Black Mountain Mining Prospecting Rights Application:

Geohydrological Specialist Study:

TIERKLIP AREA

Report Prepared for

EIMS | ENVIRONMENTAL IMPACT MANAGEMENT SERVICES

Report Number 549553/TIERKLIP

Report Prepared by

srk consulting

July 2019

Black Mountain Mining Prospecting Rights Application:

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TIERKLIP AREA

EIMS

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SRK Project Number 549553/TIERKLIP

July 2019

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Executive Summary

Environmental Impact Management Services (Proprietary) Limited (EIMS) appointed SRK Consulting (South Africa) (Pty) Ltd (SRK) to undertake a Geohydrological Desktop Specialist study as part of a basic assessment report (BAR) in support of a Mining Prospecting Rights Application.

Summary of principal objectives

The aim of this assessment is to assess the baseline groundwater conditions for the aquifer system/s within the Tierklip Area and to highlight possible risks to the groundwater environment accordingly (from a desktop perspective). The scope of work comprises a desk study in which potentially sensitive geohydrological features are highlighted, to investigate the potential impact on these (if any) and to develop management plans to prevent / mitigate any potential impacts.

Outline of work programme

EIMS appointed SRK on 12 June 2019 to conduct a desktop geohydrological assessment on five areas where exploration drilling is planned. The Tierklip Area, the focus of this report, is one of the five areas.

Focus on results

From the desktop study and information provided to SRK, by EIMS, the following are concluded for the Tierklip Area:

- Although the majority of the area is classed as a minor aquifer system with variable water quality and low expected yields, there are existing groundwater users for which boreholes could be the only water source. It is therefore critical that existing groundwater users be taken into account and that their boreholes are not negatively affected in any way.
- Any negative impact on groundwater and/or groundwater users, whether factual or perceived (complaints from surrounding borehole users) can have a significant financial and reputational impact on the exploration programme and subsequent mining.
- It is not possible to accurately predict the aquifers that will be penetrated when drilling 400 m or more and it is therefore important that support by a geohydrologist is provided before and during the drilling activities.
- Due to the lack of available information, such as hydrocensus information, exact drilling positions, drilling depths and drilling processes, only a basic sensitivity map could be compiled at this stage, incorporating areas covered by quaternary deposits (e.g. sands) and surface water / pans. This information was taken from available geological and topographical maps.

Potential impacts have been identified as:

- Degradation of aquifers;
- Impacts on existing groundwater users; and
- Impacts on surface water features (e.g. streams, rivers, wetlands, saltpans) – which may be recharged by groundwater.

Proposed mitigation measures include:

- Detailed hydrocensus (to include surface water features);

- Once the exact drilling positions are known and the hydrocensus completed, the geohydrological report must be updated and must include an assessment of potential aquifers that could be penetrated by the drilling and whether mixing the water of these aquifers can lead to degradation of any of the aquifers penetrated.

Assumptions, uncertainties and gaps in knowledge

Assumptions: SRK assumes that the main purpose of this desktop study is to provide a broad overview of what has been documented for this specific area in terms of the geohydrology. SRK further assumed that the planned exploration has not yet been publicised or discussed with the local municipalities, local farming unions, or any other private or public sector body. SRK therefore did not make contact with any private or public body in terms of the gathering of site specific data. SRK further assumes that a public participation process will be followed whereby existing groundwater users will be consulted.

Limitations: The potential impacts of any drilling activity on the groundwater regime will vary from site to site, even over short distances due to changes in geology and receptors. As no recent hydrocensus across the entire exploration area has been conducted, SRK did not have access to, for example, positions of existing boreholes, dependency on groundwater, specific water quality, depth to groundwater levels and borehole depths. The sensitivity map and groundwater management plan, as presented in this report, must be seen as working documents that must be improved as more information becomes available.

Gaps: Based on the information presented to SRK, by EIMS, the following information gaps have been identified:

- Exact drilling positions and drilling depths;
- On-site storage and handling of any potentially hazardous materials / substances on the drilling site, e.g. fuels (diesel, petrol, paraffin, etc.), oils and cleaning chemicals;
- Detailed hydrocensus within the areas where exploration drilling will take place – the hydrocensus must be completed by a geohydrologist / geohydrological technician who has experience in the collection of geosite data, as prescribed by the Department of Human Settlement, Water and Sanitation (DHSWS).
- Detailed scientific reports (geological and geohydrological) of the exploration area (if any) – sourcing these reports will require open conversations with private and public bodies, in which the purpose of the exploration programme and exploration areas will have to be revealed.

Table of Contents

List of Tables

List of Figures

Disclaimer

The opinions expressed in this Report have been based on the information obtained by SRK Consulting (South Africa) (Pty) Ltd (SRK) from various sources such as the Department of Human Settlement, Water and Sanitation (DHSWS), the National Groundwater Archive (NGA) and others listed under References. SRK has exercised due care in reviewing the obtained information. Whilst SRK has compared the available data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the available data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

List of Abbreviations

DWS	-	Department of Water and Sanitation (before 30 May 2019)
DHSWS	-	Department of Human Settlement, Water and Sanitation (after 30 May 2019)
NEMA	–	National Environmental Management Act
NWA	–	National Water Act
MPRDA		Mineral and Petroleum Resources Development Act
WMA		Water Management Area
EWR	-	Ecological Water Requirements
GRU	-	Groundwater Resource Units
GIA	-	Groundwater Impact Assessment
BAR	-	Basic Assessment Report
EMPR	-	Environmental Management Program
EIA	-	Environmental Impact Assessment
GRA2	-	Groundwater Resource Assessment Phase 2
AGEP	-	Average Groundwater Exploitation Potential
SANS	-	South African National Standard
NGA	-	National Groundwater Archive
m amsl	-	metres above mean sea level
m bgl	-	metres below ground level
L/s	-	litres per second
mg/L	-	milligrams per litre
EC	-	Electrical Conductivity
GPS	-	Global Positioning System
GIS	-	Geographic Information Systems

1 Introduction

Environmental Impact Management Services (Proprietary) Limited (EIMS) appointed SRK Consulting (South Africa) (Pty) Ltd (SRK) to undertake a Geohydrological Desktop Specialist study as part of a basic assessment report (BAR) in support of a Mining Prospecting Rights Application, TIERKLIP AREA.

1.1 Scope of Work and Terms of Reference

The aim of this assessment was to assess the baseline groundwater conditions for the aquifer system/s within the Tierklip Area and to supply an indication of possible risks to the groundwater environment accordingly. The scope of work comprises a desk study in which potentially sensitive geohydrological features are highlighted, to investigate the potential impact on these (if any) and to develop management plans to prevent / mitigate any potential impacts. No fieldwork or site visit(s) were to be undertaken.

1.2 Legislative and Policy Framework

As per EIMS's request, the geohydrological desktop study is to satisfy the requirements of the NEMA EIA Regulations and the NWA WUL Applications, as well as the relevant MPRDA regulations. The **NWA**, Chapter 3, Part 4 states the following "*The person who owns, controls, occupies or uses the land in question is responsible for taking measures to prevent pollution of water resources*". This includes groundwater. The **MPRDA**, Part IV: Pollution Control and Waste Management Regulation states that the groundwater investigations may include an assessment of "(*iv) the vulnerability and existing potential use of the groundwater resource within the zone that could potentially be affected by the residue facility".* In terms of this report (focussing only on exploration and not mining itself) SRK will replace the term "residue facility" with "exploration activities".

1.3 Statement of SRK Independence

Neither SRK nor any of the authors of this Report have any material present or contingent interest in the outcome of this Report, nor do they have any pecuniary or other interest that could be reasonably regarded as being capable of affecting their independence or that of SRK. SRK has no beneficial interest in the outcome of the assessment which is capable of affecting its independence.

1.4 Summary of Specialist Expertise

Gert Nel is a partner in SRK, qualified **Principal Geohydrologist** and registered Professional Natural Scientist **(Pr. Sci. Nat.)** with over 26 years' of experience in the water and waste fields. Gert started off the first eight years of his career with the South African Department of Water Affairs (DWA) and was involved in geohydrological mapping, water supply and the permitting of solid waste facilities. He then joined the private sector where he continued his involvement in the water and waste fields, but also became involved in geohydrological risk assessments for private industries, including the fuel industry and mines.

Eunice Goossens is a **Principal Hydrogeologist**, registered as a Professional Natural Scientist **(Pr. Sci. Nat.)**. Eunice has 20 years' experience in geohydrological investigations, and started her career at Department of Water Affairs (DWA) and was involved in groundwater supply investigation as well as geohydrological research projects. She joined the private sector and continued her career in Groundwater Management, Groundwater resource development and evaluation, Geophysical investigations, Sanitation Groundwater Protocol Application, Groundwater database management and processing, GIS applications / mapping and Landsat & Aerial photo Interpretation.

Connan Hempel is a **Senior Geologist** and registered Professional Natural Scientist (**Pr. Sci. Nat**.) with over 20 years' experience in academic training, mining and exploration. Connan started the first ten years of his career as a Geology Lecturer at the Nelson Mandela Metropolitan University Department of Geosciences. He later joined Anglo American where he worked as a Senior Production Geologist. Prior to joining SRK Consulting, he also worked for Elitheni Coal as a Senior Exploration & Mining Geologist.

2 Project Work

2.1 Topographical Information

The topography of the Tierklip Area is depicted in **Map 1**, **Appendix 1**. The area is located approximately 75 kilometres South of the town of Pofadder, Northern Cape, South Africa. It covers 56 farms, over an area of 180 001 Ha (1 800 km^2). Topographically, the central and western parts of the Tierklip Area are the highest with altitudes in the order of 1000 m amsl. The area then drops towards the north and southeast to elevations around 920 m amsl. Minor, non-perennial drainages can also be seen in the area. The area is also characterised by several salt pans, the largest of these occurring in the northern area.

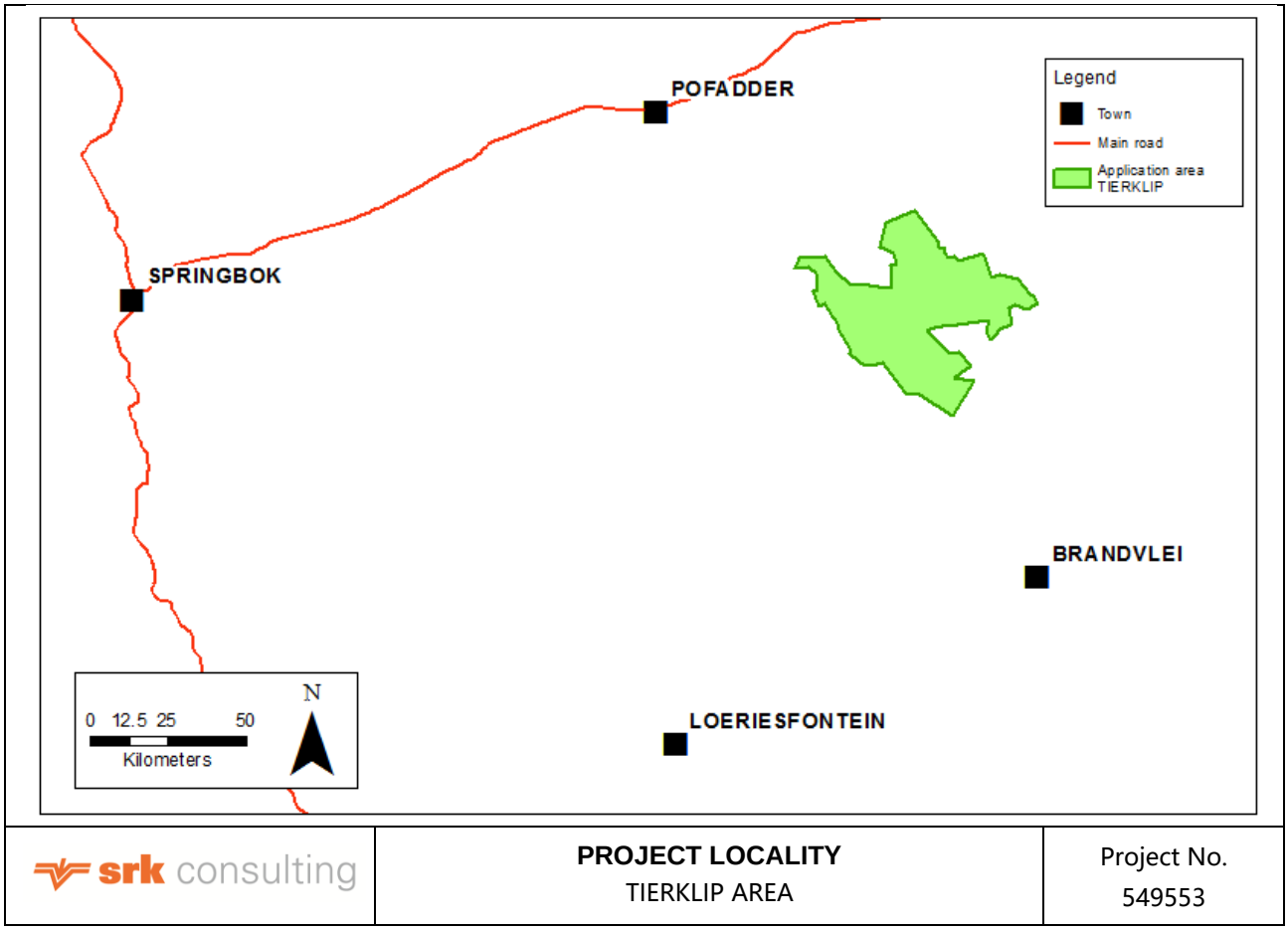

Figure 2-1: Project Locality

2.2 Geology

The terrain consists of flat lying plains with Cenozoic and Karoo-aged sediments overlying the Dwyka Group and Prince Albert Formation consisting of tillite, diamictite, sandstone and dolomitic limestone. The southern, eastern and western parts are further characterised by large dolerite intrusions. Three

dolerite dykes intruded the sedimentary rocks in the north-western parts of the area. Alluvium and sand is mapped to the central parts of the area. Refer to **Map 2** in **Appendix 1**.

2.3 Hydrogeology

The following key information sources were consulted:

- Vegter, J.R., Seymour A., 1995. Groundwater Resources of the Republic of South Africa – Two Map sheets and explanatory brochure. DWAF).
- Parsons, R., Conrad, J., WRC Report No KV 116/98, "Explanatory Notes for the Aquifer Classification Map of South Africa".
- Groundwater Resource Assessment Phase 2 (GRA 2), DWS, 2003
- Department of Water and Sanitation, South Africa, October 2016. Determination of Ecological Water Requirements for Surface water and Groundwater in the Lower Orange WMA. Groundwater EWR report.
- Department of Water Affairs and Forestry. Hydrogeological Map Series of the Republic of South Africa. Completed in 2002".

According to Vegter and Seymour (1995), a small portion in the western parts of the area have a low groundwater potential of 10 – 20% with the remainder of the area having a groundwater potential of 20 – 30 %. These percentages indicate the probability of drilling a successful borehole (yield > 2 L/s).

DWS initiated a project in 2003, referred to as the Groundwater Resource Assessment Phase 2 (GRA 2) and focussed on the quantification of the groundwater resources of South Africa on a national scale. The project included the quantification of recharge, storage and sustainable yield of the aquifer systems throughout South Africa. The expected average groundwater exploitation potential (AGEP) in the Tierklip area is < 2500 m^3/km^2/annum.

Based on the Aquifer Classification Map (Vegter), the aquifer is classified as a minor aquifer region – therefore being a moderately yielding aquifer system of variable water quality. These aquifers can be fractured or potentially fractured rocks which do not have a high permeability, or other formations with variable permeability.

The Tierklip Area falls entirely within the Lower Orange WMA (see **Figure 2-2**). The EWR report of 2016 covers the Lower Orange WMA and from this report the following information is deemed relevant to the Tierklip Area:

- The Tierklip Area have an estimated 30 – 60 % dependency of groundwater (i.e. domestic use, irrigation, stock watering, bulk supply, mining).
- The majority of the Tierklip Area falls within D57D and D53G which, according to the EWR report, is described as "poor groundwater quality from marine sediments". Two small portions of the Tierklip Area fall within catchments D53F and D53D, both also described as "poor water quality").

Refer to **Figure 2-2** (the insert) for the positioning of the Tierklip Area relevant to the quaternary catchments. The expected electrical conductivity (EC) for the entire area is 300 – 1000 mS/m. **Map 3a** in **Appendix 1** shows the expected EC's for the area.

2.3.1 Groundwater Flow Directions

In the absence of field measurements (water level data) and accurate elevations of boreholes, no accurate groundwater contour map can be compiled. If one assumes that the groundwater table will follow the topography and surface drainage directions, then the inferred groundwater flow is depicted in **Map 3b**, **Appendix 1**.

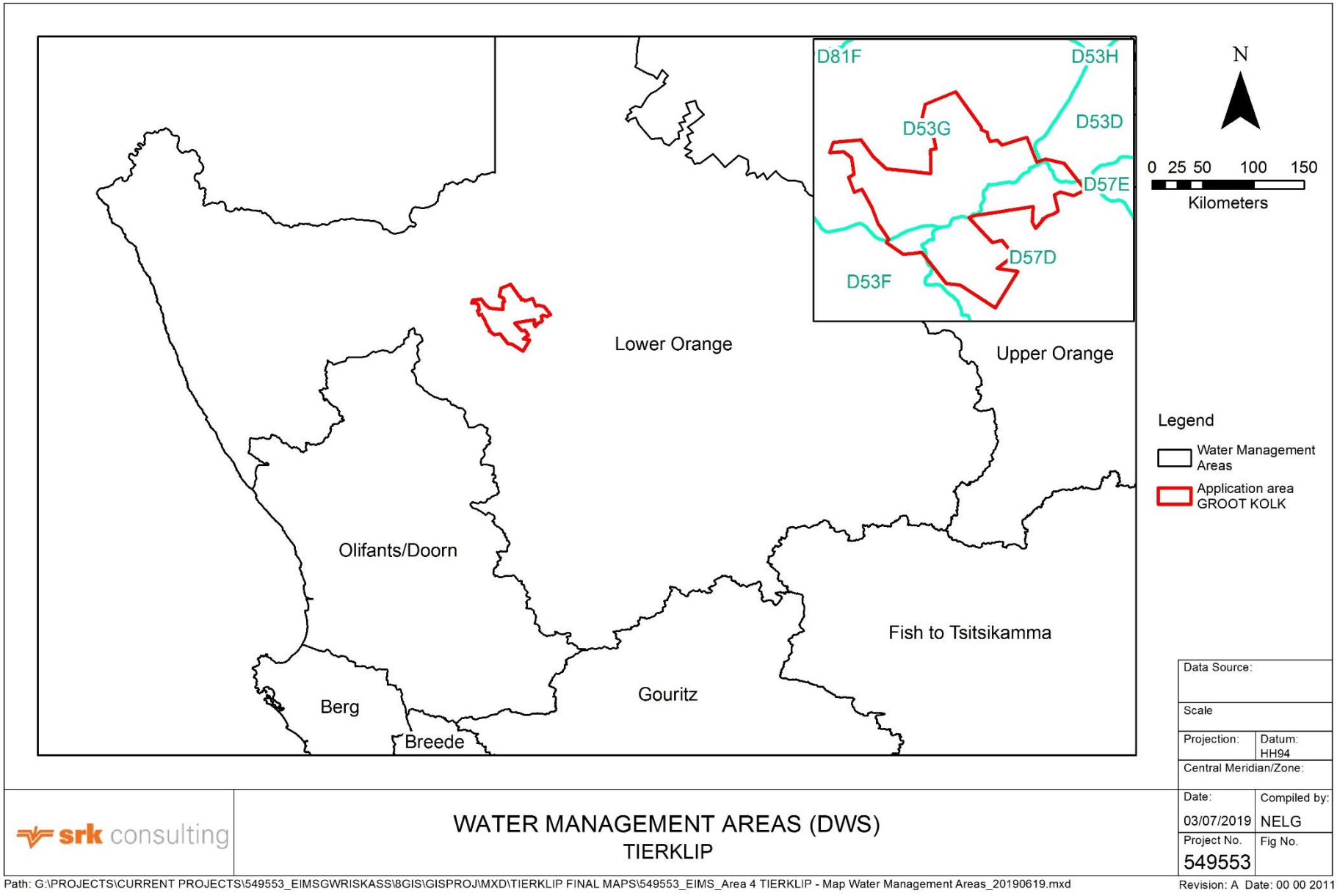

Figure 2-2: Water Management Areas (as per the DWS classification) – Quaternary Catchments inclusion

2.4 Receiving Environment

For the purpose of the geohydrological desktop assessment, and considering that no fieldwork has been conducted, the receiving environment of the Tierklip Area is considered to be:

- Existing groundwater users (via boreholes and springs, where applicable);
- Future groundwater users (via boreholes and springs, where applicable); and
- Groundwater, as a natural resource that falls under the protection of the National Water Act.

In the absence of sufficient data, aspects relating to groundwater recharge have not been taken into account. These include:

- Natural groundwater recharge areas (groundwater catchments); and
- Areas where managed aquifer recharge (artificial recharge) could be considered.

Due to insufficient data, the following receiving environments have also been excluded:

- Wetlands (if there are any in the area) that are groundwater fed - not all wetlands are partially or fully dependent on groundwater for sustainability, but due consideration must be given when boreholes are drilled within 500 m of a wetland, regardless whether the boreholes are for exploration, monitoring or water supply.
- Streams or rivers that are dependent on groundwater inflow – in many cases the base of streams and rivers sits below the groundwater table and are therefore experiencing lateral recharge from groundwater. Groundwater can therefore sustain the baseflow of a river or stream in cases where the water table (or perched water level) is located higher (in terms of elevation, i.e. metres above sea level) than the base of the river or stream.

Information provided to SRK, by EIMS, indicates that the farms listed in **Table 2-1** will be targeted for the exploration programme (Ref: Black Mountain Prospecting Work Programme).

Table 2-1: List of Properties that form part of the planned Exploration

Nr.	Registered Land Description	Magisterial District	Extent (Ha)	Title Deed/Diagram Deed	SG Code
1	Farm Loog Kolkjes 195 Portion 4	Kenhardt Rd	1695,541253	T76872/1998CTN	C03600000000019500004
2	Farm Geel Vloer 196 Portion 0 RE	Kenhardt Rd	6388,716298	T32084/2014CTN	C03600000000019600000
3	Farm Geel Vloer 196 Portion 1	Kenhardt Rd	6495,72027	T32083/2014CTN	C03600000000019600001
4	Farm Hendrik Zyn Puts 240 Portion 0 RE	Kenhardt Rd	5937,038478	T69407/2015CTN	C03600000000024000000
5	Farm Hendrik Zyn Puts 240 Portion 3	Kenhardt Rd	5592,531803	T32299/1996CTN	C03600000000024000003
6	Farm Hendrik Zyn Puts 240 Portion 7	Kenhardt Rd	3069,23921	T4059/1997CTN	C03600000000024000007
7	Farm Brosdoorns Annex 242 Portion 0 RE	Kenhardt Rd	3779,114231	T96126/2002CTN	C03600000000024200000
8	Farm Brosdoorns Annex 242 Portion 1	Kenhardt Rd	3723,132824	T96127/2002CTN	C03600000000024200001
9	Farm Brosdoorns Annex 242 Portion 2	Kenhardt Rd	3792,754523	T41356/1988CTN	C03600000000024200002
10	Farm Brosdoorns Annex 242 Portion 3	Kenhardt Rd	3758,354959	T93751/2005CTN	C03600000000024200003
11	Farm Dagab 282 Portion 0 RE	Kenhardt Rd	2895,332837	T107940/2000CTN	C03600000000028200000
12	Farm Dagab 282 Portion 2	Kenhardt Rd	743,42116	T107940/2000CTN	C03600000000028200002
13	Farm De Paarden Vleyen 283 Portion 0 RE	Kenhardt Rd	7297,452848	T52179/2003CTN	C03600000000028300000
14	Farm De Paarden Vleyen 283 Portion 2	Kenhardt Rd	2557,950064	T59522/2008CTN	C03600000000028300002
15	Farm De Paarden Vleyen 283 Portion 3 RE	Kenhardt Rd	7311,383444	T28241/2002CTN	C03600000000028300003
16	Farm De Paarden Vleyen 283 Portion 4	Kenhardt Rd	2,279856	T64504/2010CTN	C03600000000028300004
17	Farm Koranna Kolken 284 Portion 2 RE	Kenhardt Rd	2767,258409	T73814/1992CTN	C03600000000028400002
18	Farm Koranna Kolken 284 Portion 3 RE	Kenhardt Rd	1398,347791	T60270/1989CTN	C03600000000028400003
19	Farm Koranna Kolken 284 Portion 4	Kenhardt Rd	2766,353335	T49042/1988CTN	C03600000000028400004
20	Farm Koranna Kolken 284 Portion 5	Kenhardt Rd	2779,152907	T73814/1992CTN	C03600000000028400005
21	Farm Koranna Kolken 284 Portion 6	Kenhardt Rd	2774,510498	T41357/1988CTN	C03600000000028400006

Nr.	Registered Land Description	Magisterial District	Extent (Ha)	Title Deed/Diagram Deed	SG Code
22	Farm Koranna Kolken 284 Portion 7	Kenhardt Rd	2808,393233	T112445/1997CTN	C03600000000028400007
23	Farm Koranna Kolken 284 Portion 8	Kenhardt Rd	1399,755636	T60270/1989CTN	C03600000000028400008
24	Farm Tyger Kolk 286 Portion 1	Kenhardt Rd	6513,215404	T9930/2016CTN	C03600000000028600001
25	Farm Tierklip 287 Portion 0 RE	Kenhardt Rd	3824,554934	T63458/1991CTN	C03600000000028700000
26	Farm Tierklip 287 Portion 1	Kenhardt Rd	4105,883653	T27803/2014CTN	C03600000000028700001
27	Farm Tierklip 287 Portion 2	Kenhardt Rd	3986,88955	T8698/2012CTN	C03600000000028700002
28	Farm Tierklip 287 Portion 3	Kenhardt Rd	3864,303082	T63458/1991CTN	C03600000000028700003
29	Farm Corgas 288 Portion 0 RE	Kenhardt Rd	1550,993638	T19766/1966CTN	C03600000000028800000
30	Farm Corgas 288 Portion 1	Kenhardt Rd	1097,405028	T54668/2014CTN	C03600000000028800001
31	Farm Corgas 288 Portion 2	Kenhardt Rd	827,575974	T54668/2014CTN	C03600000000028800002
32	Farm Corgas 288 Portion 3	Kenhardt Rd	2093,705186	T54668/2014CTN	C03600000000028800003
33	Farm Corgas 288 Portion 4	Kenhardt Rd	1208,533245	T54668/2014CTN	C03600000000028800004
34	Farm Corgas 288 Portion 5	Kenhardt Rd	1847,942913	T9930/2016CTN	C03600000000028800005
35	Farm Ysis 289 Portion 0 RE	Kenhardt Rd	3460,975441	T21976/1977CTN	C03600000000028900000
36	Farm Ysis 289 Portion 2 RE	Kenhardt Rd	2516,077576	T14248/1957CTN	C03600000000028900002
37	Farm Ysis 289 Portion 4	Kenhardt Rd	1224,537064	T35410/2007CTN	C03600000000028900004
38	Farm Makkies Plaats 290 Portion 0 RE	Kenhardt Rd	2567,205047	T49914/1981CTN	C03600000000029000000
39	Farm Makkies Plaats 290 Portion 1	Kenhardt Rd	4314,771455	T10968/2009CTN	C03600000000029000001
40	Farm Makkies Plaats 290 Portion 2	Kenhardt Rd	1331,822886	T48093/1983CTN	C03600000000029000002
41	Farm Ramans Kolk 291 Portion 3	Kenhardt Rd	911,425182	T55001/1984CTN	C03600000000029100003
42	Farm Koic 295 Portion 0 RE	Kenhardt Rd	5105,389027	T91639/1994CTN	C03600000000029500000
43	Farm Koic 295 Portion 1	Kenhardt Rd	4638,917471	T91639/1994CTN	C03600000000029500001
44	Farm Nanibies 296 Portion 0 RE	Kenhardt Rd	6249,006579	T91639/1994CTN	C03600000000029600000
45	Farm Nanibies 296 Portion 1 RE	Kenhardt Rd	3117,041098	T91639/1994CTN	C03600000000029600001

2.4.1 Existing Groundwater Users

To capture all existing groundwater users a hydrocensus[1] will be required. The National Groundwater Archive (NGA) data for this specific area is outdated and the data can therefore not be used to accurately determine how many existing groundwater users there are, and what the water is used for.

[1] Hydrocensus – field survey to capture all existing boreholes, springs and dugholes.

Existing borehole information

A data search on the NGA[2] revealed 141 existing boreholes, of which:

- 77 boreholes had water level data – the average groundwater level was 17.26 m bgl[3];
- 73 boreholes had recorded yields - the average yield being 0.85 L/s and the maximum recorded yield 10.24 L/s;
- 141 boreholes had recorded boreholes depths – the average depth being 54 m bgl and the deepest 158 m bgl (refer to **Map 4a** for a plot of the NGA-derived **borehole depths**); and
- 82 boreholes had recorded water strike depths – the average strike depth being 33 m bgl and the maximum strike depth 83 m bgl.

The data that was obtained from the NGA however dates back to 1939, with the most recent data being from 1997. Although this data provides some information on the use of groundwater at the time, it does not necessarily reflect the current number of boreholes and current use. As GPS (Global Positioning System) technology was not readily available in the 1940's – 1980's the coordinates of the boreholes are not deemed very accurate and would have to be field-verified. This information will have to be obtained by means of a hydrocensus across the entire area. Error! Not a valid bookmark self-reference. provides the borehole information as recorded on the NGA. A plot of the **NGA data** is presented by **Map 4b**, **Appendix 1**.

Table 2-2: NGA Dataset

Site ID No.	Other No.	Latitude	Longitude	Date established	Depth [m bgl]	Groundwater level [m bgl]	Reported Yield [L/s]	Waterstrike depth [m bgl]
2920CC00001	36934	-29.97396	20.20482	25-Feb-49	99.36	51.51	0.30	83.51
2920CC00004	123644/2	-29.95036	20.19926	13-Jan-76	33	2.70	10.24	30
2920CC00002	34393	-29.95035	20.19926	10-Oct-47	76.2	45.72	0.30	46.33
2920CC00003	24324	-29.95035	20.19927	27-Jul-47	128.01	42.67	0.04	46.33
2920CC00005	123643/4	-29.95035	20.19928	20-Dec-75	24	3.30	7.31	20.3
2920CC00011	123604/4	-29.88371	20.13259	09-Oct-75	76			
2920CC00009	123601/0	-29.88370	20.13259	03-Oct-75	44	21.60	0.08	24.9
2920CC00007	139901/2	-29.88369	20.13259	26-Feb-82	40	10.00	0.12	30
2920CC00006	139902/0	-29.88368	20.13259	02-Mar-82	66	6.00	0.30	40
2920CC00008	137200/2	-29.88368	20.13260	25-Feb-82	36			
2920CC00010	121700/8	-29.88368	20.13261	02-Oct-75	26			
2919DD00021	151023	-29.84065	19.98893	18-Mar-87	30			30
2919DD00022	151025	-29.84064	19.98893	20-Mar-87	30			30
2919DD00020	151024	-29.84064	19.98894	19-Mar-87	20			20
2919DD00017	156578	-29.81230	19.94837	25-Oct-90	36			
2920CA00073	151038	-29.73591	20.19732	03-Jun-87	30			30
2920CB00019	144533/4	-29.73369	20.41593	09-Jan-84	20	6.70	2.00	13.5
2920CB00017	133161/6	-29.73368	20.41593	28-Aug-79	30	2.70	0.05	14
2920CB00018	139906/2	-29.73368	20.41594	16-Mar-82	24	10.00	0.50	18
2920CA00036	156559	-29.72258	20.07704	30-Jul-90	30	6.00	1.00	24
2919DB00004	156577	-29.71703	19.94643	24-Oct-90	48			
2920CA00053	139926/6	-29.71703	20.04926	18-Mar-82	48			
2920CA00052	139927/4	-29.71702	20.04926	22-Mar-82	45	20.00	0.30	30
2920CA00054	149141/6	-29.71702	20.04927	01-Jul-86	90	18.00	0.17	45
2919DB00007		-29.71144	19.92515		12			
2919DB00005	156576	-29.70592	19.95171	22-Oct-90	15	6.00	0.40	7
2920CA00037	164687	-29.70091	20.12259	08-Dec-94	66			66
2920CA00046	94297	-29.70055	20.21593	13-Jun-66	77.42			
2920CA00044	94299	-29.70054	20.21593	16-Jun-66	77.42			

[2] Maintained by the DHSWS
[3] Bgl = below ground level

Site ID No.	Other No.	Latitude	Longitude	Date established	Depth [m bgl]	Groundwater level [m bgl]	Reported Yield [L/s]	Waterstrike depth [m bgl]
2920CA00042	94293	-29.70053	20.21593	25-May-66	53.04			
2920CA00040	71675	-29.70052	20.21593	17-Jun-59	39.62	15.26	0.54	28.96
2920CA00038	72281	-29.70051	20.21593	19-May-59	143.26	30.48	0.01	60.96
2920CA00034	94290	-29.70050	20.21593	16-May-66	61.26			
2920CA00032	75512	-29.70049	20.21593	30-May-60	5.4			
2920CA00027	117735/5	-29.70047	20.21593	30-Aug-73	65.2			
2920CA00025	94295	-29.70046	20.21593	06-Jun-66	107.9			
2920CA00023	117725/8	-29.70045	20.21593	21-Aug-73	76.2			
2920CA00021	117733/9	-29.70044	20.21593	27-Aug-73	65.2			
2920CA00019	137198/3	-29.70043	20.21593	22-Feb-82	50			
2920CA00017	149142/4	-29.70042	20.21593	03-Jul-86	60			
2920CA00015	139928/2	-29.70041	20.21593	24-Mar-82	36			
2920CA00013	139907/0	-29.70040	20.21593		30			
2920CA00011	133164/0	-29.70039	20.21593	07-Sep-79	62			
2920CA00009	149144/0	-29.70038	20.21593	07-Jul-86	42	8.00	1.07	33
2920CA00007	147943/0	-29.70037	20.21593	24-Jun-85	36			
2920CA00004	72833	-29.70036	20.21593	21-Sep-59	24.17			
2920CA00002	75665	-29.70035	20.21593	21-Jun-60	89	21.30		
2920CA00029		-29.70035	20.21593	15-Sep-72	42.67			
2920CA00003	72389	-29.70035	20.21594	29-Aug-59	143.26	30.48	0.02	54.86
2920CA00005	114398	-29.70035	20.21595	25-Sep-72	24.38	5.79	0.45	12
2920CA00008	147944/8	-29.70035	20.21596	25-Jun-85	36			
2920CA00010	147945/6	-29.70035	20.21597	26-Jun-85	18		2.00	10
2920CA00012	133163/2	-29.70035	20.21598	04-Sep-79	18	3.60	0.38	8.5
2920CA00014	137199/1	-29.70035	20.21599	23-Feb-82	50	38.00	0.10	40
2920CA00016	147946/4	-29.70035	20.21600	26-Jun-85	30			
2920CA00018	149143/2	-29.70035	20.21601	04-Jul-86	30	6.00	5.45	24
2920CA00020	64507	-29.70035	20.21602	05-Jun-57	153.01	27.43	0.13	74.37
2920CA00022	117731/3	-29.70035	20.21603	24-Aug-73	53			
2920CA00024	117728/2	-29.70035	20.21604	22-Aug-73	48.8			
2920CA00026	117737/1	-29.70035	20.21605	31-Aug-73	65.2			
2920CA00028	117730/5	-29.70035	20.21606	23-Aug-73	61			
2920CA00030	117734/7	-29.70035	20.21607	28-Aug-73	53			
2920CA00033	72993	-29.70035	20.21608	09-Nov-59	157.9	45.70	0.02	76.2
2920CA00035	94291	-29.70035	20.21609	18-May-66	46.94	17.07	0.02	20.12
2920CA00039	71873	-29.70035	20.21610	21-Jul-59	123.75	60.96	0.03	70.1
2920CA00041	94294	-29.70035	20.21611	03-Jun-66	107.9		0.01	36.58
2920CA00043	94292	-29.70035	20.21612	24-May-66	122.22			
2920CA00045	94298	-29.70035	20.21613	17-Jun-59	71.32	20.73	0.10	36.58 and 61.57
2920CA00047	94296	-29.70035	20.21614	09-Jun-66	122.22	0.00		
2920CA00069	151034	-29.69979	20.20647	19-May-87	30	0.00		30
2920CA00071	151035	-29.69979	20.20648	20-May-87	60	27.00	2.13	54
2920CA00067	75317	-29.69979	20.20649	20-May-60	14.33	0.00		14.33
2920CA00072	151033	-29.69979	20.20650	14-May-87	30	10.00		10
2920CA00068	151037	-29.69978	20.20647	27-May-87	79	0.00	0.14	79
2920CA00070	151036	-29.69978	20.20648	22-May-87	18	9.00	1.25	15
2920CA00031	156558	-29.69757	20.12426	26-Jul-90	48	0.00		
2920CA00051	133187/8	-29.68370	20.03259	18-Sep-79	22	5.50	0.10	13
2920CA00049	133165/8	-29.68369	20.03259	13-Sep-79	94			
2920CA00048	133186/0	-29.68368	20.03259	18-Sep-79	34	6.00	0.05	11
2920CA00050	133185/2	-29.68368	20.03260	13-Sep-79	52	16.80	0.03	43
2919DB00029	156575	-29.67814	19.88698	19-Oct-90	30			
2919DB00003	156574	-29.67814	19.94198	19-Oct-90	30	15.00	0.60	24
2920CB00051	164685	-29.67202	20.28065	01-Dec-94	54			54
2920CB00052	164686	-29.66924	20.27732	07-Dec-94	42	11.00	0.20	11 and 19
2920CB00009	96066	-29.66706	20.36593	14-Mar-67	76.2			
2920CB00007	96064	-29.66705	20.36593	03-Mar-67	106.68			
2920CB00005	114395	-29.66704	20.36593	13-Sep-72	42.67	30.48	0.01	30.48
2920CB00003	114385	-29.66703	20.36593	05-Sep-72	41.15			

Site ID No.	Other No.	Latitude	Longitude	Date established	Depth [m bgl]	Groundwater level [m bgl]	Reported Yield [L/s]	Waterstrike depth [m bgl]
2920CA00001	164688	-29.66702	20.12426	09-Dec-94	96	24.00	0.14	24
2920CB00002	114387	-29.66702	20.36593	07-Sep-72	35.05			
2920CB00004	114391	-29.66702	20.36594	11-Sep-72	51.81			
2920CB00006	98964	-29.66702	20.36595	04-Apr-67	88.39	21.94	0.10	27.43
2920CB00008	96065	-29.66702	20.36596	07-Mar-67	56.38			
2920CB00010	96067	-29.66702	20.36597	22-Mar-67	112.77			
2920CB00045	154472	-29.66646	20.37204	07-Apr-89	30	10.00	1.00	21
2920CB00046	154471	-29.66618	20.36287	05-Apr-89	30	15.00	0.29	24
2920CB00041	157710	-29.66564	20.35809	28-Jun-91	36			
2920CB00042	157709	-29.66563	20.35759	28-Jun-91	42			
2920CB00040	157711	-29.66563	20.35809	01-Jul-91	36	12.00	2.00	30
2920CB00037	157716	-29.66008	20.35620	08-Jul-91	42	15.00	0.35	36
2920CB00035	157718	-29.66007	20.35620	09-Jul-91	18			
2920CB00036	157717	-29.66007	20.35621	09-Jul-91	24	6.00	2.00	18
2920CB00038	157715	-29.66007	20.35622	08-Jul-91	48			
2920CB00043	154470	-29.65924	20.33065	04-Apr-89	36			
2920CB00049	149195/3	-29.65674	20.39315	07-Oct-86	40	15.00	0.38	31
2920CB00050	149194/5	-29.65674	20.39315	06-Oct-86	45			45
2919DB00010		-29.65286	19.84921		80			
2920CB00044	154469	-29.65118	20.35398	03-Apr-89	24	9.00	0.83	15
2920CA00065	114379	-29.61707	20.21593	05-Sep-72	53.04	23.16	0.52	26.21
2920CA00063	114393	-29.61706	20.21593	12-Sep-72	39.63			
2920CA00061	114392	-29.61705	20.21593	08-Sep-72	75.9	29.87	0.10	39.01
2920CA00059	114384	-29.61704	20.21593	05-Sep-72	45.72			
2920CA00057	73881	-29.61703	20.21593	27-Jan-60	125	39.60	0.05	54.9
2920CA00055	74196	-29.61702	20.21593	08-Mar-60	126	40.00	0.07	70
2920CA00056	73581	-29.61702	20.21594	14-Dec-59	125	30.50	0.02	61
2920CA00058	74657	-29.61702	20.21595	26-Mar-60	32.6	10.60	0.53	17.1
2920CA00060	131184/4	-29.61702	20.21596	31-Oct-78	24	14.00	3.00	20
2920CA00062	114586	-29.61702	20.21597	06-Sep-72	45.72			
2920CA00064	114383	-29.61702	20.21598	31-Aug-72	48.77			
2920CA00066	147947/2	-29.61702	20.21599	27-Jun-85	30	6.00	2.00	20
2920CB00048	156585	-29.61591	20.25982	14-Nov-90	30	15.00	2.00	24
2920CB00047	156584	-29.59979	20.33259	13-Nov-90	48	15.00	0.60	40
2919DB00006	167787	-29.59480	19.85032	12-Aug-96	36	15.00	0.70	15 and 20
2920CB00039	157714	-29.59340	20.29231	04-Jul-91	72	36.00	0.60	66
2920CB00033	69771	-29.58375	20.31593	19-Nov-58	67.66	27.43	1.06	54.86
2920CB00031	70231	-29.58374	20.31593	27-Dec-58	30.48	9.14	0.31	12.19
2920CB00029	67754	-29.58373	20.31593	11-Apr-58	16.15	7.62	0.63	13.71
2920CB00027	67592	-29.58372	20.31593	08-Mar-58	10.05			
2920CB00025	53265	-29.58371	20.31593	29-Dec-53	38.7	17.67	1.24	21.33
2920CB00023	114443	-29.58370	20.31593	06-Dec-72	74.36			
2920CB00021	68504	-29.58369	20.31593	05-Aug-58	68.88	16.76	0.01	42.06
2920CB00020	25193	-29.58368	20.31593	19-Jul-39	51.2	23.46	1.76	24.68 and 38.1
2920CB00022	25582	-29.58368	20.31594	24-Oct-39	31.39	18.29	0.10	18.29 and 27.43
2920CB00024	52958	-29.58368	20.31595	30-Nov-53	53.94	3.04	0.75	10.66
2920CB00026	68048	-29.58368	20.31596	24-Jun-58	43.58	6.09	0.07	32.91
2920CB00028	67675	-29.58368	20.31597	28-Mar-58	10.66			
2920CB00030	67915	-29.58368	20.31598	28-Apr-58	22.86	6.09	0.25	13.71
2920CB00032	69982	-29.58368	20.31599	17-Dec-58	86.25	30.48	0.05	38.1
2920CB00034	68962	-29.58368	20.31600	02-Sep-58	55.77	30.48	0.01	38.4
2919DB00014		-29.56217	19.85793		80			
2920CA00006	156582	-29.53368	20.19592	08-Nov-90	36	15.00	0.25	

2.4.2 Future Groundwater Users

The drivers for future groundwater development usually include the following:

- Existing boreholes that dry up;

- Increase in groundwater demand (e.g. population growth, economic growth, agricultural growth);
- Insecurity of bulk water supplies;
- Surface water shortages (as result of global warming, increased demand); and
- Prolonged droughts.

From a desktop study it is not possible to determine the future demand on groundwater, as the existing use and growth factors have to be taken into account.

2.4.3 Groundwater as Natural Resource

Groundwater falls under the protection of the National Water Act, and may not be polluted.

2.5 Consideration of related/significant aspect management plans in the area

SRK is not aware of any specific aspect management plans in the Tierklip Area, besides the regulations previously discussed.

2.6 Spatial Sensitivity Mapping

According to UNEP-WCMC. (2018),

Sensitivity mapping provides a visual representation of risks, and assets which may be exposed to them. Multiple environmental sensitivity mapping approaches exist, with methods and uses varying based on stakeholders' values, drivers of change, data availability, and the technical capacity of the users. Sensitivity mapping is often carried out using geographic information systems (GIS) technology. The amount and/or type of data used to produce a sensitivity map will affect and limit its potential uses. Nevertheless, environmental sensitivity mapping can have a wide variety of applications. These include but are not limited to:

- *Helping decision-makers understand where protection of valuable environmental assets is needed, which could aid the development of protected area networks;*
- *Informing governmental and private sector spatial planning at the project level, targeting activities to the locations where they will have the lowest impact;*
- *Supporting all stages of impact management, including prevention, mitigation, preparedness, operations, relief, recovery and integration of lessons learned;*
- *Aiding situational awareness and response strategy development for responders and decision makers during an incident.*

In the case of the Tierklip Area and in order to create a spatial sensitive map, the following are deemed of key importance:

- Exploration methods:
    - Drilling positions and drilling methods;
    - The processes that will be followed during the exploration phase; and
    - Implementation and auditing of the groundwater management plan.
- Receiving environment (for the purpose of this report, specifically groundwater):

- Areas overlain with sand / alluvial deposits (quarternary deposits) – these are highly permeable and contamination may migrate rapidly[4] towards groundwater and surface water; and
- Proximity of surface water features such as wetlands, streams, rivers and earth dams.

Drilling Positions, Drilling depths and Exploration Processes

Exact drilling positions: According to Black Mountain: "*it is not possible to give details of the drilling program before the surveys and surface work phase 1 is completed. The targeting of all drilling activities will be dependent on the results obtained during the preceding phases of prospecting, namely the geological mapping and geophysical surveying and as such it is currently not possible to include a finalized surface plan showing the intended location, extent and depth of boreholes to be completed."*

Drilling depths and drilling methods: According to Black Mountain*: The initial planned invasive exploration activities will consist of diamond drill boreholes drilled to appropriate depths to target any anomalies identified during Phases 2 & 3 of the non-invasive portion of the prospecting work plan. Percussion Rotary Air Blast (RAB) or Reverse Circulation (RC) drilling may be carried out for pre-collaring of diamond drill boreholes or for obtaining samples if significant depth of cover is encountered over particular targets. No bulk sampling work is to be carried out during this prospecting program.*

According to Black Mountain, the planned phases detailed in **Table 2-3** below will be used to investigate the prospecting area.

Table 2-3: Planned Activities for the Exploration

Phase	Activity (what are the activities that are planned to achieve optimal prospecting)	Skill(s) required (refers to the competent personnel that will be employed to achieve the required results)	Timeframe (in months) for the activity)
1	**Non-Invasive Prospecting** Desktop Study: Literature Survey / Review	Geologist	Month 1-12
2	**Non-Invasive Prospecting** Regional Airborne Geophysical Survey	Geophysicist / Geologist / field crew	Month 6-12
3	**Non-Invasive Prospecting** Ground Geophysical Survey and Geological Field Mapping	Geologist & field crew	Month 12-24
4	**Invasive Prospecting** Exploration Boreholes (6 RAB holes – 2400m; 4 DD holes – 2000m)	Geologist / drill rig team / field crew / laboratory technicians	Month 24-34

[4] The migration of a pollution plume is dependent on (1) the viscosity of the pollutant, (2) pathway medium, (3) the volume of pollutant and (4) hydraulic head.

5	**Non-Invasive Prospecting** Compilation, interpretation and modeling of data	Geologist / Geophysicist	Month 34-36
6	**Non-Invasive Prospecting** Detailed Ground Geophysical Survey on individual positively mineralized targets to define possible extent	Geophysicist / Geologist / field crew	Month 36-42
7	**Invasive Prospecting** Boreholes to confirm continuity of mineralization & potential deposit size (20 DD holes – 8000m)	Geologist / drill rig team / field crew / laboratory technicians	Month 42-48
8	**Invasive Prospecting** Resource definition drilling (40 DD holes – 16000m)	Geologist / drill rig team / field crew / laboratory technicians	Month 48-60
9	**Non-Invasive Prospecting** Analytical Desktop Pre-Feasibility Study	Economic Geologist / Mining Geologist	Month 54-60

From the available information gathered during SRK's desktop assessment of the geology, geohydrology, NGA data and information provided by EIMS, the potentially **groundwater sensitive** areas have been restricted to:

- Areas covered by quaternary deposits (e.g. alluvial sands); and
- Existing boreholes.

Other sensitive areas that can be linked to groundwater include:

- Surface water features (e.g. rivers); and
- Salt Pans

The sensitivity map for the Tierklip Area is shown in **Appendix 1**, **Map 5** and shows the areas that have been mapped on the geological map series as quaternary deposits. Mapped rivers and saltpans are also shown. A buffer zone of 150 m from mapped rivers / streams is also drawn. The distance of 150 m has been taken from the DWS document "Groundwater Protocol for the Protection of Aquifers from On-site Sanitation". Although the current exploration activities do not involve the installation of on-site sanitation systems, in SRK's professional opinion, the protocol guidelines can be applied for this project[5].

[5] The "safe distance" between any exploration borehole and the relevant (nearest) receptors will have to be determined and adjusted once the exact drilling positions are known

A hydrocensus of the targeted areas (farms) will provide key information pertaining to specific areas where existing boreholes, springs, rivers, streams and wetlands (groundwater fed) are situated. The spatial sensitivity map can then be updated.

2.7 Identification, description and assessment of potential impacts

From Table 2-3, the "invasive Prospecting" works (Phases 4, 7 and 8) will include Diamond Drilling with possible Percussion Rotary Air Blast (RAB) or Reverse Circulation (RC) for pre-collaring of diamond drill boreholes.

Aquifers are vulnerable to degradation during and following exploration drilling in the following ways:

- Exploration boreholes left open may lead to the inflow of contaminated run-off from the surface;
- Aquifers of good water quality may be connected to aquifers with poor and/or unacceptable water quality via the drilling processes;
- Aquifers with useable quantities of water may be connected to leakage zones / unsaturated zones; and
- Groundwater wastage can occur during drilling, negatively affecting nearby boreholes (groundwater users).

Waterways, such as streams, springs and rivers are also vulnerable to negative impact from exploration drilling activities. These negative impacts may manifest via contaminated groundwater, where the groundwater table is present at a higher altitude than the base of the river or stream and groundwater therefore feeds the stream or river. Drainage of contaminated water from the drilling processes may enter rivers, streams or springs directly. Contaminated drilling spoils that are left on the surface may be washed into rivers, streams or springs during rains.

3 Possible Impacts and Mitigation Measures

The aim of this section is to make a preliminary assessment of any potential groundwater impacts that are likely to arise as a result of the proposed **prospecting activities**. It must be kept in mind that no details of the prospecting / exploration activities were available at the time of writing this report. Where reference is made to possible pollution / contamination, it refers to any contamination that can result from the invasive work, i.e. drilling. This may include, but is not limited to, on-site spills (e.g. fuels and oils), sanitation, litter and mixing of poor water quality with good water quality.

EIMS provided SRK with an evaluation format to be used in the reporting of possible impacts, the severity of the impacts and mitigation measures during the exploration phases. Based on the various evaluation criteria, the following potential impacts have been identified:

- **Potential Impact 1**: **Degradation of aquifers** (see Table 3-1)
- **Potential Impact 2:** **Impact on existing groundwater users** (see Table 3-2)
- **Potential Impact 3**: **Degradation of surface water** (that could be linked to groundwater) (see Table 3-3)

In assessing the potential impacts, and considering mitigation measures, SRK assumed that the drilling positions cannot be moved by a distance > 1 km as the drilling will be target specific and not random.

3.1 Potential Impact 1: Degradation of Aquifers

Terms used:

- **Mitigation:** To reduce the risk of the drilling activities having a negative impact on the aquifer system or various aquifer systems (to be determined) a detailed geohydrological assessment would be required for the exploration area, and could have to be adapted for every drilling position. A qualified geohydrologist must form part of the exploration project team, to provide the necessary input and scientific support in terms of preventing / mitigating degradation of aquifers.
- **Pre-mitigation**: Refers to drilling in the absence of a detailed geohydrological impact assessment and no on-site geohydrological drilling control.
- **Post Mitigation**: Assumes that the proposed mitigation measures have been put in place.
- **Alternative 1**: In this case there is no alternative to drilling and therefore Alternative 1 = No Alternative.

Table 3-1: Potential Impact 1 - Degradation of Aquifers

Impact Name	**Degradation of aquifers**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	2
Extent	3	3	Reversibility	3	2
Duration	4	2	Probability	3	3
Environmental Risk (Pre-mitigation)					-10.50
Mitigation Measures					
Detailed geohydrological assessment of expected aquifers and support during drilling phases – input to the EMP					
Environmental Risk (Post-mitigation)					-6.75
Degree of confidence in impact prediction:					Low
Impact Prioritisation					
Public Response					3
High: Issue has received an intense meaningful and justifiable public response					
Cumulative Impacts					2
Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					3
High: Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).					
Prioritisation Factor					1.83
Final Significance					-12.38

3.2 Potential Impact 2: Impact on Local Groundwater Users

Terms used:

- **Mitigation:** To reduce the risk of the drilling activities having a negative impact on any existing groundwater user (i.e. boreholes) a detailed hydrocensus, followed by a geohydrological assessment would be required for the exploration area. The geohydrological report must include a risk assessment (source-pathway-receptor) of every drill site with nearby boreholes / springs in mind. A qualified geohydrologist must form part of the exploration project team, to provide the necessary input and scientific support in terms of preventing / mitigating impacts on nearby groundwater users.
- **Pre-mitigation**: Refers to drilling in the absence of a hydrocensus, absence of a detailed geohydrological report and no on-site geohydrological drilling control.
- **Post Mitigation**: Assumes that the proposed mitigation measures have been put in place.
- **Alternative 1**: In this case there is no alternative to drilling and therefore Alternative 1 = No Alternative.

Table 3-2: Potential Impact 2: Impact on Local Groundwater Users

Impact Name	**Impact on local GW users**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	2
Extent	3	3	Reversibility	3	2
Duration	2	2	Probability	3	2
Environmental Risk (Pre-mitigation)					-9.00
Mitigation Measures					
Detailed hydrocensus, detailed geohydrological assessment and geohydrological support during drilling phases – input to the EMP					
Environmental Risk (Post-mitigation)					-4.50
Degree of confidence in impact prediction:					Low
Impact Prioritisation					
Public Response					3
High: Issue has received an intense meaningful and justifiable public response					
Cumulative Impacts					2
Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					3
High: Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).					
Prioritisation Factor					1.83
Final Significance					-8.25

3.3 Potential Impact 3: Degradation of Surface Water (linked to groundwater)

Terms used:

- **Mitigation:** To reduce the risk of the drilling activities having a negative impact on any nearby surface water that may be linked to groundwater (e.g. wetlands that are sustained by groundwater, streams / rivers that are partly recharged by groundwater), the detailed geohydrological report must include a risk assessment (source-pathway-receptor) of every drill site with nearby surface water features in mind. The drilling must also be overseen by a qualified geohydrologist, who will also brief the drilling contractor on the possible risks to the receptors so that the drilling contractor can have a contingency plan in place
- **Pre-mitigation**: Refers to drilling in the absence of a hydrocensus (which must also detect surface water features), absence of a detailed geohydrological impact assessment and no on-site geohydrological drilling control.
- **Post Mitigation**: Assumes that the proposed mitigation measures have been put in place.
- **Alternative 1**: In this case there is no alternative to drilling and therefore Alternative 1 = No Alternative.

Table 3-3: Potential Impact on Surface Water Sources

Impact Name	**Degredation of surface water**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	2
Extent	3	3	Reversibility	3	2
Duration	3	2	Probability	2	2
Environmental Risk (Pre-mitigation)					-6.50
Mitigation Measures					
Detailed hydrocensus, including capturing surface water and risk assessment report – as input to EMP					
Environmental Risk (Post-mitigation)					-4.50
Degree of confidence in impact prediction:					Low
Impact Prioritisation					
Public Response					3
High: Issue has received an intense meaningful and justifiable public response					
Cumulative Impacts					2
Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.50
Final Significance					-6.75

4 Geohydrological Management Plan

The desktop study has highlighted potential risks and impacts that the invasive phases of the exploration (i.e. drilling) could cause. As the details of the drilling processes, drilling depths and drilling positions are not known at this stage, the potential risks that have been highlighted in this report is generic of nature and applies to exploration drilling in general.

The geohydrological management plan (GMP) cannot be finalised at a desk study phase as the identified risks and potential impacts are site specific and currently the final drilling positions have not been finalised yet. A GMP can be compiled for the Tierklip Area once a hydrocensus has been completed, also taking cognisance of the specific drilling positions and potential receptors.

Site specific information / instructions that will ultimately have to be included in the final GMP and overseen by an experienced and qualified geohydrologist (Pr. Sci. Nat. registered) must include:

- A description of the expected geological formations that will be penetrated and the expected aquifer characteristics associated with each geological formation – depth of the borehole will dictate the potential risks;
- Expected water qualities of each aquifer (associated with the different geological formations) that will be penetrated – depth of the exploration borehole will dictate the potential risks;
- An assessment of the potential degradation of the aquifers should variable water qualities mix;
- Surrounding groundwater users and the protection thereof: positions of boreholes, depths, abstraction rates, water quality and dependency of the owner of his/her borehole.

The following mitigation measures should be implemented as standard during the prospecting phase in order to limit the impact on groundwater resources:

- Ensure vehicles and equipment are in good working order.
- Place oil traps under stationary machinery, only re-fuel machines at fuelling station, construct structures to trap fuel spills at a fuelling station, immediately clean oil and fuel spills and dispose contaminated material (soil, etc.) at licensed sites only.
- Ensure that good housekeeping rules are applied.
- A procedure for the storage, handling and transport of different hazardous materials must be drawn up and strictly enforced.
- Implement and follow water saving procedures and methodologies.
- If boreholes are to be drilled to supply water for the staff or drilling processes;
    - Ensure the location of the borehole/s is selected to prevent a negative effect on the groundwater levels of existing boreholes.
    - Ensure the abstraction from the borehole/s is determined scientifically to prevent over abstraction.
    - Liaise with potentially affected groundwater water users and monitor any potential impact.
    - The distance between a planned exploration drill hole and a privately owned borehole is important to note, as it also affects the distance (pathway) that any potential pollutant must migrate to reach the borehole
- Monitoring of the groundwater quality during and after activities are completed.

- Portable chemical toilets must be used during the exploration phase.
- Mud pits (if to be used) must be lined and properly covered with impermeable material after completion of exploration boreholes
- Cap and seal all exploration boreholes to prevent surface water from entering the borehole.

It is not currently known whether groundwater from boreholes is considered to be utilised during the prospecting phase. It is anticipated that water will be brought onto site and trucked to the identified drill sites.

During exploration drilling the following information must be recorded and reported on:

a) Aquifer type;

b) Depths to first water strike;

c) Depths to deeper water zones;

d) Salinity of water strike zones (EC measurement with field probe);

e) Strike yields;

f) Standing water level (allow several hours after completion); and

g) Hole completion details (e.g. cement / bentonite plug, backfill material, bore cap, bore number and coordinates).

5 Conclusions

From the desktop study and information provided to SRK by EIMS, the following are concluded for the Tierklip Area:

- Although the majority of the area is being classed as a poor aquifer system with potentially poor water quality and low expected yields, there are existing groundwater users for which boreholes could be their only water source. It is therefore critical that existing groundwater users be taken into account and that their boreholes are not negatively affected in any way.
- Any negative impact on groundwater and/or groundwater users, whether factual or perceived (complaints from surrounding borehole users) can have a significant financial and reputational impact on the exploration programme and subsequent mining.
- It is not possible to accurately predict the aquifers that will be penetrated when drilling 400 m or more and it is therefore important that support by a geohydrologist is provided before and during the drilling activities.
- Due to the lack of information, such as hydrocensus information, exact drilling positions and drilling depths, a very basic sensitivity map could be compiled at this stage, incorporating areas covered by quaternary deposits (e.g. sands) and surface water / pans. This information was taken from available geological and topographical maps.

6 Assumptions, uncertainties and gaps in knowledge

6.1 Assumptions

SRK assumes that the main purpose of this desktop study is to provide a broad overview of what has been documented for this specific area in terms of the geohydrology. SRK further assumed that the planned exploration has not yet been publicised or discussed with the local municipalities, local farming unions, or any other private or public sector body. SRK did therefore not make contact with any private or public body in terms of the gathering of site specific data. The information on which the desktop study is based, is therefore mainly the available information from the Department of Human Settlement, Water and Sanitation, on a national scale, and published reports that we could source. SRK further assumes that a public participation process will be followed whereby existing groundwater users will be included.

6.2 Limitations

The potential impacts of any drilling activity on the groundwater regime will vary from site to site, even over short distances due to changes in geology and receptors. As no recent hydrocensus across the entire exploration area has been conducted, SRK did not have access to, for example, positions of existing boreholes, dependency on groundwater, specific water quality, depth to groundwater levels and borehole depths. The sensitivity map and groundwater management plan, as presented in this report, must be seen as working documents that must be improved as more information becomes available.

6.3 Gaps

Based on the information presented to SRK, by EIMS, the following information gaps have been identified:

- Exact drilling positions and drilling depths;
- Storage and handling of any potentially hazardous materials / substances on the drilling site, e.g. fuels (diesel, petrol, paraffin, etc.), oils and cleaning chemicals;
- Detailed hydrocensus within the areas where exploration drilling will take place – the hydrocensus must be completed by a geohydrologist / geohydrological technician who has experience in the collection of geosite data, as prescribed by the DWS.
- Detailed scientific reports (geological and geohydrological) of the exploration area (if any) – sourcing these reports will require open conversations with private and public bodies, in which the purpose of the exploration programme and exploration areas will have to be revealed.

A **detailed geohydrological assessment** is required prior to any invasive exploration work (e.g. drilling).

Prepared by

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3536-4427-9135-NELG-05/07/2019

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Gert Nel (Pr. Sci. Nat.)

Partner

Reviewed by

SRK Consulting - Certified Electronic Signature

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1400-7067-6496-GOOS-08/07/2019

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Eunice Goossens (Pr. Sci. Nat.)

Principal Hydrogeologist

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

8 References

Department of Water Affairs. (February 2006). *Groundwater Resources Assessment Phase II, Project No. 3003-150.*

Department of Water Affairs. (March 2003). *A Protocol to manage the potential of groundwater contamination from on site sanitation, 2nd Ed.*

Department of Water Affairs. (March 2006). *A guideline for the assessment, planning and management of groundwater resources in South Africa.*

Directorate Catchment Management, DWA, GIS and Cartographic: Helena Fourie. (n.d.). *1: 2 000 000 Water Management areas of the Republic of South Africa.*

P.H. Macey, H. S. (2011). *The Geology of the Loeriesfontein Area, Explanation Sheet 3018.*

Appendix 1: Maps

Map 1 - Topography

Map 2 – Geology

Map 3a – EC

Map 3b – Groundwater Flow Directions

Map 4a – Boreholes Depths

Map 4b – NGA Data

Map 5 – Sensitivity Map

SRK Report Distribution Record

Report No. 549553/TIERKLIP

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SRK Electronic	SRK Consulting	2	Electronic	8 July 2019	E. Goossens

Approval Signature:

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29°30'0"S 29°40'0"S 29°50'0"S 30°0'0"S

D53G D53D D57E D57D D53F

1000 980 960

N

0 2 4 8
Kilometers

Legend

- Drainage Region
- Target Farm
- Application area
- Non perennial river
- Non-perennial river bed / Pan / Saltpan / Marsh

Altitude [m amsl]

- < 840
- 841 - 860
- 861 - 880
- 881 - 900
- 901 - 920
- 921 - 940
- 941 - 960
- 961 - 980
- 981 - 1000
- 1001 - 1020
- 1021 - 1040
- 1041 - 1060
- > 1061

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Black Mountain Mining - TIERKLIP

MAP 1: TOPOGRAPHY

Data Source:	
Scale: 1:265,000	
Projection:	Datum: HH94
Central Meridian/Zone:	
Date: 14/06/2019	Compiled by: GOOS
Project No: 549553	Fig No: MAP1

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Revision: A Date: 14 06 2019

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29°30'0"S 29°40'0"S 29°50'0"S 30°0'0"S

N

0 2 4 8
Kilometers

Code	Unit	Description
		- Alluvium
Q:		- Sand, redbrown sandy soil
Tec / T-c:		- Calcrete
J-d:		- Dolerite
Ppr / Pp:	Prince Albert Formation	- Brownish-green shale, mudstone, dolomitic limestone
C-Pd:	Dwyka Group	- Tillite, diamictite, subordinate sandstone, mudstone and dolomitic limestone
Mvl:	Vaalhoek Granite	- Foliated, fine- to medium-grained, dark-weathered biotite granite

Legend

- Target Farm
- Application area
- Non perennial river
- Perennial river
- Dolerite dyke

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MAP 2: GEOLOGY

Data Source:	
Scale: 1:265,000	
Projection:	Datum: HH94
Central Meridian/Zone:	
Date: 14/06/2019	Compiled by: GOOS
Project No: 549553	Fig No: MAP2

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Revision: A Date: 14 06 2019

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29°30'0"S 29°40'0"S 29°50'0"S 30°0'0"S

N

0 2 4 8

Kilometers

Legend

- Application area
- Target Farm
- Non perennial river
- Non-perennial river bed / Pan / Saltpan / Marsh

Expected Electrical Conductivity Readings in Groundwater

- 70 - 300 mS/m
- 300 - 1 000 mS/m

Reference: "Department of Water Affairs and Forestry, (2002). Hydrogeological Map Series of the Republic of South Africa. Completed in 2002"

Data Source:	
Scale: 1:265,000	
Projection:	Datum: HH94
Central Meridian/Zone:	
Date: 14/06/2019	Compiled by: GOOS
Project No: 549553	Fig No: MAP3a

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MAP 3a: HYDROGEOLOGY - EXPECTED ELECTRICAL CONDUCTIVITY READINGS IN GROUNDWATER

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Revision: A Date: 14 06 2019

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29°30'0"S 29°40'0"S 29°50'0"S 30°0'0"S

N

0 2 4 8
Kilometers

Legend

- Application area
- Non perennial river
- Non-perennial river bed / Pan / Saltpan / Marsh
- Regional groundwater flow direction

Altitude [m amsl]

- < 840
- 841 - 860
- 861 - 880
- 881 - 900
- 901 - 920
- 921 - 940
- 941 - 960
- 961 - 980
- 981 - 1000
- 1001 - 1020
- 1021 - 1040
- 1041 - 1060
- > 1061

960

1000

Data Source:	
Scale: 1:265,000	
Projection:	Datum: HH94
Central Meridian/Zone:	
Date: 14/06/2019	Compiled by: GOOS
Project No: 549553	Fig No: MAP3b

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MAP 3b: REGIONAL GROUNDWATER FLOW DIRECTIONS

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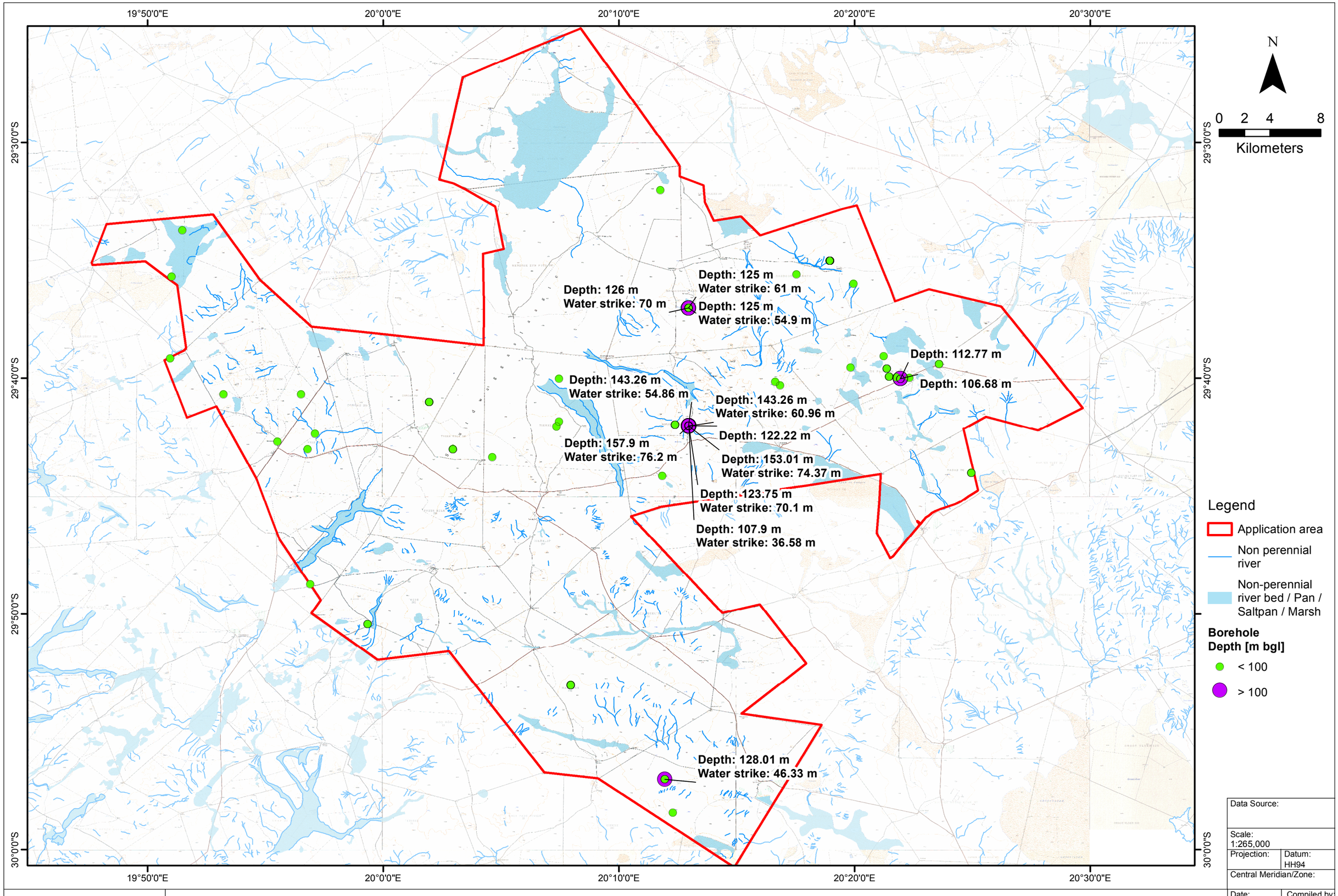
Revision: A Date: 14 06 2019



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Projection:	Datum: HH94
Central Meridian/Zone:	
Date: 14/06/2019	Compiled by: GOOS
Project No: 549553	Fig No: MAP4a

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MAP 4a: BOREHOLE DEPTHS AND GROUNDWATER STRIKE DEPTHS

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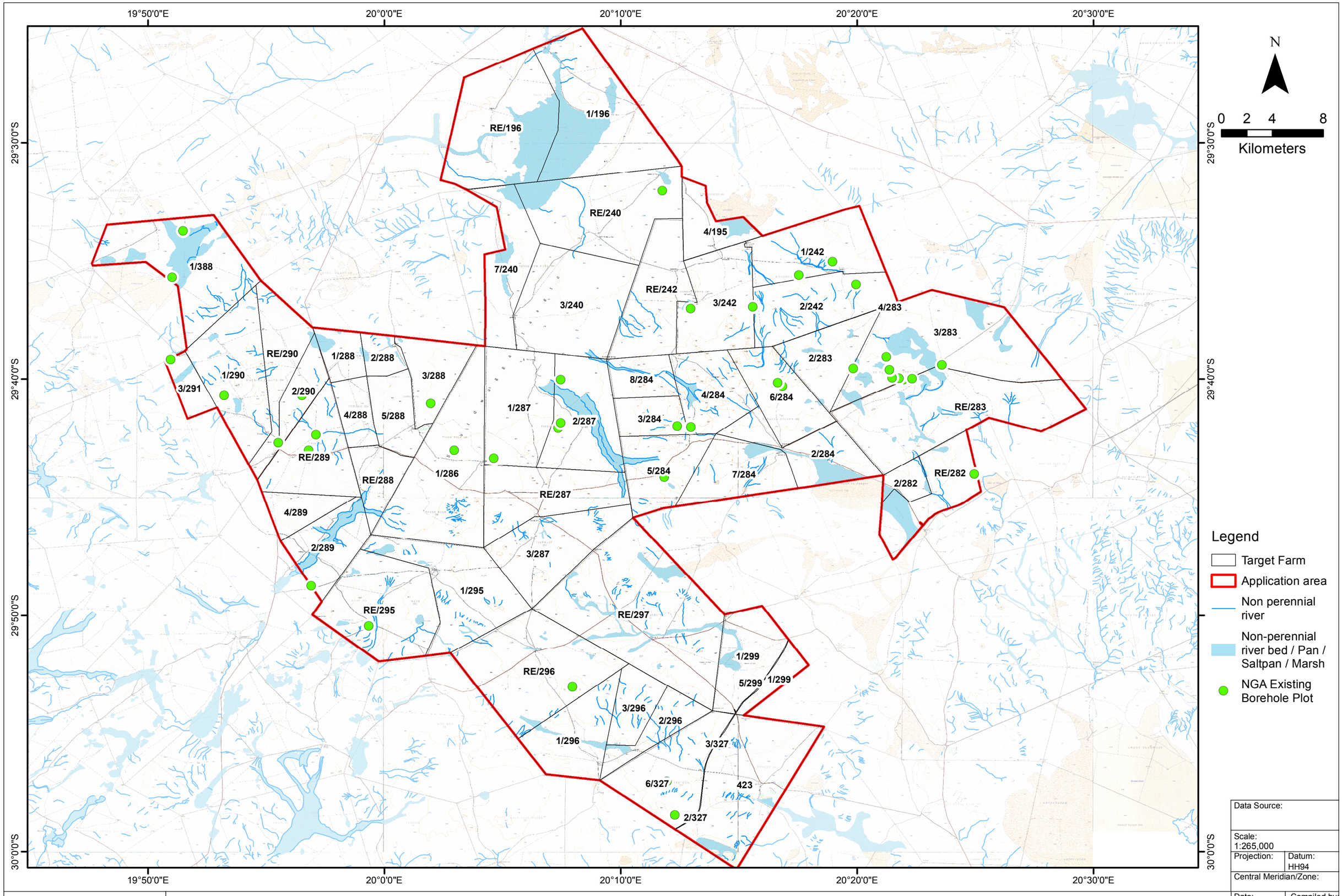
Revision: A Date: 14 06 2019



Data Source:	
Scale: 1:265,000	
Projection:	Datum: HH94
Central Meridian/Zone:	
Date: 14/06/2019	Compiled by: GOOS
Project No: 549553	Fig No: MAP4b

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MAP 4b: EXISTING BOREHOLE PLOT

Path: G:\PROJECTS\CURRENT PROJECTS\549553_EIMSGWRISKASS\8GIS\GISPROJ\MXD\TIERKLIP FINAL MAPS\549553_EIMS_Area 4 TIERKLIP - Map 4b Existing Borehole Plot_20190625.mxd

Revision: A Date: 14 06 2019

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29°30'0"S 29°40'0"S 29°50'0"S 30°0'0"S

N

0 2 4 8
Kilometers

RE/196 1/196 RE/240 4/195 1/242 7/240 RE/242 3/242 2/242 4/283 3/283 3/240 2/283 8/284 4/284 6/284 RE/283 3/284 2/284 5/284 7/284 RE/282 2/282 1/287 2/287 3/287 RE/287 1/286 RE/288 RE/289 4/289 2/289 RE/295 1/295 RE/297 RE/296 1/299 5/299 3/296 2/296 1/296 3/327 6/327 423 2/327 1/388 RE/290 1/288 2/288 3/288 1/290 3/291 2/290 4/288 5/288

Legend

- Target Farm
- Application area
- Non perennial river
- Non-perennial river bed / Pan / Saltpan / Marsh
- Quaternary Deposits
- 150 m bufferzone from rivers

Data Source:	
Scale: 1:265,000	
Projection:	Datum: HH94
Central Meridian/Zone:	
Date: 14/06/2019	Compiled by: GOOS
Project No: 549553	Fig No: MAP5

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MAP 5: SENSITIVE AREAS

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Revision: A Date: 14 06 2019