

**HYDROCENSUS REPORT FOR THE KAAP RIVER SUB-SYSTEM IN THE
CROCODILE CATCHMENT**

INKOMATI-USUTHU CATCHMENT MANAGEMENT AGENCY

MPUMALANGA PROVINCE

DECEMBER 2019

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INKOMATI-USUTHU CATCHMENT MANAGEMENT AGENCY

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DECEMBER 2019

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List of Abbreviations

DWS	: Department of Water and Sanitation
GPS	: Global Positioning System
IUCMA	: Inkomati-Usuthu Catchment Management Agency
MAP	: Mean Groundwater Precipitation
NGA	: National Groundwater Archive
SANAS	: South African National Accreditation System
SANS	: South African National Standards
WMA	: Water Management Area

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1 INTRODUCTION

1.1 Background

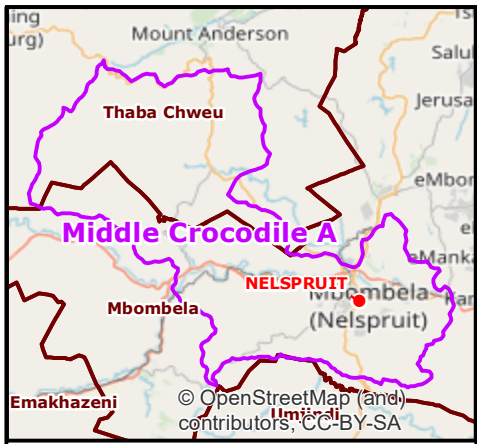
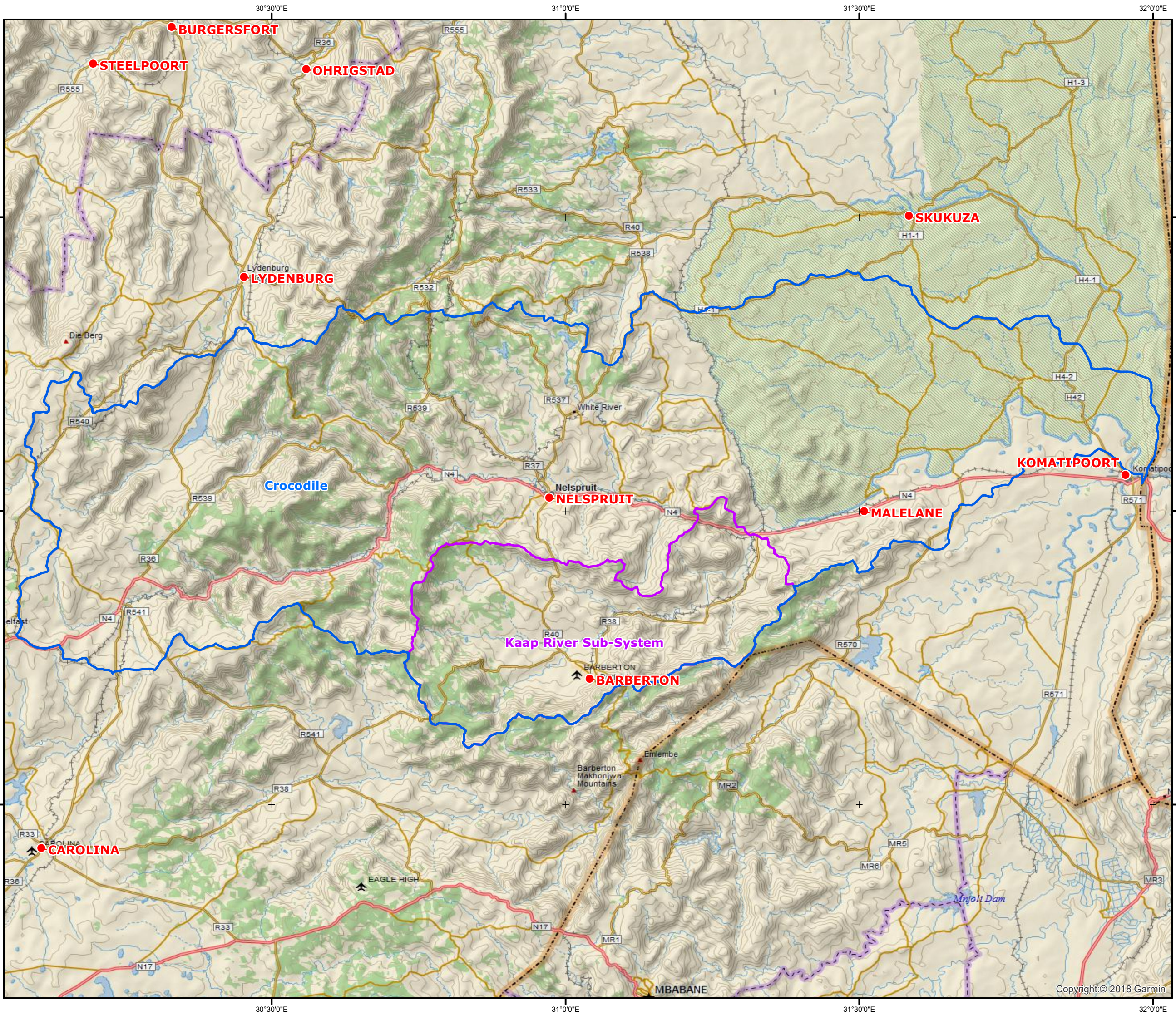
The Inkomati-Usuthu Catchment Management Agency (IUCMA) is the responsible authority within the jurisdiction of the Inkomati-Usuthu Water Management Area (WMA). As an authority, the IUCMA is responsible for managing, controlling, protecting and monitoring water resources in its area of responsibility (IUCMA, 2018). The agency manages four catchments (Sabie-Sand, Crocodile, Usuthu and Komati Catchments). The Crocodile River catchment originates near Dullstroom, where it flows into the Kweni Dam and eastwards through Nelspruit and confluences with the Komati River before entering Mozambique at the Lebombo Border Gate. The Elands River and Kaap River are two large tributaries of the Crocodile River system.

The Crocodile Catchment has been divided into eight sub-systems (Elands, Kaap River, lower Crocodile, Lower Kweni, Middle Crocodile A, Middle Crocodile B, Upper Crocodile and White River Sub-systems). Kimopax had been assigned to conduct hydrogeological assessment studies in the Kaap River, Middle Crocodile A and White River Sub-systems, see Figure 1 for the location of these sub-systems. This document reports on the hydrocensus carried out in the Kaap River Sub-system.

1.2 Hydrocensus Objectives

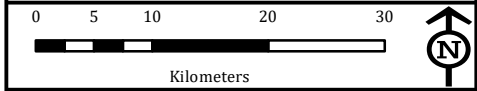
The purpose of the hydrocensus was to verify and record new information on existing production and monitoring boreholes collated within the Kaap River Sub-system. The field investigation was also carried out to identify location of existing sources, potential sources of groundwater pollution, as this information is important for assistance for future mitigation measures implementation plans or prevention measures.

- a) Locate and verify existing production and monitoring boreholes;
- b) Determination of access and distribution groundwater;
- c) Quantification of potential groundwater yield;
- d) Determination of groundwater quality;
- e) Assessment of possible negative environmental impacts; and
- f) Assessment of boreholes in need of rehabilitation.



LEGEND

- Towns
- Crocodile_Catchment
- Crocodile_Sub_Systems



REFERENCE: Transverse Mecartor (Gauss-Kruger)
WGS84 Ellipsoid
Hartebeesthoek 94 Datum
Central Meridian 31°

PROJECT:
IUCMA HYDROGEOLOGICAL SERVICES

TITLE:
LOCALITY MAP OF
KAAP RIVER SUB SYSTEM

PROJECT No.		KIM-WAT-2019-58
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1.3 Scope of Work

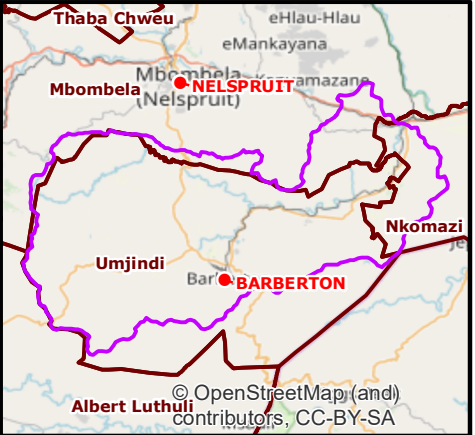
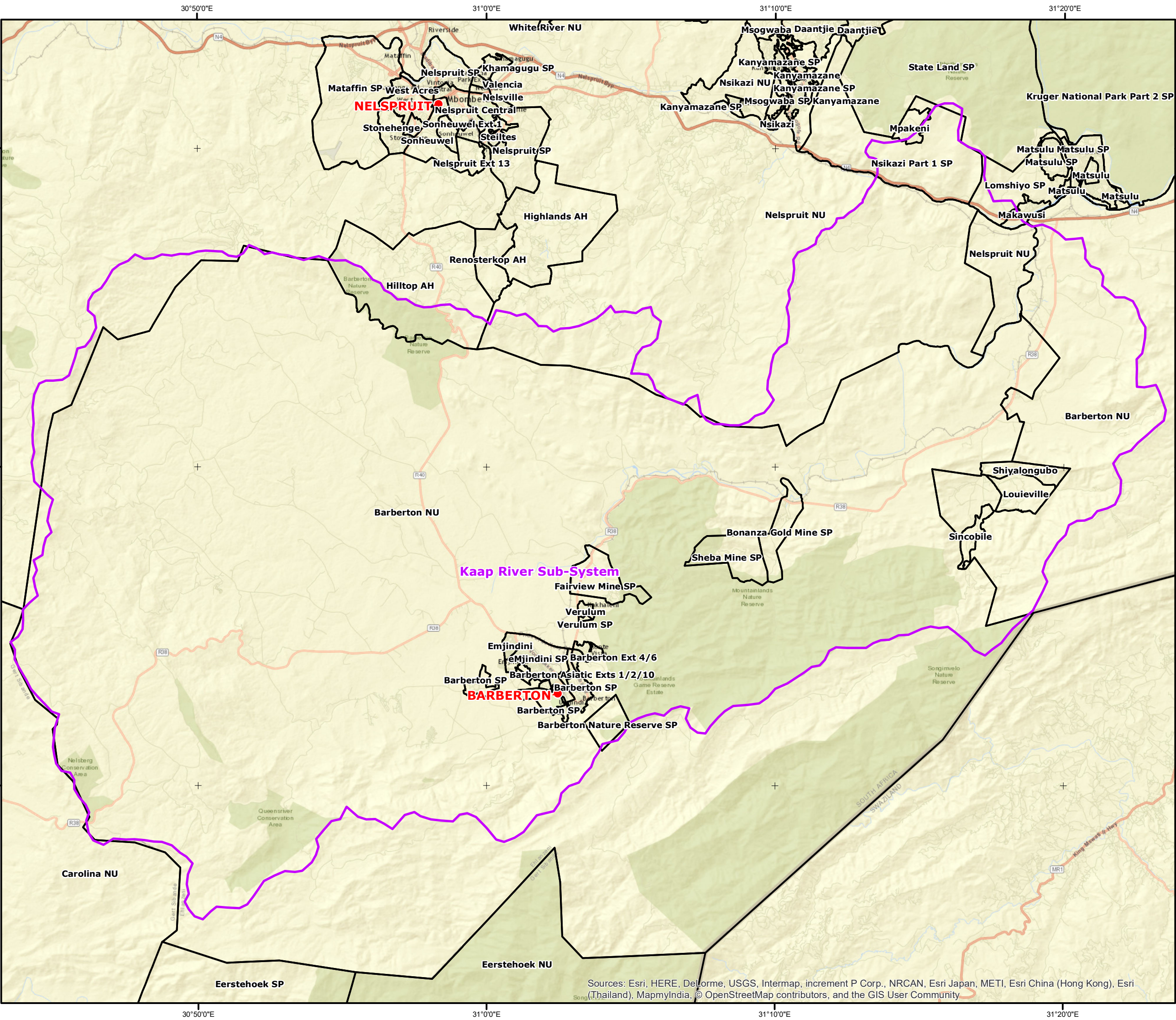
The following activities were undertaken:

- a) Revised desktop study which includes collation of existing reports, existing municipal boreholes within the catchment, existing groundwater monitoring points and other boreholes in use;
- b) Hydrocensus which includes verifying existing boreholes and locating new undocumented boreholes, hydrochemical sampling of existing accessible boreholes;
- c) Identify boreholes that need to be rehabilitated for either human consumption or monitoring facility;
- d) Identify three (3) boreholes that can be refurbished to mitigate against prolong drought stricken areas within the Kaap River Sub-system area; and
- e) Compile an investigation report of the activities undertaken up to date

2 DESCRIPTION OF THE STUDY AREA

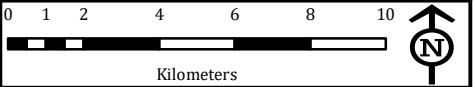
2.1 Locality

The Crocodile Catchment is located Mpumalanga Province. The catchment includes capital city of Nelspruit and regional centres like White River and Barberton. Smaller urban centres include Dullstroom, Waterval Boven, Machadodorp, Malelane, Matsulu and Hectorspruit. The catchment falls in the Thaba Chweu, City of Mbombela, and Nkomazi Local Municipalities. Approximately 20% (north-eastern portion of the catchment) lies within the southern sector of the Kruger National Park. The Crocodile River catchment covers 10440 km² total area (WRC,1999), with the Kaap River Sub-system covering 1716 km². The catchment is located latitudinally from -25.158859 to -25.897731 S and longitudinally from 30.526253 to 31.400492 E, see Figure 2.



LEGEND

- Towns
- Crocodile_Sub_Systems
- Village



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WGS84 Ellipsoid
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Central Meridian 31°

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2.2 Climate

The Catchment is characterised by a distinct pattern of warm to hot, wet summers, followed by warm to cool, dry winters. Climatic patterns within the catchment are largely influenced by the topography of the region (the Eastern Transvaal Highveld plateau, the Great Escarpment of the Transvaal Drakensburg range and the lowveld). The climate varies from wet, humid areas in the northern and southern mountainous areas in the central portion of the catchment, to hot, dry areas in the relatively flat plains zone in the east of the catchment. The higher altitude, western portion of the catchment is relatively dry and cool, and frost is often recorded during the winter months. Moving from west to east across the catchment, the values for both mean annual rainfall and mean monthly rainfall decrease. These changes are accompanied by an increase in mean monthly temperature and maximum annual temperature.

The catchment falls within the summer rainfall zone of Southern Africa and 85% of the annual rainfall is received during the warm to hot summer months of November to March. Mean annual rainfall for the whole catchment is approximately 880 mm, roughly 70% higher than the mean annual rainfall of 500 mm for South Africa. Mean annual precipitation (MAP) varies gradually from approximately 500 mm in the lower (eastern) reaches of the Crocodile River, to above 1600 mm in the northern and central regions. Moving east to west, mean annual rainfall increases with altitude until the upper part of the escarpment zone is reached (WRC, 1999).

2.3 Geology

The Crocodile Catchment is underlain by a wide variety of rocks, comprising of sedimentary, intrusive and extrusive igneous and metamorphic rocks types. The Basement rocks which are the oldest formations are a part of the Barberton Supergroup which constitutes the largest and best-known of the volcano-sedimentary remnants. It comprises a thick pile of deformed volcanic rocks (Onverwacht Group) overlain by sedimentary rocks (Fig Tree and Moodies Groups); the Nelspruit Suite which comprises several textually distinct varieties including gneiss, porphyritic granite, and two small plutons. The most widespread variety is a coarse-grained, strongly porphyritic granitoid, which is compositionally a granodiorite or quartz monzonite and, the Hebron Plutons which is made up of granodioritic and quartz-monzonitic compositions, are medium to fine-grained, and consist of plagioclase, quartz, and biotite with muscovite.

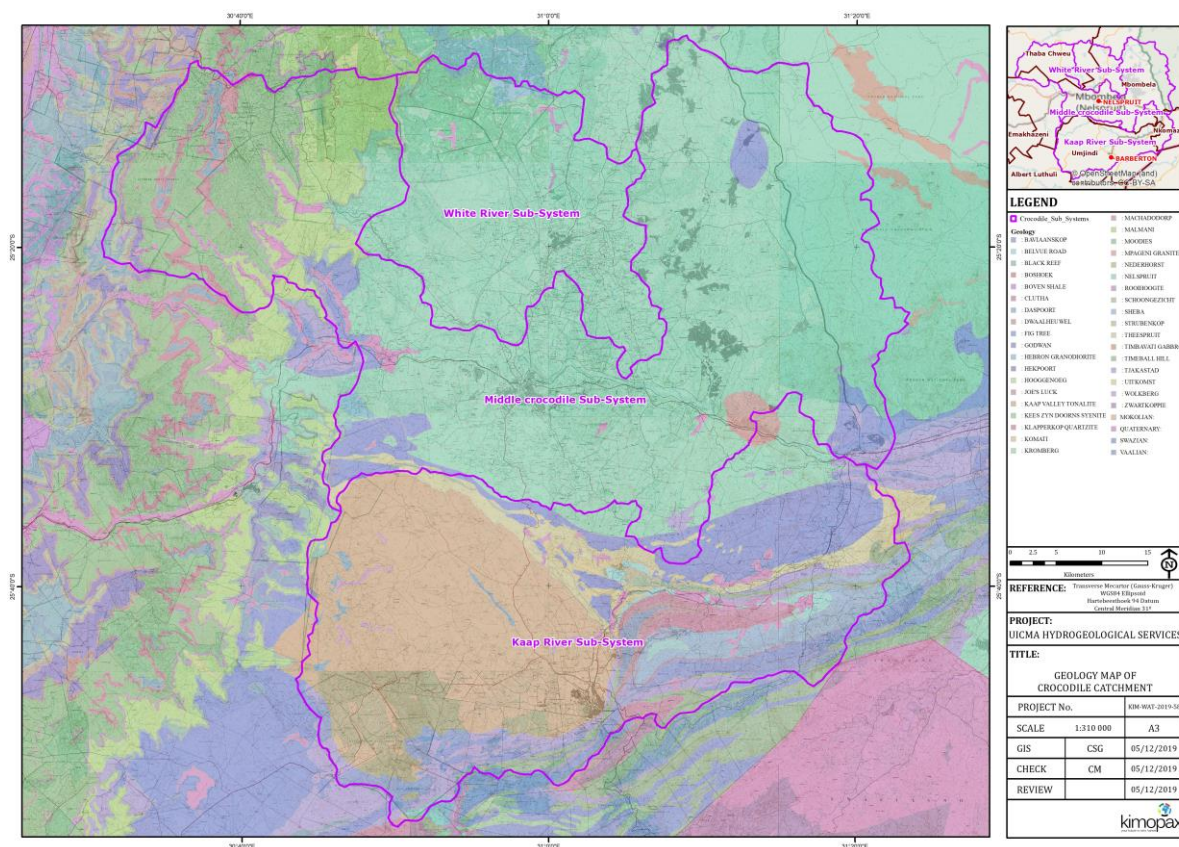


Figure 3: Geological map of the three sub-systems within the Crocodile Catchment (Geological series 2530 Barberton)

Transvaal Supergroup consist of two groups, Chuniespoort Group and Pretoria Group. The Chuniespoort Group which consist of the Malmani Sub-group which is subdivided into five dolomite formations. The Pretoria Group comprises predominant of mudrocks alternating with quartzitic sandstones, significant interbedded basaltic-andesitic lavas, and subordinate conglomerates, diamictites and carbonate rocks, all of which have been subjected to low-grade metamorphism. The youngest rocks in the catchment are the quaternary deposits which consist of surficial deposit (unconsolidated alluvial, residual or glacial deposits occurring on or near the surface of the earth), alluvium and scree. The 2530 Barberton 1:250 000 geological series map was used to identify the geological formations within the three sub-system, see Figure 3

2.4 Hydrogeology

Nelspruit (2530) 1: 500 000 scale hydrogeological map series was used to classify the different aquifers in the Crocodile catchment, see Figure 4. The following types of aquifers were identified within the Crocodile Catchment:

- a) C4 Karst aquifer type – Predominately calcareous rocks (limestone and dolomite). Solution channels and fractures occurring in the carbonate rocks of the Chuniespoort Group – 2.0 to 5.0 median l/s borehole yield class.
- b) D2 Intergranular and fractured aquifer type – Acid/ intermediate/ alkaline intrusive rocks (various granitoids (granites and gneisses) – 0.1 to 0.5 median l/s borehole yield class.
- c) D3 intergranular and fractured aquifer type – Undifferentiated rocks and various mixed lithologies (along sedimentary/ sedimentary or sedimentary/igneous rock contacts) – 0.5 to 2.0 median l/s borehole yield class.
- d) D4 intergranular and fractured aquifer type – Acid/intermediate/alkaline intrusive rocks (various granitoids) and in undifferentiated rocks and various mixed lithologies (fractures along contact zones related to heating and cooling of host rock caused by intrusion of diabase and dolerite dykes and sills) - 2.0 to 5.0 median l/s borehole yield class.
- e) D5 intergranular and fractured aquifer type – Undifferentiated rocks and various mixed lithologies - > 5.0 median l/s borehole yield class.

Figure 4: Hydrogeological map of the Crocodile Catchment, data obtained from 2530 Nelspruit hydrogeological series

3 KAAP RIVER SUB-SYSTEM

Desktop study was undertaken to generate data for the assessment of the catchment in terms of hydrogeological evaluations and providing information on recommended groundwater abstraction and monitoring in the catchment. The aim was to establish the status (quantity and quality) of the groundwater in the Kaap River Sub-system and to also understand the overall

status of the groundwater system. Various existing documents and maps were used to gather hydrogeological data and the following information was collected for the sub-system.

3.2 Groundwater Use

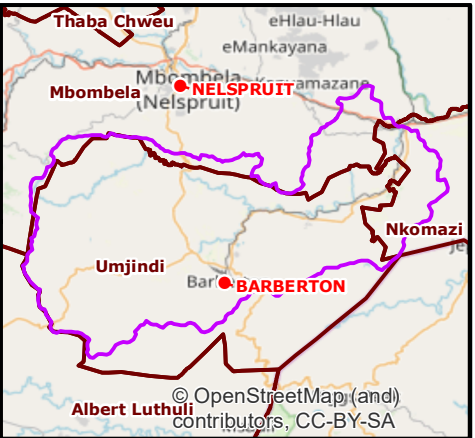
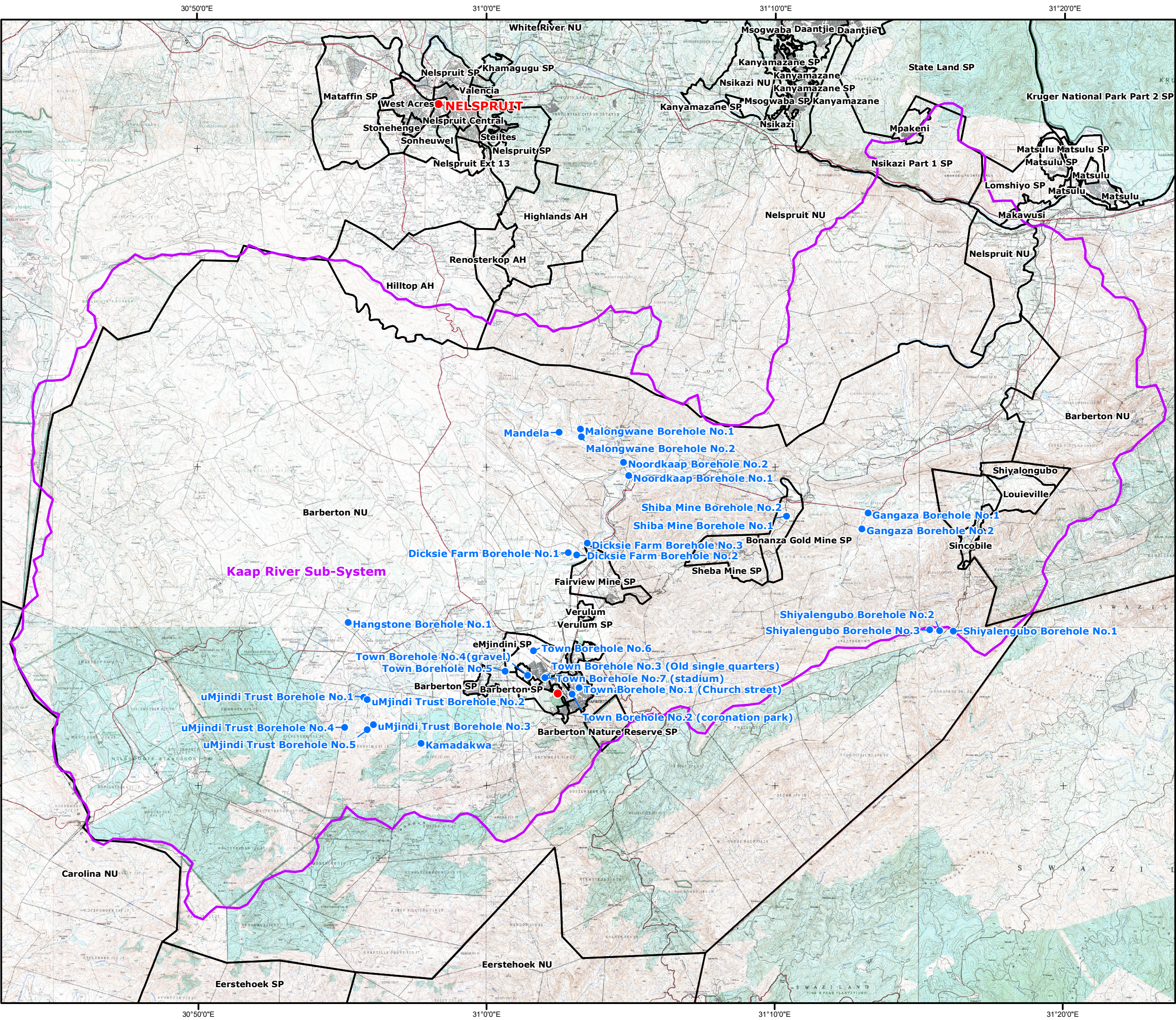
The water use is for domestic, municipal, industrial, agricultural and mining purposes. There are mining activities in the Kaap River Sub-system (IUCMA, 2018), i.e. gold mines near Barberton. The Crocodile River flows through the major towns of Nelspruit, Kaapmuiden and Malelane as well as commercial farming activities (sugar cane, fruit orchards, and vegetables) which are important characteristics of this catchment. Water requirements have increased since the building of a sugar mill near Komatipoort. Livestock and game consume about 2 million a year (WRC, 1999). The middle region of the Crocodile Catchment is characterized by increased urbanization.

3.2.1 Existing Boreholes

Two set of data were used to present existing boreholes in the Kaap River Sub-system. The first set of boreholes data was obtained from the Inkomati-Usuthu Catchment Management Agency (IUCMA). The twenty-eight (28) boreholes were submitted by the IUCMA for assessment and to further select three (3) boreholes that will be rehabilitated and used for water supply in drought stricken area in the Kaap River Sub-system, the list of the boreholes is presented in Table 1 and depicted in Figure 5. The five boreholes in Umjindi Trust village (Umjindi Trust BH01, Umjindi Trust BH02, Umjindi Trust BH03, Umjindi Trust BH04 and Umjindi Trust BH05) were the focus for selection for boreholes to be refurbished and equipped with handpumps and used for water supply for the village, as the village was identified as the village in greatest need for water.

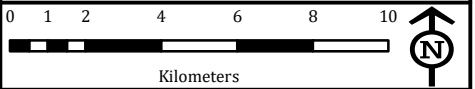
Table 1: Twenty-eight boreholes in Umjindi area in the Kaap River Sub-system

Borehole ID	Latitude	Longitude	Status	Use type
Dicksie Farm Borehole No.1	-25.71209	31.047369	unused	domestic
Dicksie Farm Borehole No.2	-25.71325	31.05224	unused	domestic
Dicksie Farm Borehole No.3	-25.70703	31.058327	unused	domestic
Gangaza Borehole No.1	-25.691138	31.22035	unused	domestic
Gangaza Borehole No.2	-25.69943	31.216865	used	domestic
Hangstone Borehole No.1	-25.7485	30.92032	unused	domestic
Kamadakwa	-25.811704	30.96232	unused	domestic
Malongwane Borehole No.1	-25.64744	31.05434	unused	domestic
Malongwane Borehole No.2	-25.65136	31.05484	unused	domestic
Mandela	-25.64895	31.04208	unused	domestic
Noordkaap Borehole No.1	-25.671674	31.082198	used	domestic
Noordkaap Borehole No.2	-25.66456	31.079166	unused	domestic
Shiba Mine Borehole No.1	-25.692634	31.173248	unused	domestic
Shiba Mine Borehole No.2	-25.692635	31.17324	unused	domestic
Shiyalengubo Borehole No.1	-25.752848	31.2697	unused	domestic
Shiyalengubo Borehole No.2	-25.75253	31.261721	unused	domestic
Shiyalengubo Borehole No.3	-25.75209	31.256134	unused	domestic
Town Borehole No.1	-25.78262	31.05359	used	domestic
Town Borehole No.2	-25.786006	31.049582	unused	domestic
Town Borehole No.3	-25.776784	31.034893	unused	domestic
Town Borehole No.4	-25.77628	31.02385	unused	domestic
Town Borehole No.5	-25.773875	31.010874	unused	domestic
Town Borehole No.6	-25.763405	31.02733	used	domestic
Town Borehole No.7	-25.7775	31.03376	unused	domestic
Umjindi Trust Borehole No.1	-25.787572	30.929151	used	domestic
Umjindi Trust Borehole No.2	-25.78892	30.93117	unused	domestic
Umjindi Trust Borehole No.3	-25.801882	30.934719	unused	domestic
Umjindi Trust Borehole No.4	-25.80321	30.91828	unused	domestic
Umjindi Trust Borehole No.5	-25.80461	30.93116	unused	domestic
Esparado	-25.78262	31.053597	unused	domestic



LEGEND

- Towns
- Boreholes
- Crocodile_Sub_Systems
- Village



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BOREHOLES MAP OF
KAAP RIVER SUB SYSTEM

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The second set of data used to identify existing boreholes in the sub-system was obtained from the National Groundwater Archive (NGA) from the Department of Water and Sanitation (DWS), the 294 boreholes were plotted on a geology map and the hydrogeology map, see Figure 6 and Figure 7. The geology map shows most boreholes are clustered in the Nelspruit Suite hornblend-biotite granites towards the west of the sub-system and in the Nelspruit Suite gneiss and migmatite in the north-east of the sub-system. The result could be these areas are also used for agricultural purposes that would explain the high quantity of borehole in the areas.

Th boreholes are situated on a hydrogeological map in the D4 intergranular and fractured aquifer type and D3 intergranular and fractured aquifer type. The boreholes towards the west of the sub-system are drilled in both the D4 intergranular and fractured aquifer type and D3 intergranular and fractured aquifer type. The boreholes located in the north-east fall with the D3 intergranular and fractured aquifer type. D4 intergranular and fractured aquifer is classed as medium yielding with yields ranging between 2.0 – 5.0 l/s, and D3 intergranular and fractured aquifer is classed as low yielding with yields ranging between 0.5 to 2.0 l/s.

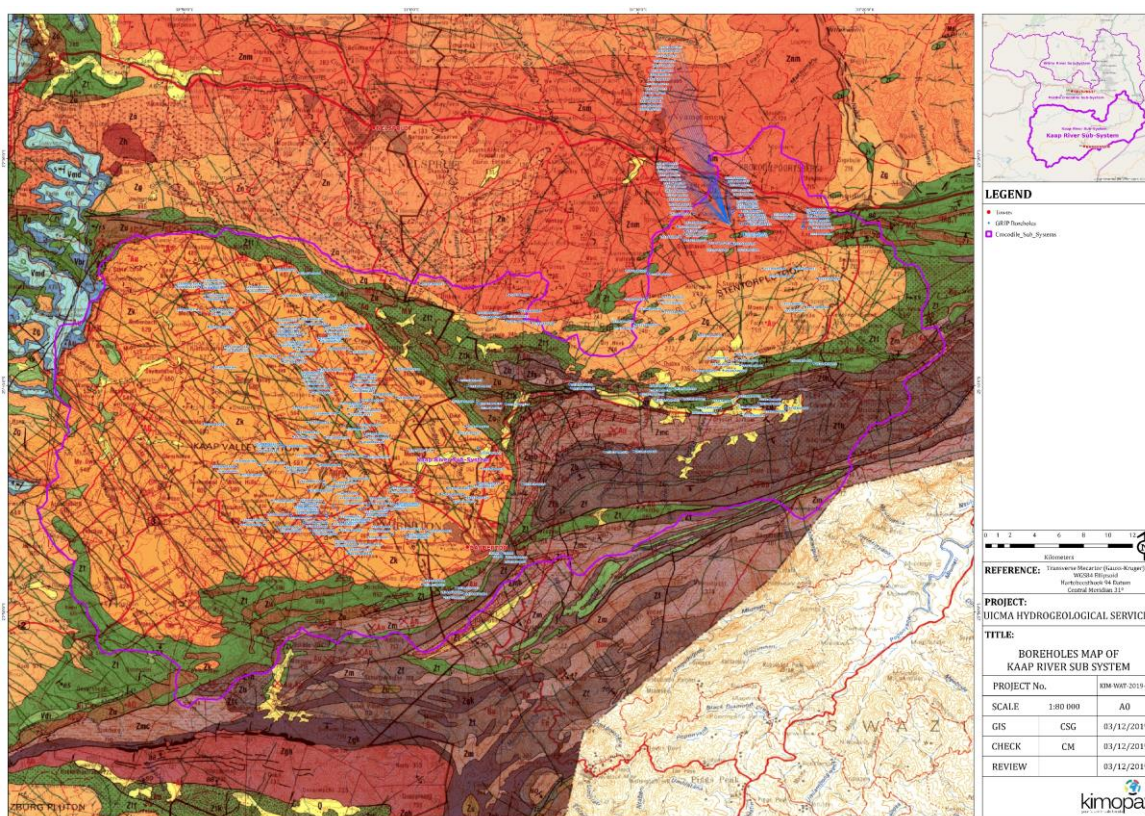
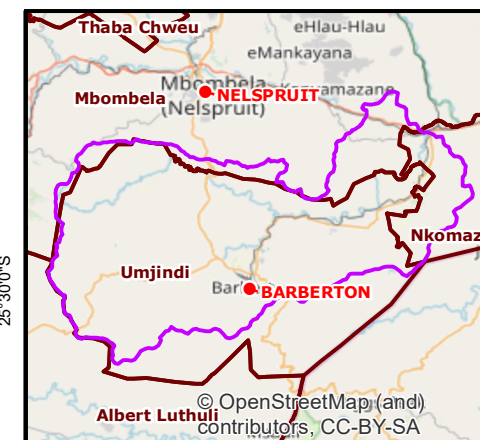
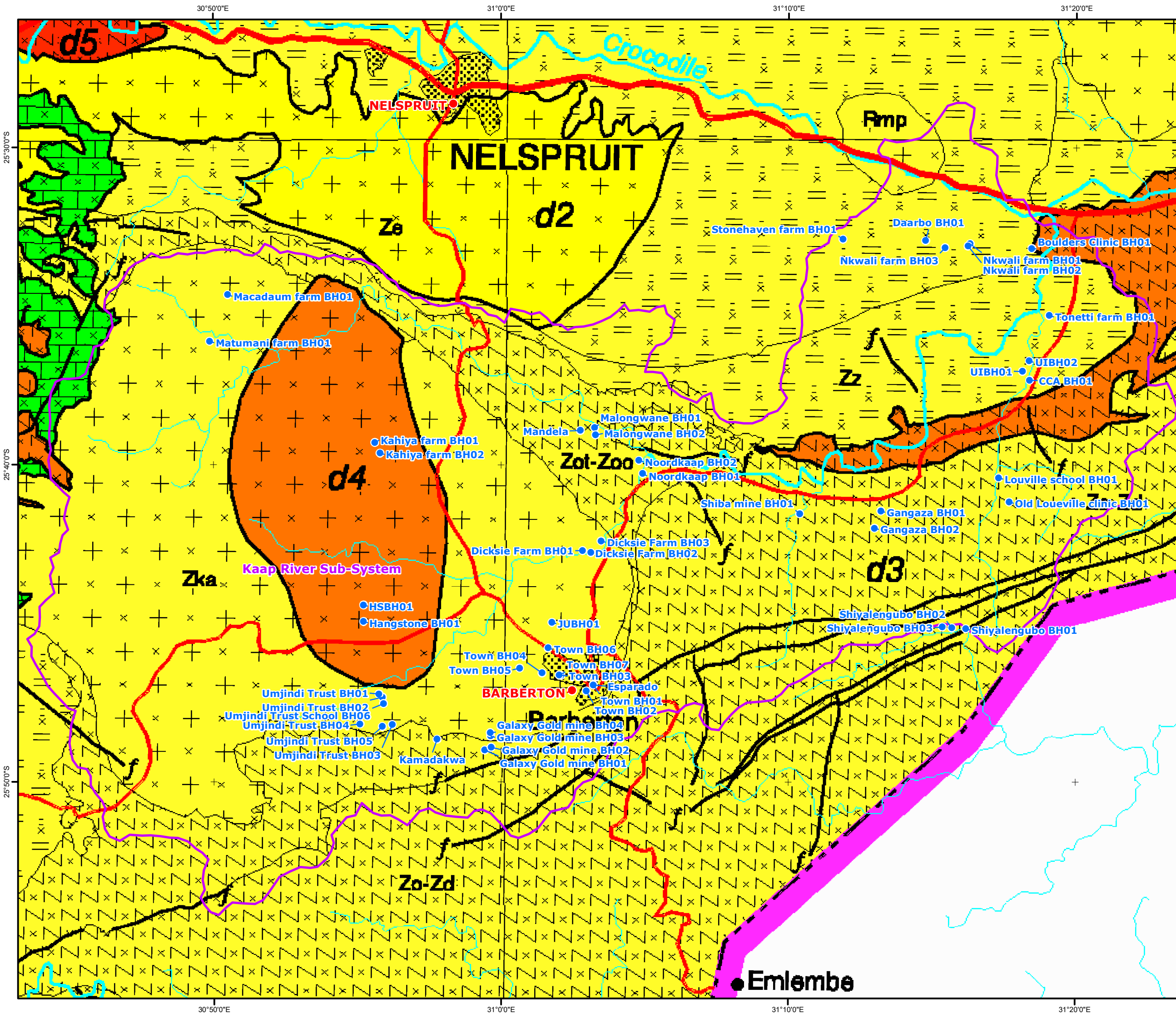


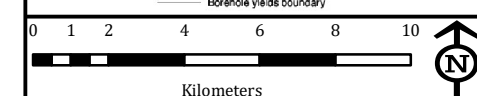
Figure 6: Kaap River Sub-system NGA boreholes on the geology map



LEGEND

- Towns
- Hydrocensus Boreholes
- Crocodile_Sub_Systems

Principal groundwater occurrence					
Borehole yield class (median l/sec) (excluding dry boreholes)					
0.0-0.1 0.1-0.5 0.5-2.0 2.0-5.0 >5.0					
Intergranular	*	*	a3	a4	*
Fractured	b1	b2	b3	b4	*
Karst	*	*	c3	c4	*
Intergranular and fractured	d1	d2	d3	d4	d5



REFERENCE: Transverse Mercator (Gauss-Kruger)
WGS84 Ellipsoid
Hartebeesthoek 94 Datum
Central Meridian 31°

PROJECT:
IUCMA HYDROGEOLOGICAL SERVICES

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HYDROCENSUS MAP OF
KAAP RIVER SUB SYSTEM

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3.2.2 Groundwater Levels

Most of the boreholes data obtained from the NGA had water levels information. The water levels data was plotted on a hydrogeology map in Figure 8). From the boreholes obtained from the NGA, ~60% (129) had water level measurements. The minimum water level measured is 1 mbgl and the maximum water level measured is 115 mbgl and an average of the data is 19.37 mbgl, see Table 2.

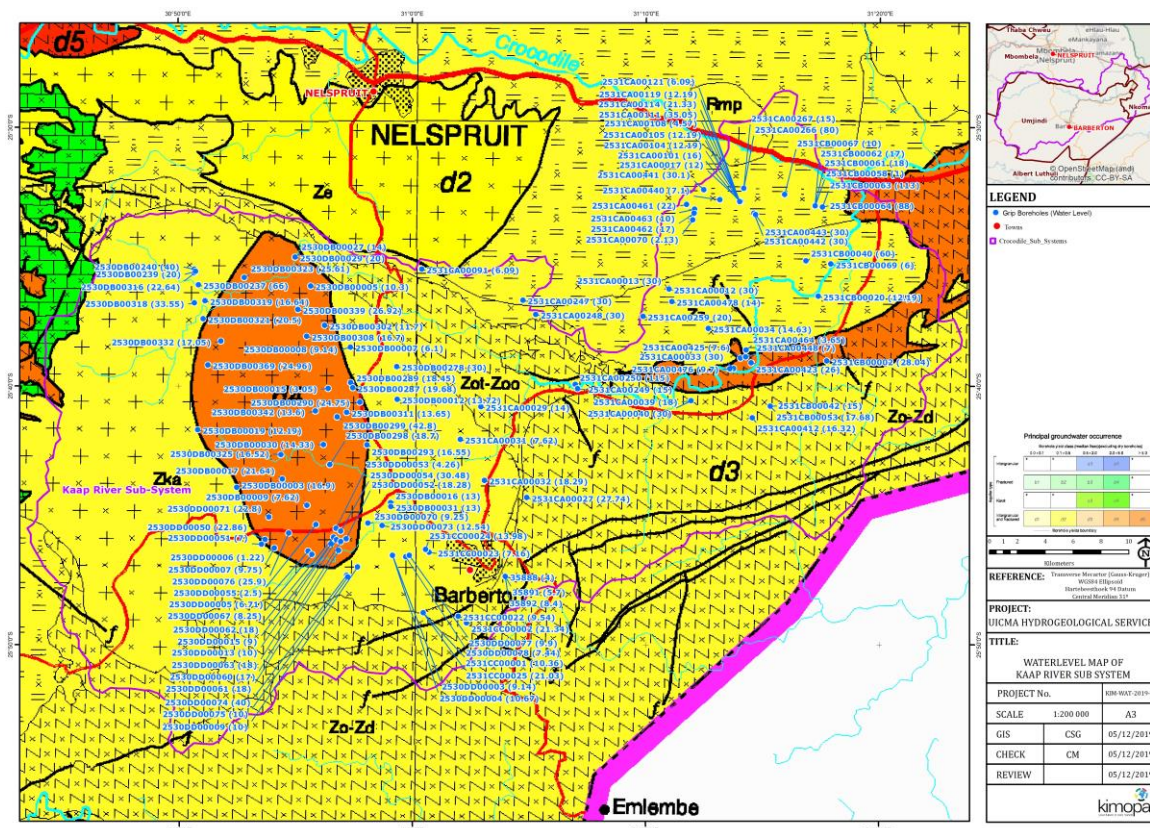


Figure 8: Water level measurement in the Kaap River Sub-system on a hydrogeology map

Table 2: The statistics of the water level measurements.

Statistics	Number of Boreholes	Water level (mbgl)
Minimum	129	1.00
Average	129	19.37
Maximum	129	115.00

3.2.3 Groundwater Quality

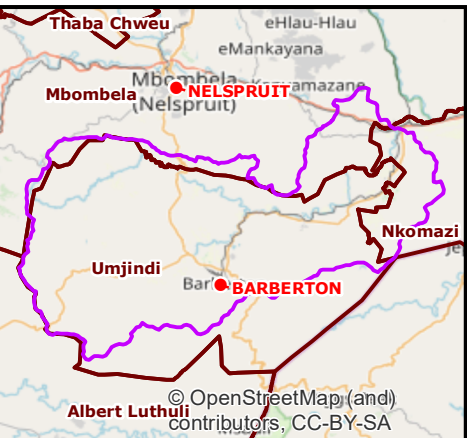
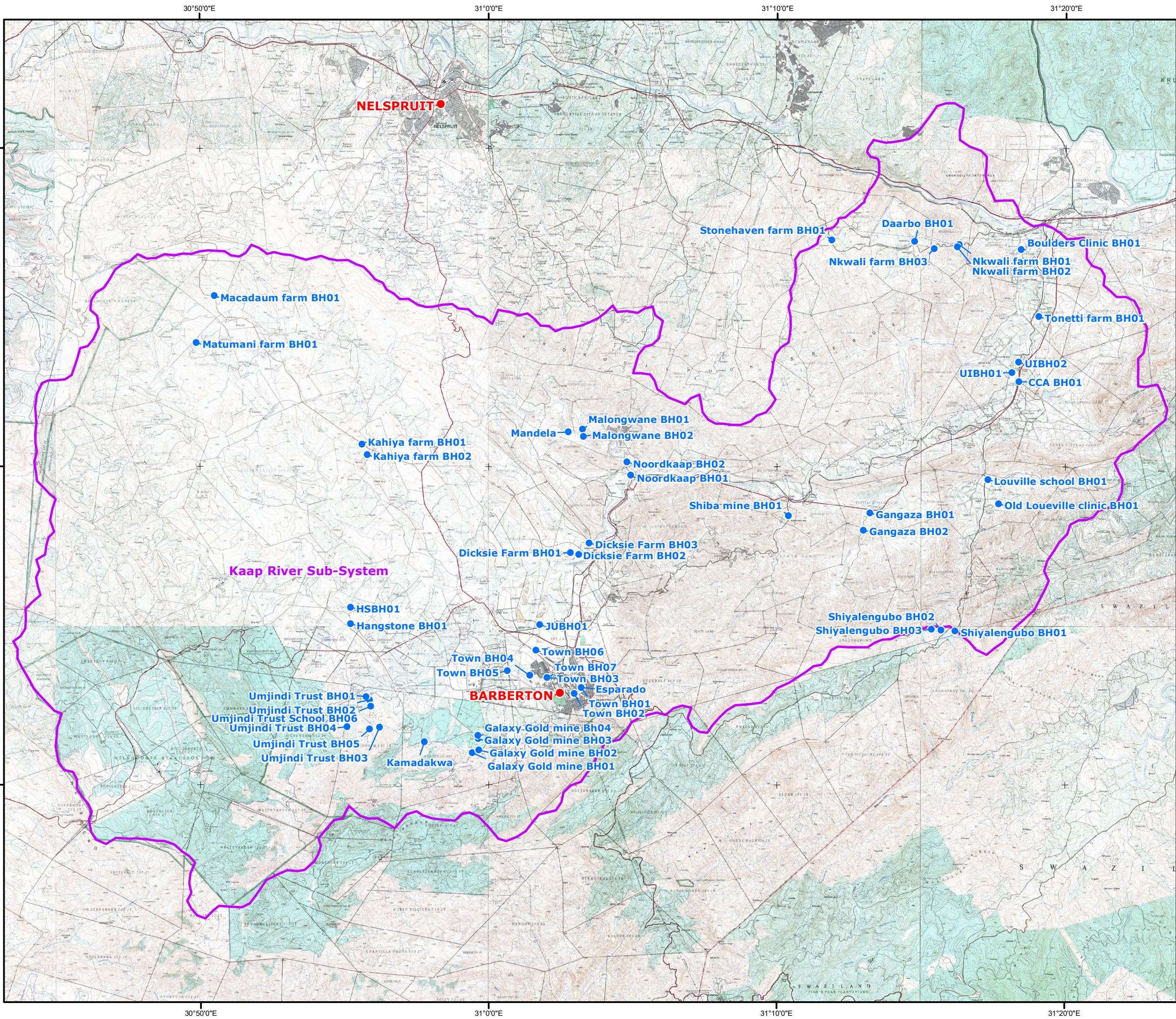
Reported groundwater quality in the areas west of the Barberton town EC values are in the 0-70 mS/m range and the areas west of the Barberton town the EC values ranges between 70-300 mS/m (Nelspruit 2530 hydrogeological map). The SANS 241:2015 drinking water standards shows that the aesthetic limit for EC is 170 mS/m. The water towards the west of the sub-catchment have EC values that falls within the SANS 241:2015 drinking water standards. The EC values at the west, north-west part of the sub-catchment is over the SANS 241:2015 limit, this could be the result of the gold mining activities in that part of the sub-catchment.

3.3 Field Investigation: Hydrocensus

The hydrocensus was carried to gather information on the groundwater activities (abstraction and monitoring) in the Kaap River Sub-system. The field investigation was also carried out to identify areas that are vulnerable to and affected by pollution. Furthermore, the focus was also to identify production boreholes in drought-stricken areas that could be rehabilitated for drought relief measure in an area that was greatly affected by the drought in the sub-system.

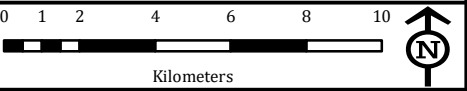
3.3.1 Boreholes Locality

The boreholes are located on farms, villages and small towns. Fifty-two (52) boreholes were identified during field investigation, see Figure 9. The location of existing groundwater points was noted using GPS and water level were being measured were accessible. Field measurements were taken (temp, pH, EC and TDS). If possible, water samples were taken, and twenty-one (21) boreholes were sampled. All water samples were collected by Kimopax hydrogeologist and submitted to a SANAS accredited laboratory (SANAS accreditation is an IWUL legislative requirement) for water quality analysis. From the 52 boreholes, fifteen (15) were boreholes that we not documented on the NGA database and from the 52 boreholes we were able to measure water level from the three (3) boreholes. The three boreholes were water level was able to measure were situated in the same village, Lanbogani.



LEGEND

- Towns
- Hydrocensus Boreholes
- Crocodile_Sub_Systems



REFERENCE: Transverse Mecartor (Gauss-Kruger)
WGS84 Ellipsoid
Hartebeesthoek 94 Datum
Central Meridian 31°

PROJECT:
IUCMA HYDROGEOLOGICAL SERVICES

TITLE:
HYDROCENSUS MAP OF
KAAP RIVER SUB SYSTEM

PROJECT No.		KIM-WAT-2019-58
SCALE		1:200 000 A3
GIS	CSG	05/12/2019
CHECK	KH	05/12/2019
REVIEW	CM	05/12/2019

3.3.2 Groundwater Sampling

Sampling of some identified boreholes and including the three pump tested boreholes was undertaken to primarily determine if the water is suitable for human consumption and to obtain a spatial understanding of the water quality in the sub-system. During the hydrocensus surveyed existing boreholes that were accessible were sampled and during pump testing exercise of the three Umjindi Trust villages boreholes, water samples were obtained. The water samples collected were submitted to WaterLab Laboratories for water quality analysis.

3.3.2.1 Parameters Analysed

Water samples were collected and submitted to Water Lab (SANAS Accredited) for water quality analysis based on SANS 241 standards and DWAF guideline for domestic use. Parameters analysed during the water sampling are based on water quality guidelines for domestic and drinking water use. shows the list of main parameters analysed together with other trace metals included in the Water Quality Standards, see Table 3.

Table 3: List of parameters to be analysed

Physical Parameters	Macro determinants	Micro determinants
pH	Ammonium as NH ₄	Aluminium (Al)
Electrical Conductivity (EC)	Calcium (Ca)	Antimony (Sb)
Total Dissolved Solids (TDS)	Chloride (Cl)	Arsenic (As)
Total Alkalinity	Fluoride (F)	Cadmium (Cd)
E. Coil	Magnesium (Mg)	Total Chromium as Cr
Faecal Coliform	Nitrate as (N)	Copper (Cu)
Total Coliform	Potassium (K)	Total Fe (Fe)
	Sodium (Na)	Lead (Pb)
	Sulphate (SO ₄)	Manganese (Mn)
	Zinc (Zn)	Nickel (Ni)

3.3.2.2 Water Quality Standards

The analytical results of the all the groundwater samples were compared to the following standards;

a) Department of Water and Sanitation, South African domestic use water quality guidelines, volume 1, Second Edition 1996 and Water Research Commission, water quality guidelines, 1998; and

b) South African National Standards, drinking water standards, SANS 241:2015.

The SANS 241:2015 drinking water standard is used as reference as it includes risk-based elements, whereas the DWAF 1998 guidelines were used to classify and discuss the baseline water quality classes discussing the baseline water quality in Table 4. The results of groundwater results compared to the SANS 241:2015 drinking water standard are presented in Table 5.

Table 4: DWS water quality classes (1998), describing the effects of the different classes of water

Water quality class	Description	Drinking health effects
Class 0	Ideal water quality	No effects, suitable for many generations.
Class 1	Good water quality	Suitable for lifetime use. Rare instances of sub-clinical effects
Class 2	Marginal water quality, water suitable for short-term use only	May be used without health effects by majority of users but may cause effects in some sensitive groups. Some effects possible after lifetime use.
Class 3	Poor water quality	Poses a risk of chronic health effects, especially in babies, children and the elderly. May be used for short-term emergency supply with no alternative supplies available.
Class 4	Unacceptable water quality	Severe acute health effects, even with short-term use.

Table 5: Summarised water quality result compared to SANS 241:2015 for hydrocensus boreholes

Parameter	Maximum	Malongwane BH01	Malongwane BH02	Mandela	Shiba Mine BH01	Gangaza BH02	Shiyalengu bo BH03	Town BH 07	Town BH05	Umjindi Trust BH02	Umjindi Trust BH03	JUBH 01	Boulder Clinic BH01	Nkwali Farm BH02	Nkwali Farm BH03	Daarbo BH01	Tonetti Farm BH01	CCA BH01	Galaxy Mine BH03	Umjindi Trust BH05	Macadaum Farm BH01	Matumani Farming BH01
	Allowable																					
	Limits																					
	(SANS 241:2015)																					
pH - Value @ 25 °C	≥5 - ≤9.7	8.0	8.3	7.7	8.1	7.6	6.7	7.7	7.4	8.2	7.6	7.5	7.8	7.6	7.6	7.0	7.3	7.7	7.1	7.8	7.9	7.7
Electrical Conductivity in mS/m @ 25°C	≤170	152	89.3	120	36.7	37.0	5.2	35.5	50.4	26.8	53.0	55.7	103	66.5	44.7	44.3	83.6	216	121	50.9	25.0	14.7
Total Dissolved Solids @ 180°C mg/ℓ	≤1200	1194	602	716	264	266	52	232	340	172	336	376	724	446	334	330	1808	1714	1028	350	196	184
Total Alkalinity as CaCO ₃ mg/ℓ	N/A	348	464	644	140	180	20	140	204	128	284	240	404	264	200	120	312	720	272	224	120	44
Total Hardness as CaCO ₃ mg/ℓ	N/A	870	135	683	150	145	18	120	191	98	251	219	204	207	119	132	219	260	683	223	97	42
Chloride as Cl mg/ℓ	≤300	53	16	28	9	12	3	16	17	11	7	12	43	39	24	32	32	201	7	14	7	11
Sulphate as SO ₄ mg/ℓ	≤500	557	6	47	34	3	<2	24	29	<2	<2	25	68	26	9	35	81	39	573	24	14	<2
Fluoride as F mg/ℓ	≤1.5	<0.2	0.2	<0.2	<0.2	<0.2	<0.2	0.3	0.4	0.2	0.3	0.6	0.8	0.8	0.6	0.8	1.3	2.6	<0.2	0.4	0.2	<0.2
Nitrate as N mg/ℓ	≤11	0.1	0.2	0.4	0.2	0.2	0.2	0.8	4.9	<0.1	0.1	4.9	2.6	0.1	0.2	4.5	0.8	<0.1	0.6	2.2	0.8	2.8
Free and Saline Ammonia as N mg/ℓ	≤1.5	0.1	12	0.1	<0.1	<0.1	0.2	1.9	0.2	0.1	0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
Sodium as Na mg/ℓ	≤200	37	132	21	11	20	3	22	33	17	19	35	152	63	47	36	95	398	22	20	13	11
Potassium as K mg/ℓ	≤50	1.4	16.7	0.8	3.4	1.4	1.0	1.2	2.3	1.6	1.2	1.4	0.6	2.0	3.2	5.4	5.3	7.6	1.0	1.3	0.7	1.0
Calcium as Ca mg/ℓ	≤80	35	11	21	24	18	2	20	31	14	49	39	42	52	28	18	40	39	71	48	22	8
Magnesium as Mg mg/ℓ	≤70	191	26	153	22	24	3	17	27	16	31	30	24	19	12	21	29	39	123	25	11	5
Aluminium as Al mg/ℓ	≤0.15	<0.100	0.287	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	0.445	0.393	<0.100	<0.100	<0.100
Cadmium as Cd mg/ℓ	≤0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper as Cu mg/ℓ	≤2.0	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.064	<0.010	<0.010	<0.010	<0.010
Iron as Fe mg/ℓ	≤2.0	5.01	1.05	6.47	0.607	0.074	3.56	7.34	2.58	2.98	1.03	<0.025	0.025	<0.025	<0.025	<0.025	<0.025	10	1.56	0.612	<0.025	<0.025
Lead as Pb mg/ℓ	≤0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.016	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.003	<0.001	<0.001	<0.001
Manganese as Mn mg/ℓ	≤0.1	0.212	0.054	0.057	<0.025	<0.025	0.313	0.059	0.025	0.091	0.074	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.209	<0.025	0.025	<0.025	<0.025
Nickel as Ni mg/ℓ	≤0.07	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Zinc as Zn mg/ℓ	≤5	0.044	<0.025	0.053	0.414	<0.025	<0.025	<0.025	<0.025	0.694	0.217	<0.025	0.029	<0.025	<0.025	<0.025	<0.025	0.104	<0.025	1.25	<0.025	<0.025
% Balancing		97.6	99.2	99.7	97.3	97.1	98.4	95.9	97.6	98.6	99.7	99.5	98.9	99.9	95.8	99.4	98.3	96.2	90.8	98.3	93.4	97.3
Potability and Suitability for human consumption		Not acceptable	Not acceptable	Not acceptable	Acceptable	Acceptable	Not acceptable	Not acceptable	Not acceptable	Not acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Not acceptable	Not acceptable	Not acceptable	Acceptable	Acceptable	Acceptable

Boreholes Malongwane BH01, Malongwane BH02, Mandela, Shiyalengubo BH03, Town Borehole 07, Town Borehole 05, Umjindi Trust BH02, Tonnetti form BH01, CCA BH01 and Galaxy mine BH03 have water quality that exceeds maximum allowable limit in comparison with the SANS 241:2015 parameters, the elevated parameters include sulphate, magnesium, iron, manganese, aluminium, free and saline ammonia, lead, total dissolved solids, fluoride and sodium.

Total Dissolved Solids as TDS – Tonnetti BH01 (1808 mg/l) and CCA BH01 (1714 mg/l) have TDS exceeding SANS 241:2015 limit of 1200 mg/l, these boreholes are situated on active farms.

Sulphate as SO₄ – Malongwane BH01 (557 mg/l) and Galaxy mine BH03 (573 mg/l) have sulphate limits that exceed SANS 241:2015 limit of 500 mg/l. Elevated concentration of sulphate in Galaxy mine BH03 could be attributed to explosives used in mining activities.

Manganese as Mn – Malongwane BH01 (0.212 mg/l), Shiyalengubo BH03 (0.313 mg/l) and CCA BH01 (0.209 mg/l) have high concentration of Manganese which exceeds SANS 241:2015 limit of 0.1 mg/l. The elevated concentrations in manganese in the can be associated with sandstone / shale formations (geogenic origin).

Ammonia as N – Ammonia levels in Town borehole 07 (1.9 mg/l) exceed the SANS 241:2015 set limit of 1.5 mg/l.

Sodium as Na – CCA BH01 (398 mg/l) has sodium concentration levels that exceeds SANS 241:2015 limit of 200 mg/l. This could be caused by the activities at the CCA timber poles plant.

Iron as Fe – CCA BH01 (10 mg/l), Malongwane BH01 (5.01 mg/l), Mandela (5.01 mg/l) Town borehole 05 (2.58 mg/l), Town borehole 07 (7.34 mg/l), Shiyalengubo BH03 (3.56 mg/l) and Umjindi Trust BH02 (2.98 mg/l) exceeds SANS 241:2015 iron limit of 2 mg/l, it can be deduced that iron in the groundwater in the area results from geological formation or processes, see **Error! Reference source not found..** The samples were not filtered while sampling.

Aluminium as Al – Malongwane BH02 (0.287 mg/l), CCA BH01(0.445 mg/l) and Galaxy mine BH03 (0.393 mg/l) have aluminium values that exceeds SANS 241:2015 limit of 0.15 mg/l. This could be the negative impact of the mining activities and the activities at the CCA timber plant.

Fluoride as F – CCA BH01 (2.6 mg/l) has fluoride value that exceed the SANS 241:2015 limit of 1.5 mg/l. This could be because of the activities at the CCA timber plant.

Lead as Pb – Umjindi Trust BH02 (0.016 mg/l) has got lead value that exceeds 241:2015 limit of 0.01 mg/l. Lead is a toxic metal that has been widely used in petrol, and borehole is close to a busy road.

Magnesium as mg – Malongwane BH0 (191 mg/l)1, Mandela (153 mg/l) and Galaxy Mine BH03 (123 mg/l) have magnesium values exceeding 241:2015 limit of 70 mg/l.

3.3.2.3 Water Quality Classes

The boreholes water was further classified according to DWS criteria into class 0, class 1, class 2, and class 3, with class 0 water being ideal and class 3 water or higher water classes not ideal, see Table 6. The groundwater quality in the aquifer falls within class 1 class 2 and class 3 for different boreholes.

Table 6: Results of the water samples compared to the classification system

Borehole ID	Physical Parameters			Macro-determinants								Micro-determinants					
	pH	Electrical Conductivity mS/m	Total Dissolved Solids mg/l	Calcium as Ca mg/l	Chloride as Cl mg/l	Fluoride as F mg/l	Magnesium as Mg mg/l	Nitrate as N mg/l	Potassium as K mg/l	Sodium as Na mg/l	Sulphate as SO ₄ mg/l	Aluminium as Al mg/l	Copper as Cu mg/l	Iron as Fe mg/l	Manganese as Mn mg/l	Lead as Pb mg/l	Zinc as Zn mg/l
Malongwane BH01	8	152	1194	35	53	<0.2	191	0.1	1.4	37	557	<0.100	<0.010	5.01	0.212	<0.001	0.044
Malongwane BH02	8.3	89.3	602	11	16	0.2	26	0.2	16.7	132	6	0.287	<0.010	1.05	0.054	<0.001	<0.025
Mandela	7.7	120	716	21	28	<0.2	153	0.4	0.8	21	47	<0.100	<0.010	6.47	0.057	<0.001	0.053
Shiba Mine BH01	8.1	36.7	264	24	9	<0.2	22	0.2	3.4	11	34	<0.100	<0.010	0.607	<0.025	<0.001	0.414
Gangaza BH02	7.6	37.0	266	18	12	<0.2	24	0.2	1.4	20	3	<0.100	<0.010	0.074	<0.025	<0.001	<0.025
Shiyalengubo BH03	6.7	5.2	52	2	3	<0.2	3	0.2	1.0	3	<2	<0.100	<0.010	3.56	0.313	<0.001	<0.025
Town borehole 07	7.7	35.5	232	20	16	0.3	17	0.8	1.2	22	24	<0.100	<0.010	7.34	0.059	<0.001	<0.025
Town borehole 05	7.4	50.4	340	31	17	0.4	27	4.9	2.3	33	29	<0.100	<0.010	2.58	0.025	<0.001	<0.025
Umjindi Trust BH02	8.2	26.8	172	14	11	0.2	16	<0.1	1.6	17	<2	<0.100	<0.010	2.98	0.091	0.016	0.694
Umjindi Trust BH03	7.6	53.0	336	49	7	0.3	31	0.1	1.2	19	<2	<0.100	<0.010	1.03	0.074	<0.001	0.217
JUBH01	7.5	55.7	376	39	12	0.6	30	4.9	1.4	35	25	<0.100	<0.010	<0.025	<0.025	<0.001	<0.025
Boulder Clinic BH01	7.8	103	724	42	43	0.8	24	2.6	0.6	152	68	<0.100	<0.010	0.025	<0.025	<0.001	0.029
Nkwali farm BH02	7.6	66.5	446	52	39	0.8	19	0.1	2.0	63	26	<0.100	<0.010	<0.025	<0.025	<0.001	<0.025
Nkwali farm BH03	7.6	44.7	334	28	24	0.6	12	0.2	3.2	47	9	<0.100	<0.010	<0.025	<0.025	<0.001	<0.025
Daarbo BH01	7	44.3	330	18	32	0.8	21	4.5	5.4	36	35	<0.100	<0.010	<0.025	<0.025	<0.001	<0.025
Tonetti farm BH01	7.3	83.6	1808	40	32	1.3	29	0.8	5.3	95	81	<0.100	<0.010	<0.025	<0.025	<0.001	<0.025
CCA BH01	7.7	216	1714	39	201	2.6	39	<0.1	7.6	398	39	0.445	0.064	10	0.209	0.003	0.104
Galaxy mine BH03	7.1	121	1028	71	7	<0.2	123	0.6	1.0	22	573	0.393	<0.010	1.56	<0.025	0.003	<0.025
Umjindi Trust BH05	7.8	50.9	350	48	14	0.4	25	2.2	1.3	20	24	<0.100	<0.010	0.612	0.025	<0.001	1.25
Macadaum farm BH01	7.9	25.0	196	22	7	0.2	11	0.8	0.7	13	14	<0.100	<0.010	<0.025	<0.025	<0.001	<0.025
Matumani farming BH01	7.7	14.7	184	8	11	<0.2	5	2.8	1.0	11	<2	<0.100	<0.010	<0.025	<0.025	<0.001	<0.025
Class 0	5-9.5	<70	<450	<80	<100	<0.7	<70	<6	<25	<100	<200	<0.15	1	<0.01	<0.1	0.05	<3
Class 1	4.5-5, 9.5-10	70-150	450-1000	80-150	100-200	0.7-1	70-100	10-Jun	25-50	100-200	200-400	0.15-0.5	1.0-2.0	0.5-1.0	0.1-1.0	0.05-0.1	3-5
Class 2	4-4.5, 10-10.5	150-370	1000-2400	150-300	200-600	1-1.5	100-200	20-Oct	50-100	200-400	400-600	>0.5	>2.0	1-5	>1.0	>0.1	5-10
Class 3	3-4, 10.5-11	370-520	2400-3000	>300	600-1200	1.5-3.5	200-400	20-40	100-500	400-1000	600-1000			5-10			10-20

EC – Malongwane BH02, Tonetti farm BH01 and Galaxy mine BH03 has class 1 and Malongwane BH01, Mandela and CCA BH01 has class 2.

Total Dissolved Solids - Malongwane BH02 has class 1, no health effects are likely. Malongwane BH01, Mandela, Tonetti farm BH01, CCA BH01 and Galaxy mine BH03 has class 2, consumption of water does not appear to produce adverse health effects in the short term.

Chloride – CCA BH01 has got class 2, water has a distinctly salty taste, but no health effects.

Fluoride – Boulder clinic BH01 and Nkwali farm BH02 has class 1, no adverse health effects or tooth damage occurs and Tonetti farm BH01 and CCA BH01 class 2, slight mottling of dental enamel may occur in sensitive individuals. No other health effects are expected.

Magnesium – Malongwane BH01, Mandela, Galaxy mine BH03 has class 2, water aesthetically unacceptable because of bitter taste. Diarrhoea in most new users if sulphate present.

Sodium – Malongwane BH02 and Boulder clinic BH01 has class 1, faintly salty taste, threshold for taste, no health effects and CCA BH01 has class 2, slightly salty taste. Undesirable for persons on a sodium-restricted diet.

Sulphate – Malongwane BH01 and Galaxy mine BH03 has class 2, diarrhoea in most non-adapted individuals. Definite salty or bitter taste.

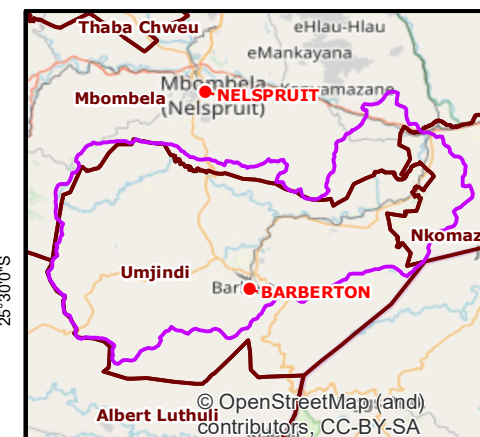
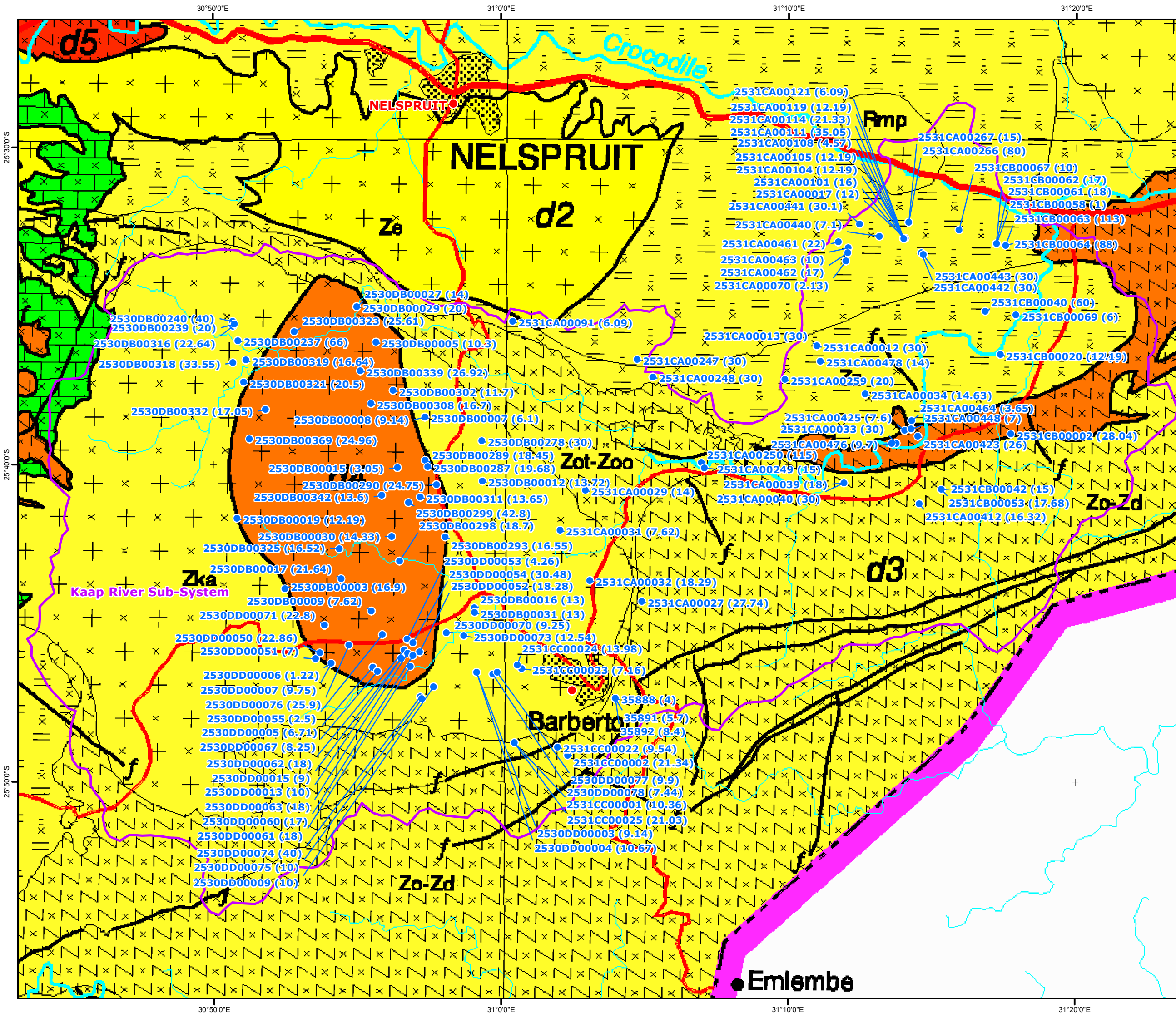
Aluminium – Malongwane BH02, CCA BH01 and Galaxy Mine BH03 has class 1, no effects on health are expected when consuming this water. The link between aluminium in water and adverse effects on human remains to be conclusively identified.

Iron – Malongwane BH01, Mandela, Town borehole 07 and CCA BH01 has class 3, pronounced aesthetic effects (taste) along with problems with plumbing. Slight health effects expected in young children, and sensitive individuals. Malongwane BH02, Shiyalengubo BH03, Town borehole 05, Umjindi Trust BH02 and Umjindi Trust BH03 has class 2, adverse aesthetic effects (taste) gradually increase as do possible problems with plumbing. No health effects

Manganese – Malongwane BH01, Shiyalengubo BH03 and CCA BH01 has class 1. Increasingly severe staining and taste problems. No health effects.

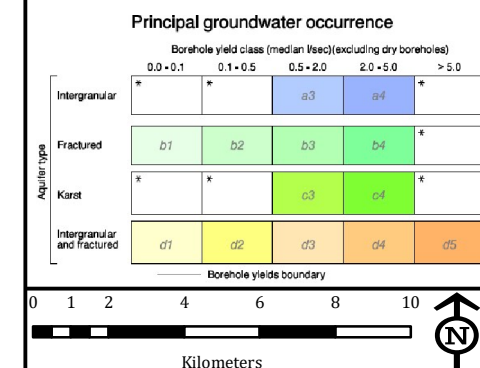
3.3.3 Water Level Measurements

The possibility of water level measurements was restricted by the fact that many fitted equipment on boreholes did not allow for insertion of water level measuring equipment (dipmeter). Water level was measured at three boreholes; Malongwane BH01 which had water level of 6.91 mbgl, Malongwane BH02 which had water level of 5.24 mbgl and Mandela borehole which had water level of 8.92 mbgl. All these three boreholes are situated in one village and situated in the D3 intergranular and fractured aquifer type.



LEGEND

- Towns
- Grip Boreholes (Water Level)
- Crocodile_Sub_Systems



REFERENCE: Transverse Mercator (Gauss-Kruger)
WGS84 Ellipsoid
Hartebeesthoek 94 Datum
Central Meridian 31°

PROJECT:
IUCMA HYDROGEOLOGICAL SERVICES

TITLE:
WATER LEVEL MAP OF
KAAP RIVER SUB SYSTEM

PROJECT No.	KIM-WAT-2019-58	
SCALE	1:200 000	A3
GIS	CSG	05/12/2019
CHECK	KH	05/12/2019
REVIEW	CM	05/12/2019

3.3.4 Conditions of the Boreholes

The sampling points for groundwater are generally hard to access due to overgrown vegetation and lack of proper pathways for accessibility. Some boreholes identified as sampling points were fitted with equipment, therefore water level could not be measured from such boreholes. Some sampling points could not be access due to access restriction, i.e. boreholes pumphouse locked by owners. Most of the boreholes were equipped with submersible pumps powered by solar panels or electrical transformers. Due to vandalism, the pumps, solar panels and electrical transformer were missing from most boreholes, see Table 7. Two boreholes were blocked by rocks inserted in the borehole.

Table 7: Summarised table of the condition of the boreholes

Borehole ID	latitude	longitude	Date	Equipment (Yes/No)	Equipment Type	Water level (mbgl)	Sampled (Yes/No)	BH Need Rehabilitation (Yes/No)	Site Description
Noordkaap BH01	-25.67161	31.08217	12-11-1019	Yes	Submersible pump		No	No	Borehole, pumphouse and 5000 l JoJo tank
Noordkaap BH02	-25.66483	31.08003	12-11-1029	Yes	Submersible pump		No	Yes	Borehole, pumphouse not in use, pump missing
Malongwane BH01	-25.64753	31.05433	12-11-2019	No		6.91	Yes	Yes	Borehole need to be equipped
Malongwane BH02	-25.65139	31.05484	12-11-2019	Yes	Submersible pump	5.24	Yes	Yes	Borehole need to be equipped
Mandela	-25.649	31.04615	12-11-2019	Yes	Submersible pump	8.92	Yes	Yes	Pump missing
Shiba mine BH01	-25.69262	31.17334	12-11-2019	Yes	Merry-go-round pump		Yes	No	Merry go-round play pump for a child centre.
Gangaza BH02	-25.70024	31.2166	12-11-2019	Yes	Submersible pump		Yes	No	Borehole sampled at the JoJo tank
Gangaza BH01	-25.69122	31.22031	12-11-2019	Yes	Submersible pump		No	Yes	Pump missing, rocks in the borehole, blocked at 11.9 m
Shiyalengubo BH01	-25.75302	31.26967	12-11-2019	Yes	Submersible pump		No	Yes	Borehole not connected to the transformer (electricity)
Shiyalengubo BH02	-25.75262	31.26171	12-11-2019	Yes	Submersible pump		No	Yes	Borehole not connected to the transformer (electricity)
Shiyalengubo BH03	-25.75215	31.25614	12-11-2019	Yes	Submersible pump		Yes	Yes	Pump missing
Dicksie Farm BH02	-25.71326	31.05223	12-11-2019	Yes	Submersible pump		No	Yes	Pump disconnected
Dicksie Farm BH01	-25.71216	31.04733	12-11-2019	Yes	Submersible pump		No	Yes	Pump disconnected
Dicksie Farm BH03	-25.70708	31.05818	12-11-2019	Yes	Submersible pump		No	Yes	Pump and solar panels missing
Town BH01	-25.78274	31.0536	13-11-2109	Yes	Mono pump		No	No	Borehole in use
Esparado	-25.78274	31.0536	13-11-2109	Yes	Mono Pump		No	Yes	Pump missing
Town BH02	-25.78602	31.04961	13-11-2019	Yes	Submersible pump		No	Yes	wires missing from the pump
Town BH03	-25.777679	31.03484	13-11-2019	No			No	Yes	BH blocked by rocks, not sure if the borehole had equipment
Town BH07	-25.77758	31.03383	13-11-2019	Yes	Submersible pump		Yes	Yes	Pump taken out
Town BH04	-25.77658	31.02384	13-11-2019	Yes	Submersible pump		No	Yes	Wires missing from the pump
Town BH05	-25.77385	31.01086	13-11-2019	Yes	Submersible pump		Yes	Yes	Pump is missing
Town BH06	-25.76336	31.02735	13-11-2019	Yes	Submersible pump		No	Yes	Pump storage case is locked
Kamadakwa	-25.81133	30.96294	13-11-2019	Yes	Submersible pump		No	Yes	Burned cables
Umjindi Trust BH02	-25.78921	30.93116	13-11-2019	Yes	Hand pump		Yes	Yes	Low yield borehole
Umjindi Trust BH01	-25.78755	30.92912	13-11-2019	Yes	Submersible pump		No	No	Borehole in use
Umjindi Trust BH03	-25.80351	30.93688	13-11-2019	Yes	Hand pump		Yes	Yes	Low yield borehole

Hydrocensus report for the Kaap River Sub-system in the Crocodile Catchment – Final Report

Borehole ID	latitude	longitude	Date	Equipment (Yes/No)	Equipment Type	Water level (mbgl)	Sampled (Yes/No)	BH Need Rehabilitation (Yes/No)	Site Description
Hangstone BH01	-25.74946	30.92028	13-11-2019	Yes	Submersible pump		No	Yes	Pump not working
HSBH01	-25.74069	30.92022	13-11-2019	Yes	Submersible pump		No	No	Borehole used for domestic use and livestock watering
JUBH01	-25.74993	31.02957	13-11-2019	Yes	Submersible pump		Yes	No	Borehole used for agricultural purposes
Boulders Clinic BH01	-25.55316	31.30749	14-11-2019	Yes	Submersible pump		Yes	No	Borehole used at the clinic
Nkwali farm BH01	-25.55073	31.27176	14-11-2019	No			No	Yes	Pump missing
Nkwali farm BH02	-25.55194	31.27068	14-11-2019	Yes	Submersible pump		Yes	No	Borehole used for agricultural purposes
Nkwali farm BH03	-25.55272	31.25736	14-11-2019	Yes	Submersible pump		Yes	No	Borehole used for agricultural purposes
Daarbo BH01	-25.54904	31.24595	14-11-2019	Yes	Submersible pump		Yes	No	Used for agricultural purposes
Stonehaven farm BH01	-25.54844	31.19822	14-11-2019	Yes	Submersible pump		No	Yes	Electrical transformer missing
Tonetti farm BH01	-25.5883	31.31776	14-11-2019	Yes	Submersible pump		Yes	No	Borehole used for agricultural purposes
UIBH01	-25.61775	31.30229	14-11-2019	Yes	Submersible pump		No	Yes	Borehole blocked, pump missing
UIBH02	-25.61219	31.30614	14-11-2019	Yes	Submersible pump		No	Not sure if the borehole is used	Pumphouse locked
CCA BH01	-25.62234	31.30635	14-11-2019	Yes	Submersible pump		Yes	Yes	Borehole used as backup water
Old Loueville clinic BH01	-25.68634	31.29468	14-11-2019	Yes	Submersible pump		No	Yes	Pump not working
Louville School BH01	-25.67368	31.28863	14-11-2019	Yes	Submersible pump		No	Yes	Pump not working
Galaxy Gold mine BH01	-25.81706	30.99071	15-11-2019	No			No	Yes	mine borehole used for monitoring
Galaxy Gold mine BH02	-25.81553	30.99429	15-11-2019	No			No	Yes	mine borehole used for monitoring
Galaxy Gold mine BH03	-25.8096	30.99406	15-11-2019	No			Yes	Yes	mine borehole used for monitoring
Galaxy Gold mine Bh04	-25.80782	30.99389	15-11-2019	No			No	Yes	mine borehole used for monitoring
Umjindi Trust BH04	-25.80321	30.91828	15-11-2019	Yes	Submersible pump		No	Yes	Electrical transformer missing
Umjindi Trust BH05	-25.80461	30.93116	15-11-2019	Yes	Hand pump		Yes	Yes	Low yield borehole
Umjindi Trust School BH06	-25.79254	30.93183	15-11-2019	Yes	Merry-go-round pump		No	No	Borehole used at school
Macadaum farm BH01	-25.57769	30.84175	15-11-2019	Yes	Submersible pump		Yes	No	Borehole used for agricultural purposes
Matumani farm BH01	-25.60212	30.83126	15-11-2019	Yes	Submersible pump		Yes	No	Borehole used for agricultural purposes
Kahiya farm BH01	-25.65529	30.92684	15-11-2019	Yes	Submersible pump		No	Yes	missing pump and solar panels
Kahiya farm BH02	-25.6609	30.92995	15-11-2019	Yes	Submersible pump		No	Yes	Wires cut/disconnected

4 CHALLENGES

- a) Farmers refusal to grant permission to go on their land/property;
- b) Locked pumphouses;
- c) Locked monitoring boreholes; and
- d) When School are closed, school boreholes are not accessible.

5 CONCLUSIONS

Based on the desktop study, field investigations and interpretation of data, the following conclusions are made:

- a) Most of the boreholes data obtained from the NGA during desktop had water levels information. The minimum water level recorded was 1 mbgl and the maximum recorded water level was 115 mbgl and the data had an average of 19.37 mbgl;
- b) Fifty-two (52) boreholes were identified during field investigation (hydrocensus) and water was sampled from twenty-one (21) boreholes;
- c) Fifteen (15) of the boreholes identified during hydrocensus were not documented on the NGA database;
- d) From the 21 borehole sampled, the hydrochemical results were compared to the SANS 241:2015 water standards limits and 10 (Shiba Mine BH01, Gangaza BH02, Umjindi Trust BH03, JUBH01, Boulder Clinic BH01, Nkwali farm BH02, Nkwali farm BH03, Daarbo BH01, Umjindi BH05, Macadaum farm BH01 and Matumani farm BH01) of the sampled boreholes were found to have all chemical parameters within the set SANS 241:2015 limits;
- e) Malongwane BH01, Mandela, Town BH07 and CCA BH01 returned elevated iron (as Fe) concentrations that are classified as class 3 according to DWS water quality classification, this can result with slight health effects in young children, and sensitive individuals if continually consumed; and
- f) Due to limited accessible in most boreholes that were equipped, water levels could only be measured from 3 of the 52 boreholes verified boreholes.

6 RECOMMENDATIONS

The following recommendations from the hydrocensus are made:

- a) Arrange with farmers' association to inform farmers about the hydrogeological study in the catchment;
- b) Additional hydrocensus is required to expand the spatial understanding of the water quality in the sub-catchment;
- c) Additional hydrocensus is essential to get a clear picture of water levels in the sub-catchment.

7 REFERENCES

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APPENDIX A: Laboratory Results



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CERTIFICATE OF ANALYSES

GENERAL WATER QUALITY PARAMETERS

Date received: 2019-11-20	Report number: 88252	Date completed: 2019-12-05
Project number: 1000		Order number: KIM-WAT-2019-58
Client name: Kimopax (Pty) Ltd	Contact person: Mr. C. Monokafala	
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Analyses in mg/ℓ (Unless specified otherwise)			Method Identification	Sample Identification: Kaap River Sub-System			
				Malongwane BH01	Malongwane BH02	Mandela	Shiba Mine BH01
Sample Number		081837		081838	081839	081840	
Date/Time Sampled		N/A		N/A	N/A	N/A	
pH - Value @ 25 °C	A	WLAB065	8.0	8.3	7.7	8.1	
Electrical Conductivity in mS/m @ 25°C	A	WLAB002	152	89.3	120	36.7	
Total Dissolved Solids @ 180°C	A	WLAB003	1194	602	716	264	
Total Alkalinity as CaCO₃	A	WLAB007	348	464	644	140	
Total Hardness as CaCO₃	A	WLAB051	870	135	683	150	
Chloride as Cl	A	WLAB046	53	16	28	9	
Sulphate as SO₄	A	WLAB046	557	6	47	34	
Fluoride as F	A	WLAB014	≤0.2	0.2	≤0.2	≤0.2	
Nitrate as N	A	WLAB046	0.1	0.2	0.4	0.2	
Nitrite as N	A	WLAB046	≤0.05	0.08	0.2	≤0.05	
Free and Saline Ammonia as N	A	WLAB046	0.1	12	0.1	≤0.1	
Sodium as Na	A	WLAB015	37	132	21	11	
Potassium as K	A	WLAB015	1.4	16.7	0.8	3.4	
Calcium as Ca	A	WLAB015	35	11	21	24	
Magnesium as Mg	A	WLAB015	191	26	153	22	
Aluminium as Al	A	WLAB015	≤0.100	0.287	≤0.100	≤0.100	
Arsenic as As	A	WLAB050	0.002	0.017	0.002	≤0.001	
Cadmium as Cd	A	WLAB050	≤0.001	≤0.001	≤0.001	≤0.001	
Hexavalent Chromium as Cr	A	WLAB032	≤0.010	≤0.010	≤0.010	≤0.010	
Cobalt as Co	A	WLAB015	≤0.025	≤0.025	≤0.025	≤0.025	
Copper as Cu	A	WLAB015	≤0.010	≤0.010	≤0.010	≤0.010	
Iron as Fe	A	WLAB015	5.01	1.05	6.47	0.607	
Lead as Pb	A	WLAB050	≤0.001	≤0.001	≤0.001	≤0.001	
Manganese as Mn	A	WLAB015	0.212	0.054	0.057	≤0.025	
Mercury as Hg	A	WLAB047	0.002	0.001	0.001	0.001	
Nickel as Ni	A	WLAB015	≤0.025	≤0.025	≤0.025	≤0.025	
Zinc as Zn	A	WLAB015	0.044	≤0.025	0.053	0.414	
% Balancing	N	---	97.6	99.2	99.7	97.3	

E. Nkabinde - Chemical Technical Signatory

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Analyses in mg/l (Unless specified otherwise)	Method Identification	Sample Identification: Kaap River Sub-System			
		Gangaza BH02	Shiyalengubo BH03	Town Borehole 07	Town Borehole 05
Sample Number		081841	081842	081843	081844
Date/Time Sampled		N/A	N/A	N/A	N/A
pH - Value @ 25 °C	A	7.6	6.7	7.7	7.4
Electrical Conductivity in mS/m @ 25°C	A	37.0	5.2	35.5	50.4
Total Dissolved Solids @ 180°C	A	266	52	232	340
Total Alkalinity as CaCO ₃	A	180	20	140	204
Total Hardness as CaCO ₃	A	145	18	120	191
Chloride as Cl	A	12	3	16	17
Sulphate as SO ₄	A	3	<2	24	29
Fluoride as F	A	<0.2	<0.2	0.3	0.4
Nitrate as N	A	0.2	0.2	0.8	4.9
Nitrite as N	A	<0.05	<0.05	0.2	0.2
Free and Saline Ammonia as N	A	<0.1	0.2	1.9	0.2
Sodium as Na	A	20	3	22	33
Potassium as K	A	1.4	1.0	1.2	2.3
Calcium as Ca	A	18	2	20	31
Magnesium as Mg	A	24	3	17	27
Aluminium as Al	A	<0.100	<0.100	<0.100	<0.100
Arsenic as As	A	<0.001	<0.001	<0.001	<0.001
Cadmium as Cd	A	<0.001	<0.001	<0.001	<0.001
Hexavalent Chromium as Cr	A	<0.010	<0.010	<0.010	<0.010
Cobalt as Co	A	<0.025	<0.025	<0.025	<0.025
Copper as Cu	A	<0.010	<0.010	<0.010	<0.010
Iron as Fe	A	0.074	3.56	7.34	2.58
Lead as Pb	A	<0.001	<0.001	<0.001	<0.001
Manganese as Mn	A	<0.025	0.313	0.059	0.025
Mercury as Hg	A	<0.001	0.002	0.003	0.002
Nickel as Ni	A	<0.025	<0.025	<0.025	<0.025
Zinc as Zn	A	<0.025	<0.025	<0.025	<0.025
% Balancing	N	97.1	98.4	95.9	97.6

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Analyses in mg/ℓ (Unless specified otherwise)		Method Identification	Sample Identification: Kaap River Sub-System			
			Umjinidi Trust BH02	Umjinidi Trust BH03	JUBH01	Boulder Clinic BH01
Sample Number			081845	081846	081847	081848
Date/Time Sampled			N/A	N/A	N/A	N/A
pH - Value @ 25 °C	A	WLAB065	8.2	7.6	7.5	7.8
Electrical Conductivity in mS/m @ 25°C	A	WLAB002	26.8	53.0	55.7	103
Total Dissolved Solids @ 180°C	A	WLAB003	172	336	376	724
Total Alkalinity as CaCO ₃	A	WLAB007	128	284	240	404
Total Hardness as CaCO ₃	A	WLAB051	98	251	219	204
Chloride as Cl	A	WLAB046	11	7	12	43
Sulphate as SO ₄	A	WLAB046	<2	<2	25	68
Fluoride as F	A	WLAB014	0.2	0.3	0.6	0.8
Nitrate as N	A	WLAB046	<0.1	0.1	4.9	2.6
Nitrite as N	A	WLAB046	<0.05	<0.05	<0.05	<0.05
Free and Saline Ammonia as N	A	WLAB046	0.1	0.1	0.1	<0.1
Sodium as Na	A	WLAB015	17	19	35	152
Potassium as K	A	WLAB015	1.6	1.2	1.4	0.6
Calcium as Ca	A	WLAB015	14	49	39	42
Magnesium as Mg	A	WLAB015	16	31	30	24
Aluminium as Al	A	WLAB015	<0.100	<0.100	<0.100	<0.100
Arsenic as As	A	WLAB050	<0.001	<0.001	<0.001	0.008
Cadmium as Cd	A	WLAB050	<0.001	<0.001	<0.001	<0.001
Hexavalent Chromium as Cr	A	WLAB032	<0.010	<0.010	<0.010	<0.010
Cobalt as Co	A	WLAB015	<0.025	<0.025	<0.025	<0.025
Copper as Cu	A	WLAB015	<0.010	<0.010	<0.010	<0.010
Iron as Fe	A	WLAB015	2.98	1.03	<0.025	0.025
Lead as Pb	A	WLAB050	0.016	<0.001	<0.001	<0.001
Manganese as Mn	A	WLAB015	0.091	0.074	<0.025	<0.025
Mercury as Hg	A	WLAB047	0.001	<0.001	0.001	0.002
Nickel as Ni	A	WLAB015	<0.025	<0.025	<0.025	<0.025
Zinc as Zn	A	WLAB015	0.694	0.217	<0.025	0.029
% Balancing	N	---	98.6	99.7	99.5	98.9

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Analyses in mg/ℓ (Unless specified otherwise)		Method Identification	Sample Identification: Kaap River Sub-System			
			Nkwali Farm BH02	Nkwali Farm BH03	Daarbo BH01	Tonetti Farm BH01
Sample Number			081849	081850	081851	081852
Date/Time Sampled			N/A	N/A	N/A	N/A
pH - Value @ 25 °C	A	WLAB065	7.6	7.6	7.0	7.3
Electrical Conductivity in mS/m @ 25°C	A	WLAB002	66.5	44.7	44.3	83.6
Total Dissolved Solids @ 180°C	A	WLAB003	446	334	330	1808
Total Alkalinity as CaCO₃	A	WLAB007	264	200	120	312
Total Hardness as CaCO₃	A	WLAB051	207	119	132	219
Chloride as Cl	A	WLAB046	39	24	32	32
Sulphate as SO₄	A	WLAB046	26	9	35	81
Fluoride as F	A	WLAB014	0.8	0.6	0.8	1.3
Nitrate as N	A	WLAB046	0.1	0.2	4.5	0.8
Nitrite as N	A	WLAB046	<0.05	<0.05	<0.05	<0.05
Free and Saline Ammonia as N	A	WLAB046	0.1	<0.1	0.1	<0.1
Sodium as Na	A	WLAB015	63	47	36	95
Potassium as K	A	WLAB015	2.0	3.2	5.4	5.3
Calcium as Ca	A	WLAB015	52	28	18	40
Magnesium as Mg	A	WLAB015	19	12	21	29
Aluminium as Al	A	WLAB015	<0.100	<0.100	<0.100	<0.100
Arsenic as As	A	WLAB050	<0.001	<0.001	<0.001	0.001
Cadmium as Cd	A	WLAB050	<0.001	<0.001	<0.001	<0.001
Hexavalent Chromium as Cr	A	WLAB032	<0.010	<0.010	<0.010	<0.010
Cobalt as Co	A	WLAB015	<0.025	<0.025	<0.025	<0.025
Copper as Cu	A	WLAB015	<0.010	<0.010	<0.010	<0.010
Iron as Fe	A	WLAB015	<0.025	<0.025	<0.025	<0.025
Lead as Pb	A	WLAB050	<0.001	<0.001	<0.001	<0.001
Manganese as Mn	A	WLAB015	<0.025	<0.025	<0.025	<0.025
Mercury as Hg	A	WLAB047	0.002	0.001	0.002	0.008
Nickel as Ni	A	WLAB015	<0.025	<0.025	<0.025	<0.025
Zinc as Zn	A	WLAB015	<0.025	<0.025	<0.025	<0.025
% Balancing	N	---	99.9	95.8	99.4	98.3

E. Nkabinde - Chemical Technical Signatory

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**WATERLAB (Pty) Ltd**

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T0391

CERTIFICATE OF ANALYSES**GENERAL WATER QUALITY PARAMETERS**

Date received: 2019-11-20

Project number: 1000

Report number: 88252

Date completed: 2019-12-05

Order number: KIM-WAT-2019-58

Client name: Kimopax (Pty) Ltd

Address: P.O. Box 4077, Halfway House, Johannesburg, Gauteng 1685

Telephone: 011 312 9765

Facsimile: 011 312 9768

Contact person: Mr. C. Monokafala

e-mail: collen@kimopax.com

Mobile: 083 662 1787

Analyses in mg/ℓ (Unless specified otherwise)		Method Identification	Sample Identification: Kaap River Sub-System			
			CCA BH01	Galaxy Mine BH03	Umjindi Trust BH05	Macadaam Farm BH01
Sample Number			081853	081854	081855	081856
Date/Time Sampled			N/A	N/A	N/A	N/A
pH - Value @ 25 °C	A	WLAB065	7.7	7.1	7.8	7.9
Electrical Conductivity in mS/m @ 25°C	A	WLAB002	216	121	50.9	25.0
Total Dissolved Solids @ 180°C	A	WLAB003	1714	1028	350	196
Total Alkalinity as CaCO₃	A	WLAB007	720	272	224	120
Total Hardness as CaCO₃	A	WLAB051	260	683	223	97
Chloride as Cl	A	WLAB046	201	7	14	7
Sulphate as SO₄	A	WLAB046	39	573	24	14
Fluoride as F	A	WLAB014	2.6	<0.2	0.4	0.2
Nitrate as N	A	WLAB046	<0.1	0.6	2.2	0.8
Nitrite as N	A	WLAB046	0.2	<0.05	<0.05	<0.05
Free and Saline Ammonia as N	A	WLAB046	<0.1	<0.1	0.1	<0.1
Sodium as Na	A	WLAB015	398	22	20	13
Potassium as K	A	WLAB015	7.6	1.0	1.3	0.7
Calcium as Ca	A	WLAB015	39	71	48	22
Magnesium as Mg	A	WLAB015	39	123	25	11
Aluminium as Al	A	WLAB015	0.445	0.393	<0.100	<0.100
Arsenic as As	A	WLAB050	0.069	<0.001	0.001	<0.001
Cadmium as Cd	A	WLAB050	<0.001	<0.001	<0.001	<0.001
Hexavalent Chromium as Cr	A	WLAB032	133	<0.010	<0.010	<0.010
Cobalt as Co	A	WLAB015	0.056	<0.025	<0.025	<0.025
Copper as Cu	A	WLAB015	0.064	<0.010	<0.010	<0.010
Iron as Fe	A	WLAB015	10	1.56	0.612	<0.025
Lead as Pb	A	WLAB050	0.003	0.003	<0.001	<0.001
Manganese as Mn	A	WLAB015	0.209	<0.025	0.025	<0.025
Mercury as Hg	A	WLAB047	0.012	0.002	0.002	0.001
Nickel as Ni	A	WLAB015	<0.025	<0.025	<0.025	<0.025
Zinc as Zn	A	WLAB015	0.104	<0.025	1.25	<0.025
% Balancing	N	---	96.2	90.8	98.3	93.4

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CERTIFICATE OF ANALYSES**GENERAL WATER QUALITY PARAMETERS**

Date received: 2019-11-20

Project number: 1000

Report number: 88252

Date completed: 2019-12-05

Order number: KIM-WAT-2019-58

Client name: Kimopax (Pty) Ltd

Address: P.O. Box 4077, Halfway House, Johannesburg, Gauteng 1685

Telephone: 011 312 9765

Facsimile: 011 312 9768

Contact person: Mr. C. Monokafala

e-mail: collen@kimopax.com

Mobile: 083 662 1787

Analyses in mg/ℓ (Unless specified otherwise)		Method Identification	Sample Identification	
Sample Number Date/Time Sampled			Matamani Farming BH01	
			081857	
			N/A	
pH - Value @ 25 °C	A	WLAB065	7.7	
Electrical Conductivity in mS/m @ 25°C	A	WLAB002	14.7	
Total Dissolved Solids @ 180°C	A	WLAB003	184	
Total Alkalinity as CaCO ₃	A	WLAB007	44	
Total Hardness as CaCO ₃	A	WLAB051	42	
Chloride as Cl	A	WLAB046	11	
Sulphate as SO ₄	A	WLAB046	<2	
Fluoride as F	A	WLAB014	<0.2	
Nitrate as N	A	WLAB046	2.8	
Nitrite as N	A	WLAB046	<0.05	
Free and Saline Ammonia as N	A	WLAB046	<0.1	
Sodium as Na	A	WLAB015	11	
Potassium as K	A	WLAB015	1.0	
Calcium as Ca	A	WLAB015	8	
Magnesium as Mg	A	WLAB015	5	
Aluminium as Al	A	WLAB015	<0.100	
Arsenic as As	A	WLAB050	<0.001	
Cadmium as Cd	A	WLAB050	<0.001	
Hexavalent Chromium as Cr	A	WLAB032	<0.010	
Cobalt as Co	A	WLAB015	<0.025	
Copper as Cu	A	WLAB015	<0.010	
Iron as Fe	A	WLAB015	<0.025	
Lead as Pb	A	WLAB050	<0.001	
Manganese as Mn	A	WLAB015	<0.025	
Mercury as Hg	A	WLAB047	0.002	
Nickel as Ni	A	WLAB015	<0.025	
Zinc as Zn	A	WLAB015	<0.025	
% Balancing	N	---	97.3	

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APPENDIX B: Boreholes Photos.



Boulder Clinic BH01



CCA BH01



Daarbo BH01



Dicksie farm BH01



Dicksie farm BH02



Dicksie farm BH03



DSCN3176



Galaxy Mine BH01



Galaxy Mine BH02



Umjindi Trust BH06



Umjindi Trust BH05



Umjindi Trust BH04



Umjindi Trust BH04



Umjindi Trust BH03



Umjindi Trust BH02



Umjindi Trust BH01



Town BH05



Town BH06

A stylized map of South Africa is shown, split diagonally from the top-left to the bottom-right. The upper-left portion is dark grey, and the lower-right portion is light grey. The map is centered on the page, with contact information listed to its right.

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