permanent facilities must be removed upon closure. This will include the associated equipment, material and waste on-site.

8.3 Potential Cumulative Impacts

The most significant cumulative impact identified at present involves that of additional groundwater abstraction for the project. As discussed above, this additional groundwater abstraction will be in direct competition with the existing groundwater users. The cumulative impact of groundwater abstraction is discussed above. Please note that a low level of confidence is assigned to the assessment. For this reason, the impact of groundwater abstraction should be confirmed through on-going monitoring during the project.

9 Areas to be Avoided

Based on the results of the hydrogeological assessment, it is recommended that the following areas are avoided as part of the planning and design phase of the project:

- The dolomitic outcrop situated in the western part of the application area must be avoided as it is vulnerable to surface sources of contamination, including hydrocarbon and sewage spills and leachate and/or spills from waste sites and seepage from the proposed slimes dam. No prospecting or surface activities must take place over this area. The extent of the dolomites is ranked as a high sensitivity from a groundwater perspective, as indicated in ***Annex B***.
- Existing private boreholes should be protected during the project. Diamond prospecting should not be undertaken within the immediate vicinity of private boreholes that are in use. These boreholes are ranked as a high sensitivity, as indicated in ***Annex B***.

10 Assumptions, Uncertainties and Data Gaps

The findings of the hydrogeological study are based on the information presented in this report. The following assumptions and limitations are noted:

- The discussions presented in this report are based on a desktop study undertaken on publicly accessible information for the area as well as a hydrocensus completed within the application area. No site-specific aquifer characteristics are currently available. Literature based permeability values were used to complete the aquifer description and impact assessments.
- It was assumed that HVWD would successfully negotiate the use of three private boreholes (HC6, HC8 and HC9) for water supply to the project. The impact assessment presented in the report is based on this assumption.

11 Project Findings

The project findings are summarised in ***Table 6*** below.

Table 6 Summary of Hydrogeological Impacts

Project stage	Impact	Comment	Rating
Planning and design Construction Operational Decommissioning Closure and rehabilitation	Reduction in groundwater availability in private boreholes due to groundwater abstraction by HVWD	Groundwater abstraction for use during the diamond prospecting may compete with local groundwater use. As groundwater is the sole source of water to farmers, existing private borehole in use are ranked as a high sensitivity.	High sensitivity
Planning and design Construction Operational Decommissioning Closure and rehabilitation	Contamination of the dolomitic aquifer	The dolomitic outcrop in the western part of the application area is ranked as a high sensitivity due to its perceived vulnerability to groundwater contamination. This area should be avoided during prospecting.	High sensitivity
Planning and design Construction Operational Decommissioning Closure and rehabilitation	Reduction in groundwater availability in private boreholes due to groundwater abstraction by HVWD	The estimated borehole capture zone for the three high-yielding boreholes within the project area is 3 km around each borehole. This zone is ranked as a medium sensitivity from a groundwater availability perspective	Medium sensitivity
Planning and design Construction Operational Decommissioning Closure and rehabilitation	Groundwater contamination from surface spills	Aeolian sand, surficial limestone and alluvial deposits are vulnerable to contamination originating from hydrocarbon, sewage spills and seepage from the proposed slimes dam. These deposits must be protected in the plant area and where vehicles are serviced and maintained.	Medium sensitivity

12 Implications of Project Findings

The project findings indicate that it is important to quantify the anticipated impacts on groundwater through on-going groundwater monitoring during prospecting. This will enable the confirmation of buffer zones and to identify unacceptable impacts. Where the alluvial, surficial limestone and Aeolian sands are not disturbed during prospecting, they should be preserved to prevent disruption of the recharge of rainwater to the underlying fractured rock aquifers. In the plant area, the surficial deposits are vulnerable to groundwater contamination and must therefore be protected.

13 Proposed Mitigation Measures for Inclusion in the EMPr

13.1 Management Plan to Protect Groundwater Availability

As a precautionary measure, a buffer zone of 3 km is set around each of the three boreholes identified for groundwater supply to the project on the application property, as a medium sensitivity area. This zone assumes that the three boreholes may be used for groundwater supply to the prospecting project, depending on the outcome of the proposed pump tests. This zone is based on the requirements a provisional impact assessment based on literature input.

The sustainable yield of the three boreholes earmarked for groundwater supply to the diamond prospecting project must be confirmed through the completion of appropriate pump tests. The effect of borehole interference during groundwater abstraction should also be determined during the pump tests. This information must be used to develop a sustainable groundwater abstraction schedule, which must be aimed at preventing over-abstraction of the boreholes.

Private boreholes in use within this zone must be monitored during prospecting, as proposed in ***Table 7***. The monitoring results must be used to confirm the impact of groundwater abstraction by HVWD on regional groundwater use. The results of the monitoring programme should be maintained in a spreadsheet or similar software to enable the assessment of trends as well as to trigger actions, should negative impacts become apparent through the monitoring programme. Monitoring results must also be submitted to the DWS on a regular basis.

Should the results of the groundwater monitoring programme indicate that existing or future private groundwater use is negatively impacted by the project, an alternative water resource should be identified and made available to the affected party through a negotiated process.

13.2 Management Plan for Surface Sources of Contamination

In most instances, the hydrogeological impacts associated with this type of project relates to spills and leaks, which can be managed through the implementation of good housekeeping practices, regular inspections as well as sound environmental management programmes and training. The regional extent of these impacts is not expected to be significant, but would rather be restricted to the site.

For this reason, it is important to ensure that diesel is stored in a suitably contain facility that will prevent overflowing and spills.

All vehicle maintenance and service should be undertaken on a paved area with suitable storm water management and oil traps. Drip trays should also be used, where appropriate.

Soil must be stripped from the area earmarked for the slimes dam and the ground must be compacted prior to slimes deposition to limit potential groundwater contamination. Seepage from the proposed slimes dam must be captured and diverted back into the mine water balance for re-use.

14 Conditions for Environmental Authorisation

The following hydrogeological conditions for environmental authorisation should be considered:

- No development should take place on the dolomitic outcrop in the western corner of the application area.
- No diamond prospecting should be undertaken in the immediate vicinity of existing private boreholes that are in use. If this cannot be avoided, HVWD should enter negotiations with the landowner to discuss potential impacts and to investigate alternative boreholes or water resources.
- The alluvial, surficial limestone and Aeolian sands must be protected against groundwater contamination in the plant area.

15 Monitoring Requirements

The groundwater monitoring requirements for the project are summarised in ***Table 7***.

Table 7 Proposed Groundwater Monitoring Requirements

Monitoring target	Frequency	Monitoring requirements	Monitoring objective
Private boreholes within a 3km radius around HVWD abstraction boreholes	Quarterly	Depth to groundwater level Borehole yield Field-measured pH, EC and TDS	<5% variation from baseline (initial) measurements

It is proposed that the yields of boreholes that are currently in use and that fall within the zone of influence of groundwater abstraction by HVWD are determined prior to the commencement of pumping for diamond prospecting. This is a measure taken by HVWD to ensure that possible future claims of loss of borehole yield against them can be dealt with on a scientific basis.

16 Professional Opinion

In my professional opinion, the most significant impact of the project on the hydrogeology is that of the cumulative impact of groundwater abstraction on existing groundwater users. If groundwater is to be sourced for water supply to the prospecting project, this should be undertaken with cognisance of existing groundwater use and should be undertaken in a manner that will not detrimentally impact on regional groundwater use patterns. As groundwater is the sole source of water to the surrounding landowners, alternative water resources must be negotiated if prospecting activities results in a reduction in groundwater availability. This can only be confirmed through on-going groundwater monitoring during prospecting. Surface sources of contamination can be managed by implementing good housekeeping and safety measures. With a sound groundwater management and monitoring programme, the project could be authorised. HVWD must however demonstrate that they have the technical and financial means to protect the aquifers and existing groundwater users during the project, as groundwater is the sole water resource to the landowners within the project area.

To this regard, the areas to be avoided are listed in Section 9; the provisional hydrogeological management measure are discussed in Section 13 and the proposed monitoring programme is listed in ***Table 7*** above.

17 Consultation Process

No formal consultation process was undertaken as part the hydrogeological specialist study. Discussion were held with landowners during the hydrocensus.

18 REFERENCES

Boscia, 2015. Scoping Report for listed activities associated with Mining Right and/or bulk sampling activities including trenching in cases of alluvial diamond prospecting, Ref. No 30/5/1/1/2/11779PR, dated 15 July 2015.

Johnson, M.R., Annhaeusser, C.R. and Thomas, R.J. (Eds), 2006. The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria, 691 pp.

SANS241-1:2015. South African National Standard – Drinking Water, Part 1: Microbiological, physical, aesthetic and chemical determinants, dated March 2015.

Annex A – Curriculum Vitae: Irene Melville Lea

SHORT CV Irene Lea

Personal Information

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Employment

Current Position:

Consulting Hydrogeologist and Environmental Scientist
Sole Proprietor, Irene Lea Environmental and Hydrogeology cc (ILEH)
September 2009 – Present

Previous Employment:

Pamodzi Gold and its predecessors – Group Environmental Manager (Dec 2002 – July 2009)
Groundwater Consulting Services – Water Unit Manager (Jan 1996 – Nov 2002)
CSIR – Staff Hydrogeologist (January 1992 – December 1995)

Professional Registration

Professional Natural Scientist (SACNASP, Reg. No. 400278/06)
In the process of obtaining EAPSA Registration

Education

B.Sc. Geology and Mathematics, University of Stellenbosch, 1988 - 1990
B.Sc. (Hons) Geology, University of Stellenbosch, 1992
M.Sc. Geohydrology, Institute for Groundwater Studies, University of the Free State, 1996 - 1997

Experience

Irene has 24 years experience in the groundwater modelling and mining industry. She has a M.Sc. in Geohydrology and is a registered Professional Natural Scientist. Her focus includes numerical groundwater flow and contaminant transport modelling, mine water treatment, mine dewatering, integrated water management strategies, mine rehabilitation and closure, environmental management systems, risk assessments and auditing. She worked in the mining industry for 8 years and has experience of the environmental and water related issues associated with mining. A project that she managed was nominated and short listed for a Nedbank Green Mining Award in 2006.

Recent Projects

Groundwater flow and contaminant transport modelling:

- Assmang Dwarsrivier Chrome - Groundwater IA and Management Plan (Groundwater Consulting Services, 2010)
- Xstrata Alloys Lesedi Power Station – Groundwater IA and Management Plan (Digby Wells Environmental, 2010)
- Mashala Resources Penumbra Colliery – Groundwater model for an Integrated WULA (Digby Wells Environmental, 2010)
- Anglo Coal Coalbrook Discard Dump – Groundwater Closure Plan (Marius van Biljon 2010/2011)
- Harmony Nooitgedacht Tailings Dam – Groundwater Impact Assessment (Golder and Associates, 2010/2011)
- Kumba Iron Ore Thabazimbi - Groundwater IA and Management Plan (Groundwater Consulting Services, 2010/2011)
- Foskor Selati Tailings Dam – Simulation of groundwater interception (Digby Wells Environmental, 2011)
- Aquila Avontuur/Gravenhage Project – Mine dewatering model (Jones and Wagener, 2011)
- Rand Gold Mali Loulo Tailings Dam – Groundwater Impact Assessment (Digby Wells Environmental, 2011)
- Harmony Kalgold – Dewatering Schedule and Mine Closure Plan (Marius van Biljon, 2011)
- Exxaro Matla Colliery – Groundwater Impact Assessment (Golder and Associates, 2011)
- Kumba Iron Ore Thabazimbi – Dewatering strategy (GCS, 2011)
- Sephaku Cement – Dwaalboom Groundwater Impact assessment (AGES, 2011)
- AECI Modderfontein Industrial Complex, Groundwater Impact Assessment (SRK, 2012)
- Exxaro Arnot Colliery – Groundwater Impact Assessment (Golder and Associates, 2012)
- Transalloys Industrial site – Groundwater Impact Assessment (Jones & Wagener, 2012)
- Barbrook Gold Mine – Groundwater Impact Assessment (Earth Sciences Solutions, 2012)
- Tschudi Copper Mine – Dewatering and groundwater supply (Jones & Wagener, 2012)
- Vantage Gold Fields – Barbrook Mine Groundwater Impact Assessment (ESS, 2013)
- Harmony Kalgold – Optimisation of abstraction boreholes and TSF EIA (Jones & Wagener, 2013)
- Fry Metals – Contaminant Transport Model to evaluate rehabilitation options (Rison, 2013)

- Assmang Chrome - Machadodorp Works Contaminant Transport Model (ESS, 2014)
- Sebilo Resources – Perth Manganese Numerical Groundwater Model (Sebilo Resources, 2014)
- Rand Gold Mali Loulo Mine – Updated Groundwater Impact Assessment (Digby Wells Environmental, 2015)
- Vantage Goldfields – Groundwater Study for IWWMP: Lily and Barbrook Mines (Vantage Gold, 2015)
- South Deep – Numerical simulations for the closure of a Tailings Storage Facility (Rison, 2015)
- Dwarsrivier Mine – Groundwater flow and contaminant transport model (EnviroGistics, 2015)
- Braeside Colliery – Groundwater specialist study for the Scoping and EIA phases (EIMS, 2015)
- Oakleaf Colliery – Numerical groundwater model for mining right application (Digby Wells Environmental, 2015)
- Withok Tailings Storage Facility – Numerical simulations for re-commissioning of TSF (Ergo Mining, 2015)
- Dwarsrivier Mine WULA – Numerical groundwater model to assess impacts (Assmang Chrome, 2015)
- Fry Metals – Contaminant Transport Model update (Rison, 2015)
- De Wittekranz Project - Numerical groundwater model to assess impacts (EIMS, 2015)
- Tetra4 Virginia Gas Project – Groundwater specialist input and numerical modelling (EIMS, 2016)
- DRD Gold – Numerical groundwater model for Withok Tailings Storage facility (Beric Robinson Tailings, 2016)

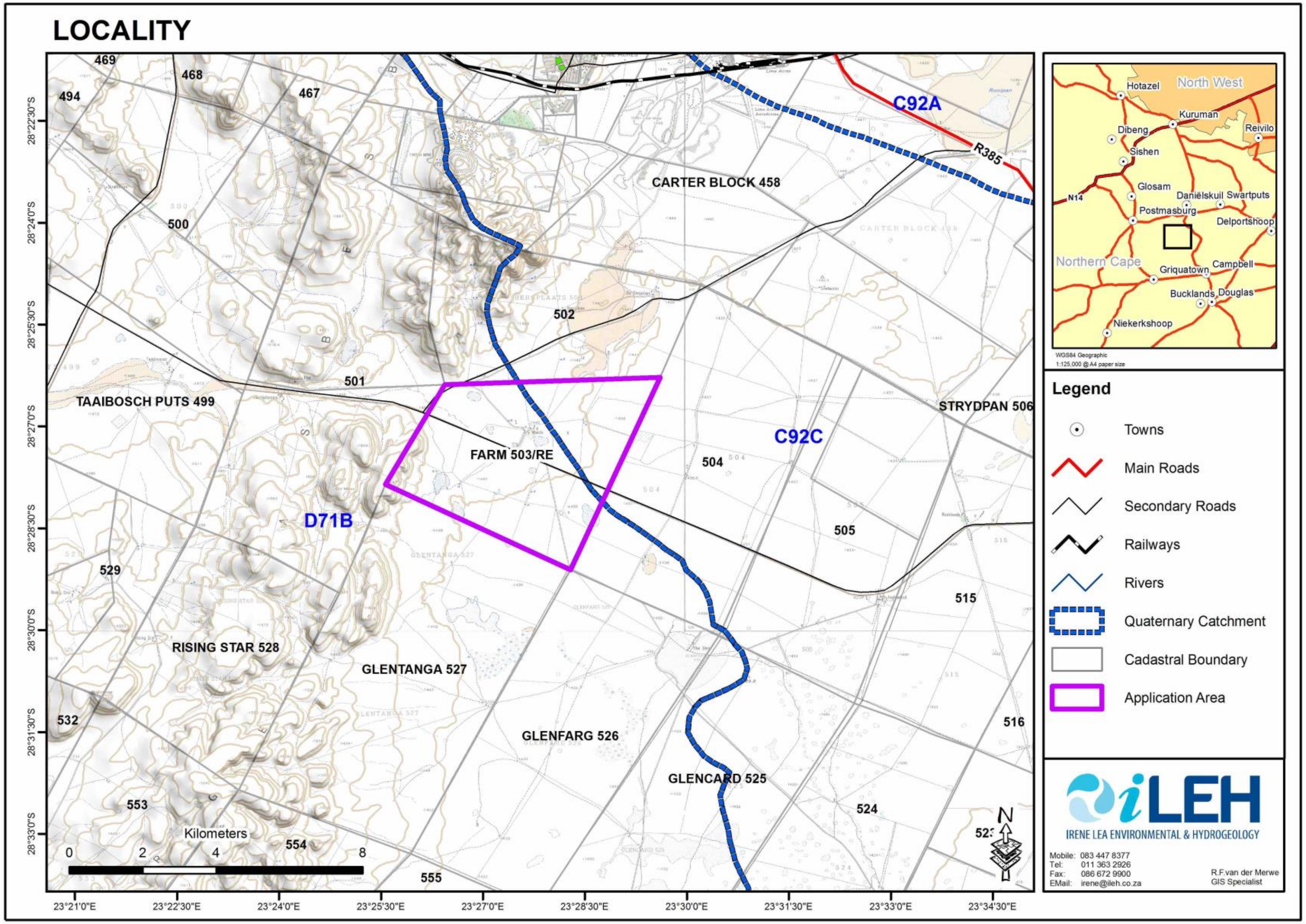
Integrated Water Management:

- Nkomati Mine Salt and Water Balance (ERM, 2007)
- Total Coal Forzando South Mine Salt and Water Balance (Groundwater Consulting Services, 2010)
- Total Coal Dorstfontein Mine Salt and Water Balance (Groundwater Consulting Services, 2010)
- Blue Ridge Platinum Salt and Water Balance (Groundwater Consulting Services, 2010)
- Sebilo Resources – Perth Manganese water use license application (Sebilo, 2014)
- Vantage Goldfields – Water Balance: Lily and Barboork Mines (Vantage Gold, 2015)
- Dwarsrivier Mine – Integrated Water Monitoring Programme (Assmang Chrome, 2015)
- RK Boerdery – Water balance for piggery (Batho Environmental, 2015)
- PMG Mining – Water balance of manganese mine (Globesight, 2016)
- Sebilo – Perth Manganese Mine – Water Use License Application (Sebilo, 2016)

Water Related Environmental Management:

- Management of the construction of a river diversion (Pamodzi Gold, 2006)
- Minxcon Competent Person’s Report (Bema Gold, 2006)
- Management of the construction and commissioning of a 10 ML/d mine water treatment plant (Pamodzi Gold, 2008/2009)
- Standard Bank Due Diligence (Pamodzi Gold, 2009)
- Environmental Baseline Assessment: Bien Venue Gold Prospect (Rock & Stock, 2010)
- Environmental Baseline Assessment: Perth Manganese Prospect (Sebilo Resources, 2010)
- Prospecting Right EMP: Aquarius Chieftans and Valhallah Prospect (SRK Consulting, 2011)
- NI43-101 Technical Report - Hydrogeology: Homeland Energy (SRK Consulting, 2011)
- Zeerust Chrome Mine EMP Amendment (Assore, 2011)
- Northam Platinum Due Diligence – Hydrogeology (SRK, 2011)
- Mogale Gold Technical Assessment – Water-related issues (MSA Geoservices, 2011)
- Rustenburg Mineral Corporation EMP Amendment (Assore, 2011)
- Mogale Gold – Lancaster Dam Baseline Assessment (Mintails SA Ltd, 2011)
- Mogale Gold – Review of Rehabilitation Quantum (Mintails SA Ltd, 2011)
- Sebilo Resources – Perth Mining Right Application EMP (2012)
- Isibaya – Performance Assessment Audit (Rock & Stock, 2012)
- Lebalelo Water Users Association – Olifants River Project (Anglo Platinum, 2012)
- Capricorn Iron Melkbosch Project – Performance Assessment Audit (Rock & Stock, 2012)
- Umlabu Colliery – Due Diligence (SRK, 2012)
- Isibaya Mining Resources – Performance Assessment Audit (Rock & Stock, 2013)
- Assore – PA Audits for RMDC, ZCM and Wonderstone Operations (Assore, 2013)
- Keegan Resources - Esaase Gold Project, Ghana – Gap Analysis and ESIA (Epoch Resources, 2013)
- Galabyte (Pty) Ltd – Middelvlei Mine Environmental Management Function (Galabyte, 2014)
- Pembani Group – Evaluation of the Carolina Operations water related liabilities (Pembani, 2014)
- Obarex – Van Roois Vley Environmental Management Programme (Rock & Stock, 2014)
- Glencore & Royal Bafokeng Holdings – Boschfontein Slag Dump Groundwater Risk Assessment (EIMS, 2014)
- Sebilo Resources – Performance Assessment Audit – Perth Mine (Sebilo Resources, 2015)
- RK Boerdery – Baseline geohydrological study for piggery (Batho Environmental, 2015)
- Sungu Sungu Gas – Geohydrological study (EIMS, 2015)
- Gold mining industry – Groundwater component of a confidential Due Diligence (EBS, 2015)
- Sungu Sungu Gas – Groundwater specialist input – Scoping and EIA (EIMS, 2016)
- Kao Diamond Mine Lesotho – Groundwater specialist input – Scoping and EIA (EIMS, 2016)
- Makulu CPR – Groundwater specialist review (MSA, 2016)
- HC Van Wyk Diamponds – Groundwater input to diamond prospecting (MojaTerre, 2016)
- Black Mountain Mine – Groundwater Basic Assessment Report (The MSA Group, 2016)
- Tetra4 – Virginia Gas Project Hydrocensus (Tetra4, 2016)

Annex B – Maps and Figures


LOCALITY
469
468
467
494
500
501
502
CARTER BLOCK 458
TAAIBOSCH PUTS 499
FARM 503/RE
504
505
STRYDPAN 506
C92A
R385
C92C
D71B
529
RISING STAR 528
GLENTANGA 527
GLENFARG 526
GLENCARD 525
515
516
524
532
553
554
555
28°22'30"S
28°24'0"S
28°25'30"S
28°27'0"S
28°28'30"S
28°30'0"S
28°31'30"S
28°33'0"S
23°21'0"E
23°22'30"E
23°24'0"E
23°25'30"E
23°27'0"E
23°28'30"E
23°30'0"E
23°31'30"E
23°33'0"E
23°34'30"E
Kilometers
0
2
4
8
N
Hotazel
North West
Kuruman
Dibeng
Reivilo
Sishen
Glosam
N14
Daniëlskuil
Swartputs
Postmasburg
Delportshoop
Northern Cape
Griquatown
Campbell
Bucklands
Douglas
Niekerkshoop
WGS84 Geographic
1:125,000 @ A4 paper size
Legend
Towns
Main Roads
Secondary Roads
Railways
Rivers
Quaternary Catchment
Cadastral Boundary
Application Area
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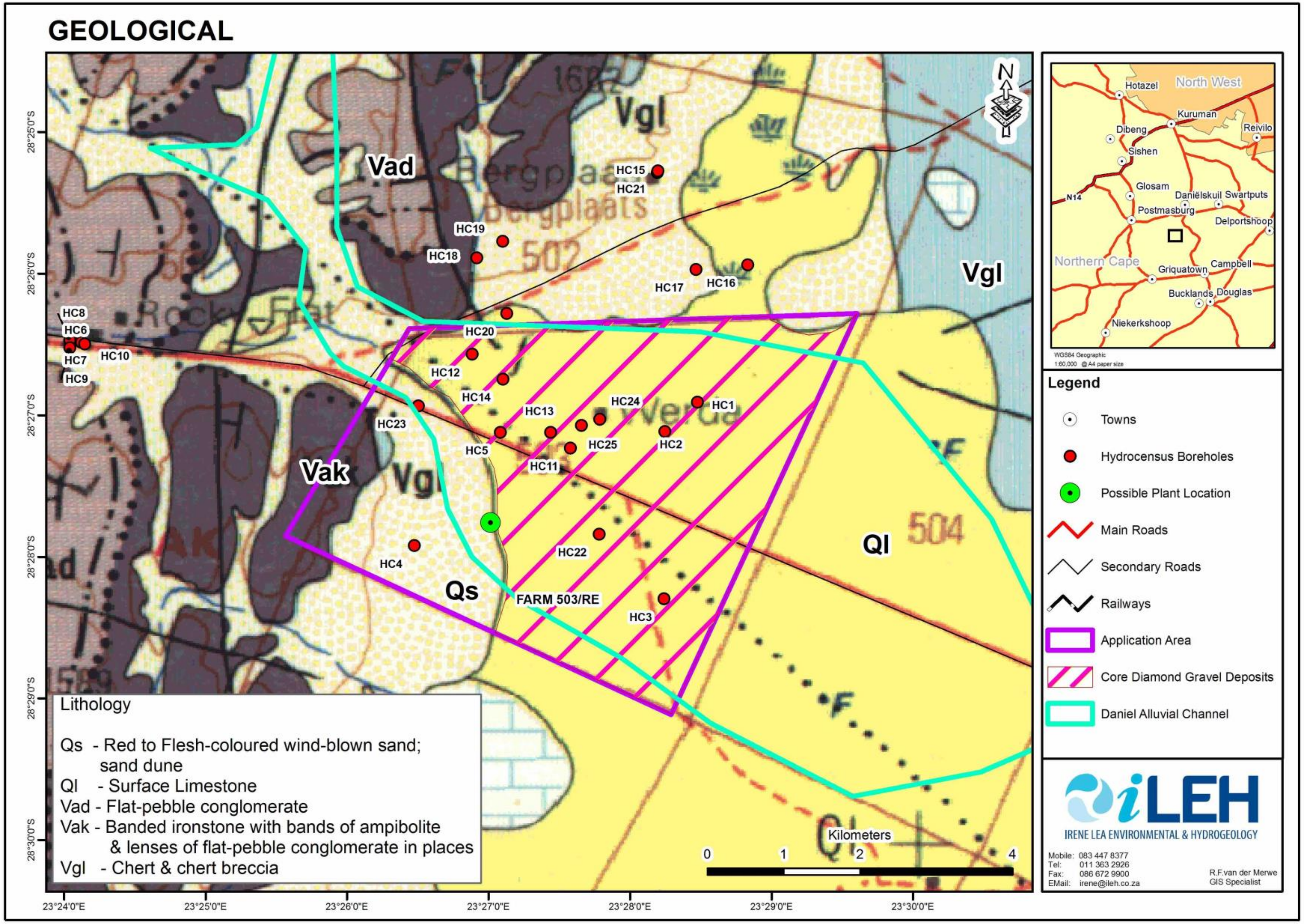
GEOLOGICAL
Vad
Vgl
Vak
Qs
Ql
Bergplaats
502
504
Rocky Flat
Werda
FARM 503/RE
HC1
HC2
HC3
HC4
HC5
HC6
HC7
HC8
HC9
HC10
HC11
HC12
HC13
HC14
HC15
HC16
HC17
HC18
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HC21
HC22
HC23
HC24
HC25
N
28°25'0"S
28°26'0"S
28°27'0"S
28°28'0"S
28°29'0"S
28°30'0"S
23°24'0"E
23°25'0"E
23°26'0"E
23°27'0"E
23°28'0"E
23°29'0"E
23°30'0"E
Kilometers
0
1
2
4
Lithology
Qs - Red to Flesh-coloured wind-blown sand; sand dune
Ql - Surface Limestone
Vad - Flat-pebble conglomerate
Vak - Banded ironstone with bands of ampibolite & lenses of flat-pebble conglomerate in places
Vgl - Chert & chert breccia
Hotazel
North West
Kuruman
Reivilo
Dibeng
Sishen
Glosam
N14
Daniëlskuil
Swartputs
Postmasburg
Delportshoop
Northern Cape
Griquatown
Campbell
Bucklands
Douglas
Niekerkshoop
WGS84 Geographic
1:60,000 @A4 paper size
Legend
Towns
Hydrocensus Boreholes
Possible Plant Location
Main Roads
Secondary Roads
Railways
Application Area
Core Diamond Gravel Deposits
Daniel Alluvial Channel
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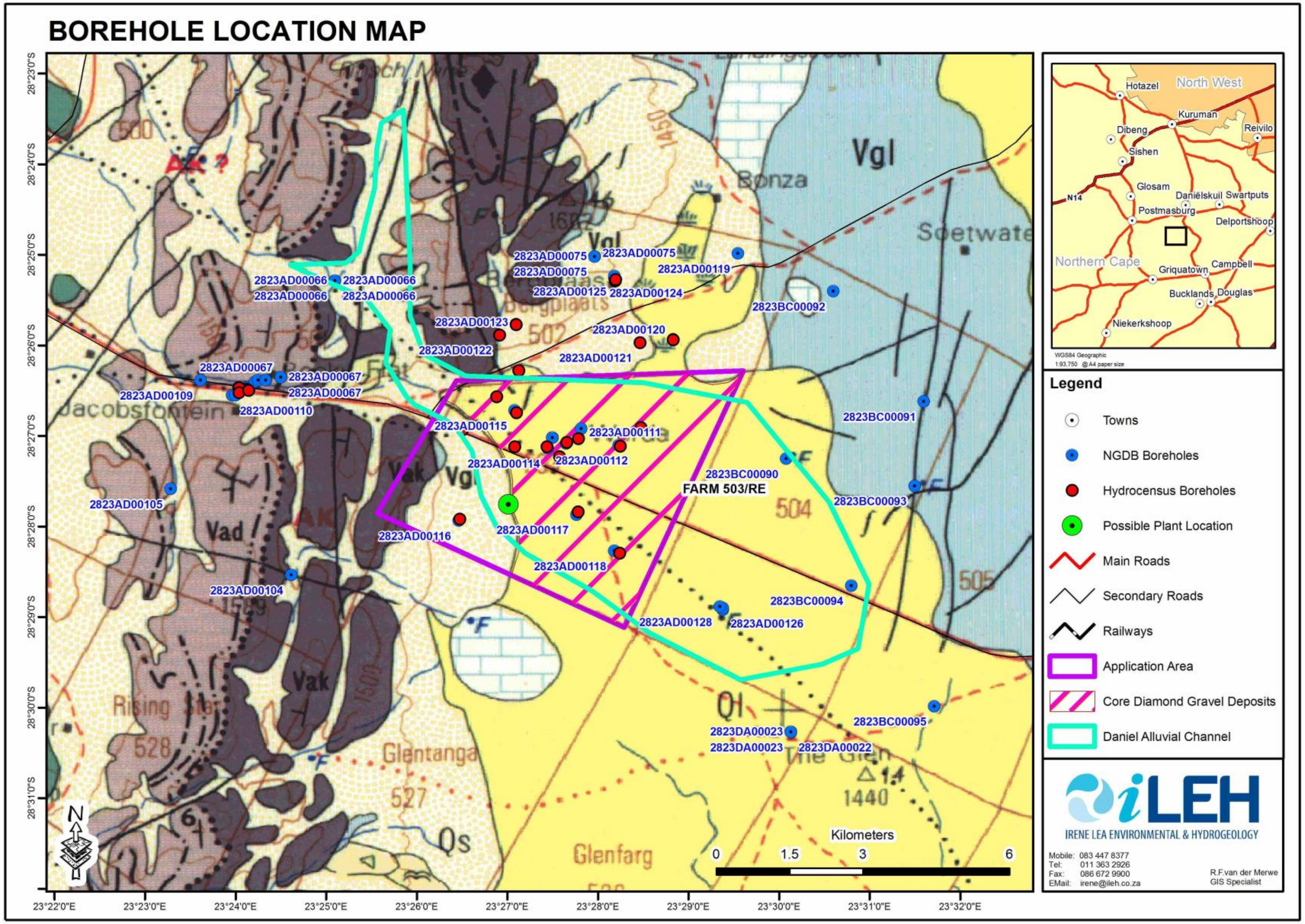
BOREHOLE LOCATION MAP
28°23'0"S
28°24'0"S
28°25'0"S
28°26'0"S
28°27'0"S
28°28'0"S
28°29'0"S
28°30'0"S
28°31'0"S
23°22'0"E
23°23'0"E
23°24'0"E
23°25'0"E
23°26'0"E
23°27'0"E
23°28'0"E
23°29'0"E
23°30'0"E
23°31'0"E
23°32'0"E
2823AD00066
2823AD00075
2823AD00119
2823AD00125
2823AD00124
2823BC00092
2823AD00123
2823AD00120
2823AD00122
2823AD00121
2823AD00067
2823AD00109
2823AD00110
2823AD00115
2823AD00111
2823AD00114
2823AD00112
2823BC00091
2823BC00090
FARM 503/RE
2823BC00093
2823AD00105
2823AD00116
2823AD00117
2823AD00118
2823AD00104
2823BC00094
2823AD00128
2823AD00126
2823BC00095
2823DA00023
2823DA00022
Vgl
Bonza
Soetwate
Jacobsfontein
Vad
Vak
Qs
Ql
Rising Star
528
Glentanga
527
Glenfarg
502
504
505
1440
Kilometers
0
1.5
3
6
N
Hotazel
North West
Kuruman
Reivilo
Dibeng
Sishen
Glosam
N14
Daniëlskuil
Swartputs
Postmasburg
Delportshoop
Northern Cape
Griquatown
Campbell
Bucklands
Douglas
Niekerkshoop
WGS84 Geographic
1:93,750 @ A4 paper size
Legend
Towns
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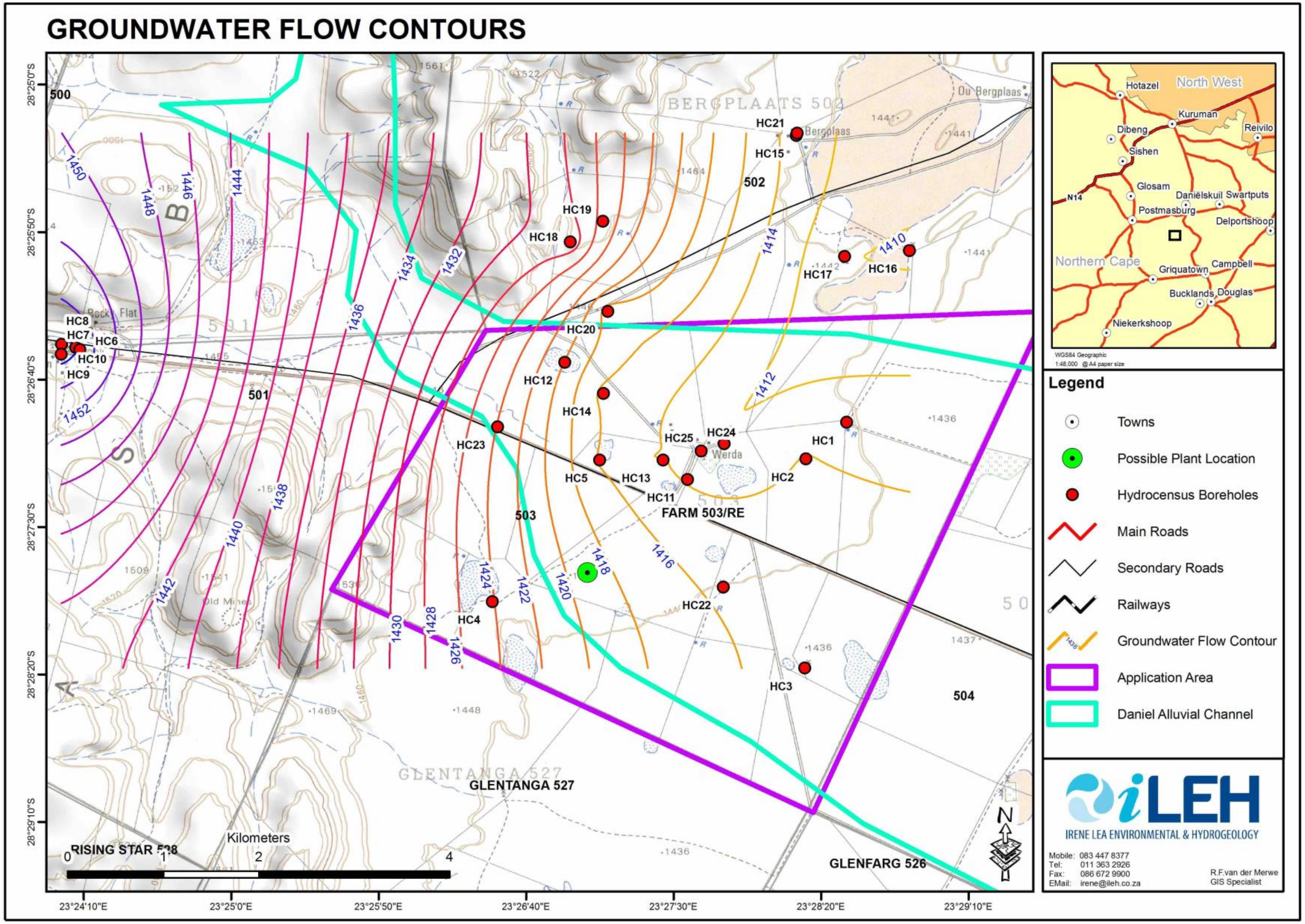
GROUNDWATER FLOW CONTOURS
28°25'0"S
28°25'50"S
28°26'40"S
28°27'30"S
28°28'20"S
28°29'10"S
23°24'10"E
23°25'0"E
23°25'50"E
23°26'40"E
23°27'30"E
23°28'20"E
23°29'10"E
500
501
502
503
504
BERGPLAATS 502
Ou Bergplaas
Bergplaas
Rocky Flat
Werda
Old Mines
FARM 503/RE
GLENTANGA 527
RISING STAR 528
GLENFARG 526
HC1
HC2
HC3
HC4
HC5
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HC7
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Kilometers
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4
N
Hotazel
North West
Kuruman
Reivilo
Dibeng
Sishen
N14
Glosam
Daniëlskuil
Swartputs
Postmasburg
Delportshoop
Northern Cape
Griquatown
Campbell
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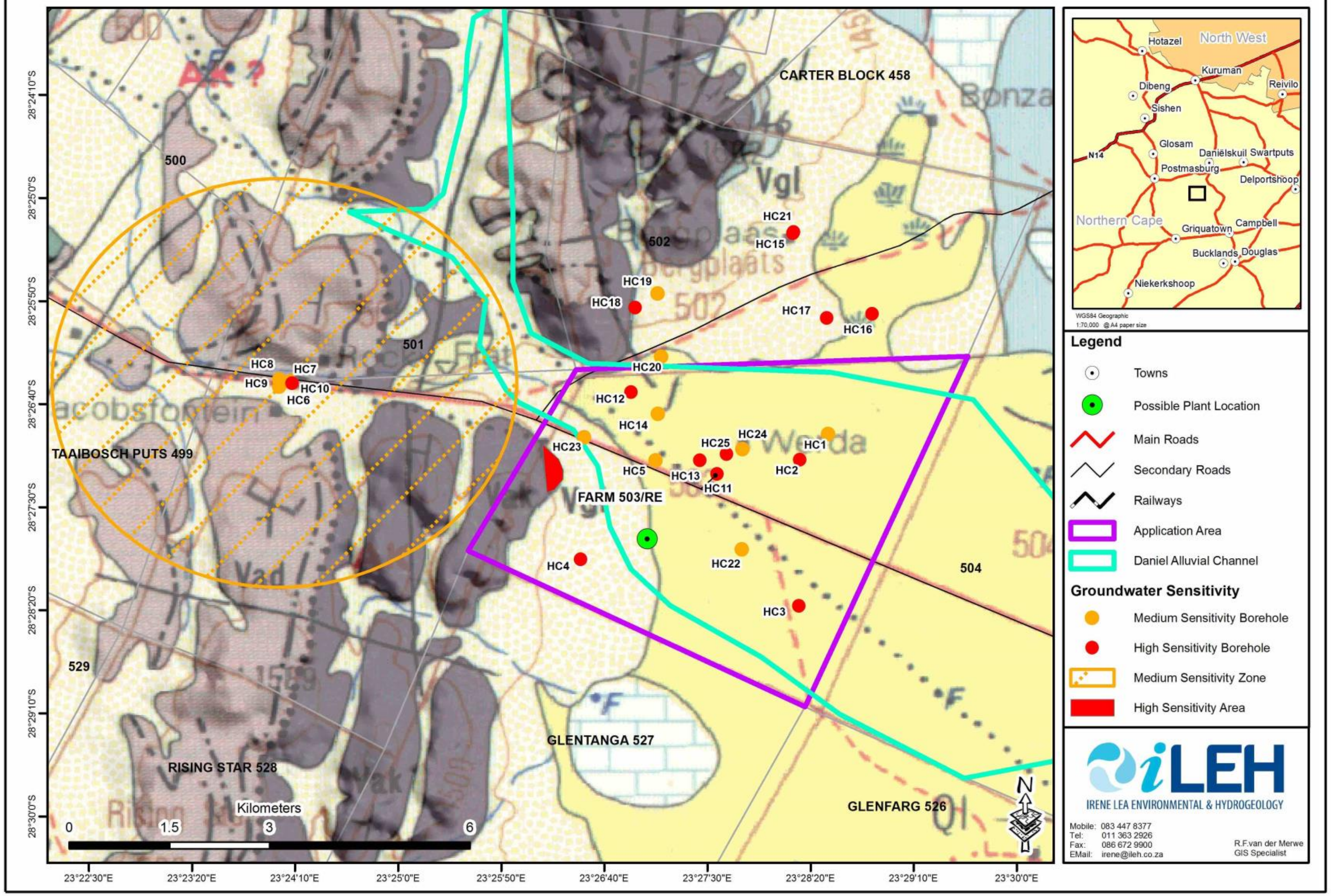
GROUNDWATER SENSITIVITY



Annex C – National Groundwater Database Information

BH ID	Latitude	Longitude	Date drilled	SWL (m)	Discharge rate (l/s)	Depth to water strike (m)	Lithology	Top of lithology (m)	Bottom of lithology (m)
2823DA00022	-28,50452	23,50223	1-Sep-40	17,7	0,16	40,2	Limestone	0	5,2
2823DA00022	-28,50452	23,50223	1-Sep-40	17,7	0,16	40,2	Dolomite	5,2	50,3
2823DA00022	-28,50452	23,50223	1-Sep-40	17,7	0,16	24,4	Limestone	0	5,2
2823DA00022	-28,50452	23,50223	1-Sep-40	17,7	0,16	24,4	Dolomite	5,2	50,3
2823DA00023	-28,50452	23,50224			0,88	35,7	Limestone	0	4,6
2823DA00023	-28,50452	23,50224			0,88	35,7	Dolomite	4,6	35,7
2823BC00095	-28,49979	23,52862	11-May-94	35,5					
2823AD00127	-28,48202	23,48972	11-May-94	11,5	0,7				
2823AD00126	-28,48174	23,48972			3,7				
2823AD00128	-28,48146	23,48917	11-May-94	17,3	0,7				
2823BC00094	-28,47758	23,51334	11-May-94	14,6					
2823AD00104	-28,47563	23,41028	11-Mar-94	47,1					
2823AD00118	-28,47119	23,46973	11-Apr-94	16,1					
2823AD00116	-28,46563	23,44111	11-Apr-94	15,9					
2823AD00117	-28,46452	23,46278	11-Apr-94	18,2					
2823AD00105	-28,45979	23,38806	11-Mar-94	30,4					
2823BC00093	-28,45924	23,52501							
2823BC00090	-28,45424	23,50139							
2823AD00114	-28,45229	23,45751	11-Apr-94	21,6					
2823AD00112	-28,45174	23,47056	11-Apr-94	18,2					
2823AD00113	-28,45146	23,46084	11-Apr-94	21,1					
2823AD00014	-28,45035	23,45834	24-Oct-63	128,01	0,77	128,01	Sand	0	26,51
2823AD00014	-28,45035	23,45834	24-Oct-63	128,01	0,77	128,01	Sandstone	26,51	81,07
2823AD00014	-28,45035	23,45834	24-Oct-63	128,01	0,77	128,01	Quartzite	81,07	139,59
2823AD00015	-28,45035	23,45834	23-Jan-64	128,93	1,08	128,93	Sand	0	35,35
2823AD00015	-28,45035	23,45834	23-Jan-64	128,93	1,08	128,93	Sandstone	35,35	78,63
2823AD00015	-28,45035	23,45834	23-Jan-64	128,93	1,08	128,93	Quartzite	78,63	167,94
2823AD00016	-28,45035	23,45834	23-Jan-64	128,93	1,08	128,93	Sand	0	35,35
2823AD00016	-28,45035	23,45834	23-Jan-64	128,93	1,08	128,93	Sandstone	35,35	78,63

BH ID	Latitude	Longitude	Date drilled	SWL (m)	Discharge rate (l/s)	Depth to water strike (m)	Lithology	Top of lithology (m)	Bottom of lithology (m)
2823AD00016	-28,45035	23,45834	23-Jan-64	128,93	1,08	128,93	Quartzite	78,63	167,94
2823AD00073	-28,45035	23,45834	30-Apr-58	24,38	1,06	24,38	Dolerite	0	31,39
2823AD00073	-28,45035	23,45834	30-Apr-58	24,38	1,06	24,38	Diabase	31,39	31,69
2823AD00074	-28,45035	23,45834	30-Oct-67	35,05	1,16	42,67	Gravel	0	3,04
2823AD00074	-28,45035	23,45834	30-Oct-67	35,05	1,16	42,67	Dolerite	3,04	40,23
2823AD00074	-28,45035	23,45834	30-Oct-67	35,05	1,16	42,67	Dolerite	40,23	49,98
2823AD00074	-28,45035	23,45834	30-Oct-67	35,05	1,16	42,67	Dolerite	49,98	75,89
2823AD00074	-28,45035	23,45834	30-Oct-67	35,05	1,16	42,67	Dolomite	75,89	83,82
2823AD00074	-28,45035	23,45834	30-Oct-67	35,05	1,16	35,05	Gravel	0	3,04
2823AD00074	-28,45035	23,45834	30-Oct-67	35,05	1,16	35,05	Dolerite	3,04	40,23
2823AD00074	-28,45035	23,45834	30-Oct-67	35,05	1,16	35,05	Dolerite	40,23	49,98
2823AD00074	-28,45035	23,45834	30-Oct-67	35,05	1,16	35,05	Dolerite	49,98	75,89
2823AD00074	-28,45035	23,45834	30-Oct-67	35,05	1,16	35,05	Dolomite	75,89	83,82
2823AD00111	-28,44868	23,46362	11-Apr-94	19,05					
2823AD00115	-28,44535	23,45139	11-Apr-94	19,7					
2823BC00091	-28,44368	23,52668	11-May-94	9,2	3				
2823AD00009	-28,44257	23,39945	31-Aug-56	30,48	0,49	41,45	Boulders	0	13,41
2823AD00009	-28,44257	23,39945	31-Aug-56	30,48	0,49	41,45	Dolerite	13,41	40,84
2823AD00009	-28,44257	23,39945	31-Aug-56	30,48	0,49	41,45	Ironstone	40,84	50,29
2823AD00009	-28,44257	23,39945	31-Aug-56	30,48	0,49	30,48	Boulders	0	13,41
2823AD00009	-28,44257	23,39945	31-Aug-56	30,48	0,49	30,48	Dolerite	13,41	40,84
2823AD00009	-28,44257	23,39945	31-Aug-56	30,48	0,49	30,48	Ironstone	40,84	50,29
2823AD00010	-28,44257	23,39945	7-Oct-56	18,28	0,01	16,45	Dolerite	0	43,28
2823AD00010	-28,44257	23,39945	7-Oct-56	18,28	0,01	16,45	Diabase	43,28	50,9
2823AD00010	-28,44257	23,39945	7-Oct-56	18,28	0,01	16,45	Ironstone	50,9	60,65
2823AD00010	-28,44257	23,39945	7-Oct-56	18,28	0,01	16,45	Shale	60,65	64,31
2823AD00010	-28,44257	23,39945	7-Oct-56	18,28	0,01	16,45	Dolerite	64,31	78,02
2823AD00011	-28,44257	23,39945	26-Jul-50	30,48	0,47	38,1	Clay	0	34,13
2823AD00011	-28,44257	23,39945	26-Jul-50	30,48	0,47	38,1	Limestone	34,13	51,51

BH ID	Latitude	Longitude	Date drilled	SWL (m)	Discharge rate (l/s)	Depth to water strike (m)	Lithology	Top of lithology (m)	Bottom of lithology (m)
2823AD00110	-28,44257	23,40001	11-Mar-94	9,4					
2823AD00108	-28,44118	23,40056	11-Mar-94	3,8					
2823AD00107	-28,44118	23,40195	11-Mar-94	3,5					
2823AD00106	-28,44118	23,40223	11-Mar-94	3,4					
2823AD00103	-28,44007	23,40362	11-Mar-94	3,1					
2823AD00109	-28,43979	23,39361	11-Mar-94	1,7					
2823AD00129	-28,43979	23,40417	11-Mar-94	3,9					
2823AD00064	-28,43979	23,40556	16-Aug-47	19,81	1,32	38,1	Boulders	0	10,36
2823AD00064	-28,43979	23,40556	16-Aug-47	19,81	1,32	38,1	Dolomite	10,36	35,96
2823AD00064	-28,43979	23,40556	16-Aug-47	19,81	1,32	38,1	Clay	35,96	38,1
2823AD00064	-28,43979	23,40556	16-Aug-47	19,81	1,32	38,1	Dolomite	38,1	41,45
2823AD00064	-28,43979	23,40556	16-Aug-47	19,81	1,32	24,38	Boulders	0	10,36
2823AD00064	-28,43979	23,40556	16-Aug-47	19,81	1,32	24,38	Dolomite	10,36	35,96
2823AD00064	-28,43979	23,40556	16-Aug-47	19,81	1,32	24,38	Clay	35,96	38,1
2823AD00064	-28,43979	23,40556	16-Aug-47	19,81	1,32	24,38	Dolomite	38,1	41,45
2823AD00065	-28,43925	23,40834					SOIL	0	4,57
2823AD00065	-28,43925	23,40834					Dolomite	4,57	14,32
2823AD00065	-28,43925	23,40834					Clay	14,32	15,84
2823AD00067	-28,43924	23,40834	22-Dec-67	45,72	1,16	70,71	Dolerite	0	40,23
2823AD00067	-28,43924	23,40834	22-Dec-67	45,72	1,16	70,71	Dolerite	40,23	67,66
2823AD00067	-28,43924	23,40834	22-Dec-67	45,72	1,16	70,71	Dolerite	67,66	83,51
2823AD00067	-28,43924	23,40834	22-Dec-67	45,72	1,16	45,72	Dolerite	0	40,23
2823AD00067	-28,43924	23,40834	22-Dec-67	45,72	1,16	45,72	Dolerite	40,23	67,66
2823AD00067	-28,43924	23,40834	22-Dec-67	45,72	1,16	45,72	Dolerite	67,66	83,51
2823AD00121	-28,43285	23,47445							
2823AD00120	-28,4323	23,48056	11-Apr-94	15					
2823AD00122	-28,43146	23,44861	11-Apr-94	34,7					
2823AD00123	-28,42952	23,45167							
2823BC00092	-28,42341	23,51001	11-May-94	8,2					

BH ID	Latitude	Longitude	Date drilled	SWL (m)	Discharge rate (l/s)	Depth to water strike (m)	Lithology	Top of lithology (m)	Bottom of lithology (m)
2823AD00066	-28,42146	23,41834	10-Feb-47	30,17	4,99	35,05	SOIL	0	9,14
2823AD00066	-28,42146	23,41834	10-Feb-47	30,17	4,99	35,05	Conglomerate	9,14	13,71
2823AD00066	-28,42146	23,41834	10-Feb-47	30,17	4,99	35,05	Dolomite	13,71	17,06
2823AD00066	-28,42146	23,41834	10-Feb-47	30,17	4,99	35,05	Clay	17,06	18,89
2823AD00066	-28,42146	23,41834	10-Feb-47	30,17	4,99	35,05	Dolomite	18,89	20,11
2823AD00066	-28,42146	23,41834	10-Feb-47	30,17	4,99	35,05	Clay	20,11	25,9
2823AD00066	-28,42146	23,41834	10-Feb-47	30,17	4,99	35,05	Dolomite	25,9	30,17
2823AD00066	-28,42146	23,41834	10-Feb-47	30,17	4,99	35,05	Clay	30,17	40,23
2823AD00066	-28,42146	23,41834	10-Feb-47	30,17	4,99	35,05	Dolomite	40,23	40,84
2823AD00124	-28,42091	23,46973	11-Apr-94	19,1					
2823AD00125	-28,42063	23,46973	11-Apr-94	20,3					
2823AD00075	-28,41702	23,46612	25-Aug-67	48,76	1,27	103,63	Boulders	0	10,05
2823AD00075	-28,41702	23,46612	25-Aug-67	48,76	1,27	103,63	Dolerite	10,05	76,5
2823AD00075	-28,41702	23,46612	25-Aug-67	48,76	1,27	103,63	Dolerite	76,5	108,81
2823AD00075	-28,41702	23,46612	25-Aug-67	48,76	1,27	48,76	Boulders	0	10,05
2823AD00075	-28,41702	23,46612	25-Aug-67	48,76	1,27	48,76	Dolerite	10,05	76,5
2823AD00075	-28,41702	23,46612	25-Aug-67	48,76	1,27	48,76	Dolerite	76,5	108,81
2823AD00075	-28,41702	23,46612	25-Aug-67	48,76	1,27	56,99	Boulders	0	10,05
2823AD00075	-28,41702	23,46612	25-Aug-67	48,76	1,27	56,99	Dolerite	10,05	76,5
2823AD00075	-28,41702	23,46612	25-Aug-67	48,76	1,27	56,99	Dolerite	76,5	108,81
2823AD00119	-28,41646	23,4925	11-Apr-94	9,1					

Annex D – Water Quality Information

Laboratory Certificates

Piper Diagram

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sanas Testing Laboratory
T0391

AMENDMENTS TO CERTIFICATE OF ANALYSES 62303
GENERAL WATER QUALITY PARAMETERS

Date received: 2016 - 09 - 26
Date completed: 2016 - 10 – 13
Project number: 1000
Report number: 62303a
Order number: PO160015

Client name: Moja Terre
Contact person: Mr. R. Pretorius
Address: P.O Box 1105 Montana Park 0159
e-mail: renier.pretorius@mojaterre.com
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Facsimile:
Mobile: 082 852 9944

Analyses in mg/ℓ (Unless specified otherwise)	**Method Identification**	**Sample Identification**					
		HC2	**HC3**	**HC8**	**HC9**	**HC15& 21**	**HC6**
Sample Number		18903	18904	18905	18906	18907	18908
pH – Value at 25°C	WLAB001	7.3	7.3	7.0	7.1	7.1	7.4
Electrical Conductivity in mS/m at 25°C	WLAB002	83.6	62.9	36.0	44.0	118	49.8
Total Dissolved Solids at 180°C *	WLAB003	538	356	248	218	810	326
Total Alkalinity as $CaCO_3$	WLAB007	328	264	164	180	320	240
Bicarbonate as HCO_3 *	WLAB023	400	322	200	219	390	293
Chloride as Cl	WLAB046	60	40	22	25	99	15
Sulphate as SO_4	WLAB046	48	28	<2	<2	209	12
Fluoride as F	WLAB014	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nitrate as N	WLAB046	7.5	3.0	0.1	0.1	7.5	2.8
Nitrite as N	WLAB046	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ortho Phosphate as P	WLAB046	<0.1	<0.1	<0.1	0.2	<0.1	<0.1
Total Cyanide as CN [s]	---	0.01	0.01	0.01	<0.01	0.01	<0.01
Chemical Oxygen Demand as O_2 (Total)	WLAB018	<10	<10	44	94	<10	<10
Free & Saline Ammonia as N	WLAB046	0.1	<0.1	1.0	11	<0.1	<0.1
Sodium as Na	WLAB015	15	18	15	14	41	9
Potassium as K	WLAB015	2.6	2.5	3.4	5.0	3.1	2.6
Calcium as Ca	WLAB015	126	82	31	30	165	65
Magnesium as Mg	WLAB015	28	24	16	15	37	23
Aluminium as Al (Dissolved)	WLAB015	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Antimony as Sb (Dissolved)*	WLAB015	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Arsenic as As (Dissolved)*	WLAB015	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

Analysis continued on next page

A. van de Wetering

Technical Signatory

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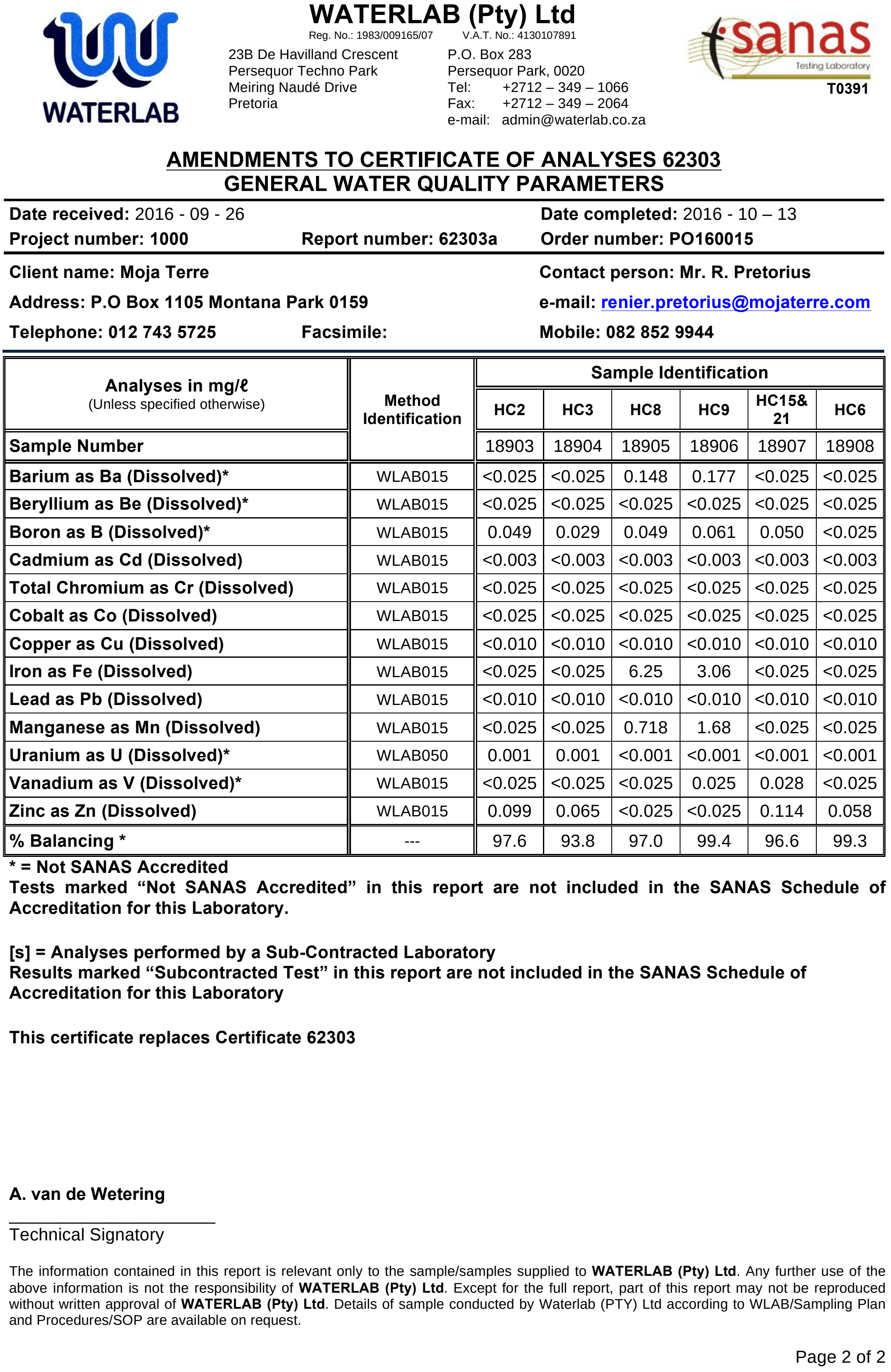

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T0391

AMENDMENTS TO CERTIFICATE OF ANALYSES 62303
GENERAL WATER QUALITY PARAMETERS

Date received: 2016 - 09 - 26 **Date completed:** 2016 - 10 – 13

Project number: 1000 **Report number: 62303a** **Order number: PO160015**

Client name: Moja Terre **Contact person: Mr. R. Pretorius**

Address: P.O Box 1105 Montana Park 0159 **e-mail: renier.pretorius@mojaterre.com**

Telephone: 012 743 5725 **Facsimile:** **Mobile: 082 852 9944**

Analyses in mg/ℓ (Unless specified otherwise)	**Method Identification**	**Sample Identification**					
		HC2	**HC3**	**HC8**	**HC9**	**HC15& 21**	**HC6**
Sample Number		18903	18904	18905	18906	18907	18908
Barium as Ba (Dissolved)*	WLAB015	<0.025	<0.025	0.148	0.177	<0.025	<0.025
Beryllium as Be (Dissolved)*	WLAB015	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Boron as B (Dissolved)*	WLAB015	0.049	0.029	0.049	0.061	0.050	<0.025
Cadmium as Cd (Dissolved)	WLAB015	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Total Chromium as Cr (Dissolved)	WLAB015	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Cobalt as Co (Dissolved)	WLAB015	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Copper as Cu (Dissolved)	WLAB015	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron as Fe (Dissolved)	WLAB015	<0.025	<0.025	6.25	3.06	<0.025	<0.025
Lead as Pb (Dissolved)	WLAB015	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Manganese as Mn (Dissolved)	WLAB015	<0.025	<0.025	0.718	1.68	<0.025	<0.025
Uranium as U (Dissolved)*	WLAB050	0.001	0.001	<0.001	<0.001	<0.001	<0.001
Vanadium as V (Dissolved)*	WLAB015	<0.025	<0.025	<0.025	0.025	0.028	<0.025
Zinc as Zn (Dissolved)	WLAB015	0.099	0.065	<0.025	<0.025	0.114	0.058
% Balancing *	---	97.6	93.8	97.0	99.4	96.6	99.3

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

[s] = Analyses performed by a Sub-Contracted Laboratory
Results marked "Subcontracted Test" in this report are not included in the SANAS Schedule of Accreditation for this Laboratory

This certificate replaces Certificate 62303

A. van de Wetering

Technical Signatory

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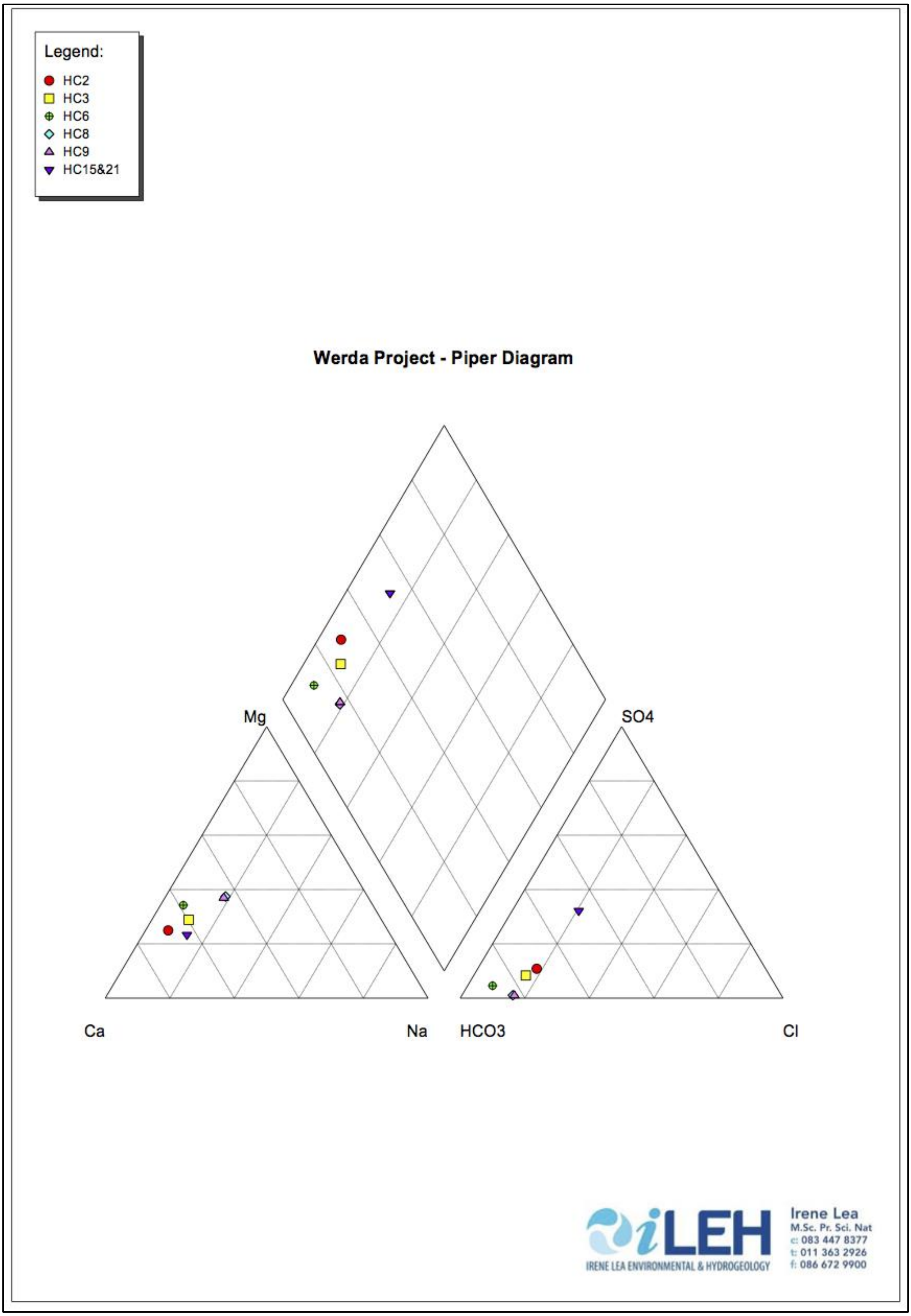
Page 2 of 2


Legend:
● HC2
☐ HC3
⊕ HC6
◇ HC8
△ HC9
▼ HC15&21
Werda Project - Piper Diagram
Mg
SO4
Ca
Na
HCO3
Cl
iLEH
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